DEPARTMENT OF THE INTERIOR.

REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY

OF

THE TERRITORIES.

F. V. HAYDEN,
UNITED STATES GEOLOGIST-IN-CHARGE.

VOLUME IX.

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LETTER TO THE SECRETARY.

OFFICE OF THE UNITED STATES GEOLOGICAL
SURVEY OF THE TERRITORIES,
Washington, D. C., June 1, 1876.

SIR: I have the honor to present, for your approval and for publication, the accompanying memoir on the "Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country" by F. B. Meek, and to commend it to the attention of the Department as one of the most important contributions ever made to the science of palæontology in any portion of the world.

To the geologist who may hereafter study the various groups of sedimentary strata over our widely-extended western domain, this volume will prove indispensable. The different divisions or groups of the Cretaceous and Tertiary ages, especially of the former, were originally established by the invertebrate remains herein described, and it therefore forms the basis of our knowledge of two of the most important formations in the West. As one of the series of volumes, in which are included those of Leidy, Cope, and Lesquereux, it forms a most valuable contribution toward the solution of one of the difficult problems in western geology, the relations of the Lignitic group to the well-defined Cretaceous immediately beneath it. The enormous labor which the author has expended on the discussion of the genera and species, together with the synonymy, will be apparent to the palæontologist at a glance.

The accumulation of the materials which compose this volume was commenced in the spring of 1854, and the greater number of the new species of fossils were discovered by the writer of this letter during that and the succeeding year. From 1856 to 1858, he was attached to the Exploring Expedition to the Northwest, as geologist, under the command of General G. K. Warren, United States Engineers; and in 1859 and 1860 he was

connected in a similar capacity with Col. W. F. Raynolds, United States Engineers, director of an expedition to the Lower Yellowstone, and during this time much additional material of value was obtained. The cordial thanks of the writer are due to these gentlemen for their most important aid and encouragement.

This memoir will soon be followed by the "Flora of the Lignitic Group" by Leo Lesquereux, containing sixty-five beautifully-engraved quarto plates.

Very respectfully, your obedient servant,

F. V. HAYDEN,
United States Geologist.

Hon. Z. CHANDLER,
Secretary of the Interior.

UNITED STATES GEOLOGICAL SURVEY OF THE TERRITORIES.

A REPORT

ON THE

INVERTEBRATE CRETACEOUS AND TERTIARY FOSSILS

OF THE

UPPER MISSOURI COUNTRY.

By F. B. MEEK.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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Page 56, seventh line from top, for "XII" read "VIII".
Page 62, fifth line from top, for "*mytilloides*" read "*mytiloides*".
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Page 165, seventeenth line from top, for "*Acathocardia*" read "*Acanthocardia*".
Page 260, third line from top, for "in condition" read "in a condition".
Page 324, eighteenth line from top, for "deferent" read "different".
Page 327, eighth line from top, for "*lævisucula*" read "*læviuscula*".
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Page 497, second line from top, for "*Obigyanus*" read "*Orbigyanus*".
Page 501, second line from bottom, for "phrogmaeone" read "phragmocone".
Page 533, ninth line from bottom, before "all the other forms" read "nearly".
Page 556, at end of sixteenth line from top, omit "existing", and read "existing" before "mollusks" at beginning of eighteenth line.
Page 566, fourteenth line from top, after "Fossils" omit "of N. Am."
Page 582, eleventh line from top, for "*Fulotoma*" read "*Tulotoma*".
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LETTER TO THE GEOLOGIST-IN-CHARGE.

SMITHSONIAN INSTITUTION,
Washington City, D. C.

SIR: The following is my final report on the Cretaceous and Tertiary fossils of the Upper Missouri country. It has been entirely rewritten since the original publication of the brief preliminary descriptions of the species in the Proceedings of the Academy of Natural Sciences at Philadelphia; and full description of the genera and subgenera, with their synonymy and references, and remarks on their geological and geographical ranges, have been added.

In this place, I desire to acknowledge my renewed obligations to Professor Henry for many favors and facilities at the Smithsonian Institution during the preparation of this report. For the use of rare and important works, not accessible at Washington, I am indebted to the kindness of Prof. James D. Dana and Prof. O. C. Marsh, of New Haven; also to the lamented Prof. Louis Agassiz, and, since his death, to his son, Prof. Alexander Agassiz, of Cambridge, for similar favors.

Without thereby intending to make any of the following gentlemen responsible for conclusions finally adopted, I wish to express my thanks to such naturalists and palæontologists as have from time to time given suggestions in regard to some doubtful points respecting the affinities of some of the fossils here described. In this connection should be mentioned the names of the late Dr. William Stimpson, Prof. Theo. Gill, and Wm. H. Dall, of Washington; Messrs. George W. Tryon, T. A. Conrad, and Wm. M. Gabb, of Philadelphia; Mr. W. G. Binney, of Burlington; Prof. Alpheus Hyatt, of Boston; and Mr. Thomas Bland, of New York.

I am likewise under especial obligations to Dr. A. C. Peale, of your survey, for preparing a full index, table of contents, list of illustrations, etc., for this report.

F. B. MEEK,
Palæontologist.

Dr. F. V. HAYDEN,
U. S. Geologist.

INTRODUCTORY REMARKS.

The fossils described and illustrated in this report are from the Cretaceous and Tertiary rocks of the Upper Missouri country, lying between the British possessions on the north, the north branch of Platte River on the south, the Missouri on the east, and the Rocky Mountains on the west. The original type-specimens were nearly all collected by Dr. Hayden during a two years' residence in this country on his own account, and subsequently while acting as geologist of Government exploring expeditions under the command of Lieut. (now Major) G. K. Warren; and later in charge of Capt. William F. Raynolds, both of the United States Topographical Engineers.*

Preliminary notices of nearly all of the new species were, from time to time, published by the writer, in connection with Dr. Hayden, in the Proceedings of the Academy of Natural Sciences at Philadelphia, chiefly between the years 1856 and 1862, along with remarks on the general geology of this region, including nearly all that is up to this time known on that subject.

Originally, it was intended that full descriptions of both the species and the genera of most of these fossils would be published with illustrations in Lieutenant Warren's final report on his explorations; but as no appropriation was made by Congress for the publication of such report including geological and palæontological results, it was arranged that this palæontology should be published by the Smithsonian Institution. Consequently, in accordance with this plan, descriptions of all of these collections from older formations than the Cretaceous were, in 1865, published by the Smithsonian Institution in the form of a quarto memoir of one hundred and twenty-eight pages, illustrated by five lithographed plates.

* A few of the specimens were collected by Lieut. John Mullan, of the Topographical Engineers, Lieutenant Balch, of the United States Ordnance, and others by several civilians; all of whom are duly credited in connection with the descriptions.

For a number of years after the issue of this memoir, the writer was so constantly pressed with palæontological investigations in connection with State geological surveys and General Government explorations of the Western Territories, that no time was left for the rather heavy task of writing out more extended descriptions of the species and genera of the much larger remaining collections of Upper Missouri fossils from the later formations.

The necessity, however, for the issue of this work became more and more manifest as the several government explorations, both of our own Western Territories and those of the Canadian Dominion in the adjacent portions of British America, were progressing. The engraving of the plates, however, being necessarily a work of time, it was urged by those most interested that it ought to be commenced without waiting for the entire completion of the text. About this time, it was also ascertained that the whole could be published at Government expense, under the direction of the Interior Department, in connection with Dr. Hayden's United States Geological Survey of the Territories. Consequently, in accordance with a long-established rule of the Smithsonian Institution not to publish any work that could be as well brought out by any other agency, Professor Henry assented to this arrangement, but expressed an entire willingness to publish it, should anything occur to prevent the proposed plan from being carried out.

This method of publishing the work in connection with Dr. Hayden's survey was considered all the more appropriate, because the fossils described and illustrated in it were, with few exceptions, collected by his own hands, and the survey under his direction is chiefly a geological work.

In conformity with this arrangement, the contract for lithographing and printing the plates was let out in 1872. As the lithography was slowly progressing, however, the author was still hard-pressed with work on Dr. Hayden's later collections, and those of other surveys, until, in May, 1873, he was suddenly prostrated by a dangerous attack of sickness, which rendered an entire suspension of work necessary during the following summer and autumn; and on the approach of cold weather the state of his health was still such that a sojourn in Florida through the winter and early spring months was considered necessary.* Many of the Upper Missouri type-speci-

* Never having been provided with an assistant, the author's labors have always necessarily been entirely suspended whenever his own health failed.

mens, however, were taken along, and such progress as a feeble state of health would permit, was made in writing out portions of the text.

Being compelled by the continued infirm condition of his health to pass the succeeding winters in Florida, and the sultry summer months out of the city, the author has necessarily had to complete the work away from many desired facilities. The difficulties, therefore, under which he has labored during the preparation of this report and its passage through the press, will, it is hoped, be a sufficient apology for its long delay, as well as for such imperfections as may catch the eye of the critical reader.

In regard to the progress of geological discoveries, and the nature and extent of the geological formations, in the remote country from which the collections here described were obtained, some preliminary remarks seem to be necessary here. These remarks will commence with the extensive marine series of undoubted Cretaceous age; after which the later Lignite formations of brackish- and fresh-water origin will be considered; and, finally, the still more modern Tertiary beds, mainly of fresh water origin, will be noticed.

CRETACEOUS FORMATION.

Commencing with the earliest explorers of the Upper Missouri, the first intimations of the existence of Cretaceous deposits there, seem to have been derived from specimens obtained by Lewis and Clarke during their expedition to the sources of the Missouri, and across to the Columbia, in 1804, 1805, and 1806. Subsequently, Nuttall, and later, Colonel Long, brought from this country a few Cretaceous fossils; and in 1832, the Prince of Neuwied discovered the remains of *Mosasaurus Missouriensis*, and other Cretaceous types, at the Great Bend, below Fort Pierre. None of these explorers, however, seem to have given attention to the structure and geographical extent of these Cretaceous rocks, or to the order of succession of their subdivisions.

In 1839, the geographer Nicollet ascended the Missouri to Fort Pierre, collecting on his way up, at the Great Bend and other localities, a number of Cretaceous Molluscan remains.* Although passing rather rapidly through the country, he formed a tolerably correct idea of the subdivisions of the Cretaceous rocks seen by him below Fort Pierre. He seems, however, not

*These collections were figured and described by Dr. Morton in the Journal of the Acad. Nat. Sci. Philad., VIII, 207, 1839.

to have noticed, as a separate subdivision, the Fort Benton group, and apparently subdivided the Niobrara beds into two formations; while the Dakota group he passed unnoticed, probably supposing it to be Carboniferous, and the Fox Hills group he apparently did not see.

In 1849, Dr. John Evans, one of Dr. Owen's assistants in the United States Geological Survey of portions of the Northwestern States and Territories; ascended the Missouri to Fort Pierre, and thence crossed the country to the Bad Lands, on White River, Nebraska, during which journey he not only collected many interesting vertebrate remains from the White River Tertiary beds, but also brought a number of Cretaceous invertebrate fossils from beneath the Tertiary rocks on Sage Creek and other localities. These Cretaceous fossils were figured and described by Dr. Owen in his final report in 1852.*

In 1853, the writer, assisted by Dr. Hayden, was sent by Professor Hall on an expedition to the Bad Lands, Nebraska, mainly for the purpose of procuring a collection of the Tertiary vertebrate remains so abundant there. This expedition brought a valuable collection of these Tertiary fossils; as well as many Cretaceous forms, from the upper beds of that series at Sage Creek, beneath the Tertiary: also, from a lower position at the Great Bend, and from some of the still older beds farther down the Missouri. While descending the Missouri from Fort Pierre to Bellevue, a trading-post, not far above the present site of Omaha, especial attention was given to the lithological characters, order of succession, characteristic fossils, etc., of the subdivision of the Cretaceous series, and full notes taken in relation to the same. The new Cretaceous fossils brought back by this expedition were published, with figures by Professor Hall and the writer, in the Memoirs of the American Academy of Arts and Sciences, at Boston, vol. v, in 1856. The following section of the Cretaceous rocks, made out from the notes of the writer, was also given in this paper, on page 405 of the same volume; the thickness of the various beds being merely given from estimates made of the exposures seen along the Missouri, and back along the line of travel from Fort Pierre to the Bad Lands:

* Report of the Geological Survey of Wisconsin, Iowa, and Minnesota, and incidentally of a portion of Nebraska Territory, made under instructions from the United States Treasury Department; by David Dale Owen. Philad., 1852.

Section of the members of the Cretaceous formation on the Missouri, and thence westward to the Mauvaises Terres.

Tertiary Formation.		Clays, sandstones, etc., etc., containing remains of Mammalia. The entire thickness of this formation in the Bad Lands is from	25 to 250 feet.
Cretaceous Formation.	5.	Arenaceous clays passing into argillo-calcareous sandstones	80 feet.
	4.	Plastic clays with calcareous concretions, containing numerous fossils. This is the principal fossiliferous bed of the Cretaceous formation on the Upper Missouri.	250 feet.
	3.	Calcareous marl containing *Ostrea congesta*, scales of fishes, etc	100 to 150 feet.
	2.	Clay containing a few fossils	80 feet.
	1.	Sandstone and clay	90 feet.

Buff-colored magnesian limestone of Carboniferous period.

This was the first-published section, so far as the writer is informed, showing all of the various members and their order of succession, of the marine undoubted Cretaceous series of the Upper Missouri, occupying the space between the well-marked Tertiary above and the Carboniferous below. As may be seen, it embraces the five groups recognized in all of the subsequently-published sections. Consequently, it may be regarded as the foundation, or frame-work, so to speak, of the latter, though the estimated thicknesses of the beds are now known to be below the maximum as developed at many localities. The great Brackish- and Fresh-water Lignite series, holding a position between the Tertiary beds of the Bad Lands and division No. 5 of this section, was not represented in it, because that formation nowhere occurs along the line traversed by us in 1853 between Fort Pierre and the Bad Lands, though it is well developed farther north.

In the somewhat numerous papers subsequently published in the joint names of Meek and Hayden, on the rocks and fossils of the Upper Missouri, this section was from time to time amplified by the addition of details, until finally, in our paper of December, 1861 (Proceed. Acad. Nat. Sci. Philad.), it assumed the following complete form, with local geographical names for the first time applied to the subdivisions:

*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. leuticularis, Scaphites Conradi, S. Nicolleti, Baculites grandis, Pyropsis Bairdi, Piestochilus Culbertsoni, Pyrifusus Newberryi, Anchura Americana, Pseudobuccinum Nebrascense, Mactra Warrenana, Cardium subquadratum,* and a great number of other mollusean 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 Maestricht 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 Erausi, Cucullæa Nebrascensis, Inoceramus Sageusis, 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 sublævus, 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.		

* When this was written, all of the Upper Missouri country was known under the general name Nebraska Territory; and the nomenclature of some of the fossils mentioned has been here changed.

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. pseudo-mytiloides, 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.	Eq. Lower or Gray Chalk and Upper Greensand of British Geologists (*Turonien* and *Cénomanien?* 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. tenuicostatus, I. latus?, I. fragilis, Ostrea congesta, Veniella Mortoni, Pholadomy papyracea, Ammonites Mullananus, Prionocyclus Woolgari, Mortoniceras Shoshonense, Scaphites Warreuanus, S. larvæformis, S. ventricosus, S. vermiformis, Nautilus elegans*, etc.	Extensively developed near Fort Benton on the Upper Missouri; also along the latter, from ten 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 arcuarca, 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.	

Although the foregoing section has been frequently published in papers and reports issued at various dates since its first appearance, its introduction here seems necessary, in order that the student, in using this report, may have the means of understanding the relative positions of the beds from which the fossils hereinafter described were collected, without having to refer to other publications. The following remarks on each of these subdivisions, commencing with the oldest, will also explain more fully the nature and geographical extension of each.

THE SUBDIVISIONS OF THE UPPER MISSOURI UNDOUBTED CRETACEOUS SERIES AND THEIR GEOGRAPHICAL EXTENSION WEST OF THE MISSISSIPPI INDIVIDUALLY CONSIDERED.

DAKOTA GROUP.—This subdivision, at its typical localities on the Missouri, in the region of the mouth of Big Sioux River, in Eastern Nebraska and Northwestern Iowa, consists mainly of yellowish and brown sandstones, in rather thick beds, interstratified, however, at places, with yellowish clays and some impure lignite. Above the mouth of Big Sioux River, and some little distance up that stream, it is seen to pass under the Fort Benton group, owing to the general northwesterly dip of the whole series here; while, below the mouth of Big Sioux River, it occurs, at a few places, resting on limestones belonging to the upper part of the true Coal-Measures. From this region its outcrops are seen at intervals, extending in a southwestward direction through Eastern Nebraska and Kansas; and Dr. Newberry has traced it, by its characteristic leaves, from the Arkansas River, through the Indian Territory, far into New Mexico, where it was found by him overlaid by a great thickness of later Cretaceous deposits.* Dr. Shumard also identified with it a leaf-bearing bed at the base of the Cretaceous of Texas.† Mr. Holmes and Dr. Peale found a rock agreeing with this at the base of the Cretaceous of Western Colorado; and, along the eastern base of the Rocky Mountains, Dr. Hayden has observed a similar deposit holding the same relative position, at various places, from New Mexico to the Black Hills; though none of the characteristic fossils of this formation were discovered by him at any of these last-mentioned localities.

At the typical localities along the Missouri, already mentioned, the only animal remains yet discovered in this rock are a *Pharella*, a *Cyrena*, a *Mactra*, a *Trigonarca*, and a large bivalve, believed to belong to the genus *Margaritana* (see plate 1), a group of types indicating that the beds were deposited in salt-water, along a shore, near or at the mouth of a stream. In Kansas, however, Professor Mudge discovered in this formation numerous casts and moulds of strictly marine shells, including the Cretaceous genus *Leptosolen*,

* See Am. Jour. Sci. (2d ser.), XXIX, 208, March, 1860.

† See Trans. St. Louis Acad., I, 582. Dr. S., however, described from this bed several fossils that indicate a blending there of the Dakota and Fort Benton groups. For instance, his *Inoceramus capulus* is very closely allied to our *I. umbonatus* from the Fort Benton group; and his *Ammonites Graysonensis* may be only a young example of *Prionocylus Woolgari*, Mantell (sp.) (= *Ammonites percarinatus*, H. & M.), from the same. Again, his *Scaphites vermiculus* is also allied to the Fort Benton species *S. larvæformis*.

with a few that may possibly be brackish-water types, all belonging to distinct species from those found in this rock on the Missouri. The identity of these beds at the two localities mentioned, however, is shown by the occurrence in them, in both districts, of some of the same species of fossil leaves mentioned farther on, as well as by many intermediate outcrops. The fossils from this rock are figured on our plates 1 and 2.

Although this formation was, as already shown, from the first included by us in the Cretaceous, this conclusion was for a long time disputed; Professor Marcou having at one time referred it to the Trias, and later to the Jurassic, in which former opinion some American writers were inclined to concur.

In 1858, Dr. Hayden discovered in these beds on the Missouri numerous well-preserved impressions of leaves of the higher types of dicotyledonous trees, such as *Liriodendron*, *Populus*, *Platanus*, *Sassafras*, etc.; and, although neither of us had ever given much attention to the study of fossil botany, a very limited knowledge of that subject was sufficient to convince any one that a rock containing the remains of such a flora, according to all experience, could not be as old as Jurassic; while its position beneath well-marked Cretaceous strata, in an undisturbed district, was even more conclusive evidence that it could not be Tertiary. In order, however, to remove all doubts on these points from the minds of others, sketches of some of these leaves were drawn by the writer, and sent to Professor Heer, of Zürich, well known as an eminent authority on botanical palæontology. Much to our surprise, however, a communication some time after received from him informed us that he thought, from the affinities of these leaves, that they were of Miocene age; which opinion was also expressed by him in a printed paper sent at the same time. Professor Marcou, who was at the time at Zürich, likewise published a paper adopting Professor Heer's opinion, and stating that he believed that our Cretaceous division No. 1 included all sorts of formations *excepting* Cretaceous.

Before receiving Professor Heer's reply, however, we had submitted the specimens of these leaves to Prof. J. S. Newberry, and he had fully concurred with us in the opinion that the beds from which they came are of Cretaceous age.

For a long time, however, our conclusions on this point were questioned, particularly in Europe, where Professor Heer's opinion naturally carries much weight. Nevertheless, when, some years after, Professor Marcou and Pro-

fessor Capellini visited together the localities on the Missouri River where these leaves were found in this rock, they were both entirely convinced, as they have since stated in separate papers, that it is clearly Cretaceous, as we had from the first maintained, and as is now admitted by all.* (See Bull. Soc. Géol. Français (2e sér.), XXII, 1864; and Mém. Soc. Helvétique, Sci. Nat., 1866.)

Professor Mudge and others collected some of these same plants, and a number of other species, from this rock in Eastern Kansas, all of which have been studied and described by Professor Lesquereux, who, although at one time inclined to sustain Professor Heer's opinion that they belonged to the Tertiary epoch, now admits that they are Cretaceous species.

Fort Benton group.—Respecting this and the three succeeding divisions of the section above belonging to the Cretaceous, there have never been any differences of opinion. As usually developed, this rock is composed of dark-gray laminated clays or shale, with, at places, thin seams of lignite. Among its characteristic fossils may be mentioned *Ostrea congesta*, *Inoceramus problematicus*, *Prionocyclus Woolgari* (= *Ammonites Woolgari*, Mantell), *Scaphites Warrenanus*, scales and other fragments of cycloid fishes, etc.† On the Missouri, between the mouths of Big Sioux and James Rivers, it was first observed, and at some localities there it is seen resting upon the Dakota group already described. Here it seems not to attain a thickness of more than ninety to one hundred feet; but at some localities in the Rocky Mountain region it is much thicker. From the incoherent nature of this rock in Eastern Nebraska and the adjacent country, it does not usually form perpendicular outcrops, and consequently is rarely so well exposed as the rock immediately above and that below it.

This group, or subdivision, has a wide geographical range in portions of some of the States and Territories west of about the longitude of Eastern Nebraska. It is also known to occur, overlaid by heavy deposits of drift and

* At a still later date, after all the facts in relation to this formation and the different opinions in regard to its age had been for some time published, we were naturally somewhat surprised to see Professor Marcou credited, in an address by the president of a European scientific society on the progress of geological investigations, with having made the remarkable and interesting discovery of a Tertiary flora beneath well-marked Cretaceous strata in Nebraska. This was, however, undoubtedly a mere oversight by the distinguished author of the address; and it is also due to Professor Marcou to state here that he did not himself claim it as an original discovery of his own.

† Professor Cope has described the following fishes and reptile from this rock, viz: *Lamna? cuspidata*, a shakr; *Pelecorapis varius*, related to the flying fishes; *Apsopelix sauriformis*, supposed to be related to the last; and a Crocodilian that he has called *Hyposaurus Vebbii*.

resting on granite, as far eastward as Sauk Valley, Minnesota, from which locality a few of its characteristic fossils were, some years back, sent to the writer by Mr. I. H. Kloos.* Here it presents its usual lithological characters, and also contains a few thin seams of impure lignite.

From the localities mentioned, along the Missouri near and above the mouth of Big Sioux River, outcrops of this rock range in a south and southwesterly direction through Eastern Nebraska and Kansas into the Indian Territory; and it apparently also occurs in Arkansas. For the reasons already mentioned, however, it is not generally well exposed, only a slope being, in most cases, observed at its horizon. Dr. Newberry and others have brought some of its characteristic fossils from New Mexico, and Mr. Holmes from Southwestern Colorado, where it is said to contain some valuable beds of lignite. Dr. Shumard also identified it in Texas. At these southern localities, as well as in Wyoming, this formation is more arenaceous than farther northward and eastward.

Dr. Hayden has likewise brought fossils from this rock at various localities along the eastern base of the Rocky Mountains, northward to the Black Hills, and again from far up the Missouri near Fort Benton, where it is extensively developed and more than usually fossiliferous, from which facts it has been named the Fort Benton group. In this region, it is supposed to attain a maximum thickness of from six to eight hundred feet.

The highest northern point from which we have had any indications of the existence of this rock is on the north branch of the Saskatchewan, about thirty miles west of Fort À la Corne, near the 54° of north latitude, where Professor Hind discovered fossils that were referred by the writer to this horizon.† Prof. S. J. Dawson also discovered others at a locality two hundred and fifty miles west of Fort Garry, on the Assiniboine, British America, that were likewise referred in the same way to this formation.‡

Some of the fossils of this rock were likewise brought by Dr. Hayden's party from Cinnabar Mountain, Yellowstone Valley, Montana. (See Hayden's Sixth Report U. S. Geol. Survey of the Territories, page 475, 1873.)

On the Union Pacific Railroad in Wyoming Territory, five miles east of

* See Am. Jour. Sci. and Arts, 1872, p. 17.

† See Professor Hind's Report on the Saskatchewan and Assiniboine Exploring Expedition, 179. Toronto, 1859.

‡Professor Dawson's Report on Explorations of the Country between Lake Superior and the Red River Settlements, 18. Toronto, 1859.

Fort Steele, and at other localities in that region, some of the fossils characteristic of this formation, such as *Inoceramus problematicus*, *Scaphites Warrenanus*, &c., occur in arenaceous beds. Farther westward, at Aspen station on the railroad, at an elevation of about eight thousand feet above tide, there is also an extensive series of hard, whitish and bluish, thinly-laminated, argillaceous rock, three hundred to four hundred feet in thickness, containing scales and detached bones of fishes, fragments of *Ammonites*, etc., that probably belongs to this division of the Upper Missouri section. The Cretaceous sandstone connected with a workable bed of coal, and containing numerous casts of *Inoceramus problematicus*, at the old Bear River mine, Wyoming, likewise appears to belong to the horizon of this division; as is also probably the case with the dark clay or shale above the lower main coal-bed mined at Coalville, Utah. Professor Marsh also brought a few fossils from Brush Creek, Utah, indicating the presence of this or the succeeding division, or perhaps both, at that locality, overlying or including coal. The species from this group are figured on plates 3 to 8, inclusive.

So far as yet known, the facts seem to indicate that this rock, like the others, both in the north and in the south, thins out in an easterly direction, its greatest thickness being in the region of Fort Benton, about eight hundred feet; while along the Missouri in Nebraska, below the Great Bend, it probably does not attain a thickness of more than one hundred feet. In New Mexico, it is probably at least as thick as at any place in the Upper Missouri; yet, in Texas, Dr. Shumard estimated its thickness at not more than fifty feet.

Niobrara group.—This third member of the section in the ascending order is well developed along the Missouri for some distance below the Great Bend, near which it is first seen in coming down the river to rise from beneath the Fort Pierre group. Farther down, it continues to rise with the other members of the series higher and higher, until, in the region of Niobrara River, it forms perpendicular escarpments, sometimes from ninety to one hundred feet in height. Below this, it is seen resting directly on the Fort Benton group; and on the higher country both of these divisions continue on to near the mouth of Big Sioux River, and on the west side of the river far beyond, the Fort Benton group being here seen to lap upon the Dakota group. The dip of all the rocks here being in a west-northwesterly direction, each member of the section can be clearly seen to pass beneath the next suc-

ceeding one above, as we ascend the Missouri, from the outcrops of the Dakota group near the mouth of Big Sioux River.

As developed along the Missouri at the typical localities, this group or division is a heavy-bedded pure chalk-marl, being almost entirely composed of calcareous matter, not generally harder or more compact than chalk. In fresh exposures, it presents a bluish or lead-gray color; but, when weathered, it becomes whitish or ash-colored, or often tinged with yellow. Some of the lower beds, however, at places pass into a whitish or light-gray limestone, easily splitting into irregular thin pieces. In the district mentioned along the Missouri, the maximum thickness of this division has been roughly estimated at about two hundred feet.

The most common fossils of this group here are *Ostrea congesta*, *Inoceramus problematicus*, fragments of a small compressed Baculite, and large scales of cycloid fishes. The little oyster is quite abundant at places, and nearly always found attached to pieces of the outer fibrous layer of a large *Inoceramus*, probably belonging to the species figured by the writer in Mr. King's report, under the name *I. deformis*. The specimens of *Inoceramus problematicus* are usually most abundant in the harder layers that sometimes assume the character of a whitish limestone, in which the much more rarely seen little Baculite also occurs. The fossils from this group are illustrated on our plate 9.

Although these most common fossils also occur in the Fort Benton group below, the latter rock contains a number of molluscan remains and several species of fishes and some Saurians, not known to ascend into the group under consideration. Again, the Niobrara group contains the remains of several species of birds, first made known by Professor Marsh, others of *Pterodactylus*, and other vertebrates described by Professor Marsh and Professor Cope, that are not yet known in the Fort Benton group. Professor Cope has identified from the Niobrara group *Ptychodus Mortoni* and *P. polygyrus*, Agassiz, which are also said to occur in Alabama.

It is worthy of remark that the pearlaceous inner layer of the shells of *Inoceramus* (and of other types provided with this layer) seems never to be preserved in this formation, and rarely in the next below, only the outer fibrous portion being present; while shells of other kinds, excepting those belonging to the *Ostreidæ*, are, in nearly all cases, found only represented by casts. In this respect, the fossils from these lower beds contrast strongly with those from the later Cretaceous deposits of these western districts.

From the localities mentioned along the Missouri, outcrops of this formation are seen, like those of the last, ranging in a southwesterly direction through Eastern Nebraska and Kansas. In the latter State, it occupies a broad belt of country, perhaps widest on the Smoky Hill River, where it attains the breadth, in an east and west direction, of about two hundred and fifty miles, passing on the west under later formations, probably of Tertiary age. It also extends through the Indian Territory into New Mexico, and occurs in Texas and Arkansas.* Indeed, it and the Fort Benton group seem to be the principal fossiliferous beds of the Cretaceous in these southern districts. As shown by Dr. Hayden and the writer in 1857, it and the Fort Benton group almost certainly form the upper forty feet of the Pyramid Mountain, an outlier of an extensive plateau in New Mexico, known as the Llano Estacado, the lower part of which mountain probably also corresponds wholly or in part to our Dakota group.

Mr. Holmes, Dr. Peale, and other members of Dr. Hayden's party, have brought some of the fossils of this rock from Western Colorado, where it seems to be blended with the Fort Benton group. Along the eastern base of the Rocky Mountains, some of its fossils have been brought from near Colorado City, and Dr. Hayden also observed outcrops of it farther northward in Colorado, near Cache la Poudre River, between Denver and Cheyenne. It is also known to occur on the north branch of Platte River, and near the west base of the Laramie range of Mountains, along the eastern margin of the Laramie Plains.

In passing from this formation to the next above, we cross the most strongly-marked palæontological break in the whole series, unless that between the Dakota group and Fort Benton group may be equally so. As far as yet known, none of the Dakota-group species occur in the beds above, but then the number of species yet found in that division and the Fort Benton group is hardly sufficient to warrant the conclusion that some forms may not be common to the two horizons, as seems to be the case in Texas and New Mexico. In passing from the Niobrara group, however, into the succeeding rocks above, in which great numbers of fossils occur, not a

* Dr. Shumard identified and named from the division corresponding to this in Texas *Holaster simplex, Toxaster elegans, Cidaris hemigranosus, Gryphæa Pitcheri* (typical var. = *G. Tucumcarii*, Marcou), *G. sinuata*, Marcou (not Sowerby), *Ostrea subovata* (= *O. Marshii*, Marcou), *O. carinata, O. quadriplicata, Neithea Texana, N. Wrightii, Inoceramus problematicus, Pachymya Austinensis, Lima crenulicostata, Terebratula Wacoensis, Turrilites Brazoensis, Ammonites vespertinus* (= *A. Texanus*, Roemer), *A. Brazoensis, Hamites Fremontii*, and *Nautilus Texanus*. (See Trans. St. Louis Acad., I, 587.)

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, 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) occurred between the deposition of the latest portion of the Niobrara division and the first of the Fort Pierre beds.

Fort Pierre group.—This is perhaps the most important member of the series, not only on account of its thickness and the extent of its geographical range, but also from the great number and the beautiful state of preservation of its organic remains. As already intimated, the pearly portion of the shells of *Inoceramus*, *Margarita*, *Ammonites*, *Scaphites*, and other pearlaceous types found in this rock, usually seems to have lost little, if any, of its original brilliant luster.

With local partial exceptions, this division is, throughout the Upper Missouri country, composed of a great accumulation of fine dark and lighter gray clays, in rather distinct layers, but usually without a laminated structure. When wet or moist, they become plastic, but harden and crumble in drying, so as often to obscure the marks of deposition in vertical exposures; and where they form the surface of the country, they are subject to crack open to depths of six to ten inches during continued dry weather. As might be expected, such a material forms a very poor soil, and consequently the country occupied by these clays, and not covered by drift or later alluvial deposits, presents a barren appearance.

In the Upper Missouri country, this formation has been estimated to attain a maximum thickness of seven hundred to eight hundred feet; but it may be thicker at some places in or near the Rocky Mountains.

In Dakota, the organic remains of this rock usually occur in hard concretions, composed of the same argillaceous material, with some calcareous matter, and are more numerous in the lower and upper beds than in the middle portion, which is usually nearly barren of fossils. Among the more conspicuous fossils of this division may be mentioned *Inoceramus Nebrascensis*, *I. Vanuxemi*, *I. Balchii*, *Cucullæa Nebrascensis*, a number of Univalves, *Nautilus Dekayi*, *Placenticeras placenta*, *Baculites ovatus*, *B. compressus*, *Scaphites nodosus*, bones of *Mosasaurus*, etc. The fossils from this group are illustrated on our plates 10 to 27, inclusive.

This division occupies a considerable area of country around Fort Pierre and between there and the Bad Lands, as well as at intervals between the Bad Lands and the Black Hills. In the region of Fort Pierre, it forms the entire hills bounding the immediate valley of the Missouri; and above the fort it extends northward to the region of Cheyenne and Moreau Rivers, where it dips beneath the Fox Hills group, though it continues to be seen in the bluffs along the Missouri and other streams for some distance above. It likewise appears again, and forms much of the surface of the country on the distant Upper Missouri country on Milk and Muscleshell Rivers in Montana. It also extends far northward into the British possessions, some of its characteristic fossils having been identified by the writer among collections brought by Professor Hind and Professor Dawson, in charge of Canadian government exploring parties, from the Saskatchewan and Assiniboine countries, in 1858 *

On the Yellowstone River, at a locality one hundred and fifty miles above its mouth, in Montana, outcrops occur presenting the lithological characters of this formation, and containing great numbers of its characteristic fossils, directly mingled with many of those elsewhere only found in the Fox Hills beds above.

This rock also forms the hills on both sides of the Missouri below Fort Pierre to the Great Bend, just below which, as elsewhere stated, its base is seen resting on the upper uneven surface of the Niobrara group. From the Great Bend down to the mouth of the Niobrara River, in Dakota and Nebraska, the country on both sides of the Missouri is made up of these two formations; and the Fort Pierre group finally runs out in the form of outliers on the tops of the hills below the mouth of the Niobrara. So far as known to the writer, this formation has not been certainly identified along the irregular outline of the outcrops of the older members of the series seen extending southward and southwestward, through Eastern Kansas and Nebraska, much beyond the points where it runs out on the tops of the hills, as mentioned above, near the mouth of Niobrara River. A few of its characteristic fossils, however, have been found in Texas and New Mexico; and Messrs. Holmes, Marvine, Peale, and other members of Dr. Hayden's party, have also brought a few of the same forms from Western Colorado.

From the statements of the gentlemen who have visited these districts,

* See Report of Explorations between Lake Superior and the Red River Settlement (Toronto, 18, 1859); and Professor Hind's Report of the Saskatchewan and Assiniboine Expedition, 182, 1859.

it would seem, however, that this rock is not extensively developed there, being probably only a thin bed, not differing in composition from those of the Niobrara and Fort Benton groups. Indeed, they usually think it scarcely separable there from what seems to be extensive developments of the older members of the Cretaceous series of the North.

Along the eastern base of the Rocky Mountains, the Fort Pierre group is met with through Colorado, and on northward to and far beyond the Black Hills in Dakota and Wyoming. In Southern Wyoming, some of its fossils have been brought from the mountains on the eastern margin of the Laramie Plains, and farther westward along the Union Pacific Railroad from near Miser station, Medicine Bow, and the Salt Wells in Wyoming. The latter locality is the farthest western point at which its fossils have been observed in this internal portion of the continent, and corresponds also nearly in longitude with the localities at which it occurs in Western Colorado. We have reason, however, to believe that it is represented on Vancouver and Sucia Islands, west coast of British America, as well as in California.*

Fox Hills group.—This division is much more arenaceous than the Fort Pierre group, and also differs in presenting a yellowish, or more or less ferruginous tinge. Toward the base it consists of sandy clays; but as we ascend to the higher beds the arenaceous matter is found to increase, so that at some places the whole passes into a ferruginous sandstone. It is not separated by any strongly-defined line of demarkation from the Fort Pierre group below, the change from the fine clays of the latter to the more sandy beds above being generally gradual. Nor are these rocks distinguished by any very abrupt or strongly-marked change in their organic remains, since a part of the fossils occurring in the upper fossiliferous beds of the Fort Pierre group also pass up into the Fox Hills group; while at one locality already mentioned, on the Yellowstone, there is a complete mingling of the fossils of these two rocks in the same beds. Indeed, it has sometimes been thought that we might, with almost equal propriety, on palæontological grounds carry the line separating these two groups down so as to include in the Fox Hills group the upper fossiliferons beds of the Fort Pierre group. Most of the known

* See paper by the writer describing Cretaceous fossils from Vancouver Island, in Trans. Albany Inst., December, 1856; also, another by same on Collections N. W. Boundary Survey, Proceed. Acad. Nat. Sci. Philad., XIII, October, 1861.

facts, however, especially when we take into consideration the change of sediments at or near where we have always placed the line between these two rocks, seem to mark this as about the horizon where we find evidences of the most marked change of physical conditions.

Among the most common or more conspicuous fossils of this rock may be mentioned *Cucullæa Shumardi*, *Axinæa subimbricata*, *Veniella humerosa* *Pyropsis Bairdi*, *Fusus Dakotensis*, *Baculites grandis*, *Placenticeras lenticularis*, *Scaphites Conradi*, *S. Nicolletii*, *S. Mandanensis*, *S. Cheyennensis*, *Nautilus Dekayi*, *Mosasaurus Missouriensis*, etc. The fossils of this group are figured on our plates 28 to 36, inclusive.

The typical and most characteristic localities of this division of the Upper Missouri Cretaceous series are at Fox Hills, between Cheyenne and Moreau Rivers, above Fort Pierre, Dakota; it also extends across the Missouri in the region of Long Lake, at both of which localities it contains numerous specimens of its characteristic fossils, usually in a fine condition of preservation. It is likewise seen immediately underlying the Tertiary bone-beds of the Mauvaises Terres, on Sage Creek and near there, but here it seems to be nearly barren of fossils.

On the Upper Missouri, underlying the Brackish-water Lignite beds at and near the mouth of Judith River, some fossiliferous Cretaceous beds occur that we were for a long time in doubt where to place in the section. More recently, these have been elsewhere discovered connected in such a way with the Fox Hills beds, and containing so many of the common fossils of the same, as to show that they form an upper member of that group. The fossils from this horizon are figured together on our plates 37, 38, and 39. Of these forms, the most conspicuous are *Cardium speciosum*, *Inoceramus pertenuis*, *Tancredia Americana*, *Mactra alta*, *M. formosa*, *Pholadomya subventricosa*, *Glycimeris occidentalis*, *etc.*

On the north, the Fox Hills group, like the Fort Pierre, extends into the British possessions, a few of its fossils having been identified by the writer among Professor Hind's collections from the south branch of the Saskatchewan, where they occur in a green sand matrix.

At the Black Hills, and along the mountain-ranges west of there, the Fox Hills group is seen in places well developed. It also occurs at Deer Creek on the North Platte, and at various places along the eastern base of the Rocky Mountains; the upper beds of the group (already mentioned

under the brackish-water deposits at the mouth of Judith River) being well defined west of Greeley in Colorado, at which locality their true relations to this group were first determined.

The Fox Hills beds also occur at the base of the Rocky Mountains near Pike's Peak, and probably at other localities in Colorado. It seems, however, not to have been developed as a distinct rock anywhere on the Missouri below the Fox Hills and Moreau River regions, nor have any of its fossils been brought from Eastern Nebraska, Kansas, the Indian Territory, or Arkansas.

Allusion has already been made several times to the occurrence of the Upper Missouri Cretaceous subdivisions in New Mexico. This will be more clearly illustrated by the following tabular section of the three groups into which Dr. Newberry divides the Cretaceous series there, with a column added on the right showing the Upper Missouri equivalents. The well-known species of fossils found by him there in each subdivision are also inserted in the section.*

New Mexican Cretaceous series, showing the divisions recognized there by Dr. J. S. Newberry, with Upper Missouri equivalents added here.

	NEW MEXICAN SECTION.	Upper Missouri equivalents.
I.	UPPER DIVISION.—Gray, white, and purple marls, with soft yellow calcareous sandstones, altogether 1,500 feet in thickness, containing leaves of *Aluus*, *Platanus*, etc.; and, at the base of the whole, *Placenticeras placenta* (= *Am. placenta*, DeKay), *Baculites anceps*, *Callista Deweyi*, *Avicula Nebrascana*, etc.	Fox Hills? and Fort Pierre groups.
II.	MIDDLE DIVISION.—Dove-colored and ferruginous limestones, shales, etc., altogether 1,200 to 1,500 feet.—*Ostrea congesta*, *O. lugubris*, *Inoceramus fragilis*, *I. problematicus*, *Prionotropis Woolgari* (= *Amm. Woolgari*, Mant.), *Scaphites larveformis*, etc.	Niobrara and Fort Benton groups.
III.	LOWER DIVISION.—Yellow and brown sandstone and green shales, 250 to 400 feet in thickness.—*Exogyra*, *Plicatula*, *Prionotropis Woolgari* (= *Amm.* of Mant.), and leaves of *Salix*, *Platanus*, *Quercus*, etc.	Dakota group, wholly or in part.

* See Dr. Newberry's report on the geology of the expedition from Santa Fé to the junction of the Grand and Green Rivers, under the command of Captain Macomb, of the United States Topographical Engineers, and a report by the writer on the Cretaceous fossils collected by Captain Macomb's expedition; both now issuing from the press.

In the Upper division, Dr. Newberry found no recognizable animal remains excepting in a thin bed at its base, and therefore thought that portions of this division above the base, may possibly be Tertiary. He found no fossils (either old or new species) crossing the line between his Middle and Upper divisions, which line corresponds to that separating our Niobrara and Fort Pierre groups. In the same way, Dr. Shumard found in Texas the species distinct above and below this line. (See Trans. St. Louis Acad., I, 583.)

After the foregoing rather cursory outline-sketch of the geographical distribution of the rocks under consideration in the great area of country west of the Mississippi, and chiefly east of the Rocky Mountains, their relations to the Cretaceous deposits farther eastward in this country and in Europe remain to be considered.

RELATIONS OF THE UPPER MISSOURI CRETACEOUS BEDS TO THOSE IN THIS COUNTRY EAST OF THE MISSISSIPPI.

Coming eastward to the State of Mississippi, we find the Cretaceous rocks of that State, according to Professor Hilgard, separable into four subordinate groups as follows, numbering from below.

Section of the Cretaceous rocks of Mississippi, from Professor Hilgard's report.

IV.	RIPLEY GROUP.—Hard crystalline white limestone (generally somewhat sandy and often glauconitic), underlaid by black or blue micaceous marls, whose fossils are in an admirable state of preservation.—*Cardium Tippanum, C. Spillmani, Cucullæa capax, C. Tippana, Gervillia ensiformis, Siliquaria biplicata, Dosinia densata, Crassatella Ripleyana, Baculites Spillmani, B. Tippæensis, Scaphites iris, S. Conradi, Ammonites placenta, etc.*	Fox Hills group, or No. 5 of Upper Missouri section.
III.	ROTTEN LIMESTONE GROUP.—Soft, chalky, white limestone, passing into heavy calcareous massive clays, or light-colored clay-marls.—*Placuna scabra, Janira quinquecostata, Gryphæa vesicularis (= G. convexa), Ostrea falcata, Radiata, Mosasaurus, etc.*	Fort Pierre group, or No. 4 of Upper Missouri section.
II.	TOMBIGBEE SAND GROUP.—Sharp, strongly micaceous sands, of greenish hue, laminated when indurated, and cemented by carbonate of lime.—Numerous specimens of *Inoceramus* and the gigantic *Ammonites Mississippiensis.*	
I.	EUTAW GROUP.—Bluish-black or reddish laminated clays, alternating with, and usually overlaid by, non-effervescent sands; sometimes contains mica, and of yellow tint.—Contains beds of lignite, rarely any other fossils.	Dakota group?, or No. 1 of Upper Missouri.

The column on the right is here added to indicate what are believed to be the Upper Missouri equivalents of the subordinate groups shown in the above section. If these views are correct, there would appear to be no representation here of the Fort Benton and Niobrara groups of the Upper Missouri section, so extensively developed in Texas, New Mexico, and other southwestern districts west of the Mississippi. Probably, however, one or both of these may be represented here by the division II. The evidence that I, of the above section, aside from its position, is the equivalent of the Dakota group of the Upper Missouri, is not so decided as that the beds III and IV represent the Upper Missouri, Fort Pierre, and Fox Hills groups.

As far back as May, 1857, in a paper published by the author in connection with Dr. Hayden in the Proceedings of the Philadelphia Academy (vol. ix, page 127), the opinion was expressed that at least three of the Upper Missouri Cretaceous subdivisions are represented in Alabama. In order to illustrate this parallelism more clearly, the following section of these rocks in that State, from facts furnished by Prof. A. Winchell, was given on page 126 of the paper above cited:

Alabama section, from facts communicated by Prof. A. Winchell.

	Thickness.	SUBDIVISIONS.	Equivalents of Upper Missouri section.	Equivalents of New Jersey section.
A.	10 feet.	Decomposing dark limestone, with obscure casts of shells.	No. 5.	*b*, or 2d bed of Green sand.
		Soft white limestone.—*Gryphæa vesicularis, Exogyra costata, Scaphites Couradi, Nautilus Dekayi, Baculites ovatus* (*Ammonites lobatus*,* Tuomey, here ?).		
B.	45 feet.	Loose white sand, with *Ostrea larva, Pecten 5-costatus, Gryphæa vomer*, and fragments of fossil wood.	No. 4.	Beds *c*, *d*, and *e*.
C.	150 feet or more.	Soft white limestone ("rotten limestone"), decomposing above, more argillaceous below, and near the base becoming a firm calcareous sandstone.—*Inoceramus biformis* of giganic dimensions, *Radiolites, Nautilus Dekayi, Ammonites Delawarensis, Baculites ovatus*, sharks' teeth, and bones of *Mosasaurus*.		

* Now known as *Placenticeras lenticularis*, Owen (sp.).

Alabama section, from facts communicated by Prof. A. Winchell—Continued.

	Thickness.	SUBDIVISIONS.	Equivalents of Upper Missouri section.	Equivalents of New Jersey section.
C.	6 feet.	Gray indurated sand, with *Gryphæa vesicularis, Exogyra costata, Inoceramus biformis, Pecten 5-costatus, Ammonites placenta,* A. Delawarensis,* teeth of fishes, etc.	No. 4.	Beds *c, d,* and *e.*
D.	15 feet.	Perfectly loose, obliquely-laminated sand, of gray and greenish-yellow color, with thin unconformable laminæ of dark green sand, passing in horizontal planes through the main bed.—Much fossil wood and *Teredo tibialis.* [This last-mentioned fossil was only very doubtfully identified.]		
E.	300 feet, may be much more.	Beds of dark-blue soft shale or indurated clay, alternating with strata and seams of white and mottled clays, green and ferruginous sand, and dark pyritiferous shale.—No organic remains but stems and leaves of apparently dicotyledonous plants, and a few obscure casts of other fossils. *Ceratites Americana,* † however, of Harper, is supposed to hold a position somewhere in this series.	No. 1.	Formation *f.*

From this section it will be seen that there is at the base of the Alabama Cretaceous series, as well as in Mississippi, a considerable thickness of shale or clay, sand, etc., containing, in the former State, dicotyledonous leaves, and apparently corresponding to the Dakota group, or No. 1 of the Upper Missouri section; while above, there comes a great series of sand, clays, soft whitish limestone, etc., containing a group of fossils showing that we have here a representation of perhaps both the Fort Pierre and Fox Hills groups (Nos. 4 and 5) of the Upper Missouri section. As in Mississippi, we have no satisfactory evidence, however, that either the Fort Benton or the Niobrara group is represented in the Alabama section.

In the same paper, of May, 1857, from which the foregoing Alabama section is cited, we also gave (page 127) for comparison, a section of the New Jersey Cretaceous rocks, compiled from the Geological Reports of Professor Ketchel and Professor Cook, showing the parallelism of the Cretaceous subdivisions there with those of the Upper Missouri, as follows:

* Now known as *Placenticeras placenta.*

† This has since been found to be a worn specimen of the old genus *Ammononites.*

New Jersey section, compiled from the reports of that State.

a.	Third bed of Green sand.	Green sand	60 feet.	Tertiary.
		"The sand between the second and third beds has usually been confounded with beach-sand, which it closely resembles"	45 to 50 feet.	
b.	Second bed of Green sand.	Yellow limestone. [Contains many *Polyzoa.*]		No. 5, Nebraska section.
		Green sand.—*Scaphites Conradi, Baculites ovatus, Ammonites* [*Placenticeras*] *placenta.*		
c.		Sand "much colored with oxyd of iron, and, when sufficiently firm, found almost full of the impressions of shells".—*Belemnites mucronatus* [= *Belemnitella*]	65 to 70 feet.	Represents No. 4, Nebraska.
d.	First bed of Green sand.	Green sand.—*Nautilus Dekayi, Baculites ovatus, Belemnites mucronatus,* and bones of *Mosasaurus*	50 feet.	
e.		Dark clays with "occasional streaks and irregular spots of greensand".—*Ammonites placenta* [= *Placenticeras*], *Baculites ovatus, etc*	130 feet.	
f.		Dark blue, ash-colored, and whitish clays, and micaceous sand, with thin seams of coal. Great quantities of sulphuret of iron. "Fossil wood is found in some of the layers in large quantities, and some very distinct impressions of net-veined leaves were examined in the clay at French's landing"	130 feet, or more.	Represents No. 1 of the Nebraska section.

At the time this and the Alabama sections were made out, a large area in Upper Missouri country, now separated into Nebraska proper, and the Territories since called Dakota and Montana, was known under the general name Nebraska Territory. At that time, the five members of the Upper Missouri Cretaceous section had also not received geographical names, but were merely designated by the numbers 1, 2, 3, 4, and 5, from below. Consequently, the Upper Missouri equivalents in the column on the right of these sections were merely numbered, and the whole series was there referred to what was then known as the Nebraska section.

By comparing this New Jersey section with that of the Upper Missouri Cretaceous series given farther back, the parallelism of the different divisions,

so far as those of the Upper Missouri correspond to those of New Jersey, will be readily understood. For instance, the lowest bed (marked *f*) in the New Jersey section almost certainly represents the Dakota group (No. 1) of the Upper Missouri section; at least, it holds the same position at the bottom of the series, and, like the Dakota group, it contains numerous leaves of the higher types of dicotyledonous trees. These leaves from New Jersey have not, it is true, been thoroughly compared with those found in the Dakota group, but the general aspect of the specimens from these two distantly-separated localities is the same, and indicates a similar flora; and most of the genera, as well as some of the species, are believed to be identical.*

As in Mississippi and Alabama, the Fort Benton and Niobrara groups seem to have no representatives in New Jersey, nor, so far as yet known, anywhere east of the Mississippi. That the beds marked *c*, *d*, and *e*, in the New Jersey section, represent the division No. 4, called the Fort Pierre group in the Upper Missouri, and that the New Jersey bed *b* is equivalent to the Fox Hills group (No. 5) of the Upper Missouri section, we have, it is believed, entirely satisfactory palæontologieal evidence.

In an article by Professor Hall, on the distribution of the Cretaceous rocks of America and their relations as developed at distantly-separated localities in this country, published in the July number of the American Journal of Science and Arts for 1857, it will be seen that he adopted essentially the same conclusions in regard to the parallelism of the subdivisions of the Cretaceous series of the Upper Missouri and New Jersey; also in an article on the same subject in the United States and Mexican Boundary Survey, published in 1858.†

* Since writing the foregoing, the author has observed that Professor Lesquereux states, in Dr. Hayden's Report of 1874, p. 360, that he had examined a collection of the leaves from this horizon in New Jersey, belonging to Professor Cook, and adds that they "represent many species identical with those of the Dakota group, or, at least, evidently related forms. Both *Magnolia Capellini*, and especially *M. alternans*, are among them"; thus confirming, in the most decided manner, when taken in connection with the other facts, the parallelism of the lowest Cretaceous bed in New Jersey with the Dakota group of the Upper Missouri.

Dr. Hayden and the writer once collected many of these New Jersey leaves from a locality on Raritan River, with the view of comparing them with the collections from the Dakota group; but, before this could be done, the specimens were all saturated with water during the fire at the Smithsonian Institution, and, for the most part, crumbled to pieces.

† This volume of the United States and Mexican Boundary Survey bears the date of 1857 on the title-page, but it was not published until the summer of 1858. See Am. Jour. Sci. and Arts for July, 1859, p. 149.

PARALLELISM OF THE SUBDIVISIONS OF THE UPPER MISSOURI CRETACEOUS SECTION WITH THOSE OF THE SAME IN EUROPE.

* Before proceeding to the consideration of the relations of our Upper Missouri Cretaceous subdivisions to those of foreign countries, it is proper to give a brief review of the previously-expressed views of others on this point, as well as on the parallelism of the equivalent beds in New Jersey, and farther southward in this country, with the recognized subdivisions of the Cretaceous of Europe.

The Cretaceous strata of New Jersey were first referred to that epoch by the lamented Lardner Vanuxem, one of the State geologists of New York. He did not, however, attempt to trace out the correlation of particular beds of the New Jersey series with those of the Old World. Dr. Morton, however, to whom we are indebted for figures and descriptions of a considerable number of the New Jersey Cretaceous fossils, seems to have regarded these rocks and their equivalents in the Southern States as, in a general way, representing the White Chalk of Europe.† Later, however, he regarded the upper calcareous bed of Timber Creek, New Jersey, only, as being contemporaneous with the European White Chalk; while the beds below, in New Jersey, South Carolina, Mississippi, Arkansas, and Upper Missouri, he thought represented all the Cretaceous below the White Chalk.‡

Sir Charles Lyell expressed the opinion that the fossils of the New Jersey Cretaceous beds "on the whole agree most nearly with those of the upper European series from Maestricht beds to the Gault inclusive". §

Prof. Henry D. Rogers, with his usual sagacity in such matters, remarked, in his able Report on the Geology of New Jersey, that he did not regard the Green-sands of that State, "in the strict sense of the words, as the equivalents of the Green-sand formation, so called, of Europe". ‖

In his Cours Élémentaire de Paléontologie, Alcide d'Orbigny refers the New Jersey Cretaceous beds, as well as those of Nebraska (= Upper Missouri), Arkansas, Texas, and Alabama, all to his Sénonien, the equivalent of the White Chalk and Maestricht beds of the Old World. ¶

Pictet, in his Traité de Paléontologie, also refers most, if not all, of the New Jersey Cretaceous fossils to the era of the White Chalk of Europe.

* These remarks were substantially presented in a paper published by the author, jointly with Dr. Hayden, in the Proceed. Acad. Nat. Sci. for Dec., 1861, 428, etc.

† See Synop., 83, 1834. ‡ Jour. Acad. Nat. Sci., VIII, old ser., 217, 1841. § Manual, 224.

‖ Report Geol. New Jersey, 178, 1845. ¶ Cours Élém., II, 671–672, 1852.

Dr. Isaac Lea, of Philadelphia, in an interesting paper read before the Academy in December, 1858, likewise favored the conclusion that the New Jersey Green-sands represent the Sénonien of d'Orbigny, but, at the same time, he suggested some reasons for thinking that they may possibly belong to a lower horizon.

From a careful review of the whole subject, and an attentive study of extensive collections from the various Upper Missouri Cretaceous rocks throughout wide areas, the author was led to adopt (in a joint paper with Dr. Hayden, published in the Proceedings of the Academy in December, 1861) the views of d'Orbigny, so far as regards the middle and upper beds of the New Jersey Cretaceous, and their equivalents in the Upper Missouri country and districts farther southward, both east and west of the Mississippi; that is to say, his opinion that these upper members represent the Upper or White Chalk, and probably the Maestricht beds, was fully adopted. But all of the older Upper Missouri Cretaceous beds, and their equivalents, so far as elsewhere represented in this country, almost certainly belong to the horizon of the Lower or Gray Chalk; or perhaps in part to that of the Upper Green-sand, of the Old World, as shown in the paper above cited.

The evidence respecting the exact part of the European Cretaceous series to which the Dakota group belongs is not entirely satisfactory, the few animal remains yet known from it being mainly casts, and, so far as determined, not such forms as can be regarded as especially characteristic of any particular horizon in the Cretaceous of Europe. Up to this time, we also know of no single species being common to it and any of the beds above; but then we, as yet, know comparatively only a few species of animal remains from this rock. One of these, however, belongs to the Cretaceous genus *Leptosolen;* while the other shells are allied to Cretaceous species and unlike Jurassic forms. In addition to this, the modern affinities of the numerous leaves of the higher types of dicotyledonous trees found in it, present a strong objection to the adoption of the conclusion that it may belong to a lower horizon than the Upper Green-sand of British geologists; while its position directly below beds almost beyond doubt representing the Lower or Gray Chalk, precludes its reference to any higher stratigraphical position. Consequently, we have long regarded it as most probably representing, in part, if not the whole, of the Upper Green-sand, and therefore cannot agree with d'Orbigny in referring its equivalent in New Jersey, Alabama, etc., along with the later beds, to the Sénonien or White Chalk horizon.

In making comparisons for the determination of the equivalents of the subdivisions of our Upper Missouri Cretaceous series with those of Europe, it is necessary to view the Fort Benton and Niobrara groups, and possibly even the Dakota also, as forming together one division of the Cretaceous system, because parallels of the smaller subdivisions cannot, at least in our present knowledge of the subject, be traced out in detail on opposite sides of the Atlantic. The evidence that at least the Fort Benton and Niobrara groups represent the Lower or Gray Chalk, and possibly also in part the Upper Green-sand of the English geologists, will be readily understood by the following list of Upper Missouri species from the groups mentioned, either identical with, or very closely allied to, species found at the horizons referred to in England and on the continent.

SPECIES FROM THE FORT BENTON AND NIOBRARA GROUPS OF THE UPPER MISSOURI.	SPECIES FROM THE LOWER CHALK AND UPPER GREEN-SAND OF EUROPE.
Mortoniceras Shoshonense, M.	Represented by *M. respertinus*, Morton (sp.).*
Prionocyclus Woolgari, Mantell (sp.)	= *Ammonites Woolgari*, Mantell.
Scaphites Warrenanus, M. & H., *very* nearly related to	*S. æqualis*, Sowerby.†
Scaphites larvæformis., M. & H., same type as	*S. æqualis*, Sowerby.
Nautilus elegans, Sowerby	*N. elegans*, Sowerby.
Inoceramus problematicus, Schloth	*I. problematicus*, Sch.‡
Inoceramus latus, Mantell	*I. latus*, Mant.

The foregoing list of identical or very closely-allied species might be extended by including forms found in equivalent beds of these groups farther southward, while the evidence that these divisions represent the European members of the Cretaceous suggested, receives further support from the fact that we as yet know of no foreign strictly Upper Chalk species occurring in them, and of but one marked form (our *Inoceramus umbonatus* of the Fort Benton group) that is most nearly allied to any European Upper Chalk species.§ Yet, in the succeeding rocks above, as shown farther on, the White Chalk fauna is clearly represented by a number of closely-allied, and some identical forms.

As before, however, these upper divisions—the Fort Pierre and Fox Hills groups—are so intimately related, palæontologically, that in comparing

* This is *Ammonites Texanus*, Roemer, which has, according to Mr. Gabb, been found to be exactly identical with the type of Dr. Morton's previously-published *A. respertinus*, the type of the genus *Mortoniceras*. It has been found at Gossau, France, by Hauer, where it is believed to occur in beds of the age of the Lower or Gray Chalk.

† In Agassiz and Desor's German translation of Sowerby's Mineral Conchology, this is given as a Chalk-Marl (= Gray-Chalk) species. It is now regarded as an Upper Green-sand species by European authors.

‡ This species is said to occur in the Upper Green-sand, but is generally confined to the Gray Chalk.

§ This species is most nearly related to *Inoceramus involutus*, Sowerby, from the Upper Chalk.

them with the European members of the Cretaceous system, as developed there, with the view of determining their proper horizon in the same, it becomes necessary to view them as forming together one natural division. When thus considered, it becomes clearly evident, as has long been known, that they represent the Upper or White Chalk of Europe. A longer list of species from these American upper divisions identical with, or so closely allied to, European White Chalk forms, as to be safely viewed as representatives of the same, might be made out; but the following few examples will, perhaps, be sufficient:

SP. FROM FT. PIERRE AND FOX HILLS GROUPS, AND EQ. BEDS.	AMERICAN LOCALITIES.	FOREIGN LOCALITIES AND POSITIONS.
Nucleolites crucifer, Morton	New Jersey	Occurs in White Chalk of France.
Ostrea larva, Lam	Dak., New Jersey, Alab., etc	England, France; White Chalk and Maestricht beds.
Neithea Mortoni, d'Orb	New Jersey, Alabama, etc	France; White Chalk.
Gryphæa vesicularis, Lam	New Jersey, Tennes., Alab., etc	England, France, etc.; White Chalk and Maestricht beds.
Inoceramus Barabini, Mort	Dak., New Jersey, Alab., etc	Near *I. Cripsii*, Mant.; White Chalk, England, etc.
Baculites anceps, Lam	Wyom., New Jersey, Texas ?	White Chalk of Europe.
Nautilus Dekayi, Mort	Dakota, New Jersey, etc	Near *N. lævigatus*, d'Orb., and allied White Chalk species.
Scaphites Conradi, Mort	Dak., Mont., New Jersey, Alab., etc	*Very* like *S. pulcherrimus*, Roem.; White Chalk, Germany.
Scaphites nodosus, Owen	Dak., Mont., Colorado, etc	Near *S. constrictus*, Sow., and *S. compressus*, Sow.; White Chalk, England and France.
Sphenodiscus lenticularis, Owen (sp.)	Dakota, Colorado, etc	White Chalk, Limbourg.
Belemnitella mucronata, Sch	New Jersey, Alab., Miss., etc	Widely extended in White Chalk of Europe; also in Maestricht beds.

It is true that we have from these upper beds a few forms most nearly allied to Lower Chalk and Upper Green-sand species, such for instance as our *Micrabacia Americana*, nearly related to the European *M. coronula*, from the Upper Green-sand, and our *Cucullæa Shumardi*, closely resembling *C. fibrosa*, Sowerby, from the same horizon. On the other hand, our *Websteria cretacea*, from the Fox Hills group, has no known representative in the Old World but *W. crisioides* of Edwards and Haime, from the Eocene of England, and *Ostrea* (*Gryphostrea*) *vomer*, Morton, which is scarcely distinguishable from *O. eversa*, Deshayes, from the same horizon. As a whole, however, the fauna of these beds, as already shown, clearly and unmistakably represents that of the Upper or White Chalk of the Old World.

From the foregoing facts, it will be seen that the most strongly-marked palæontological break in the Upper Missouri Cretaceous section, given farther

back, is at the line separating the Niobrara from the Fort Pierre group; and that the Upper Missouri beds above this horizon, as stated above, represent the Upper or White Chalk, and those below it the Lower or Gray Chalk, and perhaps also in part the Upper Greensand, of the English geologists. Hence this line of division assumes importance from a broader view of the subject than from any reasoning based on its known persistence from Fort Benton in the far north, to Texas and New Mexico in the distant south.

FRESH- AND BRACKISH-WATER LIGNITE DEPOSITS OF THE UPPER MISSOURI.

In regard to the Cretaceous age of all the rocks of the Upper Missouri section given on pages xxiv and xxv, it will be seen that there is now no difference of opinion. Just here, however, that is, in passing from the Fox Hills group or upper member of that section into the lignite-bearing rock above, we enter upon disputed ground. Although not very much prominence has generally been given to the fact, especially by those who have attempted the correlation of these deposits with particular rocks elsewhere in the far-west, it is nevertheless true, that there appear to be two distinct groups of lignite-bearing strata in the Upper Missouri country, that are often spoken of and viewed as if they formed one homogeneous rock. These are the *Judith River* and *Fort Union groups*.

Although we have long regarded the Judith River beds as forming a distinct group older than the Fort Union deposits, the difficulty, without more detailed stratigraphical examinations throughout considerable areas, of deciding to which of these horizons particular species only known from isolated localities properly belong, prevented the arrangement of the figures of the fossils from these groups in all cases on separate plates. For the same reason, the species have all, from both of these groups, been described together in the body of this work under one general head, though the horizon to which each belongs has, when certainly known, been definitely stated in connection with its description; and where doubts existed on this point, the horizon to which species are believed to belong, has been less confidently stated. In these remarks, however, the two groups will be separately considered as follows:

JUDITH RIVER GROUP.—The first information in regard to this group was derived from the observations and collections of Dr. Hayden during his two years' sojourn in this distant country. It was first examined by him at the typical locality near the mouth of the Judith River on the Upper Mis-

souri in Montana Territory. But we have reason now to believe that it exists at other localities in the Upper Missouri country, either under the Fort Union group, or at some other places where the latter may not exist. At the typical locality, it evidently rests upon well-marked Cretaceous strata belonging to the horizon of the upper part of the Fox Hills group; and both have been upheaved together in such a manner as to show conclusively that there is no discordance of stratification, or, in other words, that they are conformable.* Owing to this disturbed condition of the strata, it was found difficult to make out a detailed section showing the order of succession of the whole series; but the following, prepared from Dr. Hayden's notes, and the study of the fossils from these beds, will at least convey a general idea of their nature here, if not of the details of the whole group. It is given in descending order.

Section of the Judith River group as seen at the mouth of Judith River.

A.	Yellow arenaceous marl passing downward into gray grit, with small seams of lignite.—*Ostrea subtrigonalis?, Corbicula occidentalis, C. cytheriformis, Goniobasis convexa, etc.*	80 feet.
B.	Impure lignite, containing much sand and silicified wood.—*Ostrea subtrigonalis.*	10 feet.
C.	Alternations of sand and clay, with particles of lignite; also reddish argillaceous concretions, with a few Saurian teeth and fresh-water shells.	80 feet.
D.	Alternate strata of sand and clay, with impure lignite, and silicified wood in a good state of preservation.	20 feet.
E.	Variable bed consisting of alternations of sand and clay, with large concretions containing great numbers of *Goniobasis, Campeloma, Viviparus, Planorbis, Spharium, etc.*, associated with Saurian remains resembling the *Iguanodon* and *Megalosaurus;* also remains of *Trionyx*, etc.	100 feet.
F.	Alternations of impure lignite and yellowish-brown clay, the latter containing shells of *Unio, Viviparus, Goniobasis, Spharium*, and scales of *Lepidotus.*	25 feet.
G.	Ferruginous sand and clay, with in upper part a seam three or four inches in thickness, mainly composed of shells of *Unio.* Lower part coarse ferruginous grit, with a seam near the base almost entirely composed of shells of *Unio Dana, U. Deweyi*, and *U. subspatulata.*	100 feet.

*The occurrence here together of these two entirely distinct formations, has caused some little confusion in citations of what has been written about them. For instance, remarks made by the author in regard to the undoubted Cretaceous beds here, in a little report on fossils from the same horizon near Greeley, Colorado (Bull. U. S. Geol. Survey, No. 1, 2d ser., 40 and 41), have been, by an oversight, quoted by my young friend Dr. Peale, as if intended to apply to the brackish-water Judith River group, here under consideration, instead of to the well-marked Cretaceous beds there. (See Dr. Hayden's Ann. Report U. S. Geol. Survey of the Territories, first division, 1876, 145.)

The invertebrate remains from these beds were described in the joint names of Meek and Hayden in the Proceedings of the Philadelphia Academy of Natural Sciences in 1856.* They belong mainly to the genera *Ostrea*, *Anomia*, *Unio*, *Corbula*, *Sphærium*, *Corbicula*, *Campeloma*, *Viviparus*, *Planorbis*, *Goniobasis*, *Bulinus*, etc., all, with possibly the exception of one species of *Campeloma*, being specifically distinct from forms found in the Fort Union group. In addition to this, they have a decidedly older look: that is, they are all more changed by the process of fossilization than those of the Fort Union group, which are usually as fresh and unaltered in appearance as merely bleached shells of existing species. The presence of two species of *Ostrea* in considerable numbers, and of an *Anomia*, in these Judith River beds, also imparts to their fauna a more brackish-water aspect, and even renders it probable that some of the beds were deposited in salt-water, and that the associated fresh-water- and land-types were carried into the same by streams.

The fact that fresh- and brackish-water- as well as land-types of shells have been almost everywhere found to present close similarity to existing types in rocks of all ages in which they occur, taken in connection with the additional fact that the species from these beds have not yet been found in any well-established horizon elsewhere, renders them of very little use in determining the age of these beds.

The vertebrate remains from them, however, which were referred by Dr. Hayden to Professor Leidy, were found by that gentleman to present decidedly nearer relations to Cretaceous than Tertiary types, some of them being *Dinosaurian* related to the *Iguanodon*, *Megalosaurus*, etc. Hence he was led to express the opinion that these deposits represent a formation "like that of the Wealden".† From these facts, and the direct association of these isolated deposits with marine well-marked Cretaceous strata, the precise horizon of which was not then known (since found, as already stated, to belong to the upper part of the Fox Hills group), Dr. Hayden and the writer were led to express the opinion that there might be "here at the base of the Cretaceous system a fresh-water formation like that of the Wealden".‡

Dr. Leidy also described among Dr. Hayden's collections from the lowest

* Proceed. Acad., 1856, VIII, 115.

† Proceed. Acad., 1856, VIII, 72, 89, and 311. See also Trans. Am. Phil. Soc., March, 1859, 123

‡ Proceed. Acad., 1856, VIII, 114.

beds of the Upper Missouri Lignites near Moreau and Grand Rivers, Nebraska, very probably belonging to the horizon of the Judith River group, some vertebrate remains, which have been considered Cretaceous types by Professor Cope. The latter gentleman has also described from branches of Milk River, in British America, some *Dinosaurian* and other vertebrate remains, collected by Dr. Dawson, geologist of the British North American Boundary Survey, which he regards as proving the beds from which they came to be of Cretaceous age.* In his large report on the Cretaceous Vertebrata of the West, issued in 1875, Professor Cope again refers the Judith River vertebrates, and all of the others from the several other localities in the Upper Missouri country mentioned, to the Cretaceous, but assigns the whole to the Fort Union group. To the writer of these remarks, however, there seems to be very little reason to doubt that the beds from which nearly if not quite all of these Cretaceous types of vertebrates came, belong to the horizon of the older brackish- and fresh-water beds at the mouth of Judith River, for which the name Judith River group has been used.

That these older beds (the Judith River brackish- and fresh-water deposits and their equivalents elsewhere) are Cretaceous, is certainly highly probable, as has been suggested by the author on former occasions; yet this can scarcely be properly regarded as an established fact. The presence of the *Dinosaurian* and other types of vertebrate remains in them, unlike any of the forms found in other parts of the world in later than Cretaceous rocks, is undoubtedly a very strong argument in favor of the conclusion that they belong to that epoch. On the contrary, however, some Eocene types of vertebrates have also been found in these beds at certain localities, such, for instance, as *Plastomenus*, a Tortoise, the type of which is from the Eocene of Wyoming and New Mexico; and remains of Garfishes of the genus *Clastes*, discovered by Professor Dawson on branches of Milk River, in beds almost certainly of the same age as those of the typical Judith River locality, where the last-mentioned genus also occurs along with the Cretaceous types of Saurians. Some of the plants described by Professor Lesquereux, and regarded by him as decidedly Eocene, seem also to come from beds belonging to this horizon.

Respecting the occurrence of the Judith River group at other localities

* See Dr. Dawson's Report on the Geology of the British North American Boundary Survey, p. 333; Montreal, 1875.

in the Upper Missouri than those already mentioned, we have not much precise information; but, from specimens found at several other isolated localities in that region, it is believed to be somewhat extended there at the base of the Fort Union group.

Professor Cope mentions some vertebrate types found by him that would appear to indicate its existence in New Mexico. We have, however, so far as known to the writer, no evidence from invertebrate remains, of its extension so far southward, though there is no known reason why it may not do so. It can only be said that none of the Upper Missouri invertebrates characteristic of this horizon have yet been brought in from any locality south of about the latitude of the southern boundary of Montana, with one exception, mentioned below, in Southern Wyoming.

The exception alluded to above is *Corbicula cytheriformis*, M. & H., one of the most common species of the Judith River group at the typical locality, and near the mouth of Museleshell River on the Missouri in Montana. In 1873, several specimens of a *Corbicula*, agreeing exactly with the above species, were found by the writer and Dr. Bannister at the top of a very extensive series of brackish-water lignitiferous strata at Black Butte station on the Union Pacific Railroad, Wyoming. It is also an interesting fact that almost directly associated with this *Corbicula*, and species of *Ostrea*, *Viviparus*, *Goniobasis*, etc., we found bones of a large *Dinosaurian*, that has since been described by Professor Cope under the name *Agathaumas sylvestris*, and referred by him to the Cretaceous epoch, or to an intermediate horizon between the Cretaceous and the Lower Eocene. Yet, directly mingled with these *Dinosaurian* bones, numerous leaves of dicotyledonous trees occur, that Professor Lesquereux as confidently refers to the Eocene. It would be unsafe, however, to refer these Black Butte beds positively to the horizon of the Judith River group on the evidence of a single species of *Corbicula*, the presence of lignite, and *Dinosaurian* remains; but it is certainly an interesting coincidence that it should be found here at this remote locality under such similar circumstances.

In this connection, it is proper to explain that this Wyoming Lignite group, which we have called the Bitter Creek series, is of very considerable thickness, and includes a number of beds of lignite, or, more strictly speaking, brown-coal, at some places quite extensive, and of good quality. On first examining two new species of shells from a lower position in this series at

Hallville, three miles west of Black Butte, collected by Dr. Hayden in 1870, they were, from their close affinities to European Eocene species of the same genus, referred by the writer to that horizon.* On examining a few other shells, however, from a still lower position in this series, seven or eight miles farther westward, near Point of Rocks, collected by Dr. Hayden during the following summer, he was, on the contrary, led, rather by their general similarity to Cretaceous forms than from the belief that they were really identical with any known Cretaceous *species*, to include them in the Cretaceous list.† These belong to the genera *Ostrea* and *Anomia*, the latter being new and peculiar, while the former was very doubtfully referred to a California Cretaceous species, the provisional name *O. Wyomingensis* being suggested for it in case it should be ascertained to be a new species, as was believed most probably to be the case. At this time, both the geographical and stratigraphical relations of the localities and beds from which these fossils were collected at the two localities were unknown to the author.

On visiting this region in 1873, he learned for the first time that the Hallville and Point of Rock localities, which had afforded the fossils mentioned, were only a few miles apart, and that the strata between the two horizons, as well as far above that of the Hallville mines, up to and including the beds at Black Butte station, where the Saurian and other fossils were found, contained forms indicating deposition in brackish- or possibly in some cases salt-water, and that lignite beds occur at various horizons through the whole. The fossils collected at this time belong to the genera *Ostrea*, *Anomia*, *Corbula*, *Modiola*, *Corbicula*, *Goniobasis* (an American type of Melanian), a shell similar to *Viviparus trochiformis* of the Upper Missouri Fort Union Lignite group, and *Corbicula cythriformis*, of the Judith River group.

The last-mentioned fossils, and species of the other genera, were found, as already stated, almost directly associated with the *Dinosaurian* bones and Tertiary types of plants mentioned above. Of the shell so nearly resembling *Viviparus trochiformis*, only a few very imperfect specimens, consisting of the upper turns of the spire, were found; but in form and surface-markings they agree almost exactly with the corresponding part of *V. trochiformis*, which led to the expression of the opinion that they might possibly belong to the same species, though they were not definitely referred to it.

* Dr. Hayden's Second Ann. Rep. Geol. Survey of the Territories, 298, 314.
† Dr. Hayden's Fifth Ann. Rep. Geol. Survey of the Territories, 375.

In commenting on these facts, the author remarked, in Dr. Hayden's Sixth Annual Report, page 460, "that the occurrence of this last-mentioned species [the form similar to *Viviparus trochiformis*] here, along with a Cretaceous type of Reptilian, and a *Corbicula* apparently identical with *C. cytheriformis* of the Judith River brackish-water beds, together with Corbulas very closely allied to Judith River species, at lower horizons in this series, and the occurrence of some vertebrates of Cretaceous affinities at the Judith River localities, would certainly strongly favor the conclusion, not only that this Judith River formation, the age of which has long been in doubt, is also Cretaceous, but that even the higher fresh-water Lignite formation at Fort Clarke [Fort Union group], and other Upper Missouri localities, may also be Upper Cretaceous instead of Lower Tertiary." Immediately after this, however, he added the following remark:

"That the Judith River beds may be Cretaceous, I am, in the light of all now known of the geology of this great internal region of the continent, rather inclined to believe. But it would take very strong evidence to convince me that the higher fresh-water Lignite series [Fort Union group] of the Upper Missouri is more ancient than the Lower Eocene."

Since the above was written, Professor Powell and Dr. White have been so fortunate as to find, at Black Butte station, several nearly perfect specimens of the shell, the upper volutions of which are so much like those of *Viviparus trochiformis*, and these show that its lower turns develop two or three rows of nodes, thus removing it very decidedly from near relations to *V. trochiformis*, and placing it in the distinct, but analogous fresh-water genus *Tulotoma*.*

As we have no evidence yet of the occurrence of any other Fort Union group species in the Bitter Creek series, it will readily be seen that we at least still want the "very strong evidence" that it was stated would be required to satisfy the author that the Fort Union group would possibly have to be referred to the Cretaceous in case the Bitter Creek series should prove to belong to that epoch.

On the contrary, not only from the presence in these beds of *Dinosaurian* remains, and one species of *Corbicula* undistinguishable from the Judith River *C. cytheriformis*, with one or two species of *Corbula very* like forms from that group, but also from the general state of preservation of all

* It has since been described by Dr. White under the name *T. Thompsoni*.

the fossils of this series, and the evidences of the greater saltness of the waters in which many of these beds were deposited, we have much stronger reasons for believing that they, at least in part, represent the Judith River group.

After visiting these Wyoming localities in 1873, and seeing how the same general types of fossils range through the whole, from the heavy beds of lead-gray and yellowish sandstones along Bitter Creek near Rock Spring and Point of Rocks, far up through the strata including the Hallville coal-beds, to those at Black Butte station, in which the *Dinosaurian* and other fossils were found, the author was led to believe that they belong to one great series, nowhere divisible on any well-defined palæontological evidence.

This fact, and the presence of the *Dinosaurian* far up near the top of the series, rather inclined the author to the opinion that the whole belongs to the Cretaceous; but he did not regard the evidence as altogether conclusive, and mentioned the entire absence, so far as then known, of any of the peculiarly characteristic Cretaceous genera of Mollusca in these strata.*

Since that time, Dr. White and Professor Powell have found in one of the lower beds near Point of Rocks—the same as that from which the *Anomia* was obtained that was regarded by the author as scarcely distinguishable from a Texas Cretaceous species described by Dr. Roemer—a fine species of a new genus of Buccinoid shells described in this work under the name *Odontobasis*.† The only other two species of this peculiar genus known (including the type) were found in the Fort Pierre group of the Upper Missouri Cretaceous, where they occur associated with strictly marine forms. The presence here of a species of this peculiar genus—elsewhere only known in the Cretaceous—furnishes another strong argument in favor of the conclusion that these rocks belong to that epoch.

Some four hundred feet or more above the horizon at which this fossil and the *Anomia* and an *Ostrea* that the author had originally arranged in the Cretaceous list occur, Professor Powell and Dr. White draw the line between the Cretaceous and Tertiary of this region; leaving the Hallville beds containing the two fossils that had originally been referred by the author to the Lower Eocene, and all the beds above, up to and including the *Dinosaurian* bed at Black Butte, in the Lower Tertiary. They draw this line, however, entirely on stratigraphical evidence, there being something of a physical break

* Ann. Rep. U. S. Geol. Survey for 1873, 459. † See page 351.

there, as they maintain, at many places in this region; that is, there is evidence of the erosion into little irregularities of the upper surface of the bed just below this horizon previous to the deposition of that just above; while they argue that no other similar break occurs in this region at any other horizon at which the line could be drawn.

These gentlemen, however, at the same time frankly admit that there is no corresponding change in the general character of the organic remains at this horizon. If they are correct, however, in drawing the line here, this would accord almost exactly with the original reference by the author, of the fossils from the Hallville mine to the Lower Eocene, and those from near Point of Rocks to the Cretaceous, without any knowledge of the stratigraphical relations of the beds at these localities, or of the existence of any apparent physical break between the two horizons Still, after seeing the remarkable uniformity of the fossils above and below this horizon, the genera being nearly all the same, and the species often *very* closely allied, it is difficult to remove from the mind the impression that the whole should go together as one group.

Fort Union group.—Nearly all of the more extensive and important lignite beds of the Upper Missouri country seem to occur in this group, which also occupies a much more extensive surface-area there than the Judith River group. Whether or not there is any kind of physical break between them where they occur together, the writer has no satisfactory information; but it is very probable that there is none whatever. Owing to this fact, it is also doubtful whether we have been able to refer a few of the fossils described in this report exactly to their proper horizons. This is probably also the case with some of the vertebrates that have been described by others from the Upper Missouri as coming from the Fort Union group, or in a more general way referred to the Upper Missouri Lignite formation. At any rate, the invertebrate fossils from the Judith River group at the typical locality, differ from those here regarded as the characteristic Fort Union group types to such an extent as to warrant the separation of the beds from which they came as a distinct group. The Fort Union species occupy plate 44 and part of plate 43.

Wherever seen resting on the well-marked Cretaceous, the Fort Union group is always found to be conformable to the latter, whether upheaved or lying undisturbed.

Lewis and Clarke, it is believed, were the first explorers who brought

information in regard to the existence of lignite (stone-coal, as they called it) in the Upper Missouri country, though their report gives no suggestions in regard to its geological relations.

In 1843, however, Mr. Edwin Harris, who ascended the Missouri to the mouth of the Yellowstone, with Audubon, the ornithologist, evidently gave more attention to the geology of this region. On his return, in 1845, he published some remarks on this subject in the Proceedings of the Philadelphia Academy of Natural Sciences.* He also brought back a few fossils from the beds near Fort Union, that were submitted to a committee of the Academy, consisting of Dr. S. G. Morton, Prof. Henry D. Rogers, and Walter R. Johnson, who reported that they were fresh-water shells of the genera *Lymnæa*, *Planorbis*, *Anodonta*, etc. They also mention the occurrence in the collection of leaves of trees, and express the opinion that the beds from which these shells and leaves were collected belong to the Tertiary epoch.† This seems to have been the first published opinion in regard to the age of this formation.

In 1849, Dr. John Evans traced these lignite strata from below Fort Clarke on the Missouri to a locality twenty miles below the mouth of Yellowstone River; and, in 1850, Mr. Thaddeus A. Culbertson, who visited this country under the auspices of the Smithsonian Institution, also saw these deposits at a few localities above Fort Union. These gentlemen, however, brought no fossils from these rocks, nor did they publish any sections.

As the expedition of Dr. Hayden and the writer, sent by Professor Hall in 1853, did not visit any of the districts occupied by these beds, of course no additional information in regard to them was thereby obtained.

Most of the years 1854 and 1855, however, were, as elsewhere stated, spent by Dr. Hayden in exploring this country on his own account, and still later, as geologist of Government expeditions under the command of Lieutenant Warren and Captain Raynolds. During Dr. Hayden's sojourn in this country, he collected many fossils from these lignite-bearing strata, both animal and vegetable. The vertebrate remains were studied by Professor Leidy and the plants by Dr. Newberry, while brief preliminary descriptions of the invertebrates were published in the joint names of Meek and Hayden in the Proceedings of the Philadelphia Academy for 1856. All the parties concurred in referring these deposits to the Tertiary; Dr. Newberry even

* Proceed. Acad., 1845, 235.

† Proceed. Acad., 1845, 239.

regarding the plants as Miocene types, which opinion was at one time adopted with regard to the age of this group by Dr. Hayden and the writer in the following words:

"So far as we have been able to compare them [the invertebrate fossils from these rocks] with figures and descriptions of foreign species, the evidence appeared contradictory, some of them being like Miocene and others like Eocene types. As we now have, however, the additional weight of evidence derived from Dr. Newberry's investigations of the fossil flora of these formations in favor of the conclusion that they are of Miocene age, we can no longer hesitate in referring them to that epoch."*

On Dr. Hayden's subsequent discovery, however, that these beds pass at some place beneath the White River group, generally regarded as Miocene, we adopted the conclusion that the Fort Union group is probably Lower Eocene; and the writer cannot remember that either of us has departed from this opinion, though he has never hesitated to mention any facts, when met with, that might seem to cast even slight doubts upon such a conclusion.

Professor Lesquereux, who has devoted much time and study to the investigation of the fossils from this group of the Upper Missouri rocks, from much more extensive collections than those examined by Dr. Newberry, pronounces them decidedly Lower Eocene.

Undoubtedly, confusion has been created by some who have discussed the question of the age of the Lignite formations of the far-West by referring to such deposits in the Upper Missouri, and all over the Rocky Mountain region, as well as away on Vancouver's Island, as if they must of necessity all be of one age. They seem to think that to show that the lignites at some places are Cretaceous or Tertiary, as the case may be, is a strong argument that all are the one or the other, according to their own view of the subject. The fact is, however, the presence or absence of lignite proves nothing of itself, as lignite undoubtedly occurs in both Cretaceous and Tertiary rocks in the far-West. In Western Colorado, Mr. Holmes and Dr. Peale found lignite beds all through the well-marked Cretaceous rocks.

Some, who advocate the conclusion that all of these lignites are of Cretaceous age, refer to the well-known fact that the Coalville mines in Utah and the coal-beds at Bear River, Wyoming, as well as others in Colorado

* Proceed. Acad., Nov., 1856, 268.

and New Mexico, like the Vancouver coals, are unquestionably of Cretaceous age, as if this goes to show that all of the others must also belong to the same. On the other hand, others, who would make them *all* Tertiary, refer to the Evanston and Carbon station mines in Wyoming, and try to ignore the unmistakable evidences of the Cretaceous age of the lignites at other places, as if those evidences are merely exceptional and dubious.

In regard to the relations of the Fort Union group to the Lignite formations along the eastern base of the Rocky Mountains, through Colorado into New Mexico, from which Professor Lesquereux has identified some of the Upper Missouri Fort Union group plants, the author can express no opinion of his own, never having seen a single species of the Fort Union group invertebrates from the strata including the lignite beds at any of these more southern localities. A single species, however, from the coal-bearing strata at Carbon station on the Union Pacific Railroad is probably identical with *Viviparus trochiformis* from the Fort Union group; but the specimen is imperfect, and may belong to an allied species.

As already shown, all of the species of invertebrates yet known from the extensive lignite series along Bitter Creek, farther westward in Wyoming, are clearly distinct from Fort Union group forms; and consequently these Bitter Creek beds cannot be placed on the same horizon with the Fort Union group, on any evidence to be derived from their known invertebrate remains.

Yet it is an interesting fact that among Lieutenant Wheeler's collections from Southern Utah, Dr. White has figured the following Upper Missouri Fort Union group species, viz, *Viviparus trochiformis*, *Goniobasis Nebrascensis*, and *G. tenuicarinata*, from beds referred by all explorers of that region to the Tertiary, and possibly representing the Fort Union group.*

The Fort Union group occupies a large area of country in the region of Fort Union, on the Missouri, and below to Fort Clarke, and beyond on the higher country. From Fort Union it extends southward in a broad belt across the Yellowstone, between the Black Hills and Big-Horn Mountains, to where it was found by Dr. Hayden passing beneath the White River group about sixty miles north of Fort Laramie. It also extends northward into the British possessions, many of its characteristic fossils having been discovered by

* See Dr. White's Report on Lieutenant Wheeler's Collections, pl. xxi.

Professor Dawson, the geologist of the British American Boundary Commission, at different localities north of the boundary-line. Some of the brackish-water deposits, however, mentioned by him, as already stated, almost certainly belong to the older Judith River group.

No continuous detailed section showing all of the beds of the Fort Union group has ever been made out, but Dr. Hayden has roughly estimated its entire thickness at about two thousand feet. The following section, taken by him, of the few beds exposed at and near Fort Union, will give an idea of the general lithological characters of the group as seen at this typical locality, in descending order.

*Section of Fort Union group beds at Fort Union.**

1.	Ferruginous marl, with arenaceous concretions; the upper part being sometimes, for several feet in thickness, composed of concretionary sandstone, forming ledges.—Most common fossil *Viriparus trochiformis.*	20 to 30 feet.
2.	Drab, indurated, arenaceous clay.	20 feet.
3.	Impure lignite, with numerous crystals of selenite.	1 foot.
4.	Gray and drab indurated clay, with, at some localities, numerous impressions of leaves of dicotyledonous trees and of a species of fern.	50 to 70 feet.
5.	Impure lignite, with much silicified wood.	1½ feet.
6.	Gray indurated sand, with a slight mixture of clay.—Contains numerous *Viriparus trochiformis, V. retusus, V. Leai, Goniobasis Nebrascensis,* etc.; also many fragments and entire stumps of silicified trees.	30 feet.
7.	Impure lignite	½ foot.
8.	Yellowish-gray indurated clay.	2 feet.

Of course, the beds of such a formation vary greatly at different localities and different horizons. At some places, too, the beds of lignite are much thicker and of better quality, having a smaller proportion of earthy matter in their composition; this being one of the more marked distinctions between the Judith River and Fort Union groups. In general, the fossils of this group (the invertebrates) are strictly fresh-water types, with a few land-shells. Sometimes, however, as at Fort Clarke, we find a species of *Corbula* among

* Hayden's memoir Geol. and Nat. Hist. of the Upper Missouri, in Amer. Philos. Soc., XII, 96.

the fresh-water forms, and at other places a species of *Hydrobia* and one of a similar new genus that may have lived in brackish water.

As already intimated, the shells of this group are generally found in a remarkably fine state of preservation, looking, as they do, nearly as fresh as dead examples of existing species with the epidermis removed. Although in most cases they are nearly allied to our living North American forms, in a few instances they much more nearly resemble Chinese and Indian species, our *Viviparus trochiformis* being almost exactly like certain angular varieties of *V. Bengalensis* from China, with which they have been compared.

Seeing how very conflicting is the evidence in regard to the ages of this and the Judith River groups, and some similar deposits of the far-west, as derived from the reptilian, molluscan, and vegetable remains, the question naturally suggests itself whether fossils of these kinds, from such brackish- and fresh-water deposits, can be fully relied upon in deciding in regard to their parallelism with particular formations elsewhere. When reptilian remains, pronounced by Professor Cope decidedly Cretaceous types, are found directly associated with numerous remains of plants as confidently considered Tertiary types by Professor Lesquereux, and fresh- and brackish-water shells also occur in the same association, which, from their modern affinities, would be by any palæontologist referred to the Tertiary, it is quite evident that the testimony of all cannot be right. Yet it does not prove that either or any of the authorities are necessarily in error in their verdicts in regard to the affinities of the fossils as interpreted in the light of all past experience. It shows, however, that something has yet to be learned in regard to the geological range of certain types of the *Reptilia* and fossil plants, and that the affinities of new species of fresh- and brackish-water shells to recent forms, especially when the fossil species are yet unknown in any well-established horizon, are not always safe guides. It was too recently that vegetable palæontologists found it necessary to admit the existence of a decided Tertiary flora (according to all previous experience) in Kansas and Nebraska, at a horizon of one thousand to fifteen hundred feet below the top of well-marked Cretaceous strata, for us to feel quite sure that something farther in this department may not remain to be learned, and when known may not require other modifications of views. On the other hand, the occurrence of Eocene types of vertebrates, along with Dinosaurian remains, on the branches of Milk River, already mentioned, shows that we cannot be quite sure that a longer lease of life may not

have been enjoyed by the *Dinosauria* in this country than is yet known to have been granted them in the Old World.

But it may be asked, are we to regard all such fossils as of no use whatever in the determination of the ages of strata? Certainly not, because, even in case future discoveries in this country and the Old World should never modify the present conclusions in regard to the geological range of fossil plants and these types of the *Reptilia*, so as to enable us to use them with more certainty as a means of drawing parallels on opposite sides of the Atlantic, they will undoubtedly be useful, when viewed in their specific relations, for the identification of strata within more limited areas. That is, when all or most of the details of the stratigraphy of the whole Rocky Mountain region and the vertical range of species have become well known, these fossils will perhaps be found nearly as safe guides in identifying strata at one locality with those of others there, as many other kinds.

TERTIARY ROCKS OF THE WIND RIVER AND WHITE RIVER GROUPS.

WIND RIVER GROUP.—This group is not certainly known to exist at any other localities than in the Wind River Valley and west of the Wind River Mountains, Wyoming. It certainly has not been identified in the Upper Missouri country proper, and is only mentioned here because two species from it are described farther on. It probably has no near relations to either the White River or the Fort Benton group, but has been supposed to be of intermediate age, and consequently placed provisionally between them in sections. It consists of gray and ash-colored sandstones, with more or less argillaceous layers, and has been estimated by Dr. Hayden to attain a thickness of fifteen hundred feet or more. So far as explored in the Wind River region, it did not seem to be very fossiliferous; but this may have been because favorable localities were not there met with. It is probably of Miocene age. The only vertebrates found there were one species of *Trionyx* and one of *Testudo;* while the invertebrates collected include one species of *Viviparus* resembling *V. trochiformis*, a *Helix?*, and a fine large *Macrocyclis*. The latter two of these only are figured from this rock in this report (see plate 42).

No marine or brackish-water types are known to occur in this formation, which is probably wholly or in part equivalent to that since called the Bridger group.

WHITE RIVER GROUP.—This group is one of the most interesting in all

the Upper Missouri country, in consequence of the great numbers and fine state of preservation of its Mammalian and Chelonian remains. For some years previous, reports were brought by parties connected with the American Fur Company of the existence of a remarkably rugged country, known as the *Mauvaises Terres*, or Bad Lands, on White River, near the Black Hills, in what is now known as the Territory of Dakota; and it was said that many bones of unknown animals occurred there. The first published account of any of these remains, however, was given by Dr. Prout, of Saint Louis, in the American Journal of Science in 1847. Since that time, very extensive collections altogether have been brought from there by Mr. Culbertson, Dr. Evans, and later by Dr. Hayden and the writer, who visited these localities in 1853 on an expedition sent by Professor Hall. Dr. Hayden has also since the latter date visited the Bad Lands on his own account, and brought back extensive collections of vertebrate remains. All of these collections have been ably investigated and described by Dr. Leidy, partly in Dr. Owen's Report on the United States Geological Survey of Wisconsin, Iowa, and Minnesota, published by the United States Government in 1852, and partly in a quarto memoir published by the Smithsonian Institution in 1853, entitled "The Ancient Fauna of Nebraska"; and also in various smaller papers. Dr. Leidy refers this group to the age of the Miocene of Europe.

The area occupied by the Bad Lands proper is not very extensive, being probably not more than sixty miles in length by twenty-five to thirty in breadth, ranging nearly in a northeasterly and southwesterly direction. The maximum thickness of the formation has been estimated at about 1,000 feet. The material composing the beds mainly consists of indurated clays and grits, subject to soften when wet; and the whole has been weathered into extraordinary naked hills and castellated peaks, so as to present very remarkable scenery. These beds contrast strongly with those of the Fort Union group, being generally whitish or light drab in color, and entirely destitute of lignite, as well as usually of carbonaceous matter in any form. Where seen resting upon the Fort Union group, they are found to be unconformable to the same. The following section, taken in descending order by Dr. Hayden, will serve to convey a general idea of the nature of these deposits, and the positions of some of the leading fossils in the same at the typical localities

Section of the White River group on White and Niobrara Rivers.

E.	Coarse, heavy-bedded, compact, or sometimes incoherent sandstone; sometimes forming large masses of conglomerate, or, in other instances, tabular limestone [horizon of *Limnæa, Physa,* and *Planorbis,* described in this report].—Only fragments of Mammalian remains.	180 to 260 feet.
D.	Dull reddish indurated grit, with larger silico-calcareous concretions; sometimes forming a heavy-bedded fine-grained sandstone.—Comparatively few organic remains.	350 to 400 feet.
C.	Very fine yellow calcareous sand, with numerous layers of concretions, with but few organic remains; passing down into a variegated bed consisting of dark-brown clay and light-gray calcareous grit.	50 to 80 feet.
B.	Flesh-colored argillo-calcareous indurated grit; passes down into gray clay, with layers of sandstone, underlaid by a flesh-colored argillo-calcareous stratum.—Tortoises, *Oreodon,* and many other vertebrates; also *Helix Leidyi.*	80 to 100 feet.
A.	Light-colored fine sand, with more or less calcareous matter, passing down into an ash-colored plastic clay, containing masses of sandstone; then ash-colored clay with a greenish tinge, underlaid by light-gray and ferruginous sand and gravel, with pinkish bands. Traversed in every direction by seams of chalcedony.—*Titanotherium,* bones and teeth.	80 to 100 feet.

As no marine or brackish-water remains have been found in this group, it is evidently an extensive fresh-water lacustrine deposit. The number of vertebrate remains that have been found in it in the comparatively small area occupied by the Bad Lands is truly surprising. Up to 1861, Dr. Leidy had described more than sixty species of these fossils from this region, belonging to the *Ruminantia, Multungula, Solidungula, Rodentia, Carnivora,* and *Chelonia;* and Professor Marsh has since described a number of others. The Molluscan remains, however, yet known from these beds make but a small showing compared with the vertebrates, as we only know some five or six species belonging to the genera *Helix, Planorbis, Limnæa,* and *Physa* (see plate 45). So far as yet known, vegetable remains seem to be very rare in this group.

Although the area of the Bad Lands proper is comparatively small, the

formation spreads out over an extensive space south of the Black Hills in Nebraska, and extends into Colorado and the northwestern corner of Kansas, narrowing rapidly southward, however, after passing into those States. A few vertebrate remains are sometimes found in it south of the Bad Lands; but the latter seem to be the grand repository of these interesting relics of extinct beings.

On Loup River, a small tributary of the Platte, and at other places in Nebraska, there is a Pliocene lacustrine deposit overlying the White River group, or rather occupying depressions in it, that has also afforded some interesting extinct vertebrate remains, some years back described by Dr. Leidy, and others by Professor Marsh. As these beds, however, have only afforded a few species of invertebrates (*Helix*, *Physa*, etc.), and these apparently of recent species, this formation need receive no especial notice here.

Before closing this introduction the author desires to acknowledge his obligations to Capt. H. T. Brian, the efficient foreman of printing at the Government Printing-Office, for his efforts to reduce to a minimum the difficulties arising from the proof-sheets having to be sent to distant parts of the country for correction as the work went through press.

CRETACEOUS SPECIES.

RADIATA.

POLYPI.

ACTINARIA.

FUNGIIDÆ.

Genus MICRABACIA, Edwards and Haime.

Synon.—*Cyclolites*, Wm. Smith (1816), Strata identified by Org. Foss., 15 (not Lam.).
Fungia (sp.), Goldf. (1826), Petref. Germ., I, 5.—F. A. Roemer (1840), Die Verst. des Nord. Kreid., 25 (not Lam.).
Micrabacia, E. & H. (1849), Comptes rendus, XXIX, 71; and (1853), Introd. Brit. Foss. Corals, xlvii.

Etym.—μικρός, small; ἄβαξ?, a table, or counting-board.
Type.—*Fungia coronula*, Goldf.

Corallum simple, lenticular or plano-convex; septa not extremely numerous; walls not echinate, and perforated in a regular manner (E. & H.).

This very small group of fungiod corals only includes two known species, one of which—the type of the genus—occurs in the Middle Cretaceous of Europe, and the other in the Upper Cretaceous of America.

Micrabacia Americana, M. & H.

Plate 28, figs. 1, *a*, *b*, *c*, *d*.

Micrabacia coronula, Meek and Hayden (Oct. 1860), Proceed. Acad. Nat. Sci. Philad., 430 (not *M. coronula*, Edwards and Haime, 1850).
Micrabacia Americana, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 2.

Corallum small, subplano-convex, or slightly concave below, and convex with a rather deep central depression above. Intercostal foramina of the

mural disk, oval and numerous. Rays or costæ of the under side straight, about twelve at the middle, but bifurcating so as to number near one hundred around the periphery, apparently denticulate. Septa few at the center, but increasing by the intercalation of smaller ones between, so as to equal the number of the costæ, with which they alternate at the periphery, very finely and sharply denticulate on the upper and lateral edges.

Breadth, 0.28 inch; height, 0.12 inch.

Up to this time, all our knowledge of this little coral has been derived from sections, and impressions of it seen in masses of rock. It is certainly very closely allied to the European *M. coronula*, to which we had at one time referred it. It seems to differ, however, judging from Edwards and Haime's figures of *M. coronula*, in having the edges of its septa more finely and more sharply, as well as more regularly, denticulate. This difference, taken in connection with its higher geological position, has led me to think it most probably a distinct species.

This and a small undetermined, turbinate form, of which we have only seen fragments, are the only calcareous corals yet observed in the Cretaceous rocks of the Upper Missouri country; and these are both very rare.

Locality and position.—Moreau River; from the Fox Hills group, or No. 5 of the Upper Missouri Cretaceous series.

ALCYONARIA.

GORGONIIDÆ.

Genus WEBSTERIA, Edwards and Haime.

Synon.—*Websteria*, Edwards and Haime (1854), Corals of the London Clay, 43.

Etym.—Dedicated to Mr. Frederic Webster, an English naturalist.

Type.—*Websteria crisioides*, E. & H.

Corallum composite, slender, dichotomous, with straight, flat branches of the same size as the stems, extending out on one plane, and diverging at acute angles from each other; corallites forming little protuberances, oppositely arranged along the edges of the stems and branches in vertical series; calices small, circular, and oblique; stems and branches with a median line or furrow along the flat sides, and sometimes splitting longitudinally so as to expose a filiform central axis.

Breadth of branches about 0.03 inch, and height of corallites a little less.

The foregoing are substantially the characters of this genus given by Edwards and Haime. Although these authors arranged it in the *Gorgoniidæ*,

they remark that it is very similar to some *Sertulariidæ*, and even more like certain types of *Polyzoa*.

In regard to the geological range of this genus, we only know that the typical species was found in the Eocene Tertiary of England; while the form here provisionally referred to it occurs in the Upper Cretaceous.

Websteria cretacea, Meek.

Plate 28, figs. 3, *a*, *b*, *c*.

Websteria cretacea, Meek (1864), Smithsonian Check-List Cret. Fossils N. Am., 2.

The specimens of this curious fossil in the collection do not give a very clear idea of its mode of branching; indeed, I was for some time inclined to think it entirely simple. In a few instances, however, fragments of it have been seen that bifurcate once; and as none of those yet observed are more than 0.66 of an inch in length, I have been unable to determine whether or not it bifurcates more than once, though it probably does.

Each of the numerous fragments yet seen measures uniformly about 0.03 inch in breadth. They are flattened or compressed, and provided with a central axis, the diameter of which is about one-third the breadth of the branches. In many instances there is along the middle of the stems and branches, instead of the raised thread-like axis, a groove, as though the fossil had split through the center in breaking the matrix, leaving, in one part, the axis, and, in the other, a corresponding groove. This appearance, however, may be deceptive, as I have never been able to see more than one side of the same individual, and consequently do not know whether there is not always a raised axis on one side, and a corresponding groove on the other.

The cellules are small, directly opposite, and occupy serratures regularly disposed in the lateral margins, at intervals about equal to the breadth of the branches, exactly as in many graptolites. A little below where the stems bifurcate, they become slightly broader, and gradually develop two axes, which diverge to the point of bifurcation, where they separate, one following along the center of each of the branches, which diverge at an acute angle.

It is with some doubts that this fossil is here referred to the above Eocene genus, but it seems to present, so far as known, no very important characters by which it can be distinguished. Specifically, it differs from *W. crisioides* of Edwards and Haime (Fos. Corals London Clay, p. 42, pl. 7,

fig. 5) in having the marginal serratures more angular, and the cellules less distinct; while the stems appear to bifurcate less frequently.

Locality and position.—South Branch of the Cheyenne River, near Black Hills; in Fox Hills group, or formation No. 5 of the Upper Missouri Cretaceous, where it is associated with *Avicula Nebrascana* and *Scaphites Mandanensis.*

Genus **MICROSTIZIA**, Meek.

Etym.—μικρός, small; στίξις, puncture; in allusion to the numerous minute punctures of one side.
Type.—*M. millepunctata*, M.

Microstizia millepunctata, M.

Plate 28, figs. 2, *a*, *b*, *c*.

The few fragments of this fossil yet found are so imperfect that no attempt will be made here to give a formal diagnosis of the genus; but, as it seems not to agree in its generic characters with any of the described groups, I have ventured to propose, provisionally, a new genus for its reception. As nearly as can be determined from the imperfect specimens in the collection, it appears to have consisted, when entire, of a reticulated, leaf-like corallum, slightly flexed along the middle, but destitute of a distinct midrib. The fenestrules on each side of this imaginary midrib are oval or subcircular, and disposed in irregular oblique series; while the middle portion is occupied by two rows of more elongated, alternating fenestrules, arranged parallel to the longer diameter of the fossil. Cross-fractures show the whole corallum to be composed of an extremely thin, flattened, corneous central axis, covered by a comparatively thick spongy tissue.

The rays and dissepiments between the fenestrules are about equal in breadth to the latter, and the only side yet seen is occupied by innumerable, extremely minute, crowded punctures, or pores, entirely invisible to the unassisted eye, or even under a low magnifying power. As none of the specimens in the collection show the opposite side of the fossil, some doubts remain in regard to the nature of the minute pores mentioned, which seem entirely too small to be the cells occupied by the polyps. When better specimens showing the other side can be examined, it will probably be found occupied by the animal cells.

It is only provisionally that this fossil is placed here under the head of the *Alcyonaria*, as it may be found even to belong to the *Polyzoa.*

Locality and position.—Moreau River, Nebraska; Fox Hills group of the Upper Missouri Cretaceous series.

ECHINODERMATA.

ECHINOIDEA.

SPATANGIDÆ.

Genus HEMIASTER, Desor.

Synon.—Spatangus, Micraster, &c. (sp.), of several authors.
Hemiaster, Desor (1847), Cat. Rais., 121; and (1858), Synop. Éch. Foss., 367.

Etym.—ἥμι, a half; *ἀστήρ*, a star.
Examp.—Hemiaster phrynus, Desor.

Body small, short, and depressed, truncated posteriorly; provided with a more or less angular peripetal fasciole: without lateral, subanal, or marginal fascioles. Ambulacra well defined, a little concave, and diverging; anterior groove not very profound, often narrower than the lateral or posterior ambulacra. Peristome bilabiate. Apical disk very compact, and showing distinctly the four genital pores.

As has been observed by Professor Desor, in his "Synopsis des Échinides fossiles," this genus includes two sections, one of which, the typical Hemiasters, is characterized by having much shorter posterior than anterior ambulacra, while in the other the anterior and posterior ambulacra are of nearly equal length. These two subgroups would seem, upon a hasty examination, to be sufficiently distinct to rank as genera; but on comparison of a large number of species, the transition from one to the other is discovered to be so gradual that it has not been found practicable to separate them into distinct genera.

So far as known, the genus *Hemiaster* seems to have been introduced during the deposition of the "Lower Green-sand" of English geologists. It ranges through the other Cretaceous deposits, during the deposition of which it attained its greatest development. It is also represented by a number of species through the various Tertiary rocks, even down to the Miocene, but is not known among the recent *Echinoidea*.

Hemiaster Humphreysanus, M. & H.

Plate 10, figs. 1, *a, b, c, d, e, f, g*.

Hemiaster? Humphreysanus, Meek and Hayden (May, 1857), Proceed. Acad. Nat. Sci. Philad., 147.

General form broad cordate, oval, or subcircular; greatest elevation near the posterior side, declining very slightly toward the front, broadest a little in advance of the middle, and flattened below; oral aperture small, transversely

oval, a little arcuate, the convex side being toward the front, located about one-fourth the length of the fossil from the anterior side; vent small, and a little higher than wide; apical disk not more than one-third the length in advance of the posterior end; genital pores rather larger; dorsal ambulacra, excepting the odd one, distinctly petaloid, and very unequal; anterior or odd one long, lanceolate, and extending nearly to the margin, located in a rather deep, rounded groove, which passes over the front to the mouth, giving a faintly emarginate outline to the anterior end, provided with about thirty-three pairs of pores in each series; anterior lateral ambulacra slightly flexuous, a little broader than the odd one, and not quite so long, placed in rather distinct grooves, and having about thirty-five or thirty-six pairs of pores in each series; posterior ambulacra very small, not more than about one-third as long as the anterior laterals, oval in form, a little depressed, but not deeply excavated, and having some eighteen pairs of pores in each series; interambulacral spaces rather prominent, the anterior two being a little pinched up; surface unknown.

Length, 1.21 inches; height, 0.81 inch; breadth, 1.20 inches.

Not having seen specimens showing the surface-markings of this species, it is with some doubt that it has been referred to the genus *Hemiaster*, since it is impossible to determine from the specimens whether or not it possessed the peculiar fasciole characteristic of that genus. The posterior position of the apical disk, and the close proximity of the mouth to the front, as well as the great disparity of size between the posterior and anterior lateral ambulacra, are characters in which it differs from forms usually referred to the genus *Toxaster*. In some respects it resembles species of the genus *Schizaster*, but it does not decline so distinctly toward the front above, and is not so angular behind, as is common in that genus. When specimens are obtained showing all its characters, it is possible that there may be found sufficient differences between it and the groups already defined to entitle it to rank as the type of a new section.

It is a little remarkable, that, in all the collections hitherto obtained from the Cretaceous rocks of the Upper Missouri, this is the only species of *Echinoidea* yet found, and it is so rare that but two specimens, and a fragment of another from the same locality, have been met with.

The specific name of this interesting fossil was given in honor of Capt. (now General) A. A. Humphreys, of the U. S. Topographical Engineers.

MOLLUSCA.

BRACHIOPODA.

LYOPOMATA.

LINGULIDÆ.

Genus LINGULA, Bruguière.

Synon.—*Lingula*, Brug. (1792), Encyc. Méth., tab. 250.—Cuvier (1798), Tabl. élem., 435; and (1802), Ann. du Mus., I, 69.—Lamarck (1799), Prodr., 89; and (1801), Syst. An., 140.—Roissy (1805), Moll., VI, 468.—Schw. (1820), Nat., 690.—Desh. (1830), Man., 257, &c.
Pharetra, Bolten (1798), Mus. Bolt., sec. ed., 111 (not Hubn., 1816).

Etym.—*Lingula*, a little tongue.
Type.—*Lingula anatina*, Lam.

Shell thin, oblong or more or less oval, depressed, gaping at the beaks, subequivalve, rounded or subtruncate anteriorly, and more or less pointed at the umbones; substance largely phosphatic in composition, and consisting of alternate corneous and testaceous laminæ, the former of which is fibrous, and the latter tabular; valves both moderately convex or compressed, and held together by the action of muscles; beak of ventral valve more prominent and pointed than the other; surface smooth, or marked by concentric striæ, sometimes crossed by radiating lines, covered by a thin epidermis; interior without projecting laminæ or other processes. Peduncle long, cylindrical, fleshy, and flexible, being supplied with muscles, by means of which the animal can bend it about when detached, or move itself and the shell when attached to some foreign body at its extremity.

The interior of the valves, in the typical forms of this genus, is largely occupied posteriorly by the marks of the visceral sack and the scars of the complex muscular system. In the dorsal or shorter valve, this visceral area has a somewhat rhombic or suboval form, and in the ventral valve its outline is ovate-cordate, or more or less flabelliform. The area thus designated is usually slightly thicker in both valves than other parts of the shell, especially in old examples, so as to leave a faint impression on internal casts of fossil species.

Twelve muscular scars have been observed in the interior of the dorsal valve, and thirteen in the ventral. The scar of the peduncular muscle is situated

immediately within the beak of the ventral valve; and just in front of this is the scar of the divaricator muscles (of Handcock = posterior adductors of Woodward). At the anterior extremity of the visceral area, in the middle of the same valve, are the four very unequal impressions of the posterior adductor and external and central adjustor muscles (of Handcock), which are so arranged as to impart a more or less trilobate outline to the anterior margin of the slightly convex visceral area. Behind these, and just within each lateral lobe of the visceral area, are situated, one on each side, the widely-separated anterior occlusor scars; and still farther back are seen, on each side, those of the posterior adjustors, of which there are two on one side, and one larger one on the other.

In the dorsal valve there is no peduncular attachment, but the scar of the divaricator muscles is located nearly as in the other valve. The two anterior occlusor impressions of this valve are placed in contact centrally, side by side, at the farthest exterior extremity of the visceral area; and just behind these, and a little separated from each other, are the two impressions of the posterior occlusor muscles. About midway between the latter and the posterior extremity of the visceral area are situated, near each lateral margin, the small scars of the posterior external and internal adjustor muscles, of which there are four on one side, and three on the other, one of the latter being considerably larger than the others.

This genus is nearly related to *Lingulepis* of Hall, and, so far as yet known, only distinguished by the more attenuated beaks and much more distinctly trilobate form of the visceral scar in the typical form of the latter. There were, however, probably differences in the arrangement of the details of the muscles in these two types that have not yet been determined, the muscular impressions of *Lingulepis* being still unknown.

Lingulella of Salter is another allied type that was separated from *Lingula* chiefly on account of having a furrow extending along a kind of false cardinal area to the beak of the ventral valve, as supposed, for the reception of the pedunele. No such furrow has yet, I believe, been observed in any species certainly known to belong to *Lingulepis;* but there are some reasons for suspecting that this latter type may not be distinct from Mr. Salter's *Lingulella;* at least, I have seen a species agreeing with the latter in the possession of the false area and furrow, and yet showing, in the interior of the ventral valve, a similar trilobate visceral scar to that seen in the corresponding valve of the type of *Lingulepis.* (See Proceed. Acad. Nat. Sci. Philad., Oct., 1871, 185.)

The existing genus *Glottidia*, Dall, is likewise closely related to *Lingula*, but differs in having two internal projecting laminæ, diverging and extending forward from the beak of the ventral valve about one-third of the length of the shell.

The genus *Lingula* was introduced at a very early period; at least, we find species that are in no way distinguishable from it by any external characters, in some of the oldest Silurian rocks. Its shells are also found through all the subsequent formations, and several species are known to inhabit our existing seas. It seems to have attained its maximum development during the Silurian age. In rocks of all ages its shells present very nearly the same dark, shining appearance, and have been found to possess the same more or less phosphatic composition.

The existing species are found on the coasts of the Sandwich and Philippine Islands. They inhabit shallow water, being generally found at low tide, with their long pedunele deeply penetrating the sand or mud. The species often mentioned in lists, from North and South Carolina and California, are said all to possess the internal character of the genus *Glottidia*.

Lingula nitida, M. & H.

Plate 28, figs. 18, *a*, *b*.

Lingula nitida, Meek and Hayden (1861), Proceed. Acad. Nat. Sci. Philad., 443.

Shell small, moderately convex, extremely thin, narrow-subelliptic in outline, the greatest breadth being near the middle and generally less than half the length; front very narrowly rounded, sides forming very slightly convex curves; beaks rather obtusely pointed, that of the ventral valve being a little more prominent than the other; valves nearly equally convex, the greatest convexity being along the middle; surface polished, and only marked by very fine lines of growth, which are obsolete on the more convex parts of the valves, but become moderately distinct on each side.

Length, 0.33 inch; breadth, 0.16 inch; convexity of the two valves about 0.09 inch.

This shell may be readily distinguished from *L. subspatulata*, H. & M. (Mem. Am. Acad. Arts and Sci. Boston, V, 380, pl. 1, figs. 2, *a*, *b*), the only other species known from these rocks, by its uniformly smaller size, proportionally narrower and more convex form, as well as by its narrowly rounded

instead of subtruncate anterior margin. It never attains one-fifth the size of *L. Rouliniana*, d'Orbigny (Paléont. Fr. Terr. Crét., Brach., 10, pl. 490, fig. 1), and has a much less pointed beak, as well as a more narrowly rounded front margin.

Locality and position.—Mouth of the Big Horn River; from the horizon of the base of the Fox Hills group, where it was found associated with *Pteria* (*Oxytoma*) *Nebrascana*.

LAMELLIBRANCHIATA.

MONOMYARIA.

OSTREIDÆ.

Genus OSTREA, Linnæus.

Synon.—*Ostracites*, *Ostraites*, *Limnostracites*, *Ostreum*, &c. (sp.), Llwyd, Klein, and other pre-Linnæan authors.

Ostrea, Linnæus (1758), Syst. Nat., 10th ed., 696.—O. F. Müller (1776), Prodr. Zoöl. Dan., xxxi and 247.—Brug. (1789), Encyc. Meth., I, xiii.—Lam. (1799), Prodr. 81; and Syst. (1801), 132, &c.

Peloris, Poli (1791), Test. Utr. Sic., 33.

Peloriderma, Poli (1795), *ib.*, II, 255.

Lopha, Bolten (1798), Mus. Coll., 2d ed., 117.—H. and A. Adams (1858), Genera Recent Moll., II, 569 (as subgen. under *Ostrea*).

Alectryonia, Fischer de Waldheim (1807), Mus. Dem.; and (1835), Bull. Mosc., VIII.—Chenu (1862), Man. Conch., II, 167.—Stoliczka (1871), Pal. Indica, III, 454 (sec. *Ostrea*).

Dendrostrea, Swainson (1840), Malacol., 387.—G. B. Sowerby (1839), Conch. Man., 137.

Gryphæostrea, Conrad (1865,) Am. Jour. Conch., I, 15; (subgenus).

Etym.—*ὄστρεον*, an oyster.

Type.—*Ostrea edulis*, Linn.

Shell irregular, laminated, subnacreous, attached by the left or under valve; surface sometimes nearly smooth, but more frequently provided with more or less prominent imbricating laminæ and smaller marks of growth, or plicated, and very rarely armed with projecting root-like processes. Upper valve flat or concave, and often plane; lower valve convex, and having a prominent beak. Ligament occupying a mesial longitudinal furrow, extending to the beaks in a kind of cardinal area marked by transverse striæ. Muscular impression subcentral.

Of the genus *Ostrea*, there are three sections or subgenera, that are even viewed by some as forming distinct genera. These may be defined as follows:

1. OSTREA, Linn. (typical).

Shell variously shaped, and merely with concentric imbricating marks or laminæ of growth, or sometimes rather obscurely costate, the costæ not extending to, or strongly plicating the free margins.—*O. edulis*, Linn.

2. ALECTRYONIA, Fischer (= *Lopha*, Bolten; and *Dendrostrea*, Swainson).

Shell often elongated and strongly arcuate laterally, with hinge-line more straight, extended, and lateral margins on each side of the beaks more or less dilated; surface strongly plicated, the plications imparting a distinct zigzag appearance to the free margins, and very rarely bearing slender projecting processes; muscular scars eccentric.—*O. cristagalli*, Linn.: *O. carinata*, Lam.

3. GRYPHÆOSTREA, Conrad.

Shell thin, elongate, straight, narrow; lower valve rather deep and smooth; upper valve flat or slightly concave, and ornamented with distant, regular, thin, concentric laminæ; beak of lower valve contorted, or turned to one side; cartilage-pit narrow, oblique.*—*Gryphæa vomer*, Morton (sp.).

The genera *Gryphæa*, Lamarck, and *Exogyra*, Say, are included by some authors as sections of the genus *Ostrea;* but, although it is sometimes very difficult to decide to which of these genera certain forms of these shells should be referred, they can generally be readily separated into the three groups, and this arrangement has been found very convenient. Both of the latter genera usually have a more regular subovate or orbicular form than the oysters, and more frequently became free at a very early stage of growth; the umbo of the under valve being thus generally less distorted, or often without visible scar of attachment. In *Gryphæa*, the surface is generally smoother, and the beak of the under valve nearly always differs from that of *Ostrea* in being more produced and curved upward, or sometimes even spirally twisted; while that of its upper valve is more frequently truncated.

* Mr. Conrad did not publish a diagnosis of this type, but merely gave the name in a list of fossils. At my request, however, he gave me in manuscript the above diagnosis, and mentioned the above type. I would add, that in perfectly-preserved specimens, the typical species, presents the singular peculiarity of throwing out *long*, slender, auricular appendages (one on each side) from the lower valve near the beak. These being very fragile, are nearly always broken away, as the specimens are found; but I observed several with more or less of them preserved, in the New Jersey beds; and one I found growing in the inside of a *Gryphæa vesicularis* with them perfectly preserved, and apparently attached to the *Gryphæa* by their extremities. This type or section might, with almost equal propriety, be placed as a subgenus of *Exogyra*

On the other hand, *Exogyra* differs in having the beaks of both valves strongly curved laterally (to the left), and often distinctly spiral, with the ligament-furrow narrow, following the curvature of the beak of the under valve, and frequently but little defined in the upper valve.

The genus *Ostrea* seems to date back to the Carboniferous period; *O. nobilissima*, de Koninck, being apparently a well-defined oyster from the Lower Carboniferous of Belgium. Professor Winchell has also described a small oyster (*O. patercula*), said to have been found in the yellow, fine, arenaceous beds at Burlington, Iowa, equivalent to the Waverly group of the Ohio Lower Carboniferous. De Verneuil has also described a small shell, under the name *O. matercula*, from the Permian of Russia; but it has rather more the aspect of a *Gryphæa* than that of a true oyster.

It is remarkable that these older species seem to have been represented by so few individuals, only two specimens of the Belgian species being known to Professor de Koninck; and but a single specimen of *O. patercula* was found, while the more modern oysters seem always to have been gregarious.

The shells of oysters are not uncommon in the Triassic rocks; and the number of species increases as we ascend to later formations. The group *Alectryonia* is most numerously represented in the Mesozoic formations, but diminishes in the Tertiaries; while *Gryphæostrea* seems to be confined to the Cretaceous and Lower Eocene. The typical oysters continued to increase during subsequent epochs, and probably attain their maximum numerical development at the present time; though some of the Tertiary species far exceeded in size any of the known existing oysters; *O. longirostris*, for instance, having been found two feet in length. *O. Georgiana*, of this country, also probably attained an equal size.

Ostrea (sp. undt.)

Plate 2, figs. 8, *a*, *b*.

As I have only seen casts of the interior and impressions of the exterior of this little oyster, I cannot with any degree of certainty identify it with any of the described forms; and in a genus like this it would be merely adding a name, without establishing a species on any well-defined characters, to attempt to describe it as new from such material.

As near as can be determined from the specimens yet seen, it seems to be a small, rhombic-subovate species, with a moderately convex under valve,

and a flat upper one. Impressions of the surface of the latter show merely small imbricating marks of growth; while internal casts of the former retain a few obscure concentric undulations, crossed by a few oblique, faintly-marked, radiating ridges.

Length of largest internal cast seen, 1.08 inches; breadth, 0.65 inch; convexity, about 0.30 inch.

Locality and position.—From a rough ferriginous sandstone, belonging to the Dakota group, at a locality twelve miles southwest of Salina, Saline County, Kansas. Collected by Prof. B. F. Mudge.

Ostrea congesta, Conrad.

Plate 9, figs. 1, *a*, *b*, *c*, *d*, *e*, *f*.

Ostrea congesta, Conrad (1843), Nicollet's Report of Explorations in the Northwest, 167.—Hall and Meek (1854), Mem. Am. Acad. Arts and Sci. Boston, VIII,(n.s),405.—Meek and Hayden (Nov., 1856), Proceed. Acad. Nat. Sci. Philad., 286.—Hall (1856), Pacific R. R. Reports, III, 100, pl. 1, fig. 11.

"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 continued to grow, to lengths varying from 0.25 to 1 inch, when the margins were 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 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 inornata, M. & H.

Plate 10, fig. 4.

Ostrea inornata, Meek and Hayden (May, 1860), Proceed. Acad. Nat. Sci. Philad., 181.

Shell small, narrow-subovate, rather thin, attached by the whole under surface of the lower valve; beaks pointed and more or less laterally arcuate, usually turned to the left side; under valve conforming to the irregularities of the surface to which it is attached, moderately concave, area small and narrow; upper valve rather convex, having its beak less pointed than that of the other valve; surface smooth, or only marked by very obscure lines of growth, with sometimes a few very small, irregular, nearly obsolete, radiating markings near the lower border.

Length, about 1.40 inches; breadth, 0.87 inch.

This seems to be a rather rare species, since we have seen but three or four specimens of it. Only one of these (an upper valve) shows the muscular impression, which is comparatively large, of an irregular subcircular form, and placed nearer the left side. One individual shows that the inner margin of the under valve, near the beaks, was obscurely crenulate. It is quite distinct from any other species obtained in the northwestern formations.

In most of its characters, the upper valve of this species resembles that of *O. plumosa*, Morton, excepting that its radiating markings are more obscure. Its lower valve, however, in the only example of it yet seen, differs remarkably in being attached by its whole under side.

Locality and position,—Great Bend of the Missouri, below Fort Pierre; lower part of the Fort Pierre group, or No. 4 of the Upper Missouri Cretaceous series.

Ostrea pellucida, M. & H.

Plate 28, figs 4, *a*, *b*.

Ostrea larva, Hall and Meek (1854), Mem. Amn. Acad. Sci. and Arts, Boston, V, (n.s.), 406.—M. & H. (Nov., 1856), Proceed. Acad. Nat. Sci. Philad., 286 (not *O. larva*, Lam.)
Ostrea pellucida, Meek and Hayden (Oct., 1860), Proceed. Acad. Nat. Sci. Philad., 429.

Shell small, thin subovate or elongate-oval, arcuate laterally, usually attached from the umbo to near the middle of the under valve: borders undulated, so as to form a few obscure plications, which extend but slightly in from the edge; margins near the cardinal end distinctly crenate; surface with moderately distinct marks of growth, which sometimes become nearly obsolete. Lower valve convex, usually with a well-defined scar of attachment; upper valve nearly flat, or more or less convex near the beak.

Length, from beak to the opposite extremity, 1.32 inches; breadth, 0.70 inch; convexity, 0.40 inch.

This species resembles somewhat *O. larva* of Lam. (= *O. falcata*, Morton, Synop. Org. Rem., p. 50, pl. 3, fig. 5, and pl. 9, figs. 6–7), and is the same shell referred with doubt to that species in the papers above cited. A careful comparison of other specimens shows that it is clearly distinct, as it is never near so strongly and regularly plicated as *O. larva*, and is always entirely destitute of any traces of auricular appendages, and wants the straight hinge of that species; while it has a large and distinct scar of attachment, showing that the under valve was attached from the beak to near the middle. In the latter character, it is more like *O. crenulata* of Tuomey; but it wants the closely-set squamose ridges of that species.

From the last-described species, it differs in having its margins waved or subplicated, and in not being attached by the whole of its under surface. In the few obscure flexures of its lateral margins, it approaches the *Alectryonia* group; but as it wants the straightened hinge and auriculate character of that group, and has the plications but slightly developed, it may about as well go with the typical oysters.

Locality and position.—Long Lake and Moreau River; from the Fox Hills group, or No. 5 of the Cretaceous series of the West.

Ostrea (Gryphæostrea?) subalata, Meek.

Plate 28, fig. 5.

Shell small, longitudinally oval, more or less arcuate laterally; margins waved, or forming some four or five obscure undulations, which extend but

slightly in from the edges, somewhat crenate near the hinge; both valves distinctly auriculate on the left side near the beaks; surface with small concentric marks of growth. Under valve convex; umbo more or less distorted by the scar of attachment, pointed and distinctly curved to the left. Upper valve nearly flat, excepting the marginal undulations; beak small, its immediate apex curved to the left, but not projecting beyond the cardinal margin.

Length, from the umbo to the opposite extremity, 1.20 inches; breadth, exclusive of the auricular appendage, 0.70 inch; convexity, 0.45 inch.

This species is nearly of the same size as the last, and resembles it in some respects; but, so far as yet known, it seems to be distinguished by the decided lateral curvature of its beaks, and the presence of an auricular appendage on the left side of both valves, near the beaks.

It appears to be nearly related to *O. lateralis*, Neilson (= *Gryphæa vomer* [?], Morton, Synop. Org. Rem., p. 54, pl. 9, fig. 5). It differs from Neilson's species, however, in having its upper valve auriculate, as well as the lower, and its margins subplicate. Its upper valve also differs in not having distinct, regularly-arranged, concentric, imbricating laminæ. Both of these species seem to stand, as it were, intermediate between the true oysters and *Exogyra*.

Locality and position.—Moreau River; in the Fox Hills group, or formation No. 5 of the Cretaceous series.

Ostrea (Gryphæa?) patina, M. & H.

Plate 10, figs. 2, *a*, *b*; *a*, *b* (*bis*), and 3, *e*, *f*: also pl. 11, varieties.

Ostrea patina, Meek and Hayden (Nov., 1856), Proceed. Acad. Nat. Sci. Philad., 277.

Shell subcircular or subovate, a little oblique, rather compressed. Superior valve concave above, thin, excepting at the beak, where it is thickened and truncate; area broad, triangular, standing nearly at right angles to the plane of the shell, and broadly depressed in the middle; lateral margins near the area more or less contracted. Inferior valve thicker, moderately convex; lateral margins near the beak sometimes considerably thickened and distinctly lamello-striate; beak triangular, much compressed, projecting beyond the cardinal border and slightly curved upward at the point, without any visible scar of attachment; area comparatively small, broad, triangular, having a wide, shallow depression along the middle. Muscular impression subcircular or transversely oval, moderately distinct, located nearer the left side, and about half-way between the beaks and the postero-ventral extremity.

Surface only marked by obscure lines, and small, irregular, nearly obsolete wrinkles of growth.

Length and breadth of a medium-sized specimen, each about 2.40 inches; concavity of lower valve, 0.65 inch.

The specimens from which the above description was made out might with almost equal propriety be referred to *Gryphæa*, and really bear some resemblance to *Gryphæa vesicularis*, Lam. (= *G. convexa* of Say and Morton); but they present well-marked and constant differences from all the numerous varieties of that protean species. In the first place, the lower valve of our shell is never so ventricose as that of the common varieties of *G. vesicularis*, and always differs in having its cardinal margin sloping from the beaks instead of being extended in a right line, and auriculate at the extremities. Again, its umbo is never near so gibbous, nor so distinctly incurved as is usual in that species; while its upper valve is always destitute of any traces of the radiating depressed lines generally seen on that of *G. vesicularis*.

In the shallowness of its under valve, and the compressed form of its beak, it agrees with *G. mutabilis* of Morton (which is also generally regarded as a marked variety of *G. vesicularis*); but it differs in the other characters mentioned, as *G. mutabilis* has the cardinal margin as straight, and its extremities as distinctly auriculate, as well as its smaller valve as strongly marked with radiating lines, as the more convex varieties of *G. vesicularis*.

Associated with the specimens presenting the characters given in the foregoing description, there are many others which pass by slight shades of difference into much more irregular forms. Some of these scarcely differ in any other respects from those we have taken as the type of the species, than in having the umbo of the lower valve a little distorted by the scar of attachment; while others show still more and more distinct marks of attachment, become more elongate or ovate in form, and have the left or anal margin near the beak more and more sinuous, until they have departed widely from the typical forms. It is possible that some of these may belong to one or more distinct species; but I confess, after a careful study of a large number of specimens, that I am totally at a loss to find constant characters by which they can be separated. I therefore prefer, with the information now at command, to present some of the best marked of these different forms rather as varieties than as different species.

Variety A, pl. 10, figs. 3, *e*, *f*.—Obliquely broad oval; beak of under valve considerably distorted, and the area nearly obliterated by the scar of attachment; anal side having a broad shallow sinus near the hinge, produced or prominent near the other extremity; anterior and antero-ventral border forming a broad, nearly semicircular curve.

Length and breadth, each about 3 inches; concavity of under valve, 0.70 inch.

Variety B, pl. 11, figs. 3, *a*, *b*.—Obliquely ovate, narrow near the beaks, and widening toward the other extremity; beak of lower valve somewhat distorted on the left side by the scar of attachment, curving but slightly upward; lateral margin near the right side of the beak thickened, but thin and contracted on the other side.

Length, 3.10 inches: breadth, 2.30 inches; concavity of under valve, 0.35 inch.

O. intermedia would be a good name for this form if further comparison should show it to be a distinct species.

Variety C, pl. 11, figs. 4, *a*, *b*.—Irregularly subovate, oblique, narrow near the beaks, and abruptly widened by an expansion of the left border near the other extremity; umbo of under valve more or less distorted and curving slightly upward; border on right side of beak in same often thickened, thinner and profoundly sinuous on the other side; area of upper valve inclined obliquely toward the cardinal extremity.

Length, 3.20 inches; greatest breadth, 2.37 inches; breadth near beaks, 1.20 inches.

This differs so extremely from the other forms that it will perhaps be difficult to convince those who have not seen all the intermediate gradations that it is even remotely related to the form taken as the type of *O. patina*. Indeed, the differences are so great that, had we only seen the two extremes, I would not hesitate to regard the normal forms of *O. patina* as belonging to the genus *Gryphæa*, and that now before me as a true oyster. Should the latter be considered entitled to rank as a species, it may be designated as *O. subsinuata*.

Locality and position.—Two hundred miles above the mouth of Milk River on the Missouri; in Fort Pierre group, or formation No. 4 of the Cretaceous series.

Genus GRYPHÆA, Lamarck.

Synon.—*Auricularia*, *Auriculites*, &c. (sp.), of Lhwyd and some other pre-Linnæan authors.
Gryphæa, Lam. (1801), Syst. An., 398.—Roissy (1835), Moll., 202.—Blainv. (1821), Dict. Sci. Nat., XIX, 533; and many other authors.
Gryphea, Risso (1826), Hist, IV, 290.
Pycnodonta, Fischer de Waldh. (1835), Bull. Mosc., VIII, 118.—Conrad (1860), Jour. Acad. Nat. Sci. Philad., IV, 275.

Etym.—γρύψ, a griffin.
Examp.—*Gryphæa arcuata*, Lam.

Shell generally more or less broad-subovate, usually free in the adult, but often attached when young, very inequivalve, the lower valve being deep, and in most cases having its beak produced and strongly curved upward, or sometimes subspiral, and more or less oblique; upper valve nearly or quite flat, or sometimes concave, with its beak truncated; ligament-cavity arching with the beak in the lower valve, and merely occupying a slight impression in the nearly flat, transversely-striated, and truncated cardinal margin of the upper valve; surface generally with only concentric marks of growth; muscular impressions as in *Ostrea*.

The shells of this genus, especially in the well-developed adult, are generally readily distinguished from those of the genus *Ostrea*, by being less irregular in form, with the beak of the lower valve more produced and recurved. They seem also to be nearly always without the strong radiating plications often seen in that genus and *Exogyra*. They likewise differ from the latter genus in having the beak of the lower valve curved upward instead of laterally. In young or undeveloped examples, however, it is sometimes very difficult to distinguish *Gryphæa* and *Ostrea;* a young *Gryphæa* being often exactly like an oyster. In some cases, where the shell remained attached during its whole growth to adult size, it has the umbo largely truncated, and not showing the extended incurved character of the genus; but retained much the form of a true oyster during life.

The genus *Gryphæa* appears to be of more recent origin than *Ostrea;* the oldest known examples being from the Trias. It is most extensively represented in the Jurassic rocks, occurs less abundantly in the Cretaceous, and is rarely found in the Tertiary; while only one species is known in the seas of the present period, and that does not have the characteristic features of the genus, as represented in Cretaceous and older rocks, very strongly marked.

Gryphæa vesicularis, Lam.?

Plate 11, figs. 2, *a*, *b*, *c*; and pl. 16, figs. 8, *a*, *b*.

Ostrea deltoidea (part), Lamarck (1806), Ann. Mus., VIII, 160; and XIV, 375, 21, pl. fig. 3.
Ostrea vesicularis, Lamarck (1806), *ib.*, VIII, 160, pl. 22, fig. 3; and (1819), Hist. An. Sans Vert., VI, 219.—Goldf. (1826), Petref. Germ., I, 23, tab. 81, fig. 2.—Deshayes (1830), Encyc. Meth., II, 292.—D'Archiac (1837), Mem. Soc. Geol., II, 183.—Bronn (1837), Leth., tab. 32, fig. 1.—D'Orbigny (1843), Palæont. Fr., III, 742, pl. 487, figs. 1–2 (excl. figs. 6, 8, and 9).
Ostraites mysticus, Schloth. (1813), Tasc., VII. 112.
Podopsis gryphoides, Lamarck (1819), Hist. An. Sans Vert., VI, 195.
Gryphites truncatus, Schloth. (1820), Petref., 289.
Ostrea convexa, Say (1820), Am. Jour. Sci. and Arts, II, 42.
Gryphæa convexa, Morton (1828), Jour. Acad. Nat. Sci. Philad., VI, pl. 4, figs. 1 and 2; and pl. 5, figs. 1, 2, and 3; also (1834), Org. Rem., 53, pl. 4, figs. 1 and 2.
Gryphæa mutabilis, Morton (1828), Jour. Acad. Nat. Sci. Philad., VI, pl. 4, fig. 3; and (1834), Synop. Org. Rem., 53, pl. 4, fig. 3.
Pycnodonta vesicularis, Fischer de Waldh. (1835), Bull. Mosc., VIII, 118.—Conrad (1860), Jour. Acad. Nat. Sci. Philad., IV, 275.
Gryphæa vesicularis, Bronn (1848), Index Palæont., 557; and of many other authors.

Shell irregularly subhemispherical, or more or less variable in form, rather thin; anal side extended into a lobe. Under valve very gibbous; beak short, usually much distorted or truncated by the scar of attachment, moderately curved upward, and sometimes not very distinct from the cardinal margin; ligament-area short, being modified by the distortion of the beak. Upper valve flat or a little concave, and beveled within to the thin margins, thickened somewhat toward the beak, which is truncated, and sometimes slightly raised; area small, transversely triangular, and standing nearly vertical to the plane of the valve; lateral margins near the beak regularly crenate. Muscular impressions of both valves rather deep, and placed near the middle of the left, or posterior, margin. Surface of lower valve nearly smooth, or only showing obscure marks of growth; upper valve with the same kind of obscure concentric markings, and sometimes showing faint traces of radiating striæ.

Length from beak to opposite margin, about 2 inches; transverse diameter, 2.33 inches; convexity of under valve, about 0.94 inch.

It is not without some doubts and hesitation that I refer this shell to *G. vesicularis;* but after several careful comparisons, it has been found to come so near forms which have been regarded by high European authorities as only varieties of that variable species, that I have concluded that it will be better to refer it doubtfully to the same, than to run the risk of adding another synonym to a species that has already received such a multitude of

names. It at least comes nearer the true *G. vesicularis* than any other form yet known from the Upper Missouri country.

It differs from the prevailing forms of that species among the specimens so common in New Jersey and Alabama; but we sometimes meet with individuals, in collections from New Jersey, almost exactly like our shell. It resembles very closely forms referred by Goldfuss to *G. vesicularis*, especially small specimens of the upper valve, but which M. d'Orbigny considers identical with *Ostrea biauriculata*, Lam.

Although resembling our last (*O. patina*), more than any other form known from the Upper Missouri rocks, it is quite different from all the varieties of that variable species I have seen; its under valve being much more ventricose, and the scar of attachment left on its umbo much larger; while there are indications of radiating lines on the smaller valve, which are never seen on that of *O. patina*.

Locality and position.—Cheyenne River, near the Black Hills; in the Fort Pierre group of the Northwestern Cretaceous series

ANOMIIDÆ.

Genus ANOMIA, Linnæus.

Synon.—*Anomia*, (part), Linn. (1767), Syst. Nat., ed. XII, 1150.—Müller (1776), Zoöl. Dan. Prodr., xxxi.—Retzius (1788), Dessert., 9.—Brug. (1789), Encyc. Meth., I, 69.—Lamarck (1799), Prodr.; and (1801), Syst. An., 137; also, (1809), Philos. Zoöl., 317.—Roissy (1805), Moll., 239.—Defr. (1816), Dict. Sci. Nat., II, 66; and numerous others.

Echion, Poli (1791), Test. Utr. Sci., I, 34.

Echinoderma, Poli (1795), *ib.*, II, 255.

Cepa, Humph. (1797), Mus. Col., 45.

Fenestella, Bolten (1798), Mus. Boltenian. ed. 2d, 1819, 134 (not Lonsdale).

Anomya, Agassiz (1839), Mould. de Moll., I, 23.

Etym.—ἀνόμιος, unequal.

Examp.—*Anomia ephippium*, Linn.

Shell orbicular or more or less irregular, very thin. Lower valve flat, or modified by the surface of attachment, and having the sinus or aperture for the passage of the byssal plug distinct, with the upper part of its anterior lobe separated from, and often partly overlapping, the cardinal edge: plug thick, elongated, shelly, free from the margins of the aperture. Upper valve convex, smooth, lamellar, costate, or marked by lines of growth; cartilage-pit submarginal; muscular scars three, subcentral.

So far as yet known, this genus seems to have had no existence anterior to the Jurassic epoch It ranges through that and the succeeding forma-

tions, and probably attains its greatest development in the seas of the present period. It has a wide geographical distribution; the recent species occurring in the Mediterranean and European seas, as well as on the coast of North America, India, Australia, &c.

Anomia? obliqua, M. & H.

Plate 9, fig. 2.

Anomia obliqua, Meek and Hayden (May, 1860), Proceed. Acad. Nat. Sci. Philad., 181.

Shell thin, broad-oval, subcircular, or somewhat irregular, and more or less oblique. Upper valve rather convex; beak nearly or quite marginal, placed near the anterior side, moderately gibbous. Surface marked concentrically by fine obscure lines and small wrinkles of growth.

Length, about 1.33 inches; breadth, 1.16 inches.

I have not seen the under valve of this species, nor the inside of the upper one; and consequently know nothing of the nature of the muscular impressions. It resembles somewhat the figure of *A. argentea* of Morton (Synop. Org. Rem., pl. 5, fig. 10); but the umbo is less prominent and much more oblique. These differences, and the fact that it occurs in a lower geological formation, are perhaps sufficient reasons for regarding it as a different species.

It does not show the usual pearly luster of *Anomia;* and as nothing is known of the nature of the under valve, it is only retained provisionally in that group. The specimen is far from being in as good a condition as might be wished; but it has been thought desirable to call attention to it as one of the forms to be looked for in this part of the Cretaceous series of the Northwestern Territories.

Locality and position.—Near the mouth of the Niobrara River, on the Missouri; in the Niobrara division of the Upper Missouri Cretaceous series.

Anomia? subtrigonalis, M. & H.

Plate 16, figs. 4, *a*, *b*.

Anomia subtrigonalis, Meek and Hayden (May, 1860), Proceed. Acad. Nat. Sci. Philad., 181.

Shell subtrigonal, approaching subcircular, extremely thin and fragile. Upper valve moderately convex; anterior side subtruncate, with a slightly convex outline, rounding abruptly at its junction with the ventral margin;

posterior side obliquely truncated from the beak, and very narrowly rounded at its connection with the ventral border, provided with a broad, oblique, rounded fold; pallial margin nearly straight, or but slightly convex; umbo marginal, rather prominent. Lower valve ? nearly flat or compressed, and more irregular than the other. Surface marked by small, irregular, concentric wrinkles, and very obscure lines of growth.

Length, 1.37 inches; breadth, 1.14 inches.

If the flat valve seen in connection with our specimen of this species, and described above doubtfully as its lower valve, is really such, it would not be a true *Anomia*, but would more probably belong to *Placunopsis* of Morris and Lycett, and have to take the name *Placunopsis subtrigonalis*, as it seems to show no traces of a perforation or sinus for the passage of a byssal plug. It is true, *Placunopsis* was founded on Jurassic species, and is not known to occur in the Cretaceous; but that is no reason why it may not occur in rocks of that age.

Specifically, it is rather peculiar in presenting a subtrigonal outline, with a *Tellina*-like posterior fold or flexure.

Locality and position.—Bijou Hill, on the Missouri; in the Fort Pierre group, or formation No. 4 of the Cretaceous.

PECTINIDÆ.

Genus CHLAMYS, Bolten.

Synon.—*Pecten* (sp.), Klein, and other pre-Linnæan writers; and partly or entirely of numerous subsequent authors; but not of Müller (1776), as restricted by Lamarck in 1799.
Argus (sp.), Poli (1791), Test. Utri Sic., 32.—Gray (1847), Proceed. Zoöl. Soc., 200.
Argoderma (sp.), Poli (1795), Test. Utr. Sci. (not Scopoli, 1777).
Chlamys, Bolten (1798), Mus. Boltenian. (2d ed., 1819, 112).—Gray (1847), Proceed. Zoöl. Soc., 200; as sect. of *Argus*.—H. and A. Adams (1855), Gen. Recent. Moll., II, 553 (as subgen). *Pecten*.—Sotliezka (1871), Palæont. Ind., III, 425 (as subgen). *Pecten*.

Etym.—χλᾱμύς, the *toga*, or outer garment, worn by Roman gentlemen.
Examp.—*Pecten Islandicus*, Linn.

Shell closed, vertically broad-subovate, or suborbicular exclusive of the ears, equivalve or subequivalve; ears of moderate or rather large size, the anterior being usually larger, and often somewhat ascending, with beneath it a more or less deep byssal sinus in the right valve; surface ornamented with radiating, often scaly, or transversely-striate costæ; hinge-line straight, edentulous; ligament marginal, linear; cartilage occupying a central pit; muscular scar large and subcentral.

It is not without some reluctance that I have concluded to use Bolten's name *Chlamys* for this rather large group of recent and fossil shells; not being quite sure that I have had an opportunity to consult all of the works necessary to decide whether some other may not have better claims to recognition. In 1847, Dr. Gray apparently proposed to adopt for such forms Poli's name *Argus* (1791); but as that name had been used by Scopoli in 1777 for a genus of insects, it seems objectionable.

By most authorities these shells have been generally referred to the genus *Pecten*, and are even considered, by those who go back to Klein and other pre-Linnæan writers, as the typical forms of the group for which that name should be retained. As I do not believe, however, that we should cite as the authors of genera any pre-Linnæan writers, I am unwilling to view Klein as the author of the genus *Pecten*, although he, as well as other ante-Linnæan writers, used it. Coming down, then, to later authorities, Müller seems to have been the first regular binomial author who used the name *Pecten;* and, consequently, he has the best claims to be regarded as the founder of the genus (in 1776). His first species was *Pecten maximus* (= *Ostrea maxima*, Linn.), but he included also other species belonging to other groups. In 1789, Bruguière adopted the genus, also citing *P. maximus* first, though he likewise included species belonging to distinct groups, and hence cannot be regarded as having restricted the genus. In 1799, however, Lamarck adopted the genus, and cited *only*, as the typical example, *P. Jacobæus* (= *Ostrea Jacobæa*, Linn.), a species acknowledged by all to belong to the same group as *P. maximus*, to which it is specifically closely related. Consequently, Lamarck should be regarded as having restricted the genus to this particular group, which is, by most authorities, considered generically distinct from that here under consideration; and, for these reasons, I do not think we can correctly use the name *Pecten* for the group here described.

H. and A. Adams, in their valuable work on the "Genera of Recent Mollusca," use the name *Pecten* for the types here under consideration placing under it, as subgenera, *Chlamys*, *Dentipecten*, and *Pseud-amussium*. Dr. Stoliczka does the same, and also includes, in the same way, *Lyropecten*, *Camptonectes*, *Amussium*, and *Syncyclonema*. Although these groups are all more or less closely related, it seems better to view them all as distinct genera from *Chlamys*, as here defined.

The genus *Chlamys*, however, as here understood, might be conveniently divided into two or more subgenera, though no attempt will be made in this direction by the writer at present. In using the name *Chlamys* for a section of this group, under the generic name *Pecten*, Dr. Stoliczka takes *P. bifrons*, Lam., as the type of the former, and expressly excludes *P. Islandicus*, Linn.; but as this shell was Bolten's first species of *Chlamys*, and especially as it had been cited by Herrmannsen and others as its type, there seems to be no authority for considering any other form as such.

The group *Chlamys*, with the limits here assigned it, seems to be entirely unknown in the Palæozoic rocks; the similar species of that age, often described under the name *Pecten*, belonging to the genera *Aviculopecten*, *Euchondria*, *Pernopecten*, *Entolium*, and probably to several undescribed genera. In the Coal-Measures of Illinois, there is a shell having very much the external appearance of some of the less strongly costate forms of *Chlamys*, but its cartilage-pit is conical and quite oblique, more like that of some types of the *Pteriidæ* (= *Aviculidæ*).

It is probable, however, that this genus was represented as far back as during the Triassic epoch, and it seems to range through all subsequent geological formations, increasing in the number of species to the present time.*

Chlamys Nebrascensis, M. & H.

Plate 16, figs. 6, *a*, *b*, *c*.

Pecten Nebrascensis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., 87.

Shell small, suborbicular, rather inequivalve, the left valve being somewhat more convex; ventral margin regularly rounded, and about semicircular in outline; anterior and posterior margins converging from near or above the middle toward the beaks; hinge generally less than the breadth of the valves; ears more or less nearly equal, distinctly compressed, both separated from the margin below by somewhat angular sinuses, that under the anterior one of the right valve being deeper than the other; surface of each valve ornamented by about twelve to fifteen comparatively large, strongly elevated, usually simple, angular, radiating plications, separated by generally slightly

* I am far from agreeing with Dr. Stoliczka that this genus, as here restricted, "occurs in all formations, from the oldest upward." It would at least puzzle any one to find a Silurian or Devonian shell of this group.

wider, rounded furrows, in which fine, oblique, radiating, and concentric striæ may sometimes be seen; the latter of which, on well-preserved specimens, also cross the costæ, imparting a subcrenate appearance to their crests.

Length, 0.54 inch; breadth, 0.67 inch; convexity, about 0.16 inch.

I have only seen the oblique radiating striæ mentioned above between some of the lateral costæ of one specimen. In this they are arranged as if they curve laterally, as they radiate from the direction of the beak. They are very fine, regular, and appear to be generally obsolete on the specimens examined. The fine concentric striæ are smaller, and also generally obsolete. In crossing the costæ, some of the latter, at very regular intervals, seem to be raised in a somewhat imbricating manner, so as to give the crests of the same a crenate appearance where not worn. In the general, however, these finer markings are nearly or quite obsolete.

In size and general appearance, this little shell resembles *Pecten perplanus* and *P. venustus*, Morton, but has larger costæ and differently-formed ears from the latter. Its costæ agree better in size with those of *P. perplanus;* but if the ears of Dr. Morton's figured specimen were unbroken, they have a very different form; and, besides, his species is said to be from the Eocene, although supposed by him to be from the Cretaceous.

Locality and position.—Yellow Stone River, 150 miles from its mouth; in a bed containing fossils of the Fort Pierre and Fox Hills groups of the Upper Missouri Cretaceous.

Genus SYNCYCLONEMA, Meek.

Synon.—Pecten (sp.), Hall and Meek (1856), Mem. Am. Acad. Arts and Sci., V (n. s.), 381.—Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., 429 (not Müller, 1776).
Syncyclonema, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 7.

Etym.—σύν, together; *κύκλος*, a circle; *νῆμα*, a thread; in allusion to its parallel concentric striæ.
Type.—Pecten rigida, H. & M.

Shell small, compressed, nearly equivalve, vertically ovate, the height being greater than the transverse diameter; hinge-line very short; ears very small, the anterior being larger than the other; margins closed all around; no defined byssal sinus in either valve; surface only showing concentric striæ, and sometimes stronger, regularly defined concentric ridges on the right valve.

The foregoing diagnosis is made out from the typical species only, the exact limits of the genus being therefore unknown. It is possible that it may

be found desirable, however, to modify the diagnosis somewhat, so as to include some of the larger, smooth, compressed Pectens, so called, of the Cretaceous and Jurassic rocks. At any rate, such shells cannot be properly included in the genus *Pecten*, as restricted to such forms as *P. maximus*. It is more nearly related to *Amussium*, but differs in its closed margins, the strong concentric markings of its right valve, and the absence of internal radiating costæ, as well as in its narrower form, and the shape of its ears. The same characters, or at least a part of them, also distinguish it from *Pseud-amussium*.

I am not quite sure that this genus occurs in any but Cretaceous rocks; but, as already suggested, it may possibly include some Jurassic species.

Eburneopecten, Conrad, 1865, founded on an Eocene species (*P. scintillatus*, Con.), seems to be a very closely-allied type, that may be congeneric. It only differs somewhat in the form of the ears, and in wanting strong concentric markings of the right valve—both of its valves being quite smooth.

Syncyclonema rigida, H. & M.

Plate 16, figs. 5, *a*, *b*.

Pecten rigida, Hall and Meek (1854), Mem. Am. Acad. Sci. and Arts, Boston, V, 381 (n. s.), pl. 2, figs. 4, *a*, *b*, *c* (not *Pecten rigida*, Sowerby, 1818).
Pecten Hallii, Gabb (1861), Catalogue Cret. Foss., 158.
Syncyclonema rigida, Meek (1864), Smithsonian Check-List Invert. Cret. Foss. N. Am., 7.

Shell very small, vertically ovate, being about one-sixth higher than wide, narrowing upward from the middle; base regularly rounded; hinge-line about half the transverse diameter of the valves; ears unequal, posterior one obliquely truncate, and hardly half as large as the other; anterior subtrigonal, flattened and slightly pointed. Right valve ornamented with comparatively strong, regular, raised concentric ridges and furrows. Left valve smooth, or showing on exfoliated surfaces, traces of faint radiating striæ; anterior margin with only a shallow, rounded sinuosity under the ears, nearly as deep in the left as in the right valve.

Length, 0.19 inch; height, 0.23 inch.

I know of no fossil or recent species liable to be confounded with this little shell. It is perhaps more nearly like *Pecten simplicus*, Con. (Jour. Acad Nat. Sci., IV (n. s.), pl. 46, fig. 44), than any other known form; but will be at once distinguished by the concentric ridges of its right valve, and the more regularly rounded outline of its lateral margins, as well as by the different form of its ears.

Locality and position.—Sage Creek; from the upper part of the Fort Pierre group; also, from the Fox Hills group, or formation No. 5, at Fox Hills, and on Moreau River.

HETEROMYARIA.*

PTERIIDÆ.

Genus PTERIA, Scopoli.

Synon.—*Avicula*, Klein (1753), Ostrac., 120.—Brug. (1792), Encyc. Méth., pl. 177.—Lam. (1799), Prodr., 82; and (1801), Syst. An. 134.—Blainv. (1816), Dict. Sci. Nat., III, Suppl., 138.—Schum. (1817), Ess., 137.—Oken (1835), Allg. Natgsch., V, 360; and numerous others, down to the present time.

Pteria, Scopoli (1777), Introd. ad Hist. Nat., 397.—Gray (1847), Zoöl. Proc., 199.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 8; and Palæont. Upper Mo., 28.

Anonica, Oken (1815). Handb. d. Zoöl., * *; and (1821), Natgsch. d. Schulen, 652.

Oxytoma, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 39 (as a subgenus).

Pseudoptera, Meek (1873), Hayden's Ann. Report U. S. Geol. Survey of the Territories, 489 (as a subgenus).

Electroma, Stoliczka (1871), Palæont. Indica, III, 391 (as subgenus).

Etym.—πτερόν, a wing.
Type.—*Mytilus hirundo*, Linn.

Shell fragile, inequivalve, the left valve being more convex than the other; general outline usually obliquely subtrigonal; cardinal margin straight, generally provided with a narrow, flattened or concave, gaping area, and terminating in a more or less produced anterior and posterior wing, the latter of which is always larger than the other; ligament partly internal; hinge usually with a single cardinal tooth under the beaks in each valve, and sometimes a

* I follow Dr. Gray, Dr. Bronn, and my friend Dr. Gill, in the use of this convenient group between the *Monomyaria* and *Dimyaria*. It must be admitted, however, that when we undertake to classify the whole extensive series of bivalves, including all of the known extinct types of all ages, as well as the existing forms, we find, as in many other cases, that the limits of these primary divisions are often much less sharply defined than among existing mollusks only. Take, for instance, the extinct genus *Bakevellia*, with often the exact form and alations of *Pteria* (= *Avicula*), and even a series of large cartilage-pits as in *Gervillia*, *Melina* (= *Perna*, Brug.), *Inoceramus*, &c. (by all referred to the *Aviculidæ*, most usually considered by conchologists a monomyarian family); yet we see that in some of the species, the anterior muscular scar is so large, that even Professor King, a very learned naturalist, placed it in the *Dimyaria*; while Dr. Stoliczka, actually refers it to the dimyarian family *Arcidæ*. On the other hand, Dr. Geinitz and Mr. Woodward were so much impressed with the close relations of this genus (*Bakevellia*) to *Gervillia*, of the *Aviculidæ*, that they both (wrongly, as I think) include it as only a section of that genus. In another direction, among ancient types, the *Aviculidæ* shade off toward the monomyarian family *Pectinidæ*.

Various other examples might be mentioned among palæozoic shells that seem, as it were, almost to break down the distinctions between the three primary divisions *Monomyaria*, *Heteromyaria*, and *Dimyaria*; but the above will perhaps be sufficient to illustrate the fact.

Dr. Gray called the intermediate section the *Pogonopoda*, and in 1842, included in it, along with the *Mytilidæ*, the *Tridacnidæ*, the *Aviculidæ* and the *Pinnidæ*; while in 1849, Dr. Bronn called it the *Heteromya*, using it, I believe, rather as a section of the *Dimyaria*, and included in it the *Mytilidæ*, the *Aviculidæ* and *Tridacnidæ*. Dr. Gill, however, views it as an order; and (in his excellent "Arrangement of the Families of Mollusks," published by the Smithsonian Institution in 1871), only includes in it the *Mytilida*, while he writes the name *Heteromyaria*.

long posterior lateral tooth in one or both valves; muscular scars two or more, one very large, the others small; pallial line simple; byssal sinus generally more or less defined under the anterior ear of the right valve; surface marked with radiating costæ or striæ, concentric imbricating laminæ, or nearly smooth, the markings being generally stronger on the left valve.

The foregoing synonymy and diagnosis are intended to include four sections, distinguished mainly by general form, the greater or less development of the wings, the more or less strongly-defined character of the byssal sinus, &c., as follows:

1. **PTERIA**, Scopoli (typical).

   Shell generally very oblique, with wings well developed; the posterior one long, and defined by a deep marginal sinuosity; byssal sinus under the anterior wing of the right valve moderate.—(Type as already stated.)

2. **ELECTROMA**, Stoliczka.

   Shell differing from the typical section in being more inequivalve (the right valve being generally more flattened), and in having a shorter hinge, without well-developed alations; the posterior wing being very short or obsolete, and not defined by a marginal sinus; and the anterior very small, or not projecting beyond the anterior margin, but defined in the right valve by a deep, sharply-cut sinus, close up under the end of the hinge.—*Avicula Smaragdina*, Reeve.

3. **PSEUDOPTERA**, Meek.

   Shell more or less obliquely subtrigonal or subovate; hinge short, compressed; anterior wing short, not defined; posterior abbreviated, compressed, and nearly or quite without any marginal sinuosity below it; anterior margins sometimes a little sinuous near the middle, but without any byssal sinus under the anterior wing.—*Avicula anomala*, Sowerby. *Pinna fibrosa*, M. & H.

4. **OXYTOMA**, Meek.

   Shell with nearly the general outline of the typical form, but usually less oblique, and more inequivalve, with the byssal sinus very deeply and sharply cut, close up under the anterior auricle of the right valve.—*Avicula Münsteri*, Bronn.

The group for which Mühlfeldt, in 1811, proposed the name *Margaritiphora* (= *Meleagrina*, Lam., 1812), is, by several authors, also included as a

section of the foregoing genus, to which it is closely related. It differs, however, in its more nearly equivalve character, much less oblique, truncato-suborbicular form, broader cardinal margin, and edentulous hinge. It also differs from all of the sections of that group, excepting *Electroma* and *Pseudoptera*, in having its posterior wing very short, or obsolete, while it is very unlike those types in nearly all other characters.

The name *Pseudoptera* was proposed by me for a peculiar Cretaceous group, the hinge and interior of which are little known. The species of this type have generally been described under the name *Avicula;* but they differ very materially from the typical forms of that genus in having no well-defined wings or byssal sinus. I proposed, and now retain, this group, provisionally, as a section of *Pteria* (= *Avicula*); but it may be even generically distinct. In first indicating this section, in 1873, I mentioned as its type *Avicula anomala*, Sowerby; that being the best known species presenting the general form of the group. It is barely possible, however (though very improbable), that the hinge of that shell, which is entirely unknown, *may* present the characters of *Melina* or *Gervillia*, and thus make my name *Pseudoptera*, 1873, a synonym of an older genus. If so, I would beg leave to retain it for the group including *Avicula fibrosa*, M. & H., which I really had more in view at the time than Sowerby's species. The use, *de novo*, of a name originally proposed for a type that proves to belong to a previously-established genus, though generally undesirable, is still in accordance with the usages of many high authorities in natural history.

The group *Oxytoma* was also originally proposed by me as a subgenus under *Pteria* (= *Avicula*); though I distinctly stated that it forms a transition from that genus to *Eumicrotis*, a section of *Pseudomonotis* of Beyrich. The opinion has been expressed by Dr. Stoliczka that it ought rather to stand as a section of *Pseudomonotis* than of *Pteria*. It is so evenly balanced in its affinities between *Pteria* and *Pseudomonotis* that it might, with almost equal propriety, be ranged as a section of either. In obliquity and general form, as well as in the development of its wings, it agrees best with the former; while, in the nature of its byssal sinus, it agrees exactly with *Pseudomonotis*. I leave it as a section of *Pteria;* but, at the same time, place it farthest from the typical group of that genus

It may be thought that the existence of such an intermediate type warrants the union of the whole (including *Pseudomonotis*) under the one

genus *Pteria* (= *Avicula*). Such a rule, however, if consistently carried out in the classification of the whole animal kingdom, including all of the extinct and living forms, would result in the complete obliteration of most, if not all, generic distinctions.

The genus *Pteria* dates back to Palæozoic times; though most of the older Palæozoic species referred to it under the name *Avicula* belong to the genera *Pterinea*, *Aviculopecten*, and perhaps, in part, to a number of undefined genera. There certainly are, however, true typical species of this genus in the Palæozoic rocks *Pteria longa* (= *Gervillia longa*, Geinitz), from the Carboniferous rocks of the Western States, I have ascertained, has exactly both the internal and external characters of this genus. This group also ranges through all of the later formations, and is well represented in the seas of the present epoch, in which latter it probably attains about its greatest numerical development. The recent species belong both to the typical and *Electroma* sections; while *Oxytoma* seems to be mainly confined to the Jurassic and Cretaceous rocks, with possibly the exception of a few Upper Triassic species. *Pseudoptera* seems to be exclusively Cretaceous.

In regard to the name that should be retained for this genus, somewhat different opinions are entertained. Klein's name *Avicula* has long been in use, and is adopted by most authors. As Klein, however, neither in practice nor date, can be ranked as a binomial author, his names ought not to be adopted, excepting where they have been fixed in zoölogical nomenclature, by being adopted by some regular authority, previous to the application of any other names to the same groups by some regular binomial naturalist. So far as I am aware, however, the name *Avicula* was not adopted in accordance with the binomial system previous to the publication of the name *Pteria* by Scopoli in 1777. As the latter author dates after the introduction of the binomial nomenclature, with which he strictly conformed, and his type was *Mytilus hirundo*, regarded by all as the type of *Avicula*, the two names *Pteria* and *Avicula* are exactly equivalent. Consequently, I do not see how we are to avoid adopting the former if we are to follow the generally-admitted rules of nomenclature, as was shown by Dr. Gray long back. If we can disregard the rules in one case, of course we may in others, and the consequences would be that every author could follow his own rule; which would, of course, be equivalent to no rules at all, to the great confusion of all natural-history nomenclature.

Pteria linguiformis, E. & S. (sp.).

Plate 16, figs. 1, *a*, *b*, *c*, *d*.

Avicula linguiformis, Evans and Shumard (1854), Proceed. Acad. Nat. Sci. Philad., VII, 163.
Pteria linguiformis, Meek (1864), Smithsonian Check-list N. Am. Cret. Fossils, 9.
Compare *Avicula nitida*, Forbes (1846), Trans. Geol. Soc. Lond., VII, 151.—Stoliczka (1871), Palæont. Indica, III, pl. xxxviii, figs. 11–12; also, *A. petrosa*, Conrad (1850), Jour. Acad. Nat. Sci. Philad., II (n. s.), pl. 24, fig. 15.

Shell obliquely ovate-subtrigonal, or linguiform, moderately convex, and not very inequivalve, both valves being convex, but the left more so than the right; hinge-line nearly equaling the greatest length in the young, but proportionally shorter in the adult, sometimes with a narrow marginal ridge posteriorly in the right valve; posterior wing of moderate length, pointed, compressed and defined by a rather deep, rounded sinuosity of the margin below; anterior wing narrow, somewhat produced, pointed, and less compressed than the other, defined by a shallow, broad, marginal sinus that is very little, if any, deeper in the right than the left valve, though in the former the wing is separated from the swell of the umbo by a shallow sulcus extending from the sinus directly upward to the anterior side of the beak; anterior margin sloping, with more or less convexity of outline, from the sinus under the wing, obliquely backward and downward into the base, which rounds backward to the narrowly-rounded posterior basal extremity; posterior margin under the ear oblique, and generally more or less sinuous in outline; surface smooth, or only marked by lines of growth; beaks subequal, very oblique, depressed, and placed in advance of the middle of the hinge-line.

Length of an adult specimen, from outer end of anterior wing to posterior basal extremity, 1.15 inches; length of hinge, about 0.95 inch; convexity of the two valves, 0.44 inch; that of the left valve being 0.26 inch.

This shell is evidently closely related to *Avicula nitida*, Forbes (= *Avicula* (*Meleagrina*) *nitida*, Stoliczka), from the Cretaceous rocks of Southern India, and may not be specifically distinct. Indeed, young examples agree almost exactly with Dr. Stoliczka's figures of the Indian species of corresponding size. His figures of the adult specimen of *A. nitida*, however, show a much less oblique outline, and less produced wings, as well as more nearly equally convex valves than in the form under consideration. The absence of a pointed posterior wing, and the straightness of the posterior margin of the specimen represented by his fig. 11 of pl xxxviii are probably

due to the breaking away of that wing, his specimen being an internal cast. At least, casts of the interior of the form under consideration, such as that represented by our fig. 1*a* of pl. 16, show even less appearance of a posterior wing, and about as straight (though more oblique) a posterior margin. In that specimen, however, this wing is *evidently* broken away, as other adult specimens show it to be as long and as angular, and the margin as sinuous under it, as represented in outline by our fig. 1*b* of the same plate. I cannot agree with Dr. Stoliczska in referring such forms to *Meleagrina*, whether that group should be regarded as a subgenus under *Pteria* (= *Avicula*), or as a distinct genus.

Our shell seems also to be related to *Avicula petrosa*, Conrad, from the New Jersey Cretaceous; but his type-specimen is not in a condition to afford the means for a satisfactory comparison.

Locality and position.—Great Bend of the Missouri below Fort Pierre, Sage Creek, Fox Hills, Long Lake, &c. It ranges through the Fort Pierre and Fox Hills groups of the Upper Missouri Cretaceous series.

Pteria linguiformis, var. subgibbosa.

Plate 28, fig. 12.

Avicula subgibbosa, M. & H. (1860). Proceed. Acad. Nat. Sci. Philad., 180.
Pteria subgibbosa, Meek (1864), Smithsonian Check-list N. Am. Cret. Fossils, 9.

Although I formerly regarded this as a distinct species from *P. linguiformis*, later comparisons, with the aid of additional collections, seem to indicate that it is most probably only a variety of the same. It differs chiefly in its broad, less oblique form, and more broadly rounded, less produced, posterior basal margin. I have not seen specimens of the right valve of this form; but, unless they present some peculiarities, it seems improbable that it is a distinct species.

Locality and position.—Long Lake; from the upper part of the Fox Hills group of the Upper Missouri Cretaceous series.

Pteria Haydeni, H. & M.

Plate 16, figs. 2 *a*, *b*.

Avicula Haydeni, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci., V (n. s.), 382, pl. 1, fig. 5.
Pteria Haydeni, Meek (1864), Smithsonian Check-list N. Am. Cret. Foss., 9.

"Shell small, subrhomboidal, oblique; beak small, pointed, slightly

elevated above the hinge-margin; hinge-marngin straight, less than the length of the shell, and pointed at the posterior extremity; anterior extremity short, rounded; posterior margin obliquely truncate; no line of demarkation between the wing and the body of the shell; basal margin forming an elliptic curve; surface marked by sharp, strong ribs, with sometimes an intermediate smaller one, crossed by faint concentric undulations, and parallel fine lines of growth.

"Length, 0.30 inch; height, 0.22 inch; hinge-line making an angle with the posterior slope of about 129°."

Having no good specimens of this species for study, I have merely copied the original figure and description. Until the right valve can be seen, it will not be possible to determine whether or not this shell belongs to the group *Oxytoma*, but I think it most probably does not.

Locality and position.—The specimen first figured by Professor Hall and the writer, was collected at the Great Bend of the Missouri, below Fort Pierre; in the lower part of the Fort Pierre group, formation No. 4 of the Cretaceous. The only specimens of it I have since seen, came from the same place.

Pteria (Oxytoma) Nebrascana, E. & S.

Plate 16, figs. 3, *a*, *b*; and pl. 28, fig. 11.

Avicula Nebrascana, Evans and Shumard (1857). Trans. St. Louis Acad. Sci., I, 38.
Pteria Nebrascana, Meek (1864), Smithsonian Check-List Cret. Fossils N. Am., 9.

Shell small, rather compressed, obliquely oval exclusive of the wings, distinctly inequivalve, the left valve being more convex, with its ventral margin and posterior wing projecting apparently beyond those of the other; hinge generally, if not always, less than the length of the valves. Left valve with anterior wing small, triangular, compressed, generally about rectangular or sometimes a little more obtusely angular, not defined by a marginal sinus, and apparently never quite as long as the margin below; posterior wing decidedly longer than the other, but not as long as the posterior margin, compressed, acutely angular at the extremity, and defined by a rather deep, broadly-rounded sinus; posterior basal margin rather narrowly rounded; basal margin forming a broad semiovate curve, being more prominent posteriorly, and rounding up obliquely anteriorly into the regularly-rounded front; beak moderately oblique, scarcely rising above the hinge-margin, and placed

about half-way between the middle and the anterior end of the same; surface ornamented by numerous small, thread-like, radiating lines, less at and near the free margins, than the breadth of the spaces between, in some of which latter a smaller line is often intercalated; very minute concentric striæ are also to be seen on well-preserved specimens by the aid of a magnifier. Right valve with a broad compressed alation behind, that seems not to extend into a defined wing; posterior margin truncated and nearly or quite straight; anterior wing very small, and defined by the usual deep, sharply-cut byssal sinus of the subgenus *Oxytoma;* surface appearing nearly smooth, but when examined under a good magnifier, showing obscure traces of small, radiating costæ, crossed by extremely fine, regular, crowded, concentric striæ; beak more compressed than that of the other valve, and a little less prominent.

Greatest length of a medium-sized specimen, measuring from the end of the anterior wing obliquely to the posterior basal margin, 0.45 inch; length of hinge, 0.32 inch; convexity of the two valves, about 0.15 inch.

In comparing our description with that given by Evans and Shumard, it should be remembered that they only had the left valve, and knew nothing of the right. Their description, however, agrees so well with the left valve of the specimens under consideration as to leave little or no room for doubting its identity with the species described by those gentlemen. The opposite valves of these shells differ so much in form and surface-markings that they would hardly be supposed to belong to the same species if not found united.

This species will be readily distinguished from the last by its less oblique form, more prominent posterior and less prominent anterior wings, and much finer radiating markings. The beak of its left valve is also less elevated than that of the last. Its right valve reminds one of a species figured by Mr. Conrad, from the Cretaceous of New Jersey in 1854, under the name *Avicula abrupta* (Jour. Acad. Nat. Sci. Philad., 2d. ser., vol. II, pl. 4, figs. 5 and 6), which is evidently an *Oxytoma.* As Mr. Conrad says nothing about surface-markings on his species, however, it would seem to be distinct.

Locality and position.—Fox Hills, Moreau River, South Fork of the Cheyenne, Milk River above Fort Union, and on the Yellowstone. It ranges from the upper part of the Fort Pierre group, through the Fox Hills group of the Upper Missouri Cretaceous. I also identified it among Professor

Hind's collections, from south branch of the Saskatchewan, British America. It is an abundant species, and was apparently of gregarious habits.

Pteria (Pseudoptera) fibrosa, M. & H.

Plate 17, figs. 17, *a*, *b*, *c*, *d*.

Avicula? fibrosa, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., 86.
Pholadomya fibrosa, Meek and Hayden (1856), *ib.*, 286.
Pinna fibrosa, Meek (1864), Smithsonian Check-List Cret. Fossils N. Am., 9.
Avicula (Pseudoptera) fibrosa, Meek (1873), Hayden's Sixth Ann. Rep. U. S. Geol. Surv. of the Terr., 489.

Shell thin, obliquely subovate, nearly or quite equivalve, both valves being quite gibbous from the beaks obliquely backward and downward along the central and anterior regions; hinge-margin very short and compressed; posterior margin sloping backward and downward, with a slightly convex outline, from the posterior end of the hinge into the rounded posterior basal margin; anterior margin truncated obliquely backward and downward from the beaks, with a nearly straight or slightly concave outline; that of each valve being curved rather abruptly inward toward the other, and apparently gaping for the passage of the byssus, though there are no traces of a byssal sinus in either valve; beaks gibbous, very oblique, pointed, incurved with a forward obliquity, and very nearly if not quite terminal; posterior alation obsolete, or only distinguishable by its compression from the swell of the umbones, very obtusely angular, or rounding into the posterior margin behind, from which it is not separated by the slightest sinuosity; anterior wing apparently entirely wanting, surface ornamented by distinct, rounded, more or less irregular, bifurcating, radiating costæ, generally wider than the furrows between, and crossed by regular, small, concentric ridges, which divide them into little, obscure, node-like prominences.

Length from the points of the beaks to the posterior basal extremity, 1.42 inches; greatest breadth at right angles to the longest diameter, 1 inch; convexity, about 0.35 inch.

The radiating costæ mentioned in the foregoing description are generally confined to the convex portion of the valves, being obsolete on the compressed posterior dorsal region. Owing to the thinness of the shell, all of the stronger surface-markings are well defined on internal casts. Some specimens retaining portions of the shell show a few distant, subimbricating, concentric lines, arranged one on each of the concentric ridges. In no instance have any traces of muscular impressions been seen on any of the internal casts, or in the interior of the shell itself; and very little is yet

known in regard to its hinge. A single right valve exposes a little of the hinge-margin near the beak; it is narrow, concave, and shows traces of minute transverse and longitudinal striæ, somewhat like the ligament-area we see along the hinge-margin of *Pteria* proper. So far as can be seen, however, it seems to have no hinge-teeth or deep marginal excavation for a partly-internal ligament.

Of all the Upper Missouri Cretaceous shells yet studied, few, if any, have given origin to so much perplexity in the determination of their affinities as this one. This was due, of course, to a great extent, to the very imperfect, mutilated condition of the specimens, and also, in part, to the peculiar characters of the fossil itself. In first describing the species, we referred it, with a mark of doubt, to *Avicula*, stating that this was done only provisionally, as none but quite imperfect specimens, giving a very unsatisfactory idea of the entire shell, had been seen. On seeing the description, Dr. Shumard wrote to me that he had seen good examples of this species, and that he regarded it as a peculiar oblique form of *Pholadomya;* to which we afterward referred it on his authority.* Still later, on examining some additional specimens of the same, as seen flattened in masses of rock, I was led to believe it more probably a peculiar, short, gibbous form of *Pinna*, particularly in view of the fact that fragments of the shell had previously been observed to show indications of a fibrous or prismatic structure.

In studying the collections obtained in connection with Dr. Hayden's survey of 1872, I observed two species, which, although differing in form from this, still seemed, on comparison, to present, along with a European Cretaceous species, certain characters in common, warranting their arrangement in a single group, very near, if not within, the genus *Pteria* (*Avicula*); and for this group I proposed, as has already been stated, the name *Pseudoptera*, as a subgenus under *Avicula*, placing this species in the same.

Locality and position.—Forks of Cheyenne River, from the upper part of the Fort Pierre group; and from the Fox Hills group, on North Platte River, near the mouth of Deer Creek.

* Dr. Shumard may have confounded another shell with our type.

Genus INOCERAMUS, Sowerby.

Synon.—*Inoceramus* (Sowerby, MS.); Parkinson (1819), Trans. Geol. Soc., V, 59.—Sowerby (1823), Trans. Linn. Soc., XIII, 557; and Min. Conch., III, tab. 305.—Ferussac (1821), Tab. Syst., xli; and of numerous subsequent authors.

Catillus, Brongniart (1822), in Cuvier and Brong.'s Descrip. Geol. of the Environs of Paris, 386.—Blainville (1825), Mal., 529, and others.

Mytiloides, Brongniart (1822), Geol. Environs of Paris, 622.—Bronn (1838), Leth., 691, 695 (subgen. *Inoceramus*).

Actinoceramus, Meek (1864), Check-List Cret. Foss. N. Am., 32 (subgen. *Inocer.*).—Stoliczka (1871), Palæont. Indica, III, 393.

* *Volviceramus*, Stoliczka; *ib.*, 394 (subgen. *Inocer.*).

Etym.—ἴς, strength, fiber; κέρᾱμος, earthen ware; perhaps from the resemblance of large fragments of the fibrous outer-shell layer to broken pottery.

Type.—*Inoceramus Cuvieri*, Sowerby.

Shell varying, according to the sections, from subcircular to transversely, obliquely, or vertically oval or oblong, inequilateral, gibbous, or more or less compressed, with valves equal, subequal, or sometimes distinctly, or even extremely unequal in convexity, as well as in the relative prominence of the opposite beaks. Anterior margins without any defined byssal sinus in either valve; posterior dorsal margins sometimes compressed and subalate. Inner nacreous layer thin, extending to the margins of the valves; outer fibrous layer thick and coarsely prismatic. Hinge straight or very rarely a little arched, generally narrow, nearly or quite edentulous within,* ranging at various angles to the longer axis of the shell, and crossed by numerous small, regularly-arranged cartilage-pits. Surface concentrically undulated and striated, or nearly smooth; very rarely with radiating plications or costæ. Muscular and pallial impressions very obscurely marked.†

This extensive group of extinct bivalves includes a large number of species, presenting great diversities of form, size, and general appearance. An attentive study of these various forms shows that they may be conveniently arranged under the following sections or subgenera, most of which have been named by others:

1. INOCERAMUS, Sowerby (typical).

a. Shell vertically ovate or subquadrate, gibbous, and more or less distinctly inequivalve; hinge short, and ranging at right angles to

* Goldfuss' figure of *I. alatus* (Petref. Germ., pl. cxi, fig. 3, *c*, *d*) seems to show in the right valve, at or under the anterior extremity of the hinge, three short pits for small teeth in the other valve. *I. striatus*, Mantell, as figured by d'Orbigny (Palæont. Fr., III, pl. 405), also shows a tooth-like projection at the anterior end of the hinge of the left valve.

† I have never seen any traces of the muscular or pallial impressions of this genus; but according to d'Orbigny, it has one large subcentral muscular scar in each valve, as in other groups of the *Aviculidæ*.

the longer (vertical) axis of the valves; posterior dorsal region sometimes compressed and subalate; anterior side straight or broadly sinuous below the beaks, which are anterior and little oblique, excepting at the points, the left one of which is nearly always more prominent and incurved than the other.—Type as already stated.

b. Shell with posterior dorsal region compressed and extended, so as to form a wide alation, thus imparting a more or less subtrigonal outline to the valves, and giving greater length to the hinge.—*I. alatus*, Goldfuss.

2. **MYTILOIDES**, Brongniart.

Shell obliquely ovate, elongate, or somewhat mytiliform, compressed, very nearly or quite equivalve; hinge-margin generally very short, and oblique to the longer axis of the valves; posterior dorsal margin sometimes a little compressed and alate. Surface with irregular undulations and striæ.—*I. problematicus*, Schloth.

3. **CATILLUS** (Brongniart ?), Chenu.

a. Shell transversely oval or oblong, equivalve or subequivalve; beaks depressed, nearly or quite equal, and more or less anterior, but not terminal; hinge long, and ranging parallel to the longer (transverse) diameter of the valves. Surface concentrically undulated and striate.—*I. Lamarckii*, Brong. (as figured by d'Orbigny in Palæont. Fr., III, pl. 412).

b. Shell usually more compressed and proportionally shorter, or broad truncato-suborbicular in outline, with the depressed beaks at the anterior end of the hinge. Surface undulations, generally irregular.—*I. latus*, Mantell.

4. **ACTINOCERAMUS**, Meek.

Shell obliquely or nearly vertically subovate, higher than the transverse diameter, gibbous; hinge very short, rather oblique; beaks pointed, terminal, that of the left valve more prominent than the other, and curved forward and inward. Surface with radiating plications or costæ, and concentric striæ.—*I. sulcatus*, Parkinson.

5. VOLVICERAMUS, Stoliczka.

> Shell extremely inequivalve, the left valve being very gibbous, with its beak greatly elevated and strongly involute; and the right nearly flat and subcircular, with its beak very much less elevated, and its surface concentrically striated and more strongly undulated.—*Inoceramus involutus*, Sowerby.

A more natural arrangement of these groups would be to commence the series with *Volviceramus*, and then pass to *Actinoceramus*, followed by *Inoceramus* proper and the succeeding sections; but it is in accordance with the usual custom to commence with the typical group in such cases. I should also remark, that these sections are not all equally distinct from each other, or from the typical forms of the genus; the *Mytiloides* and *Catillus* groups showing more tendency to run together and into the typical section of the genus, than they do to approach either *Volviceramus* or *Actinoceramus;* which latter, however, are also quite distinct from *Inoceramus* proper.

I have preferred to cite Chenu rather than Brongniart as the author of *Catillus*, founded on *I. Lamarckii* as figured by d'Orbigny and Chenu, because it has been stated that the real *I. Lamarckii* of Brongniart, and the type of *Catillus* as proposed by him, was founded on fragments of *I. Cuvieri*, Sowerby. If this is so, of course *Catillus* of Brongniart would be exactly synonymous with *Inoceramus* proper of Sowerby.

Some species of this genus attained a very large size, specimens having been found from two to three feet in diameter. The outer fibrous layer of these large species is generally very thick, particularly near the beaks. Considerable quantities, and sometimes large pieces of it, are met with in the Cretaceous rocks of the Upper Missouri country, particularly in the calcareous Niobrara division, where none of the inner nacreous layer is to be seen; thus showing that, owing to some unknown cause, the latter was there more liable to be dissolved. Owing to the fact that the two layers readily separate, the pearly inner layer is, in the argillaceous Fort Pierre group, generally found attached to internal casts of the shell from which the outer layer has been exfoliated. This inner layer often presents a beautiful pearly luster, and is known to have secreted pearls, as in other genera of the *Aviculidæ*. The large number of individuals, and the great size of some of the

species, must have rendered these mollusks very conspicuous objects among the bivalves of the Cretaceous seas.

Dr. Stoliczka states (Palæont. Ind., III, 393) that the genus *Inoceramus* "occurs from the Silurian to the close of the Cretaceous period." I think, however, that this is a rather hasty conclusion; at least, it seems to me that it would be impossible to cite an example of any Silurian, or, indeed, other Palæozoic shell, that has yet been figured, certainly showing the hinge-characters of *Inoceramus*. Woodward and d'Orbigny both give its range from the Lias to the Chalk; and Pictet, also, states that it appears to be exclusively characteristic of the Cretaceous and Jurassic. It seems to have attained its greatest development during the Cretaceous period, and not to have survived the close of the same.

The proper discrimination of species in this genus is extremely difficult, not only on account of the great variations of form that different individuals of the same species sometimes present, but also owing to the fact that we rarely find perfect specimens with the opposite valves united; while the right and left valves of the same species generally differ more or less, and sometimes greatly, in form. In addition to this, the species are quite numerous, and, where really distinct, often closely resemble each other. Their study is, therefore, attended by nearly as many difficulties as would be met in attempting to classify the numerous species of the genus *Unio*, from merely separated, water-worn, and mutilated valves. Because the task is a difficult one, however, is no reason why no attempt should be made to separate and define the species, although we can scarcely hope to arrive at correct conclusions in all cases. In the following review of the Upper Missouri Cretaceous species, I have earnestly tried, to the best of my ability, to arrive at truth. That all of the conclusions will be sustained by those who come after me, and take up the study of these shells with more extensive and better collections for study, can scarcely be expected; though it is believed that no material changes will be found necessary.

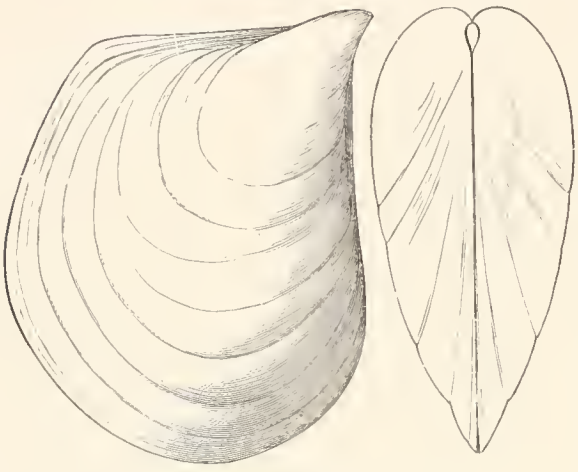
Subgenus **INOCERAMUS**.

Inoceramus fragilis, H. & M.

Plate 5, fig. 5, and accompanying cuts.

Inoceramus fragilis, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci. (n. s.), VIII, 388, pl. 2, fig. 6.

Fig. 1. Fig. 2.



Inoceramus fragilis, H. & M.

1. View of right valve.
2. Anterior profile view, showing the very nearly equal convexity of the valves.

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 undulations.

Height, about 1.43 inches; length, 1 07 inches.

The specimens from which the figure and description published by Professor Hall and the writer were made out, being to some extent flattened and distorted by pressure, as well as partly embedded in the matrix, its characters could not be very clearly understood; consequently, its truncate, concave, anterior border was mistaken for the hinge-line, and placed upward in the figure above cited. This misapprehension subsequently led to the erroneous supposition that it was only a young individual of *I. problematicus*, Schloth.

The specimens now before me, in part from the original locality, show very clearly that the hinge is on the shorter side of the beaks, and that the concave side is the anterior border; consequently, the form of the shell is quite different from that of *I. problematicus* or *I. pseudo-mytiloides*, at any stages of their growth, being much more like that of *I. substriatus*, Münster.

as figured by Goldfuss (Petrefact. Germ., tab., cxv, fig. 1). The beaks, however, are not so distinctly curved forward as in the latter species, and the posterior and basal borders form a more regular curve.

Dr. Zittel, in his valuable Monograph of the Bivalves of the Gosau Formation, cites *I. fragilis*, Hall and Meek, as a synonym of *I. Cripsii*, Mantell. This, however, is an error; *I. fragilis* being a typical *Inoceramus*, while *I. Cripsii* belongs to the *Catillus* section, and is, of course, widely distinct specifically.

Locality and position.—The original typical specimen of this species was found near the mouth of Vermillion River, on the Missouri, at or near the base of the Fort Benton group, where it was associated with *Ammonites percarinatus*, H. and M. The specimen represented by our fig. 5, pl. 5, came from near the same locality; while the larger ones, from which our woodcuts were prepared, came from the same horizon near Fort Benton, Montana. We also have it from the same rock in the Black Hills; and Dr. Newberry found it in equivalent beds in New Mexico.

Inoceramus altus, M.

Plate 14, figs. 1, *a*, *b*.

Inoceramus altus, Meek (1871), Dr. Hayden's Report Geol. Survey of the Territories, 302.

Shell attaining a medium size, vertically or a little obliquely subovate, being in the adult higher than long, and widening from the hinge downward, moderately convex, equivalve, very inequilateral; hinge very short and ranging nearly at right angles to the longer axis in the adult, but a little more oblique in young shells; anterior side straight, long, and truncated vertically, or nearly at right angles to the hinge, immediately in front of the beaks; base regularly rounded; posterior outline forming a broad, somewhat oblique, gentle curve from the posterior end of the hinge into the base; beaks nearly or quite equal, rising little above the hinge-line, pointed, obliquely incurved, and placed immediately over the anterior margin. Surface of cast showing more or less regular, rather obscure concentric undulations, and faint traces of radiating markings; the latter probably not being defined on the exterior.

Height, about 6.50 inches; length, about 4.90 inches; convexity, 2.70 inches; length of hinge, about 2.40 inches.

This species seems to belong to the typical section of the genus, but, like the last, it presents the rather unusual character of having its beaks

almost exactly equal. In size and general appearance (especially some of the less distinctly undulated specimens), it reminds one of *I. nobilis*, Münster, as figured by Goldfus (in his Petref. Germ., pl. cix, figs. 4, *a*, *b*); but even these smoother specimens still show concentric undulations not represented in the figures of Münster's species, which also has rather decidedly unequal beaks, and its anterior margins more sinuous and inflected under the same.

Our figures represent a strongly undulated specimen, reduced to about half the natural diameter. Its lower and posterior margins are broken away, and the anterior margins inflected by accidental pressure, so that the side-view does not give a very good idea of its outline, and makes the hinge appear proportionally too long. The larger specimen, from which our measurements were taken, shows the hinge to be quite short and the posterior margins of the valves curved forward above, so as to meet it at a more obtuse angle. This larger specimen also has its undulations proportionally broader and much less distinct; and the anterior margins of its valves descend straight and vertically from the beaks, without being inflected, but meeting at an obtuse, though salient, angle. It likewise shows the radiating markings rather more distinctly than the figured specimen, on which, though clearly traceable, they are so feebly marked that they escaped Mr. Elliott's attention in making the drawing.

Locality and position.—Near Medicine Bow station, Wyoming Territory; in beds equivalent to the Fort Pierre group of the Upper Missouri Cretaceous series.

Subgenus VOLVICERAMUS.

Inoceramus umbonatus, M. & H.

Plate 3, figs. 1, *a*, *b*, *c*; and pl. 4, figs. 1, *a*, *b*, and 2, *a*, *b*.

Inoceramus umbonatus, Meek and Hayden, March (1858), Proceed. Acad. Nat. Sci. Philad., 50.
Compare *I. involutus*, Sowerby (1828), Min. Conch., VI, 160, pl. 583.

Shell attaining a rather large size, vertically subovate, extremely inequivalve; height more than one-third greater than the antero-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 subcir-

cular, or a little oval transversely, much compressed or nearly flat, excepting in the central and umbonal regions, which are moderately convex; beak 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.

The description of this remarkable shell first published was made out from a portion of a small left valve, giving a rather indefinite idea of the characters of the species. Since that time, I have had an opportunity to examine some fine large specimens, brought from the same locality by Lieutenant Mullan's party, and it is mainly from these that the above description is made out. It is true, none of these specimens show the two valves connected, but there are among them right and left valves, bearing so exactly the relations to each other that the right and left valves of the most nearly analogous European species do, that I have scarcely a doubt in regard to their being the opposite valves of one species.

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.

The most nearly allied American species of which I have any knowl-

edge is a shell described by Dr. Shumard from the Cretaceous rocks of Texas, under the name of *I. capulus* (Trans. Saint Louis Acad. Sci., iv, 606). I only know the form described by Dr. Shumard from his description, not having seen figures or specimens of it; but judging from his description, I think he is right in considering it a distinct species, since it is marked by small, distinct, concentric undulations, while the corresponding valve of our Upper Missouri species is almost entirely smooth. He also mentions traces of radiating ribs on the umbo, of which I have seen no indications on any of our Upper Missouri specimens.

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. Philad., 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.

Inoceramus exogyroides, M. & H.

Plate 5, figs. 3, *a*, *b*, *c*.

Inoceramus exogyroides, Meek and Hayden (1862), Proceed. Acad. Nat. Sci. Philad., 26.

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.

Subgenus CATILLUS, Brong.

Inoceramus pertenuis, M. & H.

Plate 37, figs. 3, *a*, *b*; and plate 38, figs. 3, *a*, *b*.

Inoceramus ventricosus, Meek and Hayden (May, 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 87 (not Sowerby).
Inoceramus pertenuis, Meek and Hayden (Nov., 1856), *ib.*, 276.

Shell equivalve, or very nearly so, broad-oval or subcircular, very gibbous, apparently thin; anterior side short, rounded or curving obliquely backward and downward from the beaks; base forming a broad curve, the most prominent part of which is usually a little behind the middle; posterior side longer and higher than the anterior, very broadly rounded or subtruncate, hinge-line of moderate length, straight, and forming an angle of about 50° with the umbonal axis. Beaks tumid, rather obtuse, rising somewhat above the hinge, and located nearly over the anterior extremity, often constricted by a distinct sulcus around the umbonal region. Surface having a few irregular, obscure, concentric undulations, and marked by fine, regular, subimbricating lines of growth.

Length, 4.30 inches; height, 3.40 inches; convexity, 2.20 inches.

The ventricose, cordate form of this species, and the peculiar tumid and constricted character of its beaks, will serve to distinguish it from all the other forms known in the Upper Missouri rocks that bear any general resemblance to it. In some respects, certain varieties of it remind one of *I. multiplicatus*, Stoliczka (Palæont. Indica, III, 406, pl. xxviii, figs. 1, 1*a*); but its

less depressed form, and much more tumid, less nearly terminal, and generally constricted beaks, will readily distinguish it from the Indian species. The specimens yet found are mainly casts, retaining more or less of the outer fibrous layer of the shell only.

Locality and position.—Both these forms occur in a brown Cretaceous sandstone at the mouth of Judith River, above Fort Union; from the horizon of the upper part of the Fox Hills group.

Inoceramus Cripsii? var. subcompressus, M. & H.

Plate 38, fig. 2, *bis*.

Inoceramus Cripsii, Mantell (1822), Foss. South Downs, or Ill. Geol. Sussex, 133, pl. xxvii, fig. 11.—? Goldf. (1833), Petref. Germ. II, 116, pl. cxii, figs. 4, *a*, *b*.—Zittel (1864), Bivalves of the Gosau formation, tab. xiv, figs. 1 and 2 (varieties and synon.?)
Inoceramus subdepressus, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 181.

Shell transversely rhombic-oval, compressed, thin, anterior side rounded below the beaks; base forming a long semi-ovate curve, the most prominent part of which is behind the middle; posterior side long, very narrowly rounded, and prominent below the middle, subtruncated obliquely forward above; hinge of moderate length, forming an angle of about 40° with the umbonal axis. Beaks small, scarcely rising above the hinge, located nearly over the anterior extremity. Surface ornamented by somewhat regular concentric undulations.

Length, 2.55 inches; height, 1.70 inches.

I have intentionally avoided citing in the synonymy of Mantell's *I. Cripsii*, the long list of names representing the wide range of forms most generally regarded as synonymous with that species, because it seems to me that much uncertainty still remains in regard to the relations of many of these shells to the typical *I. Cripsii*. Indeed, until some one gives a more satisfactory figure and description of that shell than those published by Mantell, it is scarcely possible for any person who has not had an opportunity to examine his type-specimen, or others that have been identified by comparison with it, to form any very satisfactory conclusions in regard to its real characters. I certainly cannot see anything in his figure or description from which it can be very positively determined whether his type is a typical *Inoceramus* (higher than long, with a short hinge), or whether it belongs to the transverse *Catillus* group. I infer, however, that it belongs to the latter

section, from the fact that all of the shells that have been identified with it by European authors are of the latter type.*

Compared with Mantell's figure (if we view its upper end as the anterior, and not the hinge-margin, which former seems to be the way it has been generally understood), the shell here under consideration differs in having its beaks less nearly terminal, its anterior margin more prominent, and its posterior margin obliquely truncated above, and narrowly rounded below the middle. I know nothing about the convexity of Mantell's type; but the form here described is more compressed than most of those usually referred to *I. Cripsii*. With the exception of its obliquely-truncated posterior margin, it seems to agree more nearly with Goldfuss' figures of a shell referred by him to *I. Cripsii*, but which has been identified by d'Orbigny with a form from the Chalk of France, by him named *I. Goldfussii*. The identity of the latter with that figured by Goldfuss, however, does not appear to be quite demonstrated by the published figures.

Although far from being clearly satisfied that our shell really belongs to Mantell's species, I have concluded to place it provisionally as a variety of the same, until some more satisfactory comparisons can be made.

Locality and position.—Same as last.

Inoceramus Cripsii?, var. **Barabini**, Morton.

Plate 13, figs. 1, *a*, *b*, *c*; and plate 12, fig. 3.

Inoceramus Barabini, Morton (1834), Synopsis Org. Rem., 62, pl. 17, fig. 3 (pl. 13, fig. 11 ?).
Inoceramus gibbus, Tuomey (1854), Proceed. Acad. Nat. Sci. Philad., VII, 170.
Inoceramus cuneatus, Meek and Hayden (1860), *ib.*, 181.
For references to original description of *I. Cripsii*, see synon. of preceding variety.

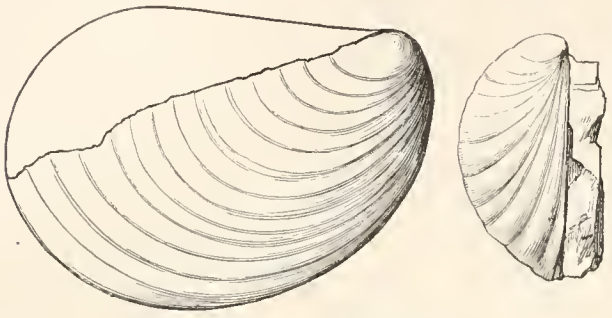
Shell transversely ovate, moderately gibbous in the anterior and umbonal regions, and cuneate posteriorly, very nearly or quite equivalve, rather thin; anterior margin descending from the beaks at first almost at right angles to the hinge, after which it gradually curves obliquely backward and downward, so as to pass by a graceful sweep into the base; posterior side long, com-

* Mantell's description reads as follows: "Obovate, much depressed, with numerous concentric, transverse ridges; beaks acuminated; posterior side small, depressed; anterior side expanded; hinge oblique ?."

He figures the shell with its longer diameter ranging vertically; but from the words "much depressed" and "transverse ridges," it would seem to be transversely elongated, and the hinge on the right side of the figure. Yet the expression "posterior side small, depressed; anterior side expanded" would scarcely be consistent with this view. He probably described the anterior side as the posterior, and the latter as the anterior, as was the custom with some of the older authors.

pressed, and rather regularly rounded; hinge long and straight, ventral margin forming a broad, semi-ovate curve; beaks very nearly terminal, or located directly over the anterior margin, rather prominent, but rising little above the hinge, equal, oblique, somewhat incurved, and nearly contiguous. Surface ornamented with moderately distinct, more or less regular, concentric undulations.

Fig. 1. Fig. 2.



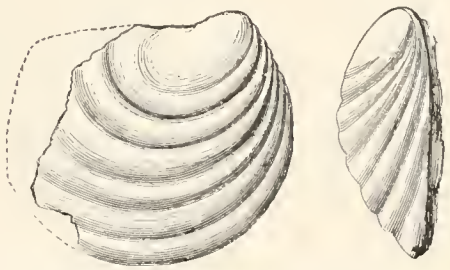
Inoceramus Barabini, Morton.

1. Side view of right valve from Morton's original type-specimen; for comparison with our shells.
2. Anterior profile view of same.

Length of a large, rather long specimen, 3.90 inches; height, 2.75 inches; convexity of the two valves, 2 inches. Young individuals are proportionally shorter.

In some of the casts of this shell, I observe a narrow, distinct sulcus, passing from the back part of the beaks obliquely backward and downward across the dorso-lateral region of each valve, as in *I. impressus*, d'Orbigny. This, however, is not like the broad depression shown in Dr. Morton's figure of his *I. alveatus*, on pl. xvii of his Synopsis, but a sublinear groove (on internal casts) caused by a small ridge only seen on the inside of the inner lamina of the shell. This character, however, is only occasionally present.

Fig. 3. Fig. 4.



Another form figured by Morton under the name *I. Barabini*; but not the one he evidently regarded as the type.

Fig. 3. Right side view of Morton's specimen.
Fig. 4. Profile anterior view of same.

After proposing the name *cuneatus* for this shell, I had an opportunity to compare it with Dr. Morton's types of his *Inoceramus Barabini*, and find that it agrees so very closely with the first of the two different forms referred to by him in connection with that name, that I cannot doubt its exact identity. In this connection, however, I should explain that Dr. Morton's fig. 3, pl. 17, of his Synopsis, gives a very incorrect idea of the specimen from which it was drawn (as may be seen from our cut fig. 1, of the same), both with regard to the portions of the specimen preserved, and the outline-restoration of the posterior dorsal region broken away; which latter

would evidently be correctly restored if made to conform much more nearly to the outline of our specimens. This view is also confirmed by other more nearly entire specimens from Alabama, which agree almost exactly with our shell. Professor Tuomey proposed the name *Inoceramus gibbus* for this form; but as it was evidently regarded by Dr. Morton as the typical form of his species, which he describes as "obliquely elliptical," while he first refers to it in connection with the name, we cannot do otherwise than retain his name for it, whether we view it as a distinct species, or regard his specimens as representing two marked varieties. I should remark, however, that the original specimen of his other form represented by fig. 11 of his pl. xiii is far from correct, its beaks being represented too prominent, and too far back. The curves of its undulations are also incorrectly represented; and the posterior margins ought not to have been drawn as if the specimen shows its outline entire, because this margin is broken, and may have presented a very different outline from his figure as engraved. (See our cut No. 3, of last page, from his original specimen.)

Although by no means satisfied that this shell is identical with Mantell's *I. Cripsii*, I have concluded to place it provisionally as a variety of that species, in deference to the opinions of European palæontologists, who seem to refer all such forms to Mantell's species. Compared with the last, it will be seen to differ in its more prominent and terminal beaks, longer hinge-line, and rounded instead of obliquely-truncated posterior margin, while its valves are also more convex in the umbonal region. In all of these characters, however, excepting its more prominent beaks and more retreating anterior ventral margin, it conforms more nearly to the general idea of *I. Cripsii* than the last-described form does.

Locality and position.—Yellowstone River, one hundred and fifty miles above its mouth, in Montana; from the Fort Pierre group of the Upper Missouri Cretaceous.

Inoceramus convexus, H. & M.

Plate 12, figs. 5, *a*, *b*.

Inoceramus convexus, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci., V (n. s.), 386, pl. 2, fig. 2, *a*, *b*.

Shell ovate, very convex, height a little more than three-fourths the length; beaks prominent; hinge-line long and straight, forming an angle

with the anterior margin of about 1.20°; anterior side somewhat prominent and regularly rounded; posterior side extended and probably subtruncate. Surface marked by strong undulations, which are simple at the extremities, while some of them become divided toward the center; being less conspicuous toward the beaks, and almost obsolete near the base of the shell. Obscure concentric lines mark the surface of exfoliated specimens somewhat irregularly.

Although several very imperfect examples apparently of this form occur in the Upper Missouri collections under consideration, none have yet been found in quite so good a condition as the original typical specimen, the figure of which is copied on our pl. 12. From the limited means of comparison at this time available, I am left in doubt in regard to the propriety of retaining it as a distinct species. Dr. Zittel cites it, in his work on the Gosau Fossils, as a synonym of *I. Cripsii*, which may be correct; but we have not yet the means of confirming or positively disproving his opinion. We have, however, as good or perhaps even better reasons for supposing it a variety of *I. Sagensis*, Owen. On comparison with Owen's figure of the type of *I. Sagensis* (taking care to place both figures with the hinge in a horizontal posture), it will be seen to differ mainly in its less prominent beaks, more convex anterior outline, and the curve of its undulations indicating a more transverse form; in nearly all of which characters, however, it agrees more nearly with *I. Nebrascensis* of Owen. My present impression is that it is probably distinct from both of Owen's types.

Locality and position.—Great Bend of the Missouri, below Fort Pierre; from the Fort Pierre group of the Upper Missouri Cretaceous.

Inoceramus Sagensis, var. Nebrascensis, Owen.

Plate 13, figs. 2, *a*, *b*.

Inoceramus Nebrascensis, Owen (1852), Report Min., Iowa, and Wisconsin, 582, pl. 8, fig. 1.
I. Sagensis, Owen (1852), *ib.*, pl. 7, fig. 3.
Compare *I. convexus*, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci., V (n. s.), 386, pl. 2, fig. 2; and our figs. 5, *a*, *b*, pl. 12.

Shell large, obliquely broad-ovate or subcircular, moderately gibbous, about as high as long; anterior side short, making a very broad, oblique curve from the beaks to the base; ventral and postero-ventral margins nearly regularly rounded; hinge rather short, forming an angle of about 50° with

the axis of the umbones; beaks moderately convex, rising little above the hinge, oblique, scarcely incurved, located about one fifth the horizontal diameter (length) of the shell behind the anterior border. Surface ornamented by regular, distinct, concentric undulations.

Length, about 5.70 inches; height, 5.60 inches. These measurements are taken from a medium-sized specimen.

A careful study of our specimens, in connection with Dr. Owen's figures and descriptions of his *I. Sagensis* and *I. Nebrascensis*, has led to the conclusion that the forms for which these names were proposed are not specifically distinct; the type of the latter being only a larger individual of very slightly different outline from that for which the name *I Sagensis* was proposed.

It will be seen, however, that the form here referred to *I. Nebrascensis* is a little more rounded, or less transverse, than the curves of the undulations on Dr. Owen's figure would indicate for the outline of his type. There appear, however, to be so many gradations in characters of this kind that to separate the form we have figured, as a variety or species, would require that we should, in the same way, separate almost every individual specimen under a different name.

In comparing our figure with those given by Dr. Owen, however, it should be remembered that his figures are turned obliquely with the beak upward. In order to make the comparison understandingly, both figures should be placed with the hinge-line upward and horizontally arranged. In making the comparison in this way, it will be seen that there is less difference between the form of the shell under consideration, and Dr. Owen's type of *I. Nebrascensis*, than would appear to exist on a hasty examination.

Locality and position.—White River, Nebraska, above Bad Lands; from the Fort Pierre group of the Cretaceous.

Inoceramus proximus, Tuomey ?.

Plate 12, figs. 7, *a*, *b*.

Inoceramus proximus, Tuomey (1854), Proceed. Acad. Nat. Sci. Philad., VII, 171.
Inoceramus Mortoni, Meek and Hayden (Oct., 1860), in catalogue, Proceed. Acad. Philad., XII, 428.
Compare *I. confertim-annulatus*, F. Roemer (1852), Kreid. von Texas, pl. vii, fig. 4.

Shell (right valve) subcircular when young, but becoming transversely suboval with age, much compressed; posterior side considerably longer than

the other, and more or less broadly rounded; base semicircular or semi-oval, usually a little more prominent behind than in front of the middle; anterior margin rounded; hinge straight and comparatively long, ranging nearly parallel to the longer diameter of the shell. Beak very small, compressed, projecting but slightly above the hinge-line, and located about one-fifth the length of the shell back from the anterior margin. Surface ornamented by small, very regular, simple, concentric undulations or costæ, which are well marked on internal casts.

Length, about 2.50 inches; height, 1.96 inches; convexity (left valve), 0.42 inch.

I have seen but a single specimen of this shell, from the Upper Missouri, and consequently have no means of judging to what extent it may vary. It resembles *Inoceramus confertim-annulatus* of F. Roemer (Kreid. von Texas) so closely that I have been almost inclined to refer it to that species. It differs, however, from Roemer's figure in the following particulars: first, its antero-ventral margin is much less prominent; secondly, its hinge-line is longer; thirdly, its beaks are placed farther forward, while the height of the valve is greater in proportion to its transverse diameter. If these differences are constant, we must regard these two forms as specifically distinct; if not, however, unless the other valve may be found to present other differences, it would be difficult to point out any characters by which they can be separated from Roemer's species.

From *I. Barabini* of Morton, as figured on pl. 17 of his Synopsis Org. Rem. (not fig. 11 of pl. 13, which may be distinct species), with the original of which we have compared it, this species differs in being more compressed, less oblique, and in having more regularly and more closely-arranged concentric undulations or costæ.

From all the other species yet known from the Upper Missouri rocks, resembling it in other respects, this shell will be distinguished by its more compressed form and smaller and more regular concentric costæ. It is not near so high in proportion to its transverse diameter nor so broadly rounded posteriorly as *I. Vanuxemi*, which resembles it in the character of its concentric costæ as well as in the slight convexity of the valves.

Since proposing to name this species after Dr. Morton, under the impression that it had not previously been described, I have seen specimens from Eufaula, Ala., regarded as authentic examples of Professor Tuomey's

I. proximus, apparently agreeing very nearly with it. Consequently, his older name is now cheerfully retained for it. Professor Tuomey's description is so brief and unsatisfactory, that I should not have ventured to refer our shell to his species without the aid derived from a comparison with specimens from near the same locality.

It is possible that the form represented by our figs. 2, *a*, *b*, of pl. 12, may belong rather to this species than to *I. Barabini*, to which I have very doubtfully referred it.

Locality and position.—Great Bend of the Missouri, below Fort Pierre; from the lower part of the Fort Pierre group; also, Columbus, Miss., and Alabama.

Inoceramus proximus?, var. **subcircularis**, M.

Plate 12, figs. 2, *a*, *b*.

Compare *Inoceramus Barabini*, Morton (1834), Synop. Org. Remains, pl. 13, fig. 11 (not pl. 17, fig. 3); and *I. Cripsii*, Mantell (broad varieties).

I have been more perplexed in regard to the proper disposition of this form than any other in the collection. It closely approaches some of those I have referred to *I. Cripsii*, var. *Barabini*, as may be seen by comparing it with fig. 3 of the same plate. Yet it not only differs in its shorter, more rounded, outline, but is constantly more compressed, as may be seen by fig. 2, *b*. In this latter character, as well as in its less depressed form, it much more nearly resembles *I. proximus* (fig. 7 of the same plate), to which I have concluded to refer it provisionally as a variety. It will be seen, however, to have proportionally larger and rather more distant undulations, which also present a somewhat different curve, though the specimens vary somewhat in these characters.

Again, it may, on the other hand, be the young of *I. Vanuxemi* (pl. 14, fig. 2). The objection to this view is, that it came from a somewhat distant locality, where no large specimens agreeing with that form have been found; while it seems not to be very uncommon, and the specimens are quite uniform in their small size. In several respects, it also resembles one of the forms included by Dr. Morton under the name *Barabini*, (see our cuts, figs. 3 and 4, page 50), though not the one I regard as the typical form of that shell, (represented by our cuts 1 and 2.) It is, however, decidedly more compressed than either of Dr. Morton's types.

Locality and position.—Yellowstone River, 150 miles above its mouth; from the upper part of the Fort Pierre group; also, from the Fox Hills group, on Deer Creek, a tributary of the North Platte. I *think* I have also seen the same form from the Cretaceous of Alabama and New Jersey.

Inoceramus Balchii, M. & H.

Plate 15, figs. 1, *a*, *b*.

Inoceramus Balchii, Meek and Hayden (May, 1860), Proceed. Acad. Nat. Sci. Philad., XII, 180.

Shell (left valve) large, subquadrate or broad oblong-oval, much compressed; anterior side truncated obliquely forward above at an angle of about 115° with the hinge, rounding into the base below; ventral margin forming a broad curve, the most prominent part being behind the middle; posterior side longer and wider than the other, broadly rounded (sometimes subtruncated above); hinge-line rather long, forming an angle of about 60° with the umbonal axis; beaks narrow, rising a little above the hinge, scarcely incurved, located about half-way between the middle and the most prominent part of the anterior border. Surface ornamented by very slightly-elevated, broadly-rounded, rather irregular undulations, which become entirely obsolete on large specimens, below the middle, and on the posterior and lower anterior regions.

Of the finer surface-markings of this shell, if there were any, we know nothing: the only specimen yet found being an internal cast, with portions of the inner laminated layer remaining. It will be readily distinguished from *I. Vanuxemi* by its less distinct and more irregular as well as broader undulations. Its beaks are also much more prominent and oblique, and placed farther forward, while the general form of the shell is more oval transversely, and its anterior side more distinctly truncated. Its proportionally more compressed form, more obscure and less regular undulations, longer hinge, and truncated anterior, will prevent it from being confounded with *I. Nebrascensis*, Owen.

The only specimen yet found of this species is not in a condition to show clearly the exact form of the adult shell; but the curve of the undulations in the region of the beaks shows that when it had attained a length of 3.40 inches, its height was 2.90 inches. The specific name was given in honor of Lieut. G. T. Balch, of the United States Ordnance, to whom we are indebted for the typical specimen of the species.

Locality and position.—Same as preceding.

Inoceramus tenuilineatus, H. & M.

Plate 12, fig. 6.

Inoceramus tenuilineatus, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci., VIII, 387, pl. 2, fig. 3, *a*, *b*.

"Shell obliquely rhomboid-ovate; height a little more than two-thirds the length; beaks toward the anterior extremity, elevated, ventricose, and incurved; hinge-line straight, making an angle with the anterior margin of about 100°; posterior side extremely elongated and rounded at the extremity; surface marked by irregular undulations, which are nearly obsolete on exfoliated specimens. A small portion of the external surface remaining near the anterior extremity, shows minute crowded concentric striæ."

The depressed, transversely-ovate form, nearly smooth surface, and oblique, prominent, gibbous beaks of this species, will distinguish it from all the others resembling it in other respects, yet known from the Cretaceous rocks of this region. It appears to be a rather thin shell. The points of the beaks are generally elevated little above the hinge; though the swell of the umbones a little farther back rises rather distinctly above it. Between this convex umbonal region and the hinge, there is usually a broad, rounded depression in casts. The specimens yet obtained are so much mutilated that I have preferred to give a copy of the original figure. It seems to be a well-defined species.

Locality and position.—Great Bend of the Missouri; in lower part of Fort Pierre group of the Cretaceous series; and at Sage Creek, in the upper beds of the same formation.

Inoceramus Vanuxemi, M. & H.

Plate 14, figs. 2, *a*, *b*.

Inoceramus Vanuxemi, Meek and Hayden (May, 1860), Proceed. Acad. Nat. Sci. Philad., III, 180.

Shell large, subcircular, much compressed; anterior side broadly-rounded, and shorter than the other; base forming a nearly semicircular curve, being a little more prominent behind than in front; posterior side wider than the other, broadly rounded or subtruncated: hinge short, straight, and forming an angle of about 90° with the vertical axis of the valves; beaks very small, compressed, and scarcely rising above the hinge, not distinctly incurved, located a little in advance of the middle. Surface ornamented by regular,

distinct, subangular, but not very prominent, concentric undulations, which are separated by rather wide, shallow, rounded depressions.

Length of the largest specimen hitherto seen, 10 inches; height of the same, 9 inches.

This species may be at once distinguished from *I. Nebrascensis* of Owen, by its much more compressed, and more nearly circular form, as well as by its less prominent and more flattened beaks; which are also not so oblique, and located farther back. The fact that the only two specimens of it yet seen are both left valves, while those now at hand for comparison, as well as that figured by Dr. Owen, of *I. Nebrascensis*, are right valves, led at first to the suspicion that they might be the opposite valves of the same species. It is manifest, however, that this cannot be the case; for, in addition to the differences already mentioned, the specimens of the species under description are, as above stated, distinctly more compressed than the right valve of *I. Nebrascensis*, while in this genus the left valve is always the more convex, where there is any perceptible difference.

The specific name was given in honor of the lamented Lardner Vanuxem, geologist of the third geological district of New York, and the discoverer of the Cretaceous system in America.

Locality and position.—Same as the preceding. Collected by Lieut. G. T. Balch, to whom we are indebted for the use of the specimens.

Inoceramus sublævis, H. & M.

Plate 12, figs. 1, *a*, *b*.

Inoceramus sublævis, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci., V (n. s.), 386, pl. 2, fig. 1.

Shell of medium size, oval in outline, moderately gibbous, nearly or quite equivalve, rather thin; extremities rounded, base forming a broad, nearly semicircular or subelliptical curve; hinge apparently long and straight; beaks small, located near the anterior side, not much elevated above the hinge, nor very distinctly incurved; surface smooth, or only marked by very obscure, concentric undulations, and fine, regular, equidistant lines of growth.

Our larger specimens are too imperfect to give accurate measurements, but some of them indicate a length of about 4.50 inches, and a height of 3 inches. This species will most generally be distinguished from the allied forms in the Nebraska rocks, by the absence of distinct undulations, though

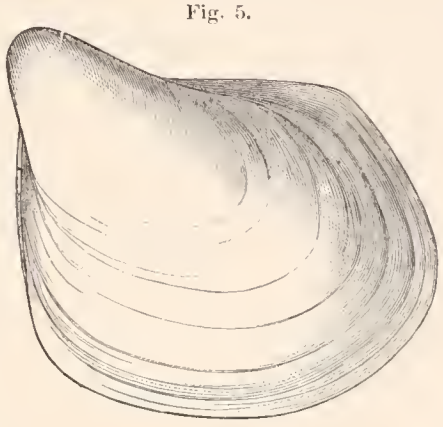
it seems to have varied somewhat in this respect. It is also usually less gibbous, has smaller beaks, and a more regular oval outline than most of its associates. Our figure represents a young shell.

Locality and position.—This species is unknown to us from any other locality than the Great Bend of the Missouri, below Fort Pierre; where it occurs in the base of the Fort Pierre group, or No. 4 of the Cretaceous.

Inoceramus tenuirostris, M. & H.

Inoceramus tenuirostris, Meek and Hayden (1862), Proceed. Acad. Nat. Sci. Philad., XIV, 27.

Fig. 5.



Inoceramus tenuirostris.

Side-view of a cast of left valve.

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 of 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.

Inoceramus undabundus, M. & H.

Plate 3, figs. 2, *a*, *b*.

Inoceramus undabundus, Meek and Hayden (1862), Proceed. Acad. Nat. Sci. Philad., XIV, 26.

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. It seems to stand, as it were, almost exactly intermediate in its characters between the typical *Inoceramus* and *Catillus* groups. In order that this may be the more clearly understood, however, it should be explained that our figure 2 *a* of this species on pl. 3, is not arranged with the hinge-line exactly horizontal; the dorsal outline not being parallel to the hinge, which ranges more obliquely forward and downward. If the figure were turned so as to bring the beak farther upward, and the longer diameter of the valve more nearly (but not exactly) vertical, the hinge-line would then be horizontal.

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 prob-

able 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 Lieutenant Mullen.

Inoceramus incurvus, M. & H.

Plate 12, figs. 4, *a*, *b*.

Inoceramus incurvus, Meek and Hayden (Nov., 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 277.

Shell subglobose, oval or ovate-cordiform, very gibbous, nearly or quite equivalve; beaks oblique, small, placed a little back of the anterior side, strongly incurved; umbonal region of both valves very ventricose, and considerably elevated above the hinge and points of the beaks. Surface ornamented by concentric undulations, which become sharply elevated over the most prominent portions of the umbones, but are less distinct, or nearly obsolete, toward the base and extremities of the shell.

Judging from the curve of the undulations near the beaks, young individuals of this species must have been nearly ovate in form; the posterior side being broader than the other. At this stage of its growth, the shell seems to have been much less convex, and the beaks more nearly terminal; but as it advanced in age, it became rapidly more ventricose, and extended somewhat in front of the beaks. The surface was probably marked by lines of growth, but, owing to the exfoliation of the external fibrous layer, they are not preserved on our specimens; none of which are in a condition to give a very clear idea of its general form. The peculiar, and equally-incurved character of the beaks, together with the ventricose, elevated umbonal region, and sharply-prominent undulations, when taken together, well serve to distinguish it from any other species known from these rocks.

I have placed this species here at the end of the group *Catillus*, merely provisionally, the specimen being too imperfect to show its subgeneric relations.

Locality and position.—Little Bear's Village, between Fort Pierre and Fort Clark; in the Fort Pierre group, or formation No. 4 of the Upper Missouri Cretaceous.

Subgenus **MYTILOIDES**, Brong.

Inoceramus problematicus, Schlot

Plate 9, figs. 3, *a*, *b*.

Mytilites problematicus, Schlot., Petrefact., 312.
Inoceramus mytilloides, Mantell (1822), Geol. Sussex, 215, pl. 28, fig. 2.—Sowerby (1823), Min. Conch., V, 61, pl. 442.—Goldf. (1836), Petrefact. Germ., II, 118, pl. exiii, fig. 4.
Inoceramus problematicus, d'Orbigny (1843), Pal. Franc., III, 510, pl. 406.—Meek and Hayden (May, 1857), Proceed. Acad. Nat. Sci. Philad., IX, 119.
? *Inoceramus pseudo-mytiloides* Schiel (1855), Pacific Railroad Reports, II, 108, pl. 3, fig. 8.

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° 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.

Some specimens of this shell are proportionally a little wider than the figures generally given of *I. problematicus*, while others seem to be almost exactly like those published by Goldfuss and d'Orbigny. Like that species, it also varied much in form at different ages, being proportionally broader and more convex when young, than at more advanced stages of its growth.

Locality and position.—Big Sioux River, six miles above its mouth; on Little Blue River near Kansas and Nebraska line, and at many other localities in that region; also at Coalville, Utah, Fort Harker, Montana, as well as in Wyoming, Colorado, Arkansas, and southward into Texas; and at numerous foreign localities. Occurs in lower part of Niobrara group, or formation No. 3, of the Upper Missouri Cretaceous series, and ranges down into No. 2, or the Fort Benton group of the same.

Inoceramus problematicus, var. **aviculoides**, M. & H.

Plate 9, fig. 4.

Inoceramus aviculoides, Meek and Hayden (May, 1860), Proceed. Acad. Nat. Sci. Philad., XII, 181.

Shell obliquely subovate, compressed, very thin, subequivalve, very inequilateral; anterior border sloping from the beaks obliquely backward and downward, with a more or less convex outline; posterior basal margin regularly rounded; posterior dorsal slope usually convex in outline below, and concave above, forming an angle of about 45° with longest diameter of the shell, compressed and generally somewhat alate posteriorly; beaks oblique, rather small, nearly terminal. Surface ornamented with small, more or less regular, concentric undulations, and finer striæ of growth. Right valve compressed; beak scarcely projecting above the hinge-margin. Left valve a little more convex; beak convex, rather pointed, incurved, and slightly more prominent than that of the other valve.

Length, measuring from the beak of the right valve obliquely back to the postero-basal extremity, about 3 inches; breadth across, at right angles to the length, 1.70 inches; convexity, about 0.88 inch.

The right valve, figured on our plate, under the above name, is the form for which we at one time proposed the name *I. aviculoides*. Later comparisons have led to the conclusion that it should probably be included as a variety of *I. problematicus*, Schlotheim. I should remark, however, that the left valve is proportionally more convex, and its beak more prominent than is usual in Schlotheim's species; while, as may be seen by our figure, its hinge is proportionally longer, and its posterior dorsal region more alate. There are among the specimens, however, so many gradations between this form and the typical *I. problematicus*, such as those represented by our figs. 3, *a*, *b*, of the same plate, that it seems hardly possible to separate them specifically.

Locality and position.—The specimen figured on pl. 9 was obtained on Little Blue River, near the Kansas and Nebraska line, where it was found associated with the typical *I. problematicus*. Both also occur near Big Blue River, in Nebraska; on Republican River, Kansas, and other localities in that region. So far as yet determined, they are both only found in the light-

colored limestone layers, near the lower part of the Niobrara group, and occasionally in the upper part of the Fort Benton group, of the Upper Missouri Cretaceous series. I have never seen either from any localities east of the Mississippi.

Genus GERVILLIA, Defrance.

Synon.—*Gervillia*, Defrance (1820), Dict. Sci. Nat., XVIII, 502.—Deslongchamps (1824), Mem. Soc. Linn. du Calvados, I, 126.—Blainv (1825), Malac., 530.—J. Sowerby (1826), Min. Conch., VI, 16.—Deshayes (1830), Encyc. Méth., III, 166.—G. B. Sowerby, jr. (1842), Man. Conch. (2d ed.), 153.—Morris (1842), Brit. Foss., 108.—d'Orbgny (1843), Palæont. Fr., III, 480.—Geinitz (1846), Grund. d. Verst., 459 (not 1866, Carb. und Dyas in Nebraska).
Gervillea, Fleming (1828), Brit. An., 381, and 390.
Gervilleia, Rominger (1846), Leonh. et Bronn's Jahrb., 296.

Etym.—Dedicated to the French naturalist Gerville.
Type.—*Gervillia solenoides*, Defr.

Shell obliquely-elongated, ensiform or subtrigonal, very inequilateral; beaks oblique and placed near or at the anterior extremity; left valve more convex than the other; anterior margins a little gaping, but without a byssal emargination in either valve: cardinal margin straight, more or less extended, and somewhat alate posteriorly, and less so in front, provided with a flat, diverging, or gaping area, or hinge-plate, crossed in each valve by from three to about six distinct pits for the reception of the cartilage, which was exposed externally; hinge generally with a more or less numerous series of irregular fold-like teeth under the area, ranging obliquely forward and upward; muscular and pallial impressions as in *Avicula*.

The genus *Gervillia* is closely related to *Bakevellia*, with which some confound it. It differs, however, in generally having a larger, more elongated shell, with usually a greater number of cartilage-pits, and more particularly in having its hinge-teeth all ranging obliquely forward and upward, instead of having those on the anterior and posterior sides elongated parallel to the hinge-margin. *Bakevellia*, also, often has a larger anterior muscular scar. From *Melina*, Retzius (= *Perna*, Bruguière), the Gervillias differ in the general possession of hinge-teeth, in being much more oblique, narrower, and usually more elongated shells.

As closely allied, however, as this genus is to *Bakevellia*, Dr. Stoliczka refers that genus doubtfully to the *Arcidæ*, while he places *Gervillia* correctly in the *Aviculidæ*.* It seems to me, however, that they should go together, wherever they are placed, and that *Gervillia* clearly belongs to the *Aviculidæ*.

* Palæont. Indica, III, 335 and 392.

A few species presenting more or less the external appearance of this genus have been described under its name from the Carboniferous rocks; but their hinges and interior are not well known in some cases, while in others they have been found to belong to *Avicula*, *Monopteria*, and other groups. The Permian species referred to it probably all belong to *Bakevellia* and *Aricula*. Some of the Upper Triassic species seem to belong to this genus, and it is known to be well represented in the Jurassic rocks, during the formation of which it probably attained its greatest development. It continued also to be represented until about the close of the Cretaceous period, after which we find no traces of its existence.

Gervillia subtortuosa, M. & H.

Plate 16, figs. 7, *a*, *b*, *c*.

Gervillia subtortuosa, Meek and Hayden (Nov., 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 276.

Shell thick, obliquely sublanceolate, tortuous, and laterally curved; right valve distinctly convex, left nearly flat; posterior side elongate, narrow, widest at its junction with the posterior extremity of the hinge; cardinal border straight, rather long, and forming an angle of about 20° with the longitudinal axis of the shell; cardinal area rather broad; cartilage-pits about six, nearly as wide as the intervals between; hinge-teeth nearly obsolete; scar of the adductor and posterior pedal muscles large, obliquely elongate, and placed nearly centrally above the middle of each valve; anterior scar small, very deep, and located close under the anterior extremity of the hinge. Surface unknown.

Our specimens of this species are imperfect at both extremities, and the external subcorneous layer of the shell is exfoliated; consequently they do not afford the means for making out a very complete diagnosis. It is evidently quite a thick shell: the remaining portion after the exfoliation of the outer layer and some of the nacreous laminæ, measuring in places as much as 0.34 inch in thickness. On the left, or more convex, valve, we observe an undefined suclus passing obliquely from the anterior side of the beak backward and downward to the lower margin, which it intersects nearly under the middle of the hinge. At this point, the lower edges of both valves are a little contracted, and, just in advance of it, they are slightly gaping for the passage of the byssus.

A side-view of this species is much like *G. aviculoides* of Sowerby (Min. Conch., vol. 6, pl. 511), but it is a more arcuate and twisted shell, though not so much so, nor apparently so obtuse at the anterior extremity, as *G. tortuosa* of the same author. So far as is known, this and our *G. recta*, and *G. ensiformis* of Conrad, from the Cretaceous of Alabama, are the only species of this genus hitherto described from the rocks of this country; the few species reported from Carboniferous rocks in the West by Professor Geinitz belonging, as already intimated, to *Aricula*, and possibly in part to *Bakevellia*.

Locality and position.—Three hundred miles above Fort Union, on the Missouri River; in the Fort Pierre group, or No. 4 of the Cretaceous series of that region.

Gervillia recta, M. & H.

Plate 29, figs. 1, *a*, *b*.

Gervillia recta, Meek and Hayden (1861), Proceed. Acad. Nat. Sci. Philad., XIII, 441.

Shell small, rather thin, obliquely elongate-oblong, more or less arcuate and nearly parallel on the lower and posterior dorsal margins, but not bent laterally or twisted; anterior basal margin oblique, nearly straight, or forming a long, slightly convex curve; posterior dorsal margin slightly concave in outline; posterior extremity generally truncated and cuneate; anterior extremity acutely angular; hinge short, and ranging at an angle of 30° to 35° above the oblique longitudinal axis of the shell; cardinal area a little gaping, provided with about three or four small cartilage-pits; beaks small, very oblique, placed near the anterior extremity of the hinge, but not terminal; surface nearly smooth, or only marked with obscure striæ of growth; posterior alation short and compressed; anterior small. Left valve convex, but flattened along the middle and behind, so as to impart a distinctly cuneate appearance to the posterior end, and form an obscure, undefined ridge along near the upper and lower magins of the flattened part. Right valve flat throughout.

Length of a mature specimen, 2.10 inches; breadth at posterior end of hinge, about 0.66 inch; convexity, 0.30 inch; length of hinge, 0.80 inch.

This little *Gervillia* is so closely allied to a Lower Greensand species, described by Professor Forbes under the name *G. linguloides* (Qr. Jour. Geol. Soc. Lond., I, pl. 3, fig. 9), that I have sometimes had doubts whether it is really distinct. Still, a critical comparison shows that it differs in having its

beaks not terminal. Again, d'Orbigny's figures of *G. linguloides* represent it as being laterally curved and having both valves convex, the right one even more so than the left; while our shell is never laterally arcuate, and always has the right valve flat and the left decidedly convex. His figures also show, as do those of Professor Forbes, that the *G. linguloides* has the posterior basal extremity more narrowly rounded than any of the specimens of our shell. These differences, which are constant in a large series of specimens of the shell under consideration, when taken in connection with different horizons at which they occur, renders it improbable that the species is the same as that described by Professor Forbes.

Locality and position.—Deer Creek, near North Platte; in the lower part of the Fox Hills beds of the Upper Missouri Cretaceous.

MYTILIDÆ.

Genus MYTILUS, Linnæus.

Synon.—**Perna* (sp.), Adanson (1757), Senegal, 217; Retzius (1788), Diss., 20.—Schum. (1817), Ess., 120 (not Brug. and others).

Mytilus (sp.), Linn. (1758), Syst. Nat., ed. X, 704; and (1767), *ib.*, ed. XII, 1155.—Müller (1776), Zoöl. Dan. Prodr., 199.—Da Costa (1778), Brit. Conch., 214.—Brug. (1792), Encyc. Méth., I, xiii.—Lamarck (1799), Prodr. 88 (as now restricted).—Gray (1847), Zoöl. Proceed., 198.—H. and A. Adams (1857), Genera Recent Moll., II, 512.

Mytulus (sp.), Retz. (1788), Dissert.

Callitriche and *Callitrichoderma* (sp.), Poli (1791), Test. Utr., 1, 194; and (1795), *ib.*, II, 254.

Aulacomya, Mörch (1853), Cat. Conch. Yoldi, 53.—H. and A. Adams (1857), Gener. Recent Moll., II, 513 (subgen. *Mytilus*).

Hormomya, Mörch (1853), Cat. Conch. Yoldi, 53.

Starelia, Gray (1858), Proceed. Zoöl. Soc. Lond., 90; and Annals & Mag. N. H., 3d ser., II, 62.—H. and A. Adams (1858), Gen. Recent Moll., II, 651 (subgen. *Mytilus*).

Etym.—*μυτίλος*, a muscle.

Type.—*Mytilus edulis*, Linn.

Shell equivalve, or very rarely inequivalve, extremely inequilateral, obliquely subovate, tapering to the beaks, more or less convex; posterior side compressed and rounded; beaks terminal, pointed, and straight, or a little arched; surface covered with an epidermis; hinge edentulous; ligament linear, marginal or subinternal; muscular impressions unequal, the anterior being small and placed near the beaks; pallial line obscurely marked.

H. and A. Adams admit three subgeneric groups under this genus, distinguished by the following not very important differences:

*Adanson's names being pre-Linnæan, and not binomial, cannot be properly retained.

1. **MYTILUS**, Linn. (typical).

Shell equivalve, with surface merely marked with concentric striæ.—(Type as already stated.)

2. **AULACOMYA**, Mörch (= *Hormomya*, Mörch).

Shell equivalve, with surface radiately costate or striate.—*M. magellanicus*, Chem.

3. **STAVELIA**, Gray.

Shell slightly inequivalve, with ventral edge sinuous.—*M. tortus*, Dunker.

The genus *Mytilus* has been supposed to date back to palæozoic times, but it is doubtful whether it really existed before the Triassic period. Certainly the so-called Carboniferous and Permian *Mytili* seem all to belong to the genus *Myalina*, or possibly, in some instances, to other genera. Some species of *Myalina* nearly simulate *Volsella* (= *Modiola*) and *Mytilus*, but they can be readily distinguished from these genera by having a broad, flat, longitudinally-furrowed cartilage-area, and a distinctly fibrous outer layer like that of *Inoceramus*. They are also nearly always inequivalve, and sometimes very decidedly so.

Species of *Mytilus* are found in all formations from the Trias upward, and are rather numerous in our existing seas, where the genus probably attains its greatest development. The existing representatives of this genus have a world-wide distribution, being found from Cape Horn to Behring's Straits, in the Black Sea, on the eastern coast of North America, the Cape of Good Hope, New Zealand, &c.

This genus presents one of the numerous instances of the great difficulties that would be met with in applying, in Conchology, the rule followed by some in other departments of natural history, of always taking the first species ranged under a genus by its author as the type of the same; Linnæus's first species of *Mytilus* being an oyster, while his first species under *Ostrea* is *Pecten maximus!* Under *Mytilus*, he included, along with species belonging to the genus as now restricted, others belonging to *Meleagrina*, *Lithodomus*, *Saxicava*, *Modiola*, *Avicula*, &c.; and none of those who followed him restricted it to the limits now assigned it, until we come down to Lamarck (1799), and he cites under it but a single example, *Mytilus edulis*, Linn., which therefore, according to the rule most generally followed in such cases, becomes the type of the genus.

Mytilus subarcuatus, M. & H.

Plate 38, figs. 2, *a*, *b*.

Mytilus subarcuatus, Meek and Hayden (1856). Proceed. Acad. Nat. Sci. Philad., VIII, 276.

Shell narrow subovate, oblique, somewhat arcuate, moderately convex; cardinal and ventral margins converging at an angle of about 40° toward the beaks, which are pointed and nearly straight; posterior extremity wider, compressed, and rather narrowly rounded below; hinge about half the length of the shell, a little arched, and passing gradually into the carinate postero-dorsal margin, which descends, with a regular convex curve, to the lower part of the posterior extremity; antero-ventral margin very slightly concave in outline. Surface unknown.

Length, 1.03 inches; height, measuring at right angles to the longer axis, 0.36 inch; convexity, about 0.28 inch.

This species resembles *M. lanceolatus* of Sowerby (Min. Con., pl. 439, fig. 2), but is proportionally wider behind, and not quite so pointed at the beaks. It seems to be about intermediate in form between that species and *M. edentulus* of the same author. The only specimen we have seen is a cast, showing none of the surface-characters, nor the muscular impressions.

Locality and position.—Dog River, near the mouth of Judith River; where it was found in a Cretaceous sandstone belonging to the latest beds of the Fox Hills group.

Genus VOLSELLA, Scopoli.

Synon.—*Perna** (sp.), Adanson (1757), Senegal, 207.—H. and A. Adams (1857), Genera Recent Moll., II, 515.—Conrad (1862), Proceed. Acad. Nat. Sci. Philad., XIV, 579; and (1865), Am. J. Conch., I, 10 (not *Perna*, Retzius, Brug., and others).

Volsella, Scopoli (1777), Intr. Hist. Nat., 397.—Modeer (1793), K. Vet. Ac. Handl., 392.—Gray (1847), Proceed. Zoöl. Soc., 197.—Meek and Hayden (1864), Palæont. Upper Mo., 85.

Tamarindiformis (part), Mensch (1787), Mus. Gevers, 412.

Callitriche and *Callitrichoderma* (sp.), Poli (1791), Utr. Sic., I, 194; and (1795), *ib.*, II, 254.

Modiolus, Lam. (1799), Prodr., 87.—Cuvier (1800), Anat. Comp., x; and (1817), Règne An., II, 471; also, *ib.* (1830), III, 136.—Link (1807), Rost. Samml., 146.—Goldf. (1820), Zoöl., 611.—Forbes (1838), Mal. Mon., 43.

Modiola, Lam., (1801), Syst. An., 113; and (1805), Ann. du Mus., VI, 119; and (1819), Hist., VI, 109.—Feruss. (1821), Tab. Syst., xlii.—Bronn (1837), Leth., 355; and of numerous other later authors.

Amygdalum, Mühlf. (1811), Entw., 69.

Brachydontes, Swainson (1840), Malac., 384 (subgenus).—H. & A. Ad. (1857), Gen. Recent Moll., II, 517.

Etym.—*Volsella*, forceps or tweezers.
Type.—*Mytilus modiolus*, Linn.

Shell transversely suboval or oblong, very inequilateral; surface smooth, concentrically striated, or with radiating or divaricating striæ or costæ, and

* Ante-Linnæan.

covered by an epidermis often bearing filaments; beaks depressed and placed near the anterior extremity, but not properly terminal; ligament linear, occupying a marginal groove; hinge generally edentulous, sometimes with a few nearly obsolete teeth, or with obscure crenulations in front; muscular and pallial impressions faintly marked, the scar of the anterior muscle being much smaller than that of the posterior.

In this genus there are two more or less strongly-marked subgenera, that may be defined as follows:

1. VOLSELLA, Scopoli (typical).

   Shell smooth or concentrically striated; hinge edentulous, or with only obscure teeth.—(Type as already stated.)

2. BRACHYDONTES, Swainson.

   Shell with surface radiately or divaricately costate or striate; hinge-margin more or less angulated, with the anterior slope crenulated.—*Mytilus sulcatus*, Lam.

H. and A. Adams propose another subgenus, *Adula*, characterized by nearly cylindrical shell, with subcentral beaks, the type being *M. soleniformis*, d'Orbigny; but it is probable that this can better be eliminated as a distinct genus.

The genus *Volsella*, or *Modiolus*, differs from *Mytilus*, Linn., in having the beaks placed more or less back from the anterior end and obtuse, instead of being pointed and quite terminal. The anterior basal margin of these shells is also always more prominent than in *Mytilus;* while *Volsella* is further distinguished by its habit of forming a kind of woven nest, or burrow, composed of small fragments of stones and shells.

Species having the external appearance of this genus occur in the Palæozoic rocks, though little is known in regard to their hinge and interior. Some of those from the Devonian, and more especially those from the Carboniferous, so closely resemble typical species of the genus as to leave little room for doubts in regard to the propriety of placing them in it. It also occurs in the Triassic rocks, ranges through all of the later formations, and is abundantly represented in the existing seas, where it probably attains its greatest development. The recent species are chiefly found in southern latitudes, though a few occur on the coast of Great Britain and in the Arctic seas; also on the coast of the United States, &c.

In regard to the particular name that should be retained for this genus, different opinions are entertained among conchologists, as well as palæontologists. As undesirable as it certainly is, however, to replace Lamarck's name *Modiolus*, or *Modiola*, by another, a strictly consistent observance of the established rules of nomenclature seems to require that it should be done. H. and A. Adams have proposed to restore for it Adanson's name *Perna;* but as Adanson dates before the Linnæan nomenclature was introduced, and of course did not conform to the binomial system, the rule most generally adopted would exclude his name: which is also objectionable on account of being in common use by many for another genus. For these reasons I have here, and in a former publication, preferred to follow Dr. Gray in the use of Scopoli's name *Vosella* for this group. Objections have been raised to this, because Scopoli included both *Modiola*, Lam., and *Mytilus*, Linn., and his name had not been used in a more restricted sense previous to Lamarck's publication of the names *Modiolus* and *Modiola*. The fact, however, that Scopoli also included species of the older genus *Mytilus* does not, I should think, invalidate his name. *Mytilus* would, of course, retain the species of that genus included by Scopoli; and this would leave the name *Volsella* to adhere to his other and first species, *Mytilus modiolus*. Consequently, Lamarck had no right to propose to found a genus on that, or any congeneric form, at a later date. If Scopoli had included other types belonging to other *previously-unnamed* genera, then Lamarck, in *restricting* the genus, might have taken *Mytilus modiolus* as the type of a new genus, and retained *Volsella* for one of the other types; but as that species is alone left to represent the genus, after the elimination of the species of the older genus *Mytilus*, it, of course, becomes the type of *Volsella*.

The following rules laid down by the British and American Associations, and very generally adopted by naturalists, seem to apply to this case: "1.—The name originally given by the founder of a group, or the describer of a species, should be permanently retained, to the exclusion of all subsequent synonyms." "3.—A generic name, when once established, should never be canceled in any subsequent subdivision of the group, but retained in a restricted sense for one of the constituent portions."

Volsella Meekii, E. & S. (sp.).

Plate 15, figs. 3, *a*, *b*, *c*.

Mytilus Meekii, Evans and Shumard (1857), Trans. St. Louis Acad. Sc., I, 40.
Modiola Meekii, Meek and Hayden (1860), Proceed. Acad. N. S. Philad., XII, 427.

Shell thin, very narrow or depressed-subovate, with length about half the height, moderately convex in the central region, and cuneate behind; cardinal margin more or less arcuate, and rounding down regularly into the posterior margin, which is rather narrowly rounded below; beaks very oblique, and convex, or rather compressed, and placed over the anterior extremity of the valves; anterior margin very short, compressed, and abruptly rounded; ventral margin nearly straight, or slightly sinuous along the middle; surface with fine concentric striæ; anterior muscular impression distinct, small, and quite near the anterior basal margin; posterior very faint, or obsolete.

Length, 1.39 inches; height, 0.60 inch; convexity, 0.47 inch.

Young specimens of this species, half an inch and less in length, are narrow-ovate in outline, but, as it advanced in age, it became proportionally longer, so as to assume a narrow oblong-oval, or very narrow subelliptic form. The beaks are placed nearly over the anterior border, which is very narrowly rounded, and extends slightly beyond them. The hinge-line is a little arcuate, and between one-half and one-third the entire length of the shell. It ranges at an angle of about 30° to the axis of the umbones, and passes very gradually behind into the postero-dorsal margin, which is a little prominent and more or less carinate. The base, although generally nearly straight, is sometimes very slightly arcuate in large specimens. The muscular and pallial impressions must be very faintly marked, as scarcely any traces of them can be seen on smooth, well-preserved internal casts.

Locality and position.—The specimens first described by Drs. Evans and Shumard were obtained on Moreau River, probably from the Fox Hills group, or formation No. 5. Ours are all from a locality on the Yellowstone, from beds containing a blending of the fossils of both the Fox Hills and the Fort Pierre groups (formations Nos. 4 and 5). It is probably confined to No. 5, where these formations are both distinctly represented.

Volsella Galpiniana, E. & S. (sp.).

Plate 28, figs. 7, *a*, *b*.

Mytilus Galpinianus, Evans and Shumard (1854), Proceed. Acad. N. S. Philad., VII, 164.—Meek and Hayden (1860), *ib.*, xii, 427.

Shell transversely arcuate-subovate, gibbous along the umbonal slopes, and cuneate posteriorly; surface marked only with fine concentric striæ; anterior end very short; beaks very oblique, placed over the anterior margin, and somewhat compressed; hinge-margin a little straightened for near half the length of the valves, and rounding off imperceptibly into the posterior margin, which curves obliquely to the narrowly-rounded posterior basal extremity; basal margin strongly arcuate along the middle, near which the flanks are compressed and contracted below the umbonal ridge; anterior muscular impression distinct.

Length, 1.45 inches; height, 0.71 inch; convexity, 0.46 inch.

The cardinal border of this species is somewhat arched, and less than half the length of the shell. It forms an angle of about 40° with the umbonal axis, and at its posterior extremity passes imperceptibly into the posterior-dorsal edge, which is carinate, and descends with a graceful curve to the narrowly-rounded lower part of the anal extremity. The anterior side of the shell is narrower than the other, and its border below the beaks projects but slightly beyond them. The most convex portion of the valves forms a kind of obscure ridge or prominence, extending with a slight curve from the beaks obliquely backward toward the lower part of the posterior border, while in front of, and below, this ridge, the valves are more compressed. Our specimens are all internal casts, showing the very narrow-oval anterior muscular impression, and pallial line, quite distinctly, but preserving only obscure traces of the larger posterior muscular scar, from which it may be inferred that the latter was generally very faintly marked.

This species will be easily distinguished from the preceding by its more arcuate form, broader posterior extremity, and more compressed beaks. It resembles more nearly several other described forms in rocks of various ages, among which may be mentioned the Oolitic species *M. Leckenbii* of Morris and Lycett; from which, however, it differs in being less strongly arcuate, and not near so distinctly angular along the middle of the valves.

Locality and position.—Long Lake, Fox Hills, and on Moreau River; in the Fox Hills group, or formation No. 5 of the Upper Missouri Cretaceous series.

Volsella attenuata, M. & H.

Plate 28, figs. 8, *a*, *b*.

Mytilus attenuatus, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 86.
Modiola attenuata, Meek and Hayden (1860), *ib.*, xii, 427.

Shell narrow, transversely elongate, nearly straight or but very slightly arcuate, rather compressed; anterior end narrow and compressed; posterior end wider, but rather narrowly rounded; hinge-line long and nearly parallel to the longer axis of the shell; pallial border slightly concave; beaks nearly terminal, small, compressed, and very oblique; surface unknown, but probably smooth or only marked by lines of growth.

Length, 1.90 inches; height at broadest part behind the middle, 0.58 inch; convexity, about 0.40 inch.

This species is more nearly like *M. Meekii* than any other known form in the Nebraska rocks; but its much narrower and more elongated outline smaller and much more compressed beaks, as well as its longer and less oblique hinge, will prevent it from being confounded with that shell.

It seems to be quite nearly allied to *M. Hillanoides*, d'Orbigny, as figured by Chapuis and Dewalque, in Mem. Acad. Royal of Belgium, xxv, pl. 25, fig. 6, but has a much longer hinge, and its anterior region is proportionally narrower. In addition to these differences, the fact that it is an Upper Cretaceous species, and *M. Hillanoides* a Jurassic form, renders it scarcely possible that they can be identical. It must be very rare, as we have seen but two specimens of it.

Locality and position.—Moreau River; from the Fox Hills group, or formation No. 5 of the Upper Missouri Cretaceous: also from near the same horizon on the Yellowstone River.

Genus CRENELLA, Brown.

Synon.—Crenella, Brown (1827), Illust. Conch., tab. xxxi; and Conch. Text-Book, 6th ed. (1845), 162.—Gray (1842), Syn. Brit. Mus., 92.—G. B. Sowerby, jr. (1842). Conch. Man., 2d ed. 72.—Macgillv. (1843), Moll. Aberd. 205.—Lovén (1846), Ind. Moll. Scand., 32.—Gray (1847), Zoöl. Proc., 199.—H. and A. Adams (1857), Gen. Recent Moll., II, 514.

Myoparo, Lea (1833), Contr. to Geol., 73.—Sowerby, jr. (1842), Conch. Man., 2d ed., 196.

Stalagmium, Con. (1833), Foss. Shells Tert., 39.—Bronn (1838), Leth., 928.—Nyst. (1846), Foss. Belg., 238.

Modiolaria, Beck (1846), Mus. Hafn., cf. Amtl. Ber., 24.—Lovén. (1846), Ind. Moll. Scand., 33.—H. and A. Adams (1857), Gen. Recent Moll., II, 515 (as a subgenus under *Crenella*).

Etym.—Crena, a notch.
Type.—Mytilus decussatus, Laskey.

Shell equivalve, more or less inequilateral, suborbicular, subovate or

transversely oval-oblong, ventricose or rather compressed; beaks anterior; surface covered with an epidermis, and ornamented, wholly or in part, by radiating, sometimes divaricately-arranged, striæ; hinge nearly or quite edentulous, but generally crenate; ligament internal; muscular impressions two, faintly marked, unequal; pallial impression obscure, entire.

It seems to me somewhat doubtful whether *Modiolaria* ought not rather to be regarded as a distinct genus, than to be included as a subgenus under *Crenella*, as is done by H. and A. Adams. The shell of this type has much more the form of *Modiola*, but differs in its markings, while the animal is much more like that of *Crenella*. Including *Modiolaria* as a subgenus under *Crenella*, the two sections may be separately defined as follows:

1. **CRENELLA**, Brown (typical).

Shell short, suborbicular, or nearly vertically ovate; surface covered by radiating striæ.—(Type as stated above.)

2. **MODIOLARIA**, Beck.

Shell transversely oblong or oval, with beaks depressed, and surface-striæ obsolete on the central parts of the valves.—*M. discors*, Linn.

Stalagmium, Conrad (= *Myoparo*, Lea), is sometimes separated, subgenerically or otherwise, from *Crenella*, but it seems to agree so nearly with the same as scarcely to deserve to be placed as a separate section. It is probable that *Nuculocardia*, d'Orbigny, as typified by *N. divaricata*, d'Orbigny, should also be included in this genus.

The genus *Crenella* is, I believe, not certainly known from older formations than the Cretaceous. It is also represented in the Tertiary, and in the seas of the present epoch, in which latter it probably attains its greatest development—that is, including the section *Modiolaria*. Both sections, however, occur among the living species, while the older fossil species seem all to belong to the typical section. The living species have a wide distribution, and show a disposition to conceal themselves among sea-weeds, corals, &c., in a kind of nest.

Crenella elegantula, M. & H.

Plate 28, figs. 6, *a*, *b*, *c*.

Crenella elegantula, Meek and Hayden (1861), Proceed. Acad. Nat. Sci. Philad., XIII, 441.

Shell nearly vertically ovate-cordate, very thin, ventricose; postero-basal and basal margins rounded; dorsal border sloping abruptly behind, with a

convex outline above, and rounding into the base below; anterior margin sinuous just under the beaks, moderately prominent near the middle, and rounding into the base below; umbonal region of both valves very gibbous; beaks prominent, anterior, or subterminal, pointed and incurved, with a forward obliquity at their extremities; hinge-margin thin and apparently smooth, or only very minutely crenate; surface marked by extremely fine, regular, closely-arranged, radiating striæ, which appear to increase chiefly by bifurcation, and continue of uniform size on all parts of the shell; crossing these, there are less regular, more distant, small, concentric marks of growth.

Length, measuring obliquely forward and upward from the base to the beaks, 0.55 inch; diameter, directly from the base to the hinge, at right angles to the greatest length, 0.40 inch; convexity, 0.37 inch.

This is a very neat little shell, still showing the pearly lustre of the interior. It is closely allied to *C. sericea*, Conrad (Jour. Acad. Nat. Sci. Philad., new ser., IV, pl. 46), but differs in being much larger, uniformly more broadly ovate in outline, and in having its beaks less elevated and not so strongly incurved. If Mr. Conrad's name *Stalagmium* should be retained for a section of this genus, the name of this species would doubtless have to be written *C.* (*Stalagmium*) *elegantula.*

Locality and position.—Deer Creek, near North Platte; from the lower part of the Fox Hills group of Upper Missouri Cretaceous; also on Yellowstone River, in the upper part of Fort Pierre group.

DIMYARIA.

ARCIDÆ.

Genus BARBATIA, Gray.

Synon.—**Daphne* (part), Poli (1791), Test. Utr. Sic., I, 33 (not Linn.).

**I am not quite sure that Poli's name *Daphne*, published in 1791, may not have to be used for this genus. Poli ranged but two species under it, the first of which was *Arca Noæ*, and the second *A. barbatia*. Those who follow the rule of always taking the first species mentioned by an author in proposing a new genus, as its type, would, of course, make *Daphne*, Poli, an *exact* synonym of the older genus *Arca*, Linn.; his first species belonging to the latter genus. This rule, however, is by no means universally followed, and could not be consistently carried out in conchology without creating great confusion among the names of the older genera. If we, therefore, view Poli's first species as being reclaimed by the older genus *Arca*, his name *Daphne* would thus be left to stand alone for the group including his second species, and, consequently, his genus would be equivalent to the much later name *Barbatia*, which it may possibly have yet to replace. It is objectionable, however, on account of being in use by botanists for a still older Linnæan genus of plants; though naturalists most generally agree that the same generic names may be used for genera in botany and zoölogy without creating confusion.

Barbatia, Gray (1840), Synon. Brit. Mus., 135; and (1847), Lond. Zoöl. Proceed., 197.—H. and A. Adams (1857), Gen. Recent Moll., II, 534.—Chenu (1862), Man. Conch., II, 172.—Stoliczka (1870), Palæont. Indica, III, 340.—Conrad (1862), Proceed. Acad. Nat. Sci. Philad., 290; and (1873), Appendix to Kerr's N. Carolina Geol. Report (issued in advance), 4.

Daphnoderma (Poli), Mörch (1853), Cat. Yoldi, 40.—H. and A. Adams (1858), Gen. R. Moll., II, 660.

Acar, Gray (1857), Ann. and Mag. Nat. History, XIX, (2d ser.), 369.—H. and A. Adams (1857), Gen. Recent Moll., II, 535 (as a subgenus of *Barbatia*).—Chenu (1862), Man. Conch., II, 173 (as a subgenus of *Barbatia*).—Stoliczka (1870), Palæont. Indica, III, 340 (as a subgenus of *Barbatia*).

Calloarca, Gray (1857), Ann. and Mag. Nat. Hist., XIX, (2d ser.), 369.—H. and A. Adams (1857), Gen. Recent Moll., II, 535.—Stoliczka (1870), Palæont. Indica, III, 340.

Striarca, Conrad (1862), Proceed. Philad. Acad. N. Sci., XIV, 270.

Granoarca, Conrad (1862), *ib.* (as a subgenus of *Barbatia*).

? *Cucullaarca*, Con. (1865), Am. Jour. Conch., I, II.

Plagiarca, Conrad (1873), Suppl. to Kerr's Geol. Report N. Carolina, 4 (as subgenus *Barbatia*).

Polynema, Conrad (1873), *ib.* (as a subgenus of *Barbatia*).

Etym.—*Barbatus*, bearded.
Type.—*Arca barbata*, Linn.

Shell varying, according to the sections and species, from transversely elongate-subovate, to rhombic-trapezoidal, moderately or rather strongly convex, with ventral margins more or less sinuous and gaping, or sometimes nearly closed anteriorly; surface ornamented with radiating striæ or costæ, or rarely cancellated, covered with a rough, usually loose, hairy epidermis; ligament-area nearly always very narrow, marked by divaricating, or obliquely, longitudinally, or rarely transversely-arranged cartilage-furrows; hinge generally somewhat arched along the under side, and narrowed at the middle, where the denticles are very short and range vertically, but widening somewhat toward the extremities, where they are longer and more oblique. Animal, as in *Arca*, forming a byssus by which it attaches itself to rocks, &c.

A thorough revision of the *Arcidæ*, including all of the recent and fossil types, would doubtless result in the establishment of other sections of this genus; but, as I am not making an especial study of the family, I prefer to note only such subordinate groups as have already been ranged under it by others. These may be severally distinguished from the typical forms, as well as from each other, as stated below:

1. BARBATIA, Gray (typical).

Shell transversely elongate-subelliptic, or subovate; cardinal margin rounding off, more or less, at the extremities; cardinal area very narrow, with divaricating longitudinal cartilage-furrows.—(Type as already given.)

2. **POLYNEMA**, Conrad.

Shell transversely trapezoid-subovate, narrowing anteriorly; cardinal margin descending forward, and meeting the anterior and posterior margins at more or less defined angles; cardinal area extremely narrow, with about two deep, divaricating cartilage-furrows; lateral denticles very oblique, those on the posterior side more elongated and striated; surface with fine radiating striæ.—*Barbatia lineata*, Conrad.

3. **ACAR**, Gray.

Shell generally small, gibbous, subovate; hinge short; area usually very small, with cartilage-furrows few, longitudinally, or somewhat divaricately arranged; surface cancellately striate or costate; posterior dorsal slopes subcarinate.—*B. divaricata*, Sowerby.

4. **CALLOARCA**, Gray.

Shell of much the form of the last, but with posterior dorsal slopes strongly carinate, and anterior and posterior portions occupied by strong radiating costæ that impart a crenate character to the inner margins behind; area very narrow, with cartilage furrows as in the last.—*B. alternata*, Reeve.

5. **STRIARCA**, Conrad.

Shell transversely oblong-oval, with rounded extremities and a deeply sinuous basal margin; surface radiately striate; area moderate; cartilage-furrows very small, crowded, and crossing the area at right angles to the cardinal margin; hinge rather distinctly arched, with denticles hollow.—*Arca centenaria*, Conrad.

6. **PLAGIARCA**, Conrad.

Shell transversely trapezoidal, with hinge nearly straight, and meeting the lateral margins at more or less defined angles; lateral denticles very oblique, one or two of the anterior series being comparatively large and slightly angulated in the middle; surface radiately costate; area very narrow, and marked by numerous minute, crowded, divaricating cartilage-furrows.—*Arca Carolinensis*, Conrad.

? 7. **GRANOARCA**, Conrad (= ? *Cucullæarca*, Conrad).

Shell sometimes attaining a large size, transversely oval-subtrapezoidal, with cardinal margin more or less rounding into the laterals; area rather broad and very oblique, with divaricating cartilage-furrows; cardinal margin very wide posteriorly; denticles smaller and more

crowded anteriorly, and larger, more oblique, and broken up into granules behind; surface strongly radiately costate.—*Arca propatula*, Conrad.

At the same time that I retain here provisionally, these seven sections as subgenera of *Barbatia*, I confess that some of them seem scarcely distinct enough to be regarded as subgenera, while it is barely possible that one or two of them (*Granoarca*, for instance) may be properly generically distinct from *Barbatia*.* One difficulty in settling this question with regard to the extinct types, is, that we have no means of determining whether or not they possessed the peculiar characteristic hairy epidermis of the existing species of this genus.

Among the more marked differences between *Barbatia* and *Arca*, to which latter the former is in some respects most nearly allied, may be mentioned the hairy epidermis of *Barbatia*, with its more arched, shorter hinge widening toward the lateral extremities, where its denticles are longer and more oblique than in *Arca*. The cardinal area is also nearly always much narrower, and the lateral extremities of the valves generally more rounded in outline, than in the latter genus.

In the present state of our knowledge of the hinge, area, and internal characters of many fossil-forms simulating this genus in external characters, it is scarcely possible to determine, beyond doubt, the geological range of *Barbatia*. Dr. Stoliczka thinks that it, as well as *Arca*, existed as far back as the Silurian epoch. To me, however, this seems to be an error. At least all the species with which I am acquainted, from the Silurian and Devonian, resembling these genera, seem to belong to *Tellinomya* and other groups. In the Carboniferous and Permian rocks, we meet with forms very similar to *Barbatia* externally; but, so far as known to the writer, they all differ in the characters of the hinge.

In the Trias, however, we meet with species agreeing pretty well with sections of this genus, among which forms may be mentioned *Cucullæa Murchisoni* of Capellini. In the Jurassic rocks, the genus is more abundantly

* *Cucullearca*, Conrad, is another type even more like *Barbatia* than his *Granoarca* in *form* and *general external appearances*, while its hinge-characters agree exactly with those of *Granoarca*, excepting that the anterior denticles, instead of being very small, erect, and crowded, are as large as those at the other end of the hinge; and also present the marked difference of being ranged horizontally, parallel to the hinge-margin, instead of merely very obliquely. According to Dr. Gray, however (Ann. and Mag. N. H, XIX, 2d ser., 319), the *degree* of obliquity of the lateral denticles in *Barbatia* is not *always* of great importance. For instance, he says that in *B. glacialis* "they are sometimes transverse, like the inner ones, while in other specimens they are nearly longitudinal, like the teeth of *Cucullæa*."

represented, both by typical, or very nearly typical, forms, and by others falling into the different subgenera. Even the curious subgenus *Calloarca* appears to be quite nearly, if not exactly, represented by such Jurassic forms as *Cucullæa discoris* of Quenstedt. This genus also continued through the Cretaceous and Tertiary periods, and is well represented in our existing seas, where the typical section, as well as the group *Acar*, probably attain their greatest development. *Polynema* and *Plagiarca* were founded on Cretaceous types, while the types of *Striarca* and *Granoarca* are from the Miocene Tertiary.

Barbatia (Polynema?) parallela, Meek.

Plate 2, fig. 10.

Arca? parallela, Meek (1872), Hayden's Second Ann. Report U. S. Geol. Survey of the Territories, 303.

Shell small, longitudinally oblong, being about twice and a half as long as high, moderately convex; cardinal and pallial margins straight and nearly parallel; anterior side short, rounding up regularly from below, and intersecting the cardinal margin at an obtuse angle above; posterior side long, a little wider than the other, with its margin compressed and obliquely truncated above, but rounded below; beaks depressed, somewhat flattened, incurved, not very remote, and placed about one-fifth the length of the valves from the anterior margin; cardinal area *very* narrow, and apparently smooth, or only marked with one or two longitudinal cartilage-furrows; muscular and pallial impressions very obscure; hinge with denticles longest posteriorly, where they are directed upward and backward at an angle of about forty-five degrees to the cardinal margin; from the posterior side they diminish rather rapidly in size and length forward, so as to become very minute and crowded between the beaks, which is as far forward as they have been traced in the specimens examined. Surface showing very fine, crowded, radiating striæ, with stronger marks of growth.

Length, 0.95 inch; height, 0.37 inch; convexity, 0.27 inch.

In first describing this species, I referred it provisionally, with a mark of doubt, to the genus *Arca*, but distinctly stated that it does not belong to that genus as restricted by modern conchologists. A more critical examination of the typical specimen leads me to believe that it also has denticles at the anterior end of the hinge like those behind, excepting that they are directed obliquely *forward* and *upward*. The hinge-margin also seems to be a little widened before, as behind. From these characters, I think there is not much room for doubt in regard to the propriety of referring it to the genus *Barbatia;*

and among the established sections of that group it seems to come nearest agreeing with Mr. Conrad's *Polynema*. It is, however, a more depressed, or proportionally more elongated, shell than Mr. Conrad's type, and less sinuous below, with its anterior ventral margin merely rounded up from the base, instead of being produced and rounded, as in the type of *Polynema;* which latter is also proportionally much wider (higher) behind. Still, I do not think these differences of sufficient importance to place our shell in a different subgenus.

Locality and position.—Twelve miles southwest of Salina, Kansas; in a ferruginous sandstone, equivalent to the Dakota group of the Upper Missouri Cretaceous. Collected by Professor Mudge.

Genus NEMODON, Conrad.

Synon.—*Arca*, *Cucullæa* and *Macrodon* (sp.), of some authors.
Nemodon, Conrad (1870), Am. Jour. Conch., V, 97; and (1873) Appendix to Prof. Kerr's Geol. Rept. N. Carolina, 3.

Etym.—*νῆμα*, a thread; *ὀδούς*, a tooth.
Type.—*Nemodon Eufalensis*, Conrad.

Shell depressed, and transversely more or less elongate-trapezoidal, thin, equivalve, with base sinuous and perhaps gaping; beaks depressed and placed in advance of the middle; cardinal area narrow; hinge long, straight, or slightly arcuate under the beaks, where it is very narrow and provided with a few minute granular denticles, in front of which there are two or three linear anterior teeth very nearly or quite parallel to the cardinal margin, while behind the beaks there are one or two elongate, linear, posterior teeth, also parallel to the cardinal edge; surface marked by very obscure, punctate, radiating striæ, and concentric lines.

This group consists of small, generally transversely-elongated, rhombic shells, having much the general external appearance of *Arca* and *Macrodon*.* It is at once distinguished from the former, however, by having its hinge-teeth elongated and parallel to the hinge-margin, instead of very short, mere crenulations, crossing the same. It is much more nearly related to *Macrodon*, and might, perhaps, without impropriety, be ranged as a subgenus under that group, from which it differs chiefly in having its anterior teeth parallel to the hinge margin, instead of ranging obliquely forward and upward, and in having a few minute granular teeth under the beaks. Mr. Conrad does not say

* The name *Macrodon* being pre-occupied for a genus of fishes, will probably have to be replaced by *Parallelodon*, Meek and Worthen, proposed in the Proceed. Chicago Acad., I, 17, 1866.

whether any of the species seen by him have a projecting plate connected with the posterior muscular scar; but perfectly preserved internal casts of the following-described species, believed to belong to this group, show no indications of such a process, there being on them only a faintly-impressed hair-line, margining both the anterior and posterior scars, and scarcely visible without the aid of a magnifier.

This genus is also nearly related to *Cucullaria* of Deshayes; but differs from that group as typified by *Arca heterodonta*, Desh., in having a longer, straighter hinge-margin, and straighter and more regular anterior and posterior teeth, with less-developed denticles under the beaks. Its general form is also more like that of *Arca*, while that of *Cucullaria* has the outline of *Barbatia*, Gray.

Mr. Conrad thinks this genus confined to the Cretaceous; but there are also some Jurassic, and perhaps older species, that approach very nearly to its characters—such, for instance, as *Cucullæa Parkinsoni*, as figured by Quenstedt (Der Jura, II, pl. 67, fig. 14), from the Jura.

It is quite probable that many persons will think it wholly unnecessary to notice such slight differences as distinguish this type from *Macrodon* and *Cucullaria;* but if we attempt to divide the whole of the *Arcidæ* of all ages into genera and subgenera, it must be evident to any one who will attentively study the numerous extinct types, that *very slight* differences must be taken into account, or else we must admit that the whole vast group shades into a single genus.

Nemodon sulcatinus, Evans & Shum. (sp.).

Plate 15, figs. 6, *a*, *b*.

Arca sulcatina, Evans and Shumard (1857), Trans. Acad. Sci. St. Louis, 1, 39.

Shell small, transversely rhombic-trapezoidal, about half as high as long; beaks rather depressed, and placed a little in advance of the middle, incurved and somewhat distant; posterior umbonal slopes oblique, prominent or subangular; cardinal margin straight, equaling about five-sixths the length of the valves; basal margin parallel to the dorsal, nearly straight, or more or less sinuous near the middle; anterior margin rounding up a little obliquely, so as to intersect the hinge above at slightly less than a right angle; posterior margin truncated from the abruptly-rounded or subangular posterior basal extremity, a little obliquely forward and upward, with a slightly sinuous outline, so as to connect with the end of the hinge at rather more than a right angle; cardinal area unknown; free margins finely crenate within; internal casts

showing a broad, deep sulcus starting from each beak, and descending, with a slight backward obliquity, to the most sinuous part of the base. Surface with radiating striæ.

Length, 0.35 inch; height, 0.19 inch; convexity, about 0.17 inch.

I have not seen specimens of this little shell showing very clearly the nature of the surface-markings, but Evans and Shumard describe it as having "18 to 20 radiating striæ, with accessory ones in the intervals." The deep sulcus seen passing downward from the beaks, in our internal casts, is doubtless nearly as strongly defined on the outer surface of the shell, which seems to be thin. Only faint traces of the radiating striæ are visible on internal casts, excepting immediately at the free margins, to which they impart a crenate appearance. The muscular scars are very faintly marked, perfectly smooth, and only show, on the casts, a scarcely perceptible, very slightly impressed, hair-line, along the anterior side of each posterior scar, and the posterior side of the anterior. By cutting away the rock about the hinge, I find it appears to agree exactly with that of *Nemodon*.

Specifically, this shell seems to be very nearly related to *Arca* (*Macrodon*) *Eufalensis*, Gabb, which Mr. Conrad says is a *Nemodon*.

If, as I have suggested, *Nemodon* should be eventually only considered a subgenus under *Macrodon*, the name of this species would have to be written *Macrodon* (*Nemodon*) *sulcatinus*, or *Parallelodon* (*Nemodon*) *sulcatinus*.

Locality and position.—Dr. Evans's specimens of the type of this species were found near Grand River, Dakota; and those here under consideration came from Yellowstone River, 150 miles above its mouth; where they occur in beds containing a mingling of the fossils of the Fort Pierre and Fox Hills groups of the Upper Missouri Cretaceous series.

Genus CUCULLÆA, Lamarck.

Synon.—*Arca* (sp.), of many authors.

Cucullæa, Lamarck (1801), Syst. An., 116.—Roissy (1805), Moll. VI, 400.—Schumacher (1817), Ess., 170.—J. Sowerby (1812?), Min. Conch., 1, pl. 67.—Fleming (1828), Brit. An., 382, and 399.—Morris (1843), Brit. Foss., 84.—Woodward (1856), Man. Conch., 268.—H. and A. Adams (1857), Gen. Recent Shells, II, 539; and of many others.

Cucullea, Hanley (1844), Ill. Cat., 151.—Catlow (1845), Conch. Nom., 48.

Idonearca, Conrad (1862), Proceed. Acad. Nat. Sci. Philad., XIV, 289 (as a subgenus of *Cucullæa*); and (1872), *ib.*, 54.

Latiarca, Conrad (1862), *ib.*, 289; and *ib.* (1872), 53 (as a subgenus of *Cucullæa*.)

Macrodon (sp.), Stoliczka (1871), Palæont. Indica, III, 350 (not Lycett).

Grammatodon? (sp.), Stoliczka (1871), *ib.* (not Meek and Hayden).

Etym.—*Cucullus*, a cap or hood.
Type.—*Arca concamerata*, Martini.

Shell cordate-trapeziform, gibbous, very nearly, or quite equivalve, subequi-

lateral or moderately inequilateral; margins nearly or quite closed, and smooth or crenate within; beaks ventricose, incurved, and generally remote; surface with radiating costæ or striæ, which usually differ somewhat on the opposite valves, and sometimes become nearly obsolete; concentric striæ more or less distinct; epidermis scaly; hinge straight, of variable thickness, provided with short, vertical denticles along the middle, and longer transverse or declining cross-striated linear teeth, in front and behind; cardinal area well defined, usually broad, and marked by distinct divaricating furrows; muscular and pallial impressions distinct; posterior muscular scars each connected with a prominent, oblique plate or lamina.

This genus is divisible into three subgenera, as follows:

1. CUCULLÆA, Lamarck (typical).

   Shell comparatively thin; hinge-margin very narrow, with most of its length occupied by the small vertical denticles; lateral denticles few, straight, horizontal and short; laminæ of posterior muscular scars very prominent.—(Type as stated above.)

2. IDONEARCA, Conrad.

   Shell thicker than the last, with a wider hinge-plate and fewer of the short mesial denticles, which are prominent and transversely striated; lateral denticles long, horizontal, or descending outward, and bent downward at the inner ends, strongly cross-striated; laminæ of posterior muscular scars prominent.—*Cucullæa Tippana*, Conrad.

3. LATIARCA, Conrad.

   Shell very thick and strong; hinge comparatively narrow, and occupied by very irregular, strong, vertical denticles, excepting at each end, where it is broad, and occupied by strong, rugosely-striated, longer denticles, declining outward, and bent downward at the inner ends; posterior muscular scars, with their lower margins somewhat raised and acute, but not forming a projecting lamina.—*Cucullæa onoclea*, H. D. and Wm. B. Rogers.

The genus *Cucullæa*, including the above sections, and possibly some others not yet defined, ranges back to the Lias, and continues through the subsequent formations; probably attaining its greatest development in the Cretaceous. Most of the Cretaceous species seem to fall into the *Idonearca* and *Latiarca* groups, though possibly some of them will form distinct sections. The Tertiary species mainly belong to *Latiarca* and the typical sections,

which latter only is represented among the existing *Mollusca*, and but two or three living species are yet known. These are found in the Chinese and other eastern seas.

The Palæozoic, and some of the Triassic, Jurassic, and possibly a few of the later species, referred to this genus, belong to *Macrodon*, or in part to allied but distinct groups. The genus *Macrodon* is distinguished from *Cucullæa* by its more depressed, transverse form, more anterior beaks, longer hinge, generally gaping basal margin, and particularly by having only one to two or three straight, smooth, linear, posterior hinge-teeth, ranging parallel to, and extending along two-thirds to three-fourths the length of, the hinge-margin; with a few very much shorter denticles at the anterior extremity of the hinge, ranging obliquely forward and upward, without any intermediate vertical denticles.

Dr. Stoliczka refers two Indian Cretaceous species (Pal. Indica, III, 350 and 351, pl. xviii, figs. 6–11; and pl. xx, figs. 6–7) to *Macrodon*, and doubtfully to *Grammatodon*, as a subgenus under the same, that seem to me to be *clearly* distinct from both of those groups, and, as suggested by Mr. Conrad, to be very closely allied to *Idonearca*. *Grammatodon*, as stated by me in proposing it, is probably not more than subgenerically distinct from *Macrodon*, as it agrees exactly in its hinge, and only differs from that type in its shorter form, closed basal margins, and in having no raised lamina connected with the posterior muscular scar.* Dr. Stoliczka's species differ *decidedly* in their hinge-characters from both *Macrodon* and *Grammatodon*, and only differ in the same from *Idonearca*, in having the short mesial denticles ranging obliquely forward and upward, instead of vertically; while their anterior denticles, instead of ranging obliquely forward and *upward*, as in *Macrodon* and *Grammatodon*, are directed decidedly *downward* and forward. Their posterior teeth are also proportionally *much* shorter than those of the last-mentioned groups. In short, the whole aspect of these shells is so nearly that of *Idonearca*, and so unlike that of *Grammatodon* and *Macrodon*, that if they cannot go properly into the first, surely they could only form another *very closely* allied section of *Cucullæa*, and not of *Macrodon*.

* Dr. Stoliczka doubts this last-mentioned character. I have only to say on this point, that no traces of any such internal processes are to be seen on casts of the shells' interior.

Subgenus IDONEARCA.

Cucullæa (Idonearca) Shumardi, M. & H.

Plate 28, figs. 15 *a–g*; and pl. 29, fig. 4.

Arca (Cucullæa) Shumardi, Meek and Hayden (Apr., 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 86.
Cucullæa Shumardi, M. & H. (Nov., 1856), *ib.*, 285.
Cucullæa fibrosa, M. & H. (Oct, 1860), *ib.*, xii, 428.
Compare *Cucullæa fibrosa*, Sowerby (1818), Mineral Conch., III, 9.

Shell transversely rhombic-oval, very slightly inequivalve, entirely closed, rather thin; anterior margin rounded, sometimes intersecting the hinge above so as to form an obtuse angle, rounding more or less obliquely into the base below; basal margin semi-ovate in outline, the most prominent part being behind the middle, not crenulate within; posterior side obliquely truncated above, and narrowly rounded below; hinge less than three-fourths the entire length of the shell; cardinal area rather narrow, marked by very fine longitudinal striæ, and about four strong, oblique, divaricating grooves; beaks gibbous, moderately elevated, incurved nearly at right angles to the cardinal line, and located slightly in advance of the middle. Surface marked by concentric striæ, which are crossed on young shells by small, obscure, radiating costæ, which become nearly or quite obsolete on adult specimens.

Length of a large specimen, 1.67 inches; height from base to top of beaks, 1.40 inches; convexity, 1.24 inches.

This species varies considerably in form, and to some extent in its surface-markings, at different stages of its growth; young individuals being generally shorter, less oblique, and more distinctly truncated behind, as well as more strongly marked by the radiating lines or costæ. As the shell advanced in its growth, the posterior ventral region became proportionally more extended, so as to give the valves a more oblique outline; while the radiating costæ gradually became obsolete, and the concentric markings stronger. Although these differences are in most cases due to age, such is apparently not always the case, as we sometimes, though less frequently, see small individuals without any traces of the radiating costæ. There are, however, so many gradations between these extremes that they cannot be considered distinct species.

On the outside of some specimens, a single raised line extends from the back part of the beak of the right valve obliquely backward to the middle of the posterior margin, following the direction of the plate, or ridge, bounding

the posterior muscular impression. Partly decomposed specimens sometimes show the outer lamina to have an obscurely subfibrous structure. Generally the margins of the valves appear exactly equal, probably owing to the wearing-away of the sharp, slightly more prominent ventral margin of one valve. Sometimes, however, the ventral edge of the left valve is seen to project a little beyond that of the right, which is received in an obscure linear groove, just within the edge of the left valve.

On first examining this species, we were struck with its remarkably close similarity to *C. fibrosa* of Sowerby, as figured by d'Orbigny in the Palæontology of France; but, owing to the fact that the pallial margins of the valves in all the specimens we had seen, appeared to be exactly equal, while that of the right valve in Sowerby's species projects a little beyond the other, led us to regard them as distinct species. Subsequently, in examining some additional specimens received from the same localities, we discovered, in some of the casts, unmistakable evidences of a very slight inequality of ventral margins of the valves; and, as there thus appeared to be no well-defined difference between our shell and Sowerby's species, they were regarded as probably identical, in making out our catalogue, published in the Proceedings of the Acad. Nat. Sci. Philad., Oct. 1860. As *C. fibrosa*, however, is Gault and Greensand species, while our shell has only been found in beds equivalent to the true Chalk, I am still left in doubt in regard to the identity of these shells, and here retain provisionally our name *Shumardi*, until the question can be settled by comparison of specimens. Another reason for doubting the identity of these shells, is the fact that it is the ventral margin of the *left* valve in the Nebraska specimens (so far as I have been able to determine) that projects beyond the other; while, according to d'Orbigny, it is that of the *right* in Sowerby's species. Our shell seems also to have a narrower cardinal area. It is likewise very closely allied to *C. Tippana* of Conrad, from the Cretaceous rocks of Mississippi, but differs in being less distinctly inequivalve, and in not having the margin of the larger valve thickened.

Locality and position.—Moreau River, Fox Hills, Long Lake, &c.; Fox Hills group, or formation No. 5 of the Cretaceous series of the Upper Missouri.

Cucullæa (Idoncarca) Nebrascensis, Owen.

Plate 29, figs. 5, *a*, *b*.

Cucullæa Nebrascensis, Owen (1852), Report Wiscon., Iowa, and Min., 582, pl. 8, figs. 1 and 1*a*.

Shell rhombic-oval, gibbous, oblique, very thick and strong; pallial border smooth; anterior side forming more or less nearly a right angle with the hinge above, retreating obliquely, with a gentle curve below; base ascending from behind obliquely forward, with a long curve; posterior side truncated at an angle of about 70° with the hinge, slightly concave in outline above, and abruptly rounding into the base below; ligament-area rather large, about two-thirds the entire length of the shell, marked by fine, straight, longitudinal striæ, and provided in each valve with eight to ten strong divaricating grooves, which are deflected outward under the beaks, so as to cross the fine longitudinal striæ obliquely; beaks elevated, gibbous, incurved at right angles to the hinge, rather distant, and located a little in advance of the middle; posterior umbonal slopes prominently rounded. Surface marked by strong concentric lines, which sometimes form, on large shells, small wrinkles or ridges.

Length of a medium-sized specimen, 2 inches; height from base to top of umbones, 1.78 inches; convexity of the two valves, 1.75 inches.

Young individuals are probably provided with obscure radiating costæ, though no traces of them are seen on any of the specimens examined. The hinge is straight, and forms with the longest axis of the shell an angle of about 30°. The middle teeth are small and rather irregular, while the lateral elongate teeth, of which there are about three at either extremity of the hinge in each valve, are transversely corrugated, and slope outward below the horizon of the hinge-line. The muscular impressions appear to be narrow and not very deep, though the ridge bounding the posterior one is quite prominent.

Although internal casts and specimens having the basal margins of the valves a little worn, seem to be exactly equivalve, when well preserved individuals are examined, it will be seen that the basal border of the left valve projects slightly beyond that of the other, and is provided with a shallow groove for the reception of the margin of the same. When the two valves are closed, and viewed on the under side, it will also be observed that the borders are a little warped laterally near the middle.

This species will be at once distinguished from the following by its much larger cardinal area, more depressed and oblique form and warped base, as well as by its more prominently-rounded umbonal slopes. It differs from old specimens of *C. Shumardi* in being more depressed, in having a larger area and a thicker shell, as well as in its warped pallial border.

In some respects, this species would conform more nearly to the group *Latiarca*, but its distinctly-projecting internal plate, connected with the posterior muscular scar, would forbid its association with that section of the genus. The two groups, however, are not always strongly distinct, I think.

Locality and position.—Fox Hills and Moreau River; from same position as the last.

Cucullæa (Idoncarca?) cordata, M. & H.

Plate 29, figs. 6, *a*, *b*.

Arca (Cucullæa) cordata, Meek and Hayden (Apr., 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 86.
Cucullæa cordata, Meek and Hayden (Nov., 1856), *ib.*, 285.

Shell rhombic-cordate, very gibbous, apparently equivalve; pallial border smooth within; anterior side short and rounded; base forming a semi-ovate curve, the most prominent part of which is near the posterior extremity; posterior side obliquely truncated with a slightly convex outline above, narrowly rounded below; beaks elevated, very ventricose, incurved nearly at right angles to the hinge, located in advance of the middle; cardinal area short, being but little more than half the length of the shell, marked by numerous very fine, straight, longitudinal striæ, and having on each valve seven or eight strong, oblique grooves, which are deflected so as to form angles of 150° under the beaks. Surface marked by distinct lines of growth, crossed by very obscure radiating costæ.

Length, 2.10 inches; height from base to top of umbones, 1.95 inches; convexity of the two valves, 1.78 inches; length of ligament-area, 1.25 inches; breadth of same, 0.30 inch.

It is probable that in young individuals the radiating costæ are more strongly marked; while on old shells, or those that have been slightly worn, they appear to be generally obsolete. The most convex portion of the valves is along the posterior side of the umbonal slopes, which are quite prominent, but not so much so as to form ridges. On the anterior side, there is an irreg-

ular, rough sulcus (possibly due to accident) extending from near the beak of each valve obliquely backward nearly to the base of the shell, a little behind the middle. None of the few specimens, yet seen, show the hinge or other internal characters.

This species differs from the last in being higher in proportion to its length, and in having more elevated beaks, while the anterior side, hinge, and ligament-area, are much shorter. It seems not to be very nearly related to any foreign species with which I am acquainted.

Locality and position.—Moreau River and Long Lake; Fox Hills group, or No 5 of the Cretaceous series of the Upper Missouri country.

Genus TRIGONARCA, Conrad.

Synon.—Trigonarca, Conrad (1862), Proceed. Acad. Nat. Sci. Philad., XIV, 289; and (1867), Am. Jour. Conch., III, 9; also (1872), Proceed. Acad. N. Sci. Philad., XX, 54; and (1873), in Appendix to Kerr's Report, Geol. Survey of N. Carolina, 2.—Stoliczka (1871), Palæont., Indica III, number V, 337.

Breviarca, Conrad (1872), Proceed. Acad. Nat. Sci. Philad., XX, 54; and (1873), Appendix to Kerr's Geological Report N. Car., 3 (as a *subgenus of Trigonarca*).

Cucullæa, Pectunculus (= *Axinæa*), and *Arca* (sp.), of several authors.

Etym—τρίγωνος, triangular; and *Arca*.
Type—Cucullæa Maconensis, Conrad.

Shell thick, gibbous, equivalve, varying from subtrigonal to subtrapezoidal, orbicular or suboval; hinge-area small or moderately developed, with cartilage-furrows longitudinal, and divaricating between the beaks, or minute and transverse; hinge more or less arched, narrow in the middle, and often widening toward the extremities, provided with numerous radiately-arranged, generally straight denticles, the lateral of which are longer than the others; posterior muscular scar provided with a slightly-projecting marginal lamina, somewhat as in *Cucullæa;* surface marked with concentric striæ, and often obscure, or obsolescent radiating striæ or costæ.

The above synonymy and diagnosis include two rather distinctly-marked groups, or subgenera, distinguished as stated below:

1. TRIGONARCA, Conrad (typical).

Shell subtrigonal or subtrapezoidal, with posterior margin obliquely truncated, and posterior basal extremity more or less angular; posterior umbonal slopes prominently rounded or angular; hinge-area divaricately furrowed; hinge-teeth rather strong.—(Type as stated above.)

2. **BREVIARCA**, Conrad.

Shell small, suborbicular or suboval, more or less rounded at the extremities, or rarely truncated obliquely behind; surface nearly smooth, or finely radiately-striated; hinge-area with minute cross-striæ; hinge-denticles very fine and crowded.—*T. perovalis*, Conrad.

It is possible that the little shells composing the *Breviarca* group should be separated generically from the typical trigonarcs. Their smaller size, generally shorter form, smoother or minutely striate surface, finely cross-striated area, and particularly their fine, crowded hinge-denticles, give them a peculiar aspect, contrasting rather decidedly with the larger typical group.

The genus *Trigonarca* is pre-eminently characteristic of the Cretaceous system, in which numerous species are found. It seems, however, to have attained its greatest development, both as to the number of species and the large size of some of them, in the Cretaceous rocks of Southern India, where only the typical section appears to occur, unless some of the species referred by Dr. Stoliczka to *Axinæa* may belong to the *Breviarca* group. Both sections occur in the Cretaceous of this country.

So far as yet known, no species of this genus occurs in either older or more recent formations than the Cretaceous. It seems to hold an intermediate position between *Cucullæa*, *Axinæa*, and *Noetia;* most nearly resembling the latter, to which the typical section is very closely allied. It differs from *Noetia* mainly in its arched instead of angular hinge-line, straighter hinge-denticles, smoother surface, and in having a slightly-projecting edge to its posterior muscular scar.

The little shells included in the *Breviarca* group most nearly approach *Axinæa*, but have generally a less regularly-rounded outline, more gibbous valves, finer and more crowded hinge-denticles, and also differ in having the hinge-area minutely cross-striated, and the edge of the posterior muscular scar a little more projecting, somewhat as in *Cucullæa*.* It would be difficult, however, to distinguish some of the round species from *Axinæa* without examining the hinge-area and interior, while others more nearly approach the typical forms of the genus.

* In some species, there are faint indications of a similar projection of the posterior margin of the anterior muscular scar also. This is the case with Mr. Conrad's *B. umbonata* as well as our *B. exigua*.

Trigonarca (Breviarca?) Siouxensis, H. & M.

Plate 1, fig. 6.

Pectunculus Siouxensis, Hall and Meek (1854), Memoirs Am. Acad. Arts and Sci., V, 384.—Gabb (1861), Synop. Moll. Cret. Form., 103.
Axinæa Siouxensis, Meek (1864), Smithsonian Check-List Cret. Invert. Foss. N. Am., 8.

Shell (as inferred from internal casts) subquadrangular, gibbous, a little longer than high; basal margin rather straight; anterior outline vertically subtruncated, but convex along the middle, and rounding rather abruptly into the base, as well as to the hinge above; posterior side obliquely truncated above, and narrowly rounded below; hinge-margin a little straightened along the middle, but curving downward at each end; hinge-denticles small and rather crowded; beaks nearly central, and slightly or not at all oblique. Cardinal area and surface-markings unknown,

Length, about 0.93 inch; height, 0.84 inch.

We yet only know this species from internal casts, which, of course, give no idea of the nature of its surface-markings or of its hinge-area. There can scarcely be any doubt, however, from its obliquely-truncated posterior margin, rather gibbous form, and general aspect, that it belongs more properly to the genus *Trigonarca* than to *Axinæa;* while the fineness of its hinge-denticles rather indicates for it a place in the *Breviarca* section, than with the typical trigonares.

As we have not succeeded in finding any specimens as well preserved as that originally figured in the paper cited above, it has been thought preferable to give merely a copy of the original figure on our plate.

Locality and position.—Mouth of Big Sioux River, on the Missouri; from the Dakota group of the Upper Missouri Cretaceous series.

Trigonarca (Breviarca?) Salinaensis, Meek.

Plate 2, figs. 1, *a*, *b*, *c*.

Shell small, suborbicular, gibbous; rounded-subtruncate anteriorly, semi-ovate below, and apparently slightly truncated behind; hinge-line declining rather distinctly from the beaks; hinge-denticles comparatively rather strong, about eight of them being seen on what appears to be the anterior side of the beaks in one valve; muscular impressions very faintly marked; beaks promi-

nent, central, very gibbous, and incurved without visible obliquity. Hinge-area and surface-markings unknown.

Length, about 0.26 inch; height, 0.23 inch; convexity, 0.23 inch.

As in the last, this little shell is only known in the condition of internal casts. At one time I thought it might possibly be the young of *T. Siouxensis*, but a more careful examination shows that it has proportionally more ventricose beaks, and that its dorsal-margin declines more directly from the same, instead of being somewhat straightened along the middle, while its denticles are proportionally larger and less numerous. The specimens are very imperfect, only the one figured showing impressions of the hinge-teeth on one side of the beaks. Still, it seems desirable to call attention to it as characteristic species of this rock.

Locality and position.—Twelve miles southwest of Salina, Kansas; in the Dakota group of the Upper Missouri Cretaceous series. Prof. B. F. Mudge, collector.

Trigonarca (Breviarca) exigua, M. & H.

Plate 15, figs. 2, *a*, *b*, *c*, *d*, *e*, *f*.

Cucullæa exigua, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 275.
Arca exigua, Meek and Hayden (Oct., 1860), *ib.*, XII, 428.

Shell very small, rather thick, subquadrate or rhombic-cordate, gibbous, equivalve; anterior margin rounded; posterior side obliquely truncated; base rounding up regularly in front and abruptly behind, being nearly straight along the middle; ligament-area well defined, equaling a little more than half the length of the shell, provided with a divaricating linear groove, extending from near the beaks to the cardinal margin so as to inclose a triangular space, which is crossed at right angles to the hinge by very regular, closely-arranged, minute parallel striæ; pallial margin smooth within; beaks prominent, gibbous, rather distant, central, and incurved at right angles to the hinge. Surface marked by a few distant concentric furrows and extremely fine striæ, crossed by equally fine, obscure, closely-arranged radiating striæ.

Length, 0.32 inch; height, 0.26 inch; convexity, 0.25 inch.

The hinge-denticles in this species are slightly bent at their inner (lower) ends, and radiate outward so that those on each side intersect the hinge-line at an angle of about 40°. The hinge is comparatively broad toward the extremities, and narrow in the middle. Internal casts show that the anterior

and posterior muscular impressions are bounded by slightly prominent linear ridges extending up toward the beaks.

This little shell seems to agree exactly in all respects with Mr. Conrad's group *Breviarca*, excepting that there is a single cartilage-furrow divaricating from near the middle, so as to inclose a triangular space between the beaks, in the hinge-area of each valve; but it also has the minute cross-striæ seen on the typical species of *Breviarca*, though they are confined to the central triangular space of each area, instead of occupying the whole. I cannot believe, however, that this slight difference is of even subgeneric importance.

Specifically, this shell seems to be most nearly allied to *T.* (*Breviarca*) *Saffordi*, Gabb (sp.), but it is proportionally higher and shorter as well as more gibbous, while nothing is said in Mr. Gabb's description of that species respecting any such peculiarities of the hinge-area as those seen in our shell.

Locality and position.—Mouth of Milk River, on the Missouri, and near the forks of Cheyenne River; in the upper beds of the Fort Pierre group, or No. 4 of the Nebraska Cretaceous series.

Genus AXINÆA, Poli.

Synon.—*Axinæa*, Poli (1791), Test. Utr. Sic., I, 32.—H. and A. Adams (1858), Gen. Recent Moll., II, 541.—Meek (1864), Smithsonian Check-List N. A. Cret. Fossils, 8.—Gabb (1864), Palæont. California, I, 197; and *ib.*, II (1869), 196.

Axinæoderma, Poli (1795), Test. Utri. Sic., II, 254.—Oken (1815), Zoöl.

Glycimeris, Humphrey (1797), Mus. Col., 50 (not of Lam. and others).

Tuceta, Bolten (1798), Mus. Bolt., 102, 2d ed.

Pectunculus, Lam. (1799), Prodr., 89; and (1801), Syst., 115.—Roissy (1805), Moll., VI, 404.—Fernss. (1821), Tabl. Syst., xli.—Rang (1829), Man., 288.—Bronn (1838), Leth., 935.—Sow., jr. (1842), Conch. Man., 2d ed., 218.—Hanley (1846), Ill. Cat., 163.—D'Orbigny (1844), Palæont. Fr., III, 186; and of many others.

Etym.—ἀξίνη, an ax.

Examp.—*Arca glycimeris*, Linn.

Shell orbicular, equivalve, nearly or quite equilateral; margins closed, smooth or crenate within; surface ornamented with radiating costæ, concentrically striate, or nearly smooth, covered by a fimbriated epidermis; beaks not oblique; ligament-area well developed and divaricately furrowed; hinge arcuate and provided with radiately-arranged denticles; muscular impressions and pallial line well defined, the former generally with somewhat projecting margins, but without a distinct plate.

H. and A. Adams propose to separate as a subgenus, under the name *Pectunculus*, the species of *Axinæa* that are ornamented by prominent radiating costæ. Among the fossil species, however, there are so many gradations

between those that are costate and those that are not, that it would be difficult to separate them into subgenera on this character.

This genus is closely related to *Trigonarca* of Conrad, particularly to the subgenus *Breviarca*. From the first it is distinguished by its more rounded, compressed form and regularly-convex valves, without prominent posterior umbonal slopes. From the *Breviarca* group it also differs, though less strongly, in the same characters of form, and in having much coarser and less crowded hinge-denticles, and in having its cardinal area divaricately furrowed instead of merely marked by very fine cross-striæ. The breviarcs are also all smaller shells than the average size of *Axinæa*.

The genus *Axinæa* is said to occur in the Trias and Jura, but the species from these rocks are few and not very well known. It is well defined, however, and not uncommon in the Cretaceous. It also ranges through the Tertiary, and probably attains its greatest development in the existing seas. The living species are most abundant on the coast of America, but they likewise occur in European seas as well as on the coasts of Africa, Australia, &c.

Axinæa subimbricata, M. & H.

Plate 28, figs. 14, *a*, *b*, *c*.

Petunculus subimbricatus, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 146.
Axinæa subimbricata, Meek and Hayden (1860), *ib.*, XII, 185.

Shell subcircular, or slightly longer than high, moderately convex; extremities rounded, the posterior side being sometimes a little broader and less regularly rounded than the other; base forming a very nearly semicircular curve, and strongly crenulate within; hinge-area rather small, marked by about five to seven distinct grooves; beaks almost central, rather gibbous, obtuse, and neither oblique nor distinctly incurved; hinge a little arched, teeth distinct, lateral ones oblique and curved, the concave sides being turned outward from the middle; muscular impressions rather large, but shallow. Surface ornamented by distinct lines of growth, crossed by numerous regular, simple, depressed, radiating costæ, about twice as broad as the grooves between.

Length, 1.55 inches; height, 1.36 inches; convexity of the two valves, 1.03 inches.

On the surface of specimens a little weathered, the concentric markings, which are slightly arched in crossing the costæ, seem to be rather imbricating near the borders of the shell; this character, however, may not be conspicu-

ous in all cases. Although the substance of the shell is distinctly laminated, the laminæ appear obscurely fibrous on cross-fractures, when examined with a magnifier.

Associated with the above, a single valve of a much smaller individual (figs. 14, *b* and *c*) was found, which has a comparatively smaller ligament-area, a less prominent beak, straighter cardinal edge, and not so many hinge-teeth; while its costæ seem to be obsolete over larger spaces at the extremities of the hinge. This may possibly belong to another species; but as the differences noted may be due to the fact of its being a young shell, it is undesirable, without more specimens for comparison, to separate it as a distinct species.

Locality and position.—Heart River; upper part of the Fox Hills beds, of the Upper Missouri Cretaceous series.

Genus LIMOPSIS, Sassi.

Synon.—*Limopsis*, Sassi (1827), Giron. Ligust. **.—Gray (1847), Zoöl. Proc., 198.—Meek and Hayd. (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 86.—H. and A. Adams (1858), Genera Recent Moll., II, 543.—Chenu (1862), Man. Conch., II, 147.—Gabb (1864), Palæont. Cal., I, 200.

Trigonocœlia, Nyst (1836), Rech. sur les coq. foss. de Honss., 12.—D'Orbigny (1843), Palæont. Fr., III, 801.

Trigonocelia, Sizmonda (1842), Synon. anim., invert., 20.—Pot. et Mich. (1844), Gall., I, 117.

Trigonocœlia, Gray (1842), Synon. Brit. Mus., 92.—Nyst (1846). Foss. Tert. Belg., 293.

Pectunculina, d'Orbigny (1843), Palæont. Fr., III, 182.—Geinitz (1846), Grundr. d. Verst., 446.

Etym.—*Lima*; and ὄψις, form.
Type.—*L. multistriata*, Forsk.

Shell suborbicular, equivalve, nearly equilateral, sometimes slightly oblique, closed all around; ligament-area small, with a triangular cartilage-pit in the middle; hinge arcuate, and provided with a series of small, radiately-arranged teeth in each valve, interrupted by the cartilage-pit; pallial line and muscular impressions as in *Axinæa*, excepting that the posterior muscular scars are sometimes larger than the anterior; surface concentrically or radiately striated, or nearly smooth.

The shells of this genus resemble *Axinæa*, but may be readily distinguished by having a cartilage-pit at the middle of the hinge-area. They are also usually smaller, more oblique shells.

The genus *Limopsis* is said to be represented in the Alpine Trias. It also occurs in the Jurassic rocks, as well as the succeeding formations, and in the existing seas. Some twelve to fourteen recent species are already known, and it is probable that the genus is quite as abundantly represented now as it was at any of the past geological periods. The existing species occur in the Chinese and Japanese Seas, the Red Sea, at the Cape of Good Hope, &c.

Limopsis parvula, M. & H.

Plate 28, figs. 17, *a*, *b*, *c*.

Pectunculina parvula, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 86.
Limopsis parvula, Meek and Hayden (1856), *ib.*, 285.

Shell very small, obliquely rhombic-suboval, moderately compressed; anterior side rounded, usually a little more prominent above than below; base forming a rather broad curve, sometimes nearly straight in the middle; posterior side obliquely truncated above, and more or less narrowly rounded below; pallial margin faintly crenulate within; hinge somewhat arched on the inside, generally equaling nearly half the length of the shell, and provided with three or four teeth on each side of the small triangular pit for the reception of the ligament; cardinal area small, but well defined; beaks moderately elevated, pointed, and incurved at right angles to the hinge, located slightly in advance of the middle. Surface marked by fine lines and occasional stronger marks of growth, crossed by exceedingly obscure, fine, radiating, subpunctate striæ, which are usually nearly or quite obsolete on the anterior part of the shell.

Length, 0.23 inch; height, 0.20 inch; convexity of the two valves, 0.14 inch.

The radiating lines are more distinct on the inside of the shell than without, especially on the middle and posterior portions, where they correspond to the crenulations of the border. They are not very distinctly punctate, but, under a good magnifier, seem to be slightly, though not regularly so. Generally speaking, the radiating lines are not visible without the aid of a lens, and often appear quite obsolete over the whole surface.

At a first glance, this little shell is apt to be confounded with *Cardium rarum* of Evans and Shumard, with which it is often associated. In form, and many of its other characters, it is very similar to *L. striato-punctata* of the same authors; but it presents a very marked difference in point of size, the latter being near four times as large as the largest specimens among hundreds of this species in our possession. The radiating striæ are also much more distinct on *L. striato-punctata* than the species now before us.*

* I have never seen the original type of *L. striato-punctata*, nor had I, at the time of writing these remarks, seen any specimen agreeing with the description of the same. Since the foregoing remarks were sent to the printer, however, a perfect example, from near the Black Hills, agreeing almost *exactly*, in size, proportions, and surface-markings, with the description and measurements of that shell, was sent to me by a friend. On comparing this with our specimens, it is found to present the additional difference of having an undefined shallow sulcus extending obliquely forward and downward from the anterior side of the beaks to the front margin, to which it imparts a slightly sinuous outline.

Locality and position.—Yellowstone River, 150 miles above its mouth; in beds containing the fossils of both the Fort Pierre and Fox Hills groups (Nos. 4 and 5), where it occurs in immense numbers and in a fine state of preservation.

NUCULIDÆ.

Genus NUCULA, Lamarck.

Synon.—*Nucula*, Lam. (1799), Prodr. 87; and (1809), Phil. Zoöl.; and (1819), Hist., VI, 1, 57.—Ferussac. (1821), Tab. Syst., xli.—Latr. (1825), Fam. Nat.—Desh. (1832), Encyc. Méth., III, 632.—Bronn. (1835), Leth. (2d ed.), 369 and 929.—Reeve (1841), Conch. Syst., I, 108; and of many others.

Acila, H. and A. Adams (1858), Gen. Recent Moll., II, 545 (subgenus of *Nucula*).—Chenu (1862), Man. Conch., II, 179.

Etym.—Diminutive of *nux*, a nut.
Type.—*Arca nucleus*, Linn.

Shell transversely-ovate or ovate-subtrigonal, short, and generally truncated behind, and longer, with a more or less rounded outline, anteriorly; beaks near the posterior side and turned backward; surface smooth, or ornamented by radiating, concentric, or zigzag divarieating striæ or costæ, and covered by an olivaceous epidermis; hinge angulated under the beaks, and provided at the angle with an oblique, prominent, internal cartilage-pit, on each side of which the small, deeply-interlocking dentieles are arranged; ligament sometimes subexternal; inner layers highly nacreous.

H. and A. Adams have proposed to separate this genus into two subgenera, distinguished as follows:

1. NUCULA, Lam. (typical).

Shell with radiating markings, smooth, or merely concentrically striate.—(Type as above.)

2. ACILA, H. & A. Ad.

Shell with zigzag divarieating markings.—*N. divaricata*, Hinds.

The fact that the truncated and shorter side of the shell in this genus is the posterior, and the beaks are directed backward instead of the reverse, as in most genera of bivalves, gives the animal and the shell the singular appearance of occupying reversed positions with relation to each other. What seems to be the lunule, and is often described as such, also differs in really corresponding to the escutcheon of other types.

The shells of this genus are readily distinguished from those of *Leda*, *Yoldia*, and *Neilo*, by their more angular hinge, strongly pearlaceous luster,

simple pallial line, and general form. They also differ from the latter by having an internal cartilage-pit.

Until the hinge and interior of a number of Palæozoic species that have been referred to *Nucula* can be more clearly seen than has yet been done, the exact period at which the genus was first introduced cannot be very satisfactorily determined. Most of the Palæozoic species that have been described under the name *Nucula* belong to *Tellinomya* and other allied groups. Some, however, seem to be true nuculas, even from the Devonian, and possibly a few from the Silurian. From the Carboniferous, we have species (such as *N. parva*, McChesney) that seem to present all the characters of the genus, both internal and external. The genus *Nucula* also occurs through all of the later formations, and is well represented in our existing seas. It was quite abundantly represented during the Cretaceous and Tertiary epochs, in the latter of which it appears to have attained its greatest development. The recent species, like the extinct, are widely distributed, the former being found generally in rather deep water on muddy bottoms of the North American seas, as well as on the coasts of Japan, China, Norway, Chili, &c.

Nucula subplana, M. & H.

Plate 17, figs. 7, *a*, *b*.

Nucula subplana, Meek and Hayden (Ap., 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 85.

Shell small, broad-ovate, approaching subtrigonal, much compressed, with height about four-fifths the length; posterior or shorter side obliquely truncated above, and narrowly rounded below; anterior side longer and more broadly rounded; basal margin semi-ovate in outline, not crenulate within; dorsum declining a little with a slightly convex curve from the beaks anteriorly, and a little concave and sloping abruptly behind; beaks moderately prominent, compressed, and located about half-way between the middle and the posterior or shorter side; teeth of the hinge about fifteen in each valve in front of the beaks, and a smaller number behind; muscular and pallial impressions faintly marked. (Surface unknown.)

Length, 0.37 inch; height, 0.26 inch; breadth, 0.12 inch.*

Having only seen internal casts of this little *Nucula*, I of course know nothing of its surface-markings, though it was probably merely marked by

* Fig. 7 *a* represents the umbonal region too much depressed.

concentric striæ, as the species of this genus having radiating costæ or striæ usually retain some traces of them on casts of the interior. Its small size, and decidedly compressed form, will distinguish it from all the other Upper Missouri species yet known.

It appears to be very similar in form and general appearance, to *N. Raymondi* of M. d'Archiac, from *Bains de Rennes* (Bul. Geol. Soc. Franç., II, 2e sér., pl. 3, fig. 16), but is proportionally a little shorter, and its muscular impressions are less distinct. It also differs in having its inner margin smooth, while that of *N. Raymondi* is described as being finely crenulate.

Locality and position.—Yellowstone River, 150 miles from its mouth, in a bed containing a blending of the fossils of the upper part of the Fort Pierre and Fox Hills groups; or Nos. 4 and 5 of the Upper Missouri Cretaceous series.

Nucula obsoletistriata, M. & H.

Plate 15, figs. 10, *c*, *d*.

Nucula obsoletistriata, Meek and Hayden (Nov., 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 275.

Shell transversely elliptic-oval, rather convex, thick; anal or shorter side obliquely truncated, with a concave outline, from the beaks to posterior basal extremity, which is angular or very narrowly rounded; anterior extremity more obtusely subangular; base forming a semi-ovate curve, the most prominent part of which is generally a little in front of the middle; cardinal edges forming at the beaks an angle of about 123°; beak small, depressed, oblique, placed a little behind the middle; surface marked by fine lines of growth, and sometimes a few very small, obscure, concentric wrinkles; lunule-like area narrow-obovate, deeply impressed, and distinctly defined on each side by an obtuse ridge.

Length, about 1.20 inches; height, 0.81 inch; convexity 0.60 inch.

The cardinal edge is thinnest near the beaks, from which point it gradually thickens toward the extremities, especially in front of the beaks. The pit for the reception of the ligament is acutely triangular and oblique. The posterior muscular impression is narrow-ovate, deeply excavated, and placed close up under the extremity of the hinge; while the anterior one is still narrower, quite shallow, and located very close up under the anterior end of the same. There are about thirty anterior hinge-teeth in each valve of adult shells, and nearly half as many behind the beaks, all of which are curved

in crossing the hinge, so as to present their concave sides toward the extremities of the shell.

The surface of slightly-worn specimens shows some faint indications of fine, radiating striæ; but these perhaps belong more to the inner laminæ, which are very distinctly striate, than to any external surface-markings. Its larger size, and other well-marked differences, will distinguish this shell from all the Upper Missouri species of this genus yet known.

It is very similar in form to *N. obtusa* of Fitton, as figured by d'Orbigny (Pal. française, III, pl. 300, figs. 1–3); but, in addition to being rather less compressed, it differs in having the middle portions of the lunule-like area nearly flat, instead of carinate. Its internal cast would also be more elevated at the beaks, while its anterior muscular impression is narrower and located closer up under the hinge, as well as farther back. Its truncated posterior dorsal margin is also decidedly more concave in outline.

Locality and position.—Great Bend of the Missouri; in the lower part of the Fort Pierre group.

Nucula planimarginata, M. & H.

Plate 15, figs. 8, *a*, *b*; and pl. 25, fig. 16.

Nucula planimarginata, Meek and Hayden (Ap., 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 85.

Shell transversely subovate or subelliptic, compressed; posterior or shorter side obliquely truncated above, and abruptly rounded or subangular below the middle; anterior or longer side cuneate and rather narrowly rounded; base forming a regular semi-elliptic curve, not crenate within; dorsum declining gently with a gradual convex curve, from near the beaks to the anterior extremity; beaks small, incurved, nearly contiguous, and located about half way between the middle and the posterior side; surface marked by very fine, irregular, radiating, and minute concentric striæ; hinge forming at the beaks an angle of about 110°, having in the adult some twenty-six or twenty-seven denticles on the longer or anterior side of the beaks, and about ten behind, in each valve; lunule-like area behind the beaks lance-ovate, flattened along each side, and a little convex in the middle.

Length, 0.95 inch; height, 0.66 inch; convexity, 0.38 inch.

The substance of the shell in this species is of moderate thickness, and generally less brilliantly pearly than that of the next. In most of our speci-

mens, the very fine radiating striæ are readily seen, even without the aid of a magnifier; but one of them is partly covered by an exceedingly thin outer layer, on which they are much more obscure. From this fact, I infer that the radiating striæ are probably not always readily seen on the outer surface-layer of well-preserved specimens.

This species has somewhat the appearance of the next, but may be distinguished at a glance by its less convex form, non-striate surface. and smooth inner margins.

Locality and position.—Moreau River, Long Lake, Butte au Grès, &c.; from the Fox Hills group, or No. 5 of the Upper Missouri Cretaceous series.

Nucula cancellata, M. & H.

Plate 28, figs. 13, *a*, *b*, *c*, *d*, *e*.

Nucula cancellata, Meek and Hayden (Ap., 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 85.

Shell transversely ovate-subtrigonal, rather gibbous; posterior or shorter side obliquely truncated above, and subangular below, the middle; anterior or longer side a little more rounded at the extremity; basal margin semi-elliptic or semi-oval in outline, neatly crenulate within; dorsum declining with a gently convex outline in front of the beaks, and sloping more abruptly behind; lunule-like area behind the beaks obovate, flattened, or a little concave, and bounded on each side by a very slight ridge; escutcheon-like area in front of the beaks lance-ovate and moderately well defined; beaks rather gibbous, incurved, nearly touching, and located a little nearer the middle than the posterior side; surface marked by numerous small, regular, simple, radiating striæ, which are broader than the linear depressions between, near the lower border, and crossed on all parts of the valves by smaller, more irregular, concentric costæ, so as to form a neat subcancellate style of sculpturing; hinge thick, forming an angle of near 120° at the beaks, and provided with about seventeen to nineteen teeth in front, and about twelve behind the beaks, in each valve of an adult.

Length, 0.93 inch; height, 0.65 inch; convexity, 0.51 inch.

In this species, the substance of the shell is rather thick, and usually retains its bright-pearly lustre. Where exfoliated, the surfaces of the inner laminæ are seen to be marked by faint radiating striæ, which are also faintly visible on the inner surface of the valves. Casts of the interior show that the muscular and pallial impressions are not very strongly marked. The scar of

the posterior adductor muscle is ovate and bounded by an obtuse ridge, which leaves on the cast a shallow groove extending up toward the beaks. The anterior muscular scar is broader than the other, and subtrigonal in form. The radiating costæ are obsolete on the lunular and escutcheon-like areas.

This beautiful *Nucula* is quite similar to *N. pectenata* of Sowerby (Min. Conch., II, 207, pl. 192, figs. 6–7; and d'Orbigny, in Palæont. France, III, pl. 303, figs. 8–11), but its costæ are decidedly smaller, and its lunule-like depression behind the beaks not near so deep nor so broad, as that of Sowerby's species, being there distinctly cordate in form, while in our shell it is rather narrow-obovate. Its muscular impressions are also much less distinct than in those of *N. pectenata*, and the crenulations of its free margins finer and more crowded. The points of difference between it and the last have been already noticed in the remarks connected with the description of that species.

Locality and position.—Moreau River, Long Lake, Deer Creek, on the North Platte, &c.; from the Fox Hills group, or No. 5 of the Upper Missouri Cretaceous series. It also occurs on Yellowstone River, Idaho Territory, in the upper part of the Fort Pierre group of the same series.

LEDIDÆ.

Genus NUCULANA, Link.

Synon.—*Nuculana*, Link (1807), Rost. Samml., III, 155.—H. and A. Adams (1858), Genera Recent Moll., II, 660.—Meek (1864), Smithsonian Check-List. N. Am. Cret. Foss., 8.—Stoliczka (1871), Palæont. Indica, III, 320.

Leda, Schum. (1817), Ess., 172.—Möll. (1842), in Kroyer's Naturh. Tidssk., IV, 91.—Phil. (1845), Arch. f. Nat., XI, 1, 194.

Lembulus, Leach (M. S., 1819).—Risso (1826), Hist., IV, 319.—Geinitz (1846), Grundr. d. Verst., 420 (not Sowerby, jr., 1842, = *Nucula*, Lam.).

Dacryomya, Agassiz (1839), Mem. sur les Moul. d. Moll., I, 34; and in Germ. Tr. Sowerby's Min. Conch., 500 and 578.

Etym.—*Nucula*, a little nut.
Type.—*N. emarginata*, Lam.

Shell transversely subovate, or more or less attenuated and subrostrate, and closed posteriorly, smooth, or concentrically-striated, and covered with an epidermis; beaks approximate, incurved, and sometimes directed a little backward; posterior umbonal slopes often angular; hinge-line slightly angulated; denticles fine, prominent, and usually numerous; cartilage occupying a small internal pit under the beaks; pallial line with a slight sinus, or sometimes very nearly simple; internal layer generally a little nacreous.

The genus *Nuculana* is nearly related to *Yoldia*, but can generally be

distinguished by the shell alone, which is usually more attenuated posteriorly, with more angular posterior umbonal ridges; but more particularly by its very slightly sinuous pallial line. It also more frequently has its beaks directed a little backward. There are species, however, that closely resemble *Yoldia* in most of these characters, excepting in not having the pallial line so deeply sinuous as in that genus.

From *Nucula*, with which it was formerly confounded, *Nuculana* is readily distinguished by its general form, less angular hinge, pallial sinus, and less pearly shell

The genus *Nuculana* is known to range back at least to the Carboniferous; several species being known from the Coal-Measures, showing all of the external and internal characters of the group. Others, presenting at least all of the external characters, occur in the Lower Carboniferous, and a few in the Devonian. Species have also been referred to it (under the name *Leda*) from Silurian rocks, but these probably belong to *Tellinomya*, *Nuculites*, and other distinct genera. The Permian species *N. vinta* (= *Leda vinta*, King), has its pallial line nearly or quite simple, and has been, for that reason, referred by Professor McCoy to the genus *Nucula*, but it has the form and habit of *Nuculana*, and, even if not belonging to the latter, could hardly be properly included in the genus *Nucula*.

This genus also ranges through the Triassic and all succeeding formations, and probably attains its greatest development in the seas of the present epoch; where it has a wide geographical distribution, being found on the coasts of Siberia, Great Britain, Japan, Australia, the West Indies, &c.

Nuculana bisulcata, M. & H.

Plate 15, figs. 4, *a*, *b*.

Leda bisulcata, Meek and Hayden (1861), Proceed. Acad. Nat. Sci. Philad., XIII, 440.
Nuculana bisulcata, Meek (1864), Smithsonian Check-List. Cret. Foss. N. Am., 8.

Shell small, transversely subovate, rather gibbous in the central region; anterior side narrowly rounded or subangular above the middle; base nearly semi-elliptic, with a very slight sinuosity near the posterior extremity; posterior end compressed, narrow, and subangular in outline above the middle; dorsal border sloping from the beaks at an angle of about 135°; beaks rather obtuse, placed slightly in advance of the middle; posterior umbonal slopes distinctly angular, the angles extending from the beaks along very near the

dorsal margin, to the upper part of the subangular extremity, where they terminate in a small fold bordered below by an obscure, oblique sulcus; escutcheon lanceolate, concave along the middle, and strongly defined by the umbonal angles, just within which there is, on each side, a narrow, well-defined sulcus, extending from the beaks to the posterior extremity of the shell; lunule not defined; surface ornamented by small, rather distinctly-elevated, regularly-arranged, concentric striæ.

Length, 0.31 inch; height, 0.16 inch; convexity, 0.13 inch.

At a first glance, this little shell might be readily mistaken for our *Yoldia scitula*, with which it closely agrees in size and form. On comparison, however, it will be at once distinguished by its angular posterior dorsal umbonal slopes, and distinctly-defined escutcheon, with a sulcus just within each of its lateral margins, as well as by its stronger concentric striæ. It is also a little less gibbous and slightly more depressed. I know nothing of its hinge or internal characters, but there is something in the expression of its posterior dorsal region, with its angular umbonal slopes, that indicates relations rather with *Nuculana* than *Yoldia*.

Locality and position.—Deer Creek, near North Branch of Platte River; in the lower part of the Fox Hills beds, or the upper part of the Fort Pierre group of the Cretaceous.

Nuculana subnasuta, H. & M.

Plate 15, fig. 9.

Nucula subnasuta, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci. Boston, V, new series, 384, pl. 1, fig. 10.
Leda (Yoldia) subnasuta, Meek and Hayden (Oct., 1860), Proceed. Acad. Nat. Sci. Philad., XII, 429.
Nuculana subnasuta, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 8.

Shell transversely subelliptical, nearly or quite equilateral, moderately gibbous in the umbonal region; extremities rather narrowly-rounded or subangular, the anterior margin being a little more obtuse than the other; posterior side having a shallow, undefined groove or depression extending obliquely from the beaks to the postero-basal margin, where it produces a very slight emargination; escutcheon margined by a faint, shallow groove, which extends from near the beaks to the upper part of the posterior extremity; beaks small, incurved, and approximate. Surface marked by regular concentric striæ, which become nearly obsolete on the extremities; crenulations of the hinge very fine.

Length, 0.78 inch; height, 0.45 inch; convexity, 0.36 inch.

I have not yet seen the interior of this shell, and consequently have no means of determining whether or not its pallial line is sinuate. It is manifest, however, that it cannot be properly retained in the genus *Nucula* as restricted and understood by conchologists; and from its analogy, externally, to the recent *Nuculana emarginata*, Lamk., it most probably belongs to that genus, though it differs from the most characteristic form of the same. I know of no other species in Upper Missouri rocks with which it is liable to be confounded.

Locality and position.—Great Bend of the Missouri, below Fort Pierre; from the lower part of the Fort Pierre group, or No. 4 of the Cretaceous series.

Nuculana? equilateralis, M. & H.

Plate 15, figs. 7, *a*, *b*.

Nucula equilateralis, Meek and Hayden (Ap., 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 84.

My knowledge of this species is entirely derived from the study of internal casts. As nearly as can be determined from these, it may be characterized as follows: transversely elongate-subelliptical, much depressed, moderately convex in the central region, and narrow at the extremities; basal margin forming a regular, but very gentle curve, apparently not crenulate within; hinge-line sloping slightly, and nearly equally, from the beaks toward the extremities, provided in front and rear of the beaks with about sixteen teeth in each valve; beaks rather depressed, and almost exactly central; surface unknown.

Length, 0.64 inch; convexity, 0.21 inch; height, 0.25 to 0.27 inch.

Until the pallial line of this species can be more clearly seen, it will be impossible to determine whether it is *Nuculana* or a *Yoldia*.* Its form, however, would exclude it from *Nucula*, as that genus is now understood by conchologists. I know of no other species in the Upper Missouri rocks with which it is liable to be confounded; all of its associates resembling it in other respects being inequilateral. Excepting in this character, it would seem to be very similar in form to *Yoldia Evansi*.

Locality and position.—Moreau River; in Fox Hills beds, or formation No. 4 of the Cretaceous series.

* In the only specimen yet seen, its pallial line *looks* as if it were simple, as represented in the figure; but it may have a small sinus; or possibly a more decided one, and have to be called *Yoldia equilateralis*.

Genus YOLDIA, Möller.

Synon.—*Yoldia*, H. P. C. Möller (1842), Kroyer's Nat. Tidssk., IV, 91; and (1844), Ind. Moll. Grœnl., 18, cf. Zeitschr. f. Moll., 12.—H. & A. Ad. (1858), Gen. Recent Moll. II, 584.—Chenu (1862), II, 180; and of many others.

Moldia, Gray (misprint), 1847.

Portlandia, Mörch (18).—H. and A. Adams (1858), Genera Recent Moll., II, 652; and others (not Chenu (1862), Man. Conch., II, 180).

Leda and *Nucula* (species) of some authors; but not *L.* of Schum., or *N.* of Lam., as properly restricted.

Etym.—Dedicated to the Countess Yoldi.

Examp.—*Nucula limatula*, Say.

Shell transversely subovate, subelliptic, or trapezoidal, thin, narrowed and compressed, or wider and truncated posteriorly, more or less inequilateral; surface smooth, or finely striated, and covered by a polished epidermis; free margins smooth within; inner layer slightly pearly; denticles of hinge small, and more or less numerous on each side of beaks. Pallial line distinctly sinuous.

Two sections of this genus are admitted by some as subgenerically distinct; while others do not seem to regard them as differing sufficiently to be separated in any way. These sections may be distinguished as follows:

1. YOLDIA, Möller (typical.)

   Shell usually depressed or narrow subovate, with posterior side often narrowed, and a little gaping.—*Nucula limatula*, Say.

2. PORTLANDIA, Mörch.

   Shell proportionally broader (higher), vertically or obliquely truncated and closed behind.—*Nucula glacialis*, Gray; and *N. thraciformis*, Storer.

These distinctions, however, do not seem to be of much importance; there being intermediate forms that might with about as much propriety be referred to one as the other of the sections. Both H. and A. Adams and Chenu recognize *Portlandia*, however, as a distinct subgenus; but by some strange mistake, the latter author cites two fossil species (*Nucula Hæsendonkii*, Nyst, from the Tertiary, and *N. pectinata*, Sowerby, from the Cretaceous) as examples; both of which seem to be true nuculas, and certainly cannot be properly included either in a subgenus, or otherwise, under *Yoldia;* while they are quite as distinct from the recent typical species of *Portlandia.*

The genera *Yoldia* and *Nuculana* sometimes so nearly resemble each

other in form and general appearance, that it is not always easy to distinguish fossil species of the two groups from each other. When the pallial line, or its impression on internal casts, can be seen, however, its more deeply sinuous character in *Yoldia* is a good distinguishing character; and the latter genus also usually has a larger cartilage-pit than *Nuculana*. Again, the valves of *Nuculana* are generally more depressed, more attenuated posteriorly, and, in many cases, have the posterior umbonal slopes more prominent or angular. There are likewise said to be differences in the animal of these two groups; *Yoldia* not having the ventral lobes seen at the posterior margin of the mantle in *Nuculana* and *Neilo*. In the form of the shell, the last-mentioned genus resembles some species of the section *Portlandia;* but the pearlaceous inner layer and internal cartilage of the latter will at once distinguish the shells of these groups.

From the genus *Nucula*, to which some palæontologists, who are not over-particular in regard to generic distinctions, still persist in referring fossil species of *Yoldia*, the latter genus may be at once distinguished, not only by the entirely different form and less nacreous character of the shell, but by the non-sinuate pallial line of *Nucula*, to say nothing of the striking differences of the animal in these groups, which no well-informed conchologist now refers to the same family.

The genus *Yoldia* seems to date back to Palæozoic times. At least, we have shells from the Carboniferous and Permian rocks that have exactly the form and crenate hinge of the typical species. I am not quite sure that I have seen the pallial sinus in any of these, though I think traces of it may sometimes be seen on some of the casts of the interior. Some of the Triassic and Jurassic species that have been referred by palæontologists to *Nuculana* (= *Leda*) probably belong here; while several of the species referred by d'Orbigny and others, to *Leda* and *Nucula*, from the Cretaceous of France, seem to be typical yoldias.

This genus was also represented by several species during the Tertiary epoch, and probably attains its greatest development in the existing seas. The recent species are chiefly found in northern and antarctic seas, and occur on the coasts of Greenland, Kamtschatka, Massachusetts, &c.

Yoldia microdonta, Meek.

Plate 2, fig. 2.

Yoldia microdonta, Meek (1872), Hayden's Sixth Report United States Geological Survey of the Territories, 304.

Shell small, longitudinally subovate, rather compressed; anterior margin more or less narrowly rounded, being generally more prominent above the middle; pallial margin forming a semi-ovate curve, being more prominent before than behind the middle, and curving up gradually and obliquely at both ends; posterior side compressed, and with its margin narrowly rounded, or almost subangular at its connection with the hinge above; cardinal margin sloping gradually from the beaks, the posterior slope being very slightly concave in outline, and the anterior nearly straight; beaks rather depressed and placed a little in advance of the middle; hinge-line equaling about three-fourths the entire length, and provided with very fine, regular, pointed denticles, of which twenty-six may be counted behind, and twenty before the beaks, in each valve. Muscular and pallial impressions very obscure, and not visible on internal casts. Surface not well known.

Length, 0.50 inch; height, 0.28 inch; convexity, 0.14 inch.

In general outline, and the nearly central positions of its beaks, this shell bears some relation to *Yoldia bisulcata*, M. and H., from the Fox Hills group of the Upper Missouri Cretaceous; but it is a very decidedly more compressed species, and, judging from impressions left in the matrix, it was evidently less strongly striated. Indeed, it seems to have been nearly smooth, in which character, as well as in some other respects, it is probably more nearly related to *Y. Evansi*, M. & H., from which it differs in being proportionally shorter, higher, and more compressed. Among European species, it is represented by such forms as *Yoldia scapha* (*Nucula scapha*, d'Orbigny, Palæont. of France, III, pl. 301, figs. 1–3), from which it also differs in being more compressed, with the posterior side wider, and the posterior dorsal slope distinctly less concave in outline.

Locality and position.—Twelve miles southwest of Salina, Kansas; from a brown sandstone of the age of the Dakota group of the Upper Missouri Cretaceous. Discovered by Professor Mudge, of the Kansas Agricultural College.

Yoldia scitula, M. & H.

Plate 28, fig. 9.

Nucula scitula, Meek and Hayden (April, 1856), Proceed. Acad. Nat. Sci., Philad., VIII, 84.
Leda scitula, Meek and Hayden (1860), *ib.*, XII, 185.
Leda (*Yoldia*) *scitula*, Meek and Hayden (October, 1860), *ib.*, 428.

Shell transversely subovate, gibbous in the central and umbonal regions; anterior extremity rather narrowly rounded; posterior side narrower and more compressed, subangular or very narrowly round in outline, the most prominent part being above the middle; base forming a semi-ovate curve, sometimes very slightly sinuous near the middle; dorsum declining from the beaks; cardinal border of each valve having a distinct marginal groove behind the beaks, which forms, when the valves are united, a lanceolate, escutcheon-like depression; beaks rather obtuse, not oblique, placed a little in advance of the middle; surface marked by regular, fine, distinct, concentric lines, which are nearly equal to the grooves between, and more strongly defined on the middle than toward the extremities of the valves.

Length, 0,40 inch; height, 0.21 inch; convexity, 0.20 inch.

This species resembles in form and general appearance *Yoldia ventricosa* (= *Nucula ventricosa* of Hall and Meek), but differs in being a much larger and less ventricose shell. It is also less prominently rounded on the ventral border, and its beaks less nearly central, while its concentric markings are proportionally smaller.

Our shell is also similar to *Leda Mariæ*, d'Orbigny (Palæont. Fr., III, pl. 301, figs. 4–6), a Galt species, but is much more gibbous, and has more elevated beaks, which are located nearer the middle.

Some internal casts of our species show that its pallial line had a rather distinct sinus, though the sinus is not deeper than we sometimes see in the genus *Leda*. As the form of the shell, however, agrees more nearly with *Yoldia*, I have placed it in that group.

Locality and position.—Moreau River and Long Lake; in the Fox Hills group, or No. 5 of the Nebraska Cretaceous series. We also have it from beds on Yellowstone River, containing a mingling of species usually found in the upper part of the Fort Pierre group and the Fox Hills beds.

Yoldia Evansi, M. & H.

Plate 28, figs. 10, *a*, *b*, *c*.

Nucula Evansi, Meek and Hayden (April, 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 84.
Leda Evansi, Meek and Hayden (May, 1860), *ib.*, XII, 185.
Leda (*Yoldia*) *Evansi*, Meek and Hayden (October, 1860), *ib.*, 429.

Shell transversely elongate-subelliptical, depressed, rather compressed, or a little gibbous in the central and umbonal regions; both extremities narrowly rounded, the most prominent part of each being above the middle; basal margin nearly straight, and parallel to the cardinal border along the middle, and rounding up gradually in front and behind; dorsal margin nearly straight, provided, behind the beaks, with a shallow groove in each valve; beaks depressed, small, and almost in contact, located a little in advance of the middle of the shell; surface smooth, excepting very obscure traces of fine concentric striæ.

Length of largest specimen, 0.77 inch; height, 0.36 inch; convexity, 0.26 inch.

Some internal casts of this species, obtained since it was first described by us, show that the posterior muscular impression is very narrow-oval, and placed with its longer diameter nearly horizontal. The anterior muscular impression is larger than the other, of an oval form, and stands with its longer diameter arranged nearly vertical. In some specimens, it appears to have had an obscure ridge extending about half-way down, from above, near the middle, so as to present a slightly bilobate aspect. These casts also show that the pallial line is provided with a rather deep, rounded sinus (see fig. 10*c*), as in the genus *Yoldia*, to which we have removed it.

In some respects this species resembles the last, but it attains a much larger size, is always more compressed, has less elevated beaks, and is proportionally more broadly rounded posteriorly. It also wants the rather distinct concentric striæ of that species, being almost perfectly smooth, excepting very obscure traces of concentric lines.

Among foreign species, one of its nearest representatives is *Y. scapha* (= *Leda scapha*, d'Orbigny, Palæont. Fr., III, pl. 301, fig. 2), from which it differs, however, in having less elevated beaks, and in being much broader behind the beaks, the posterior side of *Y. scapha* being subrostrate.

Locality and position.—Moreau River, in the Fox Hills group; and at localities on the Yellowstone River with the last-described species: also, on Milk River, apparently in the upper part of Fort Pierre group.

Yoldia ventricosa, H. & M.

Plate 15, figs. 5, *a*, *b*.

Nucula ventricosa, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci. (n. s.), V, 385, pl. 1, fig. 11 (not *N. ventricosa*, Hinds, 1843).
Yoldia ventricosa, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 429.

Shell very small, transversely ovate, ventricose in the middle, and compressed at the extremities; anterior end rather narrowly rounded, most prominent a little above the middle; posterior side more contracted and compressed, subangular at the extremity; base prominent and rounded; beaks elevated, and located slightly in advance of the middle; surface marked by regular concentric ridges, which are most distinct on the middle of the valves, and obscure near the extremities; sometimes a broad faint depression extends from near the posterior side of each beak, toward the lower part of the posterior extremity; hinge-line declining a little from the beaks, and comparatively strongly crenate.

Length, from 0.14 to 0.16 inch; height, about 0.10 inch; convexity, a little less than the height.

The similarity between the form and other characters of this little shell and *Yoldia scitula*, leaves very little room for doubt in referring it to the same genus; though none of the specimens yet examined show the pallial line very distinctly.

Locality and position.—The specimens first described and figured by Professor Hall and the writer, were collected by Dr. Hayden in 1853, on Sage Creek, from the upper beds of the Fort Pierre group. The only specimens since seen, are from the South Fork of Cheyenne River, where they occur in the same geological position.

UNIONIDÆ.

Genus MARGARITANA, Schumacher.

Synon.—*Margaritana*, Schum. (1817), Essai, 123.—Lea (1838), Trans. Am. Philos. Soc., VI (n. s.), 42; and Observ. II, 118 (as a subgenus of *Margaron*).—Swainson (1840), Malac., 288 and 382.—Agassiz (1852), Arch. f. Nat., I, 314.

Alasmidonta, Say (1818), Jour. Philad. Acad. Nat. Sci., I, 459.—Raf. (1820), Monog. Bivalves Ohio.

Alasmodonta, Say (1819), Nicholson's Encyc., 3d Am. ed., "; and in Am. Conch.—Féruss. (1819), Tab. Syst.—Barnes (1823), Am. Jour. Sci., VI, pl. 21.—Menke (1830), Synon., 2d ed., 106.—H. and A. Adams (1857), Gen. Recent Moll., II, 499 (as a subgenus of *Baphia*).

Alasmodon, Thomas (1830), Ann. Phil., XVI, 110.—Fleming (1828), Brit. An., 417.—Gray (1840), Turton's Man., 2d ed., 293.—Swainson (1840), Malac., 382.

Alasmadonta, Say (1836), Catalogue, 23.

Complanaria, Swainson (1840), Malac., 280 and 382.—H. and A. Adams (1857), Gen. Rec. Moll., II, 500 (as a subgenus under *Baphia*).
Unionopsis, Swainson (1840), Malac., 264 and 382.
Calceola, Swainson (1840), *ib.*, 289 and 382.—H. and A. Adams (1857), Gen. Rec. Moll. II, 500 (as a subgenus under *Baphia*; not *Calceola*, Lam., 1799).
* *Baphia*, H. and A. Adams (1857), Gen. Rec. Moll. II, 500 (not Meuschen, 1787?).

Etym.—*Margarita*, a pearl.
Type.—*Mya margaritifera*, Linn.

Shell varying in form from transversely elongate-subelliptic, to shorter oval, subtrigonal, subrhombic, &c.; surface smooth or plicated, and covered with an olivaceous epidermis. Hinge with anterior tooth single and erect in the right valve, and double in the left; or with two (rarely three) anterior teeth, sometimes represented by irregular tubercles; posterior teeth wanting, or occasionally represented by obscure, irregular grooves.

The following sections of this group have been admitted by H. and A. Adams, Chenu, and some others:

1. **MARGARITANA**, Schum. (typical).

Shell transversely elongate-subelliptic; anterior teeth single in right valve and double in left; posterior teeth wanting.—(Type as already stated.)

2. **ALASMODONTA**, Say.

Shell oval, subtrigonal or subtrapezoidal; beaks large and prominent; surface smooth; hinge with two cardinal teeth.—*Margaritana Curreyana*, Lea.

3 **COMPLANARIA**, Swainson.

Shell oblong, subrhombic, &c.; valves connate, with a smooth or plicated surface; anterior teeth two or three; lateral represented by irregular grooves.—*M. arcula*, Lea.

4. **UNIONOPSIS**, Swainson (= *Calceola*, Swainson, 1840; not Lam., 1799).

Shell ovate, smooth; anterior teeth two, irregular, or represented by tubercles and undulations.—*M. calceola*, Lea.

These sections are probably hardly all entitled to rank as subgenera. Indeed, the whole taken together, are regarded by Dr. Lea and some other high authorities, who have given much attention to the study of the *Unionidæ*,

* The name *Baphia*, Meuschen, 1787, according to Herrmannsen, was proposed for a group including species of *Unio*, *Psamobia*, *Vulsella*, *Mya*, and *Anomia*. If so, I should think it could not be properly made to replace *Margaritana*, Schum.

as forming a single group, itself only differing subgenerically from *Unio* proper.

The only essential difference observable between the shells of *Margaritana* (including the above sections) and *Unio*, is the entire absence of well-defined posterior teeth in the former. Professor Agassiz, however, observed some differences in the structure of the animal, in certain species of *Margaritana*, and that of the typical Uniones; that is, in the former he found the gills free from the mantle, at their posterior extremities, instead of being united to it, as in *Unio* proper; and the anal opening or region of mantle in *Margaritana* not fringed, as it is at both siphonal openings in *Unio*.

The group *Margaritana* is known to date back to the Wealden of Europe; it also occurs in the Tertiary, and, like the true Uniones, seems to attain its greatest development in the existing rivers and smaller streams of North America. There are two species and many varieties now living in the fresh-waters of Europe.

Margaritana Nebrascensis, Meek

Plate 1, figs. 5, *a*, *b*, *c*.

Unio (*Baphia* ?) *Nebrascensis*, Meek (1871), Hayden's Sec. Ann. Rep. U. S. Geol. Surv. of the Territories, 303.

Shell attaining a medium or larger size, thin, cuneate-subovate, being in the adult very gibbous anteriorly, and cuneate behind; anterior side very short and rounded; posterior sloping above obliquely from the end of the hinge to the posterior basal extremity, which is narrowly rounded; basal border sinuous behind the middle, and convex in front of it; cardinal margin rather short and nearly straight, or slightly arched; umbones very gibbous, but depressed, oblique, incurved, and placed near the anterior extremity; posterior umbonal slopes subangular from the beaks obliquely backward and downward to near the middle, beyond which they are continued as broadly-round ridges to the posterior basal extremity; below and parallel to these ridges, there are also, on the flanks, one or two large, oblique, irregular, rounded plications or undulations, that continue on to the sinuous posterior basal margin, to which they sometimes impart a distorted or waved appearance. Surface otherwise smooth, excepting moderately distinct lines of growth, which are strongly undulating in places as they cross the oblique ridges or plications of the flanks.

Length, 4.10 inches; height, 2.36 inches; convexity, 2.07 inches.

This shell has so much the aspect of the existing Uniones that I referred it provisionally to that genus in first describing it, placing the name *Baphia* (which has been by some considered synonymous with *Margaritana*) parenthetically between the specific and generic names, with a mark of doubt, to indicate that I thought it might belong more properly to the latter. It certainly has an external ligament, and all of the external characters of *Unio* and *Margaritana;* but so far as can be determined from internal casts, it almost certainly has no posterior teeth, and in this character does not agree with *Unio*. One cast shows the impression of a single compressed anterior tooth, ranging parallel to the anterior slope, just above the anterior muscular impressions and near the margins. These muscular scars are deep, and like those of *Unio* and *Margaritana*, though I am not quite sure of the presence of the pedal scars just behind those of the anterior adductors, as we see in the genera mentioned, as well as in other types of the *Unionidæ*, unless they may be represented by the little protuberance seen projecting from the posterior side of one of these scars, as represented in our figure 5, *c*. There are certainly no traces of pedal scars *above* the anterior adductors, as we see in the *Crassatellidæ* and other families to which our shell would most probably belong, if it does not fall into some genus of the *Unionidæ*. The casts do not show the pallial line, nor the impressions of the posterior adductor muscles.

Locality and position.—Dakota group (No. 1) of the Upper Missouri Cretaceous series. Opposite Sioux City, on the Missouri River, in Dakota County, Nebraska, where it occurs associated with *Cyrena Dakotensis*.

CRASSATELLIDÆ.

Genus CRASSATELLA, Lamarck.

Synon.—Crassatella, Lamarck (1801), Syst. An., 119; and (1809), Phil. Zoöl., *; also (1818), Hist. Nat., V, 480.—Blainv. (1818), Dict. Sci. Nat., XI, 356.—Desh. (1830), Encyc. Méth., III, 19.—Bronn (1838), Leth., 971.—G. B. Sowerby, jr. (1842), Conch. Man., 2d ed., 125.—Nyst, (1846), Coq. Tert. Belg., 83.—Gray (1847), Proc. Zoöl. Soc. Lond., 194.—Woodward (1856), Man. Moll., 299.—H. and A. Adams (1857), Gen. Recent Moll., II, 485; and many others (not Lamarck, 1799, = *Mactra*, Linn.).

Pachytharus, Conrad (1870), Am. Jour. Conch., V, 47; and (1872), Proceed. Acad. Nat. Sci. Philad., XIV, 50; also (1873), Kerr's Geol. Rep. S. Car., App., 6 (as a subgenus of *Crassatella*).

Etym.—Crassus, thick.
Type.—C. gibba (= *Venus ponderosus*, Chemnitz).

Shell transversely oval-oblong or subtrigonal, more or less convex, usually thick and strong, inequilateral, often somewhat attenuate posteriorly;

surface concentrically striated or furrowed; margins closed, crenate or smooth within; lunule well defined; hinge strong, provided with two, more or less diverging, generally striated, cardinal teeth in each valve, and an internal cartilage-pit behind them; lateral teeth usually one in each valve, the posterior more or less nearly parallel to the hinge-margin in the right valve, and fitting into a corresponding groove in the other, with a smaller elongated tooth below it; a small anterior lateral sometimes occurs in right valve, fitting into a corresponding pit in the left; muscular impression and simple pallial line strongly defined; anterior pedal scar distinct from that of the anterior adductor; no external ligament.

The older fossil species of this genus present, in some instances, more or less marked differences, from the Miocene and recent, in form as well as in the details of the hinge. On these characters, Mr. Conrad has proposed to divide the genus into two subgenera, nearly as stated below.*

1. **CRASSATELLA**, Lam. (typical).

   Shell with cartilage-pit behind cardinal teeth comparatively small; free margins not crenate.—(Type as above. Recent and Miocene.)

2. **PACHYTHÆRUS**, Conrad.

   Shell with cartilage-pit behind the cardinal teeth generally large, free margins crenate within.—*C. Vindinnensis*, d'Orbigny. (Eocene and Cretaceous.)

These distinctions, however, scarcely seem to be of sufficient importance to warrant the arrangement of the species under distinct subgeneric names.

Professor Agassiz separated, under the name *Ptychomya*, with *Crassatella Robinaldina*, d'Orbigny, as its type, a group thought by some not to be generically distinct from *Crassatella*. It differs, however, in having *three* diverging cardinal teeth in each valve, the posterior ones being very long, and double in the right valve, with the cartilage-pit placed *in front*. It is

* Mr. Conrad has proposed a genus *Radioconcha* (= *Pleuroconcha*) in the Am. Jour. Conch., V, 47, and Proceed. Acad. Nat. Sci. Philad., 1872, 50, with *Crassatella Gallicanei*, d'Orbigny, as the type, that seems to be closely allied to *Crassatella*. It is radiately costate, however, and is said to have no internal cartilage-pit. If the latter character really exists, it must be generically distinct from *Crassatella*; if not, however, the radiating costæ would hardly be of more than subgeneric importance. Mr. Conrad says that in first proposing this genus it was by inadvertence that he cited under it *Astarte Guerangeri* and *Crassatella Robinaldina*, d'Orbigny, instead of *C. Gallicanei*. The first is an *Astarte*-like form, that he makes the type of a new genus, *Plionema*; while the second is the type of *Ptychomya*, as stated above.

also marked with costæ, radiately arranged on the flanks and behind, and divaricating in front.

It is doubtful whether there are any true *Crassatellæ* older than the Jurassic period, and even the species of that age referred to this genus may belong to other perhaps undefined genera. We see the name sometimes used even for Palæozoic shells, but it is now only done by those who are rather careless in regard to generic distinctions.

In the Cretaceous, however, there are a number of well-marked species of *Crassatella*, belonging, however, to Mr. Conrad's section *Pachythærus;* the same group is also represented in the Eocene, while those of the Miocene and existing seas seem nearly or quite all to belong to the slightly different typical section. The number of species was perhaps greater during the Eocene or Cretaceous than at present. The recent species are generally obtained from deep waters on the coasts of Australia, Asia, Africa, North America, &c.

Crassatella (Pachythærus) Evansi, H. & M.

Plate 17, figs. 6, *a*, *b*, *c*, *d*.

Crassatella Evansi, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci. Boston, V (n. s.), 383, pl. 1, fig. 9.

Shell ovate-subtrigonal, rather gibbous, thick; anterior side obliquely truncated, and generally a little concave in outline above, and abruptly rounded below; base semi-ovate, being usually slightly more prominent before than behind the middle; posterior side longer than the other, sloping from the beaks above, and rounded or vertically subtruncate at the extremity; lunule oval, rather deep; escutcheon narrow-lanceolate, defined by an obscure ridge on each side; pallial margins regularly and finely crenate within; beaks prominent, gibbous, and located about half-way between the middle and the anterior extremity. Surface marked by fine, irregular lines of growth, which are sometimes gathered into small, obscure wrinkles near the borders; muscular and pallial impressions strongly marked.

Length, 1 inch; height, 0.90 inch; convexity, 0.71 inch.

Decomposing and exfoliated specimens of this species show on the surfaces of the inner laminæ distinct radiating lines. These were evidently left by the crenulations of the border, which, as may be seen by their marks on the edge of each lamina of growth, marked the pallial margin of the shell at all ages.

As suggested in the paper above cited, it was probably an internal cast of this species from which fig. 9, tab. 7, of Dr. Owen's Report of the Geol. Survey of Wisconsin, Iowa, and Minnesota was drawn, though no specific name was there proposed for it.

Locality and position.—This species seems not to have an extensive vertical or geological range. The specimens first described by Professor Hall and the writer were collected by Dr. Hayden and myself at Sage Creek, in upper part of the Fort Pierre group; and those now before me are from a locality near there on the Cheyenne, in the same geological position. It is not known to occur at any other localities.

Genus CRASSATELLINA, Meek.

Synon.—*Crassatellina*, Meek (1871), Hayden's Second Report Geological Survey of the Territories, 300.
Compare *Etea*, Conrad (1873), Appendix to Kerr's Geol. Report of North Carolina, 5 (issued in advance of the report in 1873).

Etym.—*Crassatella* (dimin.).
Type.—*Crassatellina oblonga*, Meek.

Shell transversely trapezoidal, equivalve, inequilateral, with free margins closed and smooth within; hinge with two cardinal teeth, and one elongated anterior and one posterior lateral tooth in each valve; anterior cardinal tooth of the left valve trigonal, and deeply emarginate below; posterior very much compressed, oblique, and somewhat elongated; cardinal teeth of right valve diverging, with a triangular pit between for the reception of the larger triangular tooth of the other valve; anterior one small, oblique, and connected at its upper end with the posterior extremity of the anterior lateral; posterior larger, oblique, longitudinally furrowed,* and perhaps emarginated below, while just behind and above it, there is a narrow oblique slit, or pit, for the reception of the thin anterior cardinal of the other valve; lateral teeth elongated parallel to the cardinal margins; the anterior one of the right valve, and the posterior of the left, apparently continued so as to connect with the upper ends of the cardinal teeth; ligament external; pallial line simple.

The typical species of this genus has the general external appearance of a *Crassatella*, from which genus, however, it is clearly removed by its hinge-characters, though evidently belonging to the same family. Its muscular impressions are faintly defined, as is also the case with the pallial line, which latter, however, can be followed so far back as to leave little or no doubt

* The furrow of this tooth is too strongly defined in fig. 3, *d*, of plate 2.

that it is really simple. The larger trigonal cardinal tooth of the left valve is probably sometimes so deeply emarginate as to give it an A-shape.

The description and figures of the hinge of this genus have been made out entirely from impressions left in the rock; a rather difficult method, it is true, but the only means we yet have of forming conclusions in regard to its generic characters. Consequently, I have found it necessary, on farther developing and more closely scrutinizing these moulds of the hinge, to modify, to some extent, the description of the details of the hinge-teeth given in the original description of the genus. What I at first supposed to be merely a compressed, sharply-raised lamina, in the bottom of the pit behind the trigonal anterior cardinal tooth of the left valve (see fig. 3, *e*, in which it is represented a little too short, and not quite oblique enough), I now believe to be properly the posterior cardinal tooth, and the oblique ridge above and behind it, which I supposed to be the posterior cardinal, I now think a continuation, forward and upward, of the posterior lateral tooth, though it is not represented exactly so in the figure; while I now believe the thin projection I here view as the posterior cardinal of the left valve, fits into a corresponding slit just *above* and *behind* the posterior cardinal of the right valve, instead of into the furrow along the middle of the same.

Some time after the publication of the original description of this genus, I had, through the kindness of Mr. Conrad, an opportunity to compare with our type, perfect examples of the type of his genus *Etea*, showing the hinge and interior of both valves as distinctly as we ever see in recent bivalves. On first receiving Mr. Conrad's specimens, I saw that they closely resembled this genus; but being at the time occupied with other collections, no critical comparisons were then made. On taking up the study of our Cretaceous fossils again, and making careful comparisons of our shell with the typical species of the genus *Etea*, I have been still more forcibly impressed with the close relations of these types, and almost led to the conclusion that they may not be generically distinct. The most essential differences that I have been able to make out are the following: in the right valve of *Etea*,* the lateral teeth are shorter and double, instead of single, as they appear to be in *Crassatellina*; the upper division of each being small, or merely rudimentary, while the lower is prominent, and on the anterior side very nearly connects with the *base* of the anterior cardinal tooth.

* In making these comparisons, it is necessary to bear in mind that Mr. Conrad has inadvertently described the hinge of the right valve of his genus as that of the left, and the left as the right.

In *Crassatellina*, however, the only anterior lateral tooth yet made out corresponds in position to the upper part of that in *Etea*, but is proportionally much larger and longer, and extends back so as to connect with the *upper* end of the anterior cardinal tooth. The posterior lateral tooth in *Crassatellina* is also apparently more prolonged backward than in Mr. Conrad's genus. In all other characters of the hinge these types agree exactly, and I am not quite sure that some of these differences may not be rather apparent than real, because, as already intimated, the specimens of *Crassatellina* yet examined are merely casts, that may not convey an entirely correct idea of the details of the hinge-teeth. I should also add that these shells likewise agree well in their muscular and pallial impressions, as well as in the obscure traces of radiating striæ of the interior. Mr. Conrad thought the pallial line in his type sometimes a little truncated, or possibly very faintly sinuous; but in the specimens that I have examined, it is well-defined, and clearly neither truncated nor in the slightest degree properly sinuous. It extends backward and downward, from near the middle of the under side of the posterior muscular scar, nearly as far as the hinder margin of the same, and then curves abruptly forward, thus leaving, as it were, a little notch between it and the muscular impression above; but this can hardly be viewed as a sinus of the pallial line itself.

Mr. Conrad's type has even more the external appearance of a *Crassatella* than our shell, and I can no longer doubt that these shells, whatever may be their generic relations to each other, really belong to the family *Crassatellidæ*.

In regard to the geological range of this genus we only know that the type was found in the Upper Cretaceous, at a horizon not far from that of the Gray Chalk of English geologists.

Crassatellina oblonga, Meek.

Plate 2, figs. 3, *a*, *b*, *c*, *d*, *e*.

Crassatellina oblonga, Meek (1871), Hayden's Second Ann. Report Geological Survey of the Territories, 301, with cuts A and B.

Shell small, short oblong-subtrapezoidal in outline, less than twice as long as high; valves rather distinctly convex, with flattened sides; anterior margin rounded; pallial margin nearly straight, or sometimes slightly sinuous along the middle; posterior obliquely truncated above and narrowly rounded

below; dorsal outline sloping rather abruptly in front of the beaks, and less distinctly so behind; beaks moderately prominent, and placed a little in advance of the middle; posterior umbonal slopes prominently rounded from the beaks to posterior basal extremity; posterior dorsal region above the umbonal prominences flattened; flanks sometimes a little concave toward the pallial margin. Surface with rather distinct lines of growth.

Length, 0.73 inch; height, 0.32 inch; convexity, 0.30 inch.

Specifically, this shell is more nearly like a species I have described from the Cretaceous near Cañon City under the name of *Mactra? Cañonensis* than it is like any other form with which I am acquainted; though it differs too widely to be confounded with that shell, even where the hinge could not be seen. They both have so much the appearance of the genus *Crassatella* externally, that few would hesitate to refer them to that genus, where their external characters only could be examined.

Locality and position.—Twelve miles southwest of Salina, Saline County, Kansas; Dakota Group of the Upper Missouri Cretaceous series. Collected by Professor B. F. Mudge.

Genus ERIPHYLA, Gabb.

Synon.—*Eriphyla*, Gabb (1864), Palæont. California, I, 180.—Stoliczka (1871), Palæont. Ind. III, 156 (but not *ib.*, 181 and 182, pl. vi, = *Dozia*, Bosquet, 1868).

Etym.—Ἐριφύλη (*Eriphyla*), the wife of Amphiarius.
Type.—*E. umbonata*, Gabb.

Shell subtrigonal, nearly equilateral; surface concentrically costate and sulcate, or striated; ligament external; lunule deep; hinge with two cardinal teeth in the right valve, and one in the left, and an elongated anterior and posterior lateral tooth in each valve; pallial line unknown.

Mr. Gabb remarks that the type of this genus is related to *Astarte* and *Gouldia*, more particularly to the latter; but that it may be readily distinguished from the former by its well-developed lateral teeth; and from the latter, by having posterior as well as anterior lateral teeth. Mr. Gabb also remarks that the left valve sometimes shows traces of a posterior rudimentary second cardinal tooth, that is received into a corresponding small pit just behind the larger posterior cardinal tooth of the other valve; and that other species may possess two well-developed cardinal teeth in each valve, in consequence of the greater size of this rudimentary cardinal of the left valve.

Since the foregoing description and remarks were in type, I have had an opportunity to examine good specimens of the recent *Gouldia mactracea*, from our eastern coast, and find that it does not differ so widely as supposed by Mr. Gabb, in the character of the posterior side of its hinge, from his type. On the contrary, it certainly has a small, but unmistakable, remote posterior lateral tooth in the left valve, that fits into a corresponding indentation under the edge of the opposite valve, just over the posterior muscular scar; while this posterior edge of the right valve is beveled and prominent, so as to fit into a long, slender, posterior marginal furrow in the left valve, as a long posterior lateral tooth. Mr. Gabb, however, describes *Eriphyla* as having an external ligament, of the existence of which I can see no traces in *Gouldia mactracea*; though, as might be expected from its affinities, it certainly has a well-developed internal cartilage, occupying the anterior half of the comparatively large central pit in the right valve, and a smaller pit just in front of the well-developed cardinal of the left.

This larger pit between the two cardinal teeth of the right valve in *G. mactracea*, has a low, slender, mesial ridge, separating its anterior half (occupied by the cartilage) from the slightly narrower posterior part that receives the cardinal tooth of the other valve. Anteriorly, the right valve has a long marginal furrow, for the reception of a long tooth formed by the mere beveling and prominence of the anterior margin of the left valve; while the lower anterior edge, under this long furrow of the right valve, just over the anterior muscular scar, projects as a single, remote, anterior lateral tooth. From these remarks, it will be seen that in *G. mactracea*, at least, there are both anterior and posterior lateral teeth, the posterior of which in the left valve, corresponds in arrangement, and nearly in size, to the anterior in the right, and the anterior in the right, to the posterior in the left, respectively. Consequently, with the exception apparently of an external ligament in *Eriphyla*, that type would appear to be quite closely related to *Gouldia*.

Dr. Stoliczka refers three round, compressed Cretaceous shells, with but slightly prominent beaks and a shallow pallial sinus, to Mr. Gabb's genus *Eriphyla*. These Indian shells seem to agree pretty nearly in the more essential generic characters of the hinge, excepting its greater breadth, with the California type; but their lenticular form and very slightly prominent beaks give them a very different aspect, suggesting, with their sinuous pallial line, as remarked by Dr. Stoliczka, affinities to *Dosinia*; while, as already

intimated, the type of *Eriphyla* has more the aspect of forms belonging near *Astarte*.

Nothing is yet known in regard to the pallial line of Mr. Gabb's type;* but if it is simple, as seems more probable, there can be little doubt that the above-mentioned Indian shells referred to *Eriphyla* by Dr. Stoliczka, belong to an entirely distinct genus, if not, indeed, to a different family. Dr. Stoliczka remarks that Mr. Gabb's figures of the hinge of his genus, and his statement that it has a deep lunule, leave no doubt that it belongs to the *Dosininæ* instead of to the *Astartidæ*. To me, however, there seems to be no reason yet known for such a conclusion, especially as its hinge is very similar, as already stated, to that of *Gouldia;* while the presence of a deep lunule is common in the *Astartidæ*, and even in *Gouldia;* though there can be little doubt that the Indian shells Dr. Stoliczka had under consideration are related to the *Dosininæ*.†

Another Indian Cretaceous form, referred by Dr. Stoliczka to *Grotriania*, Speyer, seems to be quite as nearly related, if not more nearly, to *Eriphyla* than those mentioned above. It has essentially the same hinge-characters, excepting that its cardinal margin is much broader and its lunule and escutcheon are much deeper. It is a round, lenticular shell, with a simple pallial line and finely-crenate margins. It may be worthy of remark here, however, that this species is certainly generically distinct from Speyer's type of *Grotriania*, which is both *figured* and distinctly *described* as having *no lateral teeth;* while the Indian shell here mentioned has well-developed lateral teeth. Curiously enough, Dr. Stoliczka defines *Grotriania*, contrary to its author's diagnosis and figured type, as having lateral teeth.

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* H. and A. Adams describe *Gouldia* as having the "pallial line simple, or slightly sinuated." In *G. mactracea*, however, it is certainly completely simple.

† Dr. Stoliczka neither figures, describes, nor mentions any other Indian species of *Eriphyla* than *E. lenticularis*, *E. Forbesiana*, and *E. diversa;* while he cites the first as the best known example of the genus, it having been long since described from German specimens by Goldfuss, under the name *Lucina lenticularis*. He further states that the *type of the genus* (evidently alluding to *E. lenticularis*) and two others occur in the Cretaceous rocks of India. How that species, however, came to be the *type of the genus* is difficult to comprehend, when Mr. Gabb, in founding it, only had before him the single species *E. umbonata* of California, and makes no allusion whatever to any other species in connection with the new genus. In such cases, the only species mentioned by the author of a new genus can alone be considered its type. It is very singular, that some naturalists should still have such loose ideas of the rules of zoölogical nomenclature, as to seem to think that they have a right to view any species that they may *believe* belongs to a genus as its type, without the slightest regard for the fact that the original author had founded it upon an entirely different form. Farther on, Dr. Stoliczka mentions the fact, that in 1868 Bosquet had proposed a genus *Dozia* for the reception of *Licina lenticularis*, Goldfuss.

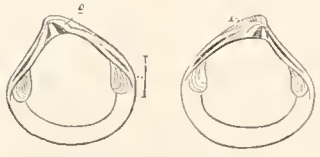
In regard to the geological range of the genus *Eriphyla*, not very much can be said, in the present state of our knowledge of this and some allied types, beyond the fact that it certainly existed during the Cretaceous epoch.

Eriphyla gregaria, M. & H.

Plate 17, figs. 9, *a*, *b*.

Astarte gregaria, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 84.

Fig. 6. Fig. 7.



Eriphyla gregaria.

Fig. 6. Hinge and interior of right valve, f, being fulcrum for ligament.

Fig. 7. Same of opposite valve.

Shell very small, rather thin, rounded-subtrigonal, a little longer than high, moderately convex; anterior side rounded below and slightly sinuous above; base forming a nearly semicircular curve; posterior side more broadly rounded than the other; dorsum sloping abruptly from the beaks with a slightly concave outline in front, convex and declining more gradually behind; pallial border not crenulate within; beaks elevated, rather pointed, incurved, approximate, and a little oblique, located slightly in advance of the middle. Surface ornamented by distinct regular concentric costæ and fine obscure lines of growth.

Length, 0.21 inch; height, 0.19 inch; transverse diameter of the two valves, 0.14 inch.

It is not without some doubts that I have referred this little shell to Mr. Gabb's genus *Eriphyla*, as it would seem to present some differences in the details of its hinge-characters from the type of that genus; that is, instead of having two well-developed cardinal teeth in the right valve, and only one in the left, it has just the reverse, or, in other words, two in the left and one in the right. In the only specimen showing the hinge of the right valve, seen at the time the above cuts were prepared, there certainly seems to be a slender, shallow, posterior lateral furrow, as if for the reception of the posterior lateral tooth of the left valve, as shown in the above cut, No. 6. In another specimen of the right valve, however, undoubtedly of the same species, the hinge of which has since been worked out, no such posterior lateral furrow is seen, the margin there being merely beveled and prominent, so as to form a long, posterior lateral tooth to fit into the corresponding posterior lateral furrow of the left valve; below the lower end of which furrow there is, in this left valve, a small, posterior lateral tooth, that would seem to fit *under* the projecting edge of the opposite valve.

Our shell shows, just behind and partly between the beaks, a minute furrow above the hinge in each valve, defining what has all the appearances of a fulcrum for the attachment of a very small, external ligament (see f, of foregoing cuts); in which character it would agree with Mr. Gabb's description of *Eriphyla*. But in this, as well as in the relative positions of its cardinal teeth of the opposite valves, it differs from *Gouldia mactracea*. I do not know, however, how far *Gouldia* may vary in the arrangement of its hinge-teeth; but certainly in *G. matracea* (as already stated), the two well-developed cardinal teeth are in the right valve, and the single one in the left; while in the published figures of *G. Pacifica* the same arrangement is shown. Dr. Stoliczka, however, defines that genus (whether from recent or fossil species he does not say) as having "one cardinal tooth in the right valve and two in the left," exactly as in our shell; while his figure of an Indian Cretaceous species shows, apparently, the same arrangement mentioned in his generic description.

In the present state of our knowledge of the affinities and range of variation of these little Cretaceous types, I am left in some doubt in regard to the proper disposition of our shell, but have concluded to refer it provisionally to *Eriphyla* for the present. If the existing species of *Gouldia* vary in the relative arrangement of the cardinal teeth in the two valves, possibly I would be nearer right to call our shell *Gouldia gregaria;* but if they are constant in this character, and further comparison should show our shell to be generically distinct from *Eriphyla*, I would propose for it the name *Eriphylopsis*.

In first describing this species, little or nothing was known of its hinge, and it was referred to *Astarte* from external characters only. On subsequently taking it up for more thorough study, however, and sacrificing some of the best specimens in cutting about the hinge, the characters here given were revealed.

Specifically, this little shell may be compared with *Astarte similis*, Münster, as figured by Dr. Zittel in his valuable Monograph of the Bivalves of the Gosau formation, with which it seems to agree very nearly in size and form. It differs, however, in having much smaller and more numerous concentric undulations and a more rounded outline. I am not acquainted with the hinge of Münster's species, but it is very probably not a true *Astarte*. Another Gosau species, figured on the same plate by Dr. Zittel under the name

A. laticosta, Deshayes, is certainly not an *Astarte*, as it has distinct lateral teeth.* Dr. Stoliczka has also figured a somewhat similar species, from the Cretaceous rocks of India, under the name *Gouldia trigonoides;* but it departs still more widely from our shell in its less rounded form and larger and less numerous concentric costæ, and also differs in having its free margins crenate within. Judging from Dr. Stoliczka's fig. 4, pl. x (vol. III, Palæont. Indica), there would seem to be reason for believing that his species, like ours, has a posterior marginal furrow for the reception of a posterior lateral tooth. It is probable that most of the Cretaceous species described under the name *Astarte* belong to *Eriphyla*, *Gouldia*, and perhaps several other allied genera.

Locality and position.—Yellowstone River, 150 miles above its mouth; from the upper part of the Fort Pierre group of the Upper Missouri Cretaceous series.

SOLEMYIDÆ.

Genus SOLEMYA, Lamarck.

Synon.—Solemya, Lam. (1818), Hist., V, 488; *ib.*, 2e éd., VI, 123.—Fèruss. (1821), Tab. Syst., xliv.—G. B. Sowerby (1822), Gen. Sh., fasc. 7.—Blainv. (1827), Dict. Sci. Nat., XLIX, 422.—Menke (1828), Syn.; and (1830), *ib.*, 2e éd., 119.—Desh. (1830), Encyc. Méth., III, tab.; and (1832), *ib.*, 956.—Roemer (1839), Verst. Ool. Nachtr., 42.—Gray (1842), Synon. Brit. Mus., 91; and (1847), Proceed. Zoöl. Soc., 192.—H. and A. Adams (1857), Gen. Recent Moll., II, 482.—Meek (1873), Palæont. Ohio, I, 206.

Solenimya (Bowdich), G. B. Sowerby (1822), Gen. Shells, fasc. 7; and (1842), Conch. Man., 2d ed., 262.

Solenomya, Leach (1823), Synon. Brit. Mus., 58.—Herrmannsen (1849), Indicis Gen. Malac., II, 481.—Meek and Worthen. (1866), Palæont. Illinois, II, 349, and *ib.* V, pl. 27.

Solenymya, Swainson (1840), Malac., 366.

? *Janeia*, King (1850), Permian Fossils of England, 177.

Etym.—Solen and *Mya;* from a fancied resemblance to these two genera.
Type.—S. australis, Lam.

Shell transversely elongate-oblong, equivalve, inequilateral, very thin, rounded and gaping at the ends; surface smooth, or showing obscure radiating marks, and covered with a polished, corneous, brownish epidermis that projects beyond the free margins; beaks depressed to the horizon of the dorsal margin, and located posteriorly; hinge with an obscure cardinal tooth in each valve, and an oblique, posterior, internal process or fulcrum for the support of the ligament, which is partly internal and partly external; pallial line simple; anterior muscular impression shallow, broad oval-subquadrate; posterior smaller and ovate.

* It should be remembered that in first proposing the genus *Astarte*, Sowerby distinctly mentions the recent *A. Scotica*, which has no lateral teeth, as the typical species.

This genus has no near relations either to *Mya* or *Solen*, as the name would appear to imply. Indeed, it differs so decidedly from all of the known genera, either among recent or fossil *Mollusca*, that it cannot be for a moment confounded with any described genus, unless the Permian and Carboniferous forms, for which Professor King proposed the name *Janeia*, are really distinct generically, which I have suspected may be the case; although Professor King has withdrawn the latter name, under the impression that it is really synonymous with *Solemya*.

The reason for believing that the name *Janeia* may possibly yet have to be retained for the Palæozoic species usually referred to *Solemya* (or, at any rate, for a part of them), is, that all of the American Carboniferous species of this type that I have seen, differ from the recent species of *Solemya* in *not being exactly equivalve;* that is, although apparently exactly like that genus in all other respects, they seem to have the beak of the left valve always lapping upon that of the right. For a long time I thought this merely due to accidental distortion; but after seeing numerous specimens, some of which, from the even adjustment of the ventral margins of the valves, as well as from their general appearance, seemed not to have suffered any distortion, and yet showing this character, I have been led to believe it natural; and as the living typical species of *Solemya* have the beaks equal, it is not altogether improbable that there may be a generic difference between them and the Palæozoic species. It is true, however, that Professor King did not mention any such inequality of the beaks as one of the characters on which he proposed to separate *Janeia;* but it is a character that might readily be overlooked, from the supposition that it was due to accidental distortion. If the name *Janeia* should have to be retained for the whole or a part of the Palæozoic species usually referred to *Solemya*, the latter would most readily be distinguished by this difference in the character of the beaks.

The Carboniferous genus *Clinopistha*, Meek and Worthen, is also related to *Solemya*, with which it agrees in the thinness of the shell, the character of the muscular impression, and in having its beaks nearer the shorter side of the valves, as well as in the nature and position of its ligament. It differs, however, remarkably in form, being a short gibbous shell, truncated behind, with both ends closed. It also differs in showing the same inequality of the beaks seen in the Palæozoic forms usually referred to *Solemya;* from which

it likewise differs, however, as decidedly in general form as from the modern types of that genus.

The foregoing two, or possibly three, types are, in my opinion, very nearly, if not quite, all of the known genera that can be properly referred to the family *Solemyidæ*. The very peculiar characters of the genus *Solemya* have led the most reliable authorities on conchology to view it as the type of a distinct family, standing apart from all the other existing groups of *Mollusca*. This view was, I believe, first expressed by Dr. Gray, of the British Museum. It was afterward adopted by Deshayes, H. and A. Adams, Dr. P. P. Carpenter, Dr. Gill, and others. Dr. Stoliczka, of the Indian geological survey, also adopts the family *Solemyidæ;* but he includes in it (provisionally only, it is true) what seems to me to be a most incongruous jumble of genera, as follows: *Cleidophorus*, *Pyrenomœus*, *Sanguinolites*, *Leptodomus*, *Orthonota*, *Anodontopsis*, *Sedgwickia*, *Dolabra*, *Grammysia*, and *Solemya*.* It is certainly difficult to understand why these genera should be included in the same family with such a genus as *Solemya*, as most of them seem to have little or nothing in common with it, or with each other, beyond what we see in numerous other bivalves. To say nothing of the other types here mentioned, it is only necessary, in order to show how widely some of these shells are removed from the family including *Solemya*, to state that *Cleidophorus*, even in the type-species, is now known to have a crenate hinge like *Nucula*.

Among the more marked generic characters of *Solemya* may be mentioned its elongated form, very thin shell, with its anterior side so much longer than the posterior, as to give it the appearance of having the ligament in front of the beaks, instead of behind them; also its shining epidermis, projecting beyond the free margins, together with its partly internal and partly external ligament.

The thin, light nature of the shell of *Solemya* enables the animal to leap and swim about in the water for some time without touching bottom, as was, I believe, first noticed by Dr. Stimpson. The leap is said to be performed by means of the sudden dilation and contraction of the umbrella-shaped foot; water being at the same time forcibly ejected from the posterior opening by the drawing together of the valves.

If the type for which Professor King proposed the name *Janeia* is not distinct from *Solemya*, this genus must have been introduced during the

* Palæont. Indica, III, 268.

Devonian, or possibly even the Silurian, period, and ranged through all subsequent epochs to the present time. The species, however, seem never to have been very numerous. At present, only some four or five recent species are known. Of these there occur two on the eastern coast of the United States, while the others are from New Zealand, New Holland, the Mediterranean, West Africa, &c. They are found burrowing in muddy bottoms at a depth of about two fathoms.

Solemya subplicata, M. & H.

Plate 28, fig. 19.

Solen subplicata, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 82.
Solemya subplicata, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 11.

Shell nearly three times as long as high, moderately compressed, extremity thin and fragile; cardinal and basal margins straight and parallel; anal extremity obliquely rounding to the base; anterior end rounding up from below, and apparently obliquely declining above; beaks near the posterior end, not distinct from, nor rising above, the dorsal border. Surface ornamented by very fine, obscure striæ of growth, crossed on the anterior side by broad, nearly obsolete, radiating costæ, some six or eight of which extend to the anal margin, to which they seem to impart a very slightly-waved outline.

Length, about 1.10 inches; height, 0.42 inch; convexity, 0.26 inch.

The radiating plications are *very* obscure, and might be overlooked. They are most distinct on the antero-dorsal region, and gradually fade away on the middle and posterior portions of the shell. In some cases, by the aid of a good lens, in a favorable light, traces of very minute, closely-set striæ may be seen crossing the lines of growth. These do not appear to radiate from the beaks, but to cross the surface at right angles to the longer diameter of the shell, and are quite as distinct on the inside as on the outside. These may, however, be due to the shell-structure rather than to surface-markings.

On casts, two shallow depressions are seen near the posterior side of the beak of each valve, one extending obliquely forward close to the truncated posterior border, and the other a little farther back, passing less obliquely downward. They seem to have been occupied by callosities connected with the hinge on the interior of the valves.

Locality and position.—Moreau River; in the Fox Hills group, or formation of the Upper Missouri Cretaceous series. It is very rare; only a single specimen being yet known.

LUCINIDÆ.

Genus LUCINA, Bruguière.

Synon.—Lucina, Brug. (1792), Encyc. Méth., tab. 284.—Lamarck (1801), Syst. An., 124 (not 1799, = *Loripes*, Poli, 1791).—Cuvier (1817), Règne An., 482.—Lam. (1818), Hist., V, 538.—Férruss. (1821), Tab. Syst., xliii.—J. Sowerby, Min. Conch., tab. 417.—Fleming (1828), Hist. Brit. An., 441.—Desh. (1830), Encyc. Méth., III, 371.—Agassiz (1839), Moul. de Moll., 37.—H. and A. Adams (1857), II, 466; and of numerous later authors.

Tridonta (sp.), Schum. (1817), Essai, 146.—Gray (1847), Proceed. Zoöl. Soc. Lond., 195 (as a sec. of *Lucina*).

Lentillaria, Schum. (1817), Essai, 147.

Myrtea (sp.), Turton (1822), Brit. Biv., 133.—Fleming (1828), Brit. An., 443.—Philippi (1844), Mol. Sic., II, 25.—H. and A. Adams (1857), Gen. Recent Moll., II, 468 (as a subgenus of *Lucina*).

Phacoides, Blainv. (1824), Dict. Sci. Nat., XXXII.

Milthea, H. and A. Adams (1857), Gen. Recent Moll., II, 468 (as a subgenus of *Lucina*).

* *Cyclas*, H. and A. Adams (1857), *ib.*, 467 (as a subgenus of *Lucina*; not *Cyclas*, Brug.).

Here, Gabb (1869), Palæont. California, II, 28 (as a subgenus of *Lucina*).

Etym.—Lucina, a name of *Juno*.
Type.—Lucina Jamaicensis, Spengler.

Shell more or less nearly circular, lenticular, or sometimes ventricose; surface-characters variable; posterior dorsal slopes often with an oblique sulcus; lunule generally well-defined, sometimes very deep; hinge usually with two diverging cardinal, and two lateral teeth in each valve; lateral teeth and one of the cardinals sometimes obsolete; ligament external, or sometimes rather deeply seated between the margins of the valves; muscular impressions well-defined, the anterior one being elongated within the well-marked simple pallial line; interior surface within the pallial line more or less rugose, and often having an oblique linear furrow in each valve.

This genus includes the following subgeneric sections:

1. **LUCINA**, Bruguière (typical).

   Shell orbicular or more or less oval, moderately convex, concentrically striated or lamellate; cardinal and lateral teeth generally well-developed.—(Type as already cited.)

2. **MYRTEA**, Turton.

   Shell ovate, rather compressed, concentrically striated, lamellated or decussate; hinge with lateral teeth, and one of the cardinals generally obsolete.—*Lucina spinifera*, Mont.

* Klein used the name *Cyclas*, in 1753, for a group including divaricately-marked species of *Lucina*; but, for reasons stated farther on, I think he ought not to be cited as authority for this subgenus.

3. CYCLAS, H. and A. Adams (not Brug.).

Shell orbicular, thin, rather compressed; hinge with cardinal and lateral teeth present, but small; surface obliquely or divaricately striated.—*Lucina divaricata*, Linn.

4. MILTHEA, H. and A. Adams.

Shell inequivalve, nearly smooth, or more or less distinctly marked with radiating striæ or costæ; hinge with lateral teeth generally obsolete.—*Lucina Childreni*, Gray.

Mr. Gabb has proposed another subgenus, *Here*, for his *L. Richthorfeani*, from the Cretaceous of California, based on its extremely profound lunule. As this species, however, agrees well in all of its other characters with typical forms of *Lucina*, and some existing, as well as other fossil species, agreeing equally well with other allied sections, also show this character, it seems scarcely desirable to separate this as the type of a distinct subgenus.

By some conchologists, *Loripes* of Poli, 1791, is also included as a subgenus under *Lucina*, and it must be admitted that the species they thus range cannot be separated from this genus upon any very distinctly-marked characters of the shell alone. If Poli did not, as suggested by Deshayes,* however, confound a tellinoid with a lucinoid species, when he figured the animal of his typical *Loripes* with a long siphonal tube, it must differ widely in this character from *Lucina*, or even from all other types of the *Lucinidæ*. Until this question can be settled, it seems more proper to view *Loripes* as a distinct genus.

Codakia, Scopoli, 1777, is also included by H. and A. Adams, Dr. Stoliczka, and others, as another subgenus, under *Lucina*. The remarkable difference presented by the comparatively very short foot of the typical species of this group (*L. tigerina*), as shown by Deshayes (Jour. Conch. Paris, I, 3e. sér, pl. xiv, fig. 3†), together with the strongly radiately costate character of the shell, and its concealed ligament, seem to be sufficiently well-marked peculiarities to separate this type generically.

Dr. Stoliczka likewise includes, as a subgenus of the group under consideration, *Lirodiscus*, Conrad, founded on the Eocene *Astarte tellinoides*, Con.

* Supp. Coq. Fossiles Environs de Paris, I, 589.

† At the time Deshayes published the paper here alluded to, he did not think the difference between the animal of the type of *Codakia* and that of *Lucina* even of subgeneric importance. In his later publications, however, he admits it doubtfully as a distinct genus (Supp. Coq. Foss. Environs de Paris, 590).

It seems to me, however, from the fact that the type of *Lirodiscus* does not show the slightest tendency to the prolongation of the anterior muscular scar, so characteristic of this genus, that it cannot be properly included in the same. Its general appearance also seems to indicate nearer relations to *Astarte*, in which genus both Mr. Conrad and Dr. Lea placed it long back.

Professor Hall, many years since, proposed the name *Paracyclas* for a Devonian Lucinoid shell, that may possibly find a place in this genus, either as a distinct section or otherwise; but, unfortunately, nothing is yet known, I believe, in regard to its hinge and internal characters.

I have the impression that this genus probably dates back to Palæozoic times. At least, we meet with Devonian shells presenting exactly all of the external characters of *Lucina*. Whether or not they possess the hinge and internal characters of any section of this genus remains to be determined. It is probable, however, that at any rate a part of them, will be found to present hinge and internal characters warranting their separation under Professor Hall's name *Paracyclas;* while some of the others may possibly belong to unnamed genera.

So far as I have observed, there seem to have been no Carboniferous or Permian shells yet discovered showing such close external resemblance to this genus as some of those found in the Devonian; though, if the group was represented during the Devonian, it must have lived through the Carboniferous and Permian periods. In the Triassic and Jurassic rocks, this genus was represented by forms apparently belonging to the typical *Lucina* section; which is well represented, along with some species of *Cyclas* and *Myrtea*, in the Cretaceous. In the Tertiary, most of the sections are known to occur, and the genus probably attained its greatest development during that period; though it is well represented in the seas of the present epoch, where all of the described sections exist.

At the present time, this genus has a world-wide geographical distribution, which also seems to have been the case during past geological epochs.

In regard to the particular name that should be retained for this genus, quite different opinions exist. As Klein, in 1753, used the name *Cyclas* for a group including a species belonging to one of the subgenera, some have adopted that name for the genus; but as he was not a regular binomial author, and dates before the Linnæan era, I do not see how his name can be adopted for the genus according to rule. H. and A. Adams retain it as a subgeneric

name for the divaricate section, for which I also use it here, but I adopt it as H. and A. Adams' name, not Klein's.

The next name applied to any type of this genus was *Lucina*, Lamarck, 1801. Nearly all authors have adopted the latter name for the genus, while several use Scopoli's name *Codakia* subgenerically under it. If this type is to be admitted into the genus at all, however, it seems to me that *Codakia*, being the oldest regularly-proposed name for the genus, would have to be adopted for it, and the costate species, with the other characters mentioned, viewed as the typical section; for I cannot see how a genus once regularly proposed, can be reduced to the rank of a subgenus under another published at a *later* date, even though the first name may not have been adopted in the interval. Such a rule would give any author who might find a type differing only subgenerically from any recently-published genus, the right to reduce the same to the rank of a subgenus, and give a new generic name for the whole group himself; a course that has, in fact, actually been pursued in one or two instances by Dr. Stoliczka.

Lucina subundata, H. & M.

Plate 17, fig. 2, *a*, *b*, *c*, *d*, *e*.

Lucina subundata, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci. Boston, V (n. s.), pl. i, fig. 6.

Shell small, subcircular, compressed, very thin; anterior side broadly rounded; basal margin semi-ovate, 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. In one specimen, from the same locality and position, agreeing exactly in its surface-markings, the thinness of the shell, and, indeed, in almost every other respect, with the above, there are two impressions, with a ridge between, passing down the front side, to the margin of which they impart a very peculiar appearance. This may be a distinct species; but, with the material now at hand for comparison, it seems probable that it is only a variety of the above. Fig. 2 *e* of pl. 17 represents this specimen.

Locality and position.—Mouth of Sage Creek, on the Cheyenne; in the upper part of the Fort Pierre group of the Upper Missouri Cretaceous series. The specimen of this species first figured in the paper cited at the head of this description was collected by Dr. Hayden from the same geological position, on Sage Creek, and near the same locality.

Lucina occidentalis, Morton.

Plate 17, figs. 4, *a*, *b*, *c*, *d*.

Tellina occidentalis, Morton (1842), Jour. Acad. Nat. Sci. Philad., VIII, 210, pl. xi, fig. 3.
Mould of *Lucina*?, Owen (1852), Report Geol. Survey Wis., Iowa, and Min., tab. vii, fig. 8.
Lucina occidentalis?, Meek and Hayden (Nov., 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 272 (not *Lucina occidentalis*, Reeve, 1850).

Shell transversely broad-oval, rather thick, moderately convex; anterior side broadly rounded; basal border semi-ovate in outline, the most prominent part being toward the front; posterior side narrower, and subtruncated at the extremity, usually having a nearly obsolete flattening, extending from near the beaks, above the umbonal slopes, obliquely backward and downward to the posterior extremity; dorsal border nearly straight, or faintly sinuous, and declining very slightly in front of the beaks, convex, and more obliquely sloping behind; beaks depressed, small, and nearly central; lunule lanceolate, small, and shallow, or somewhat excavated. Surface ornamented by very distinct, rather regular, concentric lines; exfoliated specimens also showing obscure radiating marks on the inner laminæ.

Length of a large specimen, 1.85 inches; height, 1.58 inches; convexity, 0.93 inch.

The hinge of this species shows the two cardinal teeth to be rather small in the right valve, the posterior one being a little larger than the other, and faintly emarginate at the extremity. Between these two teeth there is

a little larger pit, and farther back a smaller one, for the reception of the two cardinal teeth under the beak of the left valve. Each valve has one small, obtuse, anterior, lateral tooth, situated some distance in advance of the beaks, with apparently very faint traces of a remote posterior lateral in one or both valves.

The posterior muscular impression is shallow, subquadrate in form, and usually bounded in front by a faint linear ridge, extending obliquely up toward the beaks. The upper part of the anterior muscular impression has the same form, while its prolonged portion below is slender, a little arcuate, rather long, and directed obliquely downward toward the middle of the basal margin. Just above this impression of the anterior adductor, the small, oval scar of the pedal muscle is seen quite detached from it.

It is with some doubt and hesitation that I have identified this shell with *Tellina occidentalis* of Morton. Well-preserved specimens of it are certainly quite unlike Dr. Morton's figures, though when the shell is partly worn away along the dorsal side in front of, and behind the beaks, as is the case with some of our specimens, they present almost exactly the same appearance. In addition to this, it is evident Dr. Morton's figures were drawn from a worn and otherwise imperfect specimen, giving an incorrect idea of its original form; while the species here under consideration appears to have a wide geographical range in Nebraska, and is nearer like the specimen figured by Dr. Morton than any other shell yet known from the rocks of that region.

Locality and position.—Mouth of Milk River, and on Cheyenne River; in the upper part of the Fort Pierre group. The specimens from the latter localities have a rather shorter anterior muscular impression, and present some other slight differences, which may possibly be of specific importance; but I think that they more probably merely belong to a variety of the same. It also occurs on the Moreau River, where it seems to range up into the Fox Hills group, or formation No. 5 of the Upper Missouri Cretaceous.

Lucina occidentalis, var. **ventricosa**, M. & H.

Plate 17, fig. 3, *a*, *b*, *c*.

Lucina ventricosa, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., VIII, 427.

Shell very broad-ovate, or subcircular, rather thin, compressed or moderately convex; anterior side broadly rounded; basal border smooth

within, deeply rounded in front, and contracted behind; posterior side narrower than the other, and subtruncate at the extremity; beaks small, moderately prominent, pointed, and very nearly central; surface polished, and marked by fine, rather regular, concentric lines; ligament depression lanceolate; lunule smaller, but nearly of the same form, and deeply excavated; while on each side of it there is usually a more or less defined sulcus extending forward to the upper part of the anterior margin.

This shell may possibly belong to a distinct species from the last, instead of being a mere variety of the same; but both vary to such an extent that I am now inclined to think the form under consideration more probably only a variety of the *occidentalis*. Its chief differences are its smaller size, thinner shell, and proportionally rather shorter and more rounded outline; its anterior ventral margin being more deeply rounded. It also has a rather more finely striated and smoother surface, and generally differs in having a shallow sulcus extending from the beaks, on each side of the lunule, to the upper part of the anterior margin.

In general form, as well as in size, and the presence of the anterior sulcus, it approaches more near the first of the forms described; but it differs materially in its surface-characters, being destitute of any traces of the concentric undulations seen on that shell, which also presents a rougher appearance, as if it had been covered by a thin epidermis. Still, it may be possible that all three of the types here described are merely varieties, or represent different ages of the same species. Indeed, I confess that I am not altogether satisfied with the conclusion that they belong to more than one species; but, having already separated them, it is perhaps better to continue this arrangement than to unite the whole under one name, doubtfully.

Locality and position.—Yellowstone River, 150 miles from its mouth; in beds containing a blending of the fossils of the Fort Pierre and Fox Hills groups of the Upper Missouri Cretaceous series.

Genus SPHÆRIOLA, Stoliczka.

Synon.—*Sphæra* (sp.), d'Archiac, and some others.
Sphæriola, Stoliczka (1871), Palæont. Indica, III, 217.

Etym.—*Sphæra*, a sphere (dimin.).
Type.—*Sphæra Madridi*, d'Archiac.

Shell globose or subglobose, nearly or quite equilateral, with free margins closed and smooth within; surface with concentric striæ or sulci;

hinge provided with two diverging cardinal teeth in each valve (the anterior being somewhat extended horizontally), but without lateral teeth; muscular impressions shallow, not elongated; pallial line simple.

This genus is distinguished from *Corbis* by its want of lateral teeth, as well as by its more globose form, and smoother surface. It seems to have been introduced during the Triassic period, and occurs in the Jurassic, from which latter the typical species was obtained. Its existence during the deposition of the Cretaceous rocks is not yet positively determined; though we meet with imperfectly-known forms in rocks of that age, that are referred provisionally to it, until specimens can be found showing their generic characters. Its reference to the *Lucinidæ* is only provisional.

Sphæriola? cordata, M. & H.

Plate 29, figs. 3, *a*, *b*, *c*.

Cyprina cordata, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 143.
Bucardia? Moreauensis, Meek and Hayden (1860), *ib.*, XII, 427.
Glossus? Moreauensis, Gabb (1861), Cat. Cret. Fossils, 125.

Shell thick, globose, very gibbous, higher than long; sides and base rounded; beaks elevated, pointed, and curved somewhat obliquely forward and inward, very nearly central; muscular impressions broad-oval, faintly marked; pallial line distinct and forming a regular curve, parallel to the base, in passing from the anterior to the posterior muscular scars. Surface with distinct concentric striæ, and stronger marks of growth. Hinge unknown.

Length, about 1.66 inches; height, 1.80 inches; convexity, 1.50 inches.

The unsatisfactory condition of the only specimen of this shell yet seen renders the determination of its generic characters very difficult and uncertain. Being mainly an internal cast with portions of the shell attached, it gives little or no idea of the nature of the hinge, beyond the fact (recently determined by the removal of some adhering portions of the shell about the hinge) that it has no lateral teeth. The muscular impressions, as left on internal casts, are also seen to be very shallow and not elongated, and the pallial line to be certainly simple. In first indicating it, we thought that possibly it might be a gibbous form of *Cyprina*, and referred it, as stated at the time, provisionally only, to that genus. Subsequently, feeling quite convinced that it at least could not be properly retained in the genus *Cyprina*, we removed it, with a mark of doubt, to the genus *Bucardia*, more properly

Glossus (= *Isocardia*); and in doing this it became necessary to use another specific name, *cordata* having been previously applied to another species of that genus in Europe.

Since ascertaining, as above stated, that this shell certainly has no lateral teeth, either anterior or posterior, it becomes equally evident that it can no longer be properly retained in the genus *Glossus;* but I confess that I am still unable to locate it with any degree of confidence in any of the described genera. On the whole, it seems to agree, so far as its characters can be determined from the only specimen yet seen, about as well with Dr. Stoliczka's genus *Sphæriola*, to which I have provisionally removed it, as with any of the described groups. When specimens can be examined, however, showing the hinge, it is quite as probable, and perhaps even more so, that it will be found to present different generic characters, and possibly to belong to an undescribed genus. I would be inclined to refer it to *Sphærella*, if the muscular impressions were more elongated and the shell thinner. On the other hand, it seems to be about as apt to belong to d'Orbigny's genus *Unicardium*.

Locality and position.—Moreau River; from the Fox Hills group of the Upper Missouri Cretaceous series.

Sphæriola? Warrenana, Meek.*

Shell globose, rather thick; anterior and posterior margins regularly and subequally rounded, and each rounding into the more broadly rounded or semicircular base; beaks moderately prominent, gibbous, nearly central, and incurved, with little obliquity; surface marked by concentric striæ; muscular and pallial impressions faintly marked.

Height and length, each about 1.55 inches; convexity, 1.42 inches.

The only specimen of this shell yet found, is, like that of the last, merely an internal cast, with portions of the shell adhering. It gives no idea of the nature of the hinge, beyond the fact that it has no lateral teeth It will be readily distinguished, however, from that shell, specifically, by its less elevated beaks and greater thickness.

A portion of the left valve remaining shows a marginal furrow behind the beaks, apparently for a narrow, rather long, external ligament. In regard to its generic affinities, I can only repeat what has been said respecting the rela-

* Unfortunately, no figure of this species was prepared.

tions of the last-described species; that is, that the only specimen known is not in a condition to warrant any satisfactory conclusions on that point. Consequently, it is only referred to the same genus with great doubt, merely provisionally, until better specimens can be procured for study and comparison.

The specific name is given in honor of General G. K. Warren, of the United States Topographical Engineers, among whose collections (obtained during one of his exploring expeditions) the type-specimen was found. I have had it under consideration for many years, without attempting to describe it, hoping that better specimens, giving some knowledge of its hinge-characters, might be found.

Locality and position.—Near the eastern base of the Back Hills; from the Fox Hills group of the Upper Missouri Cretaceous series.

Sphæriola? endotrachys, Meek.

Plate 29, fig. 2.

Shell rather thin, orbicular, ventricose, about as high as wide; anterior, posterior, and basal margins regularly rounded; dorsal margins sloping and rounding off nearly equally each way into the lateral; beaks elevated, central, and incurved, with but slight obliquity; muscular impressions very shallow, rather large, the posterior ovate, and the anterior trigonal-subovate; interior surface within the pallial line roughened by irregular projecting asperities that leave the surface of internal casts distinctly pitted; external surface marked by rather distinct, irregular, concentric furrows and striæ.

Length, 1.50 inches; height, 1.45 inches; convexity, about 1.08 inches.

This species will be readily distinguished from the last, which it most nearly resembles in form, by its rather decidedly thinner shell, less gibbous valves; and particularly by the peculiar rough character of its interior within the pallial line. This latter character is strongly marked in all three of the specimens seen; while no traces of anything of the kind are observed in either of the previously-described species. Like those shells, this is merely placed in this genus provisionally, nothing being known of its hinge-characters, excepting that it has no lateral teeth.

Locality and position.—Ninety miles below Fort Benton, on the Missouri; from Cretaceous beds holding a position in the very upper part of the Fox Hills group.

TANCREDIDÆ.

Genus TANCREDIA, Lycett.

Synon.—*Donax*, *Mactra*, &c. (sp.), Dunker, Deshayes, d'Orbigny, and others.
Tancredia, Lycett (1850), Ann. Mag. Nat. Hist., VI, 407.—Morris and Lycett (1853), Moll. Great Oolite, 90.—Meek and Hayden (1864), Palæont. Upper Mo., 95.—Stoliczka (1870), Palæont. Indica, III, 132.
Hettangia, Terquem (1852), Statist. Géol. Minéral. et Palæont. du Départ. de la Mus., Atlas, 14; and (1853), Bull. Soc. Géol. Fr., X (2e sér.), 364.

Etym.—Dedicated to Sir Thos. Tancred.
Type.—*Tancredia donaciformis*, Lycett.

Shell transversely subovate or subtrigonal, moderately convex, or more or less compressed, without a defined lunule; beaks usually subcentral; posterior side often shorter and wider than the other, and more or less truncated, sometimes gaping; anterior side generally more attenuated, and always closed; ligament small, short, and external; hinge with one obtuse cardinal tooth in each valve, fitting into a corresponding pit in the other, and sometimes a smaller second cardinal tooth at the anterior side of the pit of the right valve, and on the posterior side of that of the left; lateral teeth posterior, obtuse, near the cardinal, that of the left valve fitting into a furrow dividing that of the right; muscular impressions oval; the simple pallial line rather remote from the free margins, which are not crenate within; surface with only concentric markings.

This genus seems to be closely related to *Meekia* of Gabb, from the Cretaceous rocks of California, but differs in being closed instead of gaping anteriorly, as well as in wanting the peculiar anterior angularity of that type; which also presents some differences in the nature of its hinge-plate, and is said to have its ligament subexternal instead of decidedly external.

The genus *Tancredia* dates back to the Liassic period; some ten or twelve species having been identified by Buvignier and Terquem in rocks of that age in France. So far as I am informed, it has not been recognized at any higher horizon than the Lias on the Continent; but in England it is only known to occur in the Lower Oolite. In America it appears to range still higher, the following species believed to belong to it being from the Cretaceous. In this country, however, it also seems to have made its first appearance during the Jurassic period. Up to this time it is unknown in the Tertiary, or among the *Mollusca* of the present period.

In regard to the family-affinities of this genus, rather widely different opinions have been expressed. In 1864, on comparing it and the allied genus *Meekia* with all of the different families that might be supposed to be more or less nearly related, and finding that, as these groups have been defined by the highest authorities on conchology, these shells could not be admitted into any of them, I proposed to separate them provisionally in a distinct family to themselves, until, as stated, "the affinities of some allied extinct types can be better determined." For this, I have been rather freely criticised by Dr. Stoliczka, of the Indian survey,* who places *Tancredia* in the *Donacidæ*, and yet doubtfully refers, for some incomprehensible reason, the very closely-allied genus *Meekia* to the *Trigoniidæ*.

In this connection, it is only necessary for me to remark that at least quite as good authorities have placed *Tancredia* in several other more or less widely removed families. For instance, Terquem thought it most nearly allied to the *Cardiidæ*, to which Pictet and some others refer it. Woodward, on the contrary, includes it doubtfully in the *Lucinidæ*, under which the well-known and able conchologist, Dr. P. P. Carpenter, mentions it in his Smithsonian lecture. Again, Chenu places it in the *Isocardiidæ*, while, as already stated, Dr. Stoliczka insists that it belongs to the *Donacidæ*. From this very diversity of opinion, however, it must be evident that this genus presents a peculiar combination of characters that renders the determination of its family-affinities quite difficult.

The objections to placing it with the *Donacidæ* are not only its simple pallial line, but also the fact that in some of the species the valves are clearly gaping behind; that is, not merely a little parted, as we often see in the *Tellinidæ*, but show a decided gape, with the margins closed together above and below the hiatus. I am well aware that these are not necessarily *always* family-characters; but every naturalist knows that a peculiarity which in one group is scarcely of generic importance, may in another form a constant family-character. All of the existing genera that are known by the anatomy of the animal to belong to the *Donacidæ*, have a well-defined, and generally large pallial sinus, and closed valves; and the group is so characterized by the best authorities on conchology. Indeed, Dr. Stoliczka's own description of the family *Donacidæ* would exclude *Tancredia*, as he distinctly states, in describing this family, that the shell is "always strong and solid, *closed at both*

* Palæont. Indica, III, 132.

ends"; and also, that "the pallial sinus is *deep, extending in the elongated forms like Hecuba or Iphigenia, horizontally;* in *Donax* and others it is ascending and dilated."

I think, therefore, from all that is yet known in regard to the characters of *Tancredia*, that its provisional arrangement as the type of distinct family is at least quite as apt to be correct as its introduction into a family in which a decidedly and generally largely sinuous pallial line, and closed valves, are conspicuous features. Indeed, I know of no reason for placing it in the *Donacidæ*, excepting the general external similarity of some of the species to *Donax;* and that this is not always a reliable means of deciding the question in regard to the family-affinities of shells, is, to say nothing of other cases, strikingly illustrated by Dr. Stoliczka's reference of *Tellinomya*, Hall, to the *Anatinidæ**, and *Cleidophorus* to the *Solemyidæ*, when it is now well known that both of these genera have crenated hinges, and belong to the *Nuculidæ;* although some of the species of the former agree more nearly in *form* and *general external appearances* with some types of the *Anatinidæ*, than with the usual forms of the *Nuculidæ*. Nevertheless, as long back as 1857 (see Canadian Naturalist of that year), Professor Hall fully illustrated the hinge of this genus, and showed it to be clearly crenated in the *type-species, T. nasuta* as well as in *T dubia* and *T. cuneata;* while a number of the other species referred to this genus are known to possess the same hinge-characters. The same has also more recently been determined with regard to even the type species of *Cleidophorus*.

Tancredia Americana, M. & H.

Plate 38, figs. 1, *a, b, c, d, e, f, g, h.*

Hettangia Americana, Meek and Hayden (Nov., 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 274; and (1860), *ib.*, XII, 185.

Shell thick, ovate-subtrigonal, moderately gibbous in the umbonal region; posterior end broader than the other, obliquely truncated and gaping above, rather narrowly rounded or subangular below; anterior half narrow, compressed, and presenting a more or less rostrated aspect, subangular, or very narrowly rounded at the extremity; basal margin forming a broad semi-ovate curve, being more prominent posteriorly and in the middle, than toward the front; dorsal border elevated in the region of the beaks, from which it

* Palæont. Indica, III, 62 and 326.

slopes forward with a slightly concave outline, while it is convex just behind the beaks, thence declining abruptly; beaks small, rather approximate, located a little behind the middle of the shell. Surface marked by fine lines of growth, and sometimes a few, faint, irregular, stronger, concentric furrows.

Length, 2.63 inches; height, 1.76 inches; breadth, 1.25 inches.

Although none of our specimens of this interesting shell are entire, they are quite sufficient to leave little room for doubts respecting its generic relations; and, when taken together, illustrate very satisfactorily most of its generic and specific characters.* Two of our specimens show the hinge of the left valve, which is provided with one rather strong, obtuse, cardinal tooth, slightly in advance of the point of the beak; while just behind this tooth, and immediately under the beak, there is a distinct pit for the reception of a similar tooth in the other valve. The cardinal edge immediately back of the pit is thickened, so as to form a second, but less prominent, sometimes rather undefined, cardinal tooth. Still farther back, and just at the upper termination of the lanceolate hiatus, formed by the gaping of the valves, the edge projects so as to form a more or less prominent, obtuse, and compressed lateral tooth, or callus.

The pallial line is very faintly marked, and cannot be distinctly seen along its entire course in any of our specimens, though on one internal cast it may be traced far enough to leave scarcely a doubt of its being simple.

The anterior muscular impression, as seen in relief on this cast, is very narrow, ovate, and located near the upper margin, a little farther removed from the beaks than from the anterior end of the shell. The posterior muscular impression was probably more faintly marked, as it is not visible on this cast.

In form and general appearance this species resembles *Donax securiformis*, Dunker (Palæont. 1, p. 36, pl. vi, fig. 12–14), which, as M. Terquem has shown, is a true *Tancredia* (= *Hettangia*). It differs, however, in being a larger and thicker shell; and its anterior end is longer and more distinctly rostrate, while the posterior extremity is less angular. It is perhaps quite as nearly related to *Tancredia* (*H.*) *Dionvillensis* and *Tancredia* (*H.*) *angusta*, Terquem (Bull. Soc. Géol. Fr., X, 2e sér., p. 375, pl. 1, fig. 1–4, and p. 370, pl. 2, fig. 11–13), but it is a larger and thicker shell than either, and will be readily distinguished by its narrower anterior and rather

*The hinge of the right valve, however, is yet unknown.

more rounded posterior extremities; the beaks are also located proportionally farther back.

It is a remarkable and interesting fact that this, the first of the species believed to belong to this genus discovered in America, is found in a Cretaceous rock associated with a *Baculite;* while all the known congeners in the Old World occur in the Lias and Lower Oolite.

Locality and position.—Mouth of Judith River, on the Upper Missouri, in a Cretaceous bed holding a position in the very upper beds of the Fox Hills group. The occurrence of this type at this locality, at one time, gave origin to the suspicion that these beds might be of Jurassic age; but later collections show that *Baculites* and other decided Cretaceous types occur directly in the same association.

Since the above was in type, Dr. Hayden has brought this species from a locality on Cache La Poudre River, in Colorado, where it occurred associated with other species found at the Upper Missouri locality.*

GLOSSIDÆ.†

Genus CYPRINA, Lamarck.

Synon.—Cyprina, Lam. (1812), Extr. d'un Cours., * *; and (1818), Hist. Nat., V, 556 (2e éd.), VI, 287.—Férnss. (1821), Tab. Syst., xliv.—Blainv. (1825), Malac., 552.—Desh. (1830), Encyc. Méth., III, 45.—Agassiz (1839), Monl. d. Moll., 36.—Reeve (1841), Conch. Syst., I, 90.—G. B. Sowerby, jr. (1842), Conch. Man. (2d ed.), 134.—Geinitz (1846), Gr. d. Verst., 436; and of numerous others.

Arctica, Schum. (1817), Ess., 145.

Etym.—κύπρις, a name of Venus.

Type.—Venus Islandicus, Linn.

Shell transversely oval or suborbicular, inequilateral, solid, generally rather convex; free margins closed, and smooth within; surface concentrically striated, and covered with a dark, thick, corneous epidermis; ligament prominent, and attached to strong fulera; beaks obliquely, but not very

* In giving the locality and position of the other species from this same horizon in the Upper Missouri, on some of the preceding pages of this work, it is merely stated that they came from Cretaceous beds, the exact horizon of which remained undetermined. While these pages are going through the press, Dr. Hayden's collection of the past summer (1874), in Colorado, have just come in, and they show, as above intimated, that this formation is well developed there, on Cache La Poudre River, west of Greeley, where it is intimately associated with the upper beds of the Fox Hills group.

† Since seeing the illustrations of the genus *Venillicardia,* Stoliczka, and some other intermediate extinct forms, I am led to follow Deshayes and Dr. Stoliczka in including the genus *Cyprina* and its allies with *Glossus* (= *Isocardia*) in the one family, for which Dr. Gray's name *Glossidæ* may be retained. Like Dr. Stoliczka, however, I am very far from agreeing with Deshayes in including *Cardium* in the same family. Yet Dr. Stoliczka also includes in it several genera that seem to me to belong to distinct families.

strongly, incurved; lunule obsolete; hinge with three cardinal and one remote posterior lateral teeth in each valve; muscular impressions distinct, those of the pedal muscles being connected with the upper ends of the anterior adductor scars; pallial line well defined, simple, or sometimes subtruncated under the posterior muscular impression.

In this genus, the posterior cardinal tooth of the right valve is strong, very oblique, and provided with a more or less distinct mesial longitudinal furrow; while just in front of it there is a rather large, sometimes narrow, subtrigonal pit for the reception of the middle cardinal of the other valve. The anterior upper half of this pit is bounded by the comparatively small, compressed, middle tooth, directed more or less obliquely forward and downward. A little in advance of, and obliquely below, this middle tooth, and separated from it by a longitudinal furrow, or notch, is the small, usually subtrigonal, anterior cardinal of this valve; and in front of the latter occurs the more or less elongated pit for the anterior cardinal of the other valve.

In the left valve, the posterior cardinal tooth is narrow and very obliquely elongated; while the middle cardinal is short, more or less compressed, subtrigonal, and ranges nearly vertically. In front of the latter, the anterior cardinal is seen presenting an oval or slightly-elongated form, and ranging nearly at right angles to the middle tooth, parallel to the cardinal margin, so as to present somewhat the appearance of the anterior lateral in some types of *Callista*. The posterior lateral teeth are elongated parallel to the margins of the valves, that of the left valve fitting in a furrow above that of the right.

These lateral teeth, as well as the anterior cardinal tooth of the left valve, are sometimes marked with fine, regular cross-striæ, or the latter more or less corrugated.

We sometimes see Palæozoic shells referred to this genus, but it is almost morally certain that none of them really belong to it. A few of the Upper Triassic and some Jurassic species may possibly fall into this genus, but it is more probable that a critical comparison of their hinge-characters would show that most, if not all of them, present generic differences. In the Cretaceous, however, we do meet with species agreeing *exactly*, in all generic characters, so far as it is possible to determine by the shell alone, with this genus. *Most* of the Cretaceous species, however, that have been figured by d'Orbigny and others under the name *Cyprina*, show differences in the hinge-characters that place them properly in other allied groups.

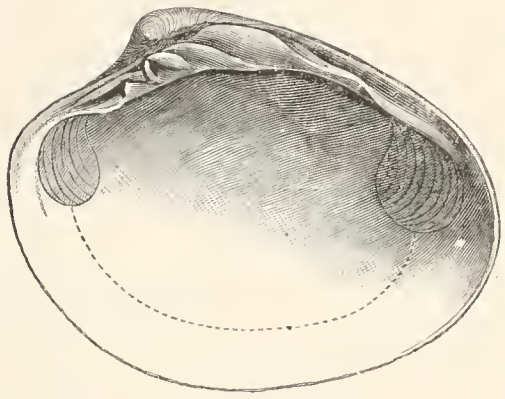
In the Tertiary rocks, we also meet with species of well-marked *Cyprina*, and it is probable that, as here defined, this genus attained its greatest development during the Tertiary epoch; though even then the species were not very numerous. At present, but the single typical species is known to inhabit our existing seas. It occurs in the Northern Atlantic, both on the American and European coasts, being generally found near where rivers empty into the ocean.

Cyprina ovata, M. & H.

Plate 29, figs. 7 *a*, *b*, *c*, and accompanying cut.

Cyprina ovata, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 144.

Fig. 8.



Cyprina ovata.

Hinge-view of right valve, to show details better than the figure on the plate. It is still faulty, however, in making the posterior cardinal tooth appear so deeply furrowed as to look rather like two teeth than one.

Shell transversely ovate, compressed or moderately convex, rather thin; extremities somewhat narrowly rounded; basal margin semi-oval; dorsal border declining with a gently convex outline posteriorly, and more abruptly in front; beaks not much elevated, rather small, moderately oblique, and located about half-way between the middle and the anterior end; surface marked by distinct lines of growth.

Length, 2.25 inches; height, 1.95 inches; convexity, 1.15 inches.

The only good specimen of this species that I have seen consists of a single right valve, which is entirely free from the matrix, and shows the hinge and other internal characters quite as distinctly as we usually see them in recent shells. Its hinge agrees almost *exactly* with that of the recent *C. Islandica*, from which the species differs mainly in being thinner, more compressed, and more transversely oval in outline. Its posterior muscular impression is broad-oval or subcircular, shallow, and apparently sinuous or indented on the inner side; while the anterior is narrower oval, and a little more deeply impressed. The small anterior pedal scar is well defined just above the anterior adductor, with which it is connected exactly as in the

recent typical species, presenting in this respect, apparently, a generic character, since in all of the more gibbous, oblique Cretaceous species more properly falling into the genus *Veniella* (= *Venilia*) that I have had an opportunity to examine, these two muscular scars are clearly disconnected. The pallial line is well defined, and a little straightened or truncated just beneath the posterior muscular scar.

Locality and position.—Mouth of Heart River; from the upper part of the Fox Hills group, or No. 5 of the Cretaceous series.

Cyprina ovata, var. compressa.

Plate 30, fig. 11.

Cyprina compressa, Meek and Hayden (May, 1857), Proceed. Acad. Nat. Sci. Philad., IX, 144.

Since describing this form as a distinct species, I have been led by further comparisons to regard it as probably only a variety of *C. ovata*, with which it was found associated. It agrees with that species in all respects, excepting in the greater elevation and more nearly central position of its beaks, which are also a little less oblique. These differences, however, are probably hardly of specific importance, especially since some fragments among the collections apparently indicate intermediate gradations of form. No good specimens of the more elevated form have yet been found.

Genus VENIELLA, Stoliczka.

Synon.—*Venilia*, Morton (1834), Synopsis Org. Rem. Cret. Form. U. S., 67.—Conrad (1854), Jour. Acad. Nat. Sci. Philad., II, 275; and (1860), *ib.*, IV, 282; also (1871), A. M. Jour. Conch., VI, 74.—Meek and Hayden (1857), Proceed. Acad. Nat. Sci., IX, 144.—Gabb (1861), *ib.*, 361.—Meek (1864), Smithsonian Check-List Cret. Foss. N. Am., 13 (not *Venilia*, Duponchel, 1829, or of Alder and Handcock, 1844).

Cyprina (sp.), d'Orbigny (1843), Paléont. Fr., III; and (1850), Prodr. de Paléont., II.—Stoliczka (1870), Palæont. Indica, III, 197 and 198 (not Lam. 1812).

Veniella, Stoliczka (1870), Pal. Ind., III, 189.

Venilicardia, Stoliczka (1870), *ib.*, 190 (as a subgenus of *Veniella*).

Etym.—*Venilia*, a mythological name.
Type.—*Venilia Conradi*, Morton.

Shell transversely ovate-oblong, trapezoidal or subquadrate, generally very gibbous, and distinctly inequilateral, with the posterior umbonal slopes elevated and angular, or prominently rounded, from the beaks to the posterior basal extremity, to which they impart a more or less angular outline; free margins closed, and smooth within; beaks gibbous, very oblique, strongly

incurved, and generally nearly anterior, or often overhanging the anterior margin; lunule nearly always well defined; ligament rarely projecting above the margins of the escutcheon on each side: surface marked by concentric striæ, and often regular concentric ridges, which sometimes develop into strong, more or less projecting varices; hinge with three cardinal,* and one remote posterior lateral teeth in each valve, the latter and the anterior tooth of the left valve being cross-striate; muscular impressions distinct; pedal muscular scars disconnected from the upper ends of those of the anterior adductors: pallial line well defined, and generally a little straightened under the posterior muscular impressions, but without any proper sinus.

Fig. 9. Fig. 10. Fig. 11.

Veniella Conradi, the type of Morton's genus.

Fig. 9 shows the exterior of the right valve of Morton's type-specimen, which is much fractured, but the pieces have been fastened together, and the drawing made without regard to the fractures.

Fig. 10 shows the hinge and interior of the same specimen.

Fig. 11 drawn from a negative photograph of the last figure, and consequently shows the nature of the hinge and interior of the left valve of the same species, approximately.

This group is made to include the following sections, which may possibly be generically distinct:

1. **VENIELLA**, Stoliczka (= *Venilia*, Morton; not of Duponchel, or Alder and Hancock).

Shell thin, or of moderate thickness, with posterior umbonal slopes prominent, angular, and imparting an angular outline to the posterior basal extremity; surface with more or less strong, concentric ridges or varices; hinge nearly as in *Cyprina*, or with middle tooth of left valve often more massive and trigonal.—(Type as stated above.)

* The middle cardinal is very small, or sometimes nearly obsolete.

2. **VENILICARDIA**, Stoliczka.

> Shell generally large, thick, and less angular in outline than the last, with umbonal slopes evenly convex, or merely prominently rounded, and surface concentrically striated: hinge with the posterior cardinal tooth of the right valve sometimes very strongly bifid, and at its anterior end curved downward; and the anterior cardinal of each valve long, flexuous, and at the posterior end tuberculur.—*Cyprina bifida*, Zittel.

The above characters of the cardinal teeth of *Venilicardia* were evidently taken by Dr. Stoliczka from *Cyprina bifida* of Zittel (which he seems to regard as the type of the group), and not from his own *V. obtruncata*, the only Indian species figured by him. The latter is a large, very gibbous, thick, subquadrangular shell, that has the posterior cardinal teeth much elongated, very oblique, entire, attenuated, and gently arcuated along their whole length. The middle cardinal of its left valve is also obliquely somewhat elongated, instead of being trigonal, as in the typical *Veniella;* while in the right valve it is also more oblique, and occupies a lower position than in the typical *Veniella*. It is likewise much larger than that of the same valve in his type of *Venilicardia*, in which, in fact, this tooth appears to be nearly obsolete, or only represented by a slight thickening of the anterior curved-down point of the posterior cardinal. On comparing the hinges of these two shells (*V. bifida* and *V. obtruncata*) as figured by Zittel and Stoliczka, it will be seen that the latter differs quite as decidedly from *V. bifida*, the type of *Venilicardia*, as that shell does from the typical *Veniella*. It is evident, however, that the hinge-teeth of the Cretaceous shells of this kind vary considerably in details, so that it is better not to make farther subdivisions until the extent of these variations can be determined by the examination of the hinges of other species.

Dr. Stoliczka also includes, as another subgenus under *Veniella*, a genus described by Munier-Chalmas, in 1863, under the name *Anisocardia*, the type of which is the Kimmeridge-clay (Wealden) species, *A. elegans*, M.-Chalmas. This is a circular shell, with elevated, rather pointed, nearly central, somewhat obliquely incurved beaks, and small but well-defined, regular radiating surface-costæ, and distinctly-crenated free margins within. Its hinge-margin is weaker, but the teeth of its hinge seem to be rather

nearly like those of the typical *Veniella*, excepting in some of the details. I am not very well acquainted with this shell, but its rounded form, central beaks, distinct radiating costæ, and regularly-crenate inner margins, altogether give it so different a physiognomy from either of the groups here described, that it seems to me rather typical of a distinct genus from both.

At any rate, if the type of *Anisocardia* is congeneric with *Veniella*, I do not see how the group to which it belongs can be placed as a subgenus under *Veniella*, unless it is done in defiance of the established rules of nomenclature, and the law of priority. Upon what principle of justice or propriety a new genus, regularly described and published in 1863, can be reduced to the rank of a subgenus under another published in 1870, is rather difficult to understand. If there is only a subgeneric difference between *Anisocardia*, 1863, and *Venilicardia*, 1870, the latter would have to stand as a subgenus under *Anisocardia*, and not the reverse. The fact that Dr. Morton had published in 1834, under the name *Venilia*, the same group that Dr. Stoliczka proposes to call *Veniella* (because *Venilia* was pre-occupied), does not alter the case, if we have to discard *Venilia*; since *Veniella*, Stoliczka, is an entirely new name, that only dates back to 1870. This conclusion, however, is too evident to require any argument beyond the mere statement of the facts.

In regard to the relations between *Veniella* and *Cyprina*, it may be desirable to say a few words. In the first place, it should be noted that, at the same time that Dr. Stoliczka recognizes Dr. Morton's proposed genus *Venilia* as distinct from *Cyprina*, and gives it a new name, wrongly characterizing it (from Dr. Morton's figure?) as having only two cardinal teeth in each valve, he actually refers the only two species he had, belonging to Dr. Morton's genus (*V. Forbesiana* and *V. cristata*), to *Cyprina*. These two shells, however, as stated by Mr. Conrad, are certainly, in all respects, true typical species of *Venilia*, Morton; and consequently, as *Veniella* was proposed *as a substitute* for *Venilia*, they must go into that group instead of into *Cyprina*.

That *Veniella* and *Cyprina*, however, agree quite nearly in their hinge-characters is certainly true. Yet, on comparison of our cuts of Morton's typical species of the former, it will be seen that in this type the hinge is more arched or bent in the middle, and that in its left valve the middle cardinal tooth is much more massive, more broadly trigonal, and more curved; while the small middle and posterior cardinal of its right valve are more distinctly connected above, and its anterior cardinal much more massive,

more conical, and more curved. I do not wish to conceal the fact, however, that the hinge of *Veniella* is found to vary more or less in these details of the teeth; another well-marked species from the Cretaceous of New Jersey, before me, having the anterior tooth of the right valve distinctly flattened, or compressed, and placed with its longer diameter parallel to the anterior margin of the valve, like that of the left valve in *Cyprina*. The middle tooth of the left valve is also not always so broad and triangular as in Morton's type-species, as is evident from Dr. Stoliczka's figures of his Indian species.

When we turn from the hinge, however, to the *ensemble* of other characters distinguishing these types, it becomes at once more obvious that they present strongly-marked differences. The very gibbous form, prominent, very oblique, strongly incurved, nearly terminal beaks, angular umbonal slopes, strongly costate surface, and generally deep and well-defined lunule and escutcheon, of the typical group of *Veniella*, are all in striking contrast with the true cyprinas. Again, in the latter, the anterior adductor muscular impression is directly connected with the pedal scar; while in *Veniella* proper, as well as in the subgenus *Venilicardia*, so far as I have been able to see, these scars are decidedly distinct.

I am led to give more weight to these differences, from the fact that they were as strongly marked, even as far back as the Cretaceous epoch, as at any time since. At least, we find our *Cyprina ovata*, from the Cretaceous, agreeing exactly in every respect with *Cyprina* proper, not only in all its hinge-characters, but in form, surface-markings, merely evenly convex valves, less prominent, more nearly central beaks, and even in having its pedal scars connected with the anterior adductors. Nor can it be argued that the *Venilicardia* group (which seems to include some Cretaceous species presenting very nearly the general form and other external characters, of *Cyprina*) forms an unbroken transition from *Veniella* to *Cyprina;* because the hinge of *Venilicardia*, so far as yet known, differs much more widely from that of *Cyprina* than that of *Veniella* does.

I should state here that, although adopting provisionally the name *Veniella* instead of *Venilia*, I am not altogether sure that this will be necessary. The change was made by Dr. Stoliczka, because Duponchel had used *Venilia* for a genus of *Lepidoptera* in 1829. It can hardly be considered a settled question, however, among naturalists, that a change is necessary in such cases, where the genera belong to different classes or subkingdoms;

though the tendency of opinion seems to be toward the adoption of such a rule, which I am inclined to favor. The reason for doubts, however, in this case, is, that *Venilia* of Duponchel itself, may prove to be a synonym. At least, some eminent entomologists regard it as synonymous with *Pseudopanthera*, Hübner, 1816; *Zerene*, Treitschke, 1825: and *Melanippe*, Boisduval, 1829; but many others consider it a good and distinct genus. If it should fall into synonymy, however, this would leave Morton's name to stand for the genus of shells under consideration, according to the rule followed by many naturalists.

In regard to the geological range of this genus, it may be remarked that the section *Venilicardia* seems to have existed as far back as the Jurassic epoch, ranges through the Cretaceous, and perhaps into the Tertiary. *Veniella* proper, however, is, so far as known, a Cretaceous group, and the fact that it does not range into the Tertiary, and is unknown in the existing seas, is another reason for regarding it as being distinct from *Cyprina*, which occurs with it in the Cretaceous, and ranges to the present time. Dr. Stoliczka criticises Mr. Conrad for speaking of *Venilia*, Morton, as a Cretaceous group only. In this, however, I think Mr. Conrad was right; for whether we regard that group, as he and I understand it, as a genus or a subgenus, it seems really to be confined to the Cretaceous.

Veniella goniophora, Meek.

Plate 4, fig. 1.

Fig 12.

Veniella goniophora.

An anterior view, mainly to show the convexity of the shell.

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 sharply 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.

Venicila Mortoni, M. & H.

Plate 4, figs. 3, *a*, *b*.

Venilia Mortoni, Meek and Hayden (1862), Proceed. Acad. Nat. Sci. Philad., XIV, 27.

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 very 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.

Venicila subtumida, M. & H.

Plate 17, figs. 5, *a*, *b*.

Cypriua subtumida, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 144.
Venilia subtumida, Meek (1864), Smithsonian Check-List North Am. Cret. Fossils, 13.

Shell rather small, transversely subovate, moderately gibbous; anterior side short, narrowly rounded below the beaks; base forming a broad, gentle curve, the most prominent part of which is usually in advance of the middle;

posterior side long and subtruncate at the extremity; dorsal outline nearly straight, or declining slightly, with a long, gentle curve from near the beaks posteriorly; beaks gibbous, very oblique or directed forward, not much elevated, located near the anterior end; umbonal slopes quite convex from near the beaks obliquely backward toward the lower part of the truncate posterior, but not angular; anterior muscular impression ovate, deep, and quite well defined; posterior one broader and very shallow; surface unknown.

Length (of cast), 0.92 inch; height, 0.65 inch; breadth, or convexity, 0.55 inch.

Our specimens being merely internal casts, with only portions of the inner lamina adhering, of course give no idea of the nature of the surface-markings, and none of them show the hinge. The shell has the general aspect, however, of a depressed *Veniella*, and the muscular and pallial impressions are as in that genus.

On the posterior side of the beaks, the internal cast is provided with a distinct, broad, lanceolate depression, bounded on each side by a rather prominent subangular ridge. This depression extends back nearly to the truncated anal end, and seems to indicate the existence of a rather strong hinge-margin, and well-developed posterior lateral teeth. The pallial line is quite distinct, and, instead of forming a regular curve in descending from the posterior muscular impression, passes first nearly straight downward, and then makes an abrupt turn forward parallel to the base.

Locality and position.—Yellowstone River: in beds containing a blending of the fossils of the Fox Hills and Fort Pierre groups.

Veniella (Venilicardia?) humilis, M. & H.

Plate 30, figs. 5, *a*, *b*, *c*.

Cyprina humilis, Meek and Hayden (May, 1860), Proceed. Acad. Nat. Sci. Philad., VIII, 179.
Venilia humilis, Meek (1864), Smithsonian Check-List North Am. Cret. Fossils, 13.

Shell transversely ovate, gibbous, thick, very oblique; anterior side scarcely extending beyond the beaks, abruptly rounded below; base semi-ovate in outline, most prominent toward the front, sometimes a little contracted behind; posterior side long, rounding obliquely with a broad curve from the dorsum to the postero-basal extremity, which is narrowly rounded; beaks very oblique, almost overhanging the anterior border, declining and curving inward at the extremities; lunule excavated, but not defined; umbonal slopes prominent from near the beaks obliquely backward

to the lower part of the anal margin, though not angular; surface marked by distinct lines of growth; ligament narrow and depressed.

Length, 1.70 inches; height, 1.34 inches; breadth, or convexity, 1.30 inches.

This is a quite thick, strong shell, and will be readily recognized by its oblique depressed form, its beaks and umbonal slopes ranging almost horizontally. Its strongly-marked anterior adductor scars are ovate and oblique; while the two little, disconnected, pedal scars above are very narrow, semi-elliptical, and range obliquely backward and upward parallel to the margins of the valves. The posterior muscular impressions are subcircular and very shallow.

None of the specimens show the entire hinge, but from fragments it can be seen to be rather strong. The anterior lateral tooth of the left valve is somewhat compressed and cross-striated One fragment shows the three cardinal teeth of the right valve distinctly; they are very similar to those of true *Cyprina*, excepting the larger size of the triangular pit between the anterior two for the reception of the large tooth of the other valve.

This species is evidently nearly related to the last, but it is much larger, and not so distinctly truncated behind. Its anterior muscular impressions are also deeper, and its anterior ventral region more cuneate. This latter character is most observable in internal casts.

Cyprina intermedia, d'Orbigny (Palæont. France, III, 107, pl. 278, figs. 1–2), is also an allied form, but our shell is more depressed and oblique, and its posterior muscular impressions are located farther back, and differ in being nearly circular instead of elliptical; the beaks also appear to be more prominent and pointed in casts than those of d'Orbigny's species.

I place this shell doubtfully in the group *Venilicardia*, from its rounded umbonal slopes and general dissimilarity in form to the typical section of *Veniella*. So far as its hinge-characters have been made out, however, they agree much better with the latter than with *Venilicardia*. Its pedal scars are disconnected from those of the anterior adductors, thus differing from those of *Cyprina*.

Locality and position.—On a branch of Cheyenne River, near the Black Hills; Fox Hills group, or No. 5 of the Upper Missouri Cretaceous series; also, in the very upper beds of the same group on Cache La Poudre river, in Colorado.

CYRENIDÆ.

Genus CYRENA, Lamarck.

Synon.—*Cyrena*, Lam. (1818), Hist., V, 551, *bis*; and 2d ed., VI, 271.—Schweigg. (1820), Natgsch., 707; (as a subgenus of *Cyclas*).—Férussac. (1821), Tab. Syst., xliii.—Blainv. (1824), Dict. Sci. Nat., XXXII, 336; and (1825), Malac., 552, (as a subgenus of *Cyclas*).—Broun (1838), Leth., 598.—Hinds (1844), Voy. Sulph. Zoöl., 66; (as a distinct genus).—H. and A. Adams (1857), Genera Recent Moll., II, 545, (as a distinct genus).—Prime (1860), Synon. Fam. Cyclades, Proceed. Acad. Nat. Sci. Philad.; and (1864), Ann. Lyc. Nat. Hist. New York, VIII, 83; also (1865), Smithsonian Miscell. Coll., 11, (as a distinct genus).

Cyanocyclas, Férussac. (1818), Dict. Sci. Nat., XII, 280.

Polymesoda, Rafinesque (1820), Monogr. Bivalves (as subgenus *Cyclas*).

Gelonia, Gray (1842), Synon. Brit. Mus., 79 and 91.

Egeta, H. and A. Adams (1858), Genera Recent Moll., II, 651 (as subgenus *Cyrena*).

Etym.—κυρήνη, the name of a nymph.

Examp.—*Cyrena Ceylanica*, Chemnitz (sp.).

Shell generally thick, suborbicular, or more or less transversely oval, usually gibbous; surface concentrically striated; beaks often eroded; hinge with three cardinal teeth in each valve, the anterior one of the right valve and the posterior of the left being smaller, and the others bifid; lateral teeth remote, smooth, more or less compressed, but not much elongated; pallial line with a small sinus, or nearly or quite simple.*

H. and A. Adams propose to divide this genus into two sections, or subgenera, as follows:

1. CYRENA, Lamarck (typical).

Shell solid, subcordate, gibbous, not much produced posteriorly.—(Type as above.)

2. EGETA, H. and A. Adams† (*Anomala*, Desh.; not Köppe).

Shell thin, and more or less ventricose; anterior side short; posterior produced and subrostrated.—*C. angulata*, Desh.

From *Corbicula*, with which palæontologists often confound this genus, it may be at once distinguished by its shorter, generally thicker, and always unstriate lateral teeth. It is more nearly allied in the characters of its hinge,

* Mr. Prime has called attention to the fact that, in the existing American species of this genus and *Corbicula*, the pallial line is always distinctly sinuous, the sinus being sometimes comparatively deep and sharply angular; while in foreign species it is but slightly, or sometimes not at all, sinuous. So far as I have had an opportunity to determine, all of our far-western fossil species, excepting *C. Dakotensis*, have a more or less distinctly sinuous pallial line; but in no instance have I seen the sinus so deep and sharply angular in the latter, as represented by Mr. Prime in some of the recent species.

† It will be observed that this section bears very nearly the same relations to the typical forms of the genus that the fossil group *Leptesthes* bears to the typical section of *Corbicula*. Indeed, *Cyrena* (*Egeta*) *Floridana*, Conrad, resembles quite closely, in form and external appearances, *Corbicula* (*Leptesthes*) *fracta*, M.

as well as in the larger size of some of the species, to *Batissa*, but differs in having shorter, and smooth, instead of striated, lateral teeth. From *Velorita*, it will be distinguished by the more gibbous, obliquely-cordate form of the latter, which also differs in having its lateral teeth finely striated, and the anterior one more nearly approaching the front cardinal tooth. All three of the cardinal teeth in *Velorita* are also directed more obliquely backward than we usually see in *Cyrena*.

Several species having the form and external characters of *Cyrena* have been described as such from Jurassic and older rocks; but as their hinges and internal characters are unknown, it remains to be determined whether they belong to this genus or not. Many species have also been described under the name *Cyrena*, from the Wealden of England and Germany; but at the time these species were published by Sowerby, Roemer, Dunker, and others, little or no attention was generally paid to the distinctions between *Cyrena* and *Corbicula;* all such shells being then (especially to palæontologists) known under the name *Cyrena*. So far as can be determined from the published figures of these shells that show the hinge, they seem all to have the elongated, linear, lateral teeth of *Corbicula*, and consequently cannot, with possibly a few exceptions, belong to the genus *Cyrena* as now understood by conchologists. It is also worthy of note that these Wealden species are generally figured, and indeed have been described by Dunker, as if they have but two instead of three cardinal teeth to each valve. If there is no mistake about this, they could not be properly included in *Corbicula*, or any of the other described genera of this family; but would constitute a distinct and unnamed genus. As has been remarked by Stoliczka, however, it is possible that they may have the third anterior cardinal tooth of the right valve, and posterior of the left (which in *Corbicula* are often very small), present in a rudimentary condition, and thus not differ generically from that group; or possibly, in some cases, they may fall into the genus *Velorita*, with which some of them nearly agree in form.

The genus *Cyrena* was undoubtedly represented during the Tertiary epoch, and probably attains its greatest development at the present time. The species are found in the brackish waters of tropical regions, in Central and South America, Australia, India, Africa, China, Islands of the Pacific, &c. Both of the sections here recognized were represented during the deposition of the Tertiary rocks, and still exist.

Cyrena Dakotensis, M. & H.

Plate 1, figs. 1, *a, b, c, d, e, f.*

Cyprina arenaria, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., 143.
Cyrena arenaria, Meek (1864), Smithsonian Check-List Cret. Moll., 13 (not *C. arenaria*, Forbes).
Cyrena Dakotensis (Meek and Hayden, MS.).—Prime (1865), Monogr. Am. *Corbiculida*, 31.

Shell subcircular, or very broad-subovate, moderately convex; anterior and posterior margins rather abruptly rounded; base forming a semi-oval curve; dorsal outline sloping from the beaks, the anterior slope being abrupt, a little concave, and the posterior convex. Beaks rather elevated, and subcentral; anterior muscular impression narrow-ovate, well defined; posterior broader and more shallow. Pallial line distinct, nearly simple, or very faintly sinuous just beneath the posterior muscular scar. Surface marked by more or less distinct concentric striæ.

Length, 1.20 inches; height, 1 inch; convexity, about 0.58 inch.

I have seen no very good specimens of this species; all of those yet found being casts of the exterior and interior. In first describing it, we referred it to the genus *Cyprina*, mainly from its form and general appearance. Some casts of the interior subsequently obtained, however, show that its hinge-characters, so far as they can be made out, differ from those of *Cyprina*, and agree much more nearly with those of *Cyrena;* and that its pallial line is also faintly sinuous. Consequently, I referred it to *Cyrena* in the Smithsonian Check-List; but, in making this change, inadvertently overlooked the fact that Professor Forbes had previously used the specific name *arenaria* for a species of that genus. Subsequently, however, I noticed that this name had been previously used in the genus *Cyrena*, and adopted the name *C. Dakotensis* for our shell, in manuscript; and on informing Mr. Prime of this fact, he very properly inserted the description of the species under that name in his valuable Monograph of the *Corbiculidæ*.

It is possible that, when better specimens can be found, this shell may prove to belong to some other genus, as it occurs associated with the marine types *Axinæa* and *Mactra*. Still, we also find, in the same association, a species having all the external characters of the estuary genus *Pharella;* while the rock is a coarse sandstone, containing many leaves of trees, some silicified wood, &c., just as we might expect would occur in a

shore-deposit, into which brackish-water shells might readily be carried and deposited along with marine forms.

Locality and position.—Mouth of the Big Sioux River, on the Missouri; in the Dakota group of the Upper Missouri Cretaceous series.

Genus CORBICULA, Mühlfeldt.

Synon.—Corbicula, Mühlfeldt (1811), Berliner Mag., V, 56.—Blainville (1825), Malac., 552 (as section *Cyclas*).—Rang (1829), Man., 313 (as a subgenus of *Cyrena*.)—Nyst (1838), Bull. Acad. Bruxelles, * *.—H. and A. Adams (1858), Genera Recent Moll., II, 447.—Prime (1860), Proceed. Acad. Nat. Sci. Philad., 267; and Annals Lyceum N. H., N. Y., VII; also (1863), Cat. *Corbiculidæ*, 3; and (1864), Notes on Species of the *Corbiculidæ*, with figures, Ann. Lyc. N. H., N. Y., VIII, 57.

Cyrena (part), of many, but not of Lamarck, as now restricted.

Etym.—Corbicula, dim. of *corbis*, a twig-basket.
Examp.—C. fluminea, Müller (sp.).

Shell usually solid, varying according to the species and sections from subtrigonal to suborbicular, or transversely subovate, and presenting a more or less cordate outline, as seen in a front or posterior view; valves closed; surface often concentrically furrowed; epidermis polished; hinge with three more or less bifid, diverging, cardinal teeth in each valve, the front in the right valve, and the posterior in the left, smallest, or sometimes nearly obsolete; lateral teeth much elongated, narrow, and finely striated transversely; pallial line with a more or less defined, sometimes very nearly obsolete, sinus.

It is quite probable that a critical study of the numerous extinct species that have been described under the general name *Cyrena*, by those who are not very particular in regard to generic distinctions, would bring to light sufficient reasons for the separation from that genus and *Corbicula*, of several groups, either holding the rank of distinct genera or subgenera. Not having at hand, however, the necessary materials for such a study, no attempt will be made here in that direction, beyond the notice of two sections that have already been proposed by the writer as subgenera under *Corbicula*. These were founded on species from brackish-water deposits in Wyoming Territory, belonging to the very latest of the Cretaceous or the oldest of the Eocene Tertiary age, and were published in Dr. Hayden's Report of 1872, under the names *Veloritina* and *Leptesthes*. These sections may be distinguished from each other, and from the typical forms of *Corbicula*, as stated below:

1 CORBICULA, Mühlfeldt (typical).

Shell orbicular-subcordate, or subtrigonal; surface generally concentrically sulcated: cardinal teeth not very oblique; laterals distinctly cross-striated, the posterior projecting out at right angles from the erect dorsal margin; ligament prominent.—(Example as already given.)

2. VELORITINA, Meek.

Shell thick, gibbous, obliquely cordate-trigonal; beaks elevated, obliquely incurved, and tumid; posterior umbonal slopes very prominently rounded; posterior dorsal margins strongly incurved; cardinal teeth typical, excepting in being more oblique; lateral teeth with striæ very minute or obsolete, the posterior one of the left valve often appearing as if merely formed by the beveled edge of the incurved dorsal margin; ligament small and depressed far below the elevated umbonal slopes: surface concentrically striated.—*Corbicula Durkeei*, Meek.*

3. LEPTESTHES, Meek.

Shell transversely elongate-subovate, compressed, typically extremely thin, very oblique; beaks depressed, subanterior; hinge-plate rather wide; cardinal and lateral teeth typical, excepting that the cross-striæ are very obscure or obsolete and the posterior lateral rather short and very remote from the cardinal, with a wide, flattened space intervening; surface concentrically striated.—*Corbicula? fracta*, Meek.†

Conchologists familiar only with the existing species of *Corbicula* would, in many cases at least, hesitate to admit either *Veloritina* or *Leptesthes* into that genus, even as marked subgenera; and I should certainly be inclined to give more importance to the peculiarities observable in these types, were it not for the fact that we find, among the numerous extinct species, forms that

* See figs. 6 to 6 *f*, pl. 16, Paleont. King's U. S. Geol. Survey Fortieth Parallel. Fig. 6 *c* of this plate, showing the hinge, is turned with the beak too much upward to give a correct idea of the obliquity of the cardinal teeth.

† It is an interesting fact, that this typical species, which was originally found in a black shale over a bed of coal, at Hallville, in the Bitter Creek beds of Wyoming, was recently brought by Dr. Hayden from a locality 200 miles east of Denver, Colorado, on the Kansas Pacific Railroad; where it was taken from a shaft, at a depth of 400 feet below the surface, from an exactly similar shale, over a bed of coal: thus indicating the existence of the Bitter Creek formation far out under the plains east of the Rocky Mountains, and the probable existence of a supply of good brown coal there.

seem hardly separable on any well-marked characters from *Corbicula*, a much greater diversity of form and other peculiarities, than are presented by the living species.

The type of the group *Veloritina* is a remarkably gibbous, trigonal shell, with the posterior dorsal margins so strongly incurved, and the umbonal slopes so very prominent on each side, that the posterior dorsal region presents a largely and profoundly sulcate appearance along its whole length. In several respects, particularly in the obliquity of its cardinal teeth and its trigonal solid valves, it agrees more nearly with *Velorita* than with *Corbicula;* but it differs materially from the type of the former genus in having its anterior lateral teeth (as well as its posterior) elongate-linear, as in *Corbicula.* It also differs from both of these groups in the strongly-incurved character of the posterior dorsal margins of its valves, and the depressed nature of its ligament, which is so deeply seated as to be entirely hidden by the very prominent posterior dorsal slopes, in looking at the shell from either side.

The type of the group *Leptesthes*, on the other hand, contrasts very strongly in form and general appearance not only with the typical section of *Corbicula* but also with the section *Veloritina;* being a transversely-subovate or subelliptic, compressed, extremely thin shell, more like some of the elongate forms of *Crassatella.* In form, it agrees much better with some of the transverse existing species of *Cyrena*, such as *C. Floridana*, Conrad, and *C. salmacida* of Morelet, than with living species of *Corbicula.* When we come to examine its hinge, however, we find that it has the elongated and striated lateral teeth of the latter genus.

It is not certainly known, I believe, that the genus *Corbicula* was represented during the Jurassic epoch; though some of the shells that have been figured from rocks of that age have the external appearance of this genus, and may possibly possess the hinge-characters of the same. Until their hinges can be seen, however, their relations to this genus must remain doubtful. In the Wealden of Europe, however, there are found numerous species that have been described under the name *Cyrena*, which, although showing a greater diversity of form than the living species, and apparently some slight differences in the cardinal teeth, seem, in part at least, scarcely distinguishable generically from *Corbicula.** If these older species, however,

* Messrs. H. and A. Adams, in speaking of the geographical and geological range of the genus *Corbicula*, state (in vol. II, p. 417 of their valuable work on the Genera of Recent Mollusca) that "very numerous extinct forms occur in the Wealden of Europe and America." This, however, is an error, so

really have constantly but two cardinal teeth to each valve, as the figures seem to indicate, and as stated by the authors who described some of them, they will probably be found to belong mainly to one or more distinct groups.

In the Tertiary rocks, however, typical forms of the genus are certainly found; and it seems to have reached its maximum development in the muddy bottoms of the rivers and estuaries of the present time. The existing species are widely distributed in America, India, China, Africa, &c.

The types of the groups *Leptesthes* and *Veloritina*, as already stated, seem to come from near the junction of the latest Cretaceous and the oldest Tertiary. Although these groups appear to have no closely-allied representatives among living species, they certainly agree quite closely with European Eocene forms.

Corbicula? nucalis, Meek.

Plate 2, fig. 5, *a*, *c*.

Corbicula? nucalis, Meek (1872), Hayden's Second Report Geol. Survey of the Territories, 304.

Shell small, trigonoid-suborbicular, gibbous, the greatest convexity being a little above the middle; basal margin forming nearly a semi-elliptic curve; posterior subtruncated or rounded; anterior margin rather narrowly rounded, its most prominent part being below the middle; dorsal outline sloping rather abruptly, and nearly equally in both directions, with slight convexity of outline near the beaks behind, and about the same concavity in front; beaks nearly or quite central, incurved, with slight forward obliquity; posterior dorsal surface sometimes very slightly furrowed immediately behind the umbonal slope in internal casts; muscular impressions shallow, comparatively rather large, and arcuate-subovate in form; pallial line with a shallow, obtuse sinus. External surface unknown; that of cast smooth.

Length, 0.47 inch; height, 0.42 inch; convexity, 0.26 inch.

Impressions of the hinge of this shell left in the rock, show that it has, in the right valve, long, narrow, transversely-striated, double lateral teeth, as in *Corbicula*. The specimens of the impressions of the cardinal teeth are not so clearly seen, being mainly hidden behind the cast of the umbones in the only specimen that I have seen with this part of the hinge well preserved.

far as is yet known, in regard to the geological range of the genus in America. We at this time only know a few species from the Cretaceous of this country probably belonging to this genus, and these came from the *upper* portions of the system. I am not aware that any rocks have been, up to this time, certainly determined to belong to the age of the Wealden in America.

So far as they can be made out, they seem to be much as in the existing species of *Corbicula*, excepting that the anterior cardinal tooth of the left valve is directed almost horizontally forward instead of obliquely forward and downward; it is also much compressed from above and below, and very prominent, and curved upward. The corresponding tooth of the other valve is much smaller, and overlaps that of the right valve. Behind this prominent anterior cardinal tooth of the left valve, I think I have seen two other diverging and emarginate cardinal teeth, with pits for two corresponding diverging teeth in the right valve. The number and arrangement of the teeth of the hinge would, therefore, if correctly understood in the specimen, seem to be almost exactly as in *Corbicula*, with the exception of the rather more nearly horizontal direction of the anterior cardinal teeth, and the prominence of that of the left valve.

It is quite possible, however, that if we had specimens showing more clearly the cardinal teeth, we might find differences enough to warrant the establishment of a distinct section allied to *Corbicula*.

Locality and position.—Twelve miles southwest of Salina, Kansas; Dakota Group of the Upper Missouri Cretaceous series. Professor Mudge.

Corbicula? subtrigonalis, Meek.

Plate 2, fig. 6.

Corbicula? subtrigonalis, Meek (1872), Hayden's Second Geol. Report Survey Territories, 305.

Shell oval-subtrigonal, about one-fourth longer than wide, rather gibbous the greatest convexity being above the middle; basal outline forming a semi-elliptic curve; extremities rather narrowly and very nearly equally rounded; beaks somewhat depressed and very nearly central; dorsal outline sloping before and behind the beaks, the latter slope being convex and the former nearly straight. Surface only showing fine lines of growth. Pallial line with a small, obtusely-subangular sinus.

Length, 1.16 inches; height, 0.90 inch; convexity, about 0.66 inch.

The only cast of the hinge of this species I have seen is that of a left valve. It shows the impressions of the same elongated and striated lateral teeth seen in the last. The cardinal teeth, however, seem to have unfortunately been much injured by maceration or erosion before they left their imprint in the rock. It shows the mould of a prominent triangular anterior cardinal tooth in front, apparently like that of the last, and behind this there

are remains of two prominences that have the appearance of being casts of two somewhat diverging cardinal teeth in the right valve, with impressions for two other cardinal teeth in the left; hence, so far as can be made out, the teeth of the hinge seem to agree with those of the last-described species.* Specifically, however, this form differs from the last in its more depressed and transverse outline as well as in having its lateral extremities more nearly equal and more narrowly rounded; the posterior margin not being truncated as in the last.

Locality and position.—Same as last. Collected by Professor Mudge.

CARDIIDÆ.

Genus CARDIUM, Linnæus.

Synon.—*Cardium*, Linnæus (1758), Syst. Nat., 10th ed., 678.—O. F. Müller (1776), Zoöl. Dan. Prodr., xxx.—Fabr. (1780), Fauna Græenl., 409.—Brug. (1789), Encyc. Méth., I, 203.—Lam. (1799), Prodr., 86; and (1801), Syst., 119.—Oken (1835), Allg. Naturg., V, 314.—Philippi (1836), Moll. Sic., I, 49.—Agassiz (1839), Moul. de Moll., 35.—Swainson (1840), Malac., 373; and of nearly all later authors on conchology.

Acathocardia, Gray (1847).

Trachicardium, Mörch (1853), Cat. Yoldi, 53.

Cerastoderma (Poli), Mörch (1853), *ib.*, 34.

Tropidocardium, Roemer (1868), Marteni and Chemnitz, Syst. Conch.-Kab., I, 13.

Criocardium, Conrad (1870), Am. Jour. Conch., VI, 75 (as a subgenus of *Cardium*).

Pectunculus (Adanson), Stoliczka (1870), Palæont. Indica (as a subgenus of *Cardium*; not Lamarck and others).

Etym.—καρδία, the heart.

Examp.—*Cardium aculeatum*, Linn.

Shell globose-cordate, or nearly vertically or somewhat obliquely suboval, rarely transversely suboval, of variable thickness; valves nearly equilateral, more or less gaping, and dentate or serrated behind, or closed and merely crenate along the free margins within; surface variously costate or striate, and often roughened by short spines, or other asperities; hinge typically with two cardinal teeth to each valve, so arranged as to cross when the valves are closed; cardinal and lateral teeth subject to more or less variation; pallial line nearly simple, or very slightly sinuous.

The foregoing diagnosis and synonymy are made to include a number

* Of course, if *all* of the indentations seen in the cast of the hinge figured were *natural*, this would certainly not be a *Corbicula*; but it is evident that these are partly due to the accidental erosion of the hinge before the shell was enveloped in the sand.

of subordinate groups, differing more or less from the typical form. These may be summarily characterized as follows:

1. CARDIUM, Linnæus (typical, = *Acanthocardium*, Gray).

   Shell subglobose, rather thick, nearly equilateral; cardinal teeth less strongly developed than the lateral; posterior gap nearly or quite closed; surface with radiating, more or less spinous, or tubercular costæ.—*Cardium aculeatum*, Linn.

2. PECTUNCULUS, (Adanson), Stoliczka; but not H. and A. Adams and others.

   Shell nearly as last, excepting in having smaller, more crowded, and smoother costæ.—*Cardium Asiaticum*, Lam

3. TRACHYCARDIUM, Mörch.

   Shell thick, subglobose, or nearly vertically suboval; hinge arched, with cardinal and lateral teeth strong; surface with numerous squamous, radiating costæ; posterior gap narrow, and often with more or less dentate margins.—*Cardium alternatum*, Sow.

4. CRIOCARDIUM, Conrad.

   Shell much as in the last, excepting in having spines or tubercles arranged in the furrows between the radiating costæ; and the posterior margins closed, and, like the free edges all around, merely crenate within.—*Cardium dumosum*, Conrad.

5. TROPIDOCARDIUM, Roemer (*Cardium* proper, of most authors).

   Shell rather thin, gibbous, cordate, nearly equilateral and erect, with hinge-line nearly or quite straight; posterior gap usually distinct, with margins dentate or serrate; cardinal teeth moderate; laterals compressed; surface ornamented with elevated, carinate, more or less spinous, radiating costæ.—*Cardium costatum*, Linn.

6. CERASTODERMA (Poli), Mörch.

   Shell transversely or more or less obliquely ovate-subcordate, convex, inequilateral; surface with thick, closely-arranged, radiating costæ; valves closed, and nearly or quite smooth posteriorly; hinge-teeth generally well developed.—*Cardium edule*, Linn.

7. NEMOCARDIUM, Meek.

> Shell closely resembling the typical forms of *Protocardia*, but thinner, with two-thirds to three-fourths of surface in front of the stronger posterior, usually echinate, radiating costæ, occupied by fine, crowded, radiating striæ, and the free margins crenate within all around; cardinal and lateral teeth generally rather slender; pallial line faintly sinuous, irregularly serrated, or nearly simple behind.—*Cardium semi-asperum*, Deshayes.

The foregoing is essentially the arrangement of H. and A. Adams, though I have added the group *Criocardium* of Conrad, and *Nemocardium*, and left out *Serripes*. The first of these is an extinct section, presenting the singular character of having spines or nodes arranged *in* the furrows *between* the costæ, instead of along the crests of the same; while the Eocene section *Nemocardium* forms a curious transition from the *Cardium* to the *Protocardia* group.* In regard to *Serripes*, it may be remarked that, although perhaps presenting no fundamental differences from the genus *Cardium*, it nevertheless seems, on account of its compressed transverse form, smooth surface, and sometimes obsolescent cardinal teeth, to have about as strong claims to rank as a distinct genus as *Lævicardium*, to which it is in several respects more nearly allied than to *Cardium* proper.

I have also viewed *Cardium aculeatum* as the typical form of the genus, instead of *C. costatum* (cited by H. and A. Adams and others as the typical species), thus making *Cardium* proper exactly identical with *Acanthocardium*, Gray. This seems to me to be necessary, according to the (in most cases good) rules adopted by the British and American associations; though the rule of taking the *first* species mentioned by an author in founding a genus (followed by many) would require *C. costatum* to be taken as the type, that being the first species in Linnæus' list. But, as he also included species belonging to *Lævicardium*, *Hemicardium*, &c., the most generally adopted rule requires that we should look to some of the systematists who first

* The *Nemocardium* section stands, as it were, so exactly intermediate in its characters between the *Cardium* and *Protocardia* groups, that it might, with almost equal propriety, be ranged as a section of either. Deshayes even places the nine Paris-basin species of this type under *Protocardia*, which he views as a section of *Cardium* proper. It differs from *Protocardia*, however, in having fine, radiating costæ, instead of concentric markings on the anterior two thirds of the valves, and the free margins crenate within all around, instead of only posteriorly; also in being thinner, and having a weaker hinge than is usual in the typical species of that group, as well as in the irregularly-serrated appearance of the pallial line posteriorly in some of the species.

followed, as deciding what species is to be the type of the genus, as Linnæus did not so designate any particular species.

If I am correctly informed, Müller, in 1776, first adopted *Cardium* after Linnæus, and, after him, Fabricius in 1780, both of whom cite first under it *Cardium echinatum* (an *Acanthocardium* of Gray). As these authors, however, were each only enumerating a local fauna, and not writing a systematic work on the mollusca, we can hardly regard them as fixing the type of the genus; and as Bruguière, in 1789, gave the genus by his citations nearly the same limits that Linnæus did, it seems that we must come down to Lamarck to know what the type of *Cardium* is. In 1799, the last-mentioned author adopted this genus in his classification of shells, citing *Cardium aculeatum* as his only example. So, unless some other systematic author that I have had no opportunity to consult, between Linnæus and Lamarck, may have taken *C. costatum* or some closely-allied form as the type of the genus, I should think *C. aculeatum* should be so regarded.

The genus *Cardium*, with the limits here assigned it, is, I believe, not certainly known to be older than the Jurassic, in which species of the typical section occur. This subgenus is also represented through the subsequent formations and in our existing seas The *Trachycardium* and *Criocardium* groups occur in the Cretaceous, in which the latter attains its greatest development, while it seems not to have survived the close of that epoch, or at least not to have been represented by decidedly characteristic species, at any subsequent time. The *Trachycardium* section, however, continued on through the Tertiary, and appears to attain its maximum numerical development in our existing seas. The subgenus *Cerastoderma* is at least as old as the Cretaceous, occurs in the Tertiary, and, according to some conchologists, is represented by twelve to fifteen existing species. *Tropidocardium*, however, is probably not older than the Eocene, and is at present only known to be represented by two or three living species; while *Nemocardium* seems to be nearly entirely confined to the Eocene Tertiary, the only Cretaceous species known to me that appears to belong to it, being *Cardium subhillanum*, Leymerie.

Cardium (Criocardium) speciosum, M. & H.

Plate 37, figs. 4, *a*, *b*, *c*.

Cardium speciosum, Meek and Hayden (Nov., 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 274.
Cardium (Acanthocardia) speciosum, Meek (1864), Smithsonian Check-List Cret. Fossils, 12.

Shell broad-ovate or subcircular, usually higher than long, very gibbous in the central and umbonal regions; anal margin slightly less rounded than the other; base regularly rounded; border crenulate?; beaks much elevated in old shells, but more depressed in smaller specimens, very slightly oblique, pointed, incurved, and almost exactly central; surface ornamented by numerous very regular, simple, radiating costæ, apparently about as wide as the grooves between, in each of which latter, on the more convex part of the valves, there is a series of small tubercles, very regularly arranged.

Length, 0.57 inch; height, 0.67 inch; breadth, 0.48 inch.

The surface-markings are not very well preserved in our specimens of this species, and consequently present some variety of appearances in their various conditions of weathering, even on different parts of the same individual. Sometimes the costæ appear as though broader than the grooves between; while in other conditions they seem to be about of the same breadth, or even narrower. Where the surface is much weathered, the costæ are often so deeply exfoliated as to leave the intermediate spaces standing out in relief, so as to present the appearance of having the tubercles arranged on the ribs instead of between them.

The tubercles do not exist on the anterior and posterior portions of valves, but occupy the grooves only on the more convex central region. None of our specimens are in a condition to show whether or not these tubercles were ever so prominent as to form short spines. On the interior, they seem to have been each represented by a corresponding pit, or depression, which leaves a distinctly elevated point on the cast. Where the exterior is exfoliated so as to leave but a thin lamina of the shell adhering to the cast, these little elevations are seen perforating it with such remarkable regularity, as to present the appearance and arrangement of the fenestrules in some of the delicate reticulate *Polyzoa;* this is the usual appearance of the surface of weathered specimens. In a few cases, where the surface is in a better state of preservation, traces of fine concentric striæ are visible, curving strongly upward in crossing the ribs.

This species is not liable to be confounded with any other shell yet discovered in any of the Upper Mo. rocks, and it seems to differ from all the otherwise similar forms known from other localities, in having the small tubercles in the depressions between the costæ of uniform size, instead of alternately larger and smaller.

Locality and position.—Mouth of Judith River, in a sandstone of Cretaceous age, believed to hold a position at the horizon of the top of the Fox Hills group. Numerous specimens of this species have also been found in the highest beds of the Fox Hills group, by Dr. Hayden, on Cache La Poudre River, Colorado.

Cardium (?) Kansasense, Meek.

Plate 2, figs. 14, *a*, *b*, *c*, *d*.

Cardium Kansasense, Meek (1871), Hayden's Second Ann. Report Geol. Survey of the Territories, 307.

Shell rather small, oval-suborbicular, being generally slightly higher than the antero-posterior diameter, and rather gibbous, with the greatest convexity usually above the middle; pallial margin rounded, or subsemicircular in outline, being in most cases more prominent behind the middle; anterior margin more or less regularly rounded; posterior outline rounded, or very faintly subtruncated; dorsal outline sloping abruptly from the beaks before and behind; beaks elevated, gibbous, incurved, and subcentral, or a little in advance of the middle, and but slightly oblique; posterior dorsal slopes somewhat flattened; surface marked by numerous regular, simple, radiating striæ, or small costæ, that are sometimes interrupted by marks of growth. Hinge strong, with cardinal and anterior lateral teeth stout; posterior lateral remote and less prominent. Anterior muscular scar rather deep; posterior shallow. Scar of pedal muscle (?) small, very deep, and situated on the inner anterior side, and near the points of the beaks, almost opposite the cardinal teeth, as shown at (*p* of fig. 14 *d*.)

Length, 0.94 inch; height, 1 inch; convexity, about 0.63 inch.

This and *Protocardia Salinaensis* are the two most common shells found at the locality where they were obtained, and being, like the other fossils with which they are associated, found in the condition of casts, not always showing even traces of the surface-markings, it is sometimes difficult to distinguish them. Where any remains of the surface-markings can be seen, however, they can be at once distinguished by the concentric costæ on the

sides and front of the former, and the radiating costæ on the corresponding parts of that under consideration. The latter seems also to have generally attained a somewhat larger size. The inner margins of both appear, from the casts, to be generally nearly smooth, though some of the casts of the form under consideration show faint traces of what seem to have been crenulations, near the middle of the base. (See fig. 14 *b*.) I at first thought the peculiar projecting point left by what I have supposed might be the scar of the pedal muscle, near the point of each beak of internal casts, might distinguish casts of the form under consideration; but this is also seen on some of the casts of the *Protocardia*, which, likewise, has the hinge-teeth very similar, so that the only sure means of distinguishing them seems to be the surface-markings. These markings are sometimes distinctly and sharply impressed in the matrix, and by taking gutta-percha impressions from these moulds, the nature of the ornamentation can be very clearly made out. No traces of nodes, or projecting points of any kind, exist on the costæ of this species. In some respects, it resembles *C. Cottaldinum*, d'Orbigny (Palæont. Fr., III, pl. 242), from the Neocomian; but it is rather more coarsely striated, and wants the posterior dorsal impression of that shell, from which it also differs in being less evenly convex.

Locality and position.—Twelve miles southwest of Salina, Kansas; in a ferruginous sandstone of the age of the Dakota group of the Upper Missouri Cretaceous series.

Genus PROTOCARDIA, Beyrich.

Synon.—*Cardium* (sp.), Sowerby, d'Orbigny, and many others; not of Linnæus.

Protocardia, Beyrich (1845), Zeitschr. f. Malak., 17.—Geinitz (1846), Grund. d. Verst., 421.—Quensted (1852), Index of Handb. der Petref., 784.—Conrad (1860), Jour. Acad. Nat. Sci. Philad., IV, 278 (as a subgenus of *Cardium*).—Meek and Hayden (1865), Palæont. Upper Mo., 98.—Roemer (1870), Geol. v. Oberschl., 334.—Conrad (1873), Supp. N. Car. Geol. Rep., 7.

Protocardium, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 418 (as a subgenus of *Cardium*).—Gabb (1869); Palæont. Cal., II, 187 (as a subgenus of *Cardium*).—Stoliczka (1870), Palæont. Indica, III, 209; and of several earlier and later authors.

Pachycardium, Conrad (1870), Am. Jour. Conch., V, 96.

Etym.—πρωτος, first; καρδια, the heart.
Type.—*Cardium Hillanum*, Sowerby.

Shell globose, subquadrate, or rarely vertically cordate-suboval, more or less gibbous; valves generally thick, closed behind; surface marked with radiating costæ or striæ on the posterior third or fourth, and concentric striæ or costæ, or sometimes nearly smooth on the sides and front; free margins

of valves more or less crenate within posteriorly, and smooth forward; hinge-teeth usually strong, and not differing from some sections of *Cardium*; pallial line with a small sinus.

This group includes three sections, that may be defined as follows:

1. PROTOCARDIA, Beyrich (typical).

   Shell thick, usually gibbous, or cordate-subglobose, with length generally nearly or quite equaling the height; hinge strong; surface-sculpturing usually well defined.—(Type as already stated.)

2. PACHYCARDIUM, Conrad.

   Shell very massive, much higher than long; valves very gibbous; hinge remarkably strong; surface-sculpturing rather obscure, the posterior radiating costæ being nearly obsolete.—*Cardium* (*Lævicardium*) *Spillmani*, Conrad.

3. LEPTOCARDIA, Meek.

   (*a*). Shell small, very thin, about as long as high; hinge weak; surface nearly smooth, the posterior radiating costæ being obsolete, or often only indicated by crenulations along the posterior third of the free margins within; pallial line with two shallow sinuses.—*Cardium subquadratum*, Evans and Shumard.

   (*b*). Shell higher than long, or agreeing more nearly in form with *Pachycardium*, but very thin.—*Cardium pertenue*, M. & H.

Mr. Conrad mentions some differences in the relative sizes and forms of the hinge-teeth of *Pachycardium* as distinguishing characters from *Protocardia*; but the species of the latter group vary in this respect so much, that I should think no great importance can be attached to these differences. In proposing the genus, he named the species cited above as the type, but also included the East Indian Cretaceous species *Cardium bisectum*, Forbes. Dr. Stoliczka, who has had an opportunity to study good specimens of the latter species, says that it agrees so exactly in all respects with *Protocardia*, that he does not think Mr. Conrad's proposed genus should be retained even as a subgenus. It may be that Mr. Conrad was a little unfortunate in including that shell; but his typical species contrasts so very strongly in form, with the usual outline of nearly all the well-marked species of *Protocardia*, that it seems to be entitled to be regarded at least as the type of a distinct subgenus.

I have been much puzzled in regard to the proper disposition of the little group of small, very thin species here placed under the new subgeneric name *Leptocardia*. These shells are generally so smooth, and show so little indications of the characteristic posterior radiating costæ, that there would often seem to be no traces of them, yet the posterior third of the free margins is always distinctly crenate within; while in front of this they are entirely smooth. In addition to this, traces of these costæ are clearly seen on the outer surface of some individuals of the same species. The curious character of having two little sinuses in the pallial line (see fig. 8, *e*, pl. 29) would also seem to favor the separation of this little group. Whether or not it should also include the subsection (*b*) cannot be *positively* determined until more is known in regard to the hinge and interior of that type.

Most authors have generally regarded *Protocardia* (or *Protocardium*, as the name is often written) as itself only forming a subgenus under *Cardium*, and it must be confessed that it scarcely differs more widely from some of the generally-admitted sections of that group, than the latter differ from the typical forms of *Cardium*. On the other hand, however, it seems to have even closer relations to *Lævicardium* than to *Cardium* proper. Indeed, if the recent species *L. lyratum*, Sowerby, and *L. colicum*, Born,* can be properly included, even in a subgenus, under *Lævicardium*, there would almost seem to be equally good reasons for placing *Protocardia* near it as another subgenus of the same group. The chief objection to this latter conclusion, however, is, that we cannot trace, or at least have not yet traced, the *Protocardia* group continuously through the Tertiaries, by an unbroken series, into the existing seas; though it is represented in the Eocene of this country and Europe by the *very* closely-allied group *Nemocardium*.†

This genus, so far as yet known, appears to have been introduced during the Liassic epoch. The species, however, were more abundant during the Cretaceous period, at which time the genus probably attained its maximum development.

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* Whether these two recent species can be properly retained in the genus *Lævicardium*, or should be referred to the more ancient group *Protocardia*, they certainly form a very marked subgenus, differing from *Lævicardium* proper in having radiating posterior striæ or costæ and oblique anterior markings; while they also differ from *Protocardia* in having the sculpturing on the anterior half of the valves oblique, and running out on the anterior margin, instead of being concentric, or parallel to the marks of growth. *Lyrocardium* would be a good name for this section.

† *Protocardia lima*, Conrad (Am. Jour. Conch., I, 139), from the Eocene of Mississippi, appears to be a true *Nemocardia*.

Subgenus **PROTOCARDIA.**

Protocardia Salinaensis, Meek.

Plate 2, figs. 13, *a*, *b*, *c*.

Cardium (*Protocardia*) *Salinaense*, Meek (1871), Hayden's Second Report Geological Survey of the Territories, 306.

Shell small, nearly orbicular, very slightly longer than high, rather gibbous; pallial margin forming a semicircular curve; anterior margin rounded, the most prominent part being at, or a little above, the middle, while below this it usually rounds off somewhat obliquely into the base; posterior margin broader, and sometimes slightly subtruncated, or merely broadly rounded; beaks rather depressed, convex, incurved, slightly in advance of the middle; dorsal outline sloping more abruptly in front than behind; posterior umbonal slopes not prominent. Surface ornamented on the sides and front by comparatively rather large, rounded, very regular concentric costæ, separated by smaller furrows; while sixteen to twenty smaller radiating costæ, roughened by very regular little vaulted prominences, formed by the marks of growth, occupy the posterior region of each valve.

Height, 0.66 inch; length, 0.68 inch; convexity, about 0.49 inch

This little shell is allied somewhat to *Cardium peregrinum*, d'Orbigny, and *C. Hillanum*, Sowerby. It is much smaller, however, than the latter, and has a different outline, not being so truncated behind, nor so regularly rounded anteriorly; while its concentric costæ are proportionally much larger and less numerous, and its radiating costæ are more roughened. In the latter character, it agrees more nearly with *C. peregrinum*. It also differs from the latter, however, in having proportionally much larger concentric costæ; and its radiating ribs are straighter, and occupy larger area of the valves. Its anterior outline is likewise less broadly and regularly rounded than in d'Orbigny's species.

Locality and position.—Twelve miles southwest of Salina, Kansas; Dakota group of the Upper Missouri Cretaceous series. Collected by Prof. B. F. Mudge.

Subgenus **LEPTOCARDIA**, M.

Section (*a*).

Protocardia (Leptocardia) subquadrata, E. & S. (sp.).

Plate 29, figs. 8, *a*, *b*, *c*, *d*, *e*.

Cardium subquadratum, Evans and Shumard (1857), Trans. Acad. Sci. St. Louis, I, 39.
Cardium (*Protocardia?*) *subquadratum*, Meek (1864), Smithsonian Check-List Cret. Fossils, 13.

"Shell small, subquadrangular, length greater than the height, gibbous; anterior margin rounded, posterior margin truncated, very slightly arched; umbones prominent, large, obtusely subangulated; beaks nearly medial, rather obtuse, and extending but little beyond the cardinal margin; substance of the shell thin; surface with fine concentric striæ of growth, waved and dentate posteriorly, where they are crossed by obscure longitudinal ribs.

"Length, $5\frac{1}{2}$ lines; height, $4\frac{3}{4}$ lines; thickness, nearly 4 lines."—(E. & S.)

Of this species, we have a number of very well preserved specimens, some of which show the hinge and other internal characters quite as well as they can be seen in a recent shell. The cardinal teeth are small and rather unequal, the posterior one in the right valve, and the anterior one in the left, being larger than the other. The lateral teeth are compressed, and also small; the anterior one in each valve being a little more prominent than the posterior.

Both muscular impressions are ovate and nearly of the same size; while the pallial line, which is quite distinct, instead of having one well-defined sinus, is merely waved behind, so as to form two faint sinuosities. The postero-ventral margins are rather distinctly crenulated within; the crenulations corresponding to the obscure radiating costæ of the posterior side, which do not extend forward quite to the middle of the base. These costæ are generally rather obscure, and on some individuals they are nearly or quite obsolete. The posterior umbonal slopes are quite prominently rounded, and just behind them the valves are rather abruptly compressed, so as to form an undefined groove, which extends from the back part of the beaks obliquely backward and downward.

Locality and position.—Moreau River, Long Lake, Fox Hills, &c.; from the Fox Hills group, or formation No. 5 of the Upper Mo. Cretaceous.

Protocardia (Leptocardia) rara, E. & S. (sp.).

Plate 17, figs. 1, *a*, *b*, *c*.

Cardium rarum, Evans and Shumard (1857), Trans. Acad. Sci. St. Louis, I, 39.
Cardium (Protocardia?) rarum, Meek (1864), Smithsonian Check-List Cret. Fossils, 12.

"Shell small, ovate-subquadrate, moderately gibbous, inequilateral; substance very thin, length and breadth nearly equal; cardinal edge short, somewhat sharp; beaks projecting above the cardinal margin, nearly medial, rather blunt, incurved; umbo oblique, somewhat gibbous, subangulated behind; buccal and pallial margins rounded; anal margin obliquely subtruncated; surface polished and marked with very fine, closely-arranged, concentric lines, crossed on the posterior side by nearly obsolete longitudinal ribs, becoming more prominent as they reach the border, which on this part of the shell is finely crenulated."—(E. & S.)

As suggested by Doctors Evans and Shumard, this species resembles, in its general form, their *C. subquadratum;* but it is more polished, much thinner, has less distinct radiating costæ behind, and more prominent beaks. Indeed, in our specimens, the radiating costæ are generally entirely obsolete, and the umbonal region is always more gibbous than in *C. subquadratum;* while its anal margin is more rounded in outline, and the valves not so compressed behind the umbonal slopes. In addition to these differences, the posterior muscular impression in the species now under consideration is much broader in proportion, and subquadrate instead of ovate. The pallial line is waved into about two shallow sinuosities behind, as in *C. subquadratum*.

Locality and position.—On the Yellowstone River, 150 miles above its mouth; where it is very abundant in a bed containing a mingling of the forms belonging to the Fox Hills and Fort Pierre groups.

Protocardia (Leptocardia?) pertenuis, M. & H.

Cardium pertenue, Meek and Hayden (1861), Proceed. Acad. Nat. Sci. Philad., XIII, 442.

Fig. 13. Fig. 14.

Protocardia pertenuis, M. & H.

Fig. 13. Right-side view.
Fig. 14. An outline anterior view, to show convexity.

Shell small, very thin, vertically broad-subovate, its height being a little greater than its breadth, very ventricose; anterior and basal margins rounding regularly together; posterior margin a little straightened and vertical near the middle, rounding to the hinge above and into the base below; beaks elevated, ventricose, central, and

incurved nearly at right angles to the hinge-line, which is short and arched; posterior umbonal slopes prominently rounded; surface ornamented by fine lines of growth and a few stronger concentric furrows, crossed on the posterior half of the valves by about fifteen to twenty, very obscure, radiating costæ, that impart a distinctly crenate character to the free margins within, as well as to some of the stronger marks of growth above the edge.

Height, 0.64 inch; antero-posterior diameter, 0.59 inch; convexity of the two valves united, 0.50 inch.

This species resembles the last two in the peculiarity of having its radiating costæ of the posterior side of the valves so faintly marked as almost to escape attention, were it not for the fact that they cause the free margins of that part of the valves, as well as some of the stronger marks of growth above the margin, to be distinctly crenate. It may be at once distinguished, however, from them both, by its much more elevated beaks, as well as by its decidedly thinner and more ventricose valves. It agrees nearly in form and surface-markings with the type of *Pachycardium*, though it still differs remarkably in its extreme thinness. It is more closely related, however, in form, as well as in having the entire posterior half of the valves occupied by the radiating costæ, to *P. bisectum*, Forbes, from the Cretaceous rocks of Southern India. As that species, however, is described by Stoliczka as being moderately thick, it must differ widely in that character from our species, which is almost as thin as common writing-paper; it also has its basal margin much less prominent behind, than that of *P. bisectum*.

Locality and position.—Deer Creek, on the North Platte; in the Fox Hills division of the Upper Missouri Cretaceous. Captain Raynolds's collection

VENERIDÆ.

Genus CALLISTA, Poli.

Synon.—*Callista*, Poli (1791), Test. Utr. Sic., I, 30.—H. and A. Adams (1857), Genera Recent Moll., II, 424.—Meek and Hayden (1861), Proceed. Acad. Nat. Sci. Philad., 443.—Chenu (1862), Man. Conch., 86.—Stoliczka (1870), Palæont. Indica, III, 150 (as a subgenus of *Cytherea*).

Meretrix and *Cytherea* of authors; but not of Lam. (1799 and 1805), as restricted to such forms as *V. meretrix*, Linn. (= *C. impudica*, Lam.).

Chione, Gray (1838), Analist, * *; and (1842), Synon. Brit. Mus., 74 and 95 (not Megerle von Muhlf., 1811).

Dione, Gray (1847), Zoöl. Proceed., 183.—Gabb (1861), Synop. Mol. Cret., 120.—Conrad (1862), Proceed. Acad. Nat. Sci. Philad., 572; and (1865), Am. Journ. Conch., I, 6; and *ib.*, 137.—Meek (1864), Smithsonian Check-List Cret. Foss. N. A., 1.3

Pitar, Roemer (1857), Kritische Unters. der Arten des Moll., 15; and (1862), Malakoz. Blätt., IX, 58.*

Caryatis, Roemer (1867), Monogr. der Moll., 79 (as a subgenus of *Venus*).—Stoliczka (1870), Palæont. Indica, III, 157 (as a subgenus of *Cytherea*; not *Caryatis*, Hubn. 1816, genus *Lepidoptera*).

? *Dosiniopsis*, Conrad (1864), Proceed. Acad. Nat. Sci. Philad., 213 (subgenus).

Amiantis, Carpenter (1865), Ann. and Mag. N. H., XV, 178 (as a subgenus of *Callista*).

Aphrodina, Conrad (1868), Am. Jour. Conch., IV, 246; and (1873) in Appendix Kerr's N. Car Geol. Report, 7.

Etym.—καλλίστη, most beautiful.
Type.—*Venus chione*, Linn.

Shell varying from transversely-ovate to elongate-ovate, subtrigonal, or subcircular, more or less convex, and inequilateral, with free margins closed, smooth, and often obtuse; hinge with three diverging cardinal teeth in each valve, the anterior two of left valve united at the apex, and one approximate anterior lateral under the lunule; rarely provided with a remote rudimentary posterior lateral tooth in one or both valves; pallial sinus generally deep, triangular, linguiform, or often abruptly pointed at the end; surface concentrically sulcated, striated, lamellose, or smooth; sometimes with more or less angular posterior umbonal ridges that rarely bear spines.

This genus, as here defined, is intended to include the following sections:

1. CALLISTA, Poli (typical, = *Chione*, Gray; not of Mühlfeldt).

   Shell transversely ovate or subtrigonal, usually moderately compressed, with surface smooth or concentrically sulcate; sublunular tooth generally close to the cardinal teeth, smooth, more or less compressed, but not much elongated; pallial sinus deep, and often abruptly pointed at the end.—(Type as already stated.)

2. DIONE, Gray.

   Shell very nearly typical in form and dentition, but with surface always distinctly sulcate or lamellose concentrically, with posterior umbonal slopes more or less prominent or subangular, and sometimes bearing a row of spines; pallial sinus deep, and generally obtuse at the end.—*Venus Dione*, Linn.

* I think the rule of priority of date will compel us to adopt Roemer's first name *Pitar* for this group, notwithstanding its barbarous origin. He first used it in 1857, giving a diagnosis, and citing *Venus tumens*, Gmelin, as the typical species; and, if I am correctly informed, it was not until the publication of his Monograph, in 1867, ten years later, that he changed the name from *Pitar* to *Caryatis*, citing the same species as the type. This change, it seems to me, he had no right or authority to make; for, when an author once *regularly* publishes a new genus or subgenus, he has no further control over it, and can only change or modify the name where the circumstances are such that any one else could do so. Descriptive names are, of course, preferable in first selecting a name for a new genus; but it will hardly be maintained that any one would have the right to change all of the regularly-published barbarous and nonsense names now current in natural history.

3. **MACROCALLISTA**, Meek.

Shell transversely elongate-oval, with surface smooth; pallial sinus and hinge nearly typical, excepting that the sublunular or anterior lateral tooth is generally more compressed, more oblique, and more remote from the cardinal, and the posterior lateral much more elongated, and nearly horizontal.—*Venus gigantea*, Gmelin.

4. **PITAR**, Roem. (= *Caryatis*, Roemer).

Shell nearly typical in form and dentition, excepting that the valves are sometimes more convex, and the anterior lateral or sublunular tooth always subconical in the left valve; pallial sinus deep, and more or less obtusely subtrigonal; surface concentrically striated.—*Venus tumens*, Gmelin.

5. **APHRODINA**, Conrad.

Shell with form, surface, and pallial line as in the last, but with anterior cardinal tooth of left valve thicker, and the anterior lateral or sublunular tooth much more compressed from above and below, rugose or granular instead of smooth, and elongated parallel to the anterior dorsal margin, instead of nearly conical.—*Meretrix Tippana*, Conrad.

? 6. **DOSINIOPSIS**, Conrad.

Shell suborbicular, or transversely ovate-subtrigonal; with surface only concentrically striated; hinge broad and strong, with anterior lateral or lunular tooth sometimes rugose, distinct from the cardinal, and somewhat extended parallel to the margin above; cardinal plate continued broad posteriorly, and provided with an obscure, remote, posterior lateral tooth in one or both valves; pallial sinus rather deep, triangular, and ascending.—*D. Meekii*, Conrad.

It is not without some hesitation and doubt that I have concluded to place the last of the above-named groups as a section of *Callista*. In its rounded outline, broad hinge, and rather well-developed posterior lateral teeth, and elongated rugose anterior lateral, it contrasts strongly with the more typical species of the genus; but it seems to agree so nearly with some of the types that appear to fall into this genus, that I have concluded to range it provisionally as a marked section of the same. I should remark here,

however, that the peculiar callus, or protuberance, mentioned by Mr. Conrad as occurring under the anterior cardinal plate in four valves of the typical specimens examined by him, does not exist in a number of fine separate valves collected at the same time and from the same locality as that at which his types were obtained, and consequently is not a constant character.

The shells included in the genus *Callista* are often considered congeneric with *Cytherea*—more properly *Meretrix*, Lamarck—and although at one time holding that opinion, I now believe that Dr. Gray, H. and A. Adams, and others who have separated them under Poli's or other names, are right. They are not only distinguished by the very faintly sinuous, or nearly simple pallial line in *Meretrix*, as properly restricted, but by the siphons of the animal in the latter group being only united half their length, and the mantle-margins plain; while in *Callista*, the margins of the mantle are plicated, and above the siphons provided with filaments. The siphons also differ in being united all the way to their extremities, which are crowned with cirrhi, instead of being plain as in *Meretrix*.

The question in regard to the particular name that should be retained for the group under consideration is a rather complicated one, and consequently quite different views are maintained on this point, even among those who separate it from *Cytherea* or *Meretrix*, as here understood, some using for it Dr. Gray's name *Dione*, and others *Callista*, Poli; while those who unite it with Lamarck's genus, in some instances use his name *Meretrix*, and in others *Cytherea*. Until recently, I had not seen Poli's work (Test. Utr. Sic.), and as my friend Mr. Conrad had stated in one of his papers that *Callista*, Poli, was founded on the animal of *Mactra*, I was thus led to believe that this name could not be properly retained for the group under consideration, and adopted for these shells Dr. Gray's name *Dione*, ranging our Cretaceous species of the Upper Missouri under the same. Through the kindness of Prof. Alexander Agassiz, I have since had an opportunity to consult Poli's work, and find that it was in his first volume, published in 1791, that he *first* used the name *Callista;* and after a brief diagnosis of the animal, he there only cites under it (1) *Venus chione* (2), *V. deflorata*, and (3) and last, *V. gallina*, Linn. Consequently, it is to this volume and date that we must go to ascertain to what group of shells his name *Callista* belongs, as well as to decide in regard to his type-species; and not to his second volume, published

four years later, in which latter volume he associated the animal of *Mactra* and other types with *Callista* and *Callistoderma*.*

From the species thus cited by Poli at the time he first proposed the name *Callista*, it is evident that the group, as he understood it, was complex, or, in other words, made to include species belonging to more than one genus; and, consequently, any subsequent author had the right to separate, under other generic names, the group or groups to which some of his cited species belong. The first author who did this, so far as I have been able to ascertain, was Lamarck, who, in 1799, proposed the name *Sanguinolaria* for a group that would, according to high authority, include *V. deflorata*, Linn. Next, in 1811, Mühlfeldt proposed a genus *Chione* for another genus that includes *V. gallina*, Linn.; thus leaving the species *Venus chione*, Linn., alone to represent *Callista*, Poli. So it would seem that, whether we follow the rule of taking the first species mentioned by an author under a new genus as its type, or the rule of elimination, if I may so call the separation of extraneous types from a complex genus, *Venus chione*, Linn., would be the type of *Callista*, Poli; and as the law of priority requires that a generic name once regularly proposed must be retained by subsequent authors for the group to which some one of the included species belongs—provided that any of them belong to a genus not previously named—it appears to me clearly evident that *Callista*, Poli, must stand for the genus here under consideration, including *Venus chione*, Linn.

I am aware that, in 1838, Dr. Gray proposed the name *Chione* for a genus, with *V. chione* as its type; but this could not stand, not only because this species, as above shown, is the type of the older genus *Callista*, but also because the name *Chione* was pre-occupied, as already shown, by another genus, named by Megerle von Mühlfelt, in 1811. Dr. Gray also named another section *Dione*, in 1847, with *V. dione*, Linnæus, as its type; but as all other authorities agree that this shell is congeneric with the genus here under consideration, the name *Dione* necessarily falls into the synonymy of *Callista*, though it may be retained in a subgeneric sense for a subordinate section of that genus.

As here defined and understood, it can scarcely be affirmed on satisfactory known evidence, that the genus *Callista* dates back farther than the Cretaceous epoch; though it is possible that some of the similar Jurassic

* Mr. Conrad had evidently not seen Poli's *first* announcement of *Callista*, 1791.

shells may yet be found to fall into sections of this group. *Aphrodina* and *Dosiniopsis* certainly occur in the Cretaceous; the latter also passing into the Lower Eocene, but not above, so far as yet known. *Callista* proper, or species that seem scarcely, if at all, separable from this section, also occur in the Cretaceous, and a few elongated forms resembling *Macrocallista* have been found in rocks of that age; but I am not quite sure that the hinges of these shells are known to agree with the typical species of the group. Both of the latter two sections, however, as well as *Dione* and *Pitar*, are abundantly represented through the Tertiary, and by numerous living species in our existing seas, where the genus appears to attain its greatest numerical development.

Callista (Dosiniopsis?) Deweyi, M. & H.

Plate 17, figs. 15, *a*, *b*, *c*, *d*, *e*.

Cytherea Deweyi, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 83.
Meretrix Deweyi, Meek and Hayden (1860), *ib.*, XII, 185.
Callista Deweyi, Meek and Hayden (1861), *ib.*, XIII, 143.
Dione Deweyi, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 13.

Shell subcircular, or very broad-suboval, rather thin, moderately convex; lateral margins rounded, the posterior side being a little broader than the other; dorsum sloping gradually with a slightly convex outline behind the beaks, and concave and more abrupt in front; base semi-oval; escutcheon lanceolate; beaks not very prominent, somewhat gibbous, incurved, nearly touching, and placed a little in advance of the middle; muscular impressions shallow, anterior one narrow-oval, posterior one broad-ovate; sinus of the pallial impression broad, triangular, its sides converging at an angle of about 35°, extending obliquely forward and upward nearly to the middle of the valves, very slightly obtuse at the immediate extremity. Surface marked by fine, regular, prominent lines of growth.

Length, 0.96 inch; height, 0.83 inch; gibbosity, 0.55 inch.

This is a very neat, symmetrical shell, which appears to vary somewhat in form at different localities. At any rate, specimens that seem not distinct from it, obtained on the Yellowstone, are often in outline a little more oval transversely; their length being slightly greater in proportion to their height. As these differ in no other respect, so far as has yet been determined, and there are intermediate gradations of form, I do not think it probable that they belong to different species.

In form and general appearance, our *C. Owenana* resembles this shell very closely, but it has a deeper sinus in the pallial impression, and the substance of its shell is thicker than in the species under consideration. Some varieties of our *C. pellucida* present, in a side-view, more or less similarity to this species; but their more compressed form and extreme thinness will prevent them from ever being confounded with it.

This species was named in honor of our lamented friend, Prof. Chester Dewey, of Rochester University, well known for his zeal in the cause of science and the diffusion of knowledge, as well as through the agency of his own contributions to several departments of science.

Locality and position.—Moreau River, in the Fox Hills group; and on the Yellowstone River, in strata containing a blending of the species usually found in the Fox Hills beds and the upper part of the Fort Pierre group.

Callista (Dosiniopsis) Owenana, M. & H.

Plate 37, fig. 1.

Cytherea Owenana, Meek and Hayden (Nov., 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 273.
Meretrix Owenana, Meek and Hayden (May, 1860), *ib.*, XII, 185.
Dione Owenana, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 13.

Shell round-oval, compressed, rather thick; extremities rounded, the anterior side being a little narrower than the other; base forming a regular semi-oval curve, sometimes more prominent before than behind the middle; dorsum declining slightly with a convex outline behind the beaks, rather concave, and sloping more abruptly in front; beaks moderately elevated, and located in advance of the middle; muscular impressions shallow, the anterior one being narrow-oval, or subovate, and the posterior broader below and attenuate above; pallial impression provided with an elongate-triangular sinus, which is a little obtuse, or very slightly rounded at the extremity, and extends obliquely forward and upward to a point near the middle of each valve.

Length, 1.56 inches; height, 1.35 inches; convexity, about 0.66 inch.

Not having seen the hinge of this species, it is impossible to determine whether or not it really presents the characters of this genus, though its deep angular pallial sinus shows that it cannot be properly retained in the genus *Meretrix* (= *Cytherea*), as that group is now understood by conchologists. The only specimen I have seen retaining any portions of the surface, shows

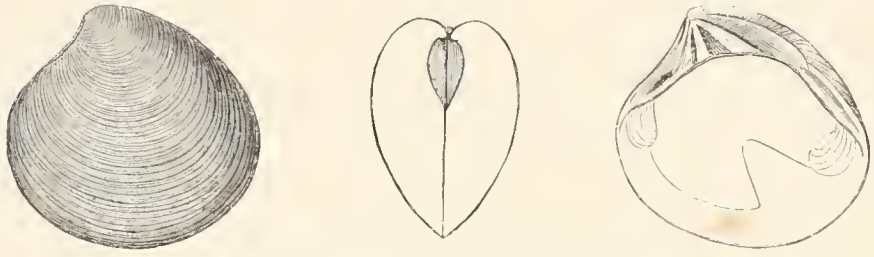
that it was merely marked by moderately distinct concentric striæ. It is very nearly related to, and possibly not distinct from, an Upper Cretaceous species we have proposed to call *C. Nebrascensis*, from the North Branch of Platte River, near the mouth of Deer Creek, but, in the only specimen seen, it seems to have a decidedly deeper and narrower pallial sinus.

The specific name was given in honor of the late Dr. David Dale Owen, of New Harmony, Indiana, the well-known western geologist.

Locality and position.—Mouth of Judith River; in a Cretaceous bed now known to hold a position at the horizon of the Fox Hills group.

Callista (Dosiniopsis) Nebrascensis, M. & H.

Fig. 15. Fig. 16. Fig. 17.



Callista (Dosiniopsis) Nebrascensis, M. & H.
Fig. 15. Left side view of exterior.
Fig. 16. An anterior profile view of the two valves united.
Fig. 17. Hinge and internal view of right valve.

Callista Nebrascensis, Meek and Hayden (1856), Proceed. Acad. N. Sci. Philad., VIII, 83.
Callista Deweyi, var. *robusta*, Meek and Hayden (1861), *ib.*, XIII, 443 (not *C. Deweyi*, M. & H., 1856).
Dione Nebrascensis, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 13.

Shell attaining a medium size, rather thick, suborbicular, or transversely a little oval, the height of large specimens being generally about seven-eighths the length; valves moderately and evenly convex; anterior margin somewhat narrowly rounded near the middle, and thence rounding regularly into the ventral outline, which forms a broad, regular, semi-oval curve; posterior margin rather more broadly rounded than the anterior; dorsal border sloping from the beaks, the anterior slope being more abrupt and concave, and the posterior longer and convex in outline; lunule subovate, and a little impressed, with sometimes a faint marginal line; escutcheon long, lanceolate, and rather impressed; ligament long, narrow, somewhat deeply seated, or scarcely as prominent as the lateral margins of the escutcheon; beaks moderately prominent, rather oblique, and subcentral, or nearer the middle than the anterior margin; surface concentrically striated; muscular impressions shallow, ovate,

the anterior one being a little deeper and narrower than the other; pallial sinus trigonal, ascending, rather deep, or slightly longer than wide.

Length of one of the largest specimens seen, 1.47 inches; height, 1.25 inches; convexity, 0.85 inch. Smaller specimens proportionally slightly higher and more compressed.

By breaking away portions of the valves about the beaks of several specimens of this species I have succeeded in making out the details of the hinge quite clearly. In the left valve, the anterior lateral or lunular tooth is not connected with the anterior cardinal, but distinct, moderately prominent, rather long, and ranges parallel to the margin above. Of the anterior two cardinal teeth (which are approximate, and at the apex even connected), the anterior one is very narrow, or laterally compressed, and ranges vertically under the point of the beak, while the other is thicker and more oblique. Behind the latter, there is a still more oblique, rather wide pit for the reception of the posterior and largest tooth of the other valve; while immediately behind this pit is the posterior cardinal, which is long, slender, and oblique. In the right valve, the pit for the reception of the lunular tooth is well defined, and just behind this the anterior cardinal is seen to be very narrow, and ranging nearly vertically, so near the larger, very slightly oblique middle tooth, as merely to leave a narrow, slit-like pit for the reception of the compressed anterior cardinal of the other valve. Just behind the middle cardinal of this valve, the rather large, more oblique pit for the reception of the stronger middle tooth of the left valve occurs, and behind this pit the rather strong, oblique, longer posterior cardinal is seen, with a narrow, elongated, oblique furrow behind it for the reception of the oblique posterior cardinal of the other valve. Behind the cardinal teeth, the hinge-margin is strong for some distance back, and somewhat thickened in one or both valves, so as to form a kind of posterior lateral tooth, quite remote from the cardinals.

The foregoing description is made out from large, fully-developed specimens, which I at one time thought might represent a more developed form of our species *C. Deweyi;* but a more careful comparison shows that they not only differ from that species in their larger size and thicker shell, but in having a more excavated lunule, a longer ligament, and a kind of excavated, narrow escutcheon. My present opinion is that these shells represent only a more robust growth of our species *C. Nebrascensis*, which was founded upon

young, or less developed, and slightly more compressed individuals; though it is barely possible that they may be distinct.

Locality and position.—The typical smaller specimens are from the upper part of the Fort Pierre group on Cheyenne and Moreau Rivers; while the larger specimens, upon which the foregoing description is mainly based, came from Deer Creek, on the North Platte River, where they occur in the Fox Hills group.

Callista (Dosiniopsis?) orbiculata, H. & M.

Plate 5, figs. 2, *a*, *b*, *c*.

Cytherea orbiculata, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci., V (n. s.), pl. 1, fig. 7.
Meretrix orbiculata, Meek and Hayden (May, 1860), Proceed. Acad. Nat. Sci. Philad., XII, 185.
Dione orbiculata, Meek (1864), Smithsonian Check-List Cret. N. Am. Fossils, 13.

"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 Professor 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 Am. Acad. 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 Professor Hall and the writer was obtained.

Callista? pellucida, M & H.

Plate 17, figs. 10, *a*, *b*, *c*, *d*, *e*; and 12, *a*, *b*, *c*.

Cytherea pellucida, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 272.
Meretrix pellucida, Meek and Hayden (May, 1860), *ib.*, XII, 185.
Dione? pellucida, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 13.

Shell extremely thin and fragile, broad-ovate, or subcircular, compressed; anterior side narrowly rounded; base forming a semi-oval curve; posterior side rather broader than the other, rounded or subtruncated at the extremity; dorsum sloping gradually, with a slightly convex outline behind the beaks, and concave and declining more abruptly in front; beaks moderately elevated and placed a little in advance of the middle; muscular impressions very faintly marked; pallial line quite distinct and provided with a rather broad-triangular sinus extending almost to the middle of the valves. Surface marked by fine lines of growth, which are quite regular in the umbonal region, but become more irregular near the free borders.

Length (of a medium-sized, subovate variety), 0.86 inch; height, 0.73 inch; convexity, 0.41 inch.

The most striking peculiarity of this species is its extreme thinness; the substance of the shell being scarcely thicker than ordinary writing-paper. This character and its more compressed form will readily distinguish it from all the other species yet obtained from these formations. It varies considerably in form, some individuals being longer than high, and others higher than long. These varieties are quite strongly enough marked to constitute

specific distinctions, were there not every gradation of form between them, and all agreeing in every other respect. The prevailing form is broad-oval, approaching ovate.

As in the other cases, we had referred this species to the genus *Meretrix* (= *Cytherea*), from external characters, not having seen the hinge. Its deep angular pallial sinus, however, shows that it must be removed from that genus. It is evidently more nearly related to sections of *Callista*, as here defined, though I am hardly satisfied that it may not belong to some allied group.

Locality and position.—Two hundred miles above the mouth of Milk River; from the Fort Pierre group, or formation No. 4 of the Upper Missouri Cretaceous series.

Callista (Aphrodina?) tenuis, H. & M.

Plate 5, figs. 1, *a*, *b*, *c*, *d*.

Cytherea tenuis, Hall and Meek (Mem. Am. Acad. Sci. and Arts, V (n. s.), 383, pl. 1, fig. 5.
Meretrix tenuis, Meek and Hayden (May, 1860), Proceed. Acad. Nat. Sci. Philad., XII, 185.
Dione ? tenuis, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 13.

"Shell thin, ovate-orbicular; length and height nearly equal; beaks elevated, nearly central; anterior and posterior extremities rounded, the latter somewhat broader; surface marked by concentric undulations, and fine parallel striæ.

"Length, 0.45 inch; height, 0.36 inch."

The specimens from which the foregoing description was made out, being young or undeveloped individuals, and more or less distorted by pressure, give an incorrect idea of the form of the adult shell. Small specimens are generally more compressed and higher in proportion to length than the larger, though the species varied somewhat in the relative proportions of height and length, even at maturity.

From a good series of specimens of various sizes, it is found that the species may be characterized as follows: 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 half-way between the middle and the 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 yet 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 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, five miles below the mouth of James River.

Genus THETIS, Sowerby.

Synon.—*Thetis*, Sowerby (1826), Min. Conch., tab. 513; and German ed., 535.—Defr. (1829), Dict. Sci. Nat., LIV, 274.—Bronn (1838), Leth., 704.—Sowerby, jr. (1839), Conch. Man., 106; and (1842), 2d ed., 274.—Gray (1842), Synon. Brit. Mus., 91.—D'Orbigny, Pal. Fr., III, 450.—Geinitz (1846), Grundr. d. Verst., 419.—Chenu (1862), Man. de Conch., II, 90 (not *Tethys*, Linn., 1740, 1758, and 1767, sometimes written *Thetys* and *Thetis;* nor *Thetis*, Adams, 1845).

Thetironia, Stoliczka (1870), Palæont. Indica, III, 158.

Etym.—Θέτις, a Nereid, the wife of Peleus.

Examp.—*T. major*, Sowerby.

Shell equivalve, subequilateral, subtrigonal, or more or less nearly orbicular, ventricose, but thin in substance, closed all around; surface concentrically striate, and often showing minute punctures under a magnifier; ligament external; hinge with three (or four?) cardinal teeth in each valve, the anterior being large, conical, and slightly curved, and the posterior small; lateral teeth none; muscular impressions broad-oval; pallial line distinctly marked, and provided with a very profound, sharply angular sinus, directed upward, and often extending almost as high as the back part of the beaks.

Specimens of this genus have generally been found in the condition of internal casts, so that its hinge-characters seem not to have been made out with entire clearness; consequently, scarcely any two authors agree exactly in regard to the details of its hinge-teeth. I have preferred, however, to follow Sowerby's original description of these parts. The most characteristic and the most readily-determined peculiarity of the genus, however, is its remarkably deep, angular, pallial sinus, directed nearly vertically, and often extending almost to the beaks.

This genus has been confounded, by Woodward, H. and A. Adams, and others, with *Poromya*, Forbes, an entirely distinct group, with altogether different hinge-characters, and a merely slightly sinuous pallial line.

I cannot agree with Dr. Stoliczka that there is any necessity for changing Sowerby's name *Thetis*, for this genus, to *Thetironia*, merely because Linnæus had previously used the name *Tethys* for another genus; the two names *Thetis* and *Tethys* being distinct in orthography as well as in meaning. It is true that Cuvier, and perhaps some others, had written the name of Linnæus's genus *Thetys* and *Thetis;* but this does not alter the case, because these authors had no right to change Linnæus's name in this way from its original orthography.

So far as known at this time, the genus *Thetis* seems to be entirely confined to the Cretaceous rocks.

Thetis? circularis, M. & H.

Plate 17, figs. 8, *a*, *b*, *c*.

Venus? circularis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 272.
Cyclina? circularis, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 13.

Fig. 18. Fig. 19.

Thetis? circularis, M. & H.

Fig. 18. Shows hinge and interior of left valve.

Fig. 19. Shows dorsal outline of same, and its projecting hinge-teeth.

Shell subcircular, ventricose, very thin; basal, anterior, and posterior margins rounded; postero-dorsal border declining from the beaks, with a moderately convex outline; pallial margin smooth within; beaks elevated, gibbous, pointed, and curved obliquely forward and inward, located slightly in advance of the middle; surface nearly smooth, or only marked with fine, obscure, concentric striæ, with some appearance of a few minute, irregularly scattering punctures; muscular impressions very faintly marked, the anterior one narrow-subovate, and occupying an elevated, nearly marginal position; posterior muscular scar broader than the other, and placed rather low and near the anal margin. Pallial sinus funnel-shaped,

or wide below and acute at the upper end, ascending vertically to the middle of the valves.

Length, 0.67 inch; height, 0.69 inch; convexity, 0.50 inch.

So much uncertainty exists in regard to the hinge-characters of the genus *Thetis* that it is not without some doubts that I have concluded to refer the above-described species provisionally to that group. So far, however, as can be determined from Sowerby's rather unsatisfactory description, our shell seems to have a similar hinge; that is, it has no lateral teeth, while there are three well-developed cardinals in each valve, the anterior one of each being trigonoid-conical, and curved upward. The middle tooth in each valve is smallest, and directed obliquely downward and backward across the hinge-plate; but, contrary to what we usually see in such teeth, it is most prominent at its upper end. In the right valve, the posterior tooth, judging from the pit for its reception in the left valve, is rather large, quite oblique, and widens from its anterior end downward and backward; while in the left valve, the posterior tooth, which fits in above that of the other, is still more oblique, long, and very narrow. These characters of the posterior teeth do not conform to Sowerby's indefinite character "small." If those of *Thetis* proper, however, have the same form and direction, their merely small size might not be of generic importance. It will also be observed from the wood-cut at the head of this description, as well as from one of the figures on the plate, that the pallial sinus of our shell, although deep and agreeing well in form and direction with that of *Thetis*, is rather decidedly shorter; and that the pallial line in front of the sinus, as well as behind it, presents a curious serrated or crenate outline.

From the differences above noted, I suspect that although related to *Thetis*, a critical comparison of our shell with specimens of Sowerby's genus, showing the hinge clearly, would bring to light sufficiently marked differences to warrant their separation. Should this prove to be the case, I would propose for our type the name *Thetiopsis*.

I am not quite sure that our shell is punctate as in *Thetis*, though some indications of this character appear to be visible under a magnifier on one of our specimens.

Locality and position.—Near Black Hills, on Cheyenne River; also near the mouth of Milk River, on the Missouri; at both localities in the Fort Pierre group of the Upper Missouri Cretaceous series.

TELLINIDÆ.

Genus TELLINA, Linnæus.

Synon.—Tellina, Linn. (1758), Syst. Nat., ed. X, 674.—Brug. (1792), Encyc. Méth., tab., 282.—Lam. (1799), Prodr., 84; and (1801), Syst., 124; also (1806), Ann. Mus., VII, 231; and (1818), Hist., V, 519.—J. Sowerby (1817), Min. Conch., tab., 161.—Férnss. (1821), Tab. Syst., xliii.—Blainv. (1824), Dict. Sci. Nat., XXXIII, 237.—Desh. (1830), Encyc. Méth., III. and (1832) *ib.*, 1006.—Gray (1842), Synon. Brit. Mus., 75 and 91.—Bronn (1838), Leth., 968.—Agassiz (1839), Moul. Moll., 38.—Goldf. (1840), Petref. Germ., II, 233; and of nearly all other conchologists.

Peronæa, Poli (1791), Test. Utr. Sic., I, 29; and (1795), *ib.*, II, 252.—H. and A. Adams (1856), Genera Recent Moll., II, 398 (as a subgenus of *Tellina*).—Stoliczka (1870), Palæont; Indica, III, 119 (as a subgenus of *Tellina*).

Angulus, Mühlf. (1811), Entwurf, 47.—H. and A. Adams (1856), Genera Recent Moll., II, 397 (as a subgenus of *Tellina*).—Stoliczka (1870), Palæont. Indica, 118 (as a subgenus of *Tellina*).

Phylloda, Schum. (1817), Ess., 148.—H. and A. Adams (1856), Genera Recent Moll., II, 397 (as a subgenus of *Tellina*).—Stoliczka (1870), Palæont. Indica, III, 118 (as a subgenus of *Tellina*).

Tellinides, Lam. (1818), Hist., V, 535.—Férnss. (1821), Tab. Syst., xliii.—Brown (1833), Conch. Text., VI, ed., 152.—H. and A. Adams (1856), Genera Recent Moll., II, 398 (as a subgenus of *Tellina*.

Fabulina, Gray (1851), Brit. Acceph., and Br., 40 (as a subgenus of *Tellina*).

Tellinella, Gray (1852), * * .—H. and A. Adams (1856), Genera Recent Moll., II, 394 (as a subgenus of *Tellina*).—Stoliczka (1870), Palæont. Indica, III, 116 (as a subgenus of *Tellina*).

Peronæoderma (Poli), Mörch (1853), Cat. Yoldi, 12.—H. and A. Adams (1856), Genera Recent Moll., II, 396 (as a subgenus of *Tellina*).—Stoliczka (1870), Palæont. Indica, III, 116 (as a subgenus of *Tellina*).

Mæra, H. and A. Adams (1856), Genera Recent Moll., II, 396 (as a subgenus of *Tellina*).

Homala, H. and A. Adams (1856), *ib.*, 398 (as a subgenus of *Tellina*); not *Homala*, Ag., 1846, corr. of *Omala*, Schum., 1817.

Metis, H. and A. Adams (1856), *ib.*, 399 (as a subgenus of *Tellina*).—Stoliczka (1870), Palæont. Indica, III, 119 (as a subgenus of *Tellina*).

Homalina, Stoliczka (1870), Palæont. Indica, III, 118 (as a subgenus of *Tellina*).

Etym.—τελλίνη, the Greek name for a kind of muscle.
Examp.—*Tellina radiata*, Linn.

Shell transversely elongate-subovate, or shorter and more or less nearly ovate, valves compressed, with free margins smooth within; posterior end generally narrowed, laterally deflected, and provided with an oblique, sometimes angular ridge, extending from the umbonal region to the posterior basal extremity; hinge with two cardinal teeth in each valve (one of which is sometimes nearly obsolete), and variable, or obsolescent lateral teeth; pallial line deeply and widely sinuous; surface smooth or striated.

A large number of subordinate groups seem to be so closely allied to the typical species of *Tellina* as not to admit of being more than subgenerically separated. These are mainly distinguished from each other and from the typical section of the genus, by differences in the variable details of the hinge-

teeth and the general form of the shell. The distinctions between these groups may be briefly stated as follows:

1. **TELLINA**, Linn. (typical).

Shell transversely elongate-oval, with well-developed cardinal and lateral hinge-teeth.—(Type as already stated.)

2. **TELLINELLA**, Gray.

Shell more or less narrowly elongated, with posterior side rostrated or subrostrated; hinge with two lateral teeth in one valve, and none (or only very obscurely-developed laterals) in the other.—*T. virgata*, Linn.

3. **PERONÆODERMA** (Poli), Mörch.

Shell oval, with posterior side not much produced or distinctly rostrated; hinge with lateral teeth in one valve.—*T. punicea*, Born.

4. **MŒRA**, H. and A. Adams (= *Donacilla*, Gray; not Lam.).

Posterior side very short and cuneate; hinge with two lateral teeth in one valve.—*T. donacina*, Linn.

5. **PALÆOMŒRA**, Stoliczka.

Shell much as in the last, with one anterior lateral, long, lamelliform tooth in each valve, that of the right being bifid, and that of the left entire; and no distinctly-developed posterior cardinal tooth in either valve; lateral teeth less distinct in the left than the right valve.—*T. strigata*, Goldfuss.

6. **PHYLLODA**, Schumacher.

Shell transversely oblong, much compressed, with posterior side narrowed, angular, and carinate; cardinal teeth divergent and compressed; one lateral tooth in one valve.—*T. foliacea*, Linn.

7. **ANGULUS**, Schumacher (= *Tellinula*, Chem., *Fabulina*, Gray).

Shell oblong or oval; posterior side more or less angular; and hinge with only one lateral tooth in one valve.—*T. exilis*, Lam.

8. **TELLINIDES**, Lam.

Shell transversely oval, without a posterior fold; hinge with one approximate lateral tooth.—*T. timorensis*, Lam.

9. **HOMALINA**, Stoliczka.

Shell oval, subtrigonal, or more or less elongated, with anterior side short and rounded, and posterior more produced and narrowly rounded; fold nearly or quite obsolete; hinge with one approximate lateral tooth in the right valve.—*T. alba*, Linn.

10. **PERONÆA**, Poli (= *Omala*, Schum., corrected *Homala*, by Agassiz; also, *Homala*, H. and A. Adams).

Shell ovate; anterior side shorter and rounded; posterior subacuminate; hinge with lateral teeth obsolete.—*T. planata*, Linn.

11. **METIS**, H. and A. Adams.

Shell oval or suborbicular; posterior side shorter and subtruncated; anterior rounded; hinder flexuosity sometimes submedian; hinge without lateral teeth.—*T. Meyeri*, Phil.

The foregoing is the arrangement of the sections of *Tellina* adopted by H. and A. Adams, in their Genera of Recent Mollusca, excepting that I have left out *Arcopagia*, and included an extinct group proposed by Dr. Stoliczka. I have also adopted the name *Homalina*, of the latter author, instead of *Homala*, H. and A. Adams, which latter name was pre-occupied by Agassiz's correction of *Omala*, Schumacher, and is also synonymous with *Peronæa*, Poli. Dr. Stoliczka also includes, as a section of *Tellina*, the group *Arcopagia*, Leach, as well as *Linearia* and *Tellinimera*, Conrad. These types are undoubtedly closely allied to *Tellina;* but it seems to me that the study of this family of shells will be simplified by treating *Arcopagia* and *Linearia* as distinct genera, rather than as sections of *Tellina;* the same may also possibly be the case with *Metis*. Mr. Conrad's *Tellinimera*, as well as his *Ænona* and *Œne*, were founded on shells presenting no external differences from some of the sections of *Tellina*, and should possibly be ranged either in or near that genus; but as he has not yet illustrated or fully described the hinges and interior of these types, I do not feel prepared to express an opinion in regard to their rank and position.

As in many other cases, the question in regard to what particular species should be considered the type of the genus *Tellina* is involved in some doubt. Linnæus, in 1758, defined it very briefly, and included a large number of species, without saying or indicating which he considered the type. If we take his first species as the type, a rule insisted upon by some, we would

have to consider an *Arcopagia* the type of *Tellina*, if I mistake not. Coming down to later authors, Müller, in 1776, adopted the name, but applied it to the fresh-water genus *Cyclas* (more properly *Sphærium*), and perhaps in part to *Unio*, &c. In 1792, Bruguière adopted it, but with rather wide limits, his first species being an *Arcopagia*. Lamarck, however, adopted it in 1799, and the only species cited by him then was *T. virgata*, Linn., belonging to the section *Tellinella*. Consequently, it seems to me very probable that this will have to be regarded as the type of the genus; Lamarck being apparently the first after Linnæus to select any one typical form. In 1801, however, he cited only *T. radiata*, now most generally considered the typical species.

This is another genus, the exact geological range of which is very difficult to determine; the shells being most generally thin, and consequently not easily separated from the matrix so as to expose the hinge-teeth, which are also often so small as to be accurately determined with difficulty in fossil species. A few shells have been referred to *Tellina* from Palæozoic rocks, but we may safely conclude that none of them belong to the genus, or probably even to the same family. The same may also be said in regard to the Triassic tellinoid shells. Some species from the Jurassic rocks have more or less the aspect of *Tellina;* but it is not probable that their hinges and internal characters would be found to agree exactly with this genus as understood by modern conchologists.

In the Cretaceous, however, we meet with apparently a few true Tellinas, and many species falling into several of the subgenera. The genus increased through the Tertiary epoch, and perhaps attains its greatest numerical development in the existing seas; the subgenus *Tellinella* being apparently more numerous at present than any of the other sections.

The genus, as represented by the various subgenera, has a world-wide geographical range, but is most abundantly represented in tropical seas, where these shells are often delicately and beautifully tinted.

Tellina (Œne?) subscitula, Meek.

Plate 2, figs. 11, *a*, *b*.

Tellina subscitula, Meek (1871), Hayden's Sec. Ann. Report Geological Survey of the Territories, 310.

Shell small, elliptic-subovate, much compressed; pallial margin forming a regular semi-elliptic curve; extremities narrowly rounded, the posterior

being a little shorter and faintly subtruncated, with a very obscure flexure, and most narrowly rounded below; dorsal outline sloping gently in both directions from the beaks, the posterior slope being a little convex in outline, and the anterior nearly straight above; beaks depressed, compressed, and placed a little behind the middle; muscular impressions moderately distinct, the posterior one being broader than the other; pallial sinus very deep, or extending slightly beyond the middle, nearly horizontal, and rather broadly rounded. Surface with only fine lines of growth.

Length, 0.84 inch; height, 0.47 inch; convexity, about 0.15 inch.

This shell is much like *Tellina scitula*, Meek and Hayden, from the upper member of the Upper Missouri Cretaceous series; but on comparison it is found to be proportionally more depressed, while its pallial sinus is very different, being much broader and more obtusely rounded at the end. Impressions of its surface in the matrix also indicate less strongly-defined lines of growth. Casts show what may possibly be faint traces of a posterior lateral tooth in one or both valves.

Locality and position.—Twelve miles southwest of Salina, Kansas; in the Dakota group of the Upper Missouri Cretaceous series.

Tellina (Peronæa?) equilateralis, M. & H.

Plate 39, figs. 5, *a*, *b*, *c*.

Tellina equilateralis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., 82.

Shell subelliptical, rather thick, moderately compressed; right valve slightly more convex than the left; anterior end rounded; anal extremity rounded, or very faintly truncated and slightly flexed to the left; basal margin broad, semi-elliptical in outline, laterally curved so as to present a slight concavity on the left side; dorsal border declining gradually from the beaks toward the extremities, the posterior slope being more convex than the anterior, and rather distinctly excavated for the reception of the ligament; posterior fold or ridge not very distinctly marked; beaks small, not much elevated, located near the center of the shell; surface marked by small, irregular, concentric wrinkles, and fine, rather obscure lines of growth.

Length (of largest specimen seen), 1.77 inches; breadth, 0.59 inch; height, 1.06 inches.

Associated with the specimens of this species, a few internal casts were

found that agree pretty nearly in outline with it, and have been thought possibly to belong to the same shell, though they may be entirely distinct. One of these is represented by fig. 4 of the same plate, though somewhat incorrectly, as the anterior muscular scar is merely narrow-ovate, and not prolonged upward as in the engraving. The posterior muscular scar is also wrongly represented too round, and a little too broad and low, so as to make the posterior end of the pallial sinus narrower than it should be. From the general form of these casts, and the nature of their muscular and pallial impressions, they may possibly belong even to a species of the distinct genus, *Linearia*.

Nothing is known in regard to the hinge and interior of the species here described, and it is only referred to the genus *Tellina* and subgenus *Peronæa* provisionally from external characters.

Locality and position.—Mouth of Judith River, from a Cretaceous bed now known to hold a position at the horizon of the summit of the Fox Hills group of the Upper Missouri Cretaceous series.

Tellina (Peronæa?) scitula, M. & H

Plate 30, figs. 1, *a*, *b*.

Tellina scitula, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 82.

Shell subelliptical, compressed, thin, a little curved laterally so as to make the left valve slightly more convex than the right; anterior side somewhat broader than the other, but rather narrowly rounded; base nearly straight, or forming a broad semi-elliptical curve; posterior side very obliquely subtruncate above, subangular at the extremity below, and with a moderately defined umbonal ridge in the right valve; dorsum declining almost equally before and behind, from the beaks, which are small, compressed, and generally located slightly behind the middle; surface ornamented by fine, regular, equidistant, concentric striæ; anterior muscular impression narrow-ovate, posterior broader; pallial line distinct, and provided with a nearly horizontal sinus, which extends beyond the middle of the valves, and is rounded at the extremity.

Length, 1.07 inches; height, 0.58 inch; convexity, 0.26 inch.

This has somewhat the form of the preceding species, but is more sharply rounded at the lower part of the posterior extremity, and its pallial sinus is quite different from that of the casts referred doubtfully to the last;

while the substance of its shell is much thinner than that of *T. equilateralis*. It approaches more nearly *T. striata*, Sowerby (Min. Conch., V, 79, pl. 456, fig. 1), but wants the radiating striæ seen near the posterior margin of that species.

So far as I have been able to determine from the examination of casts, this species seems to have no well-defined lateral teeth, and from this fact and its resemblance in form to some species of that section, I place it doubtfully in the group *Peronæa*.

Locality and position.—Abundant at Long Lake, and on the Missouri above Fort Pierre; in the Fox Hills beds, or No. 5 of the Upper Mo. Cretaceous series: also on Moreau River, and the South Branch of Cheyenne River, in the same geological position.

Genus LINEARIA, Conrad.

Synon.—*Arcopagia* (sp.), d'Orbigny and others; not Leach.
Linearia, Conrad (1860), Jour. Acad. Nat. Sci. Philad., IV, 279; and (1871) Am. Jour. Conch., VI, 73; also (1873), Appendix to Kerr's Geol. Rep. S. Carolina, 9.
Liothyris, Conrad (1873), *ib.*, 9 (as a subgenus of *Linearia*)

Etym.—*Linearia*, linear; in allusion to the lined surface.
Type.—*Linearia metastriata*, Conrad.

Shell equivalve, subequilateral, transversely oblong, or more or less oval, with extremities rounded or posterior margin a little truncated; valves rather compressed, or moderately convex, and very slightly or not at all flexuous behind; surface generally partly or entirely marked by radiating striæ, and more or less defined concentric lines; hinge with two slightly diverging cardinal teeth in each valve, directed very obliquely forward and downward; lateral teeth long, sometimes stronger in the left than the right valve, or the reverse; pallial sinus usually rather narrow, rounded at the end, directed obliquely forward and upward, and reaching to, or a little beyond, the middle of the valves.

Mr. Conrad proposes to separate the species without radiating striæ as a subgenus *Liothyris;* but the transition from species with distinct radiating lines to those with merely concentric striæ seem to be so very gradual that it will perhaps hardly be possible to separate them into two well-defined subgenera.

According to Dr. Stoliczka, of the Indian survey, who has had an opportunity to study the hinge of an Indian Cretaceous species referred by him to

this genus, and presenting all of its external characters, it would seem to vary considerably in the details of its hinge-teeth. He describes the anterior cardinal tooth as being elongated and bifid, and says that sometimes the posterior cardinal tooth is very elongated and linear in the right valve, and in other examples nearly obsolete; while, he adds, that "in the left valve, the posterior cardinal is always short and thick, sometimes grooved or bifid."

In *L. Carolinensis*, Conrad, the only species of which I have had an opportunity to see the hinge, the cardinal teeth of both valves are short, ranging very obliquely forward and downward, quite close together, and are very slightly diverging, the posterior one of the right valve being stronger than the other, while both in the left are slender, the anterior one being less prominent than the other. None of them show any indications of being emarginate or bifid. Its lateral teeth are well developed in the left valve; the anterior one being more elongated, while the posterior is remote from the cardinal teeth. These laterals fit into corresponding grooves* in the margin of the other valve, above smaller laterals of the same.

The genus *Linearia* is related to *Arcopagia*, under which most of the European species have been described. It can be distinguished, however, by its less orbicular form, generally without any traces of a posterior flexure, and its usually radiately-striated surface, as well as by the differences in the details of the hinge-teeth.

So far as known this genus seems to be confined to the Cretaceous system.

Linearia? formosa, M. & H.

Plate 30, fig. 2.

Tellina formosa, Meek and Hayden (May, 1860), Proceed. Acad. Nat. Sci. Philad., XII, 179.
Abra? formosa, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 14.

Shell transversely subelliptical, very thin, moderately convex; anterior extremity very narrowly rounded; posterior subangular; dorsum sloping gradually, with a slightly convex outline in front and behind the beaks; base forming a regular semi-elliptical curve; beaks small and almost exactly central; surface apparently smooth, but under a good magnifier seen to be

* These grooves in the margin of the right valve for the reception of the lateral teeth of the left are represented much too small, and the anterior one much too short, in Mr. Conrad's figure of this species in Professor Kerr's report.

marked by very obscure lines of growth, and traces of extremely fine, nearly obsolete radiating striæ. Hinge and interior unknown.

Length 0.69 inch; height, 0.40 inch; convexity, about 0.26 inch.

I am still in much doubt in regard to the relations of this shell. In first describing it, being inclined to believe that it might belong to some of the sections of *Tellina*, we referred it provisionally to that genus. Subsequently, however, on noticing its very close similarity in form and general appearance to the recent *Abra intermedia*, I was tempted to refer it, with a mark of doubt, to that genus, in the Smithsonian Check-List. Unfortunately, no specimen has yet been found in a condition to give any idea of the nature of its hinge and internal characters. On picking the rock from about the cardinal margin, however, I found that it shows behind the beaks unmistakable evidences of having had a decided external ligament, and from this fact it can hardly belong to *Abra*, in which the ligament is only partly external. Hence, I am now inclined to believe that it may possibly belong to Mr. Conrad's genus *Linearia*, as its radiating striæ would seem to indicate, though it is much more depressed and has much narrower extremities than any species with which I am acquainted that is certainly known to belong to that genus. In regard to its radiating striæ, however, I should remark that they are so very faint that they can only be seen by the aid of a magnifier in a cross light; consequently, no attempt was made to show them on the figure.

Locality and position.—Twenty miles below the mouth of Cannon-Ball River, in the Fox Hills group, or No. 5 of the Upper Mo. Cretaceous series.

Genus ARCOPAGELLA, Meek.

Synon.—Arcopagella, Meek (1871), Hayden's Second Ann. Report U. S. Geol. Survey of the Territories, 308.
Etym.—Arcopagia (dimin.).
Type.—Arcopagella mactroides, Meek.

Shell equivalve, more or less nearly equilateral, longer than high, with margins closed all around and smooth within. Hinge with two cardinal and one anterior and one posterior lateral teeth in each valve. Left valve with anterior cardinal tooth larger than the posterior, and trigonal in form, but sometimes rather deeply emarginated below, placed directly under the beak; posterior cardinal tooth small, slender, and ranging obliquely backward and downward close to the larger one, so as to leave only a slender pit between, corresponding to another on the anterior side of the principal cardinal tooth,

which two pits are for the reception of the cardinal teeth of the right valve; anterior and posterior lateral teeth both elongated parallel to the cardinal margin, the former approaching more nearly to the cardinal teeth. Right valve with, under the apex, two diverging, slender, cardinal teeth, like the posterior one of the other valve, with a triangular pit between them for the reception of the principal cardinal tooth of the left valve; anterior one more oblique than the other, and nearly or quite connecting with the lateral tooth on that side; lateral teeth like those of the left valve; the anterior one apparently fitting under and the posterior above that of the other valve. Muscular impressions shallow; pallial impression with a moderate rounded sinus, directed obliquely forward and upward. Ligament unknown, but believed to be external. Surface without ornamentation.

After searching in vain to find some defined group under which I could range this shell, with a reasonable degree of probability of its properly belonging to the same, I concluded to propose a new genus for its reception. It seems to be somewhat related to *Arcopagia*, or, at least, to forms that have been referred to that genus, but differs in having anterior and posterior lateral teeth in both valves, as well as in the form of the anterior cardinal tooth of the left valve and its arrangement with relation to the other. At first, I was inclined to think it might find a place in Mr. Conrad's Cretaceous genus *Tellinimera;* but a sketch of the hinge of his type, received from him, shows the latter to be quite distinct, having a double anterior lateral tooth in the right valve, and the cardinal teeth of the same consisting of one bifid, very oblique, tooth, and immediately behind this a minute, vertical second cardinal. The hinge-plate of his genus is also distinctly wider on the anterior side than in the type under consideration.

It is somewhat remarkable that the hinge-structure of the type of this genus is, in most respects, very similar to that of the group for which I have proposed the name *Crassatellina*, while the whole aspect of the two shells is so entirely different that I can scarcely doubt that they really belong to two distinct families: *Crassatellina* probably belonging to the *Crassatellidæ;* and *Arcopagella* possibly to the *Tellinidæ*, or some allied family. As closely as their hinges resemble, however, a critical comparison of the accompanying figures will show them to present important differences of details.

It is probable that this genus will be found to include other Tellinoid Cretaceous shells, the hinges of which are yet unknown.

The names of this genus and *Crassatellina* were suggested rather by their general resemblance to some of the forms that have been referred to those genera, than from any certainty that they are very nearly related to the same.

Arcopagella mactroides, Meek.

Plate 2, figs. 4, *a*, *b*, *c*, *d*.

Arcopagella mactroides, Meek (1871), in Hayden's Sec. Ann. Report United States Geological Survey of the Territories, 309, with wood-cuts A and B.

Shell longitudinally subovate; width or height about two-thirds the length, rather compressed or moderately convex; pallial margin forming a regular semi-elliptic curve from end to end; anterior margin narrowly rounded, with the most prominent part near the middle; posterior border more narrowly rounded than the anterior, particularly below, where there seems to be the faintest possible tendency to form a flexure or fold; beaks moderately prominent, located very nearly centrally; dorsal outline sloping almost equally before and behind the beaks, but with the anterior slope slightly concave in outline above, and the posterior a little convex; muscular impressions faintly marked and rather narrow-subovate; pallial line with its rather shallow, broadly-rounded sinus directed very obliquely forward and upward. Surface apparently with only fine lines of growth.

Length of one of the larger specimens, 0.78 inch; height, 0.53 inch; convexity, about 0.26 inch.

This shell will be readily distinguished from the Tellinas of our Cretaceous rocks, by its shorter, slightly more convex, subtrigonal, or subovate, nearly equilateral form, even where its hinge cannot be seen. In some respects, it looks externally like a compressed and depressed *Mactra*. I am unacquainted with any Tertiary species with a similar hinge.

Locality and position.—Twelve miles southwest of Salina, Saline County, Kansas; in the Dakota group of Upper Missouri Cretaceous. Specimens received from Prof. B. F. Mudge, of the Kansas Agricultural College.

Arcopagella? macrodonta, Meek.

Plate 1, fig. 2.

Shell subtrigonal, compressed, with height equaling about three-fourths the length; dorsal margin sloping rather abruptly, and nearly equally from

the beaks in front and posteriorly, the anterior slope being straight, and the posterior a little convex in outline; basal margin forming a regular semi-elliptic curve; extremities subangular; surface unknown; lateral teeth of hinge long, linear, and compressed.

Length, 0.93 inch; height, 0.70 inch.

Of this species, I have only seen an imperfect cast of the interior of the right valve; and it is eroded so as to remove the impression of the pallial line, while it gives no idea of the nature of the cardinal teeth. There are impressions, however, of a long, linear, compressed, lateral tooth, parallel to the cardinal margin, both in front of the beak and behind it, like those of the genus *Arcopagella*.* As the cardinal teeth and other characters, however, may be altogether different from those of that genus, I only place it here provisionally until specimens can be found giving more reliable information in regard to its affinities.

It is proportionally higher and has a different general outline from the last.

Locality and position.—Big Sioux River, three miles above its mouth; Dakota group of the Cretaceous series.

MACTRIDÆ.

Genus MACTRA, Linnæus.

Synon.—Mactra, Linn. (1767), Syst. Nat., ed., XII, 1125.—Müller (1776), Prodr., xxxi.—Brug. (1789), Encyc. Méth., I, xiii.—Lamarck (1799), Prodr., 85; and (1801) Syst. An., 121; also (1809), Phil. Zoöl.; and (1818), Hist., 471.—Féruss. (1821), Tab. Syst., xliv; also of many other authors.

Trigonella (sp.), Dacosta (1778), Test. Brit., 196 (not Conrad, 1837; nor Lovén, 1846).

Capisterium (part), Meusch., (1787), Mus. Gev., 462.

Callistoderma (sp.), Poli (1795), Test. Utr. Sic., II, 252.

Schizodesma, Gray (1837), London Magazine (n. s.), I, 370.—Swainson (1840), Malacol., 368.—Sowerby, jr. (1842), Conch. Man., 2d ed., 253.

Scissodesma, Gray (1842), Synon. Brit. Mus., 75.

Cymbophora, Gabb (1869), Geol. Report California (Palæont.), II, 180.

Etym.—μάκτρα, a kneading-trough.

Examp.—Mactra stultorum, Linn.

Shell ovate-subtrigonal, or trigonal; hinge with cardinal teeth moderately developed, that of the right valve usually smaller than in the left; lateral teeth elongated, prominent in the middle; ligament external or marginal, and occupying a triangular groove, opening into, or more frequently separated by a shelly ridge from the cartilage-pit, which is either a mere excavation in

* The slits or impressions left by these teeth in the cast are not represented near long enough in the engraving.

the hinge-plate, or a spoon-shaped cavity raised above the same; pallial sinus rounded or angular.

The above diagnosis is drawn up so as to include three groups that have been regarded by some as constituting distinct genera. This may be so; but I have preferred to unite them here as subgroups of the same genus, not only because the distinctions do not seem to be very important, or always strongly marked, but because it is practically impossible to distinguish between them, in most cases, among fossil species; while there may be some doubts which should retain the name *Mactra*, in case they should be separated as distinct genera. They may be separately defined as follows:

1. MACTRA, Linn. (typical = *Trigonella*, da Costa).

   Shell trigonal, or subtrigonal; ligament separated from the cartilage-cavity by a shelly ridge; pallial sinus rounded.—(Example as already stated.)

2. CYMBOPHORA, Gabb.

   Differs from the last chiefly in having its cartilage-cavity spoon-shaped, with its prominent margins raised above the hinge-plate, and the A-shaped cardinal tooth of the left valve more distinct from the margin of the cartilage-cavity.—*Mactra Ashburnerii*, Gabb.—(Apparently an entirely Cretaceous group.)

3. SCHIZODESMA, Gray.

   Shell trigonal; ligament connecting with the upper part of the cartilage-cavity; pallial sinus angular.—*Mactra stultorum*, Linn.

The question in regard to which of the species originally included by Linnæus in his genus *Mactra*, should be viewed as the typical form, has given origin to some confusion in nomenclature. If all of the species included by Linnæus belonged to one genus, it would, of course, be a matter of very little importance which one should be taken as the type. Unfortunately, however, this is not the case, and his diagnosis (as usual) is so short and indefinite as to give no aid in deciding this point; while he did not mention, or otherwise designate, which species *he* viewed as the typical form. Some high authorities in natural history, in such cases, always take the first species mentioned by an author as the type of a genus. If we were to follow this rule rigidly, we would have to regard *Mactra Spengleri*, Linn., as the type of the genus, which would make it exactly equivalent to Gray's more recently proposed group *Schizodesma*, which I have retained above as a subgenus.

As this rule, however, if systematically carried out, especially in conchology, would create great confusion in the nomenclature of the older genera, it has not been generally followed. On the contrary, both the British and American associations for the advancement of science, recommend the rule of allowing the first author that follows another who proposed a genus including more than one group, without in any way designating the type, to decide to which of the included forms the original name shall be applied in making subdivisions. The first author, I believe, who followed Linnæus in the use of the name *Mactra*, was Müller, in 1776 (Prodr. Zoöl. Dan.); and he mentions only the one species *Mactra solida*, Linn., the type of Gray's later group *Spisula*, generally regarded as generically distinct from *Mactra*, as now most usually understood. So, if we were to regard him as deciding which is to be taken as the type of *Mactra*, none of the groups defined in the foregoing diagnoses would belong strictly to that genus.

The fact, however, that Müller was merely enumerating a local fauna in his Prodrome, and did not propose to restrict or divide the genus, seems to be a sufficient reason for not regarding him as having selected *Mactra solida* as the type of the genus *Mactra*. In 1799, however, Lamarck, who was not making a mere list of a particular fauna, but writing a classification of the *Mollusca*, cites (in his Prodr., 85) *Mactra stultorum*, Linn., alone, as the example of the genus, as he also did in his later works. Consequently, Gray, Herrmannsen, and many others, have viewed this species as the type; which is also done in the foregoing definition of the same.

As thus defined, the genus *Mactra* will be seen to be closely allied, however, to *Spisula*, which differs chiefly, first, from the *Trigonella* group, in having its lateral teeth cross-ribbed, and its ligament not separated from the cartilage-pit by a shelly ridge. In the greater length and cross-ribbed character of its lateral teeth, as well as in its more rounded pallial sinus, it also differs from the *Schizodesma* section.

A few Jurassic, and some even older species, have been referred to the genus *Mactra;* but, so far as I am informed, none of them are known to possess the hinge-characters of this group. From the Cretaceous, however, species showing the hinge and other characters of sections of *Mactra* are known; while quite a number of others, the hinges of which have not been seen, present so exactly the general physiognomy, as well as the muscular

and pallial impressions of this genus, that we can hardly be far wrong in referring them to it. In the Tertiary rocks, we also find this genus well represented, as well as in the existing seas.

The living species are widely distributed, and usually occur along sandy shores, buried a little beneath the surface.

Mactra (Cymbophora?) Siouxensis, M. & H.

Plate 1, figs. 7, *a*, *b*, *c*.

Mactra Siouxensis, Meek and Hayden (May, 1860), Proceed. Acad. Nat. Sci. Philad., VIII, 179.

Internal cast oval-subtrigonal, moderately gibbous; anterior border narrowly rounded, posterior subangular at the extremity; base forming a nearly semi-ovate curve, the most convex part being toward the front; dorsum declining with a slightly convex outline behind the beaks, and distinctly concave just in front of them; beaks prominent, rather gibbous, very nearly central; pallial impression provided with an oval sinus, which appears to be a little narrower behind than in the middle, rounded at the anterior extremity, and extending nearly in a horizontal direction forward, about one-fourth of the length of the valves.

Length, 1.55 inches; height, 1.22 inches; convexity, 0.76 inch.

The only specimens of this species that I have seen are internal casts and moulds of the exterior, the shell itself being dissolved out. Some of these moulds show that the surface was marked by moderately distinct lines of growth, and that the escutcheon was lanceolate in form, and bounded on each side by a very obscure ridge, which extends from the back part of the beaks to near the postero-basal extremity.

Although related to our *M. Warrenana* this shell is more ventricose, has more elevated beaks, and its anterior border is less angular in outline, while the dorsum just in front of the beaks is much more concave.

Locality and position.—On Big Sioux River, two miles above its mouth, in a sandstone of the Dakota group, or formation No. 1 of the Cretaceous series of the Upper Missouri.

Mactra (Cymbophora?) formosa, M. & H.

Plate 39, fig. 7.

Mactra formosa, Meek and Hayden (Nov., 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 271.

Shell very thin, transversely ovate-subtrigonal, somewhat compressed; cardinal border sloping from the beaks at an angle of about 115°; posterior slope a little more convex than the anterior, which is nearly straight or slightly concave in outline above; extremities subangular, and very similar, excepting that the angle of the posterior is lower than the anterior; base forming a broad semi-oval or semi-elliptic curve; beaks small, rather depressed, incurved, approximate, and located near the middle of the shell. Surface marked by fine lines of growth, which become stronger, or rise into very small regular wrinkles on the large lanceolate lunule and escutcheon.

Length, 1.70 inches; height, 1.36 inches; breadth, 0.82 inch.

The lunule and escutcheon extend from the beaks to the extremities of the shell; the former being defined by a very slightly impressed margin, and the latter bounded on each side by an obscure ridge, which passes from the back part of the beaks to a point below the middle of the posterior margin, to which it imparts a subangular outline.

None of our specimens are sufficiently detached from the matrix to show very clearly the internal characters; but by grinding down upon the hinge of a right valve, it was found to be quite thin, and provided under the beak with a rather small, oblique, spoon-shaped cartilage-pit; while the posterior and anterior margins have each a long, sharply-defined groove, for the reception of the slender lateral teeth of the other valve. The cardinal tooth of this valve is very short and close to the margin. The hinge of the other valve is unknown.

Locality and position.—Mouth of Judith River, Idaho Territory; in beds holding a position at the horizon of the top of the Fox Hills group.

Mactra (Cymbophora?) Warrenana, M. & H.

Plate 30, figs. 7, *a*, *b*, *c*, *d*.

Mactra Warrenana, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 271.
Compare *Mactra* (*Cymbophora*) *formosa*, M. & H., pl. 39, fig. 7.

Shell rather thin, subtrigonal, moderately gibbous; cardinal border sloping from the beaks in front and rear, at an angle of about 110°; posterior slope slightly more convex than the anterior; extremities subangular, the anal end being a little more obtuse than the other; base forming a broad, regular curve; beaks moderately elevated, incurved, and approximate, rather gibbous and nearly central; lunule lance-oval, large, faintly impressed at the margins, and extending from the beaks nearly or quite to the anterior extremity; escutcheon having the same form, but still larger, and bounded on each side by a faint ridge, which passes from the beaks to the lower part of the anal border, to the outline of which it imparts a very slight angularity. Surface marked by faint, irregular lines of growth, which become more regular and distinct on the lunule and escutcheon. Muscular impressions not very deep, the anterior one narrow-ovate, pointed above, and a little arcuate, the other ovate; sinus of the pallial impression moderate, and rounded at the extremity.

We have not yet seen the hinge of this species, but its form and other characters are such as to leave little room for doubt respecting its generic relations. It is related to our *M. Siouxensis*, but its anterior margin is more angular in outline, and its pallial sinus is narrower and less broadly rounded at the extremity.* These differences, and their widely different geological positions, leave little reason to question the propriety of separating these shells specifically.

It is also very similar to our *M. formosa*, from which I am even led, by later comparisons, to suspect that it may not be distinct, though it seems to be more gibbous, and to have more prominent and ventricose beaks, while its dorsal slope, just in front of the beaks, is more concave in outline.

The specific name was given in honor of Lieut. (now General) G. K. Warren, of the United States Topographical Engineers.

Locality and position.—Moreau River and Long Lake, Dakota; in the Fox Hills group, or No. 5 of the Northwestern Cretaceous series. It also occurs at a somewhat higher position near Greely, Colorado.

* The pallial sinus is represented a little too wide and rounded in our fig. 7, *d*, which also makes the anterior outline of the shell too round.

Mactra (Cymbophora?) gracilis. M. & H.

Plate 17, figs. 18, *a*, *b*.

Mactra gracilis, Meek and Hayden (May, 1860), Proceed. Acad. Nat. Sci. Philad., XII, 179.

Shell small, rather thin, sub-ovate, moderately gibbous; anterior margin rounded, a little shorter and broader than the other; base forming a broad semi-ovate curve, being usually more prominent toward the front than behind; posterior side rather narrowly rounded, or subtruncate at the extremity; beaks moderately prominent, and located slightly in advance of the middle; escutcheon comparatively large, lance-ovate in form; surface marked by distinct, regular lines of growth (hinge unknown).

Length, 0.49 inch; height, 0.38 inch; convexity, about 0.24 inch.

I have placed this little shell provisionally in the genus *Mactra*, from external characters only, not having seen the hinge or pallial impression. At a first glance, it appears to be similar to our *Mactra Warrenana;* but, on comparison, it will be found to be more compressed, less nearly trigonal in form, the beaks being more developed, and not so nearly central, while the anterior outline is more rounded and the posterior side a little more extended; it also differs in being entirely destitute of any traces of a lunule-like area.

From all the other species of *Mactra* known in the Upper Mo. rocks, excepting our *M. Siouxensis*, it will be readily distinguished by its more rounded anterior outline, and the absence of any defined lunular space; and from *M. Siouxensis*, it may be known by its smaller size, much less elevated beaks (which are placed a little farther forward), and by having its dorsal slope, just in front of the beaks, not near so concave in outline.

If it should ultimately be decided by conchologists that the name *Mactra* shall be restricted to some of the other types, and the *Trigonella* group retained as a distinct genus, it is possible that this and the preceding species may have to be called *Trigonella gracilis*, *T. Warrenana*, and *T. Siouxensis*, as they have the general appearance; and at least two of them, the muscular and pallial impressions of that group, and their hinges are not *known* to correspond to that of *Cymbophora*.

Locality and position.—On the Yellowstone River, Idaho Territory, 150 miles above the mouth; in a bed containing a mingling of the fossils of the Fox Hills and Fort Pierre groups, or Nos. 4 and 5 of the Cretaceous.

Mactra (Cymbophora) alta, M. & H.

Plate 37, figs. 2, *a*, *b*.

Mactra alta, Meek and Hayden (1856), Proceed, Acad. Nat. Sci. Philad., VIII, 271.

Shell thin, triangular, compressed; dorsal slopes diverging from the beaks at an angle of about 110°; extremities subangular, or abruptly rounded; base forming a broad semi-oval curve; beaks much elevated, small or pointed, incurved, and very nearly central; lunule and escutcheon lance-oval, the latter being larger than the other and bounded by a more distinctly angular ridge; surface marked only by moderately distinct lines of growth. Hinge of right valve thick and strong, with the spoon-shaped cartilage-cavity large, and provided with very prominent margins; cardinal tooth small (not well shown in fig. 2, *a*), quite closely connected with the hinge-margin just in front of the cartilage-cavity; lateral teeth strong, and very distinctly double. Hinge of left valve unknown.

Length, about 2.62 inches; height, 2.15 inches; convexity, 1.15 inches.

Young individuals of this species, judging from the curve of the lines of growth on mature specimens, must resemble *M. formosa* in form; but even then the ridges bounding the lunule and escutcheon (particularly the latter) are more distinct. The beaks are also more elevated, and, in old or fully-developed individuals, the valves are decidedly more compressed, and proportionally much higher; it also attains a larger size than *M. formosa*, and has a thicker and stronger hinge.

So far as I have been able to make out the characters of its hinge from the left valve (fig. 2, *a*, pl. 37), this shell seems to agree well with *Cymbophora*, Gabb. Its cartilage-cavity appears to be connected with the slit for the reception of the ligament above; but this seems to be due to the breaking away of the raised upper margin of the pit. Mr. Gabb's figure of the hinge of *Cymbophora* does not show any marginal slit for the ligament; but this may have been accidentally omitted.

Locality and position.—Mouth of Judith River, on the Missouri; and at several localities in Colorado, west of Greely.

Mactra (Cymbophora?) nitidula, M. & H.

Plate 30, figs. 6, *a*, *b*, *c*.

Tellina nitidula, Meek and Hayden (1861), Proceed. Acad. Nat. Sci. Philad., XIII, 443.

Shell transversely subovate, compressed, very thin; anterior side regularly rounded; base semi-ovate, or somewhat straightened along the middle; posterior side narrower than the anterior, and narrowly rounded or subangular at the extremity below the middle; dorsal outline sloping from the beaks, the posterior slope being longer and straighter than the anterior; beaks moderately prominent, rather compressed, and placed a little in advance of the middle; posterior umbonal slopes showing a slight disposition to form an obscure ridge from the beaks toward the posterior basal extremity; surface with fine concentric striæ, and a few, irregular, stronger furrows of growth; muscular impressions very shallow; pallial line apparently of moderate depth, and rounded.

Length of a mature specimen, 1.11 inches; height, 0.87 inch; convexity, 0.42 inch.

In first describing this shell, it was stated that "we cannot determine with positive certainty its generic characters;" nothing being then known in regard to its hinge. From its extreme thinness, apparently slightly flexuous posterior, and general appearance, however, it was thought probably to belong to some of the less elongated sections of the genus *Tellina*, and referred provisionally to the same, with the remark "that the sinus of its pallial line seems to be rather short for a species of that genus."

On a more critical examination of the specimens, I became satisfied that the apparent slight lateral flexure of the posterior extremity of some of them is merely due to accidental distortion; and on clearing away some adhering portions of rock between the beaks, I soon found that it had no external ligament like that of *Tellina*. Consequently, it became evident that it must find a place in some other group. The difficulty, however, of determining the nature of its hinge still remained; none of the specimens showing the hinge-margin, while the hard rock filled the whole interior of them all. With the hope of developing, at least, some clew to the nature of its hinge, I ground away the rock, with much difficulty, from the inner side,

upon the cardinal margin of a left valve, watching carefully at frequent intervals for the appearance of the teeth. At first, a delicate Λ-shaped tooth made its appearance under the anterior side of the point of the beak, directed obliquely forward; then, after a little farther grinding, a slender, anterior, lateral tooth was seen with its posterior end close over the front division of the Λ-shaped cardinal, and extending forward close under the cardinal margin, but with a marginal furrow above it for the reception of a similar anterior lateral tooth in the other valve. Behind the Λ-shaped cardinal tooth, there also appeared, near the cardinal margin, a thin lamina or tooth, ranging very obliquely backward, so as to leave a wide space between it and the Λ-shaped cardinal, evidently for the reception of a cartilage-pit; the bottom of which, however, being hidden by the rock, could not be developed without grinding away all of the teeth. Exactly whether the oblique thin tooth or lamina behind, and extending forward over the cartilage-pit, is merely the raised margin of the latter, as in *Cymbophora*, or the anterior end of an elongated posterior lateral tooth, could not be determined; but there is evidently above and behind it, a long, narrow, marginal furrow for the reception of a posterior lateral tooth in the right valve.

From these hinge-characters, it is quite evident that this shell, notwithstanding its *Tellina* or *Arcopagia*-like look, belongs to the *Mactridæ*. It, however, is quite unlike any of the described genera of the *Mactrinæ* in form, and more nearly resembles some types of the *Lutrariinæ*, such as *Heterocardia*, to which I have been somewhat inclined to refer it.

The objection to referring it to the latter genus, however, is the fact that its valves seem to be closed all around, while those of *Heterocardia* are gaping behind. For the present, I have concluded to refer it provisionally to the genus *Mactra*, rather as a much nearer approximation to its true position, than as an expression of the opinion that it really belongs to that genus. In form it agrees, however, rather more nearly with *Spisula*, and it is possible that I would be nearer right to call it *Spisula nitidula*. Until a more satisfactory view of its hinge can be had, however, its true position must remain doubtful.

Locality and position.—Deer Creek, near the North Branch of Platte River; from the upper part of the Fort Pierre group, or the lower beds of the Fox Hills group of the Upper Missouri Cretaceous series.

PHOLADOMYIDÆ.

Genus PHOLADOMYA, Sowerby.

Synon.—Pholadomya, G. B. Sowerby (1823), Genera of Shells, fasc. 19.—Latreille (1825), Fam. Nat.—Defrance (1826), Dict. Sci. Nat., tab. xxxix, 535.—J. Sowerby (1827), Man. Conch., tab. 545.—Desbayes (1830), Encyc. Méth., III, tab. 1832; *ib.*, 756, and (1835) in Lam., 2e ed., VI, 63.—F. Roemer (1836), Verst. Ool., 126.—Bronn (1837), Leth., 384.—Agassiz (1842), Étud. Crit. Monl. Foss., 2e liv., 37.—Hanley (1842), Illust. Cat., App., 18; and of numerous other authors.

Pholadomyæa, Fleming (1828), Hist. Brit. An., 408 and 428.

Procardia, Meek (1871), Proceed. Acad. Nat. Sci. Philad., XIV, 184 (subgenus).

Etym.—Pholas; Mya.

Type.—P. candida, Sowerby.

Shell equivalve,* inequilateral, varying according to the species and sections, from transversely-oval or oblong, to rhombic, subtrigonal, trapezoidal, &c., generally ventricose anteriorly, pearly within; posterior extremity always more or less gaping; anterior closed or somewhat gaping; beaks varying greatly in prominence, convexity, and obliquity; hinge with an obscure, transversely slightly elongated cardinal tooth, and a small pit in each valve; cardinal margin often inflected, so as to form a kind of false area behind the beaks; ligament small and external; muscular and pallial impressions most usually obscurely defined, the latter provided with a moderately large sinus. Surface ornamented by radiating, often nodular or tubercular costæ, crossed by concentric striæ, or furrows.

The species of this extensive genus present very great diversities of form, ornamentation, and general appearance; yet, as remarked by Professor Agassiz, it seems to be very difficult, at least in the present state of our knowledge of these shells, to divide them into well-defined sections or subgenera. This difficulty arises, in part, from the gradual blending together, as it were, of widely different forms, and also, in part, from the great accidental distortions to which, owing to the thinness, and perhaps to some extent flexible nature of these shells, they have often been subjected, as we find them in the rocks.

Professor Agassiz, in his excellent monograph of the genus, separated the species then known into two primary divisions, distinguished by the first having a more or less defined false cardinal area, and the second by being nearly or quite destitute of the same.

* As noticed by Professor Agassiz, the costæ of the left valve are often more numerous and distinct than those of the right; thus indicating a very slight tendency to inequality of the valves, in some cases.

The first of these groups he subdivided into the following smaller sections: (1) the *Multicostatæ*, represented by such forms as *P. multicostata* and *P. semicostata*, Ag, and ranging from the Jurassic to the Cretaceous; (2) the *Trigonatæ*, represented by *P. arcuata* and *P. unda*, Ag., ranging from the Cretaceous to existing seas; (3) the *Bucardinæ*, represented by *P. cincta* and *P. decussata*, Ag., ranging from the Lias to the Tertiary.

The second primary division, he subdivided into (1) the *Flabellatæ*, represented by *P. pelagica* and *P. similis*, Ag., and apparently confined to the Jurassic; (2) the *Ovalaires*, represented by *P. tenuicostata* and *P. pectinata*, Ag., found in the Jurassic; and (3) the *Cardissoides*, represented by *P. cancellata* and *P. cardissoides*, Ag., also found in the Jurassic.

I have thought, however, that the arrangement might be simplified by disregarding, at least as a primary distinction, the presence or absence of a false cardinal area (in which character there seem to be numerous intermediate gradations, from species in which it is wanting, or only very slightly marked between the beaks, to others having it well defined along the whole hinge margin*), and grouping the subordinate sections as follows:

1. PHOLADOMYA, Sowerby (typical).

a. (= *Trigonatæ* (part), Ag.).—Shell generally transversely oval or oblong; both extremities gaping, or with anterior sometimes closed; beaks depressed or moderately prominent, sometimes the point of one indenting the other; surface with concentric ridges often extending upon the extremities, and crossed on the flanks by well-defined radiating costæ; false area obscure or wanting.—Type as stated above. (Cretaceous, Tertiary, and recent.)

b. (= *Multicostatæ* and *Flabellatæ*, Ag.).—Shell transversely oval, oblong, or more or less elongated; beaks rather depressed; radiating costæ well marked, scattering and prominent, or smaller and more numerous, generally confined to the flanks; false are well defined or obsolescent.—*P. semicostata* and *P. pelagica*, Ag. (Jurassic and Cretaceous.)

c. (= *Ovalaires*, Ag.). Shell transversely oval or oblong, rather compressed or moderately convex; gaping at one end; costæ linear, and often crenate; false area well defined.—*P. tenuicostata* and *P. pectinata*, Ag. (Jurassic.)

* This character, if we give it prominence, also separates widely, species that are closely allied in *all other* respects.

2. PROCARDIA, Meek.

a. (=? *Bucardinæ* (sp.), Ag.)—Shell short-subtrigonal, gibbous, with beaks elevated and strongly incurved or subspiral; anterior side very short, truncated, and impressed like a large cordate lunule, with a smaller, deeper, inner lunule under the beaks; cardinal margins strongly incurved and without a false area; surface provided with concentric furrows, crossed on the sides by distinct radiating costæ.—*Pholadomya Hodgii*, Meek. (Cretaceous.)

b. (=! *Bucardinæ*, Ag., and *Cardissoides* and *Trigonatæ* (sp.), Ag.).—Shell short-subtrigonal, generally high and very gibbous; anterior side often more or less truncated, and sometimes gaping; posterior generally distinctly gaping; beaks elevated; muscular and pallial impressions sometimes well defined; false area either defined or wanting; surface with a few, often tubercular, radiating costæ on the flanks, varying much in prominence.—*P. exaltata* and *P. cardissoides*, Ag., and *P. nodulifera*, Munster. (Jurassic.)

I am not quite sure that any of the species figured by Professor Agassiz, in his monograph, under the group *Bucardinæ*, belong properly to the typical section of the subgenus *Procardia*. The type of the latter, as may be seen by our figures, is a very peculiar shell. Its remarkably short, trigonal, gibbous form, elevated, subspiral beaks, and truncated front, with a deep inner lunule under the beaks, altogether present so unusual a combination of characters, that, in first publishing a preliminary description of it, I was left in considerable doubt in regard to the group or section to which it properly belongs, and placed it provisionally, with a mark of doubt, in the genus *Isocardia*. At the same time, however, I intimated that its general form, distinct double lunule, and radiating costæ, indicated quite different affinities, and suggested for it the provisional name *Procardia*, stating that it seemed to belong to the same group as the so-called *Cardium decussatum* of Sowerby.

As figured by Sowerby, Mantell, and Goldfuss, Sowerby's species mentioned above, certainly appears in no respect more than specifically different from the type of the foregoing section *Procardia*. But the form figured by Professor Agassiz under Sowerby's name *P. decussata*, is not only quite different in nearly all respects from the same, but differs so widely from the typical form of that species, as illustrated by the other authors already mentioned,

that I should not have suspected it to be the same, or even a nearly allied species. If Sowerby's species varies, however, so greatly as to include the forms figured by Professor Agassiz under the same name, and placed by him in his group *Bucardinæ*, the latter group would be at least partly identical with *Procardia*, and thus show such a transition from that type to the section *Bucardinæ*, that we might perhaps properly range the latter as a section of the subgenus *Procardia*. If, on the other hand, this transition between Sowerby's type and that figured by Professor Agassiz under the same name, has not been more decidedly established than can be done from the published figures, I should think Professor Agassiz's groups *Bucardinæ* and *Cardissoides* would properly form one, or perhaps several, distinct subgenera from *Procardia*. His names, however, are unfortunately not such as could be used for subgenera.

The genus *Pholadomya* is closely related to *Goniomya*, *Ceromya*, *Myacites*, *Pleuromya*, *Chænomya*, *Allorisma*, &c., but differs from them all in constantly having radiating costæ. In *Ceromya*, it is true, there are rarely faint radiating costæ; but in that group the beaks are more generally subspiral, and the general physiognomy different, while on the different laminæ the surface-markings of these shells (which are thicker than in *Pholadomya*) are not parallel, but run in various directions. *Goniomya* is also costate, but the costæ have a curious divaricating arrangement, and never radiate from the beaks; while the shell likewise differs in usually, if not always, having a very minutely-granulated surface. *Chænomya*, in addition to its noncostate and granular surface, also differs in its much more widely gaping posterior extremity.

Although species have been erroneously referred to the genus *Pholadomya* from older rocks, it seems highly probable that it commenced its existence during the Liassic period. The species are more numerous, however, in the later members of the Jurassic system, during the deposition of which it attained its greatest development. It was also well represented through the Cretaceous period, but much more sparingly in the Tertiary; and but one species (*P. candida*, the type of the genus) is known to be living at this time. This occurs in the West Indian seas, being found after storms on the shores of the island of Tortola, thrown up, as supposed, by the waves from deep water.

Pholadomya papyracea, M. & H.

Plate 5, figs. 4, *a*, *b*.

Pholadomya papyracea, Meek & Hayden (1862), Proceed. Acad. Nat. Sci. Philad., XIV, 27.

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 semi-ovate, 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. Cret.), 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 Lieutenant Mullen of the United States Topographical Engineers.

Locality and position.—Chippeway Point, near Fort Benton, on the Upper Missouri; in the Fort Benton group of the Cretaceous series of the Northwest.

Pholadomya subventricosa, M. & H.

Plate 39, figs. 8, *a*, *b*.

Pholadomya subventricosa, Meek and Hayden (May, 1857), Proceed. Acad. Nat. Sci. Philad., IX, 142.

Shell oval, very gibbous over the umbones and in the central and anterior regions; extremities rounded, the anterior end being slightly broader than

the other; base forming a subelliptic or semi-ovate curve; dorsum sloping with a concave outline behind the beaks, where it is provided with a distinctly circumscribed, rather broad, lanceolate area; hinge-margin straight, and not carinate. Beaks elevated, strongly incurved nearly at right angles to the hinge, closely approximate or touching, located near the anterior extremity. Surface ornamented by small, nearly equal, slightly flexuous, radiating costæ, which are crossed by numerous very small, more or less closely-arranged, concentric wrinkles or lines.

Length, about 2 inches; height, 1.10 inches; convexity, 1.10 inches.

Near the middle of the flanks, the slender radiating costæ are usually rather more closely arranged, being separated by spaces little, if any, greater than their own breadth. Toward the front, however, where they stand nearly vertical, and on the dorsal and postero-dorsal regions, where they are much more oblique, the intermediate spaces are broader; while on the anterior extremity, there is an ovate or subcordate area or space, apparently only marked by the concentric wrinkles. The small concentric wrinkles marking the whole surface are usually more closely arranged and less distinct than the costæ, to which they impart an obscurely roughened, or minutely tuberculate appearance.

It is a neat, symmetrical shell, resembling a Lower Greensand species described by Prof. E. Forbes, in the Jour. Geol. Soc. Lond. (I, 238, pl. 2, fig. 3), under the name of *P. Martini;* but its beaks are more elevated, and placed nearer the anterior end of the valves, and the concentric wrinkles are less distinct, while the radiating costæ are smaller and more closely arranged.

It is also related to a species described by me, from Vancouver's Island, in the Trans. Albany Institute (IV, 42), under the name of *P. subelongata;* but it has more elevated beaks, and finer as well as more numerous costæ, and is likewise a broader shell, with more obtusely-rounded extremities.

Locality and position.—Mouth of Judith River, Idaho Territory; in beds now known to hold a position at the horizon of the top of the Fox Hills group.

Subgenus PROCARDIA, Meek.

Pholadomya (Procardia) Hodgii, M.

Plate 13, figs. 3, *a*, *b*.

Isocardia? Hodgii, Meek (1871), Proceed. Acad. Nat. Sci. Philad., XXIII, 183.

Shell cordate-subtrigonal, very gibbous and short, the length only about equaling the height; beaks elevated, gibbous, involuted, and placed over the anterior margin; posterior dorsal slope abrupt, with margins strongly incurved, but not forming a false area; posterior extremity narrowly rounded or subangular below, and apparently moderately gaping; anterior side nearly vertically and abruptly truncated from the beaks to the subangular anterior basal extremity, and impressed or excavated so as to form a kind of large, cordate, lunule-like area, extending with the curve of the beaks nearly to their points; while within this there is a smaller, deeper, and more sharply-defined lunule under the beaks; basal margin forming a nearly semi-ovate curve from the anterior basal angle to the posterior basal extremity. Surface ornamented by small, nearly regular, radiating costæ, that are not defined on the anterior truncated end; crossing these are broader, less distinct, concentric ridges, that become smaller and more defined on the truncated anterior area.

Length and height, each 1 inch; convexity, 0.86 inch.

This shell is so peculiar that I know of but a single species with which it need be compared, that is, *Cardium decussatum*, Sowerby (= *Pholadomya decussata*, Ag.?), from which it differs specifically in its smaller size and much more slender and crowded radiating costæ.

I am under obligations to Dr. J. S. Newberry, the State geologist of Ohio, for the use of the type specimen of this species. It was brought from the Upper Missouri by Prof. J. T. Hodge, after whom I have named the species.

Locality and position.—Near the Great Bend of the Missouri, below Fort Pierre; in the Fort Pierre group of the Cretaceous series of that region.

Genus GONIOMYA, Agassiz.

Synon.—*Mya* (sp.), Sowerby (1814), Min. Conch., III (not of Linnæus).
Goniomya, Agassiz (1828), Verhandl. d. Schweiz., 102; and (1842) Étud. Crit. Sur. les Moll. Foss., I; also, Germ. Transl. Sow. Min. Conch. (1842), 275.—Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., 81; and others.
Lysianassa, Munster (1838), Goldf. Petref., II, 262 (not M. Edwards).
Pholadomya (part), d'Orbigny (1844), Paléont. Fr., Terr. Crét., III, 348; Prodr. de Pal. (1850), II, 49.—Pictet (1855), Traité. de Pal., III, 370.—Gabb (1861), Synopsis Mollusca of the Cretaceous Formation, 164 (not Sowerby).

Etym.—γωνία, an angle; *Mya*.
Type.—*Mya angulifera*, Sowerby.

Shell transversely elongate-oval, or oblong, rather convex, or more or less compressed, nearly or quite equivalve, generally inequilateral; inner layer pearly, outer subcorneous; extremities rounded or subtruncated, and gaping, the posterior hiatus being larger than the anterior; beaks depressed, contiguous, or approximate, submesial, or more or less in advance of the middle; ligament short, external or marginal; cardinal margin slightly thickened under the beaks, but without teeth; surface minutely granular, concentrically striated, and ornamented with costæ that are neither radiating nor parallel to the marks of growth, but descend and converge from the dorsal side before and behind the beaks, so as to connect along the flanks in a series of nearly equal angles, or by little short horizontal extensions; muscular scars faintly marked; pallial line unknown.

Although *Goniomya* is allied to *Pholadomya*, and by several authors included in that genus, these two groups can readily be distinguished by the peculiar divaricately-arranged costæ of *Goniomya;* those of *Pholadomya* always radiating from the beaks. *Goniomya* also has its surface occupied by numerous minute granules, not yet, I believe, seen on *Pholadomya*. There were, doubtless, likewise corresponding differences in the animals of these genera.

The granules of *Goniomya* are arranged in radiating rows, and seem to be confined to the outer subcorneous layer of the shell. Precisely similar minute granules are also seen on *Myacites*, *Allorisma*, *Chænomya*, *Sedgwickia*, and other allied genera, both recent and extinct. It is also proper to inform the student that even the peculiar divaricating character of the costæ seen in *Goniomya*, is sometimes assumed by species of very widely distinct

genera, both among extinct and recent mollusks. *Sanguinolites angulifera* of McCoy, from the Silurian (apparently an *Orthonota*), is an example of the latter; while the same style of ornamentation is also seen on a species of the recent genus *Unio* (*U. belliplicatus*, Meek), from near the junction of the Cretaceous and Eocene in Wyoming. In these and other similar instances, however, the shells are readily distinguished from *Goniomya* by other obvious characters.

The genus *Goniomya* seems to have made its first appearance during the deposition of the Liassic rocks, and attains its greatest development in the later Jurassic deposits. It also occurs less abundantly in the Cretaceous, but appears to have died out at the close of that period; no examples of it having yet been found in the Tertiary, or among existing mollusks

Goniomya Americana, M. & H.

Plate 30, figs. 12, *a*, *b*.

Goniomya Americana, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 81.
Pholadomya Americana, Gabb (1861), Synop. Moll. Cret. Formation, 164.

Our specimens of this interesting shell are too imperfect to give a very clear idea of its general form; but the curve of its lines of growth indicate a transversely oblong or narrow-oval outline, with a narrowly-rounded anterior, and a subtruncated posterior margin. Laterally, the valves appear to be rather compressed. The beaks are small, depressed, and placed in advance of the middle. The costæ are moderately distinct, though not very prominent, and at the deflection along the flanks form angles of from 20° to 30°. Those near the two extremities, although converging and passing down parallel to the others, do not meet to form angles along the flanks before they intersect the base. The surface shows obscure concentric markings of growth, which are crossed by the usual regular, equidistant, radiating rows of extremely minute granules, which appear, as seen under a magnifier, like minute drops of amber. The substance of the shell is very thin.

In its surface-markings, this species resembles *G. Duboisi* of Professor Agassiz (Étud. Crit. sur les Moll. Foss., t. 1, figs. 2–12), but its converging costæ continue to meet at the same acute angle as far as they can be traced toward the points of the beaks; while on the beaks of *G. Duboisi*, and most of the other allied species of which we have seen figures, these angles are truncated, the converging costæ coming down from before and behind the

beaks being united by short horizontal bars. Perfect specimens would doubtless show other corresponding differences.

It is probably more nearly allied to a species described by me from Vancouver's Island (Trans. Albany Inst., IV, 41), under the name of *Pholadomya* (*Goniomya*) *borealis*, but it is proportionally narrower, and has less elevated beaks.

Locality and position.—Moreau River, Dakota Territory; No. 5, or Fox Hills group of Nebraska Cretaceous series.

ANATINIDÆ.

Genus THRACIA, Leach.

Synon.—*Thracia*, Leach (1819), MS.; Blainville (1824), Dict. Sci. Nat., XXX, 347; and (1825) in Malacol., 564.—Rang (1829), Man., 324.—Deshayes (1830), Encyc. Méth., III, tab. 1832; *ib.*, 1038: and (1835) in Lam., 2e éd., VI, 82.—Menke (1830), Synon., 2e éd., 119, &c. (not *Thracia*, Westwood, 1840; a genus of insects).

Odoncinetus, Dacosta (1829), Cat. Syst., 32.

Odontocineta, Agassiz (1846), corr. in Index Univ., 255.

Shell transversely ovate or oblong, thin, inequivalve, compressed or moderately convex; posterior side somewhat narrowed, usually truncated and more or less gaping; surface concentrically striated, sometimes minutely scabrous; beaks entire; cardinal margin behind the beaks a little thickened, inflected, and somewhat projecting inward, so as to form in each valve a kind of cartilage-process; cartilage provided with a free crescentic ossicle; ligament partly internal; muscular impressions small; pallial sinus moderately deep.

This genus seems to be nearly related to *Corymya*, Agassiz; and it is thought by some that the latter is not generically distinct. According to Stoliczka, however, *Corymya* is provided with two more or less diverging, long, internal ribs, running from the beaks posteriorly and downward. The hinge-margin behind the beaks, although a little thickened, seems also to differ in not being so inflected and produced as in *Thracia*. Whether or not the pallial line in *Corymya* agrees with that of *Thracia* is yet undetermined; none of the numerous species of the former yet known showing any traces of it.

In regard to the period at which the genus *Thracia* made its first appearance, different opinions are entertained, owing to the difficulty of distinguishing the fossil species from those of *Corymya*. The opinion most generally

adopted is that it commenced its existence during the Jurassic period, and continued until the present time. Dr. Stoliczka, however, doubts its existence previous to the Tertiary, and thinks the Jurassic and Cretaceous species usually referred to it belong to *Corymya*.

It is quite possible, as we have elsewhere suggested long back, that the species here described may more properly belong to the genus *Corymya* than to *Thracia;* especially as the cardinal margin behind the beaks, as nearly as can be determined from casts and impressions, seems hardly to have been so strongly inflected in these shells as in the latter genus. The objection, however, to referring them to *Corymya*, is, that two of them show the pallial line, with its rather deep sinus, to be well defined, as in *Thracia;* while in all the numerous species of *Corymya* described by Professor Agassiz and others, not a trace of the pallial line has ever been seen.

The genus *Thracia* is certainly known to have been represented during the Tertiary epoch; and some eighteen or more species are known to inhabit our existing seas. The living species are widely distributed in the American, Chinese, and British seas, as well as in the Mediterranean and on the coast of Greenland, Norway, &c.

Thracia? subtortuosa, M. & H.

Plate 37, fig. 5.

Tellina subtortuosa, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 272.
Thracia subtortuosa, Meek (1864), Smithsonian Check-List N. Am. Inv. Cret. Foss., 14.

Shell transversely elliptical, compressed, and a little warped; anterior side rather narrowly rounded; posterior side subtruncate at the extremity, and provided with an obscure ridge, which (on casts) extends from the back part of the beaks obliquely backward and downward in the direction of the postero-basal border; pallial margin nearly straight, or forming a broad gentle curve, a little more prominent before than behind the middle, more or less arcuate laterally; dorsal margin declining slightly, with a convex outline in front of the beaks, and nearly horizontal behind them; beaks small, depressed, not very distinct from the dorsal border, located somewhat in advance of the middle; surface unknown.

Length, 2.23 inches; height, 1.27 inches; convexity (of a left valve), about 0.20 inch.

The only specimen of this species yet known is an internal cast of a left

valve, with portions of the inner laminæ of the shell adhering. On the surfaces of these, faint traces of radiating striæ are visible; but they appear to be due to the structure of the shell, and not connected with surface-markings.

The muscular impressions are shallow: the anterior one is narrow-ovate, placed near the anterior margin, and stands with its upper end slightly inclined backward; while the posterior is broad-ovate, located at the back extremity of the dorsal edge, and inclined obliquely forward.* The sinus of the pallial impression is rather broad, but a little longer than wide, and directed somewhat obliquely forward and upward, so as not to be exactly parallel with the horizontal axis of the shell. It appears to be rounded at the extremity, and extends about two-fifths of the distance from the anal margin toward the middle of the valves.

The narrow-elliptic and compressed form of this species, together with its depressed beaks, will distinguish it from all of the otherwise similar shells known to occur in the Nebraska rocks. Since first describing it, I have worked away the matrix from the hinge, and find it presents, as near as can be determined, more the characters of *Thracia* than those of *Tellina*. Until better specimens can be examined, however, there must remain some doubts in regard to its generic relations.

Locality and position.—Mouth of Judith River, Idaho Territory, on the Missouri; in a sandstone of Cretaceous age, now known to hold a position at the horizon of the top of the Fox Hills group.

Thracia gracilis, M. & H.

Plate 39, figs. 6, *a*, *b*.

Tellina gracilis, Meek and Hayden (April, 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 82.
Thracia? gracilis, Meek and Hayden (Nov., 1856), *ib.*, 284.

Shell transversely elliptical-ovate, moderately compressed, extremely thin and fragile; anterior end rounded; posterior half rather contracted, vertically subtruncated, and apparently a little gaping at the extremity, provided with an obscure ridge, which passes from the beaks obliquely backward and downward toward the postero-basal margin; ventral outline forming a broad, semi-ovate, or semi-elliptic curve; dorsum sloping slightly and convex in front of the beaks, concave and declining somewhat behind them; beaks

* Unfortunately, neither of these impressions is represented exactly right in our figures, being made to appear too obtuse above. The anterior one, especially, should be pointed, instead of rounded, at the upper end.

small, rather depressed, located just behind the middle of the shell. Surface marked by very fine lines of growth.

Length, 1.56 inches; height, 1.05 inches; convexity, 0.56 inch.

I have not yet seen the hinge or pallial impression of this species, and consequently have some doubts in regard to its affinities, though an examination of better specimens than those first obtained indicates that it is most probably a *Thracia*.

It appears to be related in form and other external characters to some of the shells referred by Professor Agassiz to his genus *Corymya*, among which we would mention the Liassic species *C. lens* (Étud. Crit. sur les Moll. Foss., tab. 36, figs. 1–15). Our shell, however, has its beaks located farther forward, and is proportionally more depressed and elongated than young individuals of *C. lens* of the same size.

M. d'Orbigny describes a few Cretaceous species in the Palæontology of France, resembling this more or less in form, which he refers to the genus *Periploma*; they all differ, however, in having slightly more gibbous beaks, and straighter ventral margins.

Locality and position.—Same as last.

Thracia? Prouti, M. & H.

Plate 37, figs. 6, *a*, *b*.

Tellina Prouti, Meek and Hayden (April, 1856), Proceed. Acad. Nat. Sci. Philad., VIII, 83.
Thracia Prouti, Meek and Hayden (1860), *ib.*, XII, 425; Meek (1864), Smithsonian Check-List, 14.

Shell transversely ovate, compressed, very thin and fragile; right valve slightly more convex than the left; anterior end elliptically rounded; posterior half more contracted, and narrowly rounded or subtruncated at the extremity, provided with an obscure ridge extending from the beaks to the postero-basal margin; base forming a broad semi-ovate curve, more or less warped or slightly curved laterally; dorsum declining gradually with a convex outline in front of the beaks, concave immediately behind them, and sloping posteriorly; beaks moderately elevated, closely approximate or touching, a little gibbous, located very near the middle of the shell; surface marked by fine lines of growth.

Length, 2.42 inches; height, 1.60 inches; convexity 0.83 inch.

The posterior muscular impression (I have not seen the other one) is subtriangular, and placed between the postero-dorsal margin and the oblique

ridge extending down the anal side. The pallial impression is moderately distinct, and provided with a nearly oblong, slightly tapering sinus, which is raised a little above the horizontal axis of the shell, and subtruncated or obtuse at the extremity; it extends about four-ninths of the distance from the anal border toward the anterior margin of the shell.

I have not yet been able to see the hinge of this species, but at first referred it provisionally to the genus *Tellina*, from external characters. Although still in doubt respecting its true relations, I am now inclined to think it presents more the appearance of a *Thracia* or a *Corymya*, and consequently remove it for the present to the former of these genera.

It resembles the last of the preceding species very nearly, but is larger and more compressed, and its basal margin more warped. It also differs in having a thicker shell, which shows, on exfoliated inner laminæ, faint traces of minute, fine, radiating striæ.

Professor Agassiz describes from the Upper Oolite a rather closely-allied form under the name of *Corymya Studeri* (Étud. Crit. sur les Moll. Foss., 269, tab. 35.) Our shell, however, appears to be a little less gibbous over the umbones, and has a more triangular posterior muscular impression. It is quite probable that this and the last of the foregoing species may have to be removed from the genus *Thracia*, and called *Corymya gracilis* and *C. Prouti*.

Locality and position.—Same as last. (Collection of Dr. Prout, Saint Louis, Mo.)

Genus LIOPISTHA, Meek.

Synon.—*Cardium* (sp.), Roemer (1849), Texas, 405; and (1852) Kreid. von Texas, 48 (not Linn.).
Pholadomya (sp.), Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 81.—?Stoliczka (sp.), (1870), Palæont. Indica, III, 79, pl. II, figs. 10-11 (not Sowerby).
Liopistha, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 12 and 32 (as subgenus).—Conrad (1873), Suppl. Kerr's Geol. Report N. Car. (issued in advance of the report). 28 (as a genus).
Cymella, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 12 and 32 (as a subgenus).—Conrad (1873), Kerr's N. Car. Geol. Report (suppl.), 10 (as a genus).
Poromya (sp.), Stoliczka, (1870), Palæont. Indica, III, 38 (not *Poromya*, Forbes, 1844).

Etym.—λεῖος, smooth; ὄπισθε, behind.
Type.—*Cardium elegantulum*, Roemer.

Illustrations of typical Liopistha.

Fig. 20.

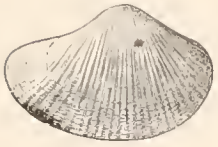


Fig. 23.

Fig. 24.

Fig. 21.

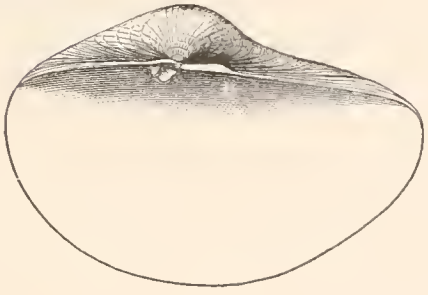
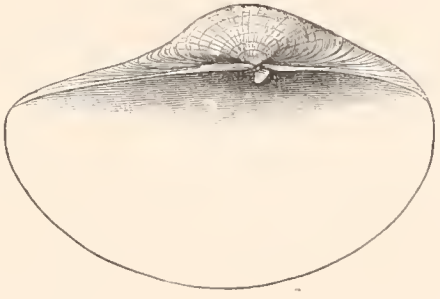


Fig. 22.



Liopistha protexta, Conrad.

Fig. 20. Exterior of right valve, natural size.
Fig. 21. Hinge of same, magnified two diameters, to give a general idea of its appearance.
Fig. 22. The same of left valve, with only the anterior conical tooth preserved.
Fig. 23. Dorsal view of right valve, magnified, to show the projection of the hinge-teeth.
Fig. 24. Hinge and adjacent parts of same more highly magnified, and turned so as to be seen more from the inner side, to show details of teeth and pits; *a. t.* being the anterior tooth; *a. p.*, the anterior pit; *p. t.*, the posterior tooth; *p. p.*, the posterior pit; and *f.*, the fulcrum.

Illustrations of the subgenus Cymella.

Fig. 25.

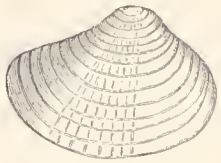


Fig. 28.

Fig. 29.

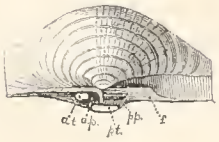


Fig. 26

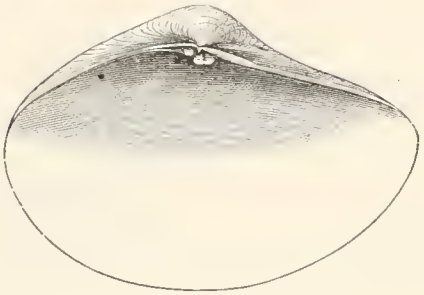


Fig. 27.

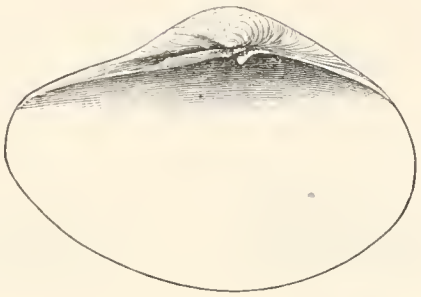


Fig. 30.

Cymella bella, Conrad.

Fig. 25. Exterior of right valve, natural size.

Fig. 26. Hinge-view of right valve, magnified two diameters, to give a general view of its appearance and for comparison with fig. 21, of *Liopistha* proper.

Fig. 27. The same, of opposite valve, for comparison with fig. 22.

Fig. 28. Dorsal view, magnified, to show profile or projection of hinge-teeth.

Fig. 29. Hinge and adjacent parts of right valve, more highly magnified, and turned over so as to be seen from inner side, to show details of teeth and pits; *a. t.* being the anterior tooth; *a. p.*, the anterior pit; *p. t.*, the posterior tooth; *p. p.*, the posterior pit; and *f.*, the fulcrum.

Fig. 30. Same view of the left valve, magnified, and seen in same way; the letters pointing to the corresponding teeth and pits as in the other valve.

Shell equivalve, inequilateral, transversely subovate, being usually narrower, more compressed, and often subrostrate behind, and ventricose in the central and umbonal regions, nearly always extremely thin; extremities rounded in outline, the posterior side usually a little gaping; surface granular, and varying, according to the sections and species, from radiately costate on the flanks and front of the valves, to strongly undulate concentrically, with only a few impressed, radiating lines on the middle, or rarely nearly smooth, concentrically striate, or furrowed, with obsolescent radiating striæ; dorsal margins generally inflected so as to form a sort of false area along its entire length; hinge with two prominent cardinal teeth, projecting out at right

angles from close up under the hinge-line, beneath the beak of the right valve (the posterior tooth being larger and compressed, and the anterior pointed), and one prominent and one rudimentary cardinal tooth under that of the left; lateral teeth none; ligament external; fulcra short and erect. (Pallial line unknown.)

The foregoing diagnosis is intended to include three sections that seem to fall within one generic group, although at one time I regarded two of them, then only known from mere external characters, as being rather widely separated from each other. These subordinate sections may be distinguished as stated below:

1. **LIOPISTHA**, Meek (typical).

Shell transversely subovate, ornamented, excepting on the posterior dorsal portions of the valves, by regular, simple, well-defined, sometimes subcrenate, radiating costæ.—(Type as already stated.)

2. **CYMELLA**, Meek.

Shell of much the same form as the last, but differing in having only large, strong, regular, concentric surface-undulations, crossed by a few impressed, radiating, linear markings on the middle portions of the valves.—*Pholadomya undata*, M. & H.

3. **PSILOMYA**, Meek.

a. Shell agreeing with the above sections in form and thinness, or sometimes a little more gibbous, but having the radiating striæ or ridges nearly or quite obsolete, and the radiating rows of granules, or spine-base, usually more distinct.—*Poromya lata*, Forbes.

b. Shell large, thick, with well-defined concentric furrows and ridges.—*Poromya superba*, Stoliczka.

This genus is undoubtedly allied, in some of its characters, to *Poromya*, Forbes, as may be inferred from the fact that two of the East-Indian Cretaceous species believed to belong to it, were actually referred by Professor Forbes, the founder of the genus *Poromya*, to that group. This fact would deter me from referring these Cretaceous shells to any other genus, were it not that they *certainly disagree* in their hinge-characters (as well as in general form) with the detailed description of the hinge and other peculiarities of the recent typical species of *Poromya*, published by Forbes and

Hanley nine years later, from much better specimens than that upon which Professor Forbes originally founded the genus. I have not seen his first description, published in 1844 (Report on the Moll. Æg. Sea, 143), but it seems that he had but an imperfect specimen, as the diagnosis published by him and Hanley (Hist. Brit. Moll., I, 203), in 1853, is said to have been made out from a much more satisfactory specimen. Their diagnosis, in the latter of the works quoted above, gives the hinge-characters as follows: "a minute cardinal ossicle or erect tooth in one valve, lodged in a pit or rather depression in the other; no lateral teeth." The ligament they here describe as being "external," and the pallial line as being "very slightly sinuated."

It is evident that Professor Forbes was unacquainted with the hinge-characters of the East-Indian Cretaceous shells, already alluded to as having been by him referred to *Poromya*, in 1844 (Trans. Geol. Soc. London, 2d ser., VII, 140); because he does not illustrate the hinge in any of his figures, or mention it in his description of any of the species; while in a generic diagnosis given there, he describes the hinge (evidently from the true *Poromya* and not from the Cretaceous species then before him) as having "in the right valve a strong cardinal tooth," and in the left, the "cardinal tooth obsolete;" characters which, it will be seen, are quite different from what the Indian Cretaceous species, then before him, are now known to present.

Nine years later (Appendix to Hist. Brit. Moll., IV, 250), Professors Forbes and Hanley give a more detailed description of *Poromya* from perfect recent specimens, in which they describe the hinge as having under the beak of the right valve "a strong and bluntly-cloven tooth, which, rising from the lower edge, curves with some slight obliquity upward," and farther add, that "a short and very small triangular cartilage-pit occupies the upper portion of the area behind it." The hinge of the left valve they here describe as having "the hinder half of the plate slightly hollowed out, excepting at the lower edge, as a subtrigonal shallow depression, that is barely divided in front below by an obscure thin ridge, from the tiny but deep triangular excavation (which receives the opposite tooth); the remaining level, or slightly-raised anterior surface, which projects with a somewhat bifid extremity above the latter, into the large triangle, suggests the idea of a complicated dentition."

It will be observed that in none of these descriptions is it stated that *Poromya* proper has more than *a single* cardinal tooth in the right valve, or *any* well-defined teeth or tooth whatever in the left valve; while the presence of a small internal cartilage-pit is constantly mentioned. Nyst, who first described the typical species of *Poromya* doubtfully under the genus *Corbula* (Coq. et Polypiers Fossiles Terr. Tert. de la Belgique, 71), from Tertiary specimens, also says that "its hinge is provided with one tooth." H. and A. Adams, who, as has been pointed out by Deshayes and Dr. Stoliczka, wrongly make *Poromya* a synonym of *Thetis*. Sowerby (an extinct genus, with which they were not well acquainted), describe the hinge, apparently partly, at least, from the typical *Poromya*, as having "a single erect cardinal tooth in the right valve, received into a corresponding fossa in the left;" adding, also, that there are "no lateral teeth in the right valve, but an anterior and posterior lateral tooth in the left; ligament internal, inserted in a socket in each valve."* Deshayes likewise describes the hinge of *Poromya*, from a Paris-basin shell, as having "one conical sharp tooth in each valve; that of the left valve being smaller and sometimes obsolete."† His species, however, is a transversely-oblong, *decidedly* inequivalve shell, that appears to me to be very unlike the typical *Poromya*, and to have no analogy whatever to our Cretaceous forms.

In first proposing the names *Liopistha* and *Cymella* for two Cretaceous shells, I was led to do so entirely from their peculiar external characters; none of the specimens then known to me showing the hinge of either. Since that time, thanks to my friend Mr. T. A. Conrad, of Philadelphia, I have had an opportunity to study typical specimens of each, discovered by him, showing the hinge-characters in the most satisfactory manner. By his permission, I have had prepared the wood-cuts at the head of this description, showing the hinges and exterior of these shells. From these it will be seen that in both there are two well-developed cardinal teeth under the beak of the right valve, and one equally well developed, with a smaller oblique or horizontal, rudimentary second cardinal in the left, without any internal cartilage-pit in either valve. Of the two cardinals of the right valve, the posterior one is the larger and (in *Cymella*) compressed from above and below, being a little

* Genera Recent Moll., II, 367. The lateral teeth they must have seen in some of the other types that they cite as synonyms.

† Suppl. Coq. Foss. des Environs de Paris, I, 248.

widened horizontally, and extending out at right angles from beneath the beak, with a slight upward curve, as it were, from close up under the hinge; its free end being transversely truncated. Partly over and slightly in advance of the anterior margin of this tooth, there is a second well-defined, but smaller, pointed cardinal, directed in the same way as the other. Partly between these, or mainly under the smaller tooth, there is a deep pit, for the reception of the larger cardinal of the other valve; while behind this pit, over the posterior part of the larger tooth, there is a shallower pit, directed nearly horizontally backward, just beneath the cardinal edge, for the reception of the smaller rudimentary tooth of the other valve; the two pits mentioned being separated by a very minute vertical ridge, extending down from directly under the very point of the beak. In the left valve (*Cymella*), there is just in front of, and below the apex of the beak, a well-defined, subtrigonal, rather pointed, conical, anterior cardinal tooth, flattened on top and a little curved upward, extending out at right angles to the hinge—this being the tooth that occupies the larger pit mentioned, partly between the two teeth of the other valve—that is, passing mainly under the smaller and partly above the anterior side of the larger. Immediately over this principal cardinal of the left valve, there is a small pit for the reception of the anterior or smaller tooth of the other valve; and just behind this, there is some appearance of a minute vertical ridge, similar to that seen in the other valve; while a little farther back, there is a slight, nearly horizontal projection, or second rudimentary posterior cardinal tooth (that might be easily overlooked without a careful examination), which, when the valves are united, fits into and exactly fills the little horizontal pit mentioned, over the posterior and larger tooth of the other valve. Directly under this little horizontal tooth of the left valve, the under-side of the cardinal margin shows a rather wide excavation for the reception of the larger flattened posterior tooth of the other valve, which thus passes under the margin of the left valve. None of the specimens examined show any traces of lateral teeth; nor have I yet seen any in a condition to show the muscular and pallial impressions.*

Notwithstanding the fact that my friend Mr. Conrad has adopted both *Liopistha* and *Cymella* as distinct genera, and I am, as might be expected, naturally desirous that they should be both sustained as such, if it can be

*Mr. Conrad describes *Cymella* as being pearly. None of those I have seen, however, show this character clearly.

consistently done, I frankly confess that a very careful study of specimens of each, showing clearly their hinges as well as their external characters, leads me to the conclusion that they cannot be properly separated more widely than as well-marked subgenera of the same group, and even this has to be done mainly on external ornamentation; that is to say, the surface of *Liopistha* is ornamented by usually well-defined, regular, simple, radiating costæ on all parts of the valves excepting the posterior dorsal, and sometimes a little of the anterior dorsal regions; while in *Cymella*, the surface is ornamented by large, regular, rounded, concentric undulations, that are crossed only on the middle portions of the valves by a few impressed, radiating lines. Both have the same general form, the same extremely thin shell, and granular surface; the larger granules in each being arranged in radiating rows, and presenting the appearance of having been minute spine-bases. On comparing the hinges, we also find that in *Liopistha* proper, there are the same characters in nearly all respects that have already been described in detail; the only observable difference being that in *Liopistha* the posterior cardinal tooth is not quite so broad, directed a little more obliquely forward, with a slight anterior slope. Its anterior tooth of the right valve, as well as that of the left, agree well with the corresponding teeth of that of *Cymella*: and although I have seen no specimen showing clearly the posterior cardinal and pits of this valve, it is evident from those of the right valve that they *must* correspond very closely with what we see in *Cymella*. Indeed, I do not think the differences mentioned in the *hinge-characters alone*, greater than we might expect to see in different species of the same subgenus. For these reasons, I am compelled to adopt the conclusion that these types should not be more than subgenerically separated, especially as the Indian Cretaceous species mentioned seem, partly at least, to bridge over, as it were, the differences in the surface-ornamentation described; being to some extent intermediate in these characters, though they appear to form a third section of the same genus.

As already stated, Professor Forbes referred the East-Indian Cretaceous species mentioned to *Poromya*, without knowing their hinge-characters. Dr. Stoliczka, having the advantage of the extensive collections obtained by the Indian geological survey, succeeded in making out the hinges of these Cretaceous species quite clearly; and, although he follows Professor Forbes in referring them to *Poromya*, it will be observed that they do not agree in

these characters with that genus as defined by Forbes, Nyst, H. and A. Adams, or any one else, but that their hinges correspond in all essential details with the group here under consideration, as the shells do in other respects. It will also be noticed that, in giving a diagnosis of the genus *Poromya* (not from the typical species, but evidently partly, at least, from the Cretaceous species before him), Dr. Stoliczka departs entirely from all of the previous descriptions, of Forbes, Nyst, Deshayes, and others, of that genus, and describes the hinge as having "*a strong tooth in the left valve, and two smaller ones in the right*," and says that in each there is "a posterior groove, in which was lodged a small cartilage;" also, adding that "the pallial line is submarginal, and the posterior sinus small."* The latter character, however, he may have taken from the true *Poromya*, as he does not illustrate or mention the pallial line in connection with his figures or descriptions of the Indian Cretaceous shells; though they and our types may, and probably do, possess a small pallial sinus.

In regard to the little "posterior groove," supposed by him to have been for the reception of a small internal cartilage, I feel quite confident, from examining his figures, that this is only the pit, I have mentioned in the right valve of our shells, for the reception of the rudimentary posterior cardinal tooth of the left; which small tooth he overlooked in his *generic* diagnosis, though he illustrates it in one of the figures of his *P. superba*, and actually mentions it in his *specific* description of that shell. That the pit mentioned by him, or any of those described by me, could have been for the reception of an internal cartilage, I cannot for a moment believe, for the simple reason that in our shells at least (which I am confident present no generic differences from the Indian species mentioned), each one of these pits exactly corresponds to, and is *entirely filled* by, a tooth, or slight projection in the hinge of the opposite valve.

I have been, I fear, tediously particular in defining this genus, and in pointing out the characters in which it differs from *Poromya* proper, as well as its identity with the Indian shells mentioned, not only because these Cretaceous shells have been wrongly confounded with *Poromya*, but also because I have been rather sharply criticised by Dr. Stoliczka for proposing the groups *Liopistha* and *Cymella*. The first he insists is not distinct from *Pholadomya*, because he thinks he has found *Pholadomya caudata*, Roemer, or at

* Palæont. Indica, III, 38.

least an Indian species referred by him to the same, to have the hinge of a *Pholadomya*; and from his remarks one would almost think that I had either founded the genus *Liopistha* on that species, or, at least, that I had included it in proposing this genus. The fact is, however, that my type-species was, as already stated, *Cardium elegantulum*, Roemer; and I did not even allude to *Pholadomya caudata* in any way in connection with *Liopistha*.

Nevertheless, from Dr. Stoliczka's figures of the exterior, and the hinge of the right valve of the Indian shell that he refers to *P. caudata*, I am inclined to believe that it will be found to be a *Liopistha* and not a *Pholadomya*, notwithstanding his very positive assertion to the contrary. At any rate, it agrees exactly in thinness and general form, and has the same granular and costate surface; while the flattened cardinal tooth shown in his figure of the right valve corresponds *closely* to the character of the posterior cardinal tooth in *Liopistha* and *Cymella*, excepting that it is placed *slightly* farther forward. Now, if we were to break out the very delicate anterior cardinal tooth of a right valve of a *Liopistha*, its agreement with Dr. Stoliczka's figure would be *exact* in almost every respect. Hence, I suspect that the Indian shell figured by him as *Pholadomya caudata* is really a *Liopistha*, and that the right valve figured by him to show the hinge, had lost the small anterior cardinal tooth by some accident.* Of course, however, this may or may not be so, without in any way affecting the question in regard to *Liopistha* being clearly and entirely distinct from *Pholadomya*, as any one may at once see by reference to our cuts of the hinge of the former.

On the other hand, Dr. Stoliczka speaks of *Cymella* as a dubious sort of genus, which he seems to think scarcely distinct from *Poromya*. So far as regards its relations to the Indian shells referred by *him* to *Poromya*, I can agree with him that *Cymella* is not more than subgenerically distinct from the same: but, for the reasons already stated, I must differ with him, and maintain that both the Indian species and the typical forms of *Cymella*, as well as *Liopistha*, are generically distinct from the true *Poromya*.

So far as I am at this time informed, the genus *Liopistha*, including the subgenera, is confined to the Cretaceous rocks. It includes *L. elegantula* (= *Cardium elegantulum*, Roemer), *L. protexta*, Conrad, *L. rostrata*, Meek,

* As an illustration of this, I would refer to Mr. Conrad's figure of the hinge of the right valve of *Cymella*, as given in the supplement of the North Carolina Report, which figure was evidently drawn from a specimen that had met with precisely this very accident, as may be seen by comparing his figure with our cut (Fig. 26) of the hinge of the right valve of the same species.

L. (*Cymella*) *undata* (= *Pholadomya undata*, M. & H.), and *L.* (*Cymella*) *bella*, Conrad, of this country; also, *L.* (*Psilomya*) *lata*, and *L.* (*Psilomya*) *globosa* (= *Poromya lata*, and *P. globosa*, Forbes), as well as *L.* (*Psilomya*) *superba* (= *Poromya superba*, Stoliczka), from the Cretaceous of India. As remarked by Mr. Conrad, *Cardium subdinnense*, and *C. Cornulinianum*, d'Orbigny, from the Cretaceous rocks of France, have at least the external characters of *Liopistha* proper, and probably belong to this group; though their hinge-characters may possibly be found different, when they can be made out.

In regard to the family-affinities of *Liopistha*, I would merely remark, that, notwithstanding its apparent relations to *Poromya*, which nearly all authorities place in the *Corbulidæ*, it seems to me to belong more properly in the *Anatinidæ*, so far as can be determined from all of its characters yet known.

Subgenus CYMELLA, Meek.

Liopistha (Cymella) undata, M. & H.

Plate 39, figs. 1, *a*, *b*.

Pholadomya undata, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 81.
Pholadomya (*Cymella*) *undata*, Meek (1864), Smithsonian Check-List N. Am. Cret. Invert. Foss., 14 and 34.

Shell transversely broad-ovate, approaching subtrigonal, moderately gibbous; anterior end rounded; posterior side narrower and a little more compressed, rounded chiefly from below; base forming a regular semi-ovate curve; dorsal margin sloping rather abruptly in front of the beaks, straighter and declining more gradually behind; hinge-margins straight, and inflected so as to form a well-defined false area both behind and a little in front of the beaks, which are somewhat elevated, incurved at right angles to the hinge-line, and located a little in advance of the middle of the shell. Surface ornamented by about seventeen to twenty of the simple, rounded, rather strong, regular, concentric undulations, which are broader than the depressions between, and, as it were, cut by the radiating linear furrows, on the central region of each valve, into about the same number of much smaller, simple, radiating costæ, less than, or nearly equaling, the furrows by which they are separated.

Length, 0.95 inch; height, 0.76 inch; convexity, 0.48 inch.

The radiating costæ occupy a triangular area on the middle of each valve, covering more than one-third of the entire surface, while the remaining

spaces on the posterior and anterior ends of the shell are only marked by the strong concentric undulations. These costæ are smaller and rather more closely arranged toward the front side of the shell, and gradually increase in size and become more distant and oblique posteriorly. They are only defined on the undulations, and not in the depressions between.

There are no traces of the lines of growth on any of our specimens; and the muscular and pallial impressions must be faintly defined, as no indication of them have been observed on any of the casts yet seen.

The only other species of this type with which I am acquainted is *C. bella*, described by Mr. Conrad from the Cretaceous rocks of North Carolina (Kerr's Geol. Report N. C., Appendix, 10, pl. 2, figs. 2, 8), which also occurs in New Jersey, and is very closely allied to the species here described. The only difference I have been able to see is that Mr. Conrad's species has rather more prominent and ventricose beaks, and less closely-arranged radiating markings. In all other respects, the two forms are almost exactly alike.

Our specimens first described did not show the granules of the surface, but I have since seen them quite clearly on one brought in with more recently received collections. They seem to be arranged in the usual radiating rows.

Locality and position.—Mouth of Judith River, on the Upper Missouri, in Idaho Territory; in Cretaceous beds now known to hold a position at the horizon of the top of the Fox Hills group.

Genus NEÆRA, Gray.

Synon.—*Neæra*, Gray (1834), Griffith's An. Kingd.—Forbes (1843), Proceed. Zoöl. Soc., 75; Report Brit. Mus. (1844), 143.—Morris (1843), Brit. Foss., 93.—Recluz (1844), Rev. Zoöl., IV, 47.—Hinds (1844) Zoöl. Sulph., 69.

Neara, Gray (typ. err.), (1839), Rev. Zoöl., 122; (1842), Synon. Brit. Mus., 78; (1847), Zoöl. Proceed., 92.

Cuspidaria, Nordo (1840), Rev. Zoöl., 30.

Naeara and *Naera*, Sowerby, (1842). Conch. Man., 95, 198, 310.

Etym.—Νέαιρα, a nymph, mother of Lampet'a.

Type.—*Mya rostrata*, Hinds.

Shell transversely globose-pyriform, distinctly rostrate, and more or less gaping behind; right valve usually smaller than the other; surface smooth, or concentrically costate or striate; umbones strengthened within by a posterior ridge; hinge provided with a small, oblique, spoon-shaped tooth, or cartilage-process, in each valve, in front of which there is often a small tooth; right valve with a more or less developed posterior lateral tooth; ligament

small, external; cartilage-ossicle small, subcircular; sinus of pallial line shallow.

In several respects, this genus seems to be related to the *Corbulidæ*, in which some conchologists range it. The presence of a free ossicle in the cartilage of these little shells, however, as well as some of their other characters, appears to indicate relations to the *Anatinidæ*.

The genus *Neæra* was probably introduced toward the latter part of the Cretaceous epoch. A few species, however, have been referred to it from the Jurassic rocks; but they are only known, I believe, from external characters, and probably belong to the genus *Leda*, or some other group. Several species are known from the Middle and Upper Cretaceous rocks, and the genus was more abundantly represented during the deposition of the Tertiary formations. It is also represented by a number of species in the seas of the present epoch, where it probably attains its maximum development. The recent species are widely distributed, and inhabit deep waters. They are found on the coasts of China, Borneo, Chili, Madeira, New Guinea, Norway, Britain, &c., as well as in the Mediterranean.

Neæra ventricosa, M. & H.

Plate 30, figs. 3, *a*, *b*, *c*, *d*, *e*.

Corbula ventricosa, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 83.
Neæra ventricosa, Meek and Hayden (May, 1860), *ib.*, XII, 185.

Shell small, nearly or quite equivalve, rather thin, very ventricose in the anterior and central regions; anterior margin somewhat narrowly rounded; base very deeply rounded toward the front, contracted behind; posterior side longer than the other, narrow, compressed, and rostriform; dorsum sloping gradually with a concave outline behind the beaks, declining more abruptly in front; beaks prominent, apparently equal, not oblique, located a little in advance of the middle; pallial border smooth; surface marked by rather distinct, concentric striæ.

Length, 0.32 inch; height, 0.20 inch; convexity, 0.14 inch.

A right valve of this species in the collection shows the cavity under the beak for the reception of the cartilage to be very small and narrow. Just behind this cavity, there is a prominent, horizontally-compressed, curved tooth, which projects distinctly beyond the cardinal margin. The posterior muscular impression, which is narrow, somewhat irregular, and quite strongly

marked, is located immediately behind the projecting tooth, close up under the cardinal margin. The anterior muscular impression is larger, proportionally broader, and more shallow than the other; and the sinus in the pallial impression is broad, triangular, and short. Both the anterior and posterior pedal scars are distinct from those of the adductor-muscles.

Leda fibrosa of Evans and Shumard* (Trans. Acad. Sci. St. Louis, 40, 1857) has very nearly the form of this species, but will probably be distinguished, even where the interior cannot be seen, by its more unequal beaks, and fibrous structure.

Our shell is also quite similar to the recent *Neæra cuspidata*; but its rostrate posterior extremity is straighter on the upper border and the hinge thicker; while the posterior tooth is more prominent, and the sinus of the pallial impression a little deeper.

Locality and position.—Moreau River, Dakota Territory, from the Fox Hills group, or formation No. 5; also, from the upper part of the Fort Pierre group, at the same locality.

Neæra Moreauensis, M. & H.

Plate 17, figs. 11, *a*, *b*, *c*.

Corbula Moreauensis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 83.
Neæra Moreauensis, Meek and Hayden (1860), *ib.*, XII, 185.

Shell small, nearly equivalve, very gibbous or subglobose toward the front; anterior side prominently rounded below; base deeply rounded in front, and contracted behind; posterior side very narrow, abruptly compressed, and rather distinctly rostrated; dorsal border concave in outline just back of the beaks, thence extended nearly horizontally behind; convex and declining abruptly in front; beaks prominent, ventricose, and apparently inclined a little backward, located in advance of the middle. Surface of the gibbous part of the shell ornamented by strong, regular, concentric lines, or small costæ, which, in passing upon the contracted posterior side, become fine, closely-crowded striæ.

Length, nearly 0.36 inch; height, 0.19 inch; convexity, 0.17 inch.

I have not yet seen the hinge of this species; but from its form and general appearance, there can be very little room for doubt in regard to the propriety of placing it in the genus *Neæra*. It will be easily distinguished from

* Possibly a *Neæra*.

the preceding species by its small, distinct, regular, concentric costæ, instead of mere striæ.

Locality and position.—Moreau River, Dakota Territory; in the Fox Hills group, or formation No. 5; and on the Yellowstone River, in beds containing a blending of the fossils of that rock and the Fort Pierre group.

CORBULIDÆ.

Genus CORBULA, Bruguiere.

Synon.—*Corbula*, Brug. (1792), Encyc. Méth., pl. 230.—Lamarck (1799), Prodr., 89; and (1801) Syst. An. 137; also, Ann. du Mus., VIII, 465; and (1818) Hist. Nat., V, 495.—Blainv. (1818), Dict. Sci. Nat., X, 397.—Defr. (1818), *ib.*, 398.—Neilsson (1827), Petref. Suec., 17.—Desh. (1830), Encyc. Méth., III, 7.—Sowerby, jr. (1842), Conch. Man., 2d ed., 122.—Geinitz (1846), Grund. Verst., 413.—Gray (1847), Proceed. Zoöl. Soc., 191.—H. and A. Adams (1856), Gen. Recent Moll., II, 355, &c.

Aloidis, Mühlf. (1811), Entwurf, 67.

Agina, Turton (1822), Brit. Bivalves, 54.—Latreille (1825), Fam. Nat. (Germ. ed.), 211.—Fleming (1828), Brit. An., 459.—G. B. Sowerby, jr. (1842), Conch. Man. (2d ed.), 60.

Lentidium, De Crist. and Jan (1832), 8.—Villa (1841), Disp. Syst., 45.

Pachydon, Gabb (1868), Am. Jour. Conch., IV, 198 (not *Pachyodon*, Stutchberry, 1842, = *Thalassides*, Berger, 1833; nor *Pachyodon* (written *Paxyodon*), Schum., 1817, = *Hyria*, Lamarck, 1814).

* *Anisothyris*, Conrad (1871), Am. Jour. Conch., VI, 196.—H. Woodward (1871), Ann. Mag. N. H. (4th ser.), VII, 104.—Dall (1872), Am. Jour. Conch., VII, 90 (subgenus).

Anisorhynchus (Con. MS.), Meek (1872), Hayden's Second Prelim. Report U. S. Geol. Survey Territories, 293 (as a subgenus).

Etym.—*Corbula*, a little basket.
Type.—*Corbula sulcata*, Lamarck.

Shell subtrigonal, transversely-oval, or subpyriform, generally rather thick, gibbous, inequivalve, the lēft valve being smaller than the other; anterior outline more or less rounded; posterior side closed, generally more produced, sometimes subrostrate; surface concentrically striate or costate, and covered by an epidermis; hinge with one prominent cardinal tooth in front of the cartilage-pit in the right valve, and a projecting cartilage-process in the left; rarely with a slight projection of the cardinal margin, resembling a rudimentary posterior lateral tooth; pallial sinus shallow or obsolete; scar of pedal muscle generally distinct from that of the anterior adductor.

The foregoing diagnosis and synonymy include three sections that have

* Mr. Conrad proposed the name *Anisothyris*, under the impression that Mr. Gabb's name, as corrected to *Pachyodon*, could not be used, because it had been applied by Stutchberry to another genus in 1842; while *Paxyodon* of Schum., used for another genus, would, when corrected, also become *Pachyodon*. Stutchberry's name, however, is a synonym of *Thalassides*, Berger, 1833; while Schumacher's is also a synonym of *Hyria*, Lamarck, 1817. Consequently, the name *Pachyodon* would seem to have been free to be used for a new genus at the time Mr. Gabb published, as has, I believe, since been noticed by Mr. Conrad.

been sometimes regarded as constituting as many distinct genera; but which appear to me not more than separable as subgenera. They may be separately defined as follows:

1. CORBULA, Brug. (typical).

Shell varying from oval to subtrigonal or subglobose, with but slight obliquity of the beaks or cartilage-process; very rarely with even the slightest traces of a posterior lateral tooth. Type as stated above.—(Strictly marine.)

2. ANISORHYNCHUS, Conrad.

Shell nearly or quite equivalve, transversely pyriform, the posterior side being rostrate; beaks nearly equal, and distinctly incurved; hinge, muscular, and pallial impressions exactly as in *Corbula* proper, excepting that the cardinal tooth is furrowed.—*Corbula pyriformis*, Meek. (Associated with fresh and brackish water types.)

3. PACHYODON (= *Pachydon*, Gabb, and *Anisothyris*, Conrad).

Shell variable in form, generally with obliquely subspiral beaks; cardinal process very oblique; sometimes with a rudimentary posterior lateral tooth.—*P. obliqua*, Gabb. (Associated with marine and estuary types.)

In regard to the propriety of including *Pachyodon* and *Anisorhynchus* as subgenera under *Corbula*, there may be different opinions. It is worthy of note, however, in this connection, that the names *Pachyodon* (or *Pachydon*) and *Anisothyris* were proposed by Mr. Gabb and Mr. Conrad for the first, under a misapprehension in regard to the cartilage of the typical species; that is, both of these gentlemen supposed that these shells had a small external ligament, and no internal cartilage; which would, of course, be a good generic distinction. On examining a full series of nearly or quite all of the described species of this group, sent by Professor Orton to the Smithsonian Institution, I saw that some of the valves have a little furrow in the cardinal margin near the beaks, that presents *very much* the appearance of being for the reception of a small external ligament. Other individuals, however, showed nothing of the kind; and on examining specimens with the opposite valves united, it became clearly evident that this little furrow, when present, is merely for the reception of the slightly-lapping dorsal edge of the opposite valve; so that there is really not the slightest space for even a very

weak external ligament. Again, on adjusting together match-valves, and then parting their ventral margins a little so as to be able to see the inner side of the hinge, the pit in the right valve is seen to be only partly filled by the cartilage-process of the left, thus leaving ample space for an internal cartilage, exactly as in *Corbula* proper. On mentioning these conclusions to Mr. Conrad, he wrote back that he was satisfied that they are correct, and that the group would have to rest on the oblique subspiral character of the beaks, the obliquity of the cartilage-process, and the brackish-water habits of these mollusks.

Mr. Dall, however, who adopts the group under Mr. Conrad's name *Anisothyris*, as a subgenus under *Corbula*, maintains that some of the associated shells are true marine types, and therefore argues that these forms for which the new genus was proposed may also be marine, or at least have lived in an estuary but little diluted by the influx of the fresh water that brought in the fresh-water types; and, consequently, that they may not be generically distinct from the marine typical forms of *Corbula*.

That these shells are, as a whole, peculiar in the obliquity and subspiral character of beaks, and their oblique cartilage-process, as well as in the possession, in some specimens, of a rudimentary posterior lateral tooth, is not denied. But, as remarked by Mr. Dall, it would hardly be possible to draw up a generic diagnosis that would separate them entirely from *Corbula*, and at the same time include *all* of the species: because, in some the rudimentary posterior lateral tooth is wanting, although at the same time the specimens without this rudimentary tooth agree with the others in all other respects; while we do sometimes see obscure traces of such a tooth in true marine species of *Corbula*. Again, the species vary in obliquity as well as in the degree of the subspiral character of the beaks.* Some are also very inequivalve, while others are almost equivalve. About the only distinguishing characters, therefore, left, are the obliquity of the cartilage-process and the *general* obliquity and subspiral character of the beaks.

Mr. Woodward, of the British Museum, in the paper cited in the synonymy, expressed the opinion that this group is not only distinguished from *Corbula* by the forward obliquity of its beaks, but by having the cartilage-pit and tooth in the *left valve*, and the cartilage-process in the *right*, instead of

* *Corbula* (*Anisothyris*) *ledæformis*, Dall, from exactly the same locality and position as the other species, has its beaks nearly erect, or but little oblique.

the reverse. In regard to this latter character, however, that usually very accurate naturalist was, doubtless from inadvertence, certainly mistaken: the arrangement of these parts with relation to the right and left valves being exactly as in *Corbula* proper.

In regard to the propriety of retaining Mr. Conrad's section *Anisorhynchus*, as subgenerically distinct from *Corbula*, there seem to me to be even stronger reasons for doubts than in the case of the South-American type for which the name *Pachyodon* has been proposed. Mr. Conrad proposed this name (*Anisorhynchus*) for the reception of a species described by me under the name *Corbula pyriformis*,* from some brackish, or nearly fresh water deposits in Wyoming. I believe he proposed to make the separation mainly, if not entirely, on the ground of the apparently brackish-water habits of this species, without knowing the characters of its hinge and interior. I have, however, had an opportunity to examine good specimens, showing the hinge and interior of both valves perfectly; and the only differences I could see between this shell and the typical forms of *Corbula*, are, that its hinge-tooth is furrowed, and its valves and beaks more nearly equal, and the latter more incurved than is usual in that genus; while the shell presents a *Neæra*-like form, being narrowed or rostrate behind. It is worthy of note, however, that Mr. Gabb has described a marine Cretaceous species of *Corbula* in vol. II of the California Palæontology, presenting almost *exactly* the same form and general appearance.† In addition to this, another species found directly associated with the *C. pyriformis*, in Wyoming, and named *C. Engelmanni* by me, has not this *Neæra*-like form, but agrees in general outline with many marine types of *Corbula*.

That the types of both *Pachyodon* and *Anisorhynchus may* have presented some generic differences in the anatomy of the animal from *Corbula*, is admitted; but, in the present state of our knowledge of these shells, it does not seem to me desirable to separate them more than subgenerically.‡

The existing South-American brackish-water group *Azara*, d'Orbigny, is also included, by several eminent authorities on conchology, as a subgenus

* See Mr. King's Report U. S. Geol. Survey of the Fortieth Parallel, part Palæontology, pl. 17, figs. 2, *a*, *b*. *c*, *d*.

† *Corbula alæformis*, Gabb, Palæont. Cal., II, pl. xxix, fig. 63.

‡ Dr. Stoliczka mentions brackish-water Indian species that cannot be distinguished from typical marine forms of *Corbula*, excepting that their shells are thin and resemble *Neæra* in outline (Palæont. Indica, III, 35).

under *Corbula*, to which it is evidently nearly related. These shells, however, differ from *Corbula* in having a small tooth on each side of the cartilage-pit, instead of only a single prominent tooth on its anterior side, as well as in having the cartilage-process broad and spatulate. The animal is also said to differ from that of *Corbula* in having elongated, instead of very short, siphons.

Until the hinges and interior of a number of fossil bivalves, now only known from external characters, can be studied, it will be difficult to determine the geological range of the genus *Corbula* with precision. Species have been referred to it from the Carboniferous rocks; but, so far as I have had an opportunity to ascertain from specimens and the published figures, there seems to be very little probability that they really belong to this genus. The same may also be said even in regard to the few Triassic species yet described under the name *Corbula*, though it is quite possible that this group may have been represented during that epoch. In the Jurassic, however, we meet with shells apparently presenting the characters of this genus, and its existence in the Cretaceous rocks is well established. The genus was also well represented through the Tertiary period, during which it nearly or quite attained its greatest development. In the existing seas, however, it still seems but little, if at all, less numerous, and the species are widely distributed.

The older species appear all to belong to the typical section; while the type of the proposed subgenus *Anisorhynchus* occurs in beds belonging to the oldest Eocene or the latest Cretaceous. The species of the group *Pachyodon* came from beds in South America apparently not older than Miocene.

Corbula crassimarginata, M. & H

Plate 17, figs. 14, *a*, *b*, *c*.

Corbula crassimarginata, Meek and Hayden (Oct., 1860), Proceed. Acad. Nat. Sci. Philad., VIII, 425.

Shell very small, short, oval-subtrigonal, rather gibbous; right valve but slightly larger than the other; basal border semi-ovate in outline, the most prominent part being toward the front, rather straighter behind, and very distinctly thickened externally, so as to form a marginal band, which is most prominent on the right valve; posterior side a little longer than the other, and subtruncated at the extremity; umbonal slopes forming a prominent oblique ridge from the back part of each beak to the postero-basal

extremity, which is subangular in outline; beaks small, nearly equal, pointed, incurved, and located slightly in advance of the middle. Surface smooth, or only obscurely undulated near the umbo of the right valve, and showing, in some conditions under a good lens, very faint traces of obsolete radiating striæ near the thickened border.

Length, 0.15 inch; height, 0.13 inch; convexity, 0.09 inch.

This little shell is remarkable for having the pallial border, particularly of the right valve, thickened so as to form a distinct marginal band; and for being very nearly equivalve. The cardinal margin of the right valve seems to overlap that of the other slightly; but, in all other respects, their borders are almost exactly equally prominent. It will be readily distinguished by its obvious characters from all the other forms known in these formations; and I know of no nearly-allied foreign species. It must be very rare, as only a single specimen has yet been found.

Locality and position.—Moreau River, Dakota Territory; from the Fox Hills group of the Upper Missouri Cretaceous series.

Corbula inornata, M. & H.

Plate 30, figs. 4, *a, b, c, d.*

Corbula inornata, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 52.

Shell small, oval-subtrigonal, very gibbous, distinctly inequivalve; anterior side of right or larger valve irregularly rounded or obliquely truncated above, and subangular below; anterior side of smaller valve more narrowly rounded; posterior side of both obliquely truncated above, and more or less distinctly angular below; basal margins of each nearly straight, or but slightly convex in outline, a little warped laterally, and not crenulated within; beaks subcentral, that of right valve considerably elevated above the other, flattened or depressed on top, incurved, and sometimes truncated at the point by pressure against that of the other valve. Surface nearly smooth, or only marked by very obscure lines of growth, and a few indistinct, irregular undulations.

Length, 0.27 inch; height of right valve, 0.23 inch; height of left valve, 0.20 inch; convexity of the two valves, 0.22 inch.

The posterior umbonal slopes are obtusely angular from the beaks quite down to the postero-basal border, and within this angle on the truncated posterior portion of each valve, but more distinctly on the right, a narrow

groove extends from the back part of the beaks, obliquely backward and downward to near the middle of the anal border. On internal casts, a rather distinct, broad, obtusely angular depression is seen just back of the beak of each valve, apparently as though corresponding to a ridge or prominence on the interior of the valves. The inequality of the valves results almost entirely from the greater convexity and more elevated beak of the right valve, and not from its margins extending beyond the edge of the other.

Locality and position.—Long Lake, near Fort Pierre, Dakota Territory; from the Fox Hills group of the Upper Missouri Cretaceous series.

Genus CORBULAMELLA, M. & H.

Synon.—*Corbula?* (sp.), Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 84.
Corbulamella, Meek and Hayden (1857), *ib.*, 143.—Gabb, Synopsis Moll. Cret. Formation, 111.—Stoliczka (1870), Palæont. Indica, III, 37.

Etym.—*Corbula*; and *lamella**, a little plate.

Type.—*Corbula? gregaria*, M. & H.

Shell small, inequivalve, subequilateral, trigonoid-subglobose; right valve more convex than the left; hinge of right valve, with a comparatively large cartilage-pit under the beak, and just in front of this pit provided with a conical tooth; left valve with a tooth or cartilage-process fitting into, and partly filling the pit of the other valve; interior of each valve with a very prominent, spoon-shaped process, connected with, or bearing the posterior muscular scar; pallial line apparently a little sinuous.

The type of this genus is a very small shell, having apparently precisely the form and hinge of *Corbula*, but differing remarkably in the possession of a very prominent, spoon-shaped plate or process, connected with the posterior muscular scar of each valve. This process is somewhat similar to that seen in *Cardilia*, Deshayes, but more prominent and rounded below. The nature of the hinge and the inequivalve character of the shell, however, readily distinguish it from that genus.

At first, I was in doubt whether or not this genus has an internal cartilage as in *Corbula*; but a single specimen, since examined, with the two valves united, and the cardinal margins exfoliated, or worn away so as to expose the hinge from above, shows that the tooth or process of the left valve

* It will be seen that *Corbulalamella* would have been the correct orthography of this name; but as it was at first inadvertently printed as above, I do not think it a matter of sufficient importance to render the change now desirable, especially as it would make the name inconveniently long.

does not entirely fill the pit under the beak of the other valve, but leaves space enough for an internal cartilage, as in *Corbula*.

Nothing is known in regard to the geological range of this genus beyond the fact that the typical and only known species occurs in the Upper Cretaceous.

Corbulamella gregaria, M. & H.

Plate 17, figs. 13, *a*, *b*, *c*, *d*.

Corbula? gregaria, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 84.
Corbulamella gregaria, Meek and Hayden (1857), *ib.*, IX, 143.

Shell very small, globose-subtrigonal; anterior side rounded below; posterior side subtruncated at the extremity; base rather broadly rounded, sometimes a little more prominent toward the front than behind; dorsum sloping abruptly from the beaks in front and rear; beaks prominent, gibbous, and subcentral, that of the right valve rising distinctly above the other; both incurved nearly or quite at right angles to the hinge. Surface smooth, or only marked by very obscure lines of growth, and a few faint, irregular, undulations.

Length and height, each 0.13 inch; convexity, 0.10 inch.

The inequality of the two valves consists not merely in the more elevated beak and more gibbous form of the right valve, but its pallial border also extends beyond that of the other valve. The tooth, or cartilage-process, of the left valve is larger and more prominent than in the right. The anterior muscular impression is narrow-ovate, faintly marked, and placed near the border; the posterior impression has the same form, and appears to occupy nearly or quite the whole surface of the projecting lamina, which is sharp on its free edge, and a little concave or spoon-shaped. The sinus of the pallial impression is quite shallow, and apparently a little angular.

Locality and position.—Occurs in great numbers on the Yellowstone River, Montana Territory; in beds containing a mingling of the fossils of the Fort Pierre and Fox Hills groups, or formations No. 4 and No. 5 of the Upper Missouri Cretaceous series.

SAXICAVIDÆ.

Genus GLYCIMERIS, Lamarck.

Synon.—*Glicimeris* (sp.), Klein (1753), Ostrac., 170 (not in accordance with the binomial system).
Glycimeris, Lamarck (1799), Prodr., 83.—Gray (1847), Zoöl. Proceed., 189; and (1851), Brit. Aceph. and Brach., 62.—H. and A. Adams (1855), Gen. Recent Moll., II, 350 (not Browne, 1756, Humphrey, 1797, nor Stoliczka, 1870; not *Glycymeris*, Lam., 1801 and 1809; nor Schum., 1817).
Panopea, Ménard de la Groye (1807), Ann. du Mus., IX, 135.
Panopæa, Lamarck (1812), Extr. d'un Cours, * *; and (1818), Hist., V, 456; also of numerous others, but not H. and A. Adams, 1856, nor Stoliczka 1870.

Etym.—γλυκύς, sweet; μερίς, a part or portion.
Type.—*Mya glycimeris*, Born (=*Panopea Faujasi*, Ménard de la Groye).

Shell large, transversely oblong, with extremities gaping, and surface concentrically furrowed and covered by an epidermis; hinge with a single cardinal tooth in each valve, fitting into a corresponding pit in the opposite valve; ligament attached to prominent external fulera; pallial impression continuous, but provided with a deep posterior sinus.

This genus is closely allied to *Panomya*, Gray (= *Panopæa*, H. and A. Adams, 1856, = *Glycimeris*, Stoliczka, 1870), but differs in having the siphons of the animal united quite to their free extremities, instead of being separated at the ends. The shell is also generally thinner, and its pallial line differs in being continuous instead of interrupted or broken up as in *Panomya*, though it is deeply sinuous in both. Slight differences are likewise observed in the hinge-teeth of these genera.

Owing to the fact that shells belonging to several genera of the *Anatinidæ*, closely resembling this genus, are found in rocks of various ages, it is difficult to ascertain its exact geological range. We frequently see species referred to it, under the name *Panopæa*, even from the Palæozoic rocks, particularly from the Carboniferous and Permian; but, although some of these shells very closely resemble this genus in form, the gaping of the valves, &c., it is almost morally certain that none of them really belong even to the same family. At least, all of them that I have had an opportunity to examine differ from *Glycimeris* (= *Panopæa* of some) in being very thin shells, with a minutely granular surface, and, so far as known, without hinge-teeth. Hence, they fall into the genera *Chænomya*, *Allorisma*, and other groups. The Triassic, Jurassic, and some of the so-called Cretaceous Panopæas also

belong to the genera *Pleuromya*, *Platymya*, *Myacites*, and other groups of the *Anatinidæ*. In the Cretaceous rocks, however, we meet with other species, which, so far as is yet known, seem to belong to this genus. It also occurs in the Tertiary rocks, and is now represented by a number of living species in our existing seas. If all of the Cretaceous species, however, that seem undistinguishable from this genus, really belong to it, it would appear to have attained its greatest development during that epoch.

The living species of this genus have a wide geographical distribution, and are usually found burrowing in sand at and near low water. *G. Australis* is said to penetrate sandy bottoms to depths of several feet. The shells of *G. glycimeris* sometimes attain a length of six to eight inches (Woodward).

The name *Glycimeris*, which, it seems to me the rules of nomenclature will compel us to retain for this genus, has, unfortunately, been applied (with slightly-varied orthography) by different authors to widely different genera. It was used as far back as 1553, by Belloni, for a group which, according to Herrmannsen, included only *Nucula* and *Pectunculus*, Lamarck. Klein was, I believe, the first author who applied it to a group including the genus here under consideration, along with species of *Mya* and *Lutraria*. As neither of these authors, however, come within the binomial rule of nomenclature, they cannot, I should think, be properly regarded or quoted as the founders of genera.

In 1799, however, Lamarck applied it, in a strictly binomial sense, to the genus here described, and cited, as the typical species, *Mya glycimeris*. Consequently, I regard him as the founder of the genus, and that species as its type. It is true, he afterwards used the name for another genus, in 1801, and at a later date, and was followed in this by many authors; while he also subsequently adopted Ménard de la Groye's later name *Panopæa* for the genus here under consideration. But I do not see how that alters the case in the least; for, when an author once regularly publishes a new genus, designating a well-known species as its type, he has no further control over it, and can only modify or cancel it under circumstances where it would be admissible for any one else to do so. If his typical species, as proposed in 1799, had proved to belong to an older genus, so that his *Cycimeris* of that date became a synonym, *then* he might, according to the rules of many naturalists, have used the name for another genus; but this was not the case.

Glycimeris occidentalis, M. & H.

Plate 39, figs. 9, *a*, *b*.

Panopæa occidentalis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 270.

Shell transversely subovate, or oblong, moderately gibbous; anterior end narrowly rounded; posterior end broader, subtruncate, and distinctly gaping; base straight along the middle, rounding up abruptly behind, and more gradually in front; dorsum in front of the beaks nearly straight, and declining forward, and horizontal, or but slightly declining behind them; beaks small, rather depressed, somewhat incurved at right angles to the hinge, located a little in advance of the middle. Surface ornamented by small, irregular, concentric wrinkles, which are most distinct in the region of the umbones.

The only specimen of this species yet seen, has the outer layer of the shell partly exfoliated, and is not in a condition to have preserved fine surface-markings, if they ever existed. Part of the posterior side and base are also broken away; consequently, it is possible that, when perfect specimens are obtained, it may be found necessary to modify the foregoing description in some respects, especially in regard to the form of the adult shell. The curves of the lines of growth, however, show that young individuals, when about one inch in length, agreed in form with the above description.

Not having seen the hinge and interior of this shell, it has been referred to the genus *Glycimeris* from external characters only. It may be congeneric with some of the forms included in the genus *Myopsis*, Agassiz, 1845.

As near as can be determined from our imperfect specimen, it must have been, when entire, about 3.50 inches in length, 2 inches in height, and about 1.42 inches in convexity.

Locality and position.—Mouth of Judith River on the Missouri, in beds holding a position at the horizon of the top of the Fox Hills group.

SOLENIDÆ.

Genus PHARELLA, Gray.

Synon.—*Pharella*, Gray (1854), Ann. and Mag. N. H., V, 24 (2d ser.).—H. and A. Adams (1854), Gen. Recent Moll., II, 343.—Chenu (1862), Man. Conch., II, 22.
Solen (sp.), of many authors; not of Linnæus.

Etym.—*Pharus* (dimin.).
Type.—*Pharella Javanica*, Linn. (sp.).

Shell much elongated transversely, subcylindrical, or somewhat compressed, with both ends rounded and gaping; surface covered with an oliva-

ceous epidermis; beaks subcentral, or placed about half-way between the middle and the front; hinge with two thin teeth in the right valve, and three in the left, the middle one of the latter bifid; anterior adductor-scars elongated very obliquely forward and downward, and placed near the anterior upper margin; pallial sinus very small.

The animal of the existing species of this genus has the siphons very short, and the lobes of the mantle protected by a wrinkled epidermis. The pedal opening is terminal, and the foot straight and truncated.

Species apparently belonging to this genus are found in Cretaceous rocks; but, owing to the fact that we know nothing of their hinge-characters, and rarely see any traces of their pallial line, we cannot be positively sure that they belong here. The genus was represented during the Tertiary epoch; while some three or four species are known to exist at the present time, and are found inhabiting muddy estuaries.

This seems to be a rather small group, that was probably not much, if any, more abundantly represented during former geological periods than at present. It is most nearly related to *Pharus*, but differs in the details of its hinge-teeth, and in wanting the strong, oblique, internal ridge, seen under the hinge in that genus, as well as in the structure of the animal.

Pharella? Dakotensis, M. & H.

Plate 1, fig. 3.

Solen? Dakotensis, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 242.
Pharella? Dakotensis, Meek and Hayden (Oct., 1860), *ib.*, XII, 125.—Gabb (1861), Synop. Moll. Cret., 161.—Meek (1861), Smithsonian Check-List Cret. Fossils, 15.

Shell elongated and narrow, rather compressed; dorsal and ventral margins nearly straight and parallel; posterior extremity very narrowly rounded, and apparently only moderately gaping; beaks scarcely distinct from the dorsal margin, and located nearly or quite centrally. Surface of cast retaining faint traces of concentric marks of growth; cardinal margin of cast showing a very obscure sulcus along its entire length, both before and behind the beaks.

Length, about 1.55 inches; height, 0.35 inch; convexity, 0.20 inch.

This shell resembles *Pharella? equalis* (= *Solen equalis*, d'Orbigny, Palćont. Fr., Terr. Crét., III, pl. 350, figs. 5 et 6), more than any species I have seen figured in works on palæontology; but it is proportionally narrower, or more depressed in form.

The only specimen yet found is a cast apparently of the interior, but it may be of the exterior. It consists of the two valves, lying partly open in the matrix, in their natural juxtaposition with relation to each other. It shows no traces of the muscular or pallial impressions, and presents no marks or indentations from which anything can be inferred in regard to the nature of the hinge; consequently, it has been only doubtfully referred to the genus *Pharella*, though it agrees more nearly in form with that than any of the described genera. It is certainly not a *Solen*.

Locality and position.—Dakota group of the Upper Missouri Cretaceous series; mouth of Vermilion River, Nebraska.

Genus LEPTOSOLEN, Conrad.

Synon.—*Siliquaria* (sp.), Conrad (1858), Trans. Acad. Nat. Sci. Philad., III, 324 (not Schum.).
Leptosolen, Conrad (1867), Am. Jour. Conch., III, 15; and *ib.*, 188.

Etym.—λεπτός, thin; and *Solen*.
Type.—*Siliqua biplicata*, Conrad.

Shell transversely elongated, with upper and lower margins straight and parallel; extremities rounded and gaping, or the posterior sometimes subtruncated; beaks not near terminal; hinge with one small tooth in the right valve, projecting at right angles inward from the cardinal margin, with its anterior side rounded, its posterior truncated, and its free end sharply cuneate; interior of each valve provided with a prominent narrow rib, extending from the beaks immediately behind the tooth, more or less directly downward, becoming more obscure near the middle of the valves, and dying out before reaching their ventral margins.

Mr. Conrad remarks that "this genus is very nearly allied to *Solena*, Browne; but having obtained a more complete view of its interior since the generic character was published, I find that the anterior muscular impression is chiefly anterior to, though its posterior end nearly covers, the rib, which is prominent in the umbonal region, truncated behind, sloping anteriorly, and situated behind the line of the apex. The upper margin of the muscular impression is on a line with the anterior hinge-line. In *Solena*, the tooth is narrowest on the hinge-plate, and there is a small pit before it; but, in *Leptosolen*, the tooth is broadest on the hinge-plate, and tapers to a very acute edge, which expands in the direction of the shell's [longer?] diameter."

The species yet known to belong to this genus are from rocks of Cretaceous age. *Leguminaria Moreana*, d'Orbigny, from the Cretaceous of France

(called *Machæra Moreana* on d'Orbigny's plate), almost certainly belongs to this group, unless there may be some differences in the character of its hinge, which has not been described or illustrated.

Leptosolen Conradi, Meek.

Plate 2, figs. 12, *a*, *b*.

Leptosolen Conradi, Meek (1872), Hayden's Second Prelim. Ann. Report U. S. Geological Survey of the Territories, 311.

Shell elongate-oblong, nearly three times as long as high, moderately convex; dorsal margin straight, pallial margin more or less nearly straight, and subparallel to the dorsal, being a little convex in outline in front of the middle, thence ascending obliquely forward to the narrowly-rounded anterior end; posterior margin subtruncated vertically, but rounding abruptly into the dorsal and ventral borders above and below; beaks not raised above the dorsal margin, and very inconspicuous, their position being only indicated externally, by the curves of the marks of growth, located about one-third the length of the valves from the anterior end; surface only showing fine lines of growth.

Length, 1.04 inches; height, 0.36 inch; convexity, 0.28 inch..

Internal casts of this species show the impression of the strong internal ridge, extending directly downward from the beaks, and gradually dying out below the middle of the valves.* These casts also show the impression of a *single* small tooth in the right valve, just in front of the upper termination of the deep furrow left by the strong internal ridge. From these characters, it is evident that this genus is allied to *Siliqua*, Mühlfeldt (*Leguminaria*, Schum.), but differs, as pointed out by Mr. Conrad, in having but a single hinge-tooth in the right valve, instead of three in each valve.

Compared with Mr. Conrad's typical species, *L. biplicatus* (*Siliquaria biplicata*, Conrad, Jour. Acad. Nat. Sci., III, pl. 34, fig. 17), our shell is seen not only to be much smaller and proportionally shorter, but to differ in not having the two broad prominences radiating forward and downward from the beak of each valve, as in that species, though it shows a single very obscure, broad prominence, extending directly downward under the beaks, and widening as it descends. In front of, and behind this, there is also, in each valve, a scarcely perceptible concavity. This broad prominence also imparts a slight convexity to the outline of the base, just at the point where the base in Mr. Conrad's species is sinuous.

* It is a little too pointed below, and made to look too much like an accidental break, in our figure.

It is probably more nearly allied to *Leptosolen Morcanus*, d'Orbigny (sp.), already cited, but differs from d'Orbigny's figure in being decidedly straighter on the dorsal margin, and wider as well as more distinctly truncated posteriorly.

Locality and position.—Twelve miles southwest of Salina, Kansas; Dakota group of the Cretaceous series of the Upper Missouri. Discovered by Professor Mudge.

PHOLADIDÆ.

Genus TURNUS, Gabb.

Synon.—*Turnus*, Gabb (1864), Palæont. California, I, 145.—Stoliczka (1870), Palæont. Indica, III, 19.
Goniochasma, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 34 (subgenus).
Xylophagella, Meek (1864), *ib.* (subgenus).

Etym.—*Turnus*, a prince of the *Rutuli*.
Type.—*Turnus plenus*, Gabb.

Shell varying from transversely-oval to globose; valves closed or somewhat gaping behind and open in front; anterior hiatus large, formed by the oblique truncation of the anterior ventral margins of the valves, or a deep rectangular notch of the same; dorsal margins of the valves in front of the beaks ascending and recurved; beaks more or less incurved; surface concentrically striate or costate, with a well-defined oblique or vertical linear umbonal sulcus; interior strengthened by two ridges in each valve, the anterior one of which is narrow, smooth, or strongly crenate, and corresponds exactly to the position and direction of the external umbonal furrow, while the posterior one is usually broader, smooth, and directed obliquely backward and downward from the beaks to, or toward, the posterior basal margin. (Accessory valves, if there were any, unknown.)

The foregoing diagnosis is drawn up so as to include, along with the typical form of the genus, two other types, that I am now inclined to believe cannot properly be separated more than subgenerically from each other, or from Mr. Gabb's genus. The three sections or subgenera may be severally characterized as follows:

1. **TURNUS**, Gabb (typical).

   Shell transversely oval; anterior hiatus formed by the oblique truncation and slightly sinuous outline of the anterior ventral margins of the valves; umbonal sulcus and both of the internal ridges very oblique, narrow, smooth, and extending to the free margins.—(Type as already stated.)

2. GONIOCHASMA, Meek.

Shell transversely ovate-oblong; hiatus formed by a deep rectangular notch in the anterior ventral margins; umbonal sulcus and corresponding internal ridge slightly oblique, and the latter finely and obscurely crenate; posterior internal ridge broad, deep, very oblique, smooth, and not extending to the free margins.—*G. Stimpsoni*, M. & H.

3. XYLOPHAGELLA, Meek.

Shell globose; anterior hiatus formed by a large, deep, rectangular notch in the anterior ventral margins; umbonal sulcus and corresponding internal ridge descending vertically, the latter being strongly crenate by little projecting points; posterior internal ridge as in the last, excepting that it is less oblique and placed in front of the posterior umbonal slopes.—*X. elegantula*, M. & H.

At the time I proposed the last two of the above groups, I had no knowledge of Mr. Gabb's genus *Turnus*, the description of which was issued only a very short time previous to the publication of the Smithsonian list containing my names. This list was in print at about the same time, but I believe not issued for a month or six weeks after copies of the text of the California report containing Mr. Gabb's name had been distributed; consequently, his name has priority of date. Since seeing his figure of the type of his genus, and that of an intermediate species published by Dr. Stoliczka, from the Cretaceous rocks of India, I am led, as already stated, to believe that both of my proposed groups may be ranged as subgenera under the same. It is still possible, however, that a better knowledge of these shells may render it desirable to separate them more widely. The type of the group *Xylophagella*, especially, will be seen to differ rather decidedly from that of *Turnus*, not only in its deep rectangular notch or hiatus, but by its short globose form and distinctly crenate internal anterior umbonal ridge. This crenate character is not alone produced by the concentric furrows of growth crossing the external furrows of the thin shell, as in the type of *Goniochasma*, but consists of projecting points that leave deep little punctures in casts of the interior.

The type of the section *Goniochasma* has much the appearance of *Martesia*, and would have been ranged under that genus, were it not for the fact that no traces of an accessory or dorsal valve have been seen in connection

with any of the numerous specimens found in their burrows; while none of them show any indications of the distinctly rectangular anterior hiatus having ever been closed by a shelly plate, at any stages of their growth. In addition to these peculiarities, internal casts always show a broad, oblique furrow, just above each posterior umbonal slope, (see fig. 9 *a*, pl. 30), that must have been occupied by a corresponding posterior internal ridge in each valve, not found in *Martesia*, and apparently representing the narrow, less oblique, posterior internal ridge seen in each valve of *Turnus*.

Mr. Gabb does not say whether his typical species of *Turnus* is gaping posteriorly or not, though Dr. Stoliczka describes the Indian species published by him as being nearly closed behind. He expresses the opinion, however, that, as the animal secreted a shelly tube, the valves "must have been much more gaping posteriorly than they are in the recent *Xylophagæ*, which only slightly protrude out of their shells." Large shelly tubes, sometimes an inch in diameter, and eight or nine inches in length, were also found so associated with the California typical species of *Turnus*, as to lead to the conclusion that they were secreted by the same. So far as yet known, however, no shelly tubes have been found associated with either of the Upper Missouri species, although large numbers of these shells have been found penetrating masses of fossil wood. Both of the Upper Missouri species also seem to have the valves always tightly closed behind.

So far as has been positively determined, these shells occur only in the Upper Cretaceous; though, as remarked by Stoliczka, *Pholas Waldheimii*, d'Orbigny, from the Jurassic or Neocomian of Russia, probably belongs to the group.

Turnus (Goniochasma) Stimpsoni, M. & H.

Plate 30, figs. 9, *a*, *b*.

Xylophaga Stimpsoni, Meek and Hayden (May, 1857), Proceed. Acad. Nat. Sci. Philad., IX, 141.
Pholas? Stimpsoni, Meek and Hayden (Oct., 1860), *ib.*, XII, 424.
Goniochasma Stimpsoni, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 16.

Shell transversely ovate-cuneiform, very thin; anterior and umbonal regions gibbous, more compressed posteriorly; anterior hiatus extending from the base above the middle of the valves, and from the front back about one-fourth their length; dorsal and ventral margins nearly straight and parallel, the latter rounding up abruptly into the notch in front; beaks strongly incurved, pointed, rather depressed, and placed near the ante-

rior extremity; surface ornamented by fine, regular, concentric striæ, following the flexures and curves of the free borders.

Length, 0.40 inch; height and convexity, each 0.26 inch.

The concentric striæ are most distinct near where they cross the linear furrows descending from the beaks; but diminish in size, become very closely and regularly arranged, and very minutely crenate, as they curve upward between this line and the margin of the hiatus. On being suddenly deflected forward upon that portion of the valve over the hiatus, they as suddenly become larger and more distinct. Of the two internal ridges, the anterior one corresponding to the single furrow of the exterior, is the more sharply defined. The posterior ridge is the larger, and leaves upon internal casts a broad, rather rounded, deep furrow, extending obliquely from the back part of each beak to the postero-basal margin.

Traces of apparently the pallial line seen on the cast, seem to indicate a wide, shallow, nearly rectangular sinus, between the anterior and oblique posterior internal ridges.

This species was named in honor of my lamented friend, the late Dr. William Stimpson.

Locality and position.—Muscle-Shell River, Idaho Territory; in the Fort Pierre group, or formation No. 4 of the Upper Missouri Cretaceous series.

Turnus (Xylophagella) elegantulus, M. & H.

Plate 30, figs. 10, *a*, *b*, *c*, *d*, *e*.

Xylophaga elegantula, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 147.
Xylophagella elegantula, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 16.

Shell small, globose-cordate, with its closed posterior and postero-basal margins rounded in outline; anterior side almost entirely occupied by the very large rectangular hiatus, which extends more than one-third of the length of the valves back from the front margin, and from the base above the middle; umbones rather elevated and distinctly incurved, located a little in advance of the middle. Surface ornamented by small, obscure, regularly-arranged, concentric costæ, and very fine lines of growth, which follow the curves and angular flexures of the free borders; umbonal groove linear, and nearly vertical.

Length, height, and convexity, each about 0.19 inch.

The concentric costæ are rather obscure on the posterior part of the valves; but on reaching the narrow groove extending from the beaks almost directly to the base, a little in advance of the middle of the valves, they become more distinct, and are deflected abruptly upward, nearly parallel to the vertical margin of the angular hiatus, becoming, as they ascend, very fine, closely-arranged, and delicately-crenated lines. In passing upon that part of the valves extending out over the hiatus, these fine lines are abruptly deflected forward and again suddenly enlarged, but continue to be very regular, and rapidly diminish in size, and converge as they pass toward the anterior extremity.

The grooves left on the internal cast by the internal ridges of the valves, are much as in the foregoing species, excepting that the one corresponding to the vertical groove on the outside of the valves is much deeper, and regularly punctate at the points where the concentric markings cross it, while the posterior one is narrower, less oblique, and passes down in front of each posterior umbonal slope, instead of behind and above it. Nearly all the space back of the oblique posterior sulcus of the cast is occupied by a large leaf-like muscular? scar. The sinus of the pallial impression, as seen on internal casts, is narrow, nearly vertical, and ascends more than half-way up between the posterior oblique groove and the vertical one in advance of it.

Locality and position.—Same as last.

Genus MARTESIA, Leach.

Synon.—Martesia (Leach, MS.), Blainv. (1824), Dict. Sci. Nat., * *.—Desh., *ib.*, III, 421.—Sowerby, jr., Conch. Man., 186.—Gray (1847), Zoöl. Proceed., 188, and (1851) Ann. and Mag. N. H., VIII, 380.—H. and A. Adams (1856), Gen. Recent Moll., II, 330.—Tryon (1862), Classification *Pholadidæ*, Proceed. Acad., 89; also (1873) Am. Marine Conch., 127.

Martresia, Gray (1842), Synon. Brit. Mus., 91. (Typogr. error.)

Etym.—?

Type.—M. striata (= *Pholas clavata*, Lam.).

Shell transversely ovate-oblong, equivalve, generally produced posteriorly; anterior hiatus closed in the adult by a shelly plate; surface with concentric sculpturing, crossed by a single umbonal furrow; umbonal valve single; dorsal and ventral margins with lanceolate accessory pieces, or valves.

This genus will be readily distinguished from the last by its anterior hiatus becoming closed by a shelly secretion in the adult, as well as by wanting the posterior internal ridge of that group. If *Turnus* has no accessory valve, as appears to be the case, that would be another strongly-marked

distinction; though it is not always easy to determine whether or not fossil species may have had such supplementary parts.

The geological range of this genus has not been very satisfactorily determined, but we have some reasons for believing that it may possibly date back to the Permian or Carboniferous period. At any rate, a shell described by the writer from rocks apparently of Carboniferous age in Texas (*Martesia? Roessleri*) was thought, by Mr. Tryon, of Philadelphia, an excellent authority on the *Pholadacea*, most probably to belong to this genus. In the Jurassic rocks, its existence seems to be established by the discovery of several species, among which may be mentioned *M. recondita* (= *Pholas recondita*, Phillips, Geol. Yorks., pl. 3, fig. 19). Several well-defined species of this genus are also known from the Cretaceous, and it also ranges through the Tertiary, and is likewise represented in our existing seas, where it probably about attains its greatest development. The living species are generally found burrowing in floating wood, and seem not to be entirely marine in their habits, as H. and A. Adams mention finding *M. rivicolor* perforating floating logs in the river Pantai, in Borneo, twelve miles from the sea, where the water was perfectly fresh.

Martesia cuneata, M. & H.

Plate 30, figs. 8, *a*, *b*.

Pholas cuneata, Meek and Hayden (March, 1858), Proceed. Acad. Nat. Sci. Philad., X, 53.
Pholas (*Martesia*) *cuncata*, Meek and Hayden (Oct., 1860), *ib.*, XII, 424.

Shell small, thin, transversely elongated, and a little arcuate; gibbous and truncated anteriorly, cuneate, and very sharply rounded behind; posterior gape very slight; anterior hiatus formed by a rectangular notch extending about half-way up from the beaks, and but a short distance back from the anterior margin; callous plate filling the hiatus at maturity, very thin, smooth, and slightly ventricose; beaks depressed, incurved, and nearly terminal; surface marked by fine lines of growth, and small, rather obscure, concentric costæ or wrinkles, which are only visible on the more gibbous anterior and antero-central portions of the valves: umbonal furrow linear, extending a little obliquely backward and downward, so as to intersect the base in advance of the middle. Accessory valves unknown.

Length, 0.37 inch: height at the anterior end, 0.18 inch; convexity, 0.16 inch.

It is probable that the concentric lines, where deflected upward in front of the transverse groove, are minutely crenate; but the only specimen seen, is not in condition to retain such delicate markings, if they ever existed. The posterior muscular scar is seen on the internal cast to be very narrow, elongated, and placed near the dorsal margin, a little behind the middle of the valves, while the deep pallial sinus is rounded at the extremity.

It is not without some doubts that this shell has been referred to the genus *Martesia*, as but a single imperfect specimen, showing no traces of the accessory valves, has been seen.

Locality and position.—Long Lake, near Fort Pierre, Dakota Territory; in the Fox Hills group, or No. 5 of the Upper Missouri Cretaceous series.

TEREDIDÆ.

Genus TEREDO, Linnæus.

Synon.—*Teredo*, Pliny, Sellius, Adanson, and other pre-Linnæan authors.

Teredo, Linnæus (1758), Syst., ed. x, 651; and (1767) *ib.*, ed. xii, 1267.—Brug. (1789), Encyc. Méth., I, xii.—Spengl. (1792), Skrivt. Nat. Selsk., II, 99.—Lamarck (1799), Prodr., 90; and (1801) Syst., 129.—Cuvier (1812), Ann. du Mus., XIX, *; and (1817) R. An., II, 493.—Lamarck (1818), Hist., V, 438.—Rang (1829), Man., 346.—Menke (1830), Syn., 2d ed., 122.—W. Thompson (1835), Jam., Edinbg. New Phil. Jour., XVIII, 121.—Swainson (1840), Malac., 364.—D'Orbigny (1845), Paléont. Fr. Terr. Crét., III, 301.—Gray (1847), Proceed. Zoöl. Soc. Lond., part xv, 188.—H. and A. Adams (1856), Gen. Recent Moll., II, 331.—Tryon (1862), Proceed. Acad. Nat. Sci. Philad., 104; and (1873) Am. Mar. Conch., 129, &c.

Calobates, Gould (1862), Proceed. Bost. Soc. N. H., VIII, 280; and (1862) Otia Conch., 241.—Tryon (1862), Proceed. Acad. Nat. Sci. Philad., 117.

Etym.—τερηδών, the ancient name of the ship-borer.
Type.—*Teredo navalis*, Linn.

Shell small, globose-trilobate, gaping anteriorly and posteriorly; surface concentrically striated, and each valve crossed by a single more or less nearly vertical umbonal furrow; cardinal margin reflexed in front; interior provided in each valve with a long, slender, curved process for the attachment of the pedal muscles. Burrow-tubes shelly, subcylindrical, sometimes concamerated. Siphonal palletes of the animal simple, oblong, often truncated, entire; sometimes stilt-shaped, with the basal prolongation bony.

H. and A. Adams include, as subgenera under *Teredo*, *Xylotrya*, Leach, and *Uperotus*, Guettard; but Mr. Tryon, who has given especial attention to this and allied families of *Mollusca* separates the latter two groups as distinct genera, on account of the solitary burrows, the compound pinnate nature of the siphonal palletes, and the broad valves of the first; and the club-shaped,

contorted burrows, and narrow elongate valves of the latter. He admits *Calobates* of Gould, however, as a subgenus under *Teredo*. Adopting this view, the typical section and subgenus may be separately characterized as follows:

1. **TEREDO**, Linnæus (typical).

Animal with siphonal palletes, simple, oblong, often truncated.—(Type as above.)

2. **CALOBATES**, Gould.

Animal with siphonal palletes, large, stilt-shaped, and bony.—*T. thoracites*, Gould.

It is scarcely necessary to remark that it would generally be impossible to distinguish among fossil species the last section, or, indeed, the groups *Xylotrya* and *Uperotus*, from the typical Teredines, by the differences observable in the palletes alone, because these delicate parts are very rarely found in a fossil state. The differences in the shells and tubes of *Xylotrya* and *Uperotus*, however, will, perhaps in most cases, enable the palæontologist to distinguish them from *Teredo*.

The ship-borers, or "ship-worms," as the Teredines are often (from the worm-like form of the animal) improperly called, were well-known, even to the ancients, in consequence of their habit of burrowing in the bottoms of ships, and all other wooden structures exposed to the sea-water, or sometimes even to brackish-waters. The injury they do in this way is often very great; and there seems to be no reliable means of preventing their ravages, excepting the expensive one of applying copper or other metallic sheathing over the whole of the submerged surface.* Like some other pests, however, their injurious habits are not wholly unattended by some compensating good, as they often cause old wrecks and floating timbers, that would otherwise obstruct the entrances to harbors and rivers, to break to pieces and disappear. Their burrows, or borings, usually follow more or less nearly the direction of the grain of the wood, excepting at the immediate start into the side of planks or timbers, but are often tortuous, and generally lined with a calcareous secretion. They increase gradually in size from the external opening, which is very small and never increases in size, to the inner extremity; and, in excavating their way in, the animals scrupulously avoid coming in contact

* I was informed in Florida, that the "ship-borer" will not attack piles or other structures made of the trunks of Palms; but these are not solid and firm enough for structures requiring great strength.

with each other; that is, where two are boring in directions that would cause them to cross each other's paths, one or both instinctively turn aside, leaving a more or less thin wall of wood between the two burrows.

It has long been a matter of speculation, and quite different views are yet entertained, in regard to the agency by which these little creatures manage to penetrate the hardest kinds of wood, and some allied genera of mollusks even hard rocks. It is now believed by many, however, that this is mainly, if not entirely, accomplished by the attrition of the surface of the anterior part of their valves, which is always covered by little sharp projections, against the substance that they wish to penetrate. Others maintain that it is by means of the muscular foot, that the animal excavates its burrows.

As in many other cases, we cannot, in the present state of palæontological science, state very nearly at what period the Teredines made their first appearance. Borings of wood, very similar to those of *Teredo*, have been found even in the Carboniferous rocks, and referred to this genus (*T. antiqua*, McCoy); also, from the Jurassic; but there is no certainty that the mollusks that formed these borings would fall properly into the genus *Teredo* as restricted by modern conchologists. Indeed, the probabilities are that the Palæozoic species, at least, would be found to present generic, if not greater differences, if we had the means of knowing all of their characters. In the Cretaceous, however, we find not only the burrows, but the delicate valves of a number of species that agree so nearly with the corresponding parts of the modern typical species of *Teredo*, as to leave little or no room for doubts in regard to their belonging to that, or some very nearly allied genus. It is also represented in the Tertiary rocks, and in our existing seas and estuaries. The known living species are not very numerous; but it is probable that the genus nearly or quite attains its greatest development at the present time. Although the number of known recent species is not very great, vast numbers of individuals exist in almost all seas; the genus having a nearly world-wide distribution.

Teredo selliformis, M. & H.

Plate 17, figs. 19, *a*, *b*, *c*, *d*.

Teredo selliformis, Meek and Hayden (May, 1860), Proceed. Acad. Nat. Sci. Philad., XII, 178.

Shell subglobose; posterior side narrowly rounded above, and provided with a broad angular notch below; anterior ventral side having a very large

hiatus, formed by a similar but deeper rectangular notch, which extends from the base nearly half-way up to the beaks, and back almost to the middle of the valves; base between the anterior and posterior notches, extended downward in the form of a narrow prolongation, which curves under, and is the only part of the ventral borders of the two valves that comes in contact; beaks elevated, gibbous, incurved, and located between the middle and the anterior margin. Surface ornamented by small concentric lines, which are curved and deflected parallel to the great irregularities of the free borders, and crossed by two radiating grooves, the posterior of which passes from the back part of the beaks obliquely downward and backward to the corner of the posterior notch; and the other, which is more distinct, extends almost directly downward to the extremity of the ventral prolongation.

Length, of a medium-sized specimen, 0.16 inch; height, 0.14 inch; convexity, 0.13 inch.

On the posterior side of the shell, the concentric lines, or wrinkles, are comparatively large, rather irregular and depressed; but where deflected upward parallel to the straight vertical margin of the anterior hiatus, they become very fine, regular, closely arranged, and minutely and beautifully crenulate. On being suddenly deflected horizontally forward upon that part of the anterior extending over the hiatus, they become again suddenly enlarged, but continue to be very regular, and seem to retain some traces of crenulations.

The posterior oblique groove is so much larger and deeper on internal casts than on the exterior of shell, as to indicate the presence of a corresponding strong ridge on the inside of the valves; while the other nearly vertical groove is smaller and less distinct than on the external surface.

The tubes are rather small, nearly straight, or sometimes a little bent; and increase gradually from one extremity to the other. They usually penetrate the fossil wood in which they are found, nearly parallel to each other, and are often crowded so as to leave narrow spaces between. They vary in size from 0.10 to 0.20 inch in diameter, and sometimes seem to have been provided with a few incomplete, irregular, transverse septa, near the smaller or outer extremity.

Locality and position.—Fort Clark, on the Missouri, Dakota Territory; in the Fort Pierre group, or formation No. 5 of the Upper Missouri Cretaceous series.

Teredo globosa, M. & H.

Plate 30, fig. 13 (burrows).

Teredo globosa, Meek and Hayden (1858), Proceed. Acad. Nat. Sci. Philad., X, 53.

Fig. 31. Fig. 32.

Teredo globosa, M. & H.*

Fig. 31. Posterior view, magnified three diameters.

Fig. 32. Left side view of same, magnified in same way.

Shell globose-cordate, thin; posterior side rounded or subtruncated, and not very widely gaping; anterior hiatus large, rectangular, extending from the middle of the base half-way up the valves; dorsum rounding posteriorly; umbonal region gibbous; beaks distinctly incurved obliquely forward, located in advance of the middle. Surface ornamented by concentric lines, which follow the curves and angular flexures of the free border, and are crossed by an obscure, small groove, descending from the beaks.

Length, 0.23 inch; height, 0.24 inch; convexity, 0.22 inch.

The parts of the ventral borders of the valves which come in contact beneath are comparatively narrow and prolonged downward; being that portion of the base between the anterior angular hiatus and the much smaller oval aperture formed by the gaping of the valves behind. I have not been able to determine very exactly the nature of the vertical groove descending from the beaks. On internal casts, it is small, and passes from the beaks to the corner of the anterior notch, thence down near its vertical margin to the base. Some little distance back of this groove (on the cast), there is sometimes a single, raised, thread-like line extending from the beaks nearly straight down to the base. Between this line and the groove, there is a narrow band-like space, passing down from the beaks, which is a little more elevated and rougher than other parts of the cast.

Our specimens are not in a condition to show very clearly the details of the surface-markings; but the concentric lines can be seen, as usual, to be coarser and less regular on the posterior side; and, under a good lens, they are seen, where deflected upward parallel to the margin of the anterior hiatus, to be fine, regular, and minutely crenulate.

The tubes (see pl. 30, fig. 13) are generally nearly straight and parallel,

* Figures of the shell of this species having been inadvertently omitted in making up the plates, the above cuts of the same are introduced here to aid in its identification.

but sometimes curved or variously bent, and often closely crowded. They are faintly marked, at regular intervals, by obscure annular impressions, which pass around somewhat obliquely; and some of them are at places provided with a few transverse septa. Diameter varying from 0.20 to 0.35 inch.

This species will be distinguished from the preceding by the absence of a notch or sinus in the border of its posterior side, and by having its dorsal margin rounding regularly down behind, instead of nearly horizontal. It also differs in having no traces of the obscure, oblique, posterior sulcus on internal casts, and in the annular, or ringed, appearance of its tubes, which are also larger than those of that species.

Locality and position.—Same as last.

GASTEROPODA.

SOLENOCONCHÆ.

DENTALIIDÆ.

Genus DENTALIUM, Linn.

Synon.—*Tubulus, Dentale, Dentalis, Syringites,* &c., wholly, or in part, of pre-Linnæan authors.
Dentalium, Linnæus (1758*), Syst. Nat. (ed. X), 785.—Lamarck (1799), Prodr. Syst., 78; and (1801) Syst. An., 326; also (1818) Hist., V, 341.—Blainv. et Defr. (1819), Dict. Sci. Nat., XIII, 69.—Blainv. (1824), *ib.*, XXXII, 286; and (1825) Malac., 496.—Desh. (1825), Monogr. in Mém. Soc. Nat. Hist. de Paris, II, 321; and (1830) Encyc. Méth., III, 65.—Reeve (1841), Proceed. Zoöl. Soc., 73; and (1842) Conch. Syst., II, 5.—Forbes and Hanley (1853), Hist. Brit. Moll., II, 448.—H. & A. Adams (1854), Genera Recent Moll., I, 458.—Gould & Binney (1870), Invert. Mass. (2d ed.), 266.—Tryon (1873), Am. Marine Conch., 96; and of numerous others.

Etym.—*Dens*, a tooth.
Type.—*Dentalium elephantinum*, Linn.

Shell slender, tubular, regularly tapering, and more or less arcuate from the aperture to the posterior open end; aperture simple, not constricted; posterior opening small, without a proper slit or denticulations, but sometimes with a faint dorsal (or dorsal and ventral) marginal indentation, and a thin, slightly projecting, inner tube, ending in a dorso-ventral oval opening; surface ornamented with longitudinal costæ or striæ.

In this singular genus, the animal has a remarkably simple structure, being without tentacles or eyes, or, indeed, even without a well-developed head, and only a rudimentary foot. Yet it is known to have red blood.

The genus *Dentalium* dates back to the Devonian epoch, and also ranges through rocks of all subsequent ages. It is also well represented in our existing seas, where the recent species generally occur in deep waters, burrowing in mud and sand.

Dentalium gracile, H. & M.

Plate 18, figs. 13, *a, b, c, d.*

Dentalium gracile, Hall and Meek (1854), Mem. Am. Acad. Arts & Sci., Boston, V (n. s.), 393, pl. 3, fig. 11.
Dentalium fragile, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 69.

Shell long, slender, gently curved from the apex to the larger extremity; section and aperture very nearly or quite circular; surface ornamented by

* I am aware that the name *Dentalium* was used by Aldrovandus as far back as 1642, and by Linnæus in 1740; but as the binomial system only dates back to Linnæus's tenth edition, I do not go behind its issue for the dates or authors of genera.

rounded, thread-like, longitudinal, raised lines, which are crossed somewhat obliquely upward from the inner to the outer side of the curve, by very fine, regular lines of growth; the longitudinal lines terminating abruptly a little below the apex, or smaller extremity (where they number about fourteen), and increasing in number by intercalation, and diminishing in size and regularity toward the larger end, so as to become nearly obsolete on the lower half of the shell.

Diameter at smaller end, 0.05 inch; diameter of a fragment 1.16 inches in length, 0.15 inch; diameter of largest fragment near aperture, 0.22 inch.

Since describing this shell under the name of *D. fragile*, I have seen other specimens, which show that it varies a little in thickness and some of its other characters, so that there seems to be no satisfactory constant differences by which it can be distinguished from *D. gracile* of Hall and Meek. Still it is possible that a more complete series of specimens from the two localities may show some slight differences by which they can be separated.

Compared with foreign species, this will, in the first place, be at once distinguished from the Cretaceous *D. decussatum*, Sowerby, by its smaller size, more gradually tapering form, and finer and closer longitudinal striæ; that is, making the comparison with d'Orbigny's figure of that species in the Paléont. Fr., t. II, 40, pl. 236, figs. 1–6, Sowerby's figure being very unsatisfactory. It is perhaps more nearly related to *D. crassulum*, Stoliczka, from the Cretaceous of India, but differs in being less pointed at the immediate apex, and more finely striated toward the other extremity.

Locality and position.—The type-specimens of this species were found on Sage Creek, Dakota, in the upper beds of the Fort Pierre group; and those figured on our plate were found at about the same horizon on the Yellowstone River.

Genus ENTALIS, Sowerby.

Synon.—*Antalis, Entale, Entalites*, &c., wholly or in part, of pre-Linnæan authors.
? *Entalium*, Defrance (1819), Dict. Sci. Nat., XIV, 517 (= *Pharetrium*, König, 1825).
Entalis, Sowerby (1839), Man. Conch., 42.—Gray (1844), Synop. Brit. Mus., 58; and (1847) Proceed. Zoöl. Soc., 158.—Stoliczka (1870), Palæont. Indica, II, 438.

Etym.—?
Type.—*Dentalium entale*, Linn.

Shell tubular, gradually tapering and more or less arcuate from the aperture to the open posterior extremity; aperture circular, simple, without constriction; posterior opening small, provided with a slightly projecting,

thin, inner layer, having a broad notch, or sinus, on the dorsal side, that is continued as a more or less deep slit through the outer shell; surface smooth or longitudinally striated.

This group is difficult to distinguish from *Dentalium* among fossil species; the specimens of which are most generally found with the slender end bearing the characteristic dorsal slit, broken away. Indeed, some conchologists deny that this character can be relied upon as a generic distinction in all cases, though there are some slight differences in the animals of these two groups; while the shell of *Entalis* is also more generally smooth than that of *Dentalium*.

H. and A. Adams retain the name *Antalis* for this group, citing Aldrovandus as the author; while Stoliczka (Palæont. Indica II, 438) retains Aldrovandus's name (writing it *Antale*), for another type, with a smooth shell, without any posterior dorsal slit, or even emargination, such as *Dentalium tarentinum*, Lamarck. He also expresses the opinion that *Entalium*, Defrance, is probably a synonym of this latter group, and not of that here under consideration, for which he uses the name *Entalis*. I have not had access to the necessary works to clear up these points; but, in any event, I am opposed to going back to Aldrovandus, or any other pre-Linnæan author, as already explained. Consequently, if the shells with a smooth surface and no marginal posterior dorsal slit, such as Dr. Stoliczka ranges under the name *Antale*, Aldrovandus, are generically distinct from *Dentalium* proper, they may have to stand under Defrance's name *Entalium*.

Shells agreeing in smoothness of surface and general appearance with this group occur as far back as the Carboniferous; but I am not sure that any of these, or the Permian or Triassic species, really belong to it. Some of the Jurassic forms more probably belong here; while the genus is represented in the Cretaceous and Tertiary rocks, as well as in our existing seas.

Dr. Stoliczka has proposed, in the Indian Palæontological Report, II, page 439, for a group including Cretaceous, Tertiary, and recent species of *Dentaliidæ*, the name *Fustiaria*. These are smooth, generally slender shells, only differing from *Entalis*, as here understood, in having the posterior dorsal slit *very* deep and sharply linear. I suspect, however, that this type may not be more than subgenerically distinct from *Entalis*, unless some difference of more importance can be shown to exist in the structure of the animal.

Entalis? pauperculus, M. & H.

Plate 18, fig. 14.

Dentalium pauperculum, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 178.—Meek (1864) Smithsonian Check-List N. Am. Cret. Fossils, 17.

Shell small, arcuate, tapering rather gradually; section circular; substance comparatively thick; surface smooth, but showing under a magnifier extremely fine obscure lines of growth, which pass around somewhat obliquely.

Length of an imperfect specimen, measuring from the apex, 0.36 inch; diameter of same at apex, 0.03 inch; diameter at larger extremity, 0.06 inch.

I have not yet seen an entire specimen of this species, and even fragments of it are rare. Its most marked peculiarities are its small size and smooth surface. In the latter character, it differs from all the Cretaceous species known to me excepting *D. arcotinum*, Forbes (Trans. Geol. Soc. London, vol. VII, pl. 12, fig. 16), from the Cretaceous rocks of Southern India It differs, however, from that species in being more arcuate and less robust.

I only place this species provisionally in this group, on account of its being entirely smooth, not having seen any specimens in a condition to show the characteristic posterior slit. If the smooth forms without any posterior marginal slit, for which Dr. Stoliczka proposes to retain Aldrovandus's old pre-Linnæan name *Antale*, are distinct from *Dentalium* proper, and, as he thinks generically identical with *Entalium*, Defrance, then it is quite probable that this species may be found to belong to that group, and have to take the name *Entalium pauperculum*.

Locality and position.—Moreau River; from the Fox Hills group of the Upper Missouri Cretaceous series. Fragments, apparently of the same, have also been seen in masses of rock from the Fort Pierre group of the same series.

TECTIBRANCHIATA.

BULLIDÆ.

Genus HAMINEA, Leach.

Synon.—*Bulla* (sp.), of many authors, but not as restricted.
Haminæa (Leach, MS.), Gray (1847), Ann. Mag. N. H., XX, 268; without a description.
Haminea, Gray (1847), Proceed. Zoöl. Soc., 161.—H. and A. Adams (1854), Genera Recent Moll., II, 16.—Chenu (1859), Man. Conch., I, 390.—Stoliczka (1868), Palæont. Indica, II, 429.

Etym.—*Hamus*, a hook; from the curved form of the aperture.
Type.—*Bulla hydatis*, Linn.

Shell thin, ventricose, oval or subglobose, involute, in the recent state corneous, flexible, and without coloration; surface transversely striated, and usually covered with a thin epidermis; aperture as long as the shell, narrow posteriorly, widened and entire below; inner and outer lips simple; spire hidden.

The shells of this genus are *very* similar in form to those of *Bulla*, but are always transversely striated, and much thinner; those of that genus and *Atys*, another allied type, being solid. The animal of *Haminea* differs from that of *Atys*, and agrees with *Bulla*, in having well-developed eyes. It, however, envelops the shell more completely than in either of those types, and presents some other differences of anatomical details, which are, of course, not directly available to the palæontologist in dealing with fossil species. Like *Bulla*, these mollusks inhabit the muddy bottoms of estuaries, and feed on bivalves.

Many conchologists, and nearly all palæontologists, make no distinction whatever between this group and *Bulla* proper, of which it might, perhaps, without impropriety, be regarded as a subgenus. It seems to range back to the Cretaceous at least—ranges through the Tertiary rocks, and is well represented among the mollusks of the present epoch.

I am much puzzled in regard to the Cretaceous species here referred to this genus. They certainly differ from *Bulla* proper in their less solid and constantly transversely-striated shell. It is true, *Haminea* and *Bulla* are both regarded as rather estuary than marine types; while the species here under consideration are found associated with marine shells only. This, however, *may* have resulted from their dead shells being carried by currents from estuaries into salt-water, or, possibly, from the species having become naturalized in the latter. These shells also closely resemble some forms referred by high authorities to the genus *Atys*, particularly the group *Roxania*

of Leach. In *Atys*, however, the shells are not only more solid, as above stated, but generally have the transverse striation confined to the upper and lower portions of the shell, instead of covering the whole surface; while, in most cases, the form of *Atys* is different, and its columella ends below in a fold or tooth, and the outer lip is twisted and produced above.

Haminea occidentalis, M. & H.

Plate 18, figs. 11, *a*, *b*, and 12, *a*, *b*.

Bulla occidentalis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 69 (not *B. occidentalis*, A. Adams, of earlier date).

Bulla Nebrascensis, Meek and Hayden (1861), Proceed. Acad. Nat. Sci. Philad., XIII, 427.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 16.

Shell exceedingly thin, subovate, being generally a little widest slightly below the middle; upper end a little obliquely subtruncated, and rounding into the small umbilicoid central pit or perforation marking the position of the sunken spire; aperture narrow, arcuate, widening moderately, and rather narrowly rounded below; inner lip very thin, and reflexed below, but not always so closely appressed as quite to cover the very small, oblique umbilical chink, very thinly spread on the body-volution above; outer lip in entire specimens rising somewhat above the summit, and rounding inward posteriorly; entire surface ornamented by very small, transverse, impressed striæ, separated by wider space, in each of which may sometimes be seen a smaller one; revolving striæ usually more or less visible on internal casts.

Length of a medium-sized specimen, 0.46 inch; breadth, 0.31 inch.

This species resembles the recent *Haminea solitaria* of Say, from our eastern coast, but is a little more ventricose, has stronger transverse striæ and its inner lip is a little wider and appressed below. The latter characters, however, are not well represented in our figures, which are from internal casts.* It is a very thin shell, being not much thicker than strong, heavy writing-paper; which fact seems to forbid its reference to *Bulla* proper. In first describing it, we called it *Bulla occidentalis;* but, on subsequently learning that A. Adams had previously described a recent *Bulla* under that name, we proposed to call it *B. Nebrascensis.* In now referring it to the genus *Haminea*, however, the original specific name has to be retained.

Locality and position.—Yellowstone River, 150 miles above its mouth; in

* The magnified fig. 12, *b*, being from an internal cast, with the outer and lower margins broken away, gives the erroneous appearance of the columella being strongly truncated below, which is not natural.

beds containing a mingling of the fossils of the Fox Hills and Fort Pierre groups of the Upper Missouri Cretaceous series; also, from the same horizon on Deer Creek, near Platte River.

Haminea subcylindrica, M. & H.

Plate 18, figs 10, *a*, *b*.*

Bulla subcylindrica, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 270 (not d'Orbigny, 1847).

Bulla speciosa, Meek and Hayden (1860), *ib.*, XII, 185.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 16.

Shell attaining a large size, extremely thin, narrow-subelliptic; summit rounded, with a small umbilicoid pit marking the position of the sunken spire; lower extremity obliquely and narrowly rounded; aperture very narrow, somewhat arcuate along the upper three-fourths, rising a little above the summit of the body, narrowly rounded at the upper extremity, and about twice as wide below as at the middle; inner lip thin, reflexed, and appressed, but leaving a narrow, oblique, umbilical chink passing under it below, continued above as a thin film on the inner side of the body-volution; entire surface ornamented by obscure lines of growth, crossed by small, impressed, transverse striæ, generally separated by somewhat wider spaces, sometimes bearing each one or two smaller impressed lines.

Length, about 1 inch; breadth, 0.55 inch; breadth of widest part of aperture, 0.23 inch; breadth of same near the upper end, 0.12 inch.

This species will be readily distinguished from the following, not only by its decidedly larger size, but by its proportionally more elongated and more nearly cylindrical form. Like the last, it is a very thin shell; which thinness causes the transverse striæ to be generally rather well defined on internal casts. The differences of size and form between these shells is certainly not due to differences of age; the specimens of *H. occidentalis* being numerous, and the largest of them but little exceeding the size of that represented by our figs. 11, *b*, and 12, *a*, which are evidently adults, while the more ventricose and shorter form of that species is constant at all ages.

As with the last-described species, we had to change the specific name of this shell because d'Orbigny had published a *Bulla subcylindrica* at an earlier date. From its thinness, and transverse striation over the whole surface, I am led to refer it, like the last, to the genus *Haminea*, in which I

* Fig. 10, *a*, is from an internal cast broken at the base of the aperture, so as to give an unnatural appearance of a truncation there; while it does not show, as figured, the thin, reflexed, inner lip.

believe the specific name *subcylindrica* had not been used, and consequently must be retained here. It rather nearly resembles *Atys* (*Roxania*) *Cranchii*, Leach, the type of that author's group *Roxania*, which Adams has proposed to retain as a subgenus under *Atys*.

Locality and position.—Near the mouth of Milk River, on the Upper Missouri; from the Fort Pierre group of the Upper Missouri Cretaceous series.

Haminea minor, M. & H.

Plate 31, figs. 1, *a*, *b*.

Bulla minor, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., 69.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 16.

Shell small, ovate, very thin, greatest breadth a little below the middle, rather narrow at the upper extremity; summit a little oblique, and provided with a small, central, umbilicoid depression; aperture narrow in the middle and above, arcuate, widening rather gradually on the inner side below, where it is rounded; surface marked by small transverse grooves or impressed striæ, separated by spaces generally greater than their own breadth, but sometimes less, and crossed by fine lines of growth, which are sharply elevated in the grooves, so as to give the latter the appearance of being punctate.

Length, 0.42 inch; breadth, 0.27 inch.

When we first characterized this species, we had only seen a very small, young individual, from which it was supposed to be a very small species. Since that time, other specimens have been brought in, showing that the adult shell attains nearly a medium size. In its general appearance, it resembles the preceding species, but differs in being proportionally wider below the middle, and more narrowed toward the summit. Its aperture also widens more gradually below, and the transverse grooves on its surface are larger; while its lines of growth are more sharply elevated in crossing the grooves. As in the preceding species, its surface-markings are quite distinct on the internal cast. Possibly it may be only a variety of the last, but I have not seen specimens connecting the two forms

This species will be seen to approach somewhat the genus *Scaphander*, and possibly may have to take the name *Scaphander minor*; though it does not differ very materially from the forms of some species of *Bulla* and *Haminea*.

Locality and position.—Morean River; from the Fox Hills group, or formation No. 5, of the Upper Missouri Cretaceous series.

CYLICHNIDÆ.

Genus CYLICHNA, Lovén.

Synon.—*Cylichna*, Lovén (1846), Ind. Moll. Scand., 10.—A. Adams (1850), in Sowerby's Thes., XI, 558.—H. and A. Adams (1854), Genera Recent Moll., II, 9.—Chenu (1859), Man. Conch., I, 385.—Gabb (1864), Palæont. California, I, 143.—Stoliczka (1863), Palæont. Indica, II, 428.—Gould and Binney (1870), Invert. Mass. (2d ed.), 220.—Tryon (1873), Am. Marine Conch., 102.

Bullina, Risso (1826), Hyst., IV, 50 (not Férussac, 1821).

Cylindrella, Swainson (1840), Malac., 155 and 326 (not Pfeiffer, 1810).

Volvaria, Brown (1827), Ill. Conch., tab. 39 (not Lam., 1801).

? *Mnestia*, H. and A. Adams (1854), Genera Recent Moll., II, 10 (as a subgenus under *Cylichna*).—Chenu (1859), Man. Conch., II, 388.

Etym.—κυλίχνη, a small cup.

Type.—*Bulla cylindracea*, Penn.

Shell cylindrical or subovate, involute, solid; spire none, or very rarely a little exposed in the deep umbilicoid cavity of the summit; aperture narrow and equaling the greatest length of the shell, rarely produced, and angular above and below; inner lip a little thickened, and bearing a single anterior fold; outer lip simple; surface generally transversely striated, or sometimes puncto-striate.

The shells of this genus resemble those of *Bulla*, but are less ventricose, have a narrower aperture, and a fold on the columella. There are also differences in the animal that cause some high authorities to place *Cylichna* in a distinct family; while others only separate in a different subfamily, or even merely as a marked genus of the *Bullidæ*.

Messrs. H. and A. Adams propose a subgenus *Mnestia*, to include a few peculiar forms that they range under *Cylichna*. Possibly, these might be better separated generically, though the foregoing diagnosis of *Cylichna* has been drawn up so as to include both types. Adopting this view, the two subordinate groups may be distinguished as follows:

1. **CYLICHNA**, Lovén (typical).

   Shell cylindrical, or narrow-subovate; spire completely wanting, its position being occupied by an umbilicoid cavity; aperture not produced and angular above or below.—(Type as already stated.)

2. **MNESTIA**, H. and A. Adams.

   Shell with spire visible, sunken in the umbilicoid cavity of the summit; aperture produced and angular above and below; surface marked with transverse bands of color.—(*C. marmorata* and *C. bizona*, A. Adams.)

Owing to the difficulty of distinguishing this genus from *Bulla* and several of the allied groups, as the shells are found in a fossilized condition, it is very difficult to arrive at satisfactory conclusions in regard to its geological range. Forms closely resembling it occur in the Triassic and Jurassic rocks. It seems to be represented by well-defined, and characteristic species in the Cretaceous, and ranges through the Tertiary. In the existing seas, it is also represented by a number of living species, including those of both sections. They occur mainly in deep water, on the coasts of the United States, Northern Europe, the Philippine Islands, Australia, &c.

Cylichna? volvaria, M. & H.

Plate 31, figs. 2, *a, b.**

Bulla volvaria, Meek and Hayden (1856), Proceed. Acad. Nat Sci. Philad., VIII, 69.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 16.

Shell thin, elongate-subovate, being widest below the middle, and tapering upward gradually, with moderately convex sides, to the summit, which is narrowly rounded, with apparently a very small central pit; lower extremity oblique and subangular, or narrowly rounded; aperture very narrow, gently arcuate, and not much expanded below, rising a little above the summit of the body at the upper extremity; inner lip thin, reflexed, and closely appressed below, where it shows a faint oblique fold or ridge; surface marked by fine, obscure lines of growth, which are crossed by shallow, transverse striæ, narrower than the spaces between, excepting on the upper and lower extremities, where they are more crowded, and more distinctly defined.

Length, 0.68 inch; breadth, 0.37 inch; breadth of aperture at its widest part below, 0.18 inch; breadth of same near upper extremity, 0.07 inch.

This species will be readily distinguished from all of the other shells of this type yet found in the Upper Missouri rocks, by its narrower, proportionally longer form, tapering from below the middle to its narrower upper extremity; and by its narrower aperture. In these characters, it resembles our *Haminea minor*, figured on the same plate, more nearly than any of the others, but is still proportionally more elongated, and has a differently-formed aperture, which is less arcuate and not so wide below. In size and general appearance, it is more nearly like *Cylichna costata*, Gabb, from the Cretaceous rocks of California; but, as may be seen by the figure, it is more regu-

* Our figured specimen, having the lip broken, is represented too angular at the base; and fig. 2, *b*, is defective in not having the lip projecting a little above.

larly tapering upward, and has a much narrower aperture, and a proportionally wider coil of involuted body-turns.

The only specimen of this shell yet seen has the thin, reflexed, inner lip closely appressed below, where it is wider than represented in our figure 2, *b*, and shows, in certain lights, a very obscure, oblique ridge, not seen in the figure. Unfortunately, the lip is broken away, so as to leave some doubts in regard to the true nature of the ridge; but, from what can be seen, I am induced to refer the species doubtfully to the genus *Cylichna*. It is a thinner shell, however, and less cylindrical in form than the species of that genus usually are. If not a *Cylichna*, however, it should possibly be called *Haminea*, or *Atys* (*Roxania*) *volvaria*, as its thin shell and other characters would seem to indicate relations to these genera.

Locality and position.—Moreau River; from the Fox Hills group of the Upper Missouri Cretaceous series.

Cylichna scitula, M. & H.

Plate 31, figs. 3, *a*, *b*.

Cylichna scitula, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 178.

Shell small, rather solid, narrow-subelliptical, approaching subcylindrical; summit truncated, and occupied by a comparatively large umbilicoid depression; aperture very narrow, arcuate, widening little below; umbilical region slightly impressed; inner lip reflexed and twisted, so as to form a small indistinct fold at its base;* surface marked by fine, obscure lines of growth, which are crossed by impressed transverse striæ, separated by spaces about two or three times their own breadth near the middle of the outer whorl, but becoming much more closely crowded toward the extremities.

Length, 0.24 inch; breadth, 0.14 inch; widest part of aperture, 0.07 inch; breadth of same near upper extremity, only 0.02 inch.

At a first glance, this little shell might be mistaken for the young of our *C. volvaria;* but, on comparison, they will be found to differ essentially in several respects. In the first place, the summit of the species now before us is truncated, and has a larger umbilicoid impression; while that of *C. volvaria* is tapering, narrowly round, and provided with a very small impression. The aperture of the latter is also comparatively broader below, its sides less con-

* This character is not well shown in fig. 3, *a*, which also makes the base of the aperture much too angular, and the summit of the shell too narrow.

vex, and its umbilical region less impressed. It is in most respects, excepting size, however, more similar to our *Hamiuea subcylindrica*, but is much smaller, less nearly cylindrical, and differs in the presence of the fold at the base of the columella, while it is proportionally a decidedly thicker shell.

Locality and position.—Moreau River: from the Fox Hills group of the Upper Missouri Cretaceous series.

ACTÆONIDÆ.*

Genus ACTÆON, Montfort.

Synon.—Actæon, Montfort (1810), Conch. Syst., II, 314.—Cuvier (1817), Règne An.—Conrad (1830), Jour. Acad. Nat. Sci. Philad., VI, 226; Proceed. Acad. N. S. (1862), XIV, 570, and Am. Jour. Conch. (1865), I, 34.—D'Orbigny (1842), Paléont. Fr. Terr. Crét., II, 123.—H. and A. Adams (1854), Genera Recent Moll., II, 4.—Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 63; and (1858) *ib.*, X, 54.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 17.—Gabb (1864), Palæont. Cal., I, 142; and (1869) *ib.*, II, 115 and 232.—Stoliczka (1868), Palæont. Indica, II, 402; and of many others (not of Oken, 1815).

Tornatella, Lamarck (1812), Extr. d'un Cours, 117; and (1822) Hist., VI, 219.—Féruss. (1819), Prodr., 99; and (1821) Tab. Syst., xxxiii.—Goldf. (1820), Zoöl., 657.—Blainv. (1824), Dict. Sci. Nat., XXXII, 245.—Desh. (1832), Encyc. Méth., III, 1041; and (1864) Descr. An. sans Vertèbres Bassin Paris, II, 592.—Philippi (1836), Moll. Sic., 166.—Sowerby, jr. (1839), Conch. Man., 106.—Adams (1840), Bost. Soc. N. Hist., III, 323.—Gray (1842), Synon. Brit. Mus., 90.—Forbes and Hanley (1853), Hist. Brit. Moll., III, 523.—Chenu (1859), Man. Conch., II, 385.—Gould and Binney (1870), Inv. Mass. (2d ed.), 224.—Tryon (1873), Am. Marine Conch., 99.

Kanilla, Silvertrop (1833), Edingb. New Philos. Jour., XV.

Myosota, Gray (1847), Proc. Zoöl. Soc., 160.

Etym.—Ἀκταίων, a mythological name.

Type.—*Voluta tornatilis*, Linn.

Shell subovate, thin, spirally striated or puncto-striate; spire moderately produced, but shorter than the body-volution; aperture rather narrow, long, acute behind, and rounded and entire below; lip thin; columella provided with one oblique fold.

The genus *Actæon* is very closely related to *Solidula*, Fischer: so closely, indeed, as to lead some high authorities to unite them; while others treat them as two distinct genera. About the only differences that can be pointed out are the greater thinness of the shell, and the presence of only one fold on the columella in *Actæon;* while *Solidula* has two folds and a thick shell. It is quite possible that these may be only subgeneric characters; and, if this conclusion should be established, it will be necessary to use Fischer's name *Solidula* for the genus, as it has priority of date over *Actæon*. Among fossil species, we find some with three folds on the columella: but these generally

* See note at the end of this description of the genus *Actæon*.

have a rather thick shell, like *Solidula*, to which they seem more properly to belong.

The genus *Actæon*, as here understood, seems to date back to the Triassic epoch, and ranges through all the succeeding rocks into our existing seas. It is probably not more numerously represented, however, at present than during the Cretaceous and Tertiary periods. The recent species are found in tropical and some more northern seas. One occurs in the Mediterranean and British seas, and a very similar species is found on the northeastern coast of the United States. About sixteen to eighteen recent species are enumerated in conchological works, though this enumeration, of course, does not include nearly all of the existing species.

NOTE.—Perhaps this may be the most appropriate place for me to notice some criticisms in which Dr. Stoliczka has indulged, in the second volume of his Palæontologia Indica, of a paper of mine published in the American Journal of Science and Arts, in 1863, on the family *Actæonidæ*. His strictures are written in his usual supercilious style, and hardly require any other reply than the simple statement of the fact that (as a result of all his objections) of the ten old groups included, and the three new ones proposed by me, as good and distinct genera of this family, as well as a new subfamily at the same time proposed, he admits nine of the old genera, with the new subfamily, and only rejects one of the new genera. The old genus not included by him is *Globiconcha*, d'Orbigny, which is generally referred to this family, though it was founded on imperfect and unsatisfactory materials.

The newly-proposed genus *Aptycha* that he rejects, was intended for the reception of an East Indian Cretaceous shell, described many years back by Prof. E. Forbes. It has the form, thickened outer lip, and general appearance of *Ringicula*, but was *clearly figured* and *distinctly described* by Professor Forbes as having its inner lip *destitute of any traces of folds or plaits;* a combination of characters which any well-informed conchologist of the present day, will at once see would mark it as the type of a new genus, as the genera of this family are now more precisely restricted. Dr. Stoliczka, however, states that, on examining Professor Forbes's original type-specimen (which, of course I never saw), in London, he found, after clearing the rock out of the aperture, that it really *has* the plaits of *Ringicula* on its inner lip. This being the case, my name *Aptycha* necessarily falls into the synonymy of that genus; but I think any fair-minded naturalist will admit that the

fault, if any exist, is not properly chargeable to me, but to the justly-distinguished author who originally figured and described the species as stated.

Again, Dr. Stoliczka admits the correctness of my conclusion (published at a later date than that of the paper he criticises), that the *Ringicula* group should stand apart as a distinct family. So it would seem, when so many of my conclusions have been adopted by one writing in a manifestly unfriendly spirit, that, although far from claiming perfection for my work, I have not very much to fear from impartial criticism.

Of the six sections of the included genera likewise proposed and admitted by me (one of them being an old group), Dr. Stoliczka also admits two, not merely as subgenera, but as full genera. The four others, however, he rejects, on the ground that there are intermediate types between them and the typical sections of the genera under which I ranged them. Of course, there are some intermediate types; if there were not—that is, if these sections stood *entirely* disconnected from the typical forms of the genera under which they are placed—they would not be merely subgenera, but full genera. In fact, Dr. Stoliczka admits himself two genera, *Myonia* (a pre-occupied name), and *Leucotina* of Adams, which he, curiously enough, acknowledges are only distinguished from each other and *Actæon*, by difference in the proportional length of the spire and in the form of the body-volution, which are precisely the characters that he rejects as insufficient to distinguish my subgenera. I was fully aware, as any one may see by consulting my paper, of the existence of the intermediate types to which he alludes, and called especial attention to them as a reason for not admitting these subordinate groups to higher rank than subgenera.

One of the most positively-asserted objections, however, that Dr Stoliczka thinks he finds to my paper, is the omission of certain genera that he includes in the family. In the first place, however, it will be seen that a part of these have been made known *since* the publication of my paper, while some of the others are admitted by him to have only doubtful claims to a place in the family. Again, he further augments the number of genera by including as a subfamily of the family *Actæonidæ*, the *Aplustridæ*—a group that such high authorities as Dr. Gray, Dr. Gill, Dr. P. P. Carpenter, and H. and A. Adams, to say nothing of Chenu and others, admit to the rank of a distinct family; while Woodward includes most of the group in the family *Bullidæ*.

No one will deny that Dr. Stoliczka had a right to entertain his own peculiar views, and to express them freely; but it is to be regretted, for his own sake, that he has shown through all of his Indian Palæontology (which, aside from this blemish and some eccentricities of opinion, is a creditable enough production), such a chronic fault-finding spirit as almost to assume the attitude of a "common scold" toward all other palæontologists—a character probably not at all applicable to him in his daily intercourse with his fellow-men.

Actæon subellipticus, M. & H.

Plate 19, fig. 16.*

Actæon subellipticus, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 63.
Solidula (Actæonina?) subelliptica, Meek and Hayden (1860), *ib.*, XII, 185.
Solidula subelliptica, Meek and Hayden (1860), *ib.*, 424.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 17.

Shell small, narrow-subovate, or short-subfusiform; spire short, pointed; volutions four and a half, those of the spire moderately convex, last one large, but not very ventricose, narrowed and somewhat produced below; suture distinct; surface polished and ornamented by fine, revolving striæ, a little less than the spaces between, and composed of small punctures, which also range parallel to the lines of growth, about eight to ten of the revolving striæ being seen on the second turn, and some twenty-seven or twenty-eight on the last one; aperture narrow, widest at the middle, acutely angular above, and very narrowly rounded below; columella with apparently a small, oblique fold.

Length, 0.22 inch; breadth, 0.12 inch; apical angle, about 50°.

This shell seems to be nearly related to *Actæon costatus*, Bellardi, from the Nummulitic deposits of Nice (Mem. Geol. Soc. France (2d ser.), IV, pl. 12, fig. 4), but is smaller, and evidently has its aperture more narrowly rounded in front, though this character is exaggerated in our figured specimen by the broken condition of the lip below. Our specimen is not in a condition to show the fold on the columella clearly and satisfactorily, and this has led to the suspicion that it may belong to the genus *Actæonina*, though it seems more probably to be an *Actæon*. In adopting the conclusion that the genus *Actæon* is identical with *Solidula*, Fischer, as maintained by some good authorities, we ranged this species under that older name. If the types of these two groups, however, represent two distinct genera, then this shell will, if not an *Actæonina*, have to stand under *Actæon* proper, as it is too thin

* This figure is magnified about two and a half diameters.

a shell to go into *Solidula*, and almost certainly has not two folds on the columella.

Locality and position.—Crow Creek, near the Black Hills, Dakota; from the Fort Pierre group of the Upper Missouri Cretaceous series.

Actæon attenuatus, M. & H.

Plate 19, fig. 17, *a*, *b*.

Actæon (Solidula?) attenuatus, Meek and Hayden (1858), Proceed. Acad. Nat. Sci. Philad., X, 54
Solidula attenuata, Meek and Hayden (1860), *ib.*, XII, 185; and *ib.*, 424.—Meek, Smithsonian Check-List N. Am. Cret. Fossils, 17.

Shell elongate-subovate, approaching subterete, very thin; spire produced to about two-thirds the length of the body-volution; whorls about five, compressed-convex, last one narrow or subcylindrical; suture distinct; surface polished, and ornamented by small punctate revolving striæ, generally less than the spaces between on the spire, but more closely arranged and less regular on the body-volution, near the base of which they become stronger; aperture narrow, being very acutely angular above, widest below the middle, and very narrowly rounded or subangular at the base.

Length, 0.54 inch; breadth, 0.19 inch; angle of spire, near 22°.

This species differs from the last remarkably in the relative sizes of its spire and body-volution; the former being proportionally much longer and the latter much narrower than in the preceding species. The only specimen yet found has the lip and the lower part of the columella broken away, so as to leave room for doubts whether or not it had the characteristic fold on the columella of *Actæon*, though I think I can see obscure evidences, on very critical examination, of a single fold. If it has no fold, however, of course it will have to be removed to the genus *Actæonina*.

I am not acquainted at present with any very nearly allied species. In the Proceedings of the Academy of Natural Sciences of Philadelphia for March, 1860, Mr. Gabb has figured a somewhat similar shell, from the Cretaceous rocks of New Jersey, under the name *Actæonina biplicata*, a name that he attributes to Meek and Hayden; but I do not remember that we ever described any such shell under that name. Mr. Gabb states that it has two plications on the columella, and that he had supposed it to be new until he saw our type-specimen at Washington, which he says is not in a condition to show the folds on the columella, so clearly seen on the New Jersey specimen. From his remarks, I think he must have seen the type of the species here under consideration, and by some accident obtained a wrong name for it.

However that may be, judging from his figure of the New Jersey shell, I should think it entirely distinct from our species, which differs in form, and almost certainly has not two plications on the columella, while Mr. Gabb's enlarged figure of the surface-markings of his shell does not show any indications of punctate striæ. He doubtless also wrote the name *Actæonina* by a slip of the pen for *Actæon* or *Actæonella*, as the plications mentioned on the columella would exclude it from *Actæonina*; but its other characters would also exclude it from *Actæonella* as properly restricted

As with the last, in adopting the conclusion that *Actæon* would have to be regarded as a synonym of the older name *Solidula*, we have elsewhere ranged this species under the latter name. If the two are to stand as distinct genera, however, this shell must fall into *Actæon*, and not into *Solidula*, both on account of its extreme thinness and almost certainly in consequence of not having more than one fold on its columella.

Locality and position.—Yellowstone River, one hundred and fifty miles from its mouth; from beds containing a blending of the fossils of the Fort Pierre and Fox Hills groups of the Upper Missouri Cretaceous series.

RINGICULIDÆ.*

Genus CINULIA, Gray.

Synon.—Cinulia, Gray (1840), Synon. Brit. Mus., 62, 90; and (1842) *ib.*, 62, 90; also (1847) Proceed. Zoöl. Soc., 160.—Woodward (1856), Man. Conch., 180.—Meek (1863), Am. Jour. Sci. and Arts, XXXV, 93; and (1864) Smithsonian Check-List N. Am. Cret. Fossils, 16.—Briart and Cornet (1865), Descr. Min. Géol. et Paléont. de la Meule de Braconegines, 39.

Arellana, d'Orbigny (1843), Paléont. Fr. Terr. Cret., II, 133.—Reuss (1844), Verst. Böhm., 50.—Chenu (1859), Man. Conch., I, 223.—Meek (1863), Am. Jour. Sci. and Arts, XXXV, 92 (as a subgenus under *Cinulia*).—Gabb (1869), Palæont. California, II, 264 (as a genus).—Stoliczka (1870), Palæont. Indica, II, 405 (as a distinct genus).

Etym.—?

Type.—*Auricula globulosa*, Deshayes.

Shell globose, or subglobose; body-volution comparatively large; spire short, sometimes abruptly attenuate; aperture narrow, arcuate, sometimes a

* In a note appended to the Smithsonian Check-List of North American Cretaceous Fossils, published in 1864, I mentioned having been permitted by Dr. Stimpson to examine a drawing, made by him, of the animal of a *Ringicula* that he had dredged alive on the coast of China, and remarked that from the structure of the animal of this genus, as shown in this drawing, I regarded it as being typical of a new family *Ringiculidæ*, including *Ringicula*, *Cinulia*, *Arellana*, and *Euptycha* (since changed by me to *Eriptycha*, *Euptycha* being pre-occupied).

According to Dr. Stimpson's carefully-prepared drawing, the animal of *Ringicula* would seem to be entirely without eyes, and to have its foot produced beyond the head (which it equals in breadth), its anterior extremity being transversely truncated, and a little sinuous. It is also provided with a large siphon-like organ that it carries folded back on the shell between two short and broad tentacular lobes, also folded back. The foot likewise shows a curious longitudinally oval opening, with crenate margins, on the left side.

little sinuous below; external thickening of the outer lip well-developed, the lip being crenate or smooth within; inner lip thickened, and provided with from one to three well-developed plications, or folds; surface marked with spiral, sometimes punctate striæ.

The foregoing diagnosis is drawn up so as to include three subgeneric groups, presenting the following distinguishing features:

1. **CINULIA**, Gray (typical).

   Shell with outer lip smooth within; inner lip bearing a single, very oblique, moderately prominent fold, continued downward into the outer lip at the base of the aperture; spire typically abruptly attenuated.—(Type as already cited.)

2. **OLIGOPTYCH**, Meek.

   Shell with spire much depressed and obtuse; outer lip smooth within, and very slightly sinuous at the base of the aperture; inner lip bearing a single, very prominent, nearly transverse plication, or tooth, at the base of the columella.—(*Actæon concinnus*, Hall and Meek.)

3. **AVELLANA**, d'Orbigny.

   Shell with the thickened outer lip crenate within, and the inner bearing from two to three or four prominent, nearly transverse plications, or teeth.—(*Avellana incrassata*, d'Orbigny.)*

The group *Avellana* was made, by d'Orbigny, to include the type-species of *Cinulia*, Gray, along with other species belonging to a somewhat different section, such as *A. incrassata*, *A. Hugardiana*, &c., d'Orbigny. As the latter group, however, does not seem to me to differ more than subgenerically from *Cinulia* proper, I have, elsewhere as well as here, retained it in that sense, under d'Orbigny's name *Avellana;* and now also propose another small section for the reception of such forms as *Actæon concinnus*, Hall and Meek. As thus defined, the genus *Cinulia* is related to *Ringicula*, Deshayes, but differs in having a more globose form, a more depressed spire, and particularly in wanting the deep sinus at the base of the columella, seen in that genus. So far as known, it is peculiar to the Cretaceous rocks.

* In a revision of the family *Actæonidæ*, published in 1863, in the Am. Jour. Sci. and Arts (2d. ser.), XXXV, 93, I also included, as another subgenus under *Cinulia*, a group for which the name *Euptycha* was proposed, with *Auricula decurtata*, Sowerby, as its type. I now regard that group as forming a distinct genus, and having since observed that the name proposed for it was pre-occupied for a genus of *Lepidoptera* (described by Hübner in 1816), now propose to name it *Eriptycha*. In addition to the type-species *E. decurtata*, it will include the three East Indian Cretaceous species, *E. globata* and *E. larvata*, Stoliczka, described by Dr. Stoliczka under the generic name *Euptycha;* and *E. oviformis* described by Professor Forbes as *Nerita oviformis*.

Cinulia (Oligoptycha) concinna, H. & M. (sp.).

Plate 31, figs. 6 *bis*, *a*, *b*, *c*.

Actæon concinnus, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci., Boston, V (n. s.), 390, pl. iii, fig. 4.
Avellana subglobosa, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 64.
Avellana concinna, Meek (1859), Hinds' Report Saskatchewan and Assinib. Exped., 184.
Cinulia concinna, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 425.

Shell small, subglobose; spire very short; volutions four, increasing very rapidly in size, the last one forming nearly the entire bulk of the shell; those of the spire slightly convex; suture distinct; surface ornamented by small, punctate, revolving striæ, generally less than the spaces between, and numbering about twenty-six to twenty-eight on the body-volution; aperture sublunate or auriform, widest below the middle, and narrowing upward; reflexed and smooth outer lip forming only a narrow, moderately-thickened band; inner lip rather thick all the way up, and wider where it supports the very prominent, transverse, tooth-like fold, or plication, below; margin of aperture faintly sinuous below.

Length, 0.30 inch; breadth, 0.28 inch; length of aperture, 0.22 inch; breadth of same, 0.10 inch.

The original type-specimen of this species seems to have been an immature individual, that had not developed the thickened marginal rim of the lip, as we now know from others that this character is always present in adult individuals, unless in cases where the lip has been broken. This being the case, it cannot, of course, be properly retained in the genus *Actæon*, but falls within the genus *Cinulia*. I know of no species so nearly related in its specific characters as to render a critical comparison necessary.

Locality and position.—Moreau River, Dakota; from the Fox Hills group of the Upper Missouri Cretaceous series. I have also seen specimens of it from the Yellowstone River of Montana, and others in Professor Hinds' collections, from about the same horizon on the Assiniboine River, British America. The original type-specimen was found on Sage Creek, Dakota, in the upper beds of the Fort Pierre group of the Cretaceous series.

PULMONATA.

SIPHONARIIDÆ.

Genus ANISOMYON, M. & H.

Synon.—*Patella, Acmæa, Helcion*, &c. (sp.), of palæontologists.

Anisomyon, Meek and Hayden (1860), Am. Jour. Sci. and Arts, XXIX (2d ser.), 35.—Gabb (1861), Synop. Moll. Cret. Form., 38; (1864) Palæont. Cal., I, 142; and (1869) *ib.*, II, 231.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 17.—Stoliczka (1868), Palæont. Indica, II, 325.—Dall (1870), Am. Jour. Conch., VI, 39.

Etym.—ἄνισος, unequal; μῦών, muscle.

Type.—*Helcion patelliformis*, Meek and Hayden.

Shell very thin, patelliform, obliquely conical, or bonnet-shaped; base oval or circular, with simple margins; surface nearly smooth, or only marked by obscure lines of growth, crossed on some species by fine, faintly-marked, radiating striæ, and sometimes a few obscure posterior ridges; summit more or less elevated, located between the middle and the anterior end, or sometimes nearly central; immediate apex very small, abruptly curved backward, but not spiral; interior without a siphonal groove, projecting lamina, or other appendage; horse-shoe-shaped muscular scar enlarged at the anterior extremities, with the open part directed toward the shorter end of the shell, becoming abruptly attenuate, or broken into a few small spots on the right posterior side; anterior extremities connected by a linear impression, usually passing across just in front of the summit.

On the left side of the shell, the anterior end of the muscular impression is generally less enlarged than on the right, but sometimes extends slightly farther forward. Posteriorly, it passes around in the form of a band to the middle of the slope behind (figs. 5, *c* and *f*, pl. 18), where it is abruptly enlarged and curves upward From this point to the larger anterior extremity on the right side, there is usually only a slender line, or row of spots. Sometimes this slender line seems to be quite entire, while in other specimens, even of the same species, it is broken into a few small spots or scars, as seen in fig 5, *f*, of pl. 18; and in still other examples it seems to be entirely obsolete, so as to leave the enlarged anterior extremity on the right quite isolated, as seen in fig. 5, *c*, of the same plate.

In most instances, the specimens, as broken or weathered from the matrix, have lost the small reflexed apex, as seen in our figures 7 *a*, and 9 *b*, *e*, of pl. 18; and, in this condition, its former existence would scarcely be

suspected. At one time I was rather inclined to think that there might have been a minute perforation at the immediate point of the summit, owing to the fact that one of the specimens of *A. borealis* has a little opening there, with apparently smooth margins; while some of the others show some indications of such a perforation. The fact, however, that in all of the latter there is unmistakable evidence of fracture of the point, while in one specimen of another species (see fig. 5, *a*, pl. 18) this little reflexed apex of the summit comes to an abrupt point, without the slightest opening, shows, as is now believed, that this is always the case, where the point is not accidentally broken or worn off. So very minute a natural opening at that point would also be against all analogy in such a shell; while the delicacy and the peculiar hooked form of this little apex would render it especially liable to accidental fracture.

In two of the species, there are six equidistant impressed hair-lines radiating from the apex down the lateral anterior and posterior slopes, nearly or quite to the margins: and in another species, only known from its internal cast, six similarly-disposed, rather deep, and wider furrows extend from the apex to the margins, to which they impart slightly emarginate appearances at their terminations (see fig. 8, *a*, *b*). As nothing of this kind, however, is seen on some of the other species, apparently agreeing in all other respects excepting mere specific details, I cannot believe this a generic character.

From the foregoing description and the accompanying figures, it will be seen that this group consists of shells more or less nearly resembling in form the well-known genus *Patella*. But on closer examination, the conchologist will readily see that they present marked and important differences. In the first place, they are all thinner and smoother shells than we generally see in that genus; but the most important distinctions consist in the nature of the muscular scar and the abruptly pointed and reflexed apex, the former of which at least, indicates fundamental differences in the organization of the animal.

The peculiar interruption in the muscular impression on the right side, together with the limpet-like form of these shells, also suggests more or less near relations to the genus *Siphonaria*. They differ, however, at least generically, from that group, in having the interruption in the right *posterior* lateral, instead of the right *anterior* lateral region, and in the pointed and abruptly reflexed apex. They are also smoother and thinner shells than most

of the species of *Siphonaria*, though in the latter two characters they do not differ from one section of that genus; but, in that section, the apex is marginal, and the muscular scars and other characters as in the other section. Again, some of our specimens of the shells under consideration present such appearances as to leave doubts whether there was really a complete break in the muscular scar at the point of interruption. It is always abruptly attenuated there, and apparently, in some cases (fig. 5, *c*, pl. 18), presents a complete and wide gap. But, in other cases, it is broken into several spots, or in still others, apparently represented by a continuous slender line at that point as seen in fig. 4, *a*, of same plate: which would seem to preclude the possibility of the protrusion of a siphon there; while it is worthy of note that none of the species show any traces of a siphonal groove.

Compared with *Tectura*, *Gadinia*, and *Scurria*, these shells will be seen to differ from them all in the partial or entire interruption of the muscular scar already mentioned, as well as in the abruptly-reflexed point of the summit. In general appearance, some of the more elevated species nearly resemble *Scurria*, but differ in the characters mentioned.

In regard to the family-affinities of such fossil types, having no existing species, it is of course very difficult to arrive at satisfactory conclusions. If the partial or entire break seen in the scar of the muscular attachment of these shells was for the passage of a siphon, then the propriety of referring them to the family *Siphonariidæ*, could scarcely admit of a doubt; but the fact that in some instances, as already stated, the muscular scar does not seem to be *completely* divided (though always much attenuated) on the right posterior side, appears to indicate that there could hardly have been any such organ protruded there. Consequently, although originally inclined to refer the genus to the *Siphonariidæ*, I was left in much doubt on this point, and finally concluded to place it provisionally in the *Acmæidæ* (= *Tecturidæ*). Dr. Stoliczka, however, refers it to the *Lepetidæ*; and Mr. Dall, a much better authority, with greater probability of correctness, thought, after a careful examination of the type-specimens, that the group should go into the *Siphonariidæ*; which conclusion I have here, at least provisionally, adopted.

It is perhaps hardly necessary to add that if these shells really possessed a natural perforation at the apex, as was at one time suspected might possibly have been the case, they would not belong to any of the above-mentioned

families, but would apparently occupy a place in the widely-removed *Fissurellidæ*. Of this, however, there is, I now think, no probability.

This genus seems to range back to the Jurassic, and certainly to the Cretaceous epoch, though until the rather numerous fossil shells that have been described by palæontologists under the names *Patella, Acmæa, Helcion*, &c., have been more carefully studied by the aid of specimens giving a correct knowledge of the interior, and the nature of the apex, it will not be possible to determine its exact geological range, or to give a list of the species.

I would suggest a thorough and critical examination of internal casts, to any person who may be disposed to undertake the task of eliminating the species from the several genera to which doubtless a number of the Cretaceous, and perhaps some Jurassic (or possibly even older species), have been referred. It is very rarely, indeed, that the interior of such thin fossil shells will ever be clearly seen; but well-preserved internal casts nearly always show impressions of the muscular scars.

I have the impression that this genus did not survive the close of the Cretaceous epoch

Anisomyon borealis, M. & H.

Plate 18, figs. 9, *a*, *b*, *c*, *d*, *e*.

Hipponyx borealis, Morton (1842), Jour. Acad. Nat. Sci. Philad., VIII, 210, pl. xi, fig. 6.
Helcion carinatus, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VI, 68.
Anisomyon borealis, Meek and Hayden (1860), Am. Jour. Sci. and Arts, XXVIII (2d ser.), 35.

Shell thin, bonnet-shaped, the summit being prominent, with a general forward obliquity, and located in advance of the middle: immediate apex very small, abruptly pointed, and having the characteristic abrupt backward curve well-marked; base nearly circular anterior and anterior-lateral slopes abrupt and distinctly concave; posterior and posterior-lateral slopes convex, the former being carinated along the middle, and the latter usually supporting a few very obscure radiating ridges; surface, when slightly worn, appearing smooth, but in well-preserved examples marked by fine, inconspicuous lines of growth, which are crossed by similar closely-arranged, radiating striæ, scarcely visible without the aid of a magnifier; radiating from the apex may also be seen six equidistant, deeply-impressed hair-lines, four of which pass down the posterior and lateral slopes, and two down the anterior-lateral.

Diameter of aperture or base, 1.93 inches; height of apex, 0.80 inch.

The six radiating hair-lines are generally sharply impressed, but where the surface is a little worn they sometimes become nearly obsolete. They are never represented by any corresponding lines, furrows, or ridges on the interior of the shell, so far as can be determined from internal casts. The general obliquity of the summit is toward the front; but the very small, pointed, immediate apex, is suddenly thrown or folded backward, though it is very rarely preserved entire as the specimens are usually seen. As seen broken or worn off, the apex sometimes looks *very* much as if it were perforated by a minute opening; but, as already stated, this is probably merely accidental.

None of the internal casts yet examined show the whole muscular impression, but some of them show it to become abruptly attenuated as it approaches the point on the right posterior side, where the interruption is seen in that of the other species.

Locality and position.—Great Bend of the Missouri, below Fort Pierre; from the base of the Fort Pierre group.

Anisomyon Shumardi. M. & H.

Plate 18, figs. 7. *a*, *b*, *c*.

Anisomyon Shumardi. Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 423.

Shell obliquely conical, a little compressed laterally; aperture oval or subcircular; summit elevated, located a little in advance of the middle; immediate apex apparently presenting the usual pointed and recurved character; lateral slopes concave in outline below, nearly straight above; anterior slope slightly convex above, and concave below; posterior side nearly straight or a little convex, and provided with a rather obscure, narrow, mesial carena, which extends from the apex nearly to the base; surface marked by small, inconspicuous lines of growth, which are crossed by obscure traces of fine, radiating striæ, and six equidistant, impressed hair-lines, two of which extend from the apex to the anterior border, and four from the apex to the posterior and posteror-lateral margins.

Length of base, about 1.46 inches; breadth of base, about 1.32 inches.

This form resembles the last in its general appearance, and has the same surface-characters, but differs in being more elevated and in having its apex much more nearly central, with the abrupt anterior slope convex instead

of concave (see fig. 7*a*, and compare with fig. 9*b*). I have not seen casts of the interior; but, from the similarity of the shell to that of the last-described species, there can be little doubt in regard to its muscular impression being as in that form.

The specific name was given in honor of the late Dr. B. F. Shumard, of Saint Louis, who was one of our most able palæontologists.

Locality and position.—Same as last.

Anisomyon patelliformis, M. & H.

Plate 18, figs. 5, *a*, *b*, *c*, *f* (not *d*; and *e*?).

Helcion patelliformis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci., VIII, 68.
Anisomyon patelliformis, Meek and Hayden (1860), Am. Jour. Sci. and Arts, XXVIII, 35, pl. 1.

Shell thin, ovate or subelliptic-patelliform, usually broadest toward the posterior or longer side; summit moderately elevated, a little compressed laterally, located in advance of the middle, immediate apex having the generic characters well defined; lateral slopes nearly straight, converging to the apex at an angle of about 90°; anterior slope straight, a little convex or slightly concave; posterior slope convex, and generally showing very faint traces of a few radiating ridges; surface marked by fine, very obscure lines of growth, and indistinct indications of radiating striæ.

Length, 0.94 inch; breadth, 0.83 inch; height, 0.40 inch.

Several internal casts of this species in the collections show very distinctly the peculiar muscular impression characteristic of the genus. Sometimes its enlarged anterior extremity on the right side is left completely disconnected, in consequence of the slender part passing around behind being separated into a row of small spots, or entirely obsolete.

In a few instances, I have observed the border on the right anterior side in front of the muscular impression a little raised, as if slightly modified by the protrusion there of the head or some other organ (see figs. 5 *a*, *b*); but this may have been produced by accidental distortion or inequalities in the surface upon which the animal had temporarily fixed itself. It is not often that specimens are found with the small, recurved apex of the summit unbroken; but I have seen it in a few instances, as shown in fig. 5, *a*. Sometimes it has the appearance of being perforated, and in other specimens it certainly comes to an imperforated point, as is probably always the case when entire.

In its general appearance, this species resembles somewhat *A. borealis*, but it is always much smaller, more depressed, and destitute of the distinct mesial carina, and six impressed, radiating lines, while the apex is farther removed from the anterior side. It has been taken as the type of the genus.

The specimen represented by our figure 5 *e*, of plate 18, differs slightly in outline from the typical form, being more elliptic, and possibly may belong to another species, though I have preferred to view it provisionally as a variety of that here under consideration.

Locality and position.—Yellowstone River, 150 miles above its mouth; in a bed containing a blending of the fossils of the upper part of the Fort Pierre group, and the lower beds of the Fox Hills group of the Upper Missouri Cretaceous series.

Anisomyon subovatus, M. & H.

Plate 18, figs. 5, *d*, and 6.

Helcion suboratus, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 68.
Anisomyon suboratus, Meek and Hayden (1860), Am. Jour. Sci., XXVIII (2d ser.), 35.

Shell elliptic-subovate, patelliform, rather thin; extremities obtusely, and nearly equally rounded; lateral margins nearly straight and subparallel; summit rather depressed, located about half-way between the center and the front margin; slopes of the sides convex, and forming an angle at the summit of about 80°; posterior slope more convex than the anterior; surface marked by faint, irregular, concentric wrinkles, and fine, obscure, subimbricating lines of growth.

Length, 1.16 inches; breadth, 0.81 inch; height, 0.39 inch.

When viewed in certain lights, there may be seen near the posterior margin of the only specimen of this species we have met with, extremely faint indications of small, regular, radiating costæ. This character, however, is so very obscurely marked that it might be easily overlooked, and is perhaps generally entirely absent, especially where the surface is a little worn or weathered.

The curve of the lines of growth show that, when young, this shell must have been very nearly like the following species; the apex in the first stages of its growth being more nearly central than in the adult. As it advanced in age, owing to the more rapid growth of the posterior margin, the summit was left in front of the middle.

The apex of the only specimen yet obtained being a little broken, I have not been able to determine whether or not it was abruptly attenuated and curved backward, though it appears to have been, and doubtless was, so curved. No internal casts of this species have yet been seen, consequently nothing is known of the nature of its muscular impression; but, from the appearance of the shell in other respects, it is believed that it will be found to possess the internal characters of this genus.

The side-view of this form was inadvertently numbered 5, *d*, on plate 18.

Locality and position.—Same as last.

Anisomyon alveolus, M. & H.

Plate 18, figs. 4, *a*, *b*.

Helcion alveolus, Meek and Hayden (1856), Proceed. Acad. Nat. Sci., VIII, 68.
Anisomyon alveolus, Meek and Hayden (1860), Am. Jour. Sci. and Arts, XXVIII (2d ser.), 35.

Shell small, subovate-patelliform, a little less than twice as long as wide, very thin, slightly broader behind than toward the front; extremities rather narrowly rounded; lateral margins convex in outline; summit depressed, nearly central or very slightly behind the middle; lateral slopes from the apex a little convex, and diverging at an angle of about 80°; posterior and anterior slopes nearly equally convex, and converging toward the summit at an angle of about 120°; surface smooth or only marked by obscure lines of growth.

Length, 0.63 inch; breadth, 0.42 inch

Internal casts of this species show that the muscular impression agrees in all its essential characters with that of *A. patelliformis;* though the anterior extremities are narrower in proportion to the size of the shell than in that species, and the slender part on the right posterior side seems to be always continuous.

It is possible that this may be the young of the last, though it is more narrowly rounded at the anterior extremity than that species seems to have been at any stage of its growth, while its shell is much thinner, and the apex more nearly central. I am, therefore, with the present means of comparison, compelled to keep them separate.

Locality and position.—Same as last.

Anisomyon sexsulcatus, M. & H.

Plate 18, figs. 8, *a*, *b*.

Helcion sexsulcatus, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 68.
Anisomyon sexsulcatus, Meek and Hayden (1860), Am. Jour. Sci., XXVIII (2d ser.), 35.

Shell oval or elliptic-patelliform, depressed, apparently a little broader posteriorly than in front; apex located between the middle and the anterior end; lateral slopes nearly straight, diverging from the summit at an angle of about 100°; anterior slope concave, and having (on internal casts) two rather distinct shallow grooves extending from the apex to the anterior-lateral margins; posterior slope a little convex, and showing on casts four shallow grooves, which radiate from the apex to the posterior and posterior-lateral borders; (external surface unknown).

Length, about 2.65 inches; breadth, near 1.29 inches; height, 0.48 inch.

The apex of the only specimen of this shell we have seen is broken away, but has the appearance of having been abruptly attenuated and recurved, as in the other species. The six radiating grooves seen on the cast seem to have been produced by ridges on the inside of the shell, corresponding exactly in position with the impressed lines on the exterior of *A. borealis*. Whether or not there were corresponding grooves on the exterior surface, over those seen on the cast, we have not been able to determine, not having seen the outside of the shell. The muscular impression, as seen on the cast, seems to present the same characters as that of the other species.

This shell differs from all the analogous forms known in these rocks, in the possession of the radiating grooves on the internal cast, mentioned in the description. It is also much more depressed than any of the other species attaining so large a size.

Locality and position.—Yellowstone River, 160 miles from its mouth; in beds containing a blending of the fossils of the Fort Pierre and Fox Hills groups of the Upper Missouri Cretaceous.

DOCOGLOSSA.

ACMÆIDÆ.

Genus ACMÆA, Esch.

Synon.—*Patella*, *Helcion*, *Scurria*, *Pilcopsis*, &c. (sp.), of authors; but not as properly understood.

Acmæa, Eschscholtz (1828), App. to Kotzebue's New Voy. around the World; and (1830) in Coburn and Bentley's Lond. transl. same, II, 350; also (1833) Zoöl. Atlas (ed. Rathke), 16.—Forbes and Hanley (1853), Brit. Moll., II, 433.—Dall (1870), Am. Jour. Conch., VI, 237.

Tectura, Audouin and Edwards (1830), Ann. Sci. Nat., XXI, 326; and (1832) Réch. Hist. Nat. Littor. Fr., I, 144.

Patelloidea (Quoy and Gaimard, MS.), Deshayes (1832), Encyc. Méth., III, 704.—Quoy and Gaim. (1833), Voy. Astrolabe, III, 349; and of others.

Lottia, Gray (1833), Phil. Trans., 123 and 800; also (1840) Synon. Moll. Brit. Mus., * * .—Forbes (1838), Malac. Mon., 34.—Reeve (1841), Proceed. Zoöl. Soc., 75; and (1842) Conch. Syst., II, 17.—Möller (1842), Index Moll. Grœnl., 16; and of many others.

Tectura, Gray (1847), Proceed. Zoöl. Soc., 158.—H. and A. Adams (1854), Genera Recent Moll., I 458.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 17.—Dall (1870) Proceed. Bost. Soc. N. Hist., 245; and of others.

Etym.—ἀκμαῖος, blooming.

Type.—*Acmæa mitra*, Esch.

Shell patelliform, generally depressed, regular, thin, smooth or radiately striated; base subcircular or oval; apex antero-central, or more or less in advance of the middle, obtuse, with usually a slight forward obliquity; aperture very large; muscular impression horse-shoe-shaped, interrupted anteriorly.

My friend Mr. Dall, to whose excellent paper on this and allied groups (published in the Journal of Conchology) I am indebted for the foregoing synonymy, divides this genus into two subgenera; that is, into *Acmæa* proper, and the subgenus *Collisella*; but these distinctions, being based on peculiarities of the soft parts and the dentition, of course cannot be made available in palæontology.

Indeed, among fossil species, it is very difficult, and perhaps often impossible, to distinguish this genus from *Patella*. Most generally the shell in *Acmæa* is more depressed and thinner than in *Patella*; and, as noticed by Forbes and Hanley, the recent shells of the former are, to some extent, distinguished by "an absence of a nacreous gloss on the upper surface." As conchologists mainly rely on differences in the animals of these two genera, however, it may readily be understood that the task of the palæontologist, in attempting to separate them among fossil species, is very difficult. Consequently, the geological range of *Acmæa* is far from being well determined. Species undistinguishable, however, by any known characters, occur

in rocks of different ages, even back to the Carboniferous. It is probable, however, that many of those found in the Cretaceous and Jurassic rocks will prove to have the internal characters of *Anisomyon;* though some of them seem, even from internal characters, to belong to this genus

The genus *Acmæa* also occurs in the Tertiary rocks, and perhaps attains its greatest development in our existing seas The living species range from low tide to thirty fathoms, and occur on the eastern and western shores of North America, Australia, &c.

I merely followed Gray, H. and A. Adams, and other high authorities in using the name *Tectura* for this genus in former publications, because I had not thoroughly traced out its synonymy. Since doing so, I am satisfied that Mr. Dall is right in adopting the oldest name, *Acmæa*, for it.

Acmæa occidentalis, M. & H.

Plate 18, figs. 3, *a*, *b*.

Orbicula (undt.), Owen (1852), Geological Report Wisconsin, Iowa, and Minnesota, pl. 8, fig. 11.
Capulus occidentalis, Hall and Meek, Mem. Am. Acad. Arts and Sci. Boston, V (n. s.), 385, pl. 1, fig. 13.
Tectura? occidentalis, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 423.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 17.

Shell suborbicular, much depressed, and very thin; summit slightly in advance of the middle, apparently obtusely pointed, and directed slightly toward the front; surface smooth, or only marked by fine, obscure lines of growth. Faint radiating lines are also seen on the surface of internal casts, but they are very obscure and irregular, and appear to be in no way connected with the surface-markings.

Greater diameter, 0.49 inch; breadth, 0.47 inch; height, 0.11 inch.

Although I am in doubt respecting the generic relations of this shell, it is clearly not congeneric with the recent typical forms of *Capulus*. In the first place, it is a much more depressed shell than any true *Capulus*, and has its apex much less attenuated, and not in the least degree spiral or incurved. Again, it differs in having its apex and the open end of its horse-shoe-shaped muscular scar (which latter is clearly seen on some of the internal casts) directed toward the same end of the shell, while the reverse is the case in *Capulus*. It will be readily distinguished from any of the other known patelliform shells found in the Upper Missouri rocks, by its more depressed form, as well as by having its muscular scar uninterrupted posteriorly.

It is referred to this genus instead of *Patella*, on account of its depressed form, thinness, and nearly smooth surface.

Locality and position.—The specimen first figured and described in the Memoirs of the American Academy of Arts and Sciences, cited above, was collected by the writer at Sage Creek, in the Upper beds of the Fort Pierre group, or No. 4 of the Upper Missouri Cretaceous. That here described came from the same beds on Cheyenne River near the Black Hills.

Acmæa? parva, M. & H.

Plate 18, figs. 1, *a*, *b*, *c*, and fig. 2.

Tectura? parva, Meek and Hayden (1860), Proceed. Acad. Nat. Sci., 423.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 17.

Shell very small, thin; summit rather elevated, located in advance of the middle; aperture circular: (surface unknown).

Breadth, 0.26 inch; height, 0.12 inch.

The only specimen of this little shell yet seen, is embedded in the matrix in such a manner as to show only the interior. On the internal cast, the muscular impression is seen to have the usual horse-shoe-form, without being interrupted on the posterior side, as in the genus *Anisomyon*. I have only placed it provisionally, however, in the genus *Acmæa*.

Locality and position.—The specimen and label have been both mislaid, and the exact locality is not remembered; no doubts, however, are entertained in regard to its having been obtained in the Cretaceous beds either on the Yellowstone, or Cheyenne River, in the upper beds of the Fort Pierre group (No. 4 of the Upper Missouri Cretaceous series).

Acmæa? papillata, M. & H.

Plate 31, figs. 4, *a*, *b*.

Capulus fragilis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VII, 68 (not *Acmæa fragilis*, Quoy and Gaimard, of an earlier date).

Tectura? papillata, Meek and Hayden (1860), *ib.*, XII, 423.—Meek (1864), Smithsonian Check-List N. Am Cret. Fossils, 17.

Shell very thin, of a depressed conical form, being much elevated, with the prominent summit nearly or quite central; lateral slopes a little convex near the summit, and diverging at an angle of about 80°: anterior (?) slope nearly straight, and posterior (?) moderately convex; immediate apex, as seen in the internal cast, having the form of a small nipple; base circular; surface, as determined from some fragments of the shell remaining about the lower

margin, marked by very fine, closely-set, obscure, concentric striæ; internal cast showing faint traces of irregular radiating striæ, and obscure indications of the horse-shoe-shaped muscular scar.

Diameter of base, 1.22 inches; height of apex, about 0.74 inch.

This shell has very much the form and general appearance of a species described by Professor Forbes from the Cretaceous rocks of Southern India, under the name *Calyptræa elevata.** I infer, however, from Dr. Stoliczka's remarks in regard to the Indian shell, after examining the type-specimen in the collection of the Geological Society at London, that it is thicker than our species, as he says that "the shell itself is rather thick as compared with *Calyptræa* and *Anisomyon*."† His figure also shows it to have a slightly more depressed form than our species, while it is without any indications of the small nipple seen at the apex of the internal cast of the latter. The two shells, however, must be very nearly related; and I should have made more critical comparisons in first studying our type, had it not been for the fact that Professor Forbes had referred his species to the genus *Calyptræa*, while ours is clearly, and beyond all doubt, not a *Calyptræa*. Dr. Stoliczka, however, says that Professor Forbes's species is also certainly not a member of that genus, as he could discover, in the cast of the interior, no traces of the internal process of *Calyptræa*.‡ Although not impossible, therefore, that these two forms may yet prove to be specifically identical, this is still improbable, owing to their widely distant geographical positions.

Although it is certainly not a *Calyptræa* or *Capulus*, I am still in doubt in regard to the generic relations of this species. Its summit is much more elevated than is usual in *Acmæa*, the form and general appearance being much the same as in *Scurria*, Gray; and I am only prevented from calling it *Scurria fragilis* by its greater thinness than we usually see in that genus. In removing it to the genus *Acmæa* (= *Tectura*), it became necessary to give it a different specific name, since the name *A. fragilis* had been previously applied to a recent species of the genus.

Locality and position.—Fox Hills, Dakota; from the Fox Hills group of the Upper Missouri Cretaceous series.

* Trans. Geol. Soc. Lond., VII (2d ser.), pl. 12, fig. 10.

† Palæont. Indica, II, 322.

‡ Dr. Stoliczka refers the Indian species doubtfully to *Tectura* (= *Acmæa*).

RHIPIDOGLOSSA.

TROCHIDÆ.

Genus MARGARITA, Leach.

Synon.—*Trochus* and *Turbo* (sp.) of some, but not as properly defined.

Margarita, Leach (1819), Journ. Phys., LXXXVIII, 464.—Brod. and Sowerby (1829), Zoöl. Journ., IV, 363.—Gould (1841), Invert. Mass., 252; and (1870) 2d ed., 278.—Reeve (1841), Proc. Zoöl. Soc., 76; and (1842) Conch. Syst., II, 168.—H. P. C. Möller (1842), Ind. Moll. Grœnl., 8; and (1843) Naturh. Tidssk., IV, 81.—Lovén (1846), Ind. Moll. Scand. Occ., 20.—Philippi (1847), Zeitschr. f. Malak., 20 (as a subgenus under *Trochus*).—H. and A. Adams (1854), Genera Recent Moll., I, 433.—Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 185.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 18.—Gabb (1864), Palæont. Cal., II, 85.—Tryon (1873), Amer. Mar. Conch., 87 (not *Margarita* of Lea, 1838).

Etym.—*μαργᾰρίτης*, a pearl.

Examp.—*M. helicina*, Fab. (sp.).

Shell small, varying, according to the species, from subglobose to subturbinate, or rarely to subovate, thin, nearly always umbilicate, the umbilicus being without crenate margins; surface not colored; nacre of interior generally brilliantly iridescent; volutions rounded, or last one rarely subangular around the periphery; aperture circular; lip sharp, not quite continuous on the inner side above; columella often ending in a simple point below; surface striated, and sometimes with revolving ridges, or rarely nearly or quite smooth.

The shells of this genus seem to be nearly related to *Solariella* of Wood, founded on *S. maculata*, Wood, from the English Crag. They differ, however, in wanting the conspicuously crenate margin around the umbilicus seen in that genus, and in having a more rounded aperture. They are generally quite small shells.

This genus probably does not date back farther than the Cretaceous epoch, and but few species are yet known from rocks of that age. It is more abundantly represented in the Tertiaries, and attains its maximum development at the present time, mainly in northern and antaretic seas. Some ten or twelve recent species have been described from the northeastern coast of the United States.

Margarita Nebrascensis, M. & H.

Plate 19, figs. 8, *a*, *b*, and 9, *a*, *b*.

Turbo Nebrascensis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 64.

Margarita Nebrascensis, Meek and Hayden (1860), *ib.*, XII, 185.

Shell turbinate, thin; length and breadth nearly equal; spire depressed-conical; volutions five, rounded or with last one sometimes slightly angular

around the outer side below the middle; suture quite distinct in consequence of the convexity of the volutions; umbilicus rather small, but deep; aperture very nearly circular; surface ornamented by fine, regular, closely-arranged, revolving striæ, crossed by delicate, rather oblique, lines of growth, which are gathered into little, regular, oblique wrinkles near the suture and around the umbilicus; columella not terminating in a point below.

Length, about 0.26 inch; breadth, 0.28 inch; angle of spire, 68° to 70°.

This is a neat little shell, still retaining the brilliant pearly luster of its inner layer, while the lines of growth on the exterior are often strong enough to form, with the revolving striæ, a delicately-cancellated style of ornamentation. The first specimens studied have the whorls almost regularly rounded; but others, since obtained, show more or less tendency to become subangular around the outer volution below the middle; while there seem to be all gradations in this character. Our figure 8, *a*, however, has this angularity a little exaggerated, although the specimen from which it was drawn is unusually angular. Most of the specimens have the volutions as round as represented in figure 9, *a*. So far as can be determined, there seems to be no angularity at the base of the columella, as often seen in recent species of this genus. In the latter, this character, when it exists, is generally, if not always, caused by the termination of a small revolving ridge around the umbilicus. In the shell under consideration, no such ridge exists; the whorls rounding almost regularly into the umbilicus.

The large specimen represented by our figure 9, *b*, is from a different locality, and apparently a somewhat higher position. The figure represents its natural size, which is also that of all the mature specimens from this locality; while figures 8, *a*, *b*, and 9, *a*, represent the mature average size of the shell from other localities. All of the large specimens, such as that represented by 9, *b*, have the shell exfoliated so as to give only an unsatisfactory idea of the surface-markings, which I am not sure are correctly represented on the figure. Consequently, I have some doubts in regard to the specific identity of these larger shells with the typical specimens.

Locality and position.—The smaller typical specimens, such as are represented by figures 8, *a*, *b*, and 9, *a*, were found on the Yellowstone River, 150 miles from its mouth, in beds containing apparently a blending of the fossils of the Fort Pierre and Fox Hills groups; and the large ones represented by figure 9, *b*, came from the latter horizon at Long Lake.

Margarita Mudgeana, Meek.

Plate 2, figs. 9, *a*, *b*.

Turbo Mudgeanus, Meek (1871), Hayden's Report U. S. Geol. Survey of the Territories, 313.

Shell rather large, turbinate, about as high as wide; spire moderately prominent; volutions four and a half to five, increasing rather rapidly in size, convex, last one somewhat obliquely flattened below and above, and laterally compressed or flattened around the middle of the outer side, at the base of which it is angular; suture more or less channeled; aperture circular; outer lip thin and oblique; columella arched and flattened below; axis imperforate; surface ornamented by strong, raised, oblique lines of growth, which are crossed by four equidistant rather sharp, revolving carinæ, only three of which are seen on the volutions of the spire.

Height, 0.66 inch; breadth, about 0.64 inch; divergence of slopes of the spire, about 75°.

This shell is evidently related to *Turbo tricostatus*, d'Orbigny (Paléont. Fr. Terr. Cret., II, pl. 186 *bis*, figs. 5, 6), but clearly differs in having its spire decidedly more depressed, and in having four revolving carinæ on its body-volution instead of only three. Its body-whorl is also more rounded, in consequence of its greater convexity on the upper side, which also imparts a more rounded outline to its aperture. It likewise wants the small umbilicus said to exist in d'Orbigny's species, and does not show the lower carina of the body-turn above the suture on those of the spire. In the entire absence of any umbilical perforation it differs from the usual characters of the genus *Margarita;* but Mr. Dall informs me that there are some existing northern species that are entirely without any traces of an umbilicus.

The specific name was given in honor of Professor Mudge, of the Kansas State Agricultural College, to whom I am indebted for the typical specimens of this, as well as of the other species here described from the same locality.

Locality and position.—Twelve miles southwest of Salina, Kansas; from the Dakota group of the Upper Missouri Cretaceous. Prof. B. F. Mudge.

Genus MARGARITELLA, M. & H.

Synon.—*Solarium* (sp.), of several authors, but not of Lamarck.

Margaritella, Meek and Hayden (1860), Proc. Acad. Nat. Sci. Philad., XII, 423.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 18 (not Gabb (1864), Palæont. Cal., I, 118, and *ib.*, II, 172; or Stoliczka (1870), Palæont. Ind., II, 367).

Etym.—*Margarita*, a pearl (dimin.).

Type.—*Solarium flexistriatum*, Evans and Shumard.

Shell subdiscoidal or nearly lenticular, thin; nacre of interior bright; umbilicus large, deep, and entirely without crenate margins; volutions nar-

row, very much depressed, the last one sharply angular around the periphery, and obtusely subangular around the umbilicus; aperture transversely rhombic; lip thin and simple; surface cancellately striated in the typical species.

This genus was originally proposed by us for the reception of a small shell described by Evans and Shumard under the name *Solarium flexistriatum*. We originally separated it from *Solarium* mainly on account of the pearly nature of its inner layer. At that time, we also thought it might also include several of the depressed or subdiscoidal shells, with acutely-angular periphery, a large, open umbilicus, and transversely-rhombic aperture, described from the Cretaceous rocks, by d'Orbigny and others, under the names *Solarium ornatum*, Fitton, *S. dentatum*, *S. granosum*, &c., d'Orbigny. Since that time, however, better specimens of our type have been found, that show the margin of its umbilicus not to be crenate (another distinction from *Solarium*); while the foreign Cretaceous forms alluded to show, in part at least, a tendency to become crenate around the middle of the under side (which may be regarded as the margin of the umbilicus), though in a very different way from what we see in *Solarium* proper. These shells also differ from our type in being covered with coarse granules. Whether these differences should exclude them entirely from association with our type may admit of some doubt; but, at any rate, it seems to me that such forms are clearly distinct both from *Solarium* and *Solariella*.

Dr. Stoliczka very positively asserts that our *Margaritella* "must be considered as synonym of *Solariella*" of Wood, 1842. In this, however, the doctor was certainly too hasty. If he had seen our type-species, or read Evans and Shumard's description of it attentively, he would have seen at once that it differs very materially from the type of Wood's genus. On the contrary, however, he seems to have formed his ideas of our genus from two or three Cretaceous shells referred to it by Mr. Gabb in his California reports. Like Dr. Stoliczka, however, Mr. Gabb had an incorrect impression of our genus, (the type of which had not been figured at that time), and was wrong in referring these California shells to it. Any one who will take the trouble to compare our figures and description of the type-species of *Margaritella*, will at a glance see that it is in all respects widely distinct from *Solariella maculata*, Wood, the type of his genus; which is a subglobose shell, with rounded volutions, and a distinctly crenate margin around its umbilicus.

I agree with Dr. Stoliczka, however, that *Solariella* is clearly separated

from *Solarium* by its distinctly pearlaceous shell; and that it will include a portion of the Cretaceous species generally referred to *Solarium*, such as *S. asterianum*, *S. Neocomiense*, &c., d'Orbigny, as well as the California species described by Mr. Gabb, and various others.

So far as yet certainly known, this genus is confined to the Cretaceous system; but it will probably be found in the Jurassic, and perhaps Tertiary rocks.

Margaritella flexistriata, E. & S.

Plate 19, figs. 11, *a*, *b*, *c*, *d*.

Solarium flexistriatum, Evans and Shumard (1854), Proceed. Acad. Nat. Sci. Philad., VI, 163.
Margaritella flexistrata, Meek and Hayden (1860), *ib.*, XII, 423.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 18.

Shell small, depressed-convex, terminating externally in a sharp cutting-edge; volutions four or five; spire very slightly elevated; inner edge of volutions bounded by a row of tubercles;* surface marked by fine, revolving, thread-like striæ, which are crossed by fine flexuous striæ, giving an exceedingly neat reticulate appearance to the shell; umbilicus large; mouth subquadrangular.—Evans and Shumard.

Breadth of a small specimen, 0.21 inch; height, 0.08 inch.

This little shell is much depressed or subdiscoidal in form, and composed of five volutions, which are rather acutely angular at the periphery, and vertically flattened on the side forming the walls of the umbilicus, around the margins of which they are subangular. On the upper side, they are compressed, with an outward slope, though not quite flattened, and more convex below. The umbilicus is very nearly as broad as the widest part of the last whorl, rather deep, and shows nearly or quite all the volutions to the apex of the spire. Around the moderately-distinct suture, on the upper side of the shell, the lines of growth are gathered into a series of very small, regularly-arranged wrinkles. The aperture is transversely rhombic-subquadrangular, and the inner layers of the shell brilliantly pearly.

Our measured specimens are smaller than those described by Evans and Shumard, which were more than 0.26 inch in breadth, but seem to agree well in all other known characters.

Locality and position.—Cheyenne River, near the mouth of Sage Creek; in the upper part of the Fort Pierre group.

* The words "row of tubercles" are not correctly used here, as I know from drawings of the type-specimen sent to me by Dr. Shumard, as well as from our own specimens. There are little *wrinkles* around the inner margin of the volutions, near the suture, that may, perhaps, in some cases assume somewhat the appearance of little tubercles.

PECTINIBRANCHIATA.

TRITONIDÆ.

Genus TRACHYTRITON, Meek

Synon.—*Buccinum* (sp.), Hall and Meek; not Linnæus.
Trachytriton, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22 and 37.—Gabb (1869), Palæont. Cal., II, 154 (as a subgenus under *Tritonium*).—Schmidt (1873), Petref. der Kreidf. von der Insel Sachalin, 17 (as a genus).

Etym.—τρᾱχύς, rough; *Triton*.
Type.—*Buccinum vinculum*, Hall and Meek.

Shell fusiform or subfusiform, with spire shorter than the combined lengths of the aperture and canal; volutions convex, rounded, or angular, last one more or less enlarged, and contracting into a somewhat produced, nearly straight, or moderately bent canal below; surface with vertical folds, or costæ, and revolving lines or little ridges; inner lip typically well developed all the way up, but not much thickened; columella without plaits or folds; outer lip thin, excepting at irregular intervals, where it became thickened and denticulate within, so as to form distinct internal varices, which were not subsequently absorbed, but left behind as the shell advanced in growth, thus producing strongly-defined, pitted furrows, on casts of the interior.

The most marked feature of this type, is, the internal thickening and denticulation of the outer lip at irregular intervals, so as to form internal varices that leave their impressions strongly defined on casts of the interior. The external folds, or costæ, of the type-species are quite well defined and regular on the upper volutions, but become less distinct and more irregular on the body-volution. Generally, there are some irregularities or interruptions of the marks of growth at the points where the internal varices occur; but no well-marked external varices, distinct from the vertical folds, exist.

The California species referred by Mr. Gabb to this genus have the body-volution somewhat more ventricose than in our type, and, in one instance, angular around the middle; while, in the other, the vertical folds are mainly confined to the most convex part of the body-volution, and show a slight tendency to assume the character of mere elongated nodes. In one of the Russian species referred to it by Schmidt, this character is even more decidedly marked; the folds on the volutions of the spire being merely represented by a row of nodes around the middle of each turn. In all of these species, however, the revolving external ridges, or little bands, as well as the charac-

teristic internal thickening and denticulation of outer lip, at intervals, are well defined.

It is possible that a critical study of more extensive collections may bring to light reasons warranting the arrangement of this group of shells as a section of the genus *Tritonium;* but, with our present material for comparison, I cannot believe that they can be properly included in that group, as typified by the recent *Murex tritonis*, Linnæus.

In several respects, the type of this genus resembles the recent *Argobuccinum Oregonense;* and at one time I supposed it to be so closely related to that shell that the two forms might be congeneric. A more critical comparison, however, with specimens of the west-coast species, in the collection of my friend Mr. Dall, leads me to believe that they do not belong to the same genus. At any rate, the *A. Oregonense* shows no traces of the internal crenate varices seen in our type: while it always has a kind of tooth or callus near the top of the inner side of the aperture, and a strong twist and flexure of the beak, that do not occur in the type under consideration.

So far as yet certainly known, this genus would seem to be confined to the Cretaceous rocks.

Trachytriton vinculum, H. & M. (sp.).

Plate 19, figs. 7, *a*, *b*, *c*, *d*.

Buccinum ? vinculum, Hall and Meek (1856), Mem. Am. Acad. Arts and Sci., V (n. s.), 390, pl. iii, fig. 5, *a*, *b*.
Fusus vinculum, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 185.
Trachytriton vinculum, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22 and 37.

Shell thin, fusiform; spire conical, equaling about four-fifths the length of the aperture and canal; volutions about six, convex, last one slightly ventricose, and tapering rather rapidly into the moderately-produced beak below; suture distinct; surface ornamented by small vertical folds, or costæ, crossed by little band-like revolving ridges that are as strongly elevated between, as upon, the vertical folds; aperture oval, approaching obovate, rather obtusely angular above, and tapering into the canal below; outer lip thin, excepting where it becomes thickened and denticulate within to form the internal varices, broadly sinuous above, and slightly more prominent in outline below; inner lip well developed, and a little spread on the body-volution above; columella moderately arcuate.

Length of the most nearly perfect specimen seen, 1.35 inches; breadth,

0.62 inch; slopes of spire a little convex, with a divergence from the apex of about 38°.

Of the little revolving bands, which are narrower than the spaces between, some seven to eight may be counted on the penultimate volution, where they are, like those above, usually of uniform size. On the body-volution, there is generally a smaller band, or line, between each two of the larger; and sometimes, especially on the lower half of this volution, those of this smaller series become nearly or quite as large as the others. On well-preserved specimens, there may sometimes be seen, by the aid of a magnifier, traces of very obscure, minute striæ, between the revolving bands. These very minute striæ, however, are more generally entirely obsolete. Notwithstanding the strong sculpturing of this shell, the entire surface, both upon and between the folds and revolving bands, has a peculiar shining, polished appearance.

The vertical folds, or costæ, are slightly arched, and although not wide, are distinctly defined, especially on the volutions of the spire, where they equal the spaces between, and number about eighteen to each turn. On the body-volution, they become more irregular, or often nearly obsolete toward the aperture, and below the middle.

The original type-specimen of *Buccinum? vinculum*, believed to be identical with the shell here described, is small, and has its beak and upper volutions broken away, and its aperture not exposed; consequently, its generic characters could not be clearly determined. The specimens now before me, however, from the same locality and position, are larger and in a much better condition, showing not only the entire form and ornamentation, but the aperture also. These, as may readily be seen from the figures, certainly do not belong to the genus *Buccinum*, but agree much more nearly with *Fusus*, to which we at one time removed the species. The presence of the internal varices, however, shows that this shell cannot belong properly to *Fusus*, but that it has apparently nearer relations to *Tritonium*.

By comparing our figures with those of the original type-specimens of *Buccinum? vinculum* and *Fusus Shumardii*, Hall and Meek, it will be seen that they represent an almost exactly intermediate form between the two. This fact, and the exact agreement of the ornamentation of these shells, has sometimes led me to suspect that *B.? vinculum* and *Fusus Shumardii* may possibly have been founded on extreme varieties of one species, especially as the type-specimen of the former is so imperfect as not to give a clear idea

of its form. Still, however, supposing our shell to be identical with *B.? vinculum*, of which I can scarcely have any doubts, its much larger size, proportionally less slender form, and well-developed inner lip, would seem to forbid its reference to *F. Shumardii*, which, notwithstanding its decidedly smaller size, has the same number of volutions as our largest specimen; while it is nearly always the case that young univalves are proportionally less elongated than the adults of the same species This latter fact strongly favors the conclusion that the typical specimen of *B.? vinculum* (and not that of *Fusus Shumardii*) is a young individual of the shell here under consideration. I have no means of knowing whether or not the type-specimen of *Fusus Shumardii* has internal varices*; but it very probably has, whether *specifically* distinct from *B.? vinculum* or not; because, from its external characters, it probably belongs to the same genus, at least. Casts of our shell, however, show it to possess this character as in the original typical *B.? vinculum*.

Among foreign forms, this species may be compared with *Tritonium Gosauanum*, Zekeli (Gast. Gosaugeb., 82, pl. 15, fig. 2), from which it differs in having its body-volution less abruptly contracting below, and its vertical folds, or costæ, much less distinct on the same. The Gosau species also shows more indications of external varices than our shell. I believe, however, that it belongs to the same group.

Locality and position.—The original type-specimen of *Buccinum? vinculum* came from the Great Bend of the Missouri River, Dakota, where it was found in the Fort Pierre group of the Upper Missouri Cretaceous series. Our figured specimens were also obtained from the same locality and bed.

FAMILY-AFFINITIES UNDETERMINED.

Genus CLOSTERISCUS, Meek.

Synon.—*Fusus?* (sp.), Hall and Meek; not Lamarck.

Etym.—κλωστήρ, a spindle (dimin.).
Type.—*Fusus? tenuilineatus*, Hall and Meek.

Shell thin, fusiform, with spire slender and produced to a greater length than the aperture and canal; body-volution not ventricose, terminating below in a canal; surface smooth, or minutely striate; aperture rhombic; outer lip broadly retreating above the middle, thin, excepting at irregular intervals, where it became thickened and denticulate within, so as to leave internal

* These comparisons are made with the published figures only of *F. Shumardii*, as I have not seen the original type for many years.

varices behind as the shell advanced in growth; inner lip very thin, or wanting: columella smooth?

The type of this group has the general aspect of a smooth, slender *Tritonifusus*, but differs from that and the allied groups in the peculiarity of forming, at irregular intervals, internal varices, by the thickening and denticulation of the interior of the outer lip: the varices being left behind as the shell increased in size, and not absorbed. Between these internal thickenings, the lip was always thin and sharp. Another peculiarity is the almost entire absence of an inner lip.

In the presence of internal varices, this type agrees with that for which I have proposed the name *Trachytriton;* but it differs materially in surface-markings and texture, and to a less extent in form. Some very similar species have been referred to *Pterodonta* and *Tylostoma* by foreign palæontologists; but our shell, and the foreign species alluded to, differ widely in form and general appearance from the typical oval species of *Pterodonta,* with a dilated outer lip, such as *P. elongata* and *P. ovata*, d'Orbigny; while, according to Dr. Stoliczka, *Tylostoma* has no canal, or even well-marked anterior sinus.

Dr. Stoliczka has described from the Cretaceous rocks of India (Palæont. Indica, II, 42), under the name *Pterodonta? terebralis*, a shell that agrees with this type so nearly in form, surface-characters, and even in the possession of denticulate internal varices, that I should not for a moment hesitate to adopt the conclusion that the two species are congeneric, were it not for the fact that he says his shell has two plaits on the columella. As he states, however, that the plaits are obsolete at the aperture, and I have not yet been able to see the columella of our type quite far enough around within the aperture, it is still possible that it may possess this character also. If so, its agreement with the Indian species would apparently be exact in every respect except in mere specific characters. However that may be, I cannot for a moment believe that such slender fusiform shells, which we have no reason whatever to believe had the lip in the least expanded, can properly be referred to the genus *Pterodonta*. Indeed, Dr. Stoliczka himself expresses the opinion, on page 294 of the same work, that his species may even prove to belong to the *Pyramidellidæ* or to the *Cerithiidæ*.

So far as known, this type seems to be confined to the Cretaceous.

Closteriscus tennilineatus, H. & M. (sp.).

Plate 19, figs. 10, *a*, *b*, and 9 *c*.

Fusus? tennilineatus, Hall and Meek (1856), Mem. Am. Acad. Arts and Sci. Boston, V (n. s.), 392, pl. iii, fig. 9.—Gabb (1861), Synop. Moll. Cret. Form., 53.
Tritonifusus? tennilineatus, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22.

Shell elongate-fusiform; spire acutely elevated; volutions about seven, very slightly convex, last one compressed above and contracting abruptly into the beak below; suture distinct; surface appearing to the eye smooth, or even polished, but, by the aid of a magnifier, seen to be marked by extremely minute, obscure lines of growth, and equally small, but slightly more regular, minutely flexuous, revolving striæ, which become a little larger near the upper margin of volutions, and still stronger and much more oblique near the base of the last turn; aperture rhombic-oval, being rather acutely angular above, and contracting rapidly on the outer side into the canal below; length of canal unknown.

Length of the largest specimen known, exclusive of the canal, about 2 inches; breadth, about 0.70 inch; slopes of spire nearly straight; divergence of same 30°.

No specimens of this species have yet been found with the beak and the apex of the spire unbroken. From the general appearance of the broken beak, and the base of the body-volution, it is probable, however, that the former was rather shorter and a little more curved than represented by the outline-restoration of our figures; which also have the suture represented slightly too oblique, and the lines of growth too strong. Generally, the surface appears smoothly polished to the unassisted eye; but, under a magnifier, the minute lines of growth and revolving striæ are seen nearly as in the enlargement, numbered by mistake 9*c*, instead of 10*c*, on our plate 19.

The denticulate internal varices, or, more properly, their impressions, are distinctly seen on casts of the interior, as shown in figure 9, *a*, plate iii, of the memoir in which the species was originally described. Since our figures were drawn, I have also picked off a piece of the shell at about the same position in our figured specimen, and found that it shows this character equally well developed.

As already intimated, *Pterodonta? terebralis*, from the East Indian Cretaceous rocks, more nearly resembles this shell than any other with which I am acquainted. Its volutions, however, are more flattened than in the species here under consideration, and its last one differs in being sub-

angular instead of rounded. Dr. Stoliczka's figures of the Indian shell show the impressions, on the cast of the interior, of the internal varices, exactly as in our species. If the latter, however, has no plaits on the columella, their presence on that of the Indian shell would, of course, be a very strongly-marked distinction. This point, however, remains to be settled when other collections can be examined; though I have seen the columella of our specimens far enough around within the aperture to lead at least to the impression that it is *most probably* destitute of plaits.

Locality and position.—The original typical specimens of this shell were found on Sage Creek, Dakota, where they occur in the upper beds of the Fort Pierre group of the Upper Missouri Cretaceous series. Our figured specimen also came from the same position on Cheyenne River, of which Sage Creek is a tributary.

NATICIDÆ.

Genus GYRODES, Conrad.

Synon.—*Natica* (sp.), Michelin, d'Orbigny, Pictet and Roux, and others.
Gyrodes, Conrad (1860), Jour. Acad. Nat. Sci. Philad., IV, 289 (as a subgenus under *Natica*).—Gabb (1861), Proceed. Acad. Nat. Sci. Philad., XIII, 32; and (1864) Palæont. California, I, 108 (as a genus).—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 21 (as a genus).—Stoliczka (1868), Palæont. Indica, II, 297 (as a genus).

Etym.—γυροειδής, like a circle; in allusion to the revolving umbilical margin.
Examp.—*Natica* (*Gyrodes*) *crenata*, Con.

Shell more or less depressed-subglobose; aperture rhombic or subovate, and generally angular or narrowly rounded below; inner lip thin; umbilicus wide, deep, and without any traces of a callosity, bounded by a revolving, more or less crenate, carina, and sometimes provided with a second small revolving ridge within; volutions truncated above, so as to give the suture a canaliculate appearance, the outer edge of the truncation being generally wrinkled or crenate; general surface showing merely lines of growth, with sometimes faint traces of microscopic revolving striæ.

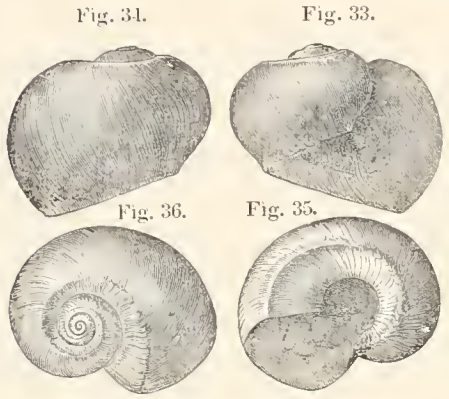
This genus is readily distinguished by its thin shell, wide, open umbilicus, bounded by an angular, more or less crenate, margin, and without a trace of a callosity within, as well as by the truncated, slightly concave, and more or less wrinkled upper edge of its volutions—a combination of characters unknown in any other type of the *Naticidæ*. The species have generally been referred to the genus *Natica* by palæontologists, who are too often far behind the present state of conchological science. Few well-informed con-

chologists would now refer such a shell to the genus *Natica*, if it were to be found among existing mollusks,

This genus seems to be nearly, if not entirely, confined to the Cretaceous rocks; though a few Tertiary species approach it more or less nearly in general appearance. It occurs in both American and European Cretaceous strata, as well as in those of Southern India.

Gyrodes Conradi, Meek.

Compare *Natica* (*Gyrodes*) *crenata*, Conrad (1860), Jour. Acad. Nat. Sci. Philad., IV, 289.



Gyrodes Conradi.

Fig. 33. View showing aperture and edge of umbilicus.
Fig. 34. An opposite side-view.
Fig. 35. A view of the under side, showing the wide, open umbilicus, with its sharply carinate revolving margin.
Fig. 36. An upper view of the same.

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 subrhombic 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.

* This inner angle, or ridge, is not seen in the figure showing the under side, as it passes around just at the margin of the dark rock filling the deeper part of the umbilicus.

Height, 0.91 inch; breadth, about 1.10 inches; height of aperture, 0.86 inch; breadth of same, 0.43 inch.

This shell, judging from Mr Conrad's description of his *Natica* (*Gyrodes*) *crenata* (of which no figure has yet been published), must be very closely allied to that species, with which I had supposed it to be identical. On sending the type-specimen, however, to Mr. Conrad, for comparison with his species, he informed me that he thinks it clearly distinct; the lower carina of his shell being *much* more strongly crenate, and the truncated upper edge of its volution decidedly more distinctly wrinkled. As I yet only know a single specimen of our species, however, it may possibly be found to vary in these characters, so that no well-defined and constant differences can be found on which to base a distinction.

Locality and position.—Cheyenne River, Dakota Territory; where it occurs associated with other forms believed to belong to the horizon of the Fort Benton group of the Upper Missouri Cretaceous. Collected by the late Dr. Hitz, of Washington City.

Genus LUNATIA, Gray.

Synon.—*Natica* and *Ampullaria* (sp.) of authors (not *Natica*, Adanson, nor *Ampullaria*, Lam.).

Lunatia, Gray (1847), Proceed. Zoöl. Soc. Lond., IV, 149.—H. and A. Adams (1853), Genera Recent Moll., II, 206 (as a genus).—Woodward (1856), Man. Moll., 123 (as a section of *Natica*).—Chenu (1859), Man. Conch., I, 214 (as a subgenus under *Natica*).—Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 422 (as a subgenus under *Natica*).—Gabb (1861), Synops. Moll. Cret. Formation, 58; and (1864) Palæont. California, I, 105 (as a genus).—Conrad (1863), Proceed. Acad. Nat. Sci. Philad., XV, 565 (as a subgenus under *Natica*); and (1865) Am. Jour. Conch., I, 23 (as a genus); also (1873), Suppl. to Kerr's N. Carolina Geol. Report, 13 (as a genus).—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 20 (as a genus).—Tryon (1873), American Marine Conch., 59 (as a genus).

Etym.—*Luna*, the moon; from semilunar form of the aperture.
Type.—*Natica ampullaria*, Lamarck.

Shell ovate-subglobose, rather thin, covered in recent examples with a dull olivaceous epidermis; spire more or less elevated; aperture ovate-semilunar; inner lip thin, or sometimes a little thickened above; umbilicus moderate or small, and without a callosity; operculum wholly corneous.

Until comparatively recently, conchologists generally included this group in the genus *Natica*, either as a subgenus or without any distinction. The most prevalent opinion, however, at this time, among the more reliable authorities, is, that it is really a distinct genus from *Natica*, as properly restricted to such forms as *N. canrena*, Linn., from which genus it differs not only in its entirely corneous operculum, but in its more oval, usually thinner

shell, without an umbilical callosity, and with a more produced spire. Some of the fossil species, however, show a very slight tendency to develop a small spiral ridge within the umbilicus; though this is not always observable, even in different individuals of the same species in which it sometimes occurs.

It would be very difficult to determine the exact geological period at which the genus *Lunatia* was first introduced, even if we could be sure that we know all of the fossil species, because the shells of several extinct groups closely resemble it in form and general appearance, while we know little or nothing of the nature of the operculum of any of these ancient species. It may be regarded as almost beyond doubt, however, that it did not exist during palæozoic times; since even the Permian and Carboniferous forms most nearly resembling it, and often referred to *Natica* by palæontologists who make no distinction between that group and *Lunatia*, belong to *Naticopsis*, short forms of *Macrocheilus*, and perhaps other extinct genera. Some of the Triassic so-called Naticas may possibly belong to this genus, and a few of the Jurassic species closely resemble it; but it is, perhaps, not until we ascend to the Cretaceous rocks that we meet with forms agreeing so closely that no distinction can be made, at least from the shell alone. It seems also to be well represented through the Tertiary formations; and some forty or more species are known in our existing seas. The latter are found mainly in cold or temperate climates, though a few occur in more southern latitudes. Some of the existing species attain to quite large sizes; *L. heros* (=*Natica heros*, Say) being, according to Dr. Gould, sometimes found as much as four and a quarter inches in length, and three and a half in breadth.

I see Dr. Stoliczka proposes, in his Palæontology of India, vol. II, page 296, to make the name *Euspira* of Agassiz, published in the German translation of Sowerby's Mineral Conchology in 1837, replace Dr. Gray's name *Lunatia*, published in 1847, and now in general use for this genus; and I am not altogether sure that this may not be correct. Professor Agassiz did not designate any particular species as the type of *Euspira;* but the first species mentioned or described by him in connection with this name was the extinct *Natica glauconoides*, Sowerby, which, so far as can be determined *by the shell alone*, without the *animal* or *operculum*, would seem to be a *Lunatia*. Farther on, in the same translation, however, he refers to *Euspira* species apparently belonging to the older genera *Straparollus*, Montfort, 1810, and *Ampullina*, Lamarck, 1813; while he also includes others apparently belonging to the

subsequently-published genus *Amauropsis*, and one that seems to be either a *Macrocheilus*, Phillips, 1841, or a *Naticopsis*, McCoy, 1844.

Hence, if we take the first species mentioned under *Euspira* as its type, this would very probably make *Lunatia* a synonym of that genus. For reasons elsewhere explained, however, the rule of *always* taking the first species mentioned under a genus as its type, cannot be carried out in conchology without creating intolerable confusion among the older genera; while there will probably always remain some doubts whether or not the species *N. glauconoides* of Sowerby really possessed the corneous operculum of *Lunatia*. On the other hand, if we follow the much better and more generally adopted rule of allowing the first authors who divides a complex genus, to separate *any* of his included species under a new generic name, so long as any previously-unnamed type is left to inherit the original name, it may be a question whether we should not only retain the name *Lunatia* for the group to which Dr. Gray applied it, but retain *Euspira* for the group subsequently named *Amauropsis* by Mörch, or for some of the other included types; though it, of course, could not be made to replace either of the older genera *Ampullina* or *Straparollus*. For the reasons above stated, it seems undesirable to replace *Lunatia*, founded on a well-known type, by *Euspira;* at least until the question has been decided in regard to which of the species originally included under that name is to be viewed as the type, and whether or not that type has beyond doubt the corneous operculum of *Lunatia*.

Dr. Stoliczka has correctly remarked that H. and A. Adams were in error in citing *Euspira*, Agassiz, as a synonym of *Ampullina;* and, according to M. Deshayes, they were also equally in error in applying the name *Ampullina*, Lamarck, to the group including the recent *Natica fluctuata*, Sowerby. Lamarck's genus was founded on such shells as *Natica segaritina*, Deshayes, and *N. patula*, Lamarck, which have the inner lip not near so thickened in the middle as *N. fluctuata*, and also differ in having this lip a little free and carinate below, the carina being continuous with the lower margin of the aperture. Dr. Stoliczka, however, seems to have also fallen into an error in citing *Globularia*, Swainson, as a synonym of *Euspira;* Swainson's name being apparently a synonym of the *true Ampullina*, Lamarck (not of H. and A. Adams).

Again, H. and A. Adams were unfortunate in citing *Deshayesia* as a

synonym of *Ampullina;* this latter genus differing from both the *true Ampullina* and from the group to which they apply it, in having its columella not only thickened, but flattened and dentate nearly as in *Nerita*, to which family some refer it.

Lunatia concinna, H. & M. (sp.).

Plate 32, figs. 11, *a*, *b*, *c*.

Natica concinna, Hall and Meek (1854), Am. Acad. Arts and Sci., V, 384, pl. iii, figs. 2, *a*, *b*, *c*, *d*.—Gabb (1861), Synop. Moll. Cret. Form., 60.

Natica Morcauensis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci., Philad., VIII, 64; and *ib.*, 282.

Natica (*Lunatia*) *Morcauensis*, Meek and Hayden (1860), *ib.*, XII, 422.

Lunatia Morcauensis, Gabb (1861), Synop. Moll. Cret. Form., 58.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 20.

Compare *Natica obliquata*, Hall and Meek (1854), Am. Acad. Arts and Sci., 384, pl. iii, figs. 1, *a*, *b*; and *N. rectilabrum*, Conrad, Jour. Acad. Nat. Sci., Philad., IV (2d ser.), 344, pl. 58, fig. 28.

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 proportionally 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. Morcauensis* 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 now 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. Morcauensis* was proposed.

It should be here more distinctly explained, however, that the inner lip is represented too thin, and too straight on its left margin, and not enough reflected upon the body-volution above the umbilicus, in our figure 11, *b;*

which defect gives a somewhat unnatural appearance to that part of the figure.

Lunatia obliquata (= *Natica obliquata*, Hall and Meek), is also a very closely allied type, so much so, indeed, that I have sometimes suspected that both the original *E. concinna*, and the shell here ranged under that name, should be regarded as belonging to that species. In one character, however, *E. obliquata* seems to present a rather marked and important difference; that is, in having a well-defined opercular groove along the columella, not seen in the original *E. concinna*, nor any of the well-preserved specimens here referred to the same.

Mr. Gabb cites *E. rectilabrum* (= *Natica rectilabrum*, Conrad) as a synonym of *Natica concinna*, Hall and Meek; but if the presence of the opercular groove is a specific character, Mr. Conrad's species would seem more properly to be a synonym of *N. obliquata*, Hall and Meek. At any rate, some good specimens before me from Alabama, belonging to the Smithsonian Museum, labeled *N. rectilabrum*, Conrad, by Mr. Gabb, and agreeing nearly in form and general appearance with both *N. obliquata* and *N. concinna*, Hall and Meek, show the opercular groove of the former well defined. Of course, if the name *Euspira* should ultimately be made to replace *Lunatia* for this genus, the name of this shell will have to be written *Euspira concinna*.

Locality and position.—The original typical specimen of *L. concinna* was found on Sage Creek, Dakota, in the higher beds of the Fort Pierre group of the Upper Missouri Cretaceous series. Those now before me are from the Fox Hills group of the same series, on Moreau River, in Dakota Territory. Dr. Hayden has also found imperfect specimens, believed to belong to the same species, near the eastern base of the Rocky Mountains, seven to ten miles west of Greeley, Colorado.

Lunatia occidentalis, M. & H.

Plate 32, figs. 12, *a*, *b*, *c*.

Natica occidentalis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 64.
Natica (Lunatia) occidentalis, Meek and Hayden (1860), *ib.*, XII, 422.
Lunatia occidentalis, Gabb (1861), Synop. Moll. Cret. Form., 58.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 21.

Shell obliquely ovate; spire rather elevated; volutions four and a half to five, convex, and separated by a very distinctly-defined suture; surface marked by fine lines of growth, crossed by numerous, very fine, obscure, minutely flexuous, revolving striæ; aperture obliquely ovate, nearly straight

on the inner side, widest and rounded below, subangular above; outer lip sharp; inner lip slightly thickened, and a little reflexed on the body-volution above the small umbilical perforation.

Length about 1 inch; breadth, 0.73 inch; length of aperture, 0.57 inch; breadth of aperture, 0.34 inch; apical angle, a little convex, divergence, 70°.

This shell, in some of its variations, is so very nearly like the last that I have some doubts whether it should not rather be regarded as a variety of that species. Still, it differs so much in the elevation of the spire that it would scarcely seem possible that they can be mere varieties of the same species. It also has one volution more than the last, and its second whorl is proportionally larger and more convex. This latter character is sometimes so marked as to give it a constricted appearance around the suture, between the first and second volutions. Its body-whorl is likewise often more oblique and less convex above, near the aperture, than in the last.

The revolving lines seen on both of these forms are very obscure, and indistinctly visible without the aid of a lens. Where the surface is a little worn or weathered, they are often obsolete.

Locality and position.—Moreau River, Dakota; from the Fox Hills group of the Upper Missouri Cretaceous series

Lunatia subcrassa, M. & H.

Plate 39, figs. 3, *a*, *b*, *c*.

Natica subcrassa, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 87.
Natica (Lunatia) subcrassa, Meek and Hayden (1860), *ib.*, XII, 422.
Lunatia subcrassa, Gabb (1861), Synops. Moll. Cret. Form., 58.

Shell rather thick, obliquely compressed-subglobose or subovate; spire short; volutions three and a half to four, last one comparatively large, sloping obliquely outward and downward almost immediately from the suture above, and rounded below the middle; suture distinct, but not deep; aperture large, subovate, being angular above, rounded below, forming a semi-ovate curve on the outer side, and nearly straight on the inner; outer lip very oblique, being much produced forward above, and extending obliquely backward, with a broad and slightly sinuous outline near the middle; inner lip nearly straight, moderately thick, and a little reflexed upon the body-volution above the small umbilical perforation; surface showing (on slightly-weathered specimens) distinct, very oblique lines of growth.

Length, 1.08 inches; breadth, 0.90 inch; length of aperture, 0.85 inch, breadth of same, 0.57 inch.

This shell will be at once distinguished from the foregoing by its greater thickness, shorter spire, obliquely-compressed body-volution, and the more oblique outline of its outer lip. Its suture is also less deep than in either of the preceding species, owing to the fact that the volutions do not round into it, but slope more immediately below it, nearly in the direction of the general slope of the spire. None of our specimens are in a condition to show whether the immediate apex of the spire was pointed or obtuse.

The rather more solid appearance of this shell, together with its obliquely-compressed body-volution, the very oblique outline of its outer lip, its short spire, rather shallow suture, and the less rounded outline of the volutions just below the same, all tend to give it a somewhat peculiar aspect from that usually presented by species of this group. Consequently, it is with some doubts that it is placed here.

In general appearance, it reminds one of a species described by Dr. Stoliczka from the Cretaceous rocks of Southern India (Palæont. Indica, II, 307, pl. xxii, figs. 5 and 5 *a*), under the name *Mammilla carnatica;* and if that shell can be properly referred to *Mammilla* (*Ruma*, as some call it), possibly our species might go into the same group. Specifically, at least, it differs from the Indian form in its rather more depressed general outline, smaller umbilical perforation, and less thickened inner lip above the umbilicus. In all of these characters, however, it differs more widely from the typical forms of *Mammilla* than Dr. Stoliczka's species does.

It is possible that the names of this and the preceding species may have to be changed to *Euspira suberassa* and *E. occidentalis;* that is, if *Euspira* is made to replace *Lunatia*, as already suggested.

Locality and position.—Mouth of Judith River, on the Upper Missouri, where it occurs with other Cretaceous fossils in beds elsewhere found to hold a position at the horizon of the top of the Fox Hills group.

Genus AMAUROPSIS, Mörch.

Synon.—*Natica, Amaura,* &c. (sp.), of some (not *Natica*, Ad., nor *Amaura*, Möller).
Amauropsis, Mörch (1857), Nat. Bidr. Belkr. Grønl., 81.—H. and A. Adams (1858), Genera Recent Moll., II, 621.—Stimpson (1860), Smithsonian Check-List Shells N. Am., 5.—Stoliczka (1868), Palæont. Indica, II, 294.—Gould and Binney (1870), Invert. Massachusetts (2d ed.), 348.—Tryon (1873), Am. Marine Conch., 61.

Etym.—*Amaura;* ὄψις, form.
Type.—*Natica canaliculata*, Gould.

Shell ovate or subovate, imperforate, or only with a very narrow umbilical slit; spire more or less produced; suture channeled; aperture subovate;

inner lip in the living typical species, nearly straight and somewhat callous; surface smooth or striated, and, in recent examples, covered with a dark gamboge-colored epidermis; operculum corneous, subspiral.

This group seems to be nearly related to *Amaura*, Möller, and may even be found not to be more than subgenerically distinct when the fossil species are more carefully compared with the living typical forms. At any rate, there are a number of Cretaceous and Jurassic species that seem to stand, as it were, intermediate between the two in form. Looking at the very few known living species of these two types, the most observable differences in the shells alone, consist in the more elevated spire, shallower suture, thinner inner lip, and entirely imperforate columella of *Amaura*. It should be remembered, however, that but a single species of the latter and some two or three of *Amauropsis* are known among our existing *Mollusca*, while in groups containing many species, even more marked differences are sometimes not considered of generic value.

The genus *Amauropsis*, as here understood, appears to have been represented at least as far back as the Jurassic epoch; and a number of Cretaceous so-called Naticas seem to belong to it. In the Tertiary, a few species also occur; and two or three living species are known. Two of the latter are found in northern seas, and one is said to occur on the coast of Japan. From the associates of some of the fossil species, they would appear to have lived in warm climates.

Amauropsis paludinæformis, H. & M. (sp.).

Plate 19, figs. 15, *a*, *b*, *c*.

Natica paludinæformis, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci. Boston, V (new ser.), 389, pl. iii, fig. 3 (not *N. paludiniformis*, d'Orbigny, 1850).*

Amauropsis paludinæformis, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 185.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 20.

Shell subovate, rather thin; spire elevated and turreted; volutions convex, last one moderately large and somewhat produced below; suture

* I am not aware whether any one can tell to what genus *Natica paludiniformis*, d'Orbigny, belongs, as I believe no figure or full description of it has ever been published. In his Prodr. de Paléont., II, 312, he merely says that it is near his *Natica sinuosa*, "but without a sinus in its columellar lip; and has its volutions slightly striated longitudinally." But all we know of his *N. sinuosa* is that he says, on the same page of the same work, that "it is near *N. spirata*, but smaller, and remarkable for having a sinus of the columellar border near the umbilicus." Now his *N. spirata*, he says, is *Nerita spirata*, Sowerby; which is a Carboniferous species, apparently of *Naticopsis*, McCoy. So it would certainly be a "pursuit of knowledge under difficulties" to undertake, from such a description, to determine even to what genus his *N. paludiniformis* really belongs. If, however, it is congeneric with the Cretaceous shell here described, and his species *can be regarded as established*, then it would be necessary to find another name for our shell.

rather deeply channeled by the sudden inflection of the upper margins of the volutions; aperture subovate, a little oblique, and on the inner side nearly straight, equaling a little more than half the entire length; inner lip rather thin; umbilical chink small; surface appearing nearly smooth to the eye, but, when examined by the aid of a lens, seen to be marked by minute, closely-arranged lines of growth, crossed by equally fine, minutely-undulating, revolving striæ.

Length of a medium-sized specimen, 0.65 inch; breadth, 0.43 inch; length of aperture, 0.37 inch; breadth of same, 0.20 inch. Angle of spire nearly regular; divergence, 57°.

This species will be at once distinguished from all of the otherwise similar forms yet known from the Upper Missouri Cretaceous rocks, by its more elevated spire, more slender general form, and more distinct revolving striæ. In general appearance, it agrees more nearly with a Jurassic species described by d'Orbigny under the name *Natica calypso* (Paléont. Fr. Terr. Jur., II, pl. 292, figs. 9 and 10); from which, however, it differs in having more convex whorls, and rather more distinct revolving striæ. Among Cretaceous species, it may be compared with such forms as *Naticā clementina* and *N. Cassisiana*, d'Orbigny, from the Cretaceous rocks of France; though it is too evidently distinct from both to require an enumeration of the points of difference. It closely resembles in form some species of the recent fresh-water genera *Viviparus* and *Campeloma* (= *Melantho*?); but, all its associates being marine types, there is no probability that it belongs to either of those groups.

This is one of the fossil species already alluded to, in connection with the remarks on the genus, that seem to show intermediate gradations between *Amaura* and *Amauropsis*. By reference to the figures, it will be seen to stand, as it were, almost exactly intermediate between those groups; that is, in its elevated and subturreted spire, and thinner inner lip, as well as in some other respects, it agrees well with *Amaura;* though, in its proportionally larger body-volution and aperture, *deeply-channeled suture*, and subperforate columella, it agrees more nearly with *Amauropsis*. If, as already intimated, it shall be found necessary to unite those two groups under one name, then the shell here described would have to stand under the name *Amaura paludinæformis*.

Locality and position.—Sage Creek and Cheyenne River, Dakota Territory; in the upper part of the Fort Pierre group.

APORRHAIDÆ.

Genus APORRHAIS, Dillwyn.

Synon.—Aporrhais, Dillwyn (1823), Philos. Trans., II, 395.—Gray (1835), *ib.*, 305; and (1847) Trans. Zoöl. Soc. Lond., 136.—Swainson (1840), Malac., 141 and 309.—G. B. Sowerby, jr. (1842) Thes. Conch., I, 21; and Conch. Man. (2d ed.), 71.—Forbes and Hanley (1853), Hist. Brit. Moll., III, 185.—H. and A. Adams (1854), Genera Recent Moll, I, 281.—Gabb (1868), Am. Jour. Conch., IV, 143.—Stoliczka (1868), Palæont. Indica, II, 23 and 447.—Gould and Binney (1870), Invert. Mass. (2d ed.), 320.—Tryon (1873), Am. Marine Conch., 17 (not Aldrovandi, Gualt. and Klein).

Chenopus, Phillipi (1836), Moll. Sic., 214.—Koch and Dunker (1837), Beitr. Verst. Nord. Oolite, 34.—Bronn (1838), Leth., 1088.—Munster (1839), Beitr. Petref., I, 98.—Deshayes (1843), Lamarck (2d ed.), IX, 656.

Alipes, Conrad (1865), Am. Jour. Conch., I, 31 (as a subgenus under *Aporrhais*).

Goniocheila, Gabb (1868), Am. Jour. Conch., IV, 144 (proposed as a subgenus under *Aporrhais*).

Arrhoges, Gabb (1868), *ib.*, 145 (proposed as a subgenus under *Aporrhais*).

Etym.—ἀποῤῥήγνυμι, to tear apart.

Type.—*Strombus pes-pelicani*, Linnæus.

Shell never attaining a large size, more or less fusiform before maturity, but in the adult with outer lip thickened, expanded, and produced into from one to three pointed digitations, or sometimes with only one obtuse lobe-like projection, generally sinuous anteriorly; inner lip callous; aperture provided with a posterior canal extending more or less upward, and terminating anteriorly in a canal of variable length and form, according to the sections and species; surface variously ornamented with folds, costæ, nodes, and striæ, or rarely cancellated.

The foregoing synonymy and diagnosis are intended to include three sections, distinguished as follows:

1. APORRHAIS, Dillwyn (typical, = *Chenopus*, Phill.).

   Shell with the expanded outer lip produced into two or three angular digitations which are furrowed within, and carinate externally; posterior canal produced up the spire, and free at the extremity; anterior canal rather produced, somewhat expanded or narrow, and curved or straight.—(Type as already stated.)

2. ALIPES, Conrad (= *Goniocheila*, Gabb).

   Shell with posterior canal extending about half way up the spire, and not free at the end; expanded outer lip with only one projecting angular process, but bearing one or more external carina in front of this that do not terminate in marginal digitations; canal short and strongly incurved; inner lip thick.—*A. liratus*, Conrad.

3. ARRHOGES, Gabb.

> Shell with expanded lip, merely terminating in a single posterior obtuse lobe-like extension, and having its anterior sinus nearly or quite obsolete; posterior canal *very* short; anterior canal also short and obtuse.—*Rostellaria occidentalis*, Beck.

In regard to the value of the last two sections, there will doubtless be different opinions. Some will probably maintain that they ought to be separated generically from *Aporrhais;* while others will either retain them as subgenera under the same, or even scarcely regard them as subgenerically distinct. I would be inclined to give them greater importance were it not for the fact that we find *Alipes* so closely connected through the Tertiary *A. speciosa* (= *Strombus speciosus*, Schlotheim) with the typical *Aporrhais;* while, on the other hand, the group *Arrhoges* seems to be equally connected through the Tertiary *A. analoga* (= *Chenopus analogus*, Deshayes), and the section *Drepanochilus* with *Anchura* proper of Conrad.

Many palæontologists, and, until recently, some conchologists, ranged all such shells under the old genus *Rostellaria.* It is now well known, however, to all intelligent palæontologists, and, of course, to conchologists, that *Aporrhais* is widely removed from the genus *Rostellaria* by the characters of the animal, as well as by only less strongly-marked differences in the shell. There are several extinct types, however, in regard to the structure of the animals, of which we, of course, know nothing from direct observation, which have shells more nearly like that of *Aporrhais.* Among these may be mentioned *Alaria*, Morris and Lycett, *Anchura*, Conrad, *Tessarolax*, *Dicroloma*, and *Helicaulax*, Gabb. From *Anchura* and *Dicroloma*, however, it is at once distinguished by its well-defined posterior canal, and differently-formed lip; from *Alaria* and *Tessarolax*, it is distinguished by having no varices on the volutions, as well as from the want of a posterior canal in the former, and the callus covering most of the spire in the latter. *Helicaulax* has a posterior canal, extending up the spire, but connected with a more spreading and callous inner lip; while its expanded outer lip has more the character of that of *Anchura.*

Aldrovandi has most generally been cited as the author of this genus, but, according to Mr. Gabb and Dr. Stoliczka, incorrectly. I have not had an opportunity to refer to his works; but both of the last-mentioned authors

say that, although he used the name *Aporrhais*, he applied it to *Pterocera*. Dr. Stoliczka cites Petiver (1711) as the author of this genus; but, as both he and Aldrovandi (1778) did not conform to the binomial system of nomenclature, neither of them ought to be cited as the founders of genera; and the same may also be said of Klein, who used this name apparently for a *Strombus* in 1753. It is, therefore, Dillwyn, who first used the name *Aporrhais* in a regular binomial sense in 1823, that we must regard as the founder of the same

So far as is at present known, the genus *Aporrhais* seems not to date back farther than the Cretaceous period, during which it was represented by only a very few species, so far as our knowledge now extends. The Jurassic shells that have been referred to it by some, belong to *Alaria*, Morris and Lycett, *Dicroloma*, Gabb, and perhaps other groups; while most of those from the Cretaceous belong to *Anchura*, *Helicaulax*, and other allied types. A single species hereinafter described from the Cretaceous seems to me to have all the essential characters of the typical section of this genus. There are also a few forms in the Cretaceous, and, as already intimated, in the Tertiary, that closely approach the group *Arrhoges*, but may possibly be distinct. The typical section is also represented in the Tertiaries, and, like the section *Arrhoges*, in our existing seas. The living species of the former occur on the English coast and in the Mediterranean; while the existing typical species of *Arrhoges* is found on the northeastern coast of the United States, on the Banks of Newfoundland, Labrador, &c.

Aporrhais biangulata, M. & H.

Plate 19, figs. 6, *a*, *b*, *c*.

Rostellaria biangulata, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 65.
Aporrhais biangulata, Meek and Hayden (1860), *ib.*, XII, 186.

Fig. 37.

Aporrhais biangulata.

A magnified outline from a specimen showing that it has the usual posterior canal ascending the spire.

Shell rather small, of nearly typical form; spire acutely elevated; volutions about eight, moderately convex; suture distinct; last turn prominent and biangular around the middle, the angles or carinæ being near each other, with a vertical, flattened, or slightly concave space between, while the upper side is flattened with an outward slope from the suture to the upper angle, and the lower abruptly contracted to the rather short, pointed, and nearly straight beak; outer lip forming a broad biangular expansion,

one of the angles being situated at the termination of each one of the rapidly-diverging carinæ of the body-volution; aperture rather obliqne, narrow-oval, terminating above in the posterior canal (which extends far up the spire, becoming free at the end),* narrowed into the small canal below; surface marked by obscure lines of growth, and faint indications of nearly obsolete, very flexuous, vertical costæ, which are crossed by very fine, closely-arranged, revolving striæ.

Length, 0.53 inch; breadth of body-volution, exclusive of the extended lip, 0.21 inch; slopes of spire nearly or quite straight, with a divergence from the apex of about 34°.

The costæ mentioned above are only seen on the volutions of the spire, and are very obscure, or possibly sometimes entirely obsolete. Of the two smooth keels around the body-volution, the upper one is a little larger than the other. They pass around nearly parallel to each other, until they reach the commencement of the expansion of the lip, where they diverge and cross the lip, one extending to each of the marginal angles of the same. The edge of the lip is very broadly and slightly sinuous, horizontally across below, from the lower angle to the beak, and nearly vertically between the two angles, as well as obliquely inward and upward from the upper, and slightly more prominent angle, to the posterior canal ascending the spire.

Mr. Gabb, in his revision of the family *Aporrhaidæ*, makes the inquiry whether this species may not rather belong to his subgenus *Goniocheila* than to *Aporrhais* proper, and seems to doubt the existence of the typical forms of *Aporrhais* in the Cretaceous. A glance at our wood-cut figure, however, which he had not seen, will show that our shell certainly has not the characters of his subgenus; its lip being decidedly and almost equally biangular, its beak not incurved, and, as our other specimens show, its posterior canal as in *Aporrhais* proper. I can therefore see no other differences, than such as may, I think, be fairly considered specific, between it and typical forms of the genus.

Locality and position.—Yellowstone River, 150 miles from its mouth, in beds containing a blending of the fossils of the Fort Pierre and Fox Hills groups of the Upper Missouri Cretaceous series.

* The specimens from which our figures on plate 19 were drawn, have the posterior canal broken away. Others were subsequently found showing it to extend up the spire as in typical forms of the genus.

Genus ANCHURA, Conrad.

Synon.—*Anchura*, Conrad (1860), Jour. Acad. Nat. Sci, IV (2d ser.), 284; and (1873) in Appendix to Kerr's N. Car. Geol. Rep., 12.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils. 19.—Gabb (1868), Am. Jour. Conch., IV, 145; and (1869) Palæont. Cal., II, 165.—Stoliczka (1868), Palæont. Indica, II, 26.—Dana (1874), Man. Geol. (2d ed.), 461.

Drepanochilus, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 19 and 35 (proposed as a subgenus under *Anchura*).—Dana (1874), Man. Geol. (2d ed.), 461 (retained as a subgenus under *Anchura*).

Perissoptera, Tate (1865), Geol. and Nat. Hist. Repertory, Lond.

Etym.—ἀγχι, near; οὐρά, a tail; from the tail-like appearance of the beak of the type-species.
Type.—*Anchura abrupta*, Conrad.

Shell, exclusive of the extended lip, fusiform: beak slender, more or less produced, pointed, and straight, or very slightly flexuous; outer lip at maturity narrow, more or less sinuous below, and extended either into two unequal pointed digitations, directed one anteriorly, and the other posteriorly, or terminating in a single backwardly curved, scythe-shaped process; inner lip callous; aperture without a posterior canal.

In this genus, I admit the following two not very strongly-deferent sections:

1. ANCHURA, Conrad (typical).

   Shell with outer lip terminating in two unequal pointed processes, one directed backward and the other forward; beak typically very long and slender.—(Type as above given.)

2. DREPANOCHILUS, Meek (= *Perissoptera*, Tate, in part).

   Shell with outer lip terminating in a single backwardly-curved, scythe-shaped, pointed process; beak short.—(*Rostellaria Americana* Evans and Shumard.)

As elsewhere stated, this genus is distinguished from *Aporrhais* by being entirely without any traces of a posterior canal ascending the spire, as well as by the different forms of its expanded lip. The beak of the species belonging to the typical section is also much longer and more slender than in *Aporrhais*. It is more nearly related to *Dicroloma*, Gabb, which also has no posterior canal, and seems to differ chiefly in its much more deeply bifid outer lip and curved canal.

The genus *Anchura* is probably mainly, if not entirely, confined to the Cretaceous rocks. It is certainly unknown in the Tertiaries, and among existing mollusks. Some of the Jurassic shells, however, seem to approach it pretty nearly, and may not be generically distinct.

Anchura (Drepanòchilus) Americana, E. & S. (sp.).

Plate 32, figs. 8, *a*, *b*.

Rostellaria Americana, Evans and Shumard (1857), Trans. St. Louis Acad. Sci., I, 42 (not d'Orbigny, 1826).
Aporrhais Americana, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 423.
Anchura (Drepanochilus) Americana, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 19.

Shell rather small, exclusive of the lip unequally fusiform; spire rather acutely conical, and about equaling the length of the aperture and canal; volutions seven and a half to eight, moderately convex, last one unequally biangular around the middle, obliquely flattened above, and abruptly contracted into the rather short, straight, mucronate beak below; upper carina or angle of the body-volution more prominent than the other, usually subcrenate before reaching the lip, on which it is strongly defined to its upward-curved extremity; suture well defined; outer lip of the breadth of the body-volution at its commencement, but rapidly narrowing outward, and curving strongly upward to its acutely-pointed extremity, almost without a lower marginal sinuosity, but having a broad, rounded sinus above; inner lip rather thick all the way up, and connecting above with outer; aperture rhombic-oval and somewhat oblique; surface ornamented by numerous, very regular, strongly-arched, little, vertical costæ, and very fine, regular, thread-like, revolving lines; costæ generally obsolescent on the body-volution, where the revolving lines become somewhat stronger, below the lower carina, which is itself continued only as a stronger line on the lip, without producing the slightest angularity to the outline of the latter.

Length, 1.08 inches; breadth of body-whorl, 0.38 inch; slopes of spire a little convex, with a divergence from the apex of about 30°.

This is one of the most abundant and beautiful of the Upper Missouri Cretaceous univalves, and is often found so finely preserved as to show nearly all of its characters as clearly as we usually see in recent shells. Its lines of growth are very obscure on the upper volutions, but become more distinct on the last one, and on the expanded lip. The little vertical costæ are quite well defined, and very regular on the spire, but become much more obscure, or even only appear as little crenulations, on the larger carina of the body-volution. The revolving lines are exceedingly fine, regular, and crowded on the volutions of the spire and the upper slope of the body-whorl, but become stronger on the lower side of the same, and as they approach the margin

of the expanded lip, where they spread more widely apart, and sometimes have an intermediate smaller one intercalated between. The expanded lip is strengthened by the upper carina of the body-volution being continued along the middle all the way to its mucronate, upcurved point. On its inner side, there is a furrow corresponding to the external carina; but this furrow is not well represented in our figure 8 *a*, of plate 32.

I know of no described species with which this is liable to be confounded.

Locality and position.—Moreau River, Long Lake, and other localities; in the Fox Hills group of the Upper Missouri Cretaceous series; also, on the Yellowstone River, in beds containing a mingling of the fossils of that and the Fort Pierre groups.

Anchura (Drepanochilus) Nebrascensis, E. & S. (sp.).

Plate 19, figs. 5, *a*, *b*, *c*.

Rostellaria Nebrascensis, Evans and Shumard (1854), Proceed. Acad. Nat. Sci. Philad., VI, 164.
Aporrhais Nebrascensis, Meek & Hayden (1860), *ib.*, XII, 423.—Gabb (1861), Synon. Moll. Cret. Form., 39.
Anchura (Drepanochilus) Nebrascensis, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 19.

Shell small, irregularly subfusiform; spire acutely conical, about equaling the length of the body-volution and beak; volutions six and a half to seven, convex, and separated by a distinct suture, last one flattened on the oblique upper slope, unequally bicarinate around the middle, and abruptly contracting below into the short mucronate beak; upper carina of the body-volution more prominent than the lower, and continued along the labial extension to its extremity; surface ornamented by numerous small, strongly flexuous, vertical costæ, that become obsolete on the body-volution, and very fine, regular, closely-arranged, revolving lines, which are less closely arranged as they pass upon the extended lip, and on the lower part of the body-volution, where they usually show an intermediate, much smaller, series; outer lip equaling, at its commencement, the breadth of the body-volution, but very rapidly narrowed by the nearly straight, obliquely ascending, lower margin, and the broadly sinuous outline of the upper, so as to form a single slender, mucronate, slightly backward-curved process; aperture unknown.

Length, about 0.52 inch; breadth of body-volution, exclusive of the extended lip, 0.23 inch; slopes of spire a little convex, with a divergence from the apex of about 20°.

This species resembles the last in general appearance and surfaced

markings, but is always decidedly smaller at maturity than the adult of that shell, and has a narrower spire, more flexuous costæ, rather more convex volutions, and a much narrower labial extension. These differences are constant, and (particularly the last-mentioned one) render the separation of the two species very easy.

This shell has been referred to Drs. Evans and Shumard's species on the authority of the latter, to whom we sent specimens for comparison. Among foreign species, it may be compared with *A. lævisucula* (= *Rostellaria læviuscula*, Sowerby), from which it differs in having smaller, more numerous, and more arched vertical costæ, and a somewhat differently-formed labial appendage.

Locality and position.—Crow Creek, near Black Hills; from the upper beds of the Fort Pierre group of the Upper Missouri Cretaceous series; also, from same horizon on Sage Creek, near the Bad Lands of White River.

Anchura? sublevis, M. & H.

Plate 19, figs. 3, *a*, *b*.

Aporrhais sublevis, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 178.
Aporrhas sublevata (misprint), Meek and Hayden (1860), *ib.*, 428.
Anchura? sublevis, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 19.

Shell unequally subfusiform; spire elevated; volutions seven or more, convex, and separated by a rather distinct, though not deep, suture, last one convex above and abruptly contracted below, with a single small revolving angle, which passes around to the suture, but is not visible on the succeeding turns of the spire; surface polished, and marked by moderately distinct arcuate lines of growth, which are crossed by rather obscure revolving lines, nearly equaling the spaces between on the spire, but more distant, with sometimes a few indistinct, irregular, very fine, parallel striæ between on the body-whorl; aperture and lip unknown.

Length, about 0.54 inch; breadth of body-whorl, 0.26 inch. Apical angle slightly convex; divergence, 37°.

I have not seen specimens of this species retaining the apex of the spire or showing the aperture or lip. Its surface-markings, however, are so different from those of all the other species yet known in these rocks, that it may be readily distinguished, even by comparing quite imperfect specimens. It differs from all its associates with which we are acquainted, excepting *A. biangulata*, in being destitute of costæ on all its whorls; and from that

species it may be at once distinguished by its more convex whorls and much coarser, as well as more distant, revolving lines. Its lines of growth are also not near so flexuous in crossing the volutions of the spire as those of *A. biangulata*.

This and the following species are ranged provisionally in the genus *Anchura*, and may belong to some other group, as we have seen no specimens of either showing the form of the lip, or whether or not there was a posterior canal.

Locality and position.—Yellowstone River, 150 miles from its mouth; in beds containing a mingling of the fossils of the Fort Pierre and Fox Hills groups.

Anchura? parva, M. & H.

Plate 19, figs. 4, *a*, *b*.

Aporrhais parva, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 178.
Anchura? parva, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 19.

Shell very small, irregularly subfusiform; spire moderately elevated, and acute at the apex; volutions six or seven, separated by a small but rather distinct suture, and having around the middle a single series of very oblique, flexuous folds, or node-like costæ, which do not extend to the suture either above or below; last whorl rather large, and having, just below the row of nodes, a small but well-defined revolving ridge; surface marked by very obscure lines of growth, and fine, closely-set, revolving striæ; (beak and lip unknown).

Length, about 0.28 inch; breadth of body-whorl, 0.15 inch. Apical angle a little convex; divergence, 33°.

I have seen but one specimen of this little shell, which has the lip broken away, and does not show the columella or the form of the aperture. Consequently, it is only provisionally that it has been referred to the above genus. It may be readily distinguished from all of the allied forms yet known from these rocks, by its broader form, less attenuated spire, and proportionally larger, more distant, and more oblique, flexuous, node-like folds around the middle of the whorls. These folds, or nodes, are entirely unlike the small vertical costæ on any of the other species already described, being so broad and distant that only about ten of them occupy the whole of the body-whorl.

Locality and position.—Same as last.

VANIKORIDÆ.

Genus VANIKORO, Quoy and Gaim.

Synon.—*Vanikoro*, Quoy and Gaimard (1832), Voy. Astrol., Zoöl., II, 239.—H. and A. Adams (1854), Gen. Recent Moll., I, 374.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 18.—Stoliczka (1868), Palæont. Indica, II, 307.

Merria, Gray (1839), Beechey's Voy., Zoöl., 137.

Niomia, Gray (1840), Synon. Moll. Brit. Mus., 124.

Leucotis, Swainson (1840), Malac., 346.

Narica, Récluz (MS.), d'Orbigny (1841), Moll. Cub., 39; and (1843) Pal. Fr., II, 170.—Récluz (1844), Rev. Zoöl., 4 and 49.—De Koninck (1844), Terr. Anthr., 474.—Geinitz (1845), Grundr. d. Verst., 341.—Chenu (1859), Man. Conch., I, 331.

Etym.—*Vanikoro*, the name of one of the Pacific islands.

Type.—*Nerita cancellata*, Gmelin.

Shell subglobose, thin or moderately thick, in the recent state often covered with a velvety epidermis; volutions few, last one large; surface ribbed, cancellated, or spirally striated; inner lip moderately thickened or rather thin, simple, and slightly reflexed; columella excavated or slightly perforated, the umbilical opening usually ending in an arched channel behind; aperture varying, according to the species, from semilunar to subovate, but generally somewhat modified by the body-volution.

The shells of this genus are usually rather thin, subglobose, and, in recent examples, white. Some species have distinct, regular, vertical costæ, while others have only revolving striæ and furrows The genus seems to have been first proposed by its authors as a section of *Velutina*, to include cancellated species from the Pacific islands. Nearly all later authors, however, admit it as a distinct genus; though the name *Narica* has been most generally used for it. The laws of priority, however, require that we should go back to the older name *Vanikoro*, notwithstanding the fact that it was only proposed as a subgenus, and subsequently, I believe, altogether abandoned by its founders; for the fate of a generic or subgeneric name, once regularly proposed, does not depend on the later opinions of the author proposing it, but on the fact whether or not its type represents a good new genus.

It seems very probable that this genus existed as far back as the Triassic epoch; and we also find forms agreeing quite nearly with it in the Jurassic and Cretaceous rocks; also, a few in the Tertiary. Some twenty to thirty living species have likewise been described by conchologists from our existing seas, and there are doubtless a number of others yet unknown.

Vanikoro ambigua, M. & H.

Plate 19, figs. 12, *a*, *b*, *c*, *d*.

Natica? ambigua, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 64.
Fossar? Nebrascensis, Meek and Hayden (1860), *ib.*, XII, 423.
Vanikoro ambigua, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 18.

Shell rather small, obliquely rhombic-subglobose; spire of moderate height, composed of about four convex volutions, which are separated by a well-defined suture; surface ornamented by distinct lines and obscure wrinkles of growth, which are crossed by numerous irregular revolving lines, generally larger than the grooves between; aperture ovate, very oblique, obtusely angular above, and rounded below; outer lip sharp, joining the whorl above nearly at right angles, slightly reflexed at its junction with the columella below; axis apparently perforated by a very small umbilical opening, which is not covered by the lip.

Length, about 0.56 inch; breadth, 0.48 inch; length of aperture, 0.36 inch; breadth of same, 0.25 inch. Apical angle regular, or nearly so; divergence varying from 70° to 80°.

The revolving lines are generally quite well defined, especially on the lower part of the body-whorl. They are very irregular in size, though almost always broader, particularly on the middle of the body-volution, than the grooves between, which are each sometimes occupied by a smaller line. By the aid of a lens, faint indications of very fine, revolving, impressed striæ may be seen irregularly distributed upon and between the larger lines.

In form, this shell varies somewhat; the spire of some individuals being more elevated than that of others. Some specimens have the body-whorl rounded and rather gibbous, while in others it is slightly compressed above, so as to give the shell a more conical form.

In first indicating this species, we were in much doubt in regard to its generic relations, and placed it provisionally, with a query, in the genus *Natica*. Later comparisons, however, soon led to the conclusion that it at least could not be properly retained in that genus, and we afterward removed it, still doubtfully, to the genus *Fossar*. In making this change, it also became necessary to find a new specific name, there being already a *Fossar ambiguus*. Still more recently, some specimens were brought in showing more clearly the parts about the columella and umbilical region, and from these it appeared much more probable that this shell belongs to the genus *Vanikoro*, to which

I removed it in the Smithsonian Check-List, under the original specific name. It is one of those puzzling types, such as the palæontologist not unfrequently has to dispose of in some way, without being entirely satisfied with any conclusion that he can form in regard to its relations.

Locality and position.—Yellowstone River, 150 miles above its mouth; in the beds containing a mingling of the fossils of the upper part of the Fort Pierre group with those of the Fox Hills group, of the Upper Mo. Cretaceous series.

Genus VANIKOROPSIS, Meek.

Synon.—*Natica* and *Neritopsis?* (sp.), Meek and Hayden (neither *Natica*, Ad., nor *Neritopsis*, Gratel.).

Etym.—*Vanikoro*; ὄψις, form.

Type.—*Natica Tuomeyana*, Meek and Hayden.

Shell subglobose, thick, and solid; body-volution large; spire depressed; aperture ovate; axis imperforated; outer lip simple, beveled; inner lip closely folded upon, and adhering to, the columella and the body-volution, very little thickened, and not flattened, toothed, notched, or serrated; surface with distinct revolving lines and furrows, and on the body-volution developing strong oblique folds or plications and furrows, parallel to the lines of growth.

The type and only known species of this genus has long been a subject of much doubt and perplexity. In first indicating it, we placed it temporarily in the genus *Natica*, with really very little idea that it properly belonged there. Subsequently, we removed it, with a mark of doubt, as a nearer approximation to its true position, to the genus *Neritopsis*. In general form, and the possession of distinct revolving lines and furrows, it reminds one of the genus *Vanikoro;* but its very thick, solid shell, want of an umbilical perforation, and the close connection of the slightly-thickened inner lip with the columella and the body-volution above, forbid its reference to that group. On the other hand, it presents quite as well-marked distinctions from *Neritopsis*, since its inner lip wants the thickened and flattened character of that genus, and shows not the slightest tendency to the formation of a broad central notch, or sinus, such as we see in the same.

In regard to its geological range, nothing can be said, in the present state of our knowledge, beyond the fact that the typical species came from the higher part of the Upper Cretaceous.

It is difficult to decide respecting the family-affinities of such a fossil shell without, so far as known, any existing congeneric representatives. I have the impression, however, that it may find a place in the family *Vanikoridæ*.

Vanikoropsis Tuomeyana, M. & H. (sp.).

Plate 39, figs. 2, *a*, *b*.

Natica Tuomeyana, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 270.
Naticopsis? Tuomeyana, Meek and Hayden (1860), *ib.*, XII, 423.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 18.

Shell depressed-subglobose, very strong; volutions four to four and a half, convex, last one composing most of the entire bulk, and regularly rounded; suture rather deep; aperture ovate or nearly so, being a little straighter on the inner side; columella with the faintest appearance of a very small umbilical indentation by the side of the smooth, scarcely thickened, inner lip. Surface of the upper volutions showing only the regular, distinct, revolving lines and fine striæ of growth, the former of which increase regularly in size on the body-whorl, on which the strong, vertical, or more or less oblique, folds, or plications, are inclined to be angular on their crests, with broad, rounded, deep depressions between.

Length and breadth, each, about 0.88 inch. Apical angle with nearly straight slopes, and a divergence of about 110°.

This species will be at once distinguished from all of the other known Upper Missouri univalves resembling it in other respects, by its thick shell and distinct revolving lines, crossed on the body-volution by large, strong, oblique folds, or plications; thus giving it a peculiar rough appearance. I am not acquainted with any described foreign species resembling it closely enough to render a comparison necessary. It seems to be very rare, as all of the collections yet brought from the Far West have only afforded us a single specimen.

Locality and position.—Mouth of Judith River, on the Upper Missouri; from Cretaceous beds holding a position at the horizon of the top of the Fox Hills group.

TURRITELLIDÆ.

Genus MESALIA, Gray.

Synon.—Mesalia, Gray (1842), Synon. Moll. Brit. Mus., 61, 90; and (1847) Zoöl. Proceed., 155.—H. and A. Adams (1853), Genera Recent Moll., I, 35.—Chenu (1859), Man. Conch., I, 317 (as a subgenus under *Turritella*).

Etym.—(? Mesal, Ad., a word of barbarous origin.)
Type.—Cerithium mesal, Adanson.

Shell many-whorled, short-subterete; volutions more or less convex, and spirally striated, the last one rounded below; aperture suborbicular, produced

below, with the lower margin a little sinuated or notched and reflexed; inner lip somewhat twisted and flattened; outer lip thin and sinuate above the middle.

This genus seems to be to some extent intermediate, in the characters of its shell, between *Turritella*, Lamarck, and *Proto*, Defrance. It is, however, generally proportionally shorter, with volutions more rapidly increasing in size than is common in *Turritella*; from which it also differs in having its aperture produced, with a sinuated margin anteriorly. From *Proto* it differs in not having the anterior margin of its aperture near so strongly notched, as well as in having its body-volution rounded below, and proportionally larger, and its outer lip sinuous above.

This genus probably commenced its existence during the Cretaceous epoch. It certainly occurs in the Tertiary, and is represented by some six to eight or more existing species.

Mesalia? Kansasensis, Meek.

Plate 2, figs. 7, *a*, *b*.

Turritella Kansasensis, Meek (1871), Hayden's Report Geological Survey of the Territories, 312.

Shell elongate-conical, or gradually and regularly tapering from below to the apex, with the lateral slopes of the spire straight; volutions eight to ten, increasing regularly in size, flattened, or only very slightly convex; last one rounded below; suture nearly linear; aperture ovate; surface with small, thread-like, revolving lines, varying much in their arrangement and distinctness, but usually more strongly defined on the lower half of the last turn; lines of growth very fine, obscure, and strongly arched or sigmoid, so as to indicate a deep sinuosity in the outer lip above the middle.

Length of a large specimen, 1.10 inches; breadth, 0.34 inch; divergence of slopes of the spire, about 22°.

This shell varies much in its surface-markings; some of the specimens appearing almost smooth, or only showing faint indications of a few revolving lines, while others show a few distantly-separated, very slender, raised lines. In still others, five or six well-defined slender lines may be seen on some of the volutions, and a smaller number of less distinctly-defined ones on the other turns. The arrangement of these lines and their comparative size on different individuals, as well as on different parts of the same specimen, vary much. Usually, the upper turns near the apex of the spire appear to be

smooth, though this may be partly due to accidental erosion before the shells were embedded in the matrix.

It is with considerable hesitation that I have concluded to remove this species to the genus *Mesalia;* none of the specimens being in a condition to show the base of its aperture. Consequently, I have been unable to determine whether or not its lower margin is produced and notched, or subcanaliculated, as in that genus. From its rounded body-volution, and the deep sinuosity of its outer lip (as shown by the curve of its lines of growth), as well as its general resemblance to some of the species of that group, however, I have been led to think it may probably be a *Mesalia.*

Locality and position.—Twelve miles southwest of Salina, Kansas; Dakota group of the Upper Missouri Cretaceous. Prof. B. F. Mudge, collector.

CERITHIOPSIDÆ.

Genus CERITHIOPSIS, Forbes and Hanley.

Synon.—Cerithium (sp.) of some earlier authors.
Cerithiopsis, Forbes and Hanley (1849), Brit. Moll., III, 364.—H. and A. Adams (1852), Genera Recent Moll., I, 240.—Chenu (1859), Man. Conch., I, 231.—Gabb (1864), Palæont. Cal., I, 116; *ib.*, II, 114.—Stoliczka (1868), Palæont. Indica, II, 185.—Gould and Binney (1870), Invert. Mass. (2d ed.), 385.
Alaba, H. and A. Adams (1853), Genera Recent Moll., I, 241 (as a subgenus).
Seila, A. Adams (1861), Ann. Mag. Nat. Hist., VII (3d ser.), 131 (as a subgenus).

Etym.—Cerithium; ὄψις, form.
Type.—Murex tuberculatis, Mont.

Shell small, turriculated, many-whorled, dextral, marked with revolving rows of granules, or small ridges, sometimes cancellated, smooth, or with a few irregular varices; aperture more or less rounded, or subquadrate, anteriorly sinuate, with a small, short, oblique canal, or merely emarginate; outer lip acute, arcuate, and a little produced anteriorly; inner lip reflected and rather broad.

H. and A. Adams, in their joint work on the recent *Mollusca*, separated the species belonging to this genus into two subgenera; and subsequently one of those authors added another. These sections may be severally distinguished as follows:

1. CERITHIOPSIS, Forbes and Hanley (typical).

Shell with surface granular, cancellated, or with revolving ridges; aperture sinuated, and having a short canal anteriorly.—(Type as above stated.)

2. ALABA, H. and A. Adams.

Shell smooth, or sometimes with a few irregular varices, semi-pellucid; aperture only slightly emarginate.—(*C. melanura*, C. B. Ad.)

3. SEILA, A. Adams.

Shell differing from other species of the genus in being transversely lirate, instead of ribbed, granular, or cancellated.—(*Triphoris dextroversus*, Adams and Reeve.)

Although the little shells included in this genus so nearly resemble those of *Cerithium* that it is exceedingly difficult to distinguish the two groups from each other, when the soft parts are unknown, the animal of *Cerithiopsis* is so peculiar that an entirely distinct family has been established for the reception of the genus.

Although I have not very much faith in the possibility of distinguishing this genus from *Cerithium* among fossil species, as I have already referred to it elsewhere one of our Upper Missouri Cretaceous species that certainly resembles some of the recent species of this group in size and form, as well as in the nature of its aperture, I do not like to remove it to *Cerithium* on uncertainties, and therefore have had to characterize the genus here.

The difficulty of distinguishing this genus from *Cerithium*, of course, precludes the possibility of fixing or determining its geological range with precision. There are certainly, however, forms in the Cretaceous rocks that seem to present all of its characters, so far as the shell can be relied upon as a guide; also in the Tertiary. It is likewise moderately well represented in our existing seas.

Cerithiopsis Moreauensis, M. & H.

Plate 31, fig. 4 (not 4 *a b*).

Turritella Moreauensis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 70.
Cerithiopsis Moreauensis, Meek and Hayden (1860), *ib.*, 185.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 20.

Shell small terete; volutions flattened on a line with the general slope of the spire, increasing gradually and regularly in size from the apex, and all without traces of varices; last one nearly rectangular around the lower margin, each turn bearing three continuous, prominent, revolving lines, or little ridges, separated by furrows of the same, or very slightly larger size; suture appearing like a mere impressed hair-line, in a spiral furrow between

the lowest revolving ridge on each turn, and the highest one on the next below; marks of growth very fine, regularly-disposed, elevated hair-lines, much more distinct in the furrows than on the revolving ridges, all making a rather deep, graceful, backward curve in crossing the outer flattened sides of the volutions, and an equally distinct forward curve on the lower side of the body-volution below its angle, thus indicating a broadly-sinuous outline for the outer lip above, and an equally prominent outline below the angle of the last turn; aperture subquadrangular, with the canal at its lower inner angle very narrow and oblique; columella twisted, and bearing a very distinct, prominent, rounded plait on its oblique lower edge, and faint traces of one or two much smaller ones just above.

Fig. 38.

Cerithiopsis Morcauensis.

Enlarged about three diameters, to show the little ridge seen at the base of the columella.

Length, about 0.47 inch; breadth, 0.15 inch; slopes of spire straight, with a divergence of about 9°.

In form and surface-markings, this little shell has exactly the appearance of a *Turritella*, to which genus we referred it before seeing any specimens giving a correct idea of the nature of its aperture. On subsequently seeing the specimen represented by figure 4 of our plate, it became evident that there is a little canal at the inner lower angle of the mouth, though the lower part of the lip and a portion of the columella being partly broken away, the exact appearance of the parts could not be made out. It showed enough of the characters of the aperture, however, to render it very clear that the shell is certainly not a *Turritella;* and from its general appearance we were led to refer it provisionally to the genus *Cerithiopsis.* Another specimen, since brought in, although not showing the aperture, has one side of one of the lower volutions broken away, and thus shows that there is a prominent oblique ridge just at the lower edge of the columella, and faint traces of one or two more much smaller ones just above, as we see in some of the Paris-basin species of *Cerithium.* Consequently, it is possible that I would be nearer right to call it *Cerithium Moreauense.* After seeing the ridge at the base of the columella of the broken specimen mentioned above, the one figured on the plate was more carefully examined and a little more developed, when the little ridge was also found to exist in it, as shown in the foregoing enlarged wood cut.

Specifically, this little shell may be compared with such forms as *Ceri-*

thium inæquiliratum, *C. secale*, and *C. mundulum*, Deshayes, from the Paris-basin Tertiary; all of which very nearly resemble it in form and surface-markings. Our shell, however, has a more quadrangular aperture than any of these, and also differs in having the lower edge of its columella raised in the form of a much more distinct, less oblique, ridge, as well as in showing traces of one or two much smaller ridges above.

Locality and position.—Moreau River; from the Fox Hills group, apparently very rare.

PYRAMIDELLIDÆ.

Genus CHEMNITZIA, d'Orbigny.

Synon.—*Chemnitzia*, d'Orbigny (1850), Palæont. Française Terr. Jurass., II, 30 (not (1839) Moll. Canar., 77, which is = *Turbonilla*, Risso, 1826).—Conrad (1860), Jour. Acad. Nat. Sci. Philad. (new ser.), IV, 287.—Gabb (1861), Synop. Moll. Cret. Form., 46.—Stoliczka (1868), Palæont. Indica, II, 286; and in part of many others.

Etym.—Dedicated to the conchologist Chemnitz.
Examp.—*Chemnitzia melanopsis*, Conrad.

Shell of comparatively large size, and elongate-conical, with spire many-whorled and not reversed at the apex; last volution generally moderately large and somewhat produced below; aperture ovate, sometimes faintly effuse at the base; peritreme not continuous; outer lip sharp, with usually a faintly sinuous outline near or above the middle; inner lip a little thickened, or rather thin; columella somewhat arcuate, and without plaits, folds, or umbilical perforation; surface ornamented with regular, vertical, more or less arcuate or sigmoid costæ or lines, sometimes crossed by revolving striæ—rarely nodular.

The name *Chemnitzia* has been so variously used that it becomes a matter of some doubt to what genus it should be applied, or even whether it ought not to be discarded entirely. As first proposed by d'Orbigny in 1839 in Webb and Berthollet's Natural History of the Canaries, it was founded on a very small, elongate-conical, costated shell, with a sinistral apex (*C. campanellæ*, = *Melania campanellæ*, Phillipi), which, according to all authorities, belongs to the genus *Turbonilla*, Risso, 1825 or 1826. As this was d'Orbigny's typical and only species, it would seem beyond question that his genus *Chemnitzia* of 1839 is a synonym of *Turbonilla*, Risso.

At a later date, however, d'Orbigny, in his great work "Voy. dans l'Amér. Mérid., V," included a number of other small recent species under his name *Chemnitzia*, some of which are congeneric with his original type, while others belong to several other genera, according to later classifications.

Several authors, who acknowledge the identity of *Turbonilla*, and *Chemnitzia*, d'Orbigny, as the latter was first used, and that the former name has priority of date, continue to use d'Orbigny's name for some of the extraneous types included by him *at the second date;* but I hardly think this can be properly done, as we have to go back to the original date to settle the question in regard to the type of d'Orbigny's genus, and that makes it a synonym of *Turbonilla*, Risso. Forbes and Hanley, who also admit the identity of *Turbonilla* and *Chemnitzia*, and the fact that the former has priority, still retain *Chemnitzia* for the *Turbonilla* group, mainly on the ground that the name *Turbonilla* is, as they think, too nearly like those of some other widely dissimilar genera. This, however, does not seem to me a valid reason for rejecting *Turbonilla* for that group, as there is no danger whatever of its being confounded with any of the similar names; and there are many other names as nearly like others already in general use, still retained without inconvenience, in several departments of natural history.

In 1850, however, d'Orbigny proposed (in volume II of his Paléont. Franç. Terr. Jurass., page 30) the name *Chemnitzia, de novo,* for an entirely different group of very much larger extinct shells with a non-reversed apex. He did not here merely propose to *extend* the genus, so as to make it include these larger shells, but, as stated above, proposed to use the name anew for an entirely different group, acknowledging that his *Chemnitzia* of former dates is a synonym of *Turbonilla*, and pointing out the distinctions between it and his *Chemnitzia* of 1850. Authorities differ in regard to the use of an abandoned name that has fallen into synonymy, in this way, for another genus; some maintaining that it cannot be properly done, while perhaps a majority of the most reliable authorities admit that a name that has fallen into synonymy is free to be again used for another genus. If so, I can see no reason why the author who first used it has not as good a right to use it again, in such a case, for a different genus, as any one else.

Even as thus used by d'Orbigny, at this last-mentioned date, however, he evidently included species belonging to several distinct groups. His *C. condensata*, for instance, with its auriculiform aperture and very decidedly continuous peritreme, seems to represent a different group from the large majority of his other species. The same may also be said of his *C. Roissyi*, with its flat whorls, quadrangular aperture, and distinct, open umbilicus. I think it also probable that the short, smooth species like his *C. curta* and *C. vesta* may likewise represent another distinct group, as may

possibly be the case with a few of his other species. A large majority of the species included by him seem to be congeneric, however; and, as Mr. Conrad in 1860, and Dr. Stoliczka in 1868, have proposed to retain the name *Chemnitzia* for shells more nearly of the latter type, I am inclined to adopt this conclusion.*

Many palæontologists refer the Palæozoic shells for which Phillips in 1841 proposed the name *Loxonema*, to *Chemnitzia*, and it is possible that this may be correct, at least in part; that is, as *Chemnitzia* is here understood; but certainly not as first proposed by d'Orbigny in 1839. Others, again, consider *Turbonilla*, *Chemnitzia*, and *Loxonema* as being all synonymous; but in this view I cannot concur, for the reasons already explained.

Whether the genus *Chemnitzia* is to be regarded as dating back to Palæozoic times depends entirely upon the limits assigned it. If the numerous species referred to *Loxonema* are to be included, it would, of course, extend far back into the Palæozoic rocks. I incline to the opinion, however, that most, if not all, of the Palæozoic species that have been referred to this genus, ought to be separately arranged under *Loxonema*, *Michelia*, and other groups. Some Triassic forms approah this genus, and may possibly fall within it. In the Jurassic and Cretaceous rocks, it is certainly well developed; and it seems not to have survived the close of the Cretaceous period.

If the group *Loxonema* is not distinct, as many think, from *Chemnitzia* as here understood, of course the former name will have to take precedence for the shells here in view, as d'Orbigny's name *Chemnitzia*, 1850, would be antedated; for we cannot go back to d'Orbigny's original date, 1839, when the group *then* named by him is identical with the still older genus *Turbonilla*, Risso.

Chemnitzia cerithiformis, M. & H. (sp.).

Plate 32, figs. 10, *a*, *b*.

Scalaria cerithiformis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 63 (not Watel., 1853).
Turbonilla cerithiformis, Meek and Hayden (1860), *ib.*, XII, 185.
Scala (Acirsa) cerithiformis, Meek and Hayden (1860), *ib.*, 422.—Meek (1860), Smithsonian Check-List N. Am. Cret. Fossils, 20.
Scalaria Meeki, Nyst (1871), Ann. Soc. Malacologique de Belgique, VI, 44.

Shell elongate-conical; spire turreted; volutions about eight, convex, increasing rather gradually from the apex, last one rounded, and but little

* The shells for which Mr. Conrad and Dr. Stoliczka retain the name *Chemnitzia*, have the body volution and aperture more produced below than perhaps any of d'Orbigny's types; but this is probably not a generic distinction.

produced below; suture distinct, but not very deep; surface ornamented by numerous small, slightly-arched, vertical costæ, crossed by much smaller, thread-like, revolving lines; aperture rather broad-ovate, being angular above, most convex on the outer side, and subangular, or narrowly rounded, and slightly effuse at the inner side of its base; inner lip thin or nearly obsolete.

Length, about 1.65 inches; breadth, 0.68 inch; length of aperture, 0.55 inch; breadth of same, 0.37 inch. Slopes of spire very nearly straight, with a divergence of 28°.

The little vertical costæ on this shell number about twenty-two to twenty-three on each turn, and are usually separated by depressions some three or four times their own breadth. They are rather angular, but not very prominent. About thirteen of the small revolving lines may be counted on the second turn, where they are separated by spaces nearly twice their own breadth. On the last whorl, a smaller line, and sometimes two or three smaller ones, are developed between each two of the larger revolving lines, so as to give the whole a more crowded and irregular appearance.

Among foreign fossil forms, this species may be compared with *Scalaria gurgitis* of Pictet and Roux (Mem. Soc. Phys. et Nat. Hist. de Genève, XII, pl. 16, fig. 4), which it nearly resembles; though it differs in having a less attenuated form and a smaller number of volutions than the European species, which is probably not a true *Scalaria*.

I have long been in doubt in regard to the generic relations of this shell. Originally, we supposed that it belonged to some section of the genus *Scalaria*, to which genus we at first referred it; and this opinion was, of course, also held at the time we placed it under the equivalent name *Scala*. Better specimens, however, show that it differs from that genus in not having its peritreme continuous, and in having its aperture more angular behind, as well as subangular and slightly effuse at its inner side below. Its volutions are likewise less convex, and do not round into the suture above, as we see in that genus. From all of its known characters, it seems to be very much more nearly allied to *Chemnitzia* as that genus is here defined. Indeed, we at one time held the opinion, long back, that it belonged to that genus, as understood by many who consider it a synonym of *Turbonilla*, Risso.

The name *cerithiformis* having been previously used in the genus *Scalaria*, to which we at first referred this species provisionally, Professor Nyst proposed to call it *S. Meeki;* but, as we now know that it is not a

Scalaria, it has to retain its original specific name *cerithiformis*. If the name *Chemnitzia* as here used should prove identical with *Loxonema*, however, the name of this shell will, of course, have to be changed to *Loxonema cerithiformis*.

Locality and position.—Moreau Trading Post; in the Fox Hills group of the Upper Missouri Cretaceous series. It seems to be very rare.

LITTORINIDÆ.

Genus SPIRONEMA, Meek.

Synon.—*Turbo* (sp.) and *Tuba* (sp.) of authors (not *Turbo*, Linn., nor *Tuba*, Lea).
Spironema, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 35.—Stoliczka (1868), Palæont. Indica, II, 263.
? *Callonema*, Conrad (1873), Appendix to Kerr's North Carolina Geological Report, 12.

Etym.—σπεῖρα, wound around; νῆμα, a thread; in allusion to the spiral lines of the type species.
Type.—*Turbo tenuilineatus*, Meek and Hayden.

Shell turbinate or subovate, thin; spire rather prominent; suture channeled; axis perforated; aperture ovate, not modified by the body-volution above; peristome continuous; outer lip sharp; inner lip thin, not reflexed or flattened below, and only connected with the body-volution toward the upper part of the aperture; umbilical perforation small; surface with revolving lines and furrows.

The shell for the reception of which this genus was proposed, has much the form and general appearance of some of the Cretaceous species referred by d'Orbigny and others to the genus *Turbo*. It differs, however, from that, and indeed all other genera of the *Turbinidæ* as properly restricted, in its entirely non-pearlaceous interior, as well as in its distinctly-channeled suture. In first referring it doubtfully to the genus *Turbo*, we had attributed its want of the usual pearly luster to some change that the substance of the shell had undergone while embedded in the rock. The fact, however, that the associated *Ammonites*, *Baculites*, *Margarita*, *Nucula*, *Inoceramus*, and other pearly shells, retain their nacreous luster, shows that this cannot be the case; and, from its combination of characters, there is little or no reason to doubt that it belongs to the family *Littorinidæ*.

It differs, however, from the genus *Littorina*, in the greater thinness of the whole shell, but particularly in its inner lip, which is neither reflexed nor in the slightest degree flattened; also, in its perforated axis and distinctly-channeled suture. In some respects, it resembles the genus *Fossar*, Gray;

but its channeled suture, and more rounded aperture, with its inner lip, as it were, disconnected from the umbilical region, are characters that forbid its reference to that genus.

Mr. Conrad has referred a Cretaceous species doubtfully to Dr. Lea's genus *Tuba*, that seems almost certainly congeneric with the type of this genus. His specimen appears not to have been in a condition to show the aperture. In our type, however, the aperture is clearly seen to be rounded instead of angular below, as in the species upon which Dr. Lea founded his genus; which is also described as having its columella thickened and reflexed at the base. Mr. Conrad has also proposed, in the North Carolina Report (Appendix, page 12), a genus *Callonema*, that appears to me very closely related to this.

So far as yet known, this seems to be a Cretaceous genus only, though it may also include some Tertiary forms.

Spironema tenuilineata, M. & H. (sp.).

Plate 32, figs. 9, *a*, *b*, *c*.

Turbo tenuilineatus, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 64.
Spironema tenuilineata, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 19 and 35.

Shell obliquely subovate, comparatively thin; spire forming about half the entire length, apparently rather acute at the apex; volutions about five and a half, prominently convex, last one rounded and somewhat produced below; surface marked with fine lines of growth, which are crossed by stronger, irregular, revolving lines, about equaling the grooves between; much finer, obscure, revolving striæ may also sometimes be seen by the aid of a magnifier, upon and between the larger lines. Aperture a little oblique, very nearly ovate, but a little straighter on the inner than the outer side: umbilicus small.

Length, 0.79 inch; breadth, 0.60 inch; apical angle regular, 68°.

The revolving lines give this shell a rather neatly ornate appearance. They are smallest on the upper part of each whorl, and increase in size below. Some of those near the middle of the body-whorl are divided by a small, impressed line along the middle. The excavated character of the suture gives a slightly-truncated aspect to the summit of the whorls, and a turreted appearance to the spire.

From *Tuba? bella* of Conrad, mentioned in the remarks under the

genus, this shell differs in having a proportionally larger body-whorl, shorter spire, and fewer whorls; its revolving lines are also smaller and more numerous. I am not acquainted with any species with which it is apt to be confounded.

Locality and position.—Moreau River; from the Fox Hills group, or No. 5 of the Nebraska Cretaceous series.

MURICIDÆ.

Genus PYRIFUSUS, Conrad.

Synon.—*Fusus* (sp.) of authors, but not of Lamarck, as properly restricted.
Pyrifusus, Conrad (1858), Jour. Acad. Nat. Sci. Philad. (n. s.), 332.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22.
? *Neptunella*, Meek (1864), *ib.*, 38 (not *Neptunella*, Gray * * which is = *Cabastana*, Bolten, 1789, and *Aquillus*, Montf., 1810).

Etym.—*Pyrula* and *Fusus*.
Type.—*Pyrifusus subdensata*, Conrad.

Shell varying from subpyriform to short-fusiform; spire one- to three-fifths the length of the aperture and canal, not papillate at the apex; body-volution rather ventricose, and prominent, or obtusely subangular around the upper third, dorso-ventrally compressed, or more generally rounded, tapering below into a nearly straight, moderately-produced canal; aperture rhombic-subovate in outline, being angular, but not notched or canaliculate above, and tapering downward; outer lip thin, sometimes broadly sinuous above the middle; columella solid, gently arcuate along the middle, nearly straight, and without twist below, sometimes more or less flattened, but always without the slightest umbilical ridge, and at least typically imperforate; inner lip smooth, and closely attached to the columella and body-volution; surface with vertical, sometimes node-like, folds, around the most convex part of the volutions, and revolving striæ, or small ridges.

The foregoing diagnosis is drawn up so as to include, along with Mr. Conrad's typical form, a group of apparently congeneric Upper Missouri Cretaceous species, that still seem to differ in some of their characters. I only know Mr. Conrad's type from his figures and description; but, on sending him some of our specimens of these shells several years back, he wrote that he thought they might go into his genus *Pyrifusus*. Although not entirely satisfied with this arrangement, having elsewhere adopted it by referring our species to that genus, I prefer not to remove them from all connection with the same, at least until their relations can be more satisfactorily settled; and,

in now leaving them there, it seems to be at least desirable to place them in a separate section, as stated below:

1. PYRIFUSUS, Conrad (typical).

   Shell with body-volution a little compressed dorso-ventrally; columella flattened; spire about one-fifth the length of the aperture and canal.—(Type as stated above.)

2. NEPTUNELLA, Meek (not Gray).

   Shell with body-volution rounded; columella not flattened; spire one-half to two-thirds the length of the aperture; outer lip broadly sinuous above the middle.—(*Fusus Newberryi*, Meek and Hayden.)

The most important difference between these two sections, or groups, is the flattening of the columella in the type of *Pyrifusus;* while, in our shells, it is certainly not in the slightest degree flattened. I suspect that the broadly sinuous character of the upper part of the outer lip (see the following wood-cuts) is another difference; but, as neither Mr. Conrad's figure nor his description gives any information on this point, his shell may possibly not differ in this character.

In the same paper containing Mr. Conrad's description of his genus *Pyrifusus*, he also proposed another genus, or rather subgenus, *Afer;* and the species described by him under this group seems to me to agree exactly, in all but mere specific details, with our shells. Consequently, I would not hesitate to place our species under his group *Afer*, had he founded it upon his Cretaceous species alluded to (*Fusus* (*Afer*) *bellaliratus*, Con.). Unfortunately, however, he distinctly mentions as the type of that genus the recent *Fusus afer*, Lamarck, which to me seems not to be congeneric with any of these Cretaceous shells, as it has a very suddenly contracted, or pinched, and twisted canal, and a distinct revolving umbilical ridge, raising the inner lip into a kind of oblique ridge, and passing down the left side of the canal; characters not at all indicated in any of these shells.*

In the American Journal of Conchology, volume IV, page 248, Mr. Conrad has some remarks on two Indian Cretaceous species figured by Dr. Stoliczka in his Palæont. Indica, under the names *Rapa nodifera* and *R. cancellata*, and states that they belong to his genus *Pyrifusus*. To me, however, these Indian shells seem to differ so materially from the idea I had formed of that genus from Mr Conrad's figures and description of the same,

* The presence of this ridge implies the existence of a notch at the base of the canal, as well as the probable presence of an umbilical perforation, in at least some species of the same group.

and to agree so much more nearly with another genus, *Pyropsis*, proposed by him, that, if left to form a conclusion from the published figures and descriptions alone, I should have been more inclined to refer these Indian shells to the latter genus, than to the genus *Pyrifusus*. At any rate, they seem to differ from Mr. Conrad's figure of the typical species of *Pyrifusus*, and to agree much more nearly with that of *Pyropsis*, not only in form, but in having the inner lip raised so as to form a more or less prominent fold or ridge nearly opposite the base of the aperture, while they both show a kind of posterior notch at the top of the aperture, more nearly corresponding to the figure of the type of *Pyropsis* than to that of *Pyrifusus*. Again, the Indian shells have an umbilicated or perforated axis, with an obliquely-ascending, spiral, umbilical ridge, or fasciole; while, in the type of *Pyrifusus* as figured, nothing of this kind is seen. I am fully aware, however, that the presence or absence of an umbilicus, or perforation of the axis, cannot always be relied upon as a generic, or sometimes even as a specific, character. Yet it is certainly the case that in some groups this character never occurs, while in others it nearly always exists; and in genera having the general aspect of those under consideration, with the perforation of the axis usually present, but sometimes wanting, we almost always see, in the latter cases, the umbilical ridge still remaining.

It therefore certainly seems to me, that, if the Indian species mentioned belong to *Pyrifusus*, the shells here referred to that genus under the subgeneric name *Neptunella*, should be viewed rather as forming a distinct genus than a subgenus under that group.

In general appearance, some of the species of the group *Neptunella* resemble certain recent forms, such as *Fusus? dilatatus*, Quoy and Gaimard, referred by H. and A. Adams to the genus *Neptunea*, Bolten. Yet they differ from the recent typical forms of the latter genus, such as *Fusus antiquus*, Lamarck, in being thicker shells, with more angular volutions, and in wanting a papillary apex, as well as in having a solid axis, a straight canal, and no umbilical ridge.

The classification of all such forms was, until recently, "made easy" by referring them indiscriminately to that common receptacle of all sorts of fusiform shells—the genus *Fusus*. They certainly, however, seem to differ from that genus as typified by such forms as *Fusus colus*.

So far as yet known, the genus *Pyrifusus*, as here understood, appears to be mainly, if not entirely, confined to the Cretaceous rocks.

Pyrifusus (Neptunella) Newberryi, M. & H.

Plate 31, figs. 6, *a*, *b*, *c*, *d*, *e*, *f*.

Fusus Newberryi, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 66.
Fusus (*Pyrifusus*?) *Newberryi*, Meek and Hayden (1860), *ib.*, XII, 421.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22.

Fig. 39.

Pyrifusus (*Neptunella*) *Newberryi.*

A dorsal view, to show the curves of the lines of growth, indicating a broad sinuosity of the upper part of the outer lip, not well shown in the figures on plate 31.

Shell rhombic-subfusiform, rather thick; spire conical, acute at the apex when not eroded; volutions five, obliquely flattened or a little concave above and convex around the middle, where they are ornamented by a row of more or less prominent, vertically-elongated nodes, or costæ; last turn comparatively large, and tapering rather abruptly into the rather short, straight canal below; surface marked by distinct lines of growth, crossed by numerous well-defined, round, thread-like, revolving lines; suture linear; aperture rhombic-obovate, rather obtusely angular above, and narrowing more gradually below; outer lip beveled; inner lip scarcely distinct from the slightly arcuate columella.

Length, 1.43 inches; breadth, 0.81 inch; length of aperture and canal, 0.87 inch; breadth of aperture, 0 32 inch. Apical angle convex, regular, or even a little concave; divergence variable, but usually about 60° to 65°.

This species varies more or less in form, as well as in the prominence of the node-like costæ. In some individuals, the spire is more elevated and the body-whorl proportionally much narrower than in others. The nodes, or costæ—of which about fifteen may be counted on the last turn—are usually quite distinct on all the whorls, but in some specimens they become obsolete on the last one, as represented in figure 6, *f*. The upper part of all the volutions is generally more or less flattened and steeply sloping; and that part of the body-whorl is often a little concave. The margin of the outer lip is most prominent in outline a little below the middle, and more or less retreating, or broadly sinuous above the most prominent part of the volutions, as shown by the lines of growth in the foregoing wood-cut. On the upper sloping part of the whorls, the revolving lines are in most cases smaller, and about equal to the spaces between; farther down, however, they are generally a little larger, rather more distant, and often have between each two of the principal ones a smaller line.

I know of no described species from other regions nearly enough related to this to render a critical comparison necessary. Mr. Gabb has figured, on pl. 18, fig. 45, vol. I, of the California Palæontology (apparently without any reference to it in the text), a somewhat similar form, belonging, I should think, to the same group, but presenting very obvious specific differences.

Locality and position.—Fox Hills, Moreau Trading Post, and Long Lake, Dakota, in the Fox Hills group; also, on the Yellowstone River, 150 miles above its mouth, in a bed containing a mingling of the fossils usually found in the Fox Hills group with those of the upper part of the Fort Pierre group.

Pyrifusus (Neptunella) subturritus, M. & H. (sp.).

Plate 32, figs. 3, *a*, *b*.

Fusus subturritus, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 139.
Pyrifusus subturritus, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22.

Fig. 40.

Pyrifusus (Neptunella) subturritus.

A dorsal view, to show the curves of the lines of growth, indicating a broad sinuosity of the lip above the middle, not well represented in the figures on the plate.

Shell fusiform, rather thin; spire conical, turreted, apparently two-thirds as long as the aperture and canal, acute at the apex; volutions about seven and a half, obliquely flattened or a little concave above, and convex and subangular around the middle, where they are each ornamented by about twelve very regular, distinct, vertically-elongated nodes or folds, separated by spaces equaling their own breadth; surface marked by fine lines of growth, crossed by distinct, elevated, thread-like, revolving lines, about as wide as the intervening depressions; suture moderately distinct, and, when viewed from above, seen to deviate from a regular curve in following the flexuous outline of the vertical folds; aperture rhombic-obovate, obtusely angular above, most convex on the outside, and tapering into the straight canal below; inner lip not very distinct from the solid, straight columella.

Length, 1.73 inches; breadth, 0.90 inch. Apical angle nearly regular, sometimes a little concave above, and convex below; divergence, 55°.

This shell is related to the last, but differs in having a more elevated spire, which is more acute and attenuate at the summit, while the body-volution is proportionally less expanded in the middle. It likewise differs from that species in having from two to two and a half volutions more,

and its folds or costæ stronger and swelling out into more distinct nodes, while the substance of the shell is rather thinner.

The outer lip and canal of our specimen are imperfect; but the lines of growth show that the margin of the first did not differ materially in its outline from that of the last-described species, though its canal appears to have been rather straighter.

Locality and position.—Grand River; upper part of the Fort Pierre group, or formation No. 4 of the Cretaceous series of the Northwestern Territories.

Pyrifusus (Neptunella) intertextus, M. & H. (sp.).

Plate 19, figs. 14, *a*, *b*.

Fusus intertextus, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 139.
Pyrifusus intertextus, Meek (1864), Smithsonian Check-List N. Am. Cretaceous Fossils, 22.

Shell fusiform, rather thick; spire conical, apparently about two-thirds the length of aperture and canal; volutions about five and a half, concave above, and convex around the middle, where they are each ornamented by thirteen or fourteen regular, short folds, or vertically-elongated nodes, about as broad as the spaces between; body-whorl tapering rather gradually into the canal; suture not very strongly defined; surface marked by distinct lines of growth, crossed by rather strong, elevated, revolving lines, usually a little less than the intervening depressions; aperture narrow-obovate, rather acutely angular above, and narrowing gradually below; inner lip closely anchylosed to the columella, which is slightly arcuate along the middle, and straight, or nearly so, below.

Length, about 1.87 inches; breadth, 0.86 inch. Apical angle convex; divergence, 50°.

This species is somewhat similar to *P. Newberryi*, but may be distinguished by its more elongated form, narrower body-volution, and more elevated spire. Its revolving lines are also stronger, more distant, and differ in showing a slight disposition to form small subnodose prominences at the points where they are crossed by the lines of growth.

From the last, it differs in having about two volutions less, and the upper part of the spire is not near so slender. The nodes, or folds, are also much less prominent, and its revolving lines stronger and more distant, especially near the middle of the whorls. It is also a more solid shell.

The canal of our specimen being imperfect at the extremity, we have no means of determining its comparative length; though the remaining portion shows that it ranges more nearly in a line with the central axis of the spire than that of *P. Newberryi*. The edge of the outer lip is likewise broken away, but the curve of the lines of growth indicates that it was prominent a little below the middle, and broadly retreating or sinuous above and at the base, as in the other species of the subgenus.

Locality and position.—Yellowstone River, 150 miles above its mouth; from a bed composed of a blending of the Fort Pierre and Fox Hills groups, or formations Nos. 4 and 5 of the Upper Missouri Cretaceous series.

BUCCINIDÆ.

?Genus PSEUDOBUCCINUM, M. & H.

Synon.—*Buccinum*, and *Bullia*? (sp.) of some, but not as properly understood.
Pseudobuccinum, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 67.—Meek (1867), Smithsonian Check-List N. Am. Cret. Fossils, 22.—Stoliczka (1868), Palæont. Indica, II, 142.

Etym.—ψεῦδος, false; *Buccinum*.*
Type.—*Buccinum*? *Nebrascense*, Meek and Hayden.

Shell oval, thin, ventricose; spire very short; body-volution large, not produced below; aperture large, terminating below in a rounded sinus; outer lip thin and simple; inner lip very thin, smooth, and closely and rather broadly folded upon the imperforate umbilical region and body-volution above, so as to form, with a low revolving umbilical ridge, a kind of profoundly arcuate, strongly-spiral, false columella; surface with more or less distinct revolving lines and furrows.

One of the most marked features of this type is its entire want of a proper columella, which is merely represented by the very strongly spirally-ascending, inner folded edge of the thin, inner lip, as in *Bulla*. It has, however, a low, spiral umbilical ridge, passing around up under the inner lip, and terminating below at the sinus at the base of the aperture. This absence of a columella, the deeply arcuate and spiral character of its thin inner lip, and the thinness and general form of the shell, at once distinguish this genus from *Buccinum*, as now generally restricted. It much more nearly resembles, in form and some other characters, *Sulcobuccinum*, d'Orbigny, apparently synonymous with *Pseudoliva*, Swainson; but its much thinner shell, want of a

* Hybrid names like this are objectionable; but custom seems to have sanctioned their use.

proper columella, and the characteristic external sulcus, as well as the callous inner lip of that genus, readily distinguish it.

Our type-species came from the Upper Cretaceous; but I am unacquainted with any other species from that or any older formation, or even from the Tertiary rocks. A single existing species, however, so nearly resembles our type, that I am rather inclined to believe it congeneric. This is a shell described by Middendorff, from the Great Schantar Isle, under the name *Bullia ampullacea* (see Sibirische Reise, tab. xvii, figs. 1–3). Through the kindness of Dr. Stimpson, I once had an opportunity to examine a specimen of Middendorff's species. It has a much less arcuate and tortuous inner lip (columella?) than our shell, and is not nearly so strongly striated; but in other respects it presents many points of resemblance. It has a thin epidermis, with numerous short hair-like filaments along the lines of growth. Its operculum is very small, or merely rudimentary, with its nucleus terminal, instead of submarginal and lateral, as in *Buccinum*. Its tentacles are short and the eyes at their outer bases; and its foot is ovate and broadest in front, where it is double-edged. Dr. Stimpson ascertained that its lingual dentition is as in *Buccinum*.

Whether Middendorff's shell ought to be admitted into our genus or not, there may be different opinions; but I think no one will now maintain that it belongs to the genus *Bullia*.

Pseudobuccinum Nebrascense, M. & H.

Plate 31, figs. 5, *a*, *b*, *c*, *d*.

Buccinum? Nebrascense, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 67.
Pseudobuccinum Nebrascense, Meek and Hayden (1857), *ib.*, IX, 140.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22.

Shell rhombic-oval; spire rising little above the body-volution; whorls three and a half, convex, rapidly increasing in size, last one forming nine-tenths of the entire bulk, evenly rounded; suture slightly channeled; surface showing rather distinct lines of growth, with the little revolving, impressed lines separated by spaces of nearly the same breadth on the lower half of the body-volution, but more distant above, where they are less strongly marked; aperture rhombic-oval, about four-fifths the length of the entire shell, widest at the middle, angular above, and a little truncated at the sinus below; outline of the thin outer lip slightly convex along its entire length; reflexed inner lip widest where it is thinly appressed upon the tortuous, deeply arcuate,

umbilical region, but not covering the low, strongly spiral, umbilical ridge, in crossing which the lines of growth make a backward curve parallel to the outline of the sinus at its lower termination at the base of the aperture.

Length, 0.77 inch; breadth, 0.58 inch; length of aperture, 0.61 inch; breadth of same, 0.36 inch; spire with convex slopes, which diverge at an angle of about 105°.

I know no other recent or fossil shell so nearly like this as *Bullia ampullacea* of Middendorff, already mentioned in connection with the generic description; and that differs too decidedly in its specific characters to require critical comparison.

Locality and position.—Moreau River; from the Fox Hills group of the Upper Missouri Cretaceous series.

?Genus ODONTOBASIS, Meek.

Synon.—*Fusus* and *Buccinum* (sp.), Hall and Meek; but not as properly understood.

Etym.—ὀδούς, a tooth; βάσις, a base.

Type.—*Fusus constrictus*, Hall and Meek.*

Shell buccinoid-fusiform; spire more or less produced; body-volution ventricose, and separated below from the short, narrow beak, by a sharply-defined, narrow, revolving sulcus, that terminates below at the connection of the outer lip with the canal, in a small tooth-like projection; outer lip thin, smooth within, and nearly straight in outline; inner lip not thickened, but well-defined; columella a little twisted, slightly flattened, and bearing two oblique plaits below, the lower one of which is formed by the raised lower edge of the obliquely truncated columella, and the other, which is very obscure, or perhaps sometimes obsolete, placed a little above the same; surface ornamented by vertical folds and revolving lines and furrows.

The type of this genus is a small buccinoid, or short subfusiform shell, nearly resembling *Admete* in form and surface-characters, but differing in having the lower part of its aperture abruptly contracted into a little short, oblique canal, rather than a mere notch. A still more important difference is also to be seen in the peculiar, distinctly-defined, narrow sulcus, starting at the connection of the outer lip with the little canal below, and passing around obliquely upward so as to go under the inner lip nearly opposite the

* In order to prevent the possibility of any uncertainty in regard to the type of this genus, I would state that *Fusus constrictus*, Hall and Meek, is cited as such, because it is believed to be the same as the species hereinafter described under that name. Should the latter prove distinct, however, *it* must be considered the type, as the characters on which the genus was founded were observed in this shell, which has not been directly compared with the typical specimen of *Fusus constrictus*.

middle of the aperture. I have not seen any examples with the edge of the outer lip entire; but it is evident, from the curves of the lines of growth, as seen by the aid of a magnifier, crossing the revolving sulcus mentioned above, that there is, in entire specimens, a small, pointed, tooth-like process at the lower termination of the sulcus, somewhat similar to that of the genera *Chorus*, *Acanthina*, *Pseudoliva*, and some other types. It differs, however, from all of these in having the tooth situated directly at the lower angle of the outer lip, instead of above it, and in the presence of plaits on the columella, as well as in other obvious characters, such as the smooth surface, thickened inner lip, and wider notch below, of *Pseudoliva;* the different nature of the canal, surface-characters, &c., of *Chorus;* the position of the tooth within the margin of the lip, and the crenate character of the same in *Acanthina*, &c.

In form, ornamentation, and the plaits on the columella, this type also very nearly resembles some little shells described by me, from the Cretaceous rocks at Coalville, Utah, in Dr. Hayden's Sixth Annual Report of the United States Geological Survey of the Territories, under the names *Admete? rhomboides*, *A.? gregaria*, and *A.? subfusiformis*. These were only referred to *Admete* with great doubt, however, and the provisional name *Admetopsis* was suggested for them, in case good characters should be found for the establishment of a distinct group for their reception. Notwithstanding the close general resemblance of these shells, however, to the type of the genus here proposed, no traces of the revolving sulcus and little tooth at its termination, which form the most marked characters of the latter, are to be seen in any of them; and consequently they could not be properly placed in the same genus.

So far as known, this would seem to be an exclusively Cretaceous group.

Odontobasis constricta, H. & M. (sp.).

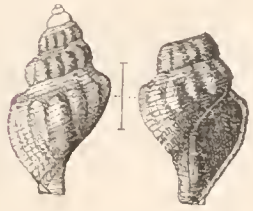
Fusus constrictus, Hall and Meek (1856), Mem. Am. Acad. Arts and Sci., V, 391, pl. iii, figs. 7, *a*, *b*, *c*, *d* (removed to *Buccinum*, *ib.*, 411).

Buccinum? constrictum, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 283.—Meek (1864), Check-List N. Am. Cret. Fossils, 22.

Shell subfusiform, with spire equaling about two-thirds the length of the aperture and canal; volutions four or five, convex, and each ornamented with about eleven comparatively strong, rounded, vertical folds, equaling the depressions between; last turn moderately convex around the middle, somewhat constricted above, and tapering into the beak below; suture linear, and

rather impressed; aperture narrow-suboval, a little oblique, obtusely angular above, and tapering below; columella typical, meeting the body-volution above, at the upper termination of the revolving sulcus, at a very obtuse, undefined angle; entire surface marked by moderately distinct, irregular lines of growth, crossed by numerous little flattened revolving, bands, or lines, wider than the furrows between, excepting on the upper constricted part of the body-volution, where they are smaller and about equal the furrows.

Fig. 41. Fig. 42.



Odontobasis constricta.

Fig. 41. A dorsal view, magnified 2½ diameters.

Fig. 42. An opposite view of same, showing aperture, &c.

Length, 0.38 inch; breadth, 0.22 inch; slopes of spire slightly convex, and diverging at an angle of about 54°.

The constriction around the upper side of the body-volution is moderately well marked, particularly near the aperture; and as the vertical folds are most prominent around the outer edge of this constricted part, and show a little tendency to terminate there, they give the body-turn a slightly shouldered appearance. Of the smaller revolving lines on the upper constricted part, there are three or four, the upper one of which is only very faintly separated from a little wider, somewhat thickened, space above, that gives a slightly banded appearance to the suture.

I am not positively sure that this shell is specifically identical, in all respects, with the type of *F. constrictus*, Hall and Meek. In the constricted and almost shouldered appearance of the upper part of its body-volution, as well as in the less straightened outline of its columella, and the consequent slightly different form of its aperture, it would seem to present well-marked differences. The fact, however, that the type of *F. constrictus* is much smaller than our specimen (being only about 0.20 inch in length, and almost certainly a young example), while the constriction mentioned seems to be only well defined on the body-volution of our shell, renders it very probable that the small size and the imperfect condition of the type of *F. constrictus* prevented the exact outline and the obscure plaits of its columella from being seen.* Consequently, as it agrees very closely in form and proportions, as well as in surface-ornamentation, and the peculiar revolving sulcus at the connection of the beak with the swell of the body-volution, I can scarcely doubt its identity. Should a direct comparison, however, show these shells to belong to distinct

* These little plaits were also overlooked by the engraver in cutting the above figure showing the aperture.

species, I would propose for that here under consideration the name *Odontobasis humerosa*, and in that case this latter form, as already explained, would become the type of the genus, as the generic characters were taken from it.

Locality and position.—Deer Creek, on the north branch of Platte River; from the Fox Hills group of the Upper Missouri Cretaceous series. The original type-specimen of *Fusus constrictus* was found at near the same horizon, on Sage Creek, Dakota.

Odontobasis ventriosa, Meek.

Plate 19, figs. 1, *a*, *b*, *c*.

Fig. 43.

Odontobasis ventriosa.

A dorsal view, enlarged to show the tooth-like projection at the base of the outer lip.

Shell subfusiform, with spire about equaling four-fifths the length of the aperture and canal; volutions six and a half, evenly convex, each provided with sixteen to eighteen little vertical folds, that become less distinct and more irregular on the body-turn, which is ventricose, and contracts abruptly to the beak below; suture linear and rather distinctly impressed; aperture rhombic-obovate, being angular above, more convex on the outer than the inner side, and tapering abruptly into the little, short, oblique canal below; columella and revolving sulcus typical; entire surface ornamented by moderately distinct lines of growth, crossed by little, flattened, revolving, band-like lines, wider than the linear furrows between, one of the former of which is a little larger than the others at the upper edge of the volutions, so as to give the suture a slightly banded appearance.

Length, 0.46 inch; breadth, 0.26 inch; slopes of the spire straight, with a divergence of about 46°.

This species will be readily distinguished from the last, by its more evenly rounded volutions, particularly the last one, which is almost entirely without the constricted and obscurely-shouldered appearance of that shell. Its vertical folds are also smaller and more numerous on all of the volutions, and become less distinctly defined and more irregular on the last one. The revolving bands, or flattened lines, are also proportionally a little wider. Again, it differs in the form of the aperture, which is proportionally wider, being more convex on the outer side. I know of no other shell with which it need be compared.

Locality and position.—Cherry Creek, near the mouth of Sage Creek, Dakota; from the upper part of the Fort Pierre group.

FASCIOLARIIDÆ.

Genus FASCIOLARIA, Lamarck.

Synon.—Fasciolaria, Lamarck (1799), Prodr., 73; and (1801) Syst. An., 83; again (1809) Phil. Zoöl., * * ; also (1822) Hist., VII, 117.—Roissy (1805), Moll., VI. 76.—Montfort (1810), Conch. Syst., II, 490.—Schum. (1817), Essai, 243.—Schweigg. (1820), Natgsch., 725 (as a subgenus under *Fusus*).—Deshayes (1830), Encyc. Méth., III, 114; and (1866) An. sans Vert. Bassin de Paris, III, 294.—Blainv. (1825), Malac., 397.—Valenc. (1833), Humb. Voy. Zoöl., II, 284.—D'Orbigny (1841), Moll. Cub., I, 200.—Gray (1847), Proc. Zoöl. Soc., 137.—H. and A. Adams (1853), Genera Recent Moll., I, 150.—Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 66.—Chenu (1859), Man. Conch., I, 180.—Gabb (1864), Palæont. California, I, 100; and (1869) *ib.*, II, 220.—Stoliczka (1868), Palæont. Indica, II, 106.—Tryon (1873), Am. Mar. Conch., 20.

Pyrula, Perry (1811), Conch., * * (not Lamarck, 1799, nor Linck, 1807).

Iocrania, Raf. (1815), Anal. Nat., 145.

Terebrispira, Conrad (1862), Proceed. Acad. Nat. Sci. Philad., XIV, 28 (as a subgenus).

Pustochilus, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22 (proposed as a subgenus under *Clavellithes*).

Etym.—Fasciola, a little band.
Type.—Murex tulipa, Linnæus.

Shell fusiform, rather thin; spire acuminate, generally papillate at the apex, usually somewhat less than the length of the aperture and canal, but sometimes equaling or exceeding the same; volutions evenly convex, more or less angular, nodular, or provided with large folds, or costæ, rarely compressed or flattened, last one tapering below into the more or less produced, generally straight canal; outer lip thin on the edge, and transversely striated, crenate or rarely smooth within; columella imperforate, somewhat twisted, and provided with a few oblique, generally anteriorly-located, plaits, or folds; surface spirally lined or ridged, or sometimes nearly smooth.

The foregoing diagnosis is worded so as to include, along with the typical forms, three apparently extinct groups, that may be generically distinct, but still seem to be so related to each other and to the typical group, as hardly to be separable more than subgenerically. These sections, or subgenera, may be distinguished as stated below:

1. FASCIOLARIA, Lamarck (typical).

Shells generally varying from medium to very large sizes, with spire and canal produced; volutions evenly convex, nodular, angular, or provided with vertical folds; plaits exposed at the lower inner margin of the columella, in a direct view into the aperture; outer lip striate or crenate within.—(Type as already stated.)

2. TEREBRISPIRA, Conrad.*

Shells of medium size, with spire much produced and canal short; volutions convex, angular, and strongly spirally ridged; plaits of columella not exposed externally; outer lip internally sulcated.—(*F. elegans*, Emmons.)

3. PIESTOCHILUS, Meek.

Shells of small size, with spire and canal produced; volutions flattened or moderately convex and finely spirally striated, sometimes with vertical folds; plait or plaits of columella not exposed in a direct view into the aperture, very oblique, and occupying a higher position than in either of the foregoing; outer lip smooth within.—(*Fusus Scarboroughi*, Meek and Hayden.)

4. MESORHYTIS, Meek.

Shell agreeing nearly with the last in form, but with plaits of columella stronger, comparatively little oblique, and exposed directly opposite the middle of the aperture; surface with fine spiral striæ, and vertical costæ.—(*Fasciolaria* (*Mesorhytis*) *gracilentis*, Meek.)

5. CRYPTORHYTIS, Meek.

Shells generally under medium size, with volutions convex, but constricted above, and provided with regular vertical costæ or small folds; plaits of columella very oblique, not exposed in a direct view into the aperture, and occupying a higher position than in the typical group; outer lip smooth within.—(*Rostellaria fusiformis*, Hall and Meek; not d'Orbigny.)

The type of the group *Piestochilus* was originally referred provisionally to the genus *Fusus*, when only imperfect specimens, merely showing its form and surface-markings, were known. Subsequently, on examining others, I was led to the conclusion that it could not be a true *Fusus*, and thought, from its general appearance, that it was at least more probably related to *Clavellithes* of Swainson. In removing it doubtfully, however, to the latter genus, I was strongly impressed with the belief that it would at least form the type

* At the same time that Mr. Conrad described the subgenus *Terebrispira*, he proposed another subgenus, *Lirosoma*, founded on his *Fusus sulcosus*, from the Miocene, a pyriform shell, with a much-depressed spire, a ventricose body-volution, a narrow, straight, rather produced canal, and a single long, very oblique, plait, exposed at the usual position on the columella. It also has the internally-striated outer lip of *Fasciolaria*; but it differs so widely in form from that genus that I have hardly felt warranted in including it as a subgenus under the same. Mr. Conrad has since described another species, in which the plait on the columella is obsolete.

of a distinct subgenus, for which I proposed the name *Piestochilus*, in allusion to the closely-appressed character of its outer lip above, as compared with that of *Clavellithes*. At a still later date, in examining other specimens, one of which was accidentally split longitudinally, the discovery was quite unexpectedly made, that it has one or two small, but distinct, revolving plaits, ascending all the way up the columella; though these are not seen at the aperture, especially when the latter is even partly filled with foreign matter; while, if continued around, so as to be seen at the inner side of the columella, they would appear at a higher position than in the typical forms of *Fasciolaria*. This discovery led to the more critical examination of the other Upper Missouri Cretaceous shells most nearly agreeing in form and general appearance with the genus *Fusus*, when it was found that these, too, possess one or more plaits on the columella not appearing at the aperture, but readily found by breaking open specimens. Consequently, it becomes evident that probably none of our known Upper Missouri Cretaceous fusiform shells can be properly retained in the genus *Fusus* or *Clavellithes*, but that nearly all of them naturally arrange themselves near, if not within, the genus *Fasciolaria;* thus confirming, as far as the evidence goes, an opinion expressed by the writer in 1864, in the Smithsonian Check-List of North American Cretaceous Fossils, that probably none of the species there provisionally retained in the genus *Fusus* really belong to that group.

A few species from older rocks have been referred to the genus *Fasciolaria;* but we have good reasons for believing that this group, even as here defined, was not introduced previous to the deposition of the later members of the Cretaceous system. The number of species, especially of typical *Fasciolaria*, was even then quite limited; but the species of the *Piestochilus* and *Cryptorhytis* were more numerous. Indeed, it is highly probable that a considerable portion of the Cretaceous shells that have been referred by various authors to the genus *Fusus*, as well as some of those referred to *Fasciolaria*, will be found to present the characters of one or the other of the latter groups. I am not sure that either of these two latter sections occur in the Tertiary rocks; but the typical section of *Fasciolaria* ranges through the Tertiary, and probably attains its maximum development in our existing seas, where some of the species grow to great sizes.

The section *Terebrispira* was founded on a Miocene species, and will

probably include other Tertiary forms; but I am not aware of its existence in the Cretaceous rocks, or among living species.

The section *Mesorhytis* occurs in the Cretaceous, and, apparently, also in the Tertiary. I am not sure that it ought to be included, even as a distinct subgenus, under *Fasciolaria*.

Fasciolaria buccinoides, M. & H.

Plate 31, figs. 8, *a*, *b*, *c*, *d*.

Fasciolaria buccinoides, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 67.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 21.

Shell small, rather short-fusiform; spire moderately elevated, composed of five to five and a half convex volutions; last turn somewhat gibbous, forming more than half the entire length, and contracting rather abruptly below into the rather short canal: suture distinct or slightly channeled; surface ornamented by fine, regular lines of growth, with sometimes small, obscure, vertical folds, which are crossed by rounded, little revolving bands or raised lines, equal to, or slightly broader than, the depressions between; on these bands, as well as in the intervening depressions, faint traces of very fine revolving striæ may sometimes be seen by the aid of a lens; aperture narrow-oval, angular above, and tapering below; outer lip thin, but apparently thickened and crenulate within, at intervals of about three or four times to each turn of the spire; columella a little twisted, and provided with two well-defined, oblique plaits, that are so far around as not to be clearly seen when the aperture is filled with rocky material that cannot be removed.

Length, 1 18 inches; breadth, 0.58 inch. Apical angle convex; divergence, 54° to 57°.

The vertical folds are never very distinct, and in many cases they are almost entirely obsolete. Sometimes they exist on the spire, but generally they are only developed on the upper part of the last turn, where they occasionally present the appearance of being slightly nodose, in consequence of the prominence of the revolving bands. These bands, of which about seven or eight may be counted on the first turn above the body-whorl, are usually very distinct and regular on all parts of the shell; in a few instances, however, they are rendered irregular, or alternately larger and smaller, especially on the lower part of the body-volution, by the development of a smaller one in each of the grooves between. Although the plaits on the columella are

small, and not always readily seen, as specimens are usually found with the aperture filled with rock, it seems to be a true *Fasciolaria*.

This species resembles in its external characters *Buccinum? vinculum*, Hall and Meek (Mem. Am. Acad. Arts and Sci. Boston, VIII (n. s.), pl. 3, fig. 3), which we now know to be even generically distinct. It may always be distinguished from that shell, even where the columella cannot be seen, by its less elongate form, shorter spire, and comparatively broader, as well as more closely-arranged, revolving lines or bands. Its vertical folds are also much less distinct on the upper whorls than on those of *B.? vinculum*.

Locality and position.—Moreau River and Long Lake; from the Fox Hills group, or formation No. 5 of the Upper Missouri Cretaceous series.

Subgenus **PIESTOCHILUS**, Meek.

Fasciolaria (Piestochilus) Scarboroughi, M. & H.

Plate 32, figs. 4, *a, b, c, d.*

Fusus Scarboroughi, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 139.
Clavellithes (Piestochilus) Scarboroughi, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22.

Shell rather elongate-fusiform; spire moderately prominent, pointed at the apex, with lateral slopes convex in outline; volutions about six and a half, flattened to the line of the lateral slopes of the spire: last one composing, with the canal, a little more than half the entire length of the shell, sometimes slightly concave above, moderately convex around the middle, and tapering rather gradually into the canal below, which is narrow, nearly straight, and of moderate length; suture linear; aperture rhombic-obovate, being angular above, and tapering gradually below; columella but slightly arched along the middle of the aperture; most prominent part of the thin outer lip below the middle; surface marked by fine, regular lines of growth, which are crossed by numerous, rather distinct, revolving lines, more or less flattened on their tops, and about equaling the breadth of the grooves between.

Length, 1.42 inches; breadth, 0.67 inch; divergence of slopes of the spire, 40°.

The revolving lines of this shell are but slightly elevated, and when a little worn, especially on the body-volution, seem to be somewhat rounded; but those on the spire have generally a more flattened appearance. About fourteen of them may usually be counted on each turn of the spire.

Generally, a few of these lines just below the suture are smaller and more crowded than the others.

I know of no shell very nearly allied to this. As already stated in connection with the generic description, it has much the general aspect of *Clavella Vicksburgensis* of Conrad, but it presents well-marked and obvious specific differences; while we have not the means of determining whether or not that shell possesses the same generic characters as this.

The specific name of this interesting shell was given in honor of my friend George Scarborough, esq. (at that time a resident of Kentucky, but now residing at Vineland, N. J.), who has been a devoted cultivator of geology and other natural sciences for nearly thirty years past.

Locality and position.—Butte au Grès, on the Missouri River; in the Fox Hills group of the Upper Missouri Cretaceous series.

Fasciolaria (Piestochilus) Culbertsoni, M. & H.

Plate 32, figs. 1, *a, b, c, d, e, f.*

Fusus Culbertsoni, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 66.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22.
Fusus Haydeni, Evans and Shumard (1857), Trans. St. Louis Acad. Sci., I, 41.

Fig. 44.

Fasciolaria (Piestochilus) Culbertsoni.

A broken specimen, showing plaits of columella.

Shell elongate-fusiform; spire produced to nearly the length of the aperture and canal, acute at the apex; volutions seven and a half, moderately convex, increasing gradually in size; those of the spire generally each provided with seven to nine obscure, or moderately distinct, vertical folds, that are usually wanting on the last and penultimate volutions; last or body volution not ventricose around the middle, and tapering into the canal, which is narrow, nearly straight, and rather long; aperture narrow, lance-ovate in form, being acutely angular above, and tapering gradually below; columella nearly straight, but slightly twisted, and appearing as if entirely destitute of plaits at the aperture, but provided with from one to four farther up; suture distinct; surface marked by fine lines of growth, which are crossed by numerous, small, revolving lines, generally about equaling the linear furrows between.

Length about 2.22 inches; breadth, 0.67 inch; divergence of the apical angle, 26° to 30°.

The revolving lines, of which about thirteen to eighteen may be counted on the second whorl, are, when not worn, a little flattened on top, and rather regular in size, excepting just below the suture, where they are generally smaller and more crowded. Sometimes, a smaller line is developed in each of the depressions between the others on the middle and lower part of the last whorl.

At the time we first described this species, and for some time after, it was supposed to be quite distinct from the form subsequently described by Dr. Evans and Dr. Shumard under the name of *Fusus Haydeni*; the latter variety being almost entirely destitute of vertical folds, while that first described by us has them quite strongly developed, not only on the upper turns of the spire, but, in a less degree, even on the body-whorl. It also has a slightly less elevated spire than the variety described by Dr. Evans and Dr. Shumard, being a younger shell.

Later comparisons of an extensive series of specimens from the same locality and position, have led to the conclusion that no specific distinction can be based on these differences, since the one variety passes by imperceptible gradations into the other. In some cases, the volutions seem to be entirely without folds; while in other specimens, apparently differing in no other respect, they are obscurely developed near the summit of the spire, as shown in figures 1, *d*, *e*. Still others have them well developed on nearly all the volutions, as seen in our figure 1, *a*, representing the variety first described by us. Generally, however, these vertical folds are entirely wanting on the last and penultimate whorls. The angle of the spire is also generally from one to three or four degrees greater in young than in adult shells. Again, the plaits on the columella seem to vary in number and distinctness. In one large specimen, like that represented by our figure 1, *d*, *e*, by looking far around the columella in the aperture, a single, very obscure, oblique plait, can be seen a little below the middle of the aperture; while, where the spire of the same specimen is broken off at the top of the third volution, the same plait can be seen on the columella, with traces of another above it. Other broken specimens show from three to four of these linear plaits at about the same position.

As our figures of this species on plate 32 were all drawn, and the plate arranged and engraved before the plaits on the columella had been discovered, none of the broken specimens in a condition to show this character were

originally drawn; but the foregoing cut has been made for that purpose. The plait can never be seen in specimens with the aperture partly full of rock, as shown in our figure 1, *e*.

Specimens of this species with the vertical folds most distinctly developed more nearly resemble the Tertiary *Fusus Noæ*, Lamarck, than any other form that I can at present recall to mind among foreign figured shells; but that form is not so nearly related as to require close comparisons, especially as it came from such a widely distinct horizon.

The more elongated spire, more convex volutions, and vertical folds will at once distinguish this from the last.

Locality and position.—Moreau River; from the Fox Hills group of the Upper Missouri Cretaceous series. It is one of the most abundant of our Upper Missouri Cretaceous gasteropods.

Fasciolaria (Piestochilus)? Galpiniana, M. & H. (sp.)

Plate 32, figs. 2, *a*, *b*.

Fusus Galpinianus, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 65.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22.

Shell unequally fusiform; spire rather elevated, or apparently slightly exceeding the length of the aperture and canal; suture distinct; volutions about six, slightly convex, upper ones with apparently obscure traces of vertical folds; last or body volution contracting rather abruptly into the comparatively short, somewhat bent, canal; aperture a little obliquely lance-oval, being acutely angular above, and tapering into the narrow canal below; columella a little twisted and bent below, not showing any plaits externally; surface marked by regular, revolving, somewhat flattened, lines, a little wider than the linear furrows between them, and more or less strong lines of growth, that show by their curves that the outer lip is broadly sinuous above.

Length, about 0.88 inch; breadth, 0.34 inch; apical angle of spire, 32°.

This shell is very similar to the last, but differs in having its canal rather decidedly shorter, more bent, and more tortuous; while the revolving lines on its body-volution are proportionally a little wider. I have had no means of deciding the question whether or not it has the columellar plaits of this group, having only seen two specimens, and these not being in a condition to show the columella, excepting at the aperture. From its close similarity to the last-described species in all known specific characters, I can scarcely

have a doubt that it belongs to the same group. Indeed, I have even sometimes supposed that it might possibly be only a variety of the same; though this seems scarcely possible, as may be seen by comparing figure 2, *b*, of the type-specimen, with figure 1, *d*, of the last species.

Locality and position.—Same as last.

Fasciolaria (Piestochilus) cretacea, M. & H.

Plate 31, figs. 11, *a*, *b*.

Fasciolaria cretacea, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 66.—Meek (1864), Smithsonian Check-List N. Am. Cretaceous Fossils, 21.

Shell small, elongate-fusiform; spire produced-conical, or about equaling the length of the aperture and canal; volutions five or six, moderately convex, last one not ventricose, rounding to the suture above, and rather distinctly narrowing below into the slender, somewhat flexuous, rather produced, and twisted canal: suture distinct; aperture very narrow, angular above, and tapering into the canal below; columella somewhat twisted, and bearing four or five small or linear, moderately oblique, plaits, nearly opposite the middle of the aperture, that do not show externally in a direct view into the aperture of unbroken specimens;* surface polished, and marked by fine, obscure lines of growth, crossed by slender, impressed, revolving lines, leaving wider, slightly raised, little, revolving bands between.

Length, 0.50 inch; breadth, 0.16 inch; angle of spire, with nearly straight slopes, diverging at an angle of about 32°.

This is a delicate, slender, little shell, much resembling a *Fusus* in form and general appearance, more particularly when the outer lip is so entire, or the aperture so filled with foreign matter, as to prevent one from examining the columella around within the aperture; the plaits of the latter not appearing in a direct view into the aperture. At a first glance, it might be mistaken for a young of *F. Culbertsoni;* but, on closer examination, its columella will be seen to be more tortuous, and the revolving surface-markings different; that is, instead of having the little revolving furrows nearly or quite as wide as the raised lines between, it has these furrows merely like impressed hair-lines, with flattened, little, band-like spaces between, of decidedly greater breadth than the impressed lines themselves. On the upper part of the

* These plaits are not represented oblique enough in our figure 11, *b*. This specimen has the outer lip broken away for nearly one-half of the distance around the last turn, thus exposing the columella farther around within the aperture than if entire.

volutions, just below the suture, the revolving impressed lines are more closely arranged, and the spaces between, of course, proportionally narrower, or merely linear. There seem to be no indications of vertical folds, or costæ, on any of the volutions; though no specimens have yet been seen with the surface well preserved on the upper part of the spire.

This little shell was originally referred doubtfully to the genus *Fasciolaria;* but its very small size, and the higher position of the plaits on its columella, as well as its apparent want of crenulations on the inner side of its outer lip, all seem to indicate much nearer relations to the other shells here grouped under the name *Piestochilus,* the most important distinguishing characters of which were then unknown. It seems to be quite rare.

Locality and position.—Moreau River; from the Fox Hills group of the Upper Missouri Cretaceous series.

? Subgenus **MESORHYTIS.**

Fasciolaria? (Mesorhytis) gracilenta, Meek.

Fig. 45.

Fasciolaria? (Mesorhytis) gracilenta.

Shell rather elongate-fusiform; spire produced, conical, nearly equaling the length of the aperture and canal; volutions six or seven, slightly convex, each ornamented by about twenty small, nearly straight, vertical folds, or costæ, that become less distinct, or almost obsolete, toward the aperture on the body-volution, which is narrow, and tapers gradually below into the slender, produced, nearly straight canal; columella very slightly arcuate above, and almost straight and scarcely at all twisted below, bearing, opposite the middle of the aperture, three rather strong, moderately oblique plaits, that scarcely come to view when the aperture is even partly filled with foreign matter; aperture narrow, or lance-oval, being angular above, slightly more convex on the outer than the inner side, and tapering gradually into the canal below; surface ornamented by fine lines of growth, that do not curve more than sufficient to indicate a very slight sinuosity in the outline of the outer lip above, and are crossed by numerous fine, irregular, revolving striæ.

Length, about 1.25 inches; breadth, 0.35 inch; slopes of spire nearly straight, with a divergence of about 32°.

The specimens of this shell in our collections were discovered in break-

ing open some masses of rock since the plates were engraved, and are consequently only illustrated here by the annexed wood-cut. It will be readily distinguished from all of the foregoing species by the three stronger, less oblique plaits of its columella, as well as by its smaller, more numerous, and straighter vertical costæ. In general form, the direction and position of the plaits of its columella, and in its vertical costæ, it more nearly approaches *Fasciolaria assimilis*, Stoliczka (Palæont. Indica, II, pl. x, fig. 7), but still it differs, not only in its smaller size, but also in having less convex volutions, a narrower and straighter canal, and a differently-formed aperture. It seems to be also allied to *Mitra cancellata*, Sowerby, as illustrated by d'Orbigny on plate 221 of the Paléont. France, II, Terr. Crét., but differs in its volutions, being more compressed above, and its aperture consequently more acutely angular posteriorly; while its vertical costæ are larger and much less numerous, and its revolving striæ much finer. The plaits of its columella also do not extend across the inner lip, as represented in that species.

I am not at all satisfied, as already stated, with the reference of this shell to the genus *Fasciolaria*, owing to the fact that the plaits of its columella are stronger, and much less oblique, and occupy so much higher a position than in *Fasciolaria* proper. I do not believe, however, that such shells can be properly referred to any section of *Mitra* or *Turricula*, as is sometimes done.

Locality and position.—Yellowstone River, 150 miles from its mouth; from beds containing a blending of the fossils of the Fort Pierre and Fox Hills groups of the Upper Missouri Cretaceous series.

? Subgenus CRYPTORHYTIS, Meek.

Fasciolaria? (Cryptorhytis) Cheyennensis, M. & H. (sp.).

Plate 19, figs. 13, *a*, *b*.

Rostellaria fusiformis, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci. Boston, V (new ser.), 393, pl. iii, fig. 10 (not *R. fusiformis*, Pictet and Roux, 1848; or *Fasciolaria fusiformis*, Valenciennes).

Gladius? Cheyennensis, Meek and Hayden (1860), Pr. ceed. Acad. Nat. Sci. Phila., XII, 422.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 20.

Shell fusiform, very thin; spire acutely elevated; volutions about six, convex, increasing gradually in size, last one moderately gibbous around the middle, and contracting rather rapidly into the straight canal below; suture deep, with a kind of constriction or furrow just below it; aperture rhombic-

subovate; surface with the vertical flexuous costæ each terminating at the outer edge of the furrow or constriction below the suture, in a small node; those on the volutions of the spire distinctly defined, rounded, and separated by furrows of the same size, while toward the aperture on the body-volution, they all become less strongly defined; lines of growth fine, but rather distinct, and crossed by fine, closely-arranged, revolving striæ, which, like the lines of growth, become somewhat stronger and less regular on the lower part of the body-volution.

Length, about 2.40 inches; breadth of body-volution, about 1 inch. Spire with nearly straight slopes, diverging at an angle of 57°.

The generic relations of this shell have long been in doubt; though I never felt satisfied with its reference to the genus *Gladius* (= *Rostellaria*). I had frequently very carefully examined its columella by cutting away the rock filling the aperture of the only specimen we have, far enough to show that it seemed entirely destitute of plaits. Noticing, however, some more or less nearly similar foreign species, in which broken specimens had shown the existence of plaits far around the columella within the aperture, I was led to cut away the rock still farther around the columella, and at last discovered that it bears one *very* oblique, linear plait, somewhat below the middle of the aperture. Consequently, it became at once evident that this shell has no near relations to *Rostellaria*, but that, like the foregoing species, it must find a place in or near the genus *Fasciolaria;* though it and the following species present sufficiently marked differences to be placed in a separate subgenus at least.

As the only specimen we have for study is less nearly complete than the original typical one, I have preferred to copy the published figure of the latter, rather than figure an inferior example of the species; but our specimens are well enough preserved to leave no doubt that they are specifically identical.

I know of no described foreign species so near this as to require a critical comparison; though some of those figured by Dr. Stoliczka from the Cretaceous rocks of India, are at least apparently members of the same subgenus.

Locality and position.—The original typical specimen of this species came from Sage Creek, Dakota, near the Bad Lands; from the upper part of the Fort Pierre Group. Others before me came from about the same horizon on the South Fork of Cheyenne River, near the Black Hills.

Fasciolaria? (Cryptorhytis) flexicostata M. & H. (sp.).

Plate 19, fig. 2.

Fusus flexicostatus, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 66.
Pyrifusus? flexicostatus, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22.

Fig. 46.

Fasciolaria? (Cryptorhytis) flexicostata.

A cut to show the single prominent plait at the base of the columella.*

Shell thin, rather short-fusiform; spire moderate, slender above, and acute at the apex, consisting of six and a half to seven convex volutions; last or body volution somewhat ventricose, slightly shouldered above, and abruptly contracting to the canal below; suture distinct; flexuous vertical costæ well defined on all the volutions, excepting perhaps some of those near the apex of the spire, and near the aperture on the last one, each terminating at the slightly-defined shoulder above, in a small node; space between these nodes and the suture narrow and concave; entire surface finely cancellated by small vertical and revolving striæ, the latter of which become somewhat stronger, more irregular, and more oblique on the lower part of the body-volution; aperture obovate; outer lip broadly and rather deeply sinuous above the middle, and prominent below.

Length, exclusive of the canal, 1.13 inches; breadth of body-volution (with lip broken), 0.64 inch; length of aperture exclusive of the canal, 0.50 inch; breadth of same, 0.29 inch. Angle of spire with slightly concave, or nearly straight slopes, and a divergence of 46°.

Like the last, this has long been viewed as a shell of doubtful relations. On recently breaking one of the specimens, however, I made the interesting discovery that it has one very prominent, oblique, sharply-elevated plait on the columella, a little above the position of those of the typical forms of *Fasciolaria;* though it is not, as in the latter, continued around far enough to be seen in unbroken specimens. As it agrees exactly with the last in surface-markings, and the smoothness of its outer lip within, it evidently falls into the same section, and, indeed, is even closely allied specifically. It differs, however, in having a less elevated and more slender spire, a more ventricose body-volution, and particularly in having the plait of its columella lower on the columella, as well as more prominent and less oblique.

Among foreign Cretaceous species, it may be compared with *Voluta monodonta*, Binkhorst, from Limbourg, and an East Indian speciesidentified by Stoliczka with *Voluta rigida*, Baily, under the name *Fasciolaria rigida.*

* The cut makes the plait continue down the margin of the canal too far.

From the first, it differs clearly in the strongly flexuous nature of its costæ; and from the latter, not only in that character, but in having only one instead of several plaits on the columella. The Indian species also attains a larger size, and has more distant vertical costæ. Neither the Indian nor the Limbourg species belongs to the genus *Voluta*, but, along with *Fasciolaria assimilis*, Stoliczka, and perhaps some of the Gosau species, fall into the same section or group as the species here under consideration.

Locality and position.—Yellowstone River, 150 miles from its mouth; where it occurs in beds containing a blending of the fossils of the Fort Pierre and Fox Hills groups of the Upper Missouri Cretaceous.

Genus PYROPSIS, Conrad.

Synon.—*Tudicla*, &c. (sp.), of some (not of Bolten).
Pyropsis, Conrad (1860), Jour. Acad. Nat. Sci. Philad., IV, 288 (as a subgenus under *Tudicla*); and (1868) Am. Jour. Conch., IV, 248 (as a genus).—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 23 (as a subgenus under *Tudicla*).
Rapa, Stoliczka (1868), Palæont. Indica, II, 152 (not Klein and others).

Etym.—*Pyrum*, a pear; ὄψις, form.
Type.—*Tudicla* (*Pyropsis*) *perlata*, Conrad.

Shell pyriform; spire much depressed, not papillate at the apex; body-volution very gibbous, and provided with revolving, generally nodular, or perhaps rarely subspiniferous carinæ, suddenly contracted below into a long, slender, straight, or somewhat twisted canal; axis more or less perforated; outer lip beveled at the edge, and smooth within; inner lip thin, rather widely spread on the body-volution, but raised into a more or less prominent fold or projection nearly opposite the base of the aperture, below which point it stands free from the umbilical perforation, or slit, and umbilical ridge, sometimes developing a small callus, or ridge, at the top of the aperture.

This genus seems to be quite nearly related to *Tudicla*, Bolten, but differs in having the apex of its spire not papillate, the outer lip smooth instead of striated or sulcated within, and more revolving ridges on the body-volution. From *Busycon* of the same author, which also has the apex of the spire slightly papillate in young examples, it differs in that character, as well as in its perforate axis, and free inner lip below the prominence of the columella,* as well as in generally having more revolving ridges around the body-volution.

Dr. Stoliczka has referred to the genus *Rapa* several Indian Cretaceous forms that seem to me, as already intimated, to belong to this group. I cannot

* In *Busycon*, the inner lip is closely anchylosed to the columella all the way down the canal.

believe that such shells can be properly included in *Rapa*, as typified by forms like *R. papyracea*, Lamarck, with their thin shell, round non-carinate body-volution, deep suture, nearly hidden spire, and strongly internally-sulcated outer lip. Mr. Conrad, however, as elsewhere stated, has expressed the opinion that these Indian species (see Am. Jour. Conch., IV, 248) belong to his genus *Pyrifusus*. To me, however, they certainly appear much more nearly related to his *Pyropsis*, in almost every respect, than to the type of *Pyrifusus*, or to the forms I have here referred to that genus.

Both Mr. Gabb and Mr. Conrad (to whom I sent plate 31, with the figures of the shells I here refer to *Pyropsis*) express the opinion that they are distinct from that genus, and really belong to a new genus. They seem to think that these forms are distinct from *Pyropsis* in their twisted canal and less prominent fold on the columella; the canal of the type of *Pyropsis* being by them viewed as perfectly straight. I should remark, however, that their opinion in regard to our type was formed entirely from the figures on plate 31, and without seeing the cut of *Pyropsis Bairdi*, var. *rotula*, given on a following page, showing the inner lip partly broken away. In this, it will be seen that the partial breaking-away of the inner lip gives it much the appearance of that of the type of *Pyropsis*, and shows that the columella, is quite straight above; the twist and umbilical ridge being only formed below, so as to be broken away in Mr. Conrad's type of *Pyropsis*. I am therefore much inclined to think that there is really less difference in these shells than they have been led to think Nevertheless, as they are both familiar with the type of *Pyropsis*, which I only know from the published figure and description, it is still possible that they may be right; in which case I would at least propose subgenerically for our type, the name *Apiotropis*, which, if retained, would require the name of the following species to be written *Pyropsis* (*Apiotropis*) *Bairdi*.

This genus, as here understood, seems to be mainly, if not entirely, confined to the Cretaceous rocks; though possibly a few Tertiary forms may belong to a section of the same group.

Pyropsis Bairdi, M. & H. (sp.).

Plate 31, figs. 10, *a*, *b*.

Pyrula Bairdi, Meek and Hayden (1856), Proceed. Acad. Nat Sci. Philad., VIII, 66.
Busycon Bairdi, Meek and Hayden (1856), *ib.*, 126.
Tudicla (*Pyropsis*) *Bairdi*, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 23.
Compare *Pyrula Richardsoni*, Tuomey (1855), Proceed. Acad. Nat. Sci. Philad., VII, 169.

Shell attaining a large size, distinctly pyriform; spire depressed to less

than half the length of the aperture exclusive of the canal; volutions five, increasing rather rapidly in size from the apex, all obliquely flattened above; last one ventricose, but vertically flattened around the middle, where it is ornamented by three more or less prominent, revolving, nodose or subnodose carinæ, only the upper one of which is seen on the spire; canal long, tapering, and slightly bent below; suture well defined; surface marked by distinct lines of growth and raised revolving lines, one of which latter, at the middle of each of the spaces between the three principal carinæ of the body-volution, as well as some of those below the same, show a tendency to assume the character of small revolving ridges; aperture oval, but obtusely subangular above, and abruptly contracting into the rather narrow canal below; inner lip thin, and spread upon the body-volution and upper part of the columella, from which latter it seems to be raised to form the prominent fold or revolving ridge of the same, nearly opposite the base of the aperture; while below this, it stands free from the revolving umbilical ridge, so as to leave uncovered a more or less distinct umbilical furrow, which is continued upward as a very small perforation of the axis.

Length of a medium-sized specimen, 3.50 inches; breadth, 2.15 inches; length of aperture, exclusive of the canal, 1.34 inches; breadth of same, about 1.10 inches; length of canal, 1.70 inches. Imperfect specimens show that it sometimes attained a size nearly one-third larger than these dimensions.

This is, perhaps, one of the largest of known Cretaceous gasteropods, and will be at once distinguished from all of those yet described from the Upper Missouri rocks. How nearly it may be related to two forms described by Professor Tuomey from the Cretaceous rocks of Noxubee County, Mississippi, many years back, under the names *Pyrula trochiformis* and *P. Richardsoni*, I am unable to say, not having seen authentic specimens of either; while Professor Tuomey did not figure his species, and only gave very brief diagnoses, doubtless intended as mere preliminary notices of shells that he expected to describe more fully at some future time. I infer, however, that his species are distinct from ours, because Mr. Gabb, who has studied the Mississippi Cretaceous fossils, referred Professor Tuomey's *P. Richardsoni* to his *Perissolax*, which has a perfectly straight canal, without any prominence on the columella; while he expresses the opinion that *P. trochiformis* of Tuomey may be identical with *P. perlata*, Conrad, the type of the genus *Pyropsis*.*

* Since this was written, Mr. Gabb informs me that he has seen specimens of *Pyrula Richardsoni*, Tuomey, *very* similar to the species here under consideration.

Among all of the published foreign species, this seems to be most nearly represented by *Pyrula cancellata*, Sowerby, as illustrated by Dr. Stoliczka in the Palæont. Indica, II, plates 12 and 13. It is readily distinguished from that species, however, by its longer canal, less strongly angular body-volution, smoother surface, and by its aperture being merely about rectangular at the connection of its outer lip with the body-volution above, instead of pinched up so as to form a kind of notch there.

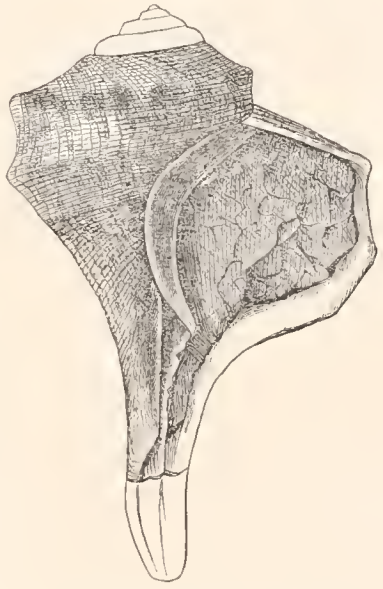
The specific name of this fine species was given in honor of Prof. Spencer F. Baird, the able and well-known naturalist of Washington City, and assistant secretary of the Smithsonian Institution.

Locality and position.—Fox Hills and other localities near Moreau River; in the Fox Hills group of the Upper Missouri Cretaceous series.

Pyropsis Bairdi, var. **rotula**, M.

Plate 31, fig. 10, *c*, and annexed cut.

Fig. 47.



Pyropsis Bairdi, var. *rotula*.

A view showing the more rounded form of the aperture in this variety; also, the appearance of the columella, &c., when the inner lip is partly broken away.

This form has long been something of a puzzle. I have frequently been nearly satisfied that it ought to be separated specifically from the last, but, after careful comparison, have always been left in doubt whether it may not more properly be only a variety of the same. This question, however, can only be definitely settled by the study of more extensive collections than have yet been obtained. Its most striking differences are the more depressed, or less ventricose, form, and more angular outline of its body-volution, which also has its third, or lower carina, less prominent than in the last, or sometimes even wanting. The upper slope of its body-volution also differs in being flat, or even slightly concave, instead of a little convex. Its revolving striæ are likewise more numerous, and uniform in size; none of those on the under side of the body-volution being larger than the others, or assuming the character of little ridges, as in the

last. Again, its aperture is proportionally broader than in the typical form, being nearly quite as wide as high, instead of higher than wide.

I have yet only seen one specimen of this form showing the aperture and inner lip. This one has the third or lower carina of the body-volution obscurely developed, and the nodes on the other two principal ones more numerous and more closely arranged than those on that represented by our figure 10, *c*, and its columella more oblique than it is restored in that figure; but no one would for a moment think of separating it, even as a variety, from that shell. In this specimen, which is larger than that represented by figure 10 *c*, the inner lip, although not entire, certainly seems to have been decidedly more free from the columella, along its outer edge opposite the middle of the aperture, than that of the more ventricose form.

Until the relations of this form to *P. Bairdi* can be determined more satisfactorily from the study of a better series of specimens, I would propose to range it under a distinct name as a variety of that shell.

Locality and position.—Same as last.

Genus FUSUS, Bruguiere.*

Synon.—*Fusus* (sp.), Klein, Martini, Schroter, and other pre-Linnæan authors.
Fusus, Bruguiere (1789), Encyc. Méth., I, xv.—Bolten (1789), Mus. Bolt. (ed. 2a, 1819, 83).—Lamarck (1799), Prodr., 73; and (1801) Syst. An., 82; also (1822) Hist., VII, 121.—Deshayes (1830), Encyc. Méth., III, 174.—Reeve (1841), Proceed. Zoöl. Soc., 76; also of numerous later authors, with various limits (but not of Humphrey, 1797).
Colus, Humphrey (1797), Mus. Col., 35.
Syrinx, Bolten (1799), Mus. Bolt. (ed. 2a, 1819, 85).
Fusinus, Raf. (1815), Anal. Nat., 145.
Sinistralia, H. and A. Adams (1853), Genera Recent Moll., I, 79 (as a subgenus).

Etym.—*Fusus*, a spindle.
Examp.—*Murex colus*, Linnæus

Shell fusiform; axis imperforate; spire many-whorled, acuminate, and produced to more or less nearly (rarely beyond) the length of the canal and body-volution; whorls angular, carinate, nodose, or provided with folds, costæ, or spines, or merely evenly convex; canal slender, and generally long and straight; aperture oval, or more or less rhombic; columella without plaits or folds; outer lip simple, and often striate or sulcate within; surface generally with revolving markings.

Probably no other generic name in the whole range of conchological science has been more indefinitely used than this, both by palæontologists

* The genus *Fusus* is very generally referred to the *Muricidæ*, but Dr. Stimpson some time back discovered that a recent typical species of the genus has decidedly the dentition of the *Fasciolariidæ*.

and conchologists, but more particularly by the former, owing to the very great difficulty of classifying, by the shell alone, a wide range of fusiform types. I accept it here, however, nearly in the restricted sense in which it is used by H. and A. Adams, in their important work on the Genera of Recent Mollusca; though I add, provisionally, under a new subgeneric name, a fossil type that may possibly represent a distinct genus.

The sections included, as the genus is here understood, may be severally distinguished as follows:

1. **FUSUS**, Bruguière (typical, = *Colus*, Humphrey).

   Shell elongate-fusiform; spire produced; volutions provided with carinæ, nodes, folds, or costæ, sometimes spiniferous; canal long, slender, and straight.—(Type as above stated.)

2. **SERRIFUSUS**, Meek.

   Shell short-fusiform; body-volution large, and bi- or tricarinate, with carinæ more or less nodose; spire and canal moderate, the latter bent and more or less twisted; outer lip broadly but slightly sinuous in outline, between the upper carina and the suture.—(*Fusus Dakotensis*, M. & H.)

3. **SINISTRALIA**, H. and A. Adams.

   Shell unsymmetrically-fusiform, sinistral; spire elongated, or more than equaling the length of the aperture and canal, which latter is short, twisted, and bent.—(*Fusus elegans*, Reeve.)

A complete revision, however, of the numerous extinct species still ranged under the general name *Fusus*, by many authors, would doubtless result in the elimination of a portion of them under other names, and the establishment of some new genera and subgenera. This is especially the case with the Cretaceous species, many of which, as elsewhere suggested, will probably, on critical examination, be found, judging from late experience, to possess plaits far around out of sight on the columella, and consequently have to be ranged in or near the genus *Fasciolaria*.

The type for which the subgeneric name *Serrifusus* is here proposed seems to be entirely destitute of any traces of such plaits on the columella, and in other respects more nearly related to the genus *Fusus*, though its shorter, bent canal, larger body-volution, and the somewhat sinuous outline of the upper part of its outer lip, seem to require its separation, at least subge-

nerically. It will be seen to present nearly the same surface-ornamentation as our *Pyropsis Bairdi;* but its more produced spire, and much shorter bent canal, non-perforate axis, &c., seem to forbid its near association with that type. Dr. Stoliczka has described two Indian Cretaceous forms under the names *Lagena nodulosa* and *L. secans*, that certainly present many strong points of resemblance to a variety of the type of the section here under consideration. I do not believe, however, that such shells can be properly ranged under the name *Lagena*, Klein, even if that author could be cited as the founder of genera, since his figured type of that genus differs widely in having evenly-rounded volutions, without traces of revolving carinæ, and a much shorter, wider, and less bent canal; while H. and A. Adams, who ought to to be regarded as the real founders of the name *Lagena*, if it is to take a place in conchological nomenclature, apply it to forms like Klein's type.

The reason for doubting the generic, and even subgeneric, identity of the Indian Cretaceous forms mentioned, with the type of the group here placed as a section of the genus *Fusus*, under the name *Serrifusus*, is the presence of what appears to be a broad, low varex, on one of Dr. Stoliczka's figured specimens.

From all that is now known in regard to the geological range of the genus *Fusus*, it possibly may have been introduced during the Cretaceous epoch. It became more extensively developed, however, in Tertiary times; while it is well represented and widely distributed in our existing seas, particularly those of China, Australia, and the distant eastern countries.

Fusus? (Serrifusus) Dakotensis M. & H.

Plate 31, fig. 11; and pl. 32, figs. 6, *a*, *b*.

Fusus Dakotensis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 65.
Fusus (*Neptunea*) *Dakotensis*, Meek and Hayden (1860), *ib.*, XII, 421.
Tudicla? Dakotensis, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 23.

Shell rhombic-fusiform, attaining a rather large size; spire conical, less than the length of the aperture and canal; volutions about five and a half to six, convex, with upper side obliquely flattened, and a prominent nodose carina passing around below the middle of those of the spire, and around the middle of the last one, which latter is ventricose, and bears a second smaller revolving ridge below the principal one, and a much smaller third one farther down; nodes of the principal carina compressed above and below; beak rather short, and bent backward below; columella moderately arcuate and

twisted; aperture rhombic-oval, being angular above, and near the middle of the outer side; surface ornamented with distinct lines of growth, that make a graceful backward curve, parallel to the outline of the outer lip, on the upper slope of the volutions, and are crossed by well-defined revolving lines, one of which, between the two principal ridges, is larger than the others; suture distinct.

Length, about 3.22 inches; breadth, 1.82 inches; slopes of the spire nearly straight, with a divergence from the apex of 57°.

The specimen from which our figures of this shell were drawn has the upper volutions considerably broken and eroded, so that it does not give a correct idea of the ridges and nodes; the first not being near as angular as in well-preserved examples, and the nodes not appearing flattened and transverse enough, nor does the figure show the lines of growth above the angle curved enough. Since the drawings were made, I have also cut away the rock about the columella, and find it somewhat more arcuate on the inner side at the middle, and more prominent below than represented in figure 6, *b*. It should also be explained that the position in which both figures are drawn prevents the curvature of the beak from being apparent; its bend being directly backward, and consequently so nearly in the line of view as not to be seen in the figures.

It is with great doubt that I refer this shell even to a distinct section of the genus *Fusus*. Unfortunately, none of our specimens show its entire canal, or inner lip. Its similarity of ornamentation suggests possibly closer generic relations to our *Pyropsis Bairdi* than may be apparent from such specimens as have yet been seen.

Locality and position.—Long Lake and Moreau River, Dakota; from the Fox Hills group of the Upper Missouri Cretaceous series.

Fusus? (Serrifusus) Dakotensis, var.

Plate 32, fig. 7, *a* (and 7, *b*?).

I have long had this form under consideration, but have never felt quite sure that it may not be a variety of the last; and consequently always laid it aside with the hope of getting other specimens for comparison. As none have yet come in, and it is neeessary to arrive at some conclusion in regard to its relations to the last, I have decided to view it provisionally as a variety of the same. If additional collections should show it to be sufficiently dis-

tinct to require a different name, either as a species or as a variety, it may be called *Fusus*? (*Serrifusus*) *goniophorus*.

I should explain, however, that these forms are much more nearly related than would be supposed from a comparison of our figured specimens; that of the larger typical *F. Dakotensis* having its upper volutions broken and eroded, so as to round off the angles and nodes, thus giving it a different aspect from some broken, smaller examples of the same in the collection. Still, none of the latter yet seen have the upper slope of the volutions so concave, the carinæ near so sharp, or the nodes of the same so compressed and transverse: while, like the large one figured, they have the spire more depressed than the form here under consideration, and the revolving lines much more distinct on the lower part of the body-volution.

The artist did not succeed in representing the carinæ exactly right on the body-volution of this form in figure 7, *a*, as he drew a mere raised hair-line between the two principal ridges, much too strong, thus giving the appearance of three of those of the smaller size, while there are only two. The angle on the upper volutions is also made to appear too much like a continuous keel, instead of being scalloped into little transverse serrations. Since the plate was engraved, I have also found, by cutting away the rock about the columella, that it is more arcuate opposite the middle of the aperture, and more prominent on the inner side, just above where the canal is broken off, than appears in the figure.

I am in some doubt whether the little specimen represented by our figure 7, *b*, belongs properly to the variety or species here under consideration, or to the last. In the concavity of the upper slope of its volutions, and the nature of its carinæ, it agrees more nearly with the shell here under consideration; but, in general form, it is more like the last. Here, too, the carinæ are, however, not exactly right in the figure; the mere hair-line first below the upper ridge, being drawn too large; while there is another revolving line, or ridge, represented below all, that does not exist on the specimen.

As already intimated, this shell resembles, in many respects, an East Indian Cretaceous species described by Dr. Stoliczka under the name *Lagena nodulosa* more nearly than any other form with which I am acquainted; though our shell has a more produced spire, a proportionally less ventricose body-volution, and wants a kind of tooth or projection on the inner lip, seen

at the top of the aperture in that figured by Dr. Stoliczka: which also differs in having a low, broad ridge, or varex, at least on one of the Indian figured specimens. The latter two characters, particularly the varex, would seem to be generic differences; though it would be a little curious if two shells, so similar in most respects, should be so widely distinct as these characters would indicate.

Locality and position.—Moreau River, Dakota; from the same horizon as the last.

Genus CANTHARUS, Bolten.

Synon.—*Cantharus*, Bolten (1798), Mus. Bolt. (ed. 2a, 98, 1819).—H. and A. Adams (1853), Genera Recent Moll., I, 84 (not Vogt, 1834, nor Phil., 1847).
Lagena, Bolten (1798), Mus. Bolt. (ed. 2a, 93, 1819); not Klein and others.
Pollia, Gray (1839), Zoöl. Beech. Voy., 111; and (1840) Wiegm. Arch., II, 212.
Tritonidea, Swainson (1840), Moll., 302.—H. and A. Adams (1853), Genera Recent Moll., I, 85 (as a subgenus).—Stoliczka (1868), Palæont. Indica, I, 117 (as a genus).
Polliana, M. E. Gray (1842), Figs. Moll. An., tab. 5.

Etym.—*Cantharus*, a kind of pot or jug, with handles.
Examp.—*Buccinum Tranquebaricum*, Gmel.

Shell buccciniform, or short-fusiform, with spire and aperture of nearly equal length; volutions with numerous equal vertical folds, or varices, and revolving ridges; last whorl more or less ventricose, and contracting abruptly below into a very short, wide, or somewhat produced narrower canal; columella arcuate in the middle, more prominent below, and generally provided with more or less obtuse ridges; inner lip usually thin or wanting, sometimes bearing a tooth-like ridge at the top of the aperture; outer lip internally crenate or sulcate, and usually provided with a superior siphonal notch, or canal.

H. and A. Adams admit two subgeneric sections under this genus; that is, they divide it into *Cantharus* proper, and *Tritonidea*, Swainson. Dr. Stoliczka, in his East Indian Palæontology, adopts these divisions, with different limits and diagnoses, as two distinct genera, using Dr. Gray's name *Pollia*, instead of *Cantharus*, for the first. This group he confines to species with a *very* short, moderately-curved canal, and the inner lip transversely grooved along its entire length, and toothed behind; while *Tritonidea* he defines as having its canal either moderately produced or short, and its "inner lip anteriorly thickened and smooth, and posterior thin, or cross-grooved, often toothed at the end." It will be observed, however, that his diagnosis of *Tritonidea* does not conform to Swainson's original description of the same,

in which the inner lip, or pillar, as he terms it, is described as having "at the base two or three obtuse and very transverse plaits." I am therefore inclined to think that Dr. Stoliczka was not familiar with Swainson's diagnosis, and defined the group more with the view of making it conform to the characters of the Cretaceous species before him, than he would have done from Swainson's recent typical species and its nearer allies. At any rate, his Cretaceous species, so far as can be learned from his figures and descriptions, have the columella, or inner lip, smooth anteriorly, and without a tooth, or even other ridges or furrows posteriorly, than such as are produced by the surface revolving ridges passing around the body-volution into the aperture. Consequently, in making *Tritonidea* include these shells, it is necessary to define it so as to make it *exclude* entirely shells conforming to Swainson's diagnosis. Hence, it seems to me that if these Cretaceous species, including one hereinafter described, are to be referred to this genus at all, we must establish a third section for them, and not place them in *Tritonidea*, either as a subgenus or otherwise. Adopting this view, the three divisions may be defined as follows:

1. CANTHARUS, Bolten (typical).

   Shell with canal *very* short, inner lip thin, and generally transversely grooved along its entire length, often toothed behind.—(Example as already stated.)

2. TRITONIDEA, Swainson.

   Shell with canal more produced; inner lip with usually two or three obtuse, transverse plaits anteriorly, and sometimes a posterior tooth or projection.—(*Buccinum undosum*, Linnæus.)

3. CANTHARULUS, Meek.

   Shell with canal moderately produced, rather narrow and twisted; inner lip smooth throughout, and rather well developed; columella arcuate and twisted, so as to form an obtuse, undefined prominence below; outer lip slightly sinuous above.—(*Fusus Vaughani*, Meek and Hayden.)

The type of the last of the above-defined sections is a moderately thick shell, and has its inner lip well developed below, and rather thinly spread upon the body-volution above, so as to extend a little beyond the edge of the outer lip, which is only very obscurely furrowed just at the inner edge, a

little sinuous above, and thence nearly straight in outline all the way down. The extremity of its canal is broken away in the only specimen seen; but it seems to have been only moderately produced, and comparatively narrow.

Whether the Indian Cretaceous species referred by Dr. Stoliczka to *Tritonidea* belong properly to the above section *Cantharulus* or not, I am hardly prepared to express a very positive opinion, only knowing them from the published figures; though I can scarcely doubt that they, as well as some of the European Cretaceous forms described under the name *Fusus*, really do belong to it.

The genus *Cantharus*, as here understood, seems to have been introduced during the Cretaceous epoch, and ranged through the Tertiary formations into our existing seas; where it probably nearly or quite maintains its greatest numerical development. The recent species belong both to the typical section and the *Tritonidea* groups, but mainly to the latter. Both of these sections also occur in the Tertiary rocks, while nearly all of the Cretaceous species seem to belong to the *Cantharulus* section. The fossil species are generally yet referred to *Fusus*, *Murex*, *Buccinum*, &c., as was formerly also done with the recent.

Cantharus (Cantharulus) Vaughani, M. & H. (sp.).

Plate 32, figs. 5, *a*, *b*.

Fusus Vaughani, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 138.
Cantharus? Vaughani, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22.

Fig. 48.

Cantharus (Cantharulus) Vaughani

A dorsal view to correct some defects in the ornamentation of the figures on plate 32.

Shell oval-fusiform, rather thick; spire turreted, moderately elevated, composed of six to six and a half convex whorls, which are obliquely a little flattened or very slightly concave above; last turn tapering quite abruptly into the rather narrow, moderately-produced canal; suture distinct; surface of each volution ornamented by about fifteen small, equidistant, vertical folds, equaling the depressions between; crossing these are a series of small, rather elevated, regular, revolving bands, less than the intermediate spaces; over the entire surface very fine, obscure, revolving striæ may also be seen by the aid of a lens, forming, with the fine lines of growth, a faint textile marking, entirely subordinate to, and distinct from, the greatly coarser net-work formed by the crossing of the folds and revolving bands; aperture

rather narrow-oval; outer lip faintly cross-sulcated at the edge within, and very slightly sinuous above; inner lip united to the outer one above, and rather closely connected with the smooth, tortuous, and arcuate columella.

Length, 1.43 inches; breadth, 0.75 inch; apical angle convex, divergence about 54°.

Four or five of the revolving bands on the body-whorl, and two of those on each turn of the spire, are larger than the others, and form rather distinct nodes at the points where they cross the folds. Below these four larger bands on the body-volution, there are about five or more smaller ones, which diminish in size, and become more oblique on approaching the canal; while on the obliquely flattened upper part of the whorls, there are some three or four much smaller and less prominent bands or lines.

The drawing of this species is faulty in representing the vertical ridges, or costæ, too narrow and too sharply defined, and in leaving out the smaller of the revolving ridges, on the upper slope of the volutions. The inner lip is also represented too narrow above, and the outer too thin, and without the very obscure sulcations within, near the margin. The figured specimen has the end of the beak broken away, and the aperture narrowed a little by accidental pressure. The columella is also not drawn prominent enough on the inner side, just above the point where it is broken off below.

Although resembling the Cretaceous species described by Dr. Stoliczka from the Indian collections, this shell still differs too decidedly in specific details to require a very careful comparison. In form, and even surface-markings, it more nearly agrees with his *Hindsia eximia*, being, indeed, *very* much like that shell; but it differs materially in having its inner lip entirely smooth.

Locality and position.—Near the mouth of Heart River, on the Upper Missouri; from the Fox Hills group.

PLEUROTOMIDÆ.

Genus TURRIS, Bolten.

Synon.—Turris, Bolten (1798), Mus. Bolt. (ed. 2a, 1819, 87).—Fabr. (1822), Fortegn., 83.—Gray (1847), Proceed. Zoöl. Soc., 134 (not 141).—H. and A. Adams (1853), Genera Recent. Moll., I, 87.—Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 422.—Gabb (1860), Jour. Acad. Nat. Sci. Philad., IV, 37; and (1861) Synop. Moll. Cret. Form., 89; also (1864) Palæont. Cal., I, 92.—Conrad (1862), Proceed. Acad. Nat. Sci., XIV, 284.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22 (not Montfort, 1810).

Pleurotoma, Lamarck (1799), Prodr., 73; and (1801) Syst., 84; also (1809), Phil. Zoöl., * * ; and (1822), Hist., VII, 90.—Cuvier (1817), Règne An., II, 442 (as a subgenus under *Fusus*); and (1830) *ib.* (éd. 2e), III, 387 (as a subgenus under *Murex*).—Blainv. (1824), Dict. Sci. Nat., XXXII, 196; and (1825) Malac., 394; also (1826), Dict. Sci. Nat., XLI, 388.—Swainson (1840), Malac., 314.—Gray (1842), Synon. Brit. Mus., 89.—Hinds (1844), Voy. Sulph., Zoöl., 15.—D'Orbigny (1850), Prodr. de Pal., II, 230.—Shumard (1861), Proceed. Bost. Soc. Nat. Hist., 197.—Stoliczka (1868), Palæont. Indica, II, 67.—Gabb, (1869), Palæont. Cal., II, 5; and of many others.

Pleurotomarius, Dum. (1806), Zoöl. An., 340.

Turricula, Schum. (1817), Essai, 217 (not Klein, 1753; Humph., 1797; Fab., 1822; or Beck, 1837).

Pleurotomus, Montf. (1810), Conch. Syst., II, 534.

Pleurotomites, Krüg. (1823), Urw., II, 425.

Surcula, H. and A. Adams (1853), Genera Recent Moll., I, 88 (as a subgenus under *Turris*).—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22 (as a subgenus under *Turris*).—Conrad (1865), Am. Jour. Conch., I, 18; and (1866) Smithsonian Check-List N. Am. Eoc. Shells, 18 (as a genus).—Gabb (1869), Palæont. Cal., II, 150 (as a genus).

Genota, H. and A. Adams (1853), Gen. Recent Moll., I, 88 (as a subgenus under *Turris*).

Surculites, Conrad (1865), Am. Jour. Conch., I, 213 (as a subgenus under *Surcula*).—Gabb (1869), Palæont. Cal., II, 150.

Etym.—*Turris*, a tower.
Type.—*Murex Babylonius*, Linnæus.

Shell fusiform; spire more or less produced, turreted, not mammillate at the apex; volutions convex, sometimes angular, and often nodose or costate; last one narrowed anteriorly into a more or less produced, straight, or slightly bent canal; columella smooth and rounded; inner lip moderately developed, or sometimes obsolete; outer lip thin, not inflexed, but provided with a more or less deep slit, or sinus, posteriorly.

Animal, in the existing species, with eyes at the outer bases of the tentacles, and provided with an ovate, pointed operculum, with an apical nucleus.

The foregoing diagnosis is drawn up so as to include four sections, or subgenera, distinguished from each other as follows:

1. **TURRIS**, Bolten (typical).

   Shell with spire elevated, and canal generally produced and straight; inner lip moderate; outer lip with a deep slit near the suture.—(Type as already stated.)

2. **SURCULA**, H. and A. Adams (= *Turricula*, Schum.; not of others).

   Shell with spire and canal generally rather produced, the latter slightly bent; inner lip obsolete: outer lip more or less sinuous posteriorly.—(*T. nodifera*, Lam.)

3. **SURCULITES**, Conrad.*

Shell with spire and body-volution nearly equal; the latter obconical, rectangular near the top, and flattened or concave above from the angle to the suture; sinus of lip above the angle of the whorls, shallow and broad.—(*S. annosa*, Conrad.)

4. **GENOTA**, H. and A. Adams (not Adanson).

Shell mitriform; canal rather short; surface cancellate; outer lip with a deep posterior sinus.—(*T. mitriformis*, Wood.)

H. and A. Adams, in their valuable work on the genera of recent *Mollusca*, include two other sections of recent species in this genus, under the names *Brachytoma*, Swainson, and *Conopleura*, Hinds. The former of these groups is represented by *Pleurotoma strombiformis*, Sowerby, which has its outer lip thickened, ascending, and forming a short canal, and its inner lip thickened above; and the latter, by *C. striata*, Hinds, a short shell, with a depressed spire, a very short canal, and a deep sinus in its outer lip near the suture. I am not well acquainted with these shells, but, judging from the published figures, would suppose they might better be separated entirely from this genus.

A thorough revision of all the known fossil and recent species that have been described under the name *Pleurotoma*, would doubtless show good reasons for separating subgenerically, or, in some cases, generically, several other types, and probably for including as subgenera a few that have already been separated as genera. Not having at hand, however, the necessary materials for such a revision, no attempt of this kind is made here.

The shells of this genus resemble more or less nearly those of the genera *Drillia*, *Bela*, *Lachesis*, *Clavatula*, *Perrona*, *Clathurella*, &c., many of which were formerly, along with those of some allied groups, often referred to this genus under the name *Pleurotoma*. They are all distinguished, however, by various characters, such as the inflexed outer lip, thickened inner lip, and shorter recurved canal of *Drillia;* the flattened columella and shorter canal of *Bela;* the mammillate apex and slightly thickened and internally crenate outer lip of *Lachesis;* the operculum with its nucleus at the center of the straight front edge in *Clavatula* and *Perrona;* and the entire absence of an

* I believe Mr. Conrad never characterized his proposed subgenus *Surculites;* but his type-species has the characters given above. It seems to be very near *Sureula*, but may probably be retained for a group of Tertiary species, with obeonic body-volutions, usually referred to *Pleurotoma*, and forming a kind of transition from *Pleurotoma* toward the *Conidæ*.

operculum in *Clathurella* and its near allies, &c. There are also peculiarities to be observed in the animals of most of these groups, distinguishing them from the genus under consideration; but, unfortunately, these characters, when not accompanied by corresponding differences in the shell, afford the palæontologist no direct aid in the classification of fossil species.

Authorities do not agree in regard to the name that should be retained for this genus. Until comparatively recently, most authors have used Lamarck's name *Pleurotoma* for it; but, since more attention has been given to the dates of generic names and to the law of priority, the older name *Turris* has been used to a considerable extent. Even among those who use the latter name, however, there is not entire agreement respecting the author who should be cited as the founder of the genus; some citing Humphrey, and others Bolten. Undoubtedly, Humphrey used this name a year before Bolten did; but, as he unfortunately cites no authorities for the species included by him, we cannot be *positively sure* that any of them belong to this genus. Among others, he mentions *T. Babylonia*, but he does not refer to Linnæus, or say that it is *Murex Babylonius*, Linnæus. In the same way, he mentions five other species; but he gives no figures or diagnoses, and, for aught we can learn from his book, they all may have been new species (or supposed by him to be such) of one or more other genera. It is quite probable that his *T. Babylonia* may have been the *Murex Babylonius* of Linnæus; yet, under the circumstances, I think we have no right to assume that it was, or that any of his other species belong to this genus. Consequently, I should think that he ought not to be cited as its founder, especially as Bolten distinctly cites, in connection with the name *Turris*, *Murex Babylonius*, referring to Martini's figures and description.

Some reject the name *Turris* altogether, and retain Lamarck's later name *Pleurotoma*, on the ground that neither Humphrey nor Bolten gave any generic diagnosis. It seems to me, however, that where an author cites a well-known species, referring to figures and description in a published work, or figures and describes the type of his proposed genus himself, where this had not been previously done, he gives more satisfactory means of ascertaining the particular genus he had in view than nine-tenths of the diagnoses of the older authors, which often apply equally well to any one of five or six different genera as now understood; so that even in many of these cases we are altogether guided by the species cited or figured, and not at all by the diagnoses, in identifying such old genera.

The genus *Turris* seems to have made its appearance during the latter part of the Cretaceous epoch; but it was, so far as known, not numerously represented until after the close of the Cretaceous period. During the deposition of the Tertiary rocks, however, this genus was represented by a number of species, and probably then attained its greatest development; though many of the Tertiary shells referred to it under the name *Pleurotoma*, belong to other allied genera, and not to this group as here defined. It is quite abundant in our existing seas, however, and has a wide geographical distribution. The species are said to be most numerous in Asiatic seas; and are found at all depths from low tide to one hundred or more fathoms.

Turris minor, E. & S. (sp.).

Plate 31, figs. 9, *a*, *b*, *c*.

Pleurotoma minor, Evans and Shumard (1857), Trans. Acad. Sci. St. Louis, I, 41.
Turris minor, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 41.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22.

Shell small, symmetrically and moderately elongate-fusiform; spire rather elevated, but not quite equaling the length of the aperture and canal; volutions about six or seven, convex, and somewhat angular around the middle; last one not ventricose, narrowing gradually into the rather produced, nearly straight, tapering canal; suture distinct; aperture lance-oval, angular above, and tapering gradually below; outer lip broadly prominent in outline near the middle, somewhat retreating below, and again retreating above, into the deep, rather wide, rounded sinus, between the suture and the most convex part of the volutions; surface ornamented by distinct lines of growth, sometimes forming minute wrinkles just below the suture, and numerous revolving lines, of which those below the mesial angle of the volutions are larger than those on the flattened slope between the angle and the suture—one directly on the angle being generally larger than any of the others; small vertical costæ are also seen on the upper turns of the spire.

Length of largest specimen seen, 0.70 inch; breadth of same, 0.24 inch; slopes of spire nearly straight, with a divergence of about 35°.

The revolving lines mentioned above number about ten to twelve on each volution of the spire; those on the upper flattened slope above the mesial angle being not more than half as large as those below, and generally more crowded. The little vertical costæ are only seen near the summit of the spire, and consequently would not be preserved on specimens with the upper

volutions broken away. They are most prominent around the middle of the volutions, and thus sometimes assume rather the appearance of a row of little nodes.

I know of no described species more nearly approaching this than some of those figured by Deshayes from the Paris Basin Tertiary; but these all differ too decidedly to require critical comparison. Possibly I should write the name of this species *Turris* (*Surcula*) *minor*, as the posterior sinus of the outer lip is not a slit, as in the more typical forms of the genus, but a rather wide, rounded sinuosity; though the lines of growth as represented by our figures, particularly figures 9, *a*, and 9, *c*, do not curve enough to give an exact idea of the depth of the sinus of the lip.

Locality and position.—Evans and Shumard's specimens of this species came from Moreau and Grand Rivers, Dakota: apparently from the Fox Hills group of the Upper Missouri Cretaceous series. Those studied and figured by us came from the Yellowstone River, Montana, 150 miles from its mouth, from beds containing a blending of the fossils of the Fox Hills and Fort Pierre groups.

Turris (Surcula)? contortus, M. & H.

Plate 31, figs. 7, *a*, *b*, *c*.

Fusus contortus, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 65.
Pleurotomaria contorta, Meek and Hayden (1860), *ib.*, XII, 185.
Turris contortus, Meek and Hayden (1864), *ib.*, 422.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 22.

Fig. 49.

Turris (Surcula)? contortus.
A dorsal view, to show the curves of the lines of growth, not correctly represented in the figures on plate 31.

Shell rather short-fusiform; spire turreted, moderately elevated, but not quite equaling the length of the aperture and canal; volutions five and a half to six, distinctly concave above, and convex around the middle, where they are each ornamented by about eleven oblique, flexuous, elongated nodes, or costæ, equaling the sinuosities between; last turn prominent around the middle, and tapering obliquely into the rather short, nearly straight, canal below; suture distinct; aperture narrow-subobovate, angular above, most convex on the outer side, and tapering into the canal below; outer lip broadly prominent in outline along the middle, somewhat contracted below, and again curving backward into the broadly rounded, rather deep, sinus

between the angle of the volutions and the suture above; surface marked by fine but distinct lines of growth, which are crossed by numerous, rather small thread-like, revolving lines.

Length, 1.09 inches; breadth, 0.55 inch; length of aperture and canal, 0.70 inch; breadth of aperture, 0.24 inch; slopes of spire nearly straight, with a divergence of about 42° in adult examples.

I am not quite sure that this shell falls strictly within the subgenus *Surcula*; though it seems to agree more nearly with that than any of the other established sections of the genus. It has not the elongate-fusiform outline and narrow labial slit seen in *Turris* proper; and, although most of the specimens seem to have the inner lip obsolete, as in *Surcula*, some have it pretty well developed, but not naturally as distinct as represented in our figure 7, *a*, in which it is too strongly apparent on account of the weathering-away of the surface of the body-volution by its side. Specimens with the outer lip broken away, and the lines of growth obliterated by weathering, would not be suspected to have had a posterior labial sinus, as in this and the allied genera; and it was from having at first only seen specimens in that condition that this shell was originally referred to the genus *Fusus*. Unfortunately, none of the figures of this species on plate 31 have the curves of the lines of growth properly delineated, as they would convey the impression that the deepest part of the labial sinus is coincident with the most prominent part of each volution, instead of farther up between this and the suture, as correctly represented by the annexed wood-cut. This want of the proper curve of the lines of growth in the figures of this species on plate 31, makes the shell more nearly resemble *Neptunella Newberryi*, as represented on the same plate, than is natural. The foregoing wood-cut is intended to correct this defect in the figures on the plate.

Locality and position.—Moreau River, Dakota; from the Fox Hills group of the Upper Missouri Cretaceous series.

Turris (Surcula)? Hitzi, Meek.

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°.

Fig. 50.

Turris (Surcula)? Hitzi.

A cut of this species from the type-specimen, which was found after the plates were arranged.

As in other cases, where we have merely imperfect specimens of univalves, I can only, as it were, balance probabilities in regard to the generic relations of this species; the only specimen seen being merely an internal cast, with the beak and lip broken away. Some portions of the thin shell remain attached to the cast, but even these are so eroded as only to show the remains of revolving lines. In general appearance, it resembles some species of *Turris* (= *Pleurotoma*); but, the margin of its lip being broken and the curves of the lines of growth not being traceable, it is impossible to determine, without other specimens, whether or not it has the characteristic, slit or sinus, of the *Turris* group. There is, however, something in the general form of the volutions, and the somewhat oblique direction of the node-like prominences on the angle of the body-whorl, that suggests the probability of there being a sinus in the lip, at the termination of the upper flattened, or slightly concave, slope of the last turn. If it belongs to the *Pleurotoma* group at all, however, it would most probably fall into the *Surcula* section.

The strongest known reason for doubting its relations to this genus is, that just where the break of the lip intersects the angle of the body-volution, there is slight projection, that looks as if it might be the commencement of an expansion of the lip at that point, as in *Anchura*, *Aporrhais*, or some allied genus. It may be that this appearance is produced by the break passing through a node; but the fact that this would require the node here to be so much more prominent than any of the others on the body-volution, raises a doubt in regard to the accuracy of this conclusion. If there was an expansion of the lip commencing at this point, this shell would most probably fall into the genus *Anchura*, and have to take the name *Anchura Hitzi*. These questions, however, can only be settled by the examination of better

specimens, which some one will doubtless have an opportunity to do hereafter.

This shell is not liable to be confounded with any of the other Upper Missouri species yet known. The form of the volutions of its spire and its surface-markings somewhat resemble those of the last; but its larger size, more numerous whorls, much more produced spire, and proportionally shorter and less expanded body-volution, will at once distinguish it. One of its most marked features is the peculiar constricted, screw-like appearance of its spire, produced by the concave upper slope of each whorl, and the convexity of the succeeding one above, all the way up.

The specific name of this shell is given in honor of the late Dr. Hitz, of Washington City, who discovered the only specimen I have yet seen.

Locality and position.—The type-specimen was brought by Dr. Hitz, along with characteristic fossils of the Fort Benton group, collected at a locality opposite Fort Shea, on the Upper Missouri.

CEPHALOPODA.

TETRABRANCHIATA.

BACULITIDÆ.

The terminology of the parts of the shell in this and the other more or less nearly allied families of the great group of complexly septate *Cephalopoda* for which Professor Gill has used the name *Ammonitoidea*, having undergone some changes since the publication of most of the works on these types, and some additional changes of this kind being made in the following descriptions, a few words of explanation on this point may be desirable here.

In nearly all of the descriptions of these shells published previous to a comparatively few years back, the siphonal side was called the dorsal, and the opposite the ventral. As pointed out by Van der Hoeven, however, in 1849, and more recently by Professor Pictet, Professor Hyatt, and others, the known posture of the animal of *Nautilus* in its shell, by analogy, renders it almost certain that in all of the involute, spiral, and arcuate types of the *Ammonitoidea*, the outer or siphonal side of the curve is really the ventral, and the opposite or inner side the dorsal. Consequently, it becomes equally evident that the siphonal side in the straight *Baculite* should be also viewed as the ventral, and the opposite as the dorsal surfaces.

Still, as the opposite arrangement was long believed to have existed,

and most of the published descriptions were made to conform to that view, any attempt now to reverse the application of the terms dorsal and ventral—that is, to call the siphonal side the ventral, and the opposite the dorsal—would necessarily result in confusion. Consequently, to avoid this difficulty, and at the same time not to continue to perpetuate an error by adhering to the old nomenclature, Pictet and some others proposed to apply to the peripheral or outer side, in involute and curved forms, the term *siphonal*, and to the inner side the term *umbilical* or *antisiphonal*.

To the distinguished geologist and palæontologist von Buch, belongs the credit of having first called especial attention to the sutures, or more or less flexed and ramose edges of the septa of these types, as seen in internal casts from which the outer part of the shell had been removed, as a means of distinguishing species and larger groups. These flexures of the edges of the septa that project backward, he called *lobes*; and the intervening spaces directed forward, or toward the aperture, he termed *saddles*. Regarding the outer side of the curve of the shell in the *Ammonitidæ* as the *dorsal*, and the inner or umbilical as the *ventral*, as has until recently been the prevalent view, he called the backward flexure of the septa situated over the siphon, on the outer side, the *dorsal lobe*, and the forward projection on each side of this he termed the *dorsal saddle*. The next lobe on the inner side of the latter (counting inward toward the umbilicus) he termed the *superior lateral lobe*; and the second forward projection the *lateral saddle*. The second lateral lobe he termed the *inferior lateral lobe*; while the third forward flexure he designated the *ventral saddle*, and the succeeding lobes and sinuses, between the last and the umbilicus, were by him called the *auxiliary lobes* and *saddles*, which he numbered consecutively from without inward to the umbilical margin. The backward flexure within that part of each volution in contact with, or lapping upon, the next inner turn, and only exposed when the volutions are broken apart, he designated the *ventral lobe*, which, in species with deeply embracing volutions, is very large.

This nomenclature of the parts of these shells has been very generally adopted by contemporaneous and subsequent authors, not only for the *Ammonitidæ*, but for the straight Baculites, and other genera of complexly septate shells of various forms, until some twenty years back, when a few modifications were proposed. About that time, Pictet proposed to call the lobe on the outer side of the curve, in the involute types, the *siphonal or median external lobe*, and the opposite or inner one, the *median internal or dorsal lobe*.

These modifications are of course improvements, and have been adopted by several later authors, particularly the term *siphonal lobe*, which I have found convenient; and, as it is readily understood and applicable to shells of all forms, while it avoids the use of either of the terms dorsal or ventral, it ought to be generally adopted. The other name, however, used by Pictet for the antisiphonal lobe—that is, his name *median internal or dorsal lobe*—seems to me to be objectionable, because it is desirable to use terms that will be equally applicable to any and all of the various types of this great group of shells, including many genera of different families, and presenting a great variety of forms, from the straight Baculites, to involute and spiral types. It would certainly be a misnomer, and cause confusion in the minds of students, to continue to call the little lobe directly on the opposite side from the siphon, in *Baculites*, the *median internal or dorsal lobe*, when none of the lobes in a straight shell of this kind can be properly called internal. Yet the lobe alluded to in the genus *Baculites* corresponds exactly to that which Pictet calls the *median internal* in the involute and curved genera.

For these reasons, I have preferred to adopt the name *antisiphonal lobe* for that directly opposite the siphonal, in whatever type it may be met with, whether it be a *Baculites*, an *Aucyloceras*, or an *Ammonitoid* shell. This term has already been used by some European palæontologists, and will always be readily understood without explanation, while it avoids any perplexing allusion to either dorsal or ventral side.

I have also long thought that von Buch's nomenclature might be much simplified by a still further modification: that is, by discarding his names *dorsal saddle*, *superior lateral lobe*, *lateral saddle*, *inferior lateral lobe*, *ventral saddle*, and *auxiliary lobes and saddles*, and simply designating the whole of these flexures, whether few or many, on each side of the *siphonal lobe*, as *lateral lobes* and *sinuses*, numbering each series consecutively from without inward to the umbilical margin. This avoids all circumlocution, and enables one to refer directly to any particular lobe or sinus, simply, for instance, as the *fourth lateral lobe*, or the *third lateral sinus*, in descriptions or comparisons.

By reference to the cut of a septum of *Placenticeras placenta*, given in connection with that species farther on, the terminology that I have used in the following descriptions will be more clearly understood.

The student should also be informed that, in comparing the septa of these shells for the purpose of identifying species, genera, or larger groups, it

is very important that the individual specimens compared should be as nearly as possible of the same size; or that the septa compared should in each shell occupy a position where the diameters of the whorls are the same, or very nearly the same. The reason for this precautionary advice is, that in all of this great group of extinct types with more or less complex septa, the sutures, or edges, of the septa became more divided and subdivided as long as the shell continued to grow. In the very young, for instance, the lobes and sinuses of a species that became remarkably ramose in large adults, may be merely represented by simple undulations; while individuals of intermediate sizes will show all intermediate gradations of complexity in their sutures; though a practiced eye will see a general plan of structure running through the whole series. It should also be remembered that where an individual has, from any cause, been dwarfed in its growth, although it may have attained adult age before death, its septa will generally be found to be as simple in their structure as those of a young shell of the same species and size. Again, it should be remembered that, even in specimens of the same size, belonging to the same species, there will also be differences in the minor details of the lobes and sinuses; while, in other cases, species clearly distinguished by external characters of form and ornamentation, may have the septa very similar.

From these remarks, it will be readily seen that great caution and considerable experience are necessary in founding species on small differences in the sutures.

Genus BACULITES, Lamarck.

Synon.—Baculites, Lamarck (1799), Prodr., 80; and (1801) Syst. An., 103.—Roissy (1805), Moll., V, 33.—Montfort (1808), Conch. Syst., I, 340.—Defrance (1816), Dict. Sci. Nat., III. Suppl., 159.—Desmarest (1817), Journ. Phys., LXXXV, 45.—Férussac (1819), Tab. Syst., XXX.—De Haan, Monogr. Amm. et Goniat., 51.—Blainv. (1828), Malac., 380.—J. Sowerby (1828), Min. Conch., VI, 186.—Say (1821), Am. Journ. Sci. and Arts, II, 41.—Morton (1829), Journ. Acad. Nat. Sci. Philad., VI, 89 and 196; also (1830), Am. Journ. Sci. and Arts, 249; and (1834) Synop. Org. Remains Cret. Form. U. S., 42.—Desh. (1830), Encyc. Méth., II, 106 and 326.—Owen (1838), Trans. Zoöl. Soc., II, 2.—G. B. Sowerby (1842), Conch. Man. (2d ed.), 79.—D'Orbigny (1841), Paléont. Franç., Terr. Cret., I, 558.—Geinitz (1845), Grundr. d. Verst., 306.—Hall and Meek (1856), Mem. Am. Acad. Arts and Sci. Boston, V, 398.—Gabb (1864), Palæont. California, I, 80; and (1869) *ib.*, II, 145 and 214.—Stoliczka (1865), Palæont. Indica, I, 196.—Favre (1870), Moll. Craie Env. Lemberg, 27; and of numerous other authors.

Homaloceratites (sp.), Hüpsch (1768), Neue Entdeckungen, III, 110.

Etym.—Baculus, a staff.

Type.—Baculites Vertebralis, Lamarck.

Shell slender, or very elongate-conoidal, more or less compressed laterally, straight, or very rarely a little arcuate along the non-septate portion; aperture ovate-subtrigonal, or subcircular: lip thin, more or less deeply

sinuous on each lateral margin, convex in outline on the antisiphonal side (ventral of some), and extended into a linguiform, or more or less angular, projection on the siphonal side, very rarely sinuous on the antisiphonal margin, with the projection of the siphonal side curved over the aperture; surface nearly smooth, or marked with striæ of growth, costæ, or ridges, and sometimes with nodes, the striæ and costæ, or ridges, corresponding more or less nearly to the curves of the margin of the lip; septa symmetrically divided, nearly always into six principal lobes and six sinuses,* all of which, excepting the antisiphonal lobe, being provided with paired branches; siphonal lobe generally a little shorter than the first lateral lobe; antisiphonal lobe small, and nearly always tripartite, or tridigitate at the end.

As usually understood, this genus seems to me to be divisible into at least two or more marked subgenera, or probably two distinct genera. These sections may be separately defined as follows:

1. BACULITES, Lamarck (typical.)

a. Shell straight throughout; aperture directed forward; lip with lateral sinuses directed backward; the projection of its siphonal margin straight, and its antisiphonal margin convex in outline; interior without regularly-disposed ridges.—(Type as already stated.)

? b. Shell straight posteriorly, but with the non-septate part gently arcuate: aperture a little oblique; appendage of siphonal side of lip arching slightly with the general curvature of the non-septate part, but not curving over the aperture.—(*B. incurvatus*, Dujardin.)†

2. CYRTOCHILU Meek.‡

Shell straight; aperture opening toward the antisiphonal side, and the lateral sinuses of the lip excavated in the opposite direction; projection of siphonal margin of lip abruptly arching over the aperture, and the antisiphonal margin of same deeply sinuous instead of convex in outline; interior with regularly-disposed ridges, leaving oblique constrictions on internal casts.—(*Hamites baculoides*, Mantell (= *Baculites obliquatus*, Sowerby).)

* *B. Neocomiensis*, d'Orbigny, has only four lobes and four sinuses to each septum; while *B. labyrinthicus*, Morton, according to a figure published by Mr. Gabb, has eight lobes and eight sinuses to each septum. These, however, are rare exceptions to the general rule.

† Since this was written, I have examined a specimen of *Hamites arculus*, Morton, from Alabama, and find from the curves of its lines of growth, that the outline of its lip agrees nearly with the lip of this section, and differs entirely from the outline of the lip in *Hamites*. Consequently, I would refer it to this section of the genus *Baculites*.

‡ κυρτος, curved; χειλος, lip.

It is possible that subsection (*b*), ranged doubtfully under *Baculites* proper, and represented by the arcuate *B. incurvatus*, Dujardin, should either stand as a distinct subgenus, or form a subsection under *Cyrtochilus*. The opinion has been expressed that the curvature of this type is abnormal, and I am not aware whether subsequent collections of the same species have warranted this conclusion or not. If the curve is merely accidental, of course the species would appear to present no essential difference from the typical subgenus *Baculites;* but if natural and constant, and especially if the lip of this shell is sinuous instead of convex in outline on the antisiphonal side, as d'Orbigny's figure (Paléont. Fr., t. 1, pl. 139, fig. 8) would seem to indicate, it would be more nearly related to the *Cyrtochilus*, or form an intermediate subgenus between that and the typical *Baculites*.

I am much inclined to believe that the section *Cyrtochilus* should be separated generically from *Baculites* proper. The direction of its aperture, and the curvature of the projection of the siphonal margin of its lip are such, that the head of the animal, and the other parts connected therewith, must have been protruded at right angles to the longitudinal direction of the shell, instead of on a line with the same—a peculiarity that was probably accompanied by important differences in the structure and habits of the animal. It will also be observed that in this type the costæ are strongest on the siphonal side; while, in the typical forms of *Baculites*, they are most generally confined to the lateral surfaces, or most strongly defined there. It is true that *B. Neocomiensis*, d'Orbigny, which agrees in form, so far as known, with the typical *Baculites*, has its costæ in the same way strongly defined on the siphonal side, but it differs from all the other known species in having only four lobes and four sinuses to each septum; and I am not sure whether d'Orbigny's figure represents its lip entire as actually seen, or as inferred from the direction of the costæ. Consequently, it may represent a third entirely distinct section. Other species have also been described with the costæ strongest on the siphonal or opposite side; but I believe they are only known in the condition of fragments that do not show the nature of the aperture and the outline of the lip.

Mr. Conrad, in 1858, used the name *Cycloceras* in a subgeneric sense under the genus *Baculites*;* and on subsequently seeing that *Cycloceras* had been previously used for another type by McCoy, he proposed to change his

* Journ. Acad. Nat. Sci., IV, pl. 47, fig. 5.

subgeneric name to *Cyclomera*.* His type is a fragment of a subcylindrical shell from the Cretaceous rocks of Texas, originally described by him under the name *Baculites annulatus*.† I am not well enough acquainted, however, with it to express any opinion of my own in regard to its relations to the group of shells here under consideration.

The genus *Baculites* resembles in form the genera *Rhabdoceras*, Hauer, from the Trias, and *Baculina*, d'Orbigny, with which types it also agrees in the number of lobes and sinuses of its septa; but it differs remarkably in having these divisions deeply subdivided into digitate branches, instead of being entirely simple. Consequently, it bears similar relations to these more simple types that the *Ammonitoid* forms bear to *Goniatites* and *Clidonites*. It is an interesting fact, however, that the very young *Baculites*, when not more than 0.05 inch in diameter, has the lobes and sinuses of its septa very nearly or quite as simple as those of the adult *Rhabdoceras*;‡ and, from analogy, we may infer that, in the very young *Rhabdoceras*, the septa will be found nearly or quite without lobes or sinuses, and thus present the characters of the old genus *Orthoceras* in this respect.

So far as known, the genus *Baculites* is confined to the Cretaceous system of rocks; the Jurassic species referred to it by Quenstedt (*B. acuarius*) belonging to the genus *Baculina*, d'Orbigny, while the few examples originally supposed to have come from Tertiary rocks were subsequently ascertained to belong to the Cretaceous.

Baculites ovatus, Say.

Plate 20, figs. 2, *a*, *b*, *d*, and 1, *a*, *b*.

Baculites ovatus, Say (1821), Silliman's Am. Jour. Sci. and Arts, II, 41.—Morton (1829), Jour. Acad. Nat. Sci. Philad., VI, 196, pl. v, figs. 5 and 6; and (1830) Am. Jour. Sci. and Arts, XVIII, 249, pl. i, figs. 6, 7, and 8; also (1834) Synop. Org. Rem. Cret. Group U. S., 42, pl. v, figs. 5, 6.—Hall and Meek (1854), Mem. Am. Acad. Arts and Sci., V (n. s.), 399, pl. v, figs. 1 *a*, *b*, and pl. vi, figs. 1–7.

Baculites baculus, Meek and Hayden (1861), Proceed. Acad. Nat. Sci. Philad., XIII, 442.

Shell attaining a large size, elongated and rather gradually tapering; section ovate, the antisiphonal side being more broadly rounded than the opposite (or very rarely a little flattened?); aperture of the same form as the transverse section; extension of the lip on the siphonal side long, tapering, and narrowly rounded at the end; lateral sinuses of same deep, and about half to one-third the greater diameter of the shell; antisiphonal margin of the lip prominently rounded in outline; surface of young and medium-sized specimens generally nearly smooth, while the non-septate part of the adult shell is

* Am. Journ. Concb., II, 76, 1866. † Proceed. Acad. Nat. Sci., January, 1855, p. 265.

‡ See Mem. Am. Acad. Arts and Sci., Boston, V (n. s.), pl. vi.

provided with broad, undefined, obliquely-transverse ridges, or undulations, that arch parallel to the obscure lines of growth, and become nearly or quite obsolete as they approach the siphonal side, on which they are rarely represented by very small, irregular ridges, scarcely distinct from the marks of growth.

Septa moderately closely arranged, or sometimes a little crowded; siphonal lobe nearly twice as wide as long, and provided with two large terminal, widely separated, more or less spreading branches, each of which has sometimes three, and sometimes two, nearly equal, digitate branchlets at the end, and two or three similar lateral ones on the outer side; first lateral sinus about as wide as long, but narrower than the siphonal lobe, and divided at the free end into two short, nearly equal branches, each of which is again less deeply subdivided into about two to three or four sinuous, spreading and digitate branchlets; first lateral lobe oblong-ovate, being longer and narrower than the siphonal lobe, and deeply divided at its end into two very nearly equal branches, with each from four to five spreading and digitate subdivisions, in part generally so arranged as to give the main branches a tripartite appearance at their extremities; second lateral sinus of nearly the same size as the first, and, excepting in unimportant details, similarly branched and subdivided; second lateral lobe broader and shorter than the first, and bearing two large, equal, tripartite, sinuous, and digitafe terminal branches, and small digitate and simple lateral branchlets; third lateral sinus much smaller than either of the others, with two unequal, short, sinuous, and dentate terminal divisions, and a few irregular, short, smaller lateral spurs; dorsal or antisiphonal lobe (ventral lobe of d'Orbigny and others) scarcely as large as one of the terminal branches of the siphonal lobe, longer than wide, with three or four small lateral branches, and normally a trifid free extremity.*

No specimens of this shell, so far as I am informed, have yet been found in a condition to give exact measurements of an entire example. Fragments, however, are not uncommon, measuring about two and a half inches in their greater diameter by about two inches in their smaller, near the aperture; and one septate fragment before me measures 3.60 inches by 3.10 inches in diameter. From the average taper of numerous fragments, it is probable that the length of large unbroken individuals may be nearly three feet.

This species varies more or less in convexity and general form, as well

* This lobe, in the particular septum figured on plate 20, is abnormally bifid at the end.

as in the details of its septa; some specimens tapering more rapidly than others, so that measurements of the angle of divergence from the smaller extremity are not always precisely the same. In most of the medium-sized and smaller fragments, the lateral ridges, or undulations, are nearly or quite wanting, as in that figured on our plate 20*; while, in other larger pieces of the non-septate portion, they are often well marked, as in that illustrated in the Memoirs of the American Academy of Arts and Sciences, Boston, V (n. s.), plate v, fig. 1 *a*.

Some of the more strongly undulated specimens of this shell resemble *B. anceps*, Lamarck; but it is evidently a *much* larger, more robust, and more rapidly tapering species, and is never carinated on the siphonal side, as *B. anceps* is illustrated by d'Orbigny and some other European authors; while the lobes and sinuses of its septa are proportionally deeper, and differ somewhat in their details. In addition to these differences, none of our numerous specimens, of such small sizes as those of *B. anceps* often figured with strong lateral undulations, show this character.

It seems, however, to be more nearly allied to *B. Faujasi*, Lamarck, which some confound with *B. anceps*. In its oval section, rounded siphonal side, and even the details of its septa, it certainly agrees very nearly with *B. Faujasi*, as sometimes illustrated by European authors. But its *very much* larger size, more robust general appearance, and more rapidly tapering form, seem to me to separate it entirely from *B. Faujasi*. Dr. Binkhorst, however, cites it as a synonym of that species in his Monograph of the Gasteropoda and Cephalopoda of the Upper Chalk of Limbourg; but for the reasons already mentioned, I cannot agree with him on this point.

Of the variations of form, &c., noticed among the specimens believed to belong to this species, the following are worthy of note: first, those with a very regularly ovate section, such as represented by our figures 2, *a*, *b*, plate 20, which seems to be the most common form among the Upper Missouri specimens. Occasionally, however, we meet with individuals presenting a more broadly ovate section, as shown by our figure 1, *b*, of plate 20; and although slight differences may be observed in the details of the septa of some of the specimens of these two forms, as shown in our figures 1, *a*, and 2, *d*, of plate 20, these differences are not greater than may be observed

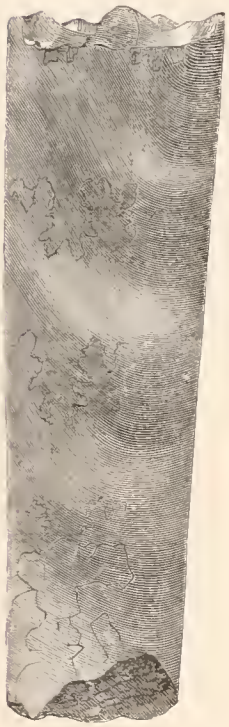
* The outline-restoration of the aperture in this figure, as well as that of *B. compressus* on the same plate, is intended to illustrate the form of the lip only, and not the length of the non-septate last chamber, which is much longer than these outlines would indicate; so that there is not room on the plate to show the full length of this last chamber.

between those of different individuals of either form. Again, we sometimes, though very rarely, meet with a specimen showing a still more convex section, as represented in the annexed cut.

This latter form contrasts so strongly with the others that we were at one time led to believe it a distinct species, and proposed for it the name *B. baculus* (Proceed. Acad. Nat. Sci. Philad., XIII, 445, 1861). As I can, on a more critical examination, make out no essential difference in the structure of its septa, however, from those of the other forms, I am now inclined to think it only a variety of *B. ovatus*, notwithstanding its much more nearly circular section. I am the more inclined to adopt this view, because, on comparison with New Jersey specimens, generally regarded as belonging to *B. ovatus*, nearly, but not quite, as great differences of form are found to exist among them. Mr. Conrad has also described a very similar, though still more convex, form, from the Cretaceous rocks of Mississippi, under the name *B. Spillmani* (Jour. Acad. Nat. Sci. Philad., III, 334, pl. 35, fig 24); but as his specimen does not show the septa, I have no means of making comparisons of internal structure.

Fig. 51.

Fig. 52.



Baculites ovatus, var. *baculus*.

Fig. 51. Section showing its round-ovate form.

Fig. 52. A side-view of a septate part of the shell.

Locality and position.—This species has a wide geographical range in this country; but no form figured from foreign localities seems to belong properly to it. It is common in New Jersey, Alabama, and at numerous localities in the Upper Missouri country*. Among the latter may be mentioned the Great Bend of the Missouri below Fort Pierre, near the base of the Fort Pierre group; also, in the upper beds of the same on Sage Creek and Cheyenne River, and near the eastern base of the Black Hills, all in Dakota. It likewise occurs along the Missouri, between Fort Benton and Fort Union, and on the Yellowstone River, in Montana, as well as at many localities along the eastern base of the Rocky Mountains and elsewhere in Colorado. It ranges all through the Fort Pierre group, and up into the Fox Hills beds of the Upper Missouri Cretaceous series.

* Say's type-specimens come from Monmouth County, New Jersey.

Baculites grandis, H. & M.

Plate 33, figs. 1, *a*, *b*, *c*, and annexed cuts.

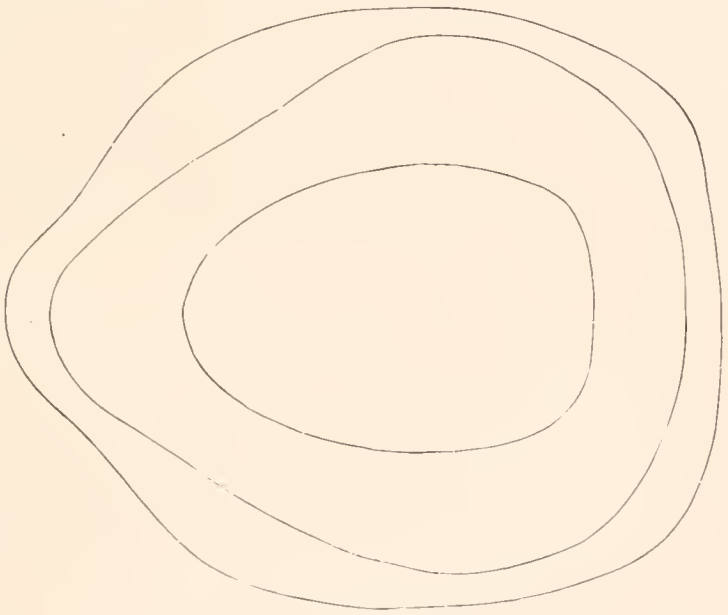
Baculites grandis, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci. Boston, V (n. s.), 402, pl. vii, figs. 1 and 2; pl. viii, figs. 1 and 2; and pl. vi, fig. 10.—Gabb (1861), Synop. Moll. Cret. Form., 21.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 23.

The form represented by the figures on our plate 33 is only known by the specimen there figured, and is merely referred very doubtfully to *B. grandis*. If it belongs to that species or variety at all, it of course must either be a part of a small specimen, or a fragment from below the undulated part of a large one. It presents an ovate section, with a convexity equaling about two-thirds its greater diameter. It is not quite so obtuse on the siphonal side, nor so flattened on the antisiphonal surface, as the corresponding part of the septate portion of the typical *B. grandis*. Like this part of both *B. grandis* and *B. ovatus*, it is entirely without lateral undulations; while in the characters of its septa, it will be seen from our figure to be about intermediate between those two forms; the differences from each being rather in minor details. The terminal branches of its lateral lobes, however, are more like those of *B. grandis*, but its antisiphonal lobe, and some of the details of the others, are more nearly as in *B. ovatus*. As the published figure of a septum of *B. grandis* was made out, however, from a somewhat weathered cast, composed of coarse material, the details of its lobes and sinuses may not have been very exactly determined, particularly the form of its antisiphonal lobe, which was only obscurely seen in the type-specimen.

From the intermediate characters of the specimen figured on our plate 33, between *B. ovatus* and *B. grandis*, I am in doubt in regard to which of these forms it should be referred; and the existence of such a type raises the question whether even the type-specimens of *B. grandis* may not really be very large examples of *B. ovatus*. To any person only familiar with specimens of Say's species of small and medium sizes, such as are usually seen, this suggestion will undoubtedly appear very improbable. Yet, with the large collection of specimens now before me, of all sizes, from the very young up to individuals nearly as large as the largest type-specimen of *B. grandis*, all apparently inseparable from *B. ovatus*, the improbability of the specific identity of these two forms is not so striking as might be supposed: though I am not contending that this can be clearly established from the collections yet known.

One very large specimen now before me from Colorado (I do not know the exact locality), imperfect at both ends, and about half its length consisting of the septate portion, measures nearly twenty-three inches in length, with its greater diameter at its larger end about 3.90 inches by nearly 3.30 inches, and at its smaller about 2.00 inches by 1.50 inches. This specimen presents nearly the same form of section, and the strong, large, lateral undulations on its non-septate part seen in *B. grandis*. Yet the two terminal divisions of its first lateral lobes, instead of being long and merely digitate, are short and distinctly bifid: the subdivisions being armed with sharp, palmately spreading digitations, more nearly as we generally see in *B. ovatus*, with which it also agrees very nearly in the form of its antisiphonal lobe, and, indeed, in the details of its other lobes and sinuses. So we here have a shell agreeing in size, the form of its section, very large lateral undulations, and other external characters, with *B. grandis*; and yet in the characters of its septa corresponding much more nearly with *B. ovatus*. I am not prepared at present to decide to which of those species or varieties it should be referred, nor yet to view it as a third species distinct from both. I rather incline, however, to the opinion that it may be only a very large example of *B. ovatus*.

Fig. 53.



Baculites grandis (sections).

Fig. 53. The ovate inner figure represents the form of a section of a medium-sized specimen, some distance behind the last septum; the middle line represents the form of the section of the non-septate part of a large specimen, measuring between the undulations; and the outer line that of same, measuring over the undulations farther forward. (Reproduced from the original illustration).

Fig. 54.

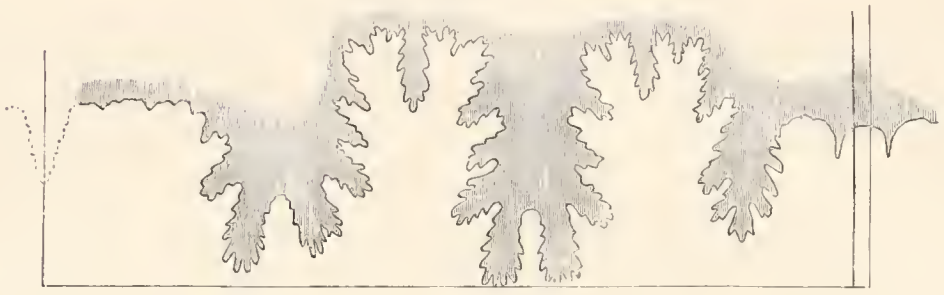


Fig. 54. A septum of same from a smaller specimen, magnified about one-third larger than the natural size.—(After Hall and Meek.)

In order to give the student better means of comparing *B. grandis* with *B. ovatus* than the figures of the form referred doubtfully to the former on plate 33 afford, the preceding cuts from the original published figures of *B. grandis* are added.

Locality and position.—The type-specimens of *B. grandis* were found in the Bad Lands of Dakota, in the very upper beds of the Cretaceous, exposed by ravines cut down through the Tertiary bone-beds. The specimen here doubtfully referred to it, and figured on plate 33, came from the Cheyenne River, near the Black Hills, Dakota. The beds at both localities seem to belong to the Fox Hills group of the Upper Missouri Cretaceous series.

Baculites compressus, Say.

Plate 20, figs. 3, *a*, *b*, *c*.

Baculites compressus, Say (1821), Am. Jour. Sci. and Arts, II, 41.—Morton (1834), Synop. Org. Remains Cret. Group of the U. S., 43, pl. ix, fig. 1; and Jour. Acad. Nat. Sci. Philad., VIII, 211.—Hall and Meek (1854), Mem. Am. Acad. Arts and Sci., Boston, V (n. s.), 400, pl. v, fig. 2; and pl. vi, figs. 8 and 9.—Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 421.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 23.

Shell attaining a large size, rather rapidly tapering, particularly in the young, or near the smaller extremity of adult specimens, strongly compressed laterally in medium-sized examples, but more convex in the young and toward the larger extremity of large adults; non-septate portion of fully-developed specimens, provided with large, broad, lateral undulations; lines of growth generally obscure; siphonal margin sometimes crossed by small, undefined wrinkles; transverse section, like the outline of the aperture, varying with size and age, being ovate in very small specimens, strongly compressed in medium-sized examples, and proportionally more broadly ovate in the large adult.

Septa usually crowded, and with lobes and sinuses deeply divided into slender branches; siphonal lobe nearly twice as wide as long, and provided with two widely-separated, tripartite and digitate terminal branches, and one smaller digitate lateral branch on each side; first lateral sinus as long as the siphonal lobe, but not much more than half as wide, and very deeply divided at the end into two equal tripartite and digitate branches, with spreading subdivisions; first lateral lobe longer than the siphonal lobe, and about half as wide, with two small, parallel, sharply digitate, terminal branches, standing, as it were, on a stem formed by the very narrow body, which also supports on each side two opposite, sharply digitate lateral branches, one pair of which shows more or less tendency to tripart division; second lateral sinus usually a little longer, but otherwise very similar to the first; second lateral lobe shorter and broader than the first, and provided with two equal tripartite and digitate, spreading terminal branches, with much smaller, irregular, lateral branchlets; third lateral sinus usually not larger than one of the main terminal branches of the others, and deeply bifurcated at the end, the divisions being more or less subdivided, or merely digitate; antisiphonal lobe generally only about half as long as the second lateral, and much narrower, with two to four very small lateral branches, or mere digitations on each side, and one small, tridentate, terminal division.

As with *B. ovatus*, this species is only known in the condition of broken specimens, from which accurate measurements of the entire shell cannot be given. It evidently attained as large a size as *B. ovatus;* some of the larger fragments of the septate part measuring about 3.50 inches in their greater diameter, by 2.20 inches in their smaller diameter.

This shell, as may be seen from the illustrations and descriptions, is rather nearly related to *B. ovatus*, but in most cases may be distinguished by its decidedly more compressed form in medium-sized specimens, and differences in the details of the septa. These differences are most strongly marked in the form of the first lateral lobe, which nearly always differs from that of *B. ovatus*, not only in having a more slender body, and like the other lobes more sharply digitate branches, but in also having its two terminal branches smaller, and standing as it were on a narrow stem.

An extensive series of specimens of this shell shows that the young is more rapidly tapering than at any later stage of its growth, and that its section is then proportionally less compressed. Soon, however, it became more

compressed toward the larger extremity of specimens three inches or so in length. At a somewhat larger size, say an inch in diameter, the compression becomes more marked; and at one and a half to about two inches, it is proportionally most strongly developed. Beyond this, the proportional convexity increases again, until it is about as great as usual in *B. ovatus*, though the greatest convexity is near the antisiphonal side, from which the lateral surfaces converge with only moderate convexity to the very narrowly-rounded periphery, so that the section of the non-septate portion of these larger adult examples assumes an ovate-subtrigonal outline.

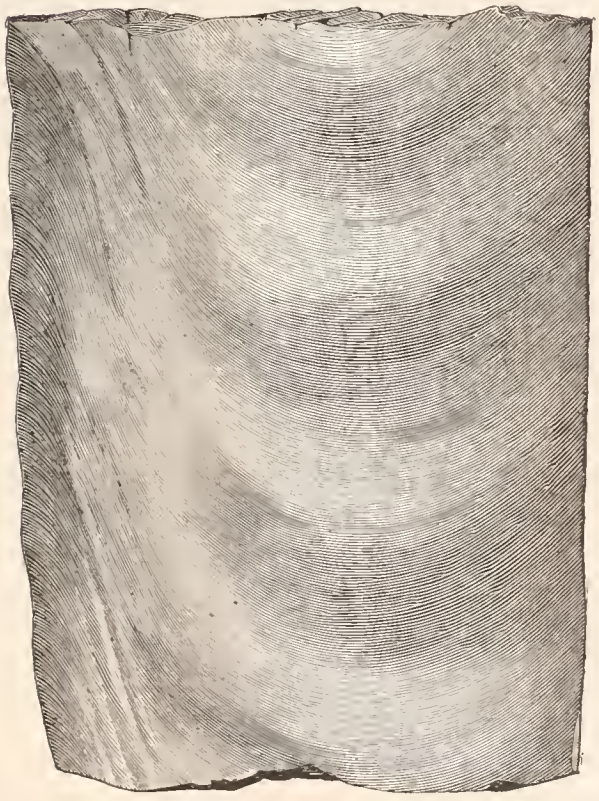
These different forms of the shell at different stages of its growth are illustrated by the following outline cuts; the outer line showing the section of an adult shell; and the next within, its section at medium size, where it is most compressed; while the others show its more oval, or less compressed section at smaller sizes.

Dr. Morton in this country, and M. d'Orbigny and some others in Europe, have regarded this shell as only a variety of *B. ovatus*, Say; while Dr. Binkhorst, in his Monogr. des Gasterop., et Cephalop. de Craie Sup. du Limbourg, page 41, on the contrary, cites it as a synonym of *B. Fanjasi*, Lamarck. In the latter opinion, however, I cannot by any means concur. In regard to its relations to *B. ovatus*, however, there are some reasons for doubt. The distinctions between this shell and *B. ovatus*, as here defined and illustrated, hold good in a very great majority of instances, through large collections, including many hundreds of specimens of all sizes. Still, however, we meet with an occasional fragment, with the compressed form and slender and sharply-digitate lobes of *B. ovatus*, having the little sinus between the two terminal divisions of its first lateral lobe so deep as to obliterate entirely the stem-like part usually supporting them, and thus to give, with the two adjacent lateral branches, a quadripartite appearance, as in *B. ovatus*, instead of the usual tripartite arrangement with the middle division bifid, as we nearly always see in *B. compressus*. Again, on the other hand, we very rarely see fragments with the ovate form of *B. ovatus*, and the slender, deeply divided, and very sharply digitate lobes of *B. compressus*, showing the terminal divisions of the first lateral lobe, very nearly as in *B. compressus*, though supported by a shorter stem-like portion of the body of the lobe than we nearly always see in the latter.

Whether or not these few intermediate types warrant the conclusion that the two forms merely represent different sexes, or varieties of one species, is a question in regard to which there will probably be different opinions. In view of the fact, however, that the compressed form has, so far as I am aware at this time, probably only been found in the far West, where it sometimes occurs with the *ovatus* form, and in other cases where the latter has not been found, I am not yet satisfied that they do not represent two closely-allied, but distinct species, with a tendency of their varieties to blend together.

Fig. 55.

Fig. 56.



Baculites compressus.

Fig. 55. Outlines showing forms of sections at different stages of growth.

Fig. 56. Part of the non-septate portion of a large specimen, showing lateral undulations.

Locality and position.— Say's type-specimens of *B. compressus* were from the Upper Missouri, where they were found near, or at, the Great Bend below Fort Pierre, in the Fort Pierre group of the Upper Missouri Cretaceous series. A part of our specimens came from the same locality and position; while we have many others from higher positions in the same formation on Sage Creek, under the Tertiary at the Bad Lands, and on Cheyenne River; also, from near the mouth of the latter, in Dakota. It likewise occurs near Milk River,

above Fort Union, as well as at several localities along the eastern base of the Rocky Mountains, farther south. I have never seen it from New Jersey, or any other locality east of the Mississippi, though my friend Mr. Gabb cites New Jersey as one of its localities, in his Synopsis of Cretaceous Mollusca.

Baculites asper, Morton?

Plate 39, figs. 10, *a*, *d* (not *b*, *c*).

Baculites asper, Morton (1834), Synopsis Org. Rem. Cret. Group U. S., 43, pl. i, figs. 12 and 13; and pl. xiii, fig. 2.—Gabb (1861), Proceed. Acad. Nat. Sci. Philad., XIII, 394, pl. iii, fig. 4.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 23.

Baculites asperoides, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., 421 (without description).

Of the form here referred doubtfully to Dr. Morton's *B. asper*, only fragments are yet known. It is a small, very gradually tapering shell, with an ovate section, and ornamented along each side, near the antisiphonal margin, both on the septate and non-septate portions, by a row of rather distantly separated, node-like prominences, that show the faintest perceivable tendency to extend obliquely forward and toward the siphonal side, as undulations, parallel to the lines of growth.

At the time we proposed, in a list, to name this shell as a new species, we only knew Dr. Morton's species *B. asper*, from his very brief description and figures of the exterior of fragments, without illustrations or description of its septa. Since that time, Mr. Gabb has published a figure of its septa, as made out by him from Dr. Morton's original type-specimen; and on comparison with this figure, although it shows some rather marked differences in the details of the lobes and sinuses, from the form here under consideration, I am rather inclined to think that it may not be distinct from Dr. Morton's species, especially as it agrees so nearly in size, form, and nodes with his type. The more observable differences consist in the relatively narrower form and more deeply sinuous character of the lateral sinuses of our shell, and its proportionally longer and more deeply-divided second lateral lobe. Still, we sometimes see quite as marked differences in the septa of different individuals of *B. ovatus*. Indeed, the septa of our type, as well as those of *B. asper*, present no very essential difference from those of *B. ovatus*, though both are readily distinguished from the last-mentioned species by their smaller size, and the possession of distant node-like prominences on both the septate and non-septate portions, instead of obliquely-curved transverse ridges or undulations along the sides of the non-septate part only.

My friend Mr. Gabb, finding the septa of *B. asper* corresponding rather nearly with those of *B. anceps*, Lamarck, adopted the conclusion that these forms are really only varieties of one species. To me, however, it seems that the more gibbous form and more rounded siphonal side of *B. asper*, together with its rows of node-like prominences, instead of curved undulations or ridges, ought to separate it from *B. anceps*. A considerable time and attention devoted to the study of specific differences in this genus has led me to the conclusion that we cannot always rely upon the septa alone, in separating species, but that we must also take into consideration external characters of size, form, ornamentation, &c. For instance, if we unite *B. asper* and *B. anceps*, on account of the similarity of the septa, without regard to other characters, I cannot see how we can avoid also including *B. ovatus*, and the gigantic *B. grandis*, in the same species. I can agree with Mr. Gabb, however, in the opinion that *B. carinatus*, Morton, is almost certainly not distinct from *B. anceps*, Lamarck.

Dr. Roemer has (in his Kreidebildungen von Texas, pl. ii, figs. 2, *a*, *b*, *c*, *d*) illustrated a small *Baculites* that he refers to *B. asper*, Morton, which seems to me hardly identical with Morton's species. At least, it differs in having short, curved, angular prominences along each side, instead of rounded nodes. He does not figure the septa, however, so we have not the means of making comparisons of internal characters.

The little fragment represented by figures 10 *b*, *c*, of our plate 39, was at first thought possibly to belong to the same species as that from which the drawings 10, *a*, *d*, were made; but I can scarcely doubt now that it represents a distinct species, its strong, oblique, nearly straight ridges or undulations, extending entirely across the sides, being a very marked feature, contrasting strongly with the node-like prominences on the other specimen represented by figures 10, *a*, *d*. Although I have here referred the latter provisionally to *B. asper*, Morton, its identity with that species is still an unsettled question, and it may yet have to be separated under another name. In that case, I would beg leave to substitute the name *B. asperiformis* for it, instead of *B. asperoides*, which was inconsiderately used in a list only, without a description, and is objectionable in construction.

Locality and position.—Near the mouth of Judith River, Montana; in beds holding a position near the top of the Fox Hills group of the Upper Missouri Cretaceous series.

Baculites anceps, var. obtusus.

Baculites vertebralis, Defrance (1816), Dict. Sci. Nat. Snppl. III, 168 (and of some others, not of Lamarck, 1801).

Baculites dissimilis, Desmarest (1817), Jour. Phys., LXXXV, 48, pl. ii, figs. 4-6.—De Haan (1825), Mon. Amm. et Goniat., 155.

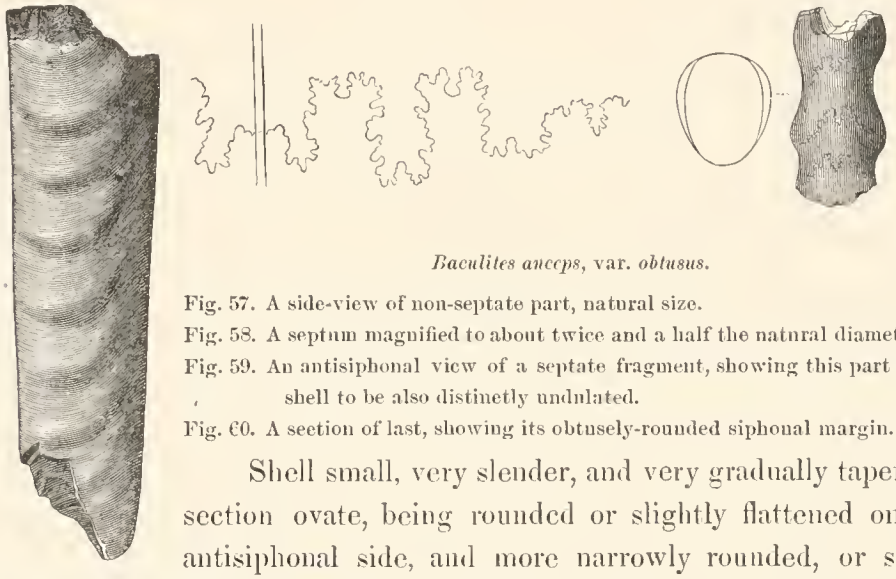
Baculites anceps, Lamarck (1822), An. sans Vert., II, 648.—D'Orbigny (1825), Tab. des Ceph., 75; and (1840), Paléont. Fr. Terr. Crét., I, 565, pl. 139, figs. 1-7.—Deshayes (1830), Encye. Méth., XII, 108; and (1831) Coq. Car., 224, pl. 6, fig. 2.—Brown (1837), Leth. Geog., 732, tab. 33, fig. 5.—Heisinger (1837), Leth. Suec., 31, tab. v, fig. 2.—Roemer (1852), Kreid. von Texas, 36, taf. II, fig. 3, *a*, *b*, *c*, (*d*, *e*, *f*, *g* ?)—Binkhorst (1861), Monogr. Gast. et des Ceph. Craie Snp. du Limbourg, 42, pl. v, figs. 3, *a*, *b*, *c*.—Gabb (1861), Proceed. Acad. Nat. Sci. Philad., XII, 395; and of numerous others.

Baculites Faujasi (part), De Haan (1825), Monogr. Amm. et Goniat., 155; and of some others.

Baculites carinatus, Morton (1834), Synop. Org. Rem. Cret. Form. U. S., 44, pl. xiii, fig. I.

? *Baculites Tippanensis*, Conrad (1858), Jour. Acad. Nat. Sci. Philad., III, 334, pl. 35, fig. 27.

Fig. 57. Fig. 58. Fig. 60. Fig. 59.



Baculites anceps, var. *obtusus*.

Fig. 57. A side-view of non-septate part, natural size.

Fig. 58. A septum magnified to about twice and a half the natural diameter.

Fig. 59. An antisiphonal view of a septate fragment, showing this part of the shell to be also distinctly undulated.

Fig. 60. A section of last, showing its obtusely-rounded siphonal margin.

Shell small, very slender, and very gradually tapering; section ovate, being rounded or slightly flattened on the antisiphonal side, and more narrowly rounded, or sometimes obtusely subangular, and often crossed by scarcely perceptible little ridges on the siphonal margin; lateral surfaces ornamented by strong, regular, arcuate costæ, or undulations, that sometimes become nearly obsolete toward the smaller extremity; septa moderately distant; siphonal lobe wider than long, with two widely-separated, diverging, digitate, terminal branches, and lateral digitations; first lateral sinus slightly longer, and distinctly narrower than the siphonal lobe, and provided with two short, subequal, sinuous and digitate terminal divisions, with one much smaller, slightly sinuous, lateral branch on either side near the terminal ones, and a few other smaller lateral digitations; first lateral lobe of nearly the same size and form as the first lateral sinus, excepting that its short principal lateral branches are broader; second lateral sinus slightly larger, but in other respects agreeing

closely in its details with the first; second lateral lobe as long on the siphonal side as the first, but broader, with two very short, digitate, terminal branches, and short, nearly simple, lateral digitations; antisiphonal lobe small, nearly ovate, and provided with one terminal and about three short, nearly or quite simple, lateral digitations.

Length unknown; greater diameter at the larger end of a specimen, consisting of a portion of the non-septate part, incomplete at both ends, 0.75 inch; smaller diameter of same, measuring across so as to include the undulations, 0.60 inch; same, between the undulations, 0.50 inch.

I refer this little Baculite to *B. anceps* with some doubts, because the specimens have the siphonal side more obtusely rounded than is generally shown in the figures of European forms usually referred to that species; while the lobes and sinuses of its septa do not agree very closely in their details with the published figures of those of Lamarck's species. D'Orbigny seems to think that shell generally carinated on the siphonal side, as he has illustrated it; though some others refer to it forms that have that margin nearly as obtuse as in our shell. Others again illustrate it as having that margin narrow and prominent, but flattened on the edge; while Dr. Roemer refers to it a Texas form even more obtuse on that side than any of our specimens.

Whether or not the true *B. anceps* really varies to such an extent as to include all of these and other forms that have been referred to it, I am unable to express any positive opinion of my own, not having had an opportunity to study an authentic series of European specimens of these forms. If I may be permitted to judge, however, from published figures and descriptions, I should think that shells belonging to more than one species have been included under Lamarck's name. For this reason, I have not cited in the synonymy several names representing forms with which I am not well acquainted, but which have been by others referred to *B. anceps*.

That our shell, however, is identical with the Texas form referred by Dr. Roemer to *B. anceps*, I can scarcely entertain a doubt; and, although it has its siphonal side more obtuse than Dr. Morton's *B. carinatus*, it may possibly be specifically identical with that shell, which agrees well with *B. anceps*, as figured by d'Orbigny, excepting in some of the less important details of the septa. Mr. Gabb has expressed the opinion that Morton's *B. asper* is also a synonym of *B. anceps;* but in this opinion I am not at present pre-

pared to coneur. If *B. anceps* includes Morton's *B. asper*, however, the form here doubtfully referred to the latter should also most probably be included under Lamarck's name.

That the shell here under consideration, as well as the others mentioned, are all specifically distinct from Say's *B. ovatus* and *B. compressus*, I see no reason whatever to doubt. The form here described agrees well in its transverse section with *B. ovatus*, Say, and also presents no essential differences in its septa; but it contrasts *very strongly* with that species in size, as well as in other respects, being very much smaller, proportionally more slender, more gradually tapering, and much more strongly undulated. Its undulations also extend, well defined, farther downward upon the septate part of the shell. That it is not the young of *B. ovatus* is clearly shown by comparing it with specimens of that species of its own size, the latter being always without lateral undulations, and decidedly more rapidly tapering. I have no doubt that this little shell represents the adult size of the species to which it belongs.

It seems rather questionable whether Lamarck's name *B. anceps* ought to be retained, instead of *B. dissimilis*, Desmarest, which latter has priority of date. Desmarest's name has been generally rejected, however, because it was founded on the merely accidental condition of his type-specimen, which had the undulations of one side worn off, so as to make its opposite sides dissimilar.

Locality and position.—Deer Creek, on the North Platte; from the Fox Hills group of the Upper Missouri Cretaceous series. As generally understood, Lamarck's species also occurs in New Jersey, Alabama, and perhaps in Mississippi, and is likewise widely distributed in the Cretaceous rocks of Europe.

ANCYLOCERATIDÆ.

Genus ANCYLOCERAS, d'Orbigny.

Synon.—*Hamites* (sp.), Sowerby and others; not Parkinson, 1811.

Ancyloceras, d'Orbigny (1841), Paléont. Fr. Terr. Crét., I, 491.—Agassiz and Desor (1842), Germ. Trans. Sowerby's Min. Conch., 623.—Geinitz (1845), Grundr. d. Verst., 302 (as a subgenus under *Hamites*).—Meek and Hayden (1858), Proceed. Acad. Nat. Sci. Philad., X, 56.—Chenu (1859), Man. Conch., I, 92.—Ooster (1860), Cat. Céph. des Alpes Suisses, part V, 5.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 23.—Gabb (1864), Palæont. Cal., I, 78; and (1869) *ib.*, II, 138.—Stoliczka (1866), Palæont. Indica, 1, 172.—Roemer (1870), Geol. von Oberschl., 281.

Ancylocerus, King (1844), Ann. and Mag. Nat. Hist., XIV (old ser.), 278.

Etym.—ἀγκύλος, curved; κέρας, a horn.

Examp.—*Ancyloceras Matheronianum*, d'Orbigny.

Shell slender and elongated, with usually an oval section, the whole

being curved on the same plane so as to present a compressed-subelliptic general outline; first turns regularly involute, but not in contact, after which the succeeding portion is deflected more or less nearly straight away from the regular curves for some distance, and then curves back in the form of a hook, without coming in contact with the other parts; surface generally ornamented with annular, often more or less oblique, nodose or spiniferous costæ; septa symmetrically divided into six unequal, branching, and digitate lobes, all of which, excepting the siphonal one, are tripartitely subdivided.

This genus is nearly related to the elongated section of *Scaphites*, such as *S. Ivanii*, Puzos, and *S. gigas*, Sowerby, from which it only differs in form, by having its first turns coiled so as not to come in contact; its relations to that genus being exactly the same as *Hamites* to *Ptychoceras*. In imperfect specimens, showing only the elongated and hooked body-part of these shells, it is difficult to distinguish this genus from *Hamites;* while the regularly-coiled portion of the shell must be with equal difficulty distinguished from *Crioceratites* (usually written *Crioceras*) of Léveillé.

The genus *Ancyloceras* seems to have first appeared during the deposition of the Lower Oolite, and ranges into the Cretaceous, being mainly, or possibly entirely, confined to the lower members of the latter series, where it attains its greatest numerical development. It is entirely unknown in the Tertiaries, or among existing mollusks.

Ancyloceras? uncum, M. & H.

Plate 21, figs. 1, *a*, *b*.

Ancyloceras (*Hamites*) *uncum*, Meek and Hayden (1858), Proceed. Acad. Nat. Sci. Philad., X, 56.

The only specimen of this species yet found is imperfect at both extremities, and consists merely of a portion of the outer chamber. It is a little compressed laterally, and rather abruptly bent in the form of a hook, after which the two extremities seem to be extended in the same direction and on the same plane, with a free space between, equaling near the curve, about half the greater diameter of the larger limb. The surface is ornamented by rather distinct, annular costæ, which are angular, less than the rounded depressions between, and encircle the shell rather obliquely, being somewhat flexuous on the sides, and passing straight across the ventral or outer side, where they support two rows of small nodes. The costæ are rather obscure on the inner side, near which they sometimes bifurcate at the curve.

Greater diameter, 1.73 inches; smaller diameter about 1.22 inches.

I know nothing of the septa of this shell, and, without seeing the other extremity, it is impossible to determine whether it is an *Ancyloceras* or a *Hamites*. It may be at once distinguished, even in fragments, from any of the forms we have referred to the genus *Heteroceras*, by being nearly straight, or only bent in the form of a hook, instead of forming a spiral curve. Its larger size and oval section would seem rather to favor the conclusion that it may be an *Ancyloceras;* but its position in the Upper Cretaceous renders this doubtful.

Locality and position.—South Fork of Cheyenne River, near the Black Hills, where it was found in the Fort Pierre group of the Upper Missouri Cretaceous series. It seems to be a rare species.

PTYCHOCERATIDÆ.

Genus PTYCHOCERAS, d'Orbigny.

Synon.—Ptychoceras, d'Orbigny (1841), Paléont. Fr. Terr. Crét., I, 554.—Morris (1843), Brit. Foss., 184.—Desbayes (1845), in Lamarck (2e éd.), 558.—Quenstedt (1852), Handb. Petref., 379.—Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 134.—Chenu (1869), Man. Conch., I, 95.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 23.—Stoliczka (1866), Palæont. Indica, I, 193.

? *Solenoceras*, Conrad (1860), Jour. Acad. Nat. Sci. (n. s.), IV, 284.

? *Diptychoceras*, Gabb (1869), Palæont. California, II, 143.

Etym.—πτυχή, a fold; *κέρας*, a horn.

Examp.—Ptychoceras Emericianus, d'Orbigny.

Shell slender, elongated, terete, at first straight, but at more advanced stages of growth folded abruptly back upon itself once or twice, the different limbs growing parallel and contiguous, or with the smaller slightly embraced by the larger; aperture oval or subcircular, with the inner side usually rather sinuous; septa symmetrically divided into six generally nearly equal lobes and sinuses, which are more or less branched and digitate; siphuncle always on the ventral or outer side; surface of the young shell often nearly smooth, but developing, at more advanced stages of growth, oblique or transverse costæ, which are strongest on the outer side, or entirely obsolete on the inner or dorsal side.

This genus seems to be most nearly allied to *Hamites* and *Hamulina*, from both of which it differs in having its folded portions in contact with each other, or slightly embracing, instead of free. Its relations to *Hamites* are therefore precisely the same as the elongated forms of *Scaphites* to *Ancyloceras;* in other words, it is a *Hamites* with the different limbs of the shell compressed together.

The original typical species of this genus only show the shell folded back upon itself once. But none of the specimens are entire, the larger folded portion being broken so that it is not possible, without seeing more complete examples, to be sure that the shell may not have made another curve back upon itself, even in these species, as in *Hamites*. Indeed, this reduplicate character has been seen unmistakably present in one of the Indian species, and some of the European, as well as in one of those described by Mr. Gabb from the Cretaceous rocks of California. Upon this character, Mr. Gabb has proposed to found a genus *Diptychoceras;* and if we could be sure that any one of the type-species of *Ptychoceras* only folds back upon itself *once*, in the mature shell, there would seem to be sufficient reasons for the division of the genus thus proposed. Until this question can be settled, however, by more nearly complete specimens, the propriety of such a division must remain doubtful, particularly as it seems quite as probable, judging from analogy, that the reduplication of the shell may take place in adult examples of the typical species of *Ptychoceras*, as in *Hamites*.*

Mr. Conrad has also proposed a genus *Solenoceras* for the reception of *Ptychoceras annulifer* (= *Hamites annulifer*, Morton), a small species that not only had its limbs in contact, but the smaller limb received into a deep furrow along the inner side of the larger. It shows no positive evidence of more than one folding upon itself; but then the specimen is broken off at both ends, so that we can hardly be sure as to the exact form of the mature unbroken shell. At the larger of the broken ends, there is, in the type-specimen, some slight appearance of the commencement of another bend, *outward* or *away from* the inner limb. Unfortunately, however, the specimen is hardly in a condition to be altogether satisfactory on this point. It looks almost as much like the remains of a kind of margined lip, as if the shell had formed there one of those premature thickenings, or constrictions, of the lip, that we have reason to believe were sometimes formed in allied genera during the growth of the shell, to be left behind, or re-absorbed as the shell increased in size. If, however, it *did* make a bend there in the direction supposed, *Solenoceras* would certainly be a good genus. If not, I should think the more deeply-embracing characters of the larger limb could hardly alone form a sufficient generic distinction, as this is a character in which the known

* Of course, in young or half-grown shells, the second folding back upon itself never occurred, this character only being developed in the adult.

species vary to a considerable extent. For these reasons, I have placed *Solenoceras* and *Diptychoceras* doubtfully as synonyms of *Ptychoceras*.

The genus *Ptychoceras* seems to be entirely confined to the Cretaceous system.

Ptychoceras Mortoni, M. & H.

Plate 20, figs. 4, *a*, *b*, *c*.

Ptychoceras Mortoni, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 134.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 23.

Shell small, subcylindrical; larger limb somewhat compressed laterally, round on the outer side, and concave along the inner, for the reception of the closely-appressed smaller limb, which is less compressed laterally, and tapers so very gradually as to appear almost perfectly cylindrical in broken specimens; surface of both limbs ornamented by rather distinct annular costæ, which pass around somewhat obliquely, and become obsolete on the inner side, while, in passing over the ventral or outer side of the larger limb, they sometimes, though rarely, bifurcate, and are each provided with two very small nodes, so arranged as to form two parallel longitudinaal rows; very fine, rather obscure, lines of growth also mark the surface parallel to the costæ.

Septa unusually simple; siphonal lobe oblong, being a little longer than wide, and merely deeply divided into two somewhat spreading, terminal branches, with two short, obtuse, unequal digitations each; first lateral sinus nearly as large as the siphonal lobe, and divided into two short, subequal, smooth, rounded, terminal lobes, that give it a nearly cordate outline; first lateral lobe a little narrower above, but otherwise very similar in size and form to the siphonal lobe; second lateral sinus agreeing nearly in size and form with the first, excepting that its two short, obtuse divisions show a slight tendency to form each two very short obtuse digitations; second lateral lobe almost exactly like the first in size and form; third sinus scarcely half as large as either of the others and merely faintly bilobate at the end; anti-siphonal or inner lobe very small, or not more than half as wide, and but little more than half as long, as either of the lateral lobes, and merely tridigitate at the end.

The only specimens of this shell yet known are too imperfect to afford exact measurements. One of them shows a portion of the non-septate limb 0.93 inch in length, which measures 0.09 inch in its greater diameter at the

larger end, and 0.07 at the smaller; while the smaller limb measures near the curve 0.05 inch in diameter.

I have described this little shell as if only folded once upon itself, so as to form only two limbs; but this is done simply because only one folding is to be seen in any of the imperfect specimens examined. As they are all broken, however, at both ends, it may possibly have folded back upon itself again in adult specimens. In such cases, of course we can only describe what we see. It is remarkable for the simplicity of its septa-lobes and sinuses, and the small size of its antisiphonal or inner lobe; the other known species having these parts more branching and digitate, and the inner lobe proportionally larger. I know of no other described species nearly enough related to it to render a critical comparison necessary.

Locality and position.—Great Bend of the Missouri River below Fort Pierre; from the lower part of the Fort Pierre group of the Upper Missouri Cretaceous series.

SCAPHITIDÆ.

Genus SCAPHITES, Parkinson.

Synon.—Scaphites Parkinson (1811), Org. Rem., III, 145.—J. Sowerby (1812), Min. Conch., I, 53.—Féruss. (1821), Tab. Syst., XIX.—Blainv. (1824), Dict. Sci. Nat., XXX, 190; and Malac., 384 and 623.—D'Orbigny (1826), Tab. des Céphal.; and (1841), Paléont. Française, I, Terr. Crét., 512.—Defr. (1827), Dict. Sci., Nat., XLVIII, 28.—Menke (1828), Synon.; and (1830) *ib.* (2e éd.).—Deshayes (1832), Encyc. Méth., III, 933.—Bronn (1839), Leth., 727.—Gray (1842), Synon. Brit. Mus., 92.—Geinitz (1845), Grundr. d. Verst., 301 (as a subgenus under *Hamites*.).—Quenstedt (1852), Handb. der Petref., 377.—Chenu (1859), Man. de Conch., 1, 91.—Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 281; and (1860) *ib.*, XII, 420.—Binkhorst (1861), Monogr. des Gastéropodes et des Céphalopodes de Craie Sup. du Limbourg, 38.—Favre (1869), Moll. Foss. de la Craie des Environs de Lemburg, 18.

Scaphita, Flem. (1828), Hist. Brit. Ann., 249.

Discoscaphites, Meek (1872), in Hayden's Sec. Ann. Rep. U. S. Geol. Surv. of the Territories, 297 (as a subgenus under *Scaphites*).

Etym.—σκάφη, a small boat.

Type.—Scaphites æqualis, Sowerby.

Shell oval, subcircular or elliptic in general outline, more or less compressed or sometimes gibbous; volutions contiguous or variously embracing in young shells, but last one in the adult more or less deflected and extended from the others, and finally curving backward again; aperture oval or subcircular; lip with a small rim or inflection, but without appendages; septa symmetrical, regularly divided into from four to six lobes and sinuses, nearly always with paired branches, excepting the inner lobe, which is often very

small, and sometimes simple; siphonal lobe generally nearly or quite as large as the first lateral; surface merely costate, or also variously nodose; periphery rounded, or, in nodose species, often somewhat flattened, and margined on each side (especially of the last turn) by a row of larger nodes, rarely with a central row between.

As defined in the foregoing diagnosis, the genus includes several more or less marked sections, some of which might perhaps without impropriety be separated generically from the typical subdivision. These sections may be separately defined as follows:

1. MACROSCAPHITES,* Meek.

Shell with inner turns merely in contact, or so slightly embracing as to leave a very large, shallow umbilicus; periphery rounded; body-portion much extended from the inner volutions; surface costate.—(*S. gigas*, Sowerby, and *S. Ivanii*, Puzos.)

2. SCAPHITES, Parkinson (typical).

a. Shell with inner turns so deeply embracing as to leave only a very small umbilicus, and often forming but a small part of the entire bulk; volutions all rounded on the periphery; surface costate, but without nodes, excepting sometimes a single row around the middle of each side of the body-portion, which is always shorter than in the last.—(Type as already stated.)

b. Differs chiefly in form, by having the involute part generally proportionally larger, and the deflected part shorter; also in having periphery of body-part more or less flattened, with a row of nodes along each of its margins, and sometimes another near the umbilicus.—(*S. nodosus*, Owen.)

†*c.* Differs from the last in having three rows of nodes around the periphery, which is rounded.—(*S. trinodosus* and *S. tridens*, Kner.)

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*I have here departed from the rule more generally followed, of commencing the series with the typical section. This arrangement, however, is necessary in this case, in order to bring nearest together the most nearly related sections.

†This should probably form a distinct subgenus; but I am unacquainted with the septa of these shells.

3. DISCOSCAPHITES, Meek.

a. Shell with general outline subcircular, or slightly oval, and generally much compressed; inner volutions forming a large part of the entire bulk, and so deeply embracing as to leave only a small umbilicus; body-portion so very short as scarcely to become free at the aperture, flattened on the periphery; surface ornamented with costæ, and provided on each side with from about four to nine rows of tubercles, the outer of which are largest and arranged along each margin of the periphery.—(*Scaphites Conradi*, Morton.)

b. Shell differing from the last chiefly in having the volutions so narrow and little embracing as to leave a large shallow umbilicus, and the body-volution deviating very little from the regular curve of the others.—(*Ammonites Cheyennensis*, Owen.)

The most marked distinction between the genus *Scaphites* and the genus *Ammonites*, as the latter is understood in its original comprehensive signification, consists in the deflected and more or less extended and recurved body-portion of the former. In *Scaphites*, however, there is not near so great a diversity in the mode of division of the septa into lobes and sinuses, as in the unrestricted old genus *Ammonites*. Still, there seems to be no means by which the inner coiled portion of a Scaphite, with outer deflected portion broken away, can be distinguished from an Ammonite, unless it might belong to a *species* known by its ornamentation, or some other specific characters.

It is a very curious fact, noticed by d'Orbigny, that in unbroken specimens of *Scaphites*, individuals of all sizes, from the smallest to the largest of the known species, seem always to have the deflected portion, and the lip of the aperture complete. Unless these smallest individuals are merely dwarfed adult specimens, it certainly seems very difficult to account for this fact.

The group *Discoscaphites* often has the characteristic deflection of the body-portion so very slightly marked that both Dr. Morton and Dr. Owen described the species as *Ammonites*. A careful examination of entire specimens of this group, however, always reveals a more or less marked tendency to develop this deflection of the body-whorl, even in such forms as *S. Cheyennensis*, Owen (sp.), and *S. Mandanensis*, Morton (sp.), as may be seen by turning to the figures on plate 35; while the nature of the septa corresponds to that of *Scaphites*.

On the other extreme, the *Macroscaphites* section very closely approxi-

mates *Ancyloceras* in form, almost the only difference being that in the latter the coiled portion of the shell has its turns free instead of in contact. There are, however, marked differences in the character of the septa of these types; those of *Ancyloceras* having the lobes apparently invariably *all* divided into unpaired parts.

So far as known, the genus *Scaphites* appears to be confined to the Cretaceous system. In Europe, according to d'Orbigny, it commenced its existence during the deposition of the Néocomien, or oldest member of that system of rocks, and continued to the close of his division Cénomanien (*Craie Chloritée* of some French writers) But, in this country, we find it well represented in beds holding a considerably higher position, or apparently corresponding to the true White Chalk of Europe. Some of the European authors, however, have, since d'Orbigny's publications were issued, cited species from the upper divisions of the Cretaceous

Although not an especial generic, or even family, character, it may not be out of place to mention the fact here that, as in *Ammonites* and some other allied groups, those problematical bodies called *Trigonellites* (= *Aptychus*) also occur, at least in sections of the genus *Scaphites*, as here understood.

The following remarks of the writer, quoted, with modifications, from a memoir on the Palæontology of the Upper Missouri, published by the Smithsonian Institution in 1865, in the joint names of Meek and Hayden, will serve to convey to the student some idea of the widely different views that have been expressed in regard to the nature of these fossils.

Few objects among all the relics of extinct life have been more puzzling to the palæontologist, or given origin to a greater diversity of opinions, than these. Most of the early palæontologists regarded them as the shells of bivalve mollusks, as did Parkinson, Deslongchamps, and some later investigators; while others supposed them to be the palatal bones of fishes. Others, again, maintained that they are the internal osselets of some extinct Cephalopod allied to *Teudopsis;* and still others that they are an internal organ of the animals that inhabited the shells in which they occur, analogous to that connected with the digestive apparatus of *Bulla* and some other *Gasteropoda* Burmeister supposed them to be external supplementary shell-pieces, designed for the protection of the branchial sac when the animal was protruded from the shell More recently, d'Orbigny, Pictet, and others have

advocated, with much ingenuity, an opinion first suggested by Scheuchzer, that they are the valves of a pedunculated Cirripedes, allied to *Anatifa*.

The impression, however, has for some time been gaining ground among palæontologists that these bodies really are organs or appendages of the *Cephalopoda*, within the shells of which they are so frequently found; and since Darwin has shown that it is against all analogy to regard them as the valves of Cirripedes, perhaps one of the most generally-received opinions has been that they are the opercula of *Ammonites*, *Scaphites*, *Goniatites*,* &c.

This latter opinion, however, is also controverted in the Upper Missouri work cited above, in consequence of its incompatibility with peculiar structure of a very remarkable *Trigonellites* (= *Aptychus*), found in *Scaphites Cheyennensis*, and described in connection with that species farther on. It is also suggested there, without positively adopting this conclusion, that this specimen favors Van Bréda's opinion that these bodies are the oral apparatus of *Ammonites* and other *Cephalopoda*, in which they occur. (See description of an *Aptychus* found in *Scaphites Cheyennensis*, at the end of the description of that species.)

Since these remarks were published, an entirely new view, originally suggested by Professor Keferstein, in regard to the nature and functions of these bodies, has been advocated by Dr. Zittel, Professor Waagen, and Professor Favre; that is, that they were connected with an organ of these ancient *Cephalopoda*, corresponding in position and functions to the nidamentary gland of the female *Nautilus*. Adopting this conclusion, Professor Waagen has proceeded to distribute certain types of the *Ammonitidæ* into groups and sections, based on the presence, absence, or peculiarities of these bodies, as follows:

A. Nidamentary gland without a solid integument (*i. e.*, without an *Aptychus*): *Phylloceras*, Suess; *Lyttoceras*, Suess; *Arcestes*, Suess; *Pinnoceras*, Mojsisovics; and *Trachyceras*, Laube.

B. Nidamentary gland with a solid integument (*i. e.*, with an *Aptychus*).

I. Gland simple, not divided.

i. Integument (*aptychus*) horny: *Arietes*, Waag.; *Ægoceras*, Waag.; *Amaltheus*, Montfort.

ii. Integument calcareous: *Aptychus numida*, Coq. (shell unknown).

* Specimens of *Trigonellites* have been found in Devonian rocks associated with *Goniatites*.

II. Gland double, with the *Aptychus* calcareous.

i. *Aptychus* furrowed externally: *Harpoceras*, Waag.; *Œkotraustes*, Waag.; *Oppelia*, Waag.; *Haploceras*, Zitt.; ? *Scaphites*, Park.

ii. *Aptychus* thin, granulated externally: *Stephanoceras*, Waag.; *Perisphinctes*, Waag.; *Peltoceras*, Waag.; *Cosmoceras*, Waag.

iii. *Aptychus* thick, smooth, and punctate externally: *Simoceras*, Zitt.; *Aspidoceras*, Zitt.*

Not having had an opportunity to examine the evidence on which these conclusions are based, I am unprepared to express any opinion of my own in regard to them. I presume, however, that the grouping proposed by Professor Waagen is only intended to be provisional, as it can hardly be supposed, even if the nature and functions of these fossils could be regarded as definitely settled, that their presence and peculiarities in a sufficiently large number of species of certain groups, or their entire absence from a sufficient number of those of others, have been determined, to warrant the conclusion that future discoveries may not bring to light facts requiring modifications in this proposed grouping of the genera.

I observe that Professor Waagen places *Scaphites* with a mark of doubt in the section of genera having a calcareous *Aptychus*. If *Scaphites Cheyennensis*, described farther on, really belongs to this genus, however, it would probably be an exception to the rule, as we have every reason to believe that its *Aptychus* was corneous. It belongs, however, to a peculiar group, that possibly ought not to be admitted into the genus *Scaphites*.

Scaphites larvæformis, M. & H.

Plate 6, figs. 6, *a*, *b*, *c*.

Scaphites larvæformis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 58; and (1860) *ib.*, XII, 420.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 24.

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 rather long, slender, and straight to the recurvature, thence continued backward until it comes nearly in contact with coiled inner volutions; aperture apparently circular;

* Professor Baird's Ann. Record Sci. and Industry for 1873 (issued in 1874), p. 334.

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 two 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 (Pal. Fr., I, Terr. Crét., 525), 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 Warreni, M. & H.

Plate 6, fig. 5.

Scaphites Warreni, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 177; and *ib.*, 420.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 24.

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.

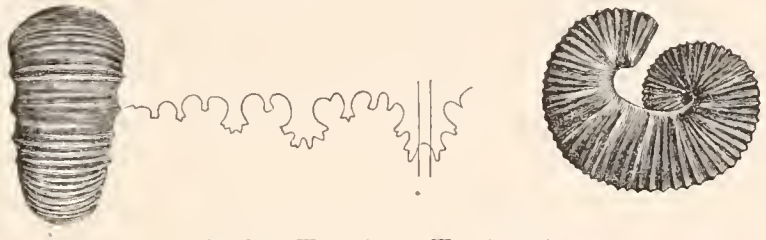
The foregoing description is made out from the original type-specimen of *S. Warreni*, which is unfortunately not in an entirely satisfactory condition, either as to form or ornamentation, while it shows no traces of the septa. I have long had under consideration some fine specimens from Wyoming Territory, and other western localities, agreeing so nearly with it that I cannot believe them specifically distinct, though the imperfect condition of the original specimen renders the comparison not altogether satisfactory.

Before proceeding to make a comparison of these shells, however, I should remark that the specimen from which our figure 5, on plate 6, was drawn, seems to have had its body-part accidentally compressed laterally, while its mouth or lip probably does not end where it would seem to in the figure, but may pass under the rock, and curve farther back toward the involuted part. It is also a little doubtful whether the latter has been worked out correctly, the enveloping rock adhering so firmly to the shell, that in cutting it away, the inner part of the whorl is made to appear smooth instead of costate, and it is not quite clear that this part is so broad as represented. The same difficulty of having to cut away the enveloping rock has prevented the bifurcations of the costæ, particularly the larger ones, from being clearly seen. When due allowances are made for the condition of the original type-

specimen represented on our plate, it will be found to agree more nearly with the Wyoming examples than would appear from the figure of the former as worked out of the matrix; at least, a very critical examination shows that its costæ do bifurcate even, as far as they can be traced around the sides of the inner part of the volution, as in the Wyoming specimens; while the larger ones on the other parts of the body, also, were pinched up, as it were, around the sides, and bifurcate and give off lateral divisions, so that the whole, including intercalated ones, all appear of more nearly uniform size on the periphery than represented on our plate.

The following cuts of one of the Wyoming specimens are given for comparison with the type of *S. Warreni*.

Fig. 61. Fig. 63. Fig. 62.



Scaphites Warreni, var. *Wyomingensis*.

Fig. 61. A peripheral view, natural size.
Fig. 62. A side-view of the same specimen.
Fig. 63. A septum of same, magnified about two diameters.

From these cuts it will be seen that the Wyoming shell, making due allowance for the condition of the type-specimen of *S. Warreni*, and some defects in the figure of the same given on our plate, agrees pretty nearly, though we yet know nothing of the nature of the septa in the latter.

It will also be seen that the Wyoming form agrees *very* closely with the well-known European *S. æqualis* of Sowerby. Indeed, it resembles that shell so nearly that I have sometimes been strongly inclined to regard it as only a variety of the same, even after a direct comparison with European specimens of Sowerby's species.

Sowerby's specimens of his species were imperfect, and did not show the termination of the lip; nor do Mantell's figures of the same (given by him under the names *S. costatus* and *S. striatus*) show the lip; but the latter author describes one of his supposed species as having the aperture "marginated." D'Orbigny also both figures and describes French examples of *S. æqualis* as having a thickened rim around the margin of the lip.

This character is also well marked in a European specimen of that shell now before me. In the Wyoming specimens, however, nothing of this kind is seen; the lip, on the contrary, being abruptly beveled, without the slightest traces of a marginal rim. This I have ascertained to be the case, not merely from examining internal casts, but from seeing, in one instance, a portion of the shell itself remaining at the edge of the lip.

Farther comparisons also show the following additional external differences. In the European specimens of *S. æqualis*, the body-portion, just at the point where the last septum crosses, becomes abruptly more ventricose, and continues so on nearly to the aperture, where it again contracts somewhat. In the Wyoming form, however, this is not the case, the body-part only increasing in size regularly in proportion to the increase of the inner turns. Again, the costæ on the periphery of the Wyoming shell are all quite distinctly larger and more distant, and likewise differ in becoming regularly larger and more distant to, and beyond, the middle of the body-portion, and then again smaller and more closely arranged toward the aperture. But, on the periphery of European specimens of *S. æqualis*, they are larger and less crowded some distance behind the position of the last septum, and become smaller and more crowded to a little beyond the point where the body-part suddenly assumes a more ventricose form, where they are so very fine and close together as to leave only faint traces on internal cast; then beyond this they become gradually larger and more distant on to the aperture; near which they are larger and less crowded than on any other part of the periphery.

The only illustration of the septa of *S. æqualis* I have seen, is that given by d'Orbigny in vol. I, Paléont. Fr., pl. 129. On comparing our cut of a septum of the Wyoming shell, it will be seen that the latter has its principal lobes and sinuses much more simple, and its smaller lobes much narrower and more prominent. I should remark, however, that the septa of the European specimens of *S. æqualis*, now before me, agree more nearly with those of the Wyoming shell than d'Orbigny's illustration of the same does, though still differing in the more slenderly branched and digitate nature of the siphonal and first lateral lobes, as well as in some other details.

From all the means of comparison within my reach, I am inclined, for the reasons already mentioned, to regard the Wyoming specimens as representing only a variety of *S. Warreni*, and at the same time *very* closely allied

to *S. æqualis*. Should a thorough comparison of a good series of specimens from the original locality from which the type of *S. Warreni* was obtained, show it to be specifically distinct from the Wyoming shell, the latter might take the name *S. Wyomingensis*. Even if, on the other hand, it should be thought too closely related to *S. æqualis* to be separated specifically, it would still be distinct enough to stand as a marked variety, under the name *Wyomingensis*.

This and the preceding species belong to the division (*a*) of the typical subgenus *Scaphites*.

Locality and position.—The type-specimen was obtained at the southern base of the Black Hills; in the Fort Benton group of the Upper Missouri Cretaceous series. Dr. Newberry also found this shell at several localities in New Mexico; and Dr. Schiel figures, on plate 3 of his Report on the Geology of the Thirty-eighth and Forty-first Parallels of North Latitude (Pacific Railroad Report, II), a fragment apparently of this fossil. The specimens from Wyoming, illustrated by our cuts, came from Medicine Bow River; and it occurs in the same Territory east of Fort Steele. I have never seen this fossil from any locality east of the Mississippi.

Scaphites vermiformis, M. & H

Plate 6, figs. 4, *a*, *b*.

Scaphites vermiformis, Meek and Hayden (1862), Proceed. Acad. Nat. Sci. Philad., XIV, 22.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 24.

Shell under medium size, ovate-subdiscoidal in form; umbilicus very small; inner regularly-coiled volutions closely involute, deeply 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 cannot 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, Ann. N. Y. Lyceum, Nat. Hist., II, pl. v, fig. 5), 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 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 (Kreid. von Texas,

tab. 1, fig. 4), 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 Mullen, of the United States Topographical Engineers.

Scaphites ventricosus, M. & H.

Plate 6, figs. 7, *a*, *b*; also, figs. 8 and 8, *a*, *b*.

Scaphites ventricosus, Meek and Hayden (1862), Proceed. Acad. Nat. Sci. Philad., XIV, 22.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 24.

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, being 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*, (which is 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 terminal 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 inches.

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 *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.

This and the last described species agree most nearly with division (*a*) of the subgenus *Scaphites*, but still differ in some respects.

Locality and position.—Same as last. Lieutenant Mullen, of the United States Topographical Engineers, collector.

Scaphites nodosus, var. brevis.*

Plate 25, figs. 1, *a*, *b*, *c*.

Scaphites (*Ammonites?*) *nodosus*, Owen (1852), Report Geological Survey Iowa, Wisconsin, and Minnesota, 580, tab. 8, fig. 4.—Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 420.—Gabb (1861), Synop. Moll. Cret. Form., 32.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 24.

Compare *Scaphites compressus*, Roemer (1841), Verst. des Nordd. Kreid., 91, tab. XV, fig. 1 (not d'Orbigny (1840), Paléont. Fr., Terr. Crét., I, 517); and *S. constrictus*, Sowerby (sp.), Min. Conch., pl. 184 *a*, fig. 1.

Shell longitudinally-oval, moderately convex; volutions generally higher than convex, inner ones forming a considerable portion of the entire bulk; deflected or body-portion moderately high, but short, or only becoming a little free at the aperture; periphery rounded throughout; umbilicus small; aperture oval-subquadrate, being higher than wide, and more or less sinuous on the inner side; surface ornamented by small, bifurcating costæ, that are somewhat flexuous on the sides, but become even and nearly straight on the periphery; each side of body-portion also bearing near the periphery a row

* This species (of course including all of its varieties, and the similar European types) compose division (*b*) of the subgenus *Scaphites*.

of rather prominent, subquadrangular nodes, and a few smaller ones along about one-third the height from the umbilicus.

Septa divided into rather deep lobes and sinuses; siphonal lobe longer than wide, nearly oblong in form, and provided on each side with two principal slender branches, the two terminal of which are parallel, longer than the others, and each subdivided into two unequal, sharply digitate branchlets, while the others are scarcely more than sharply digitate; first lateral sinus almost as long and wide as the siphonal lobe, nearly oblong in form, and deeply divided into two unequal, variously sinuous and subdivided branchlets; first lateral lobe narrower and shorter than the siphonal lobe, and provided with two nearly equal, bifid, and sharply digitate terminal branches, and on each side, with one much smaller, merely tridentate, lateral branch; second lateral sinus much smaller, and proportionally narrower than the first, and nearly equally divided into two deeply sinuous and more or less subdivided terminal branches, with some smaller, nearly simple, lateral divisions; second lateral lobe not more than half as long and wide as the first, but very similarly branched; third lateral sinus much smaller than the second, and divided at the end into two equal, slightly sinuate, terminal branches, with some small, obtuse, lateral projections; third lateral lobe not larger than one of the terminal branches of the second, and trifid at the end, the divisions being very small and nearly or quite simple. Farther in there is a minute, simple projection, that probably represents the minute fourth lobe in some of the other varieties.

This shell differs from Dr. Owen's type of his *S. nodosus*, in having its non-septate deflected portion of the last volution much shorter, and its inner volutions more compressed, while the nodes near its umbilicus are decidedly smaller. I have not had an opportunity to compare it with Dr. Owen's type-specimen, and his figure of a septum of the same is evidently not drawn with sufficient completeness and accuracy of detail to afford a satisfactory means of comparison of internal structure. Nevertheless, from the similarity of form and ornamentation, I cannot doubt that our shell is not more than a mere variety of the same species.

On comparison with foreign species, our shell will be found to resemble so closely some of the European forms referred to *S. constrictus*, Sowerby (see Descrip. des Moll. Foss. Craie des Env. de Limbourg, pl. v, fig. 2, by Ernest Favre), that there really seem to be scarcely any external characters

by which it can be distinguished. Indeed, I am much inclined to think there is really no well-defined specific difference, though I have no knowledge of the nature of the septa in the forms figured by Favre. D'Orbigny figures a much more compressed shell in the Paléont. Fr., Terr. Crét., I, pl. 129, under Sowerby's name *S. constrictus*, which, with the exception of its greater compression and smaller size, also nearly resembles some specimens of that under consideration in general appearance. His illustration of a septum of a French specimen, however, will be seen to present rather marked differences from those of all the varieties of the American forms, particularly in the possession of a greater number of the small inner lobes.

When we take into consideration the variability of these shells, however, as known here, there are certainly some reasons for believing that the whole series might, without impropriety, be included as varieties of *S. constrictus*. As Dr. Owen has, however, already separated one of these shells under a new name, I prefer to retain this arrangement until a good series can be compared with the European species.

Dr. Owen's type should also be compared with *S. compressus*, of Roemer, which seems to be a similar, but doubtless distinct species, if accurately figured.

Locality and position.—Dr. Owen's type-specimen came from near Cheyenne River, Dakota, where it was found in the upper part of the Fort Pierre group. Ours is from the same horizon on Yellowstone River, Montana, 150 miles above its mouth.

Scaphites nodosus, var. quadrangularis.

Plate 25, figs. 3, *a*, *b*, *c*; 2, *a*, *b*, *c*; and fig. 4.

Scaphites nodosus, var. *quadrangularis*, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 420.—Gabb (1861), Synop. Moll. Cret. Formation, 32.
Scaphites nodosus, var. *exilis*, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 420.

This variety differs from the preceding, not only in its usually smaller size, but also in having its periphery flattened, its umbilicus rather larger, and its body-part narrower in its vertical diameter, as well as less straightened along its upper margin. Its inner row of nodes will also be seen to be nearer the umbilical margin, and the outer rows near the periphery; the latter character being of course due to the flattening of the periphery. There will also be seen to be some slight differences in the details of its septa

(fig. 3, *c*), particularly in the form of its third lateral lobe, and the presence of a small fourth lateral.

Compared with Dr. Owen's typical form of *S. nodosus*, it will be seen to differ even more strongly than the last, in form and several other respects.

Still, I have been unable fully to convince myself that, like the last, it is not a small, shorter variety of the same species.

Some specimens of this variety, such as that represented by our figures 2, *a*, *b*, are more compressed than that for which the variety-name *quadrangularis* was proposed, but agree nearly in other respects. These are even more nearly like d'Orbigny's figures of *S. constrictus* than the last, but they are still more convex and have a less constricted aperture, while they present similar differences in the details of the septa.

Locality and position.—Same as last.

Scaphites nodosus, var. plenus.

Plate 26, figs. 1, *a*, *b*, *c*.

Scaphites nodosus, var. *plenus*, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., 420.—Gabb (1861), Synop. Moll. Cret. Form., 33.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 24.

This form differs from the typical *Scaphites nodosus*, not only in its proportionally shorter deflected body-part, but also in its much more gibbous form, and in the smaller size of its inner rows of lateral nodes, which are placed nearer the umbilical side. It also sometimes shows a slight tendency to develop a third intermediate series of very small lateral nodes about midway between the other rows, such as I have not seen in any of the other varieties.

This tendency, however, is only manifested by a scarcely perceptible swelling of the costæ at this point, and consequently, escaped the attention of the artist in drawing the figures; while even this faint tendency is not constant.

Compared with the foregoing forms regarded as varieties of *S. nodosus*, this shell also presents a remarkable contrast, both in form and size. So great indeed is the difference that it seems difficult to believe that it can be properly regarded as even a marked variety of the same species as that represented by our figures 2, *a*, *b*, of plate 25; and, although I continue here to range it provisionally as a variety of *S. nodosus*, I am not altogether free from doubts on this point. Still, when we come to compare it with Owen's figure of the typical *S. nodosus*, and with the intermediate forms represented

on our plate 25, little is found to distinguish it from the same, excepting its very ventricose form, a character not alone generally reliable for distinguishing species in this and allied groups of shells. Its septa will be observed to agree almost exactly, excepting in mere minute individual details, with those of the variety *brevis*, figured on plate 25, and to present the same differences in the smaller lobes from the variety *quadrangularis*, that the variety *brevis* does. At one time I was rather inclined to think that this great difference in the convexity of these shells might be merely sexual; but the fact that the variety or species *plenus* was only found at a locality on Yellowstone River (where it occurs associated with some of the more compressed forms), while no specimens of it were found at numerous other localities where the latter forms are common, does not seem to sustain this view.

Locality and position.—Yellowstone River, 150 miles from its mouth; in the upper part of the Fort Pierre group of the Upper Missouri Cretaceous series. The splendid specimen figured on our plate 26 was discovered by Lieutenant (now General) G. K. Warren, of the United States Topographical Engineers.

Subgenus DISCOSCAPHITES.

[Section *a*.]

Scaphites Conradi, Morton (sp.)

Plate 36, figs. 2, *a–c*.

Ammonites Conradi, Morton (1834), Synop. Org. Remains Cret. Group U. S., 39, pl. 16, figs. 1, 2, and 3 (not fig. 4, pl. xix).

Scaphites Conradi, d'Orbigny (1850), Prodr. de Paléont., II, 214.—Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., 284.—Gabb (1861), Synop. Moll. Cret., 32 (not *S. Conradi*, von Buch (1849), Bull. Géol. Soc. Fr., VI, 2e sér.)

? *Scaphites pulcherrimus*, Roemer (1841), Verst. norddeutschen Kreidegeb., 91.

Ammonites Danæ, d'Orbigny (1850), Prodr. de Paléont., II, 213.

Ammonites Nebrascensis, Owen (1852), Report Iowa, Wisconsin, and Minnesota, 577, pl. 8, fig. 3; and pl. 9, fig. 2.

Shell short-oval-subdiscoid or subcircular in outline, and rather strongly compressed, often attaining a very large size; section of volutions oval, being higher than wide; inner turns closely involute and deeply embracing, generally nearly rounded on the periphery; umbilicus small; deflected part of outer volution very short, and scarcely, or not at all free at the aperture, which is oval, or with inner side more or less sinuous; surface ornamented with moderate-sized, straight, or sometimes slightly arched costæ, some of which bifurcate once or twice, while shorter ones are occasionally intercalated between the others; costæ all passing nearly straight across the periphery,

but often becoming nearly or quite obsolete toward the aperture on the non-septate deflected part of the outer volution—all occupied by the little nodes of the lateral surfaces, of which about six to eight concentric rows may usually be counted on each side of the volutions; nodes of outer row around each margin of the flattened periphery, larger than the others, and sometimes compressed.

Septa rather deeply divided into four principal lobes and as many sinuses on each side of the siphonal lobe, which is nearly oblong in form, about twice as long as wide, and bears three slender digitate main branches on each side, the two terminal of which are a little longer than the others; first lateral sinus as long as the siphonal, and a little wider—provided with three nearly equal, slender, deeply incised and digitate terminal branches and smaller lateral divisions; first lateral lobe as long as the siphonal, and nearly of the same breadth at its free end, where it is provided with two unequal branches, the larger of which (that on the inner side) is subdivided into three digitate branchlets, and the smaller into two, while its slender body supports one or two small, partly digitate, diverging lateral branchlets; second lateral sinus shorter than the first, and scarcely more than half as wide, with two nearly equal bifid and serrated terminal branches, and several short, obtuse, irregularly-notched, alternating lateral divisions, the sinuses between which are so deep as to give the body a very narrow, zigzag appearance; second lateral lobe a little more than half as long and wide as the first, and provided with two bifid and digitate terminal branches, and one small, nearly or quite simple, diverging lateral branchlet on each side of its slender body; third lateral sinus shorter than the second, but of nearly the same breadth, with a very slender body and two nearly equal, irregularly trifid subdivisions; third lateral lobe rather more than half as long and wide as the second, and very similarly formed; fourth lateral sinus half as long and wide as the third, with two small, irregularly serrated, terminal branches; fourth lateral lobe small, and bifid at the end, the two divisions being very short and bi- or tri-dentate.

Length of largest example, 6.30 inches; height of same, 5.70 inches; convexity, about 2.70 inches.

The foregoing description of the septa was prepared from the specimen represented by figs. 2, *a*, and 2, *b*, of plate 36, regarded as belonging to the typical form of the species, as it seems to agree in all essential characters

with Morton's type, though attaining a very much larger size, and consequently differing somewhat in the smaller details of the septa. In comparing our figure of its septa with those of the smaller-sized individuals from Alabama and New Jersey, it should be kept in mind that the details of the septa of these shells vary according to the size of the specimen, and the precise position of the subdivisions of the lobes and sinuses with relation to the costæ and nodes, which often, as it were, push aside and distort smaller subdivisions. Indeed, I find, on comparison of different individuals, that no two of them agree *exactly* in the minor details of the septa, those of gigantic specimens like that represented by our figure 2, *e*, being much more complex than in smaller individuals.

The specimens of this species figured by Dr. Owen under the name *Ammonites Nebrascensis* have the deflected part of the outer volution broken away, in which condition they are, of course, undistinguishable from the genus *Ammonites*, as formerly understood in its more comprehensive signification.

At least in external characters, *S. pulcherrimus* of Roemer, cited doubtfully in the foregoing synonymy, seems to be very closely allied to this species, and I am much inclined to believe that a comparison of specimens may show them to be identical. As Roemer does not figure the septa of his shell, however, and only illustrates the exterior of an imperfect specimen, this question can only be settled by a direct comparison of the shells themselves, or of good figures.

Locality and position.—Dr. Morton's type-specimens of *S. Conradi* were from the Upper Cretaceous beds of Alabama. It also occurs at the same horizon in New Jersey. I have likewise seen specimens of it from the Saskatchewan, British America, in Professor Hind's collections. Our specimens came from the same formation (Fox Hills group), at Fox Hills, Long Lake, Moreau River, and near the eastern base of the Black Hills, Dakota.

Scaphites Conradi, var. gulosus, Morton.

Plate 36, fig. 1.

Ammonites Conradi, var. *gulosus*, Morton (1834), Synop. Org. Rem. Cret. Group U. S., 39, pl. xvi, fig. 2.
Scaphites Conradi, var. *gulosus*, Gabb (1861), Synop. Moll. Cret. Form., 32.
Compare *Scaphites iris*, Conrad (1856), Jour. Acad. Nat. Sci. Philad., III (n. s.), 335.

Of this variety we have figured a perfect and well-marked specimen, which agrees in almost every respect, excepting its larger size, with Dr.

Morton's figure and description. It differs from the typical form of *S. Conradi*, in being a little more gibbous and in having two or three rows of tubercles less on each side. The deflection and widening of the non-septate portion of its outer whorl are also less distinctly marked, and the costæ on that part of the shell, instead of gradually growing finer and more crowded, become entirely obsolete toward the aperture. In the smaller number of its lateral tubercles, its rather narrower whorls, and, as far as we have been able to see, in the characters of its septa, it somewhat approaches *S. Cheyennensis*. Owen, but it differs remarkably from that form in the very small size of its umbilicus.

Mr. Conrad has figured and described under the name *Scaphites iris* (cited above), from the Cretaceous of Mississippi, a fragment of a form very like this, but he states that its septa are very different.

Locality and position.—Fox Hills, Long Lake, Moreau River, &c.; from the Fox Hills group of the Upper Missouri Cretaceous series.

Scaphites Conradi, var. intermedius.

Plate 34, figs. 3, *a*, *b*, *c*.

Shell oval-subcircular, much compressed: volutions so deeply embracing as to leave only a very narrow umbilicus, all rather distinctly compressed laterally, inner ones narrowly rounded on the periphery; last, or deflected half of outer turn so very short as not to become free at the aperture, somewhat widened and straightened near the umbilicus above, and narrowly flattened on the periphery, the flattening sometimes also continued less distinctly defined around on the inner half; aperture oval, being longer than wide, and more or less sinuous on the inner side; surface ornamented by numerous, somewhat flexuous costæ, which increase by division and the intercalation of shorter ones between, so as to number about five times as many around the periphery as at the umbilical side—those of each side of the inner volutions, as well as the inner half of the outer, being provided with about five revolving rows of small tubercles, exclusive of the row of rather larger ones around each side of the narrow periphery; costæ of the last half of the outer volution becoming very fine, crowded, and nearly or quite destitute of tubercles, excepting the two peripheral rows, which are largest and most widely separated on the lower side of this part.

Septa rather deeply divided into four lobes and four sinuses on each side

of the siphonal lobe, which is oblong in form, being about one-fourth longer than wide, and provided with three unequal branches on each side, the two terminal of which are nearly parallel, bifid, and digitate, and the laterals smaller and merely digitate, or in part nearly simple; first lateral sinus as long as the siphonal lobe, but wider, and divided at the end into two very unequal terminal branches, of which that on the siphonal side is much broader than the other, and like it provided with three or four slender, obtusely dentate branches; first lateral lobe about the size of the siphonal, or a little longer, and provided with two branches on each side, the two terminal of which are spreading and unequal, that on the siphonal side being shorter than the other and merely bifid and digitate, while the other is tripartite and digitate, its terminal branch being long; second lateral sinus considerably smaller than the first, with a narrow body bearing two small, bifid, terminal branches, and one or two short, unequal, alternating lateral divisions, one of which, on the siphonal side, is broad and obscurely trilobate at the end; second lateral lobe a little more than half as long and wide as the first, with two short, nearly equal, obtusely dentate terminal branches, of which the one on the siphonal side shows a tendency to bifurcate; third lateral sinus hardly more than half as large as the second, with merely two or three short terminal, partly-lobed divisions; third lateral lobe only about as large as one of the terminal divisions of the second, nearly oblong in form, and showing a slight tendency to trilobation at the end; fourth lateral sinus smaller than the third, and provided with two short, spreading, terminal branches, with trilobate and bilobate ends; fourth lateral lobe somewhat larger than the third, and rather deeply divided into two short, spreading, bilobate, terminal branches.

Length, 2.91 inches; height, 2.51 inches; convexity, 0.95 inch.

This form holds almost an exactly intermediate position, as it were, between the typical *S. Conradi* and *S. Nicolletii*, Morton (= *S. comprimis*, Owen), both in external and internal characters. Externally, it differs from the first in being more compressed, and in having its lateral tubercles almost entirely confined to the inner volutions and the inner half of the outer one. Its septa also conform very closely to those of the typical *S. Conradi*, excepting that their divisions are proportionally shorter, less sharply digitate, and their third lateral lobe much smaller and less deeply divided.

I have described this form in more detail than is usually necessary for a

mere variety, because it may yet prove to be specifically distinct from *S. Conradi.*

Locality and position.—Moreau River, Dakota; from the Fox Hills group of the Upper Missouri Cretaceous series.

Scaphites Nicolletii, Morton (sp.).

Plate 34, figs. 4, *a*, *b*, *c*, and 2, *a*, *b*.

Ammonites Nicolletii, Morton (1841), Jour. Acad. Nat. Sci. Philad., VIII, 209, pl. 10, fig. 3.
Ammonites Nicolletii, Owen (1852), Report of U. S. Geol. Survey of Wisconsin, Iowa, and Minnesota, tab. viii, fig. 1.
Scaphites (Ammonites?) comprimis, Owen (1852), *ib.*, 580, tab. vii, fig. 4.
Scaphites Nicolletii, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 281.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 24.

Shell oval-subcircular, much compressed; volutions so deeply embracing as to leave only a small umbilicus, all strongly compressed laterally, inner ones narrowly rounded on the periphery; deflected part of last turn so very short as not to become free at the aperture, narrowly flattened on the periphery below, and somewhat widened and straightened along the upper margin near the umbilicus; aperture narrow-oval; surface ornamented by numerous small, somewhat flexuous costæ, which increase by division and intercalation so as to number about five times as many around the periphery as at the inner side; costæ everywhere without tubercles or nodes, excepting a single row along each side of the flattened periphery of the outer volution, all crossing the periphery with a moderate forward curve.

Length, 2.31 inches; height, 1.92 inches; convexity, about 0.62 inch.

The septa of this form correspond so nearly in their general features to those of the last (as may be seen by our figures on plate 34) that the differences can be pointed out in a few words. In the first place, the terminal divisions of its siphonal lobe are a little shorter, and show a disposition to bifurcate, and the succeeding lateral pair of branches are proportionally a little larger than in the last. Its first lateral lobe also differs in having its body narrower, and its two terminal branches much more nearly equal, with differently-formed subdivisions. Again, its second lateral lobe shows more of a disposition to tripartite division, with more spreading branches. Its third lateral lobe is much more decidedly trifid, and its fourth smaller and less deeply bifid, while between the last and the umbilicus there are two very small projections not seen in the last-described form.

These differences in the details of the lobes and sinuses of the septa

are not, it must be confessed, very important, or even not greater than we may frequently see between those of different individuals of the same species; but it must be remembered that we do sometimes see the septa of species clearly distinct, as regards all other characters, quite as nearly alike as these. A more important difference, however, is the entire absence of tubercles on the sides of all the volutions, both inner and outer, of the form under consideration; while in the last they are well developed on the inner turns, as well as on a part of the outer one. Again, it will be observed that the costæ are proportionally smaller and more crowded on all of the inner volutions of the form here described than in the last, which is also decidedly more convex.

Our specimens of this shell agree in nearly all respects with Dr. Morton's figure of his *A. Nicolletii*, as well as with Dr. Owen's figures cited at the head of this description, and I cannot doubt that they all belong to the same species.

It will be observed that this shell departs from the *Discoscaphites* group in one rather prominent character; that is, in the entire absence of tubercles on the sides of its volutions. From its close general relations to the last, however, in which that character does occur, both in form and in the details of its septa, it seems improper to place it in any other section.

Among foreign species, it may be compared with varieties of *S. constrictus*, Sowerby (sp.), as illustrated by d'Orbigny (Paléont. Fr., Terr. Crét., I, pl. 129, fig. 8), which it nearly resembles, though its last turn seems never to become so free at the aperture, and the deflected part of its body-volution wants the broad costæ or undulations seen on that shell, which also has more prominent nodes around the angles of its periphery. The lobes and sinuses of the septa in these shells are also very similar, except in details Our shell, however, does not present the varieties of form illustrated by d'Orbigny's figures of *S constrictus*, being very constant in general form, and the breadth (height) of the deflected part of the last turn. Possibly, it may not be distinct from Sowerby's species; but, without specimens of that shell for comparison, I do not feel warranted in adopting that conclusion.

Locality and position.—Moreau River, Fox Hills, Long Lake, &c., Dakota, and Yellowstone River, Montana; in the Fox Hills group of the Upper Missouri Cretaceous series. Dr. Morton's type-specimens were from Dakota, but the exact locality is not given.

[Section *b*, of subgenus Discoscaphites.]

Scaphites Cheyennensis, Owen (sp.).

Plate 35, figs. 3, *a–i*.

Ammonites Cheyennensis, Owen (1852), U. S. Geol. Report Wisconsin, Iowa, and Minnesota, 578, pl. vii, fig. 2.
Ammonites Nebrascensis?, Owen (1852), *ib.*, pl. viii, fig. 2.
Ammonites Morcauensis, Owen (1852), *ib.*, 579, pl. viii, fig. 7.
Scaphites Conradi (part), Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., viii, 281.
Scaphites Cheyennensis, Meek and Hayden (1860), *ib*, xii, 420.

Shell slightly oval or subcircular, compressed; umbilicus very wide, shallow, and showing about half the breadth of each inner whorl; volutions increasing gradually in size, a little compressed laterally; last one but slightly deflected from the regular curve of the others, rather narrowly flattened on the periphery, and subrectangular, but not dilated or straightened along the umbilical side, scarcely or not at all free at the aperture, which has a subcordate outline; surface ornamented by distinct, rather angular, slightly flexuous costæ, which increase in number chiefly by the intercalation of two, three, or more shorter ones, between each two of those that pass entirely across from the periphery to the umbilical side, all passing straight over the periphery, and, excepting on the last half of the outer volution, bearing on each side small nodes so arranged as to form four or five revolving rows, exclusive of a row of larger ones on each side of the flattened periphery.

The septa of this species are divided into lobes and sinuses so nearly like those of *S. Conradi*, already described, that they can be sufficiently characterized by pointing out the few differences. In the first place, it may be mentioned that both its lobes and sinuses are all proportionally a little wider and shorter than those of *S. Conradi*, while its siphonal lobe has its terminal divisions a little more spreading, and only one instead of two slender dentate lateral branches. Its first lateral sinus is less deeply divided by its auxiliary lobe, while its two terminal divisions are of more nearly equal size, the left division being also distinctly tripartite. Its first lateral lobe has a proportionally broader body, and its two terminal divisions are more spreading and more equally bipartite. The difference of its second lateral sinus from that of *S. Conradi*, are of a similar nature to those seen in its first; and the same may be said in regard to its second lateral lobe. Its third lateral lobe is, like the other, shorter and wider than that of *S. Conradi*, and more equally bipartite, with much shorter divisions; while its fourth lateral lobe differs very little, excepting in breadth, from the corresponding lobe of *S. Conradi*.

It should be remembered, however, that the differences here noted are not always so strongly marked as in the septum figured.

This species seems to be somewhat related to Morton's variety *gulosus* of *S. Conradi*, but differs remarkably in its large open umbilicus, showing all of the inner volutions, and in having the last half of its outer volution scarcely deflected at all from the regular curve of the inner turns, or in the slightest degree dilated or straightened along the umbilical side. The sides of the last half of its outer volution are also without nodes, though distinctly costated; but the costæ that extend entirely across to the umbilicus, terminate along its margin in comparatively large node-like prominences.

Although at one time inclined to think this shell an extreme variety of *S. Conradi*, a study and comparison of more extensive collections, some years back, satisfied me that it is an entirely distinct species.

The very slight deviation of the last half of its outer volution from the regular curve of the others, with its large open umbilicus, give it very much the appearance of an Ammonite, to which genus Dr. Owen referred it. He saw only specimens consisting of inner volutions, without the very slightly-deflected half of the last turn, like the specimen represented by our figure 3, *c*; but it is evident that he would have referred even perfect specimens to *Ammonites*, had he seen them, from the fact that he was in doubt whether even his *Scaphites nodosus*, in which the characters of the latter genus are much more decidedly marked, might not belong rather to the genus *Ammonites*. Its close relations, however, to *S. abyssinus*, Morton, in which the characteristic deflection of the body-part is sometimes unmistakable, together with the general similarity of its septa to the genus *Scaphites*, and the scarcely observable tendency of the last half of its outer volution to deviate from the regular curve of the others, are sufficient reasons, I think, for placing it in the latter genus. The existence of such exactly intermediate forms, however, between the *Scaphitoid* and *Ammonitoid* types, is an interesting example of the blending together through a comparatively few species of groups that seem strongly distinct, as represented by great numbers of others.

A single fragment of the outer non-septate portion of this species, represented by figure 3, *d*, of our plate 35, is accidentally broken in such a manner as to expose within, an exceedingly interesting specimen of one of those curious bodies for which Parkinson in 1811 proposed a generic name *Trigonellites*, afterward (in 1831) named *Aptychus* by Meyer. This specimen was

fully described by the writer in 1865, on pages 118 to 121 of a memoir published by the Smithsonian Institution on the Palæontology of the Upper Missouri, in the joint names of Meek and Hayden, already cited in connection with the genus *Scaphites*. From that description and remarks, the following paragraphs are quoted, with some modifications, and references to the figures on the plate here given, instead of to the wood-cuts inserted in the text as originally published.

"The specimen here under consideration is thin, and seems to have been composed of a single lamina showing no cellular structure, and possibly consisting only of the inner layer. It is the only organic body found in the fragment of the shell; the surrounding space being filled with fine, indurated, sedimentary matter, similar to that in which the shell was originally enveloped. It occupies a position apparently about one-fourth of the distance back from the aperture to the first septum, and lies with the two valves partly open and in their natural position with relation to each other; their straight edges being joined together, and deflected so as to form a distinct carina, come in contact with the peripheral side of the shell, as shown in figure 3, *d*, plate 35; while the truncated or left ends of the two valves, as they would appear if opened and flattened out, as seen in figure 3, *i*, are directed toward the aperture of the shell.

"The fact, however, to which especial attention is called, is the occurrence of a third piece, or appendage (see figures 3, *f*, *g*, *h*, representing an under, lateral, and upper view of this part as seen in figure 3, *d*, in place, exposed by the breaking away of a part of one of the valves), differing entirely from either of the two valves already noticed, and, so far as known, from anything previously found in connection with any of these fossils. This third piece, as already explained, occupies a position between the two valves as they lie together partly opened, being nearer the extremity directed toward the aperture of the shell, and exactly fitting between the valves, as if in its natural position with relation to them. It agrees so exactly in thinness, texture, and surface-markings, and even in color, with the two valves enveloping it, that it is impossible to examine the specimen for a moment and entertain a doubt in regard to the three pieces being all parts of the same fossil.*

* It has been maintained by some that an Aptychus, as usually understood, has its two parts not merely joined together along the straight edges, but actually anchylosed there, so as really to consist of one bilobate piece. If this is so, of course what is here called a third piece, would really be only a second piece.

"This third piece, as may be seen by reference to figures 3, *f*, *g*, *h*, differs entirely from any of the usual forms of *Trigonellites* or *Aptychus*, as generally understood, and presents a very peculiar jaw-like appearance. It consists of two rami joined together at their anterior end, and extending backward so as to present, as viewed on either side, the form seen in figure 3, *g*, of plate 35; while figure 3, *h*, represents its inner side.

"The presence of this third piece would seem to furnish another argument, if any were needed, against the conclusion that these fossils are the valves of Cerripedes, since its form is such that it can scarcely be regarded as homologous with any of the external shelly plates of those animals. Its form, if not indeed its very existence, seems to be even more irreconcilable with the somewhat generally-accepted opinion that these bodies are opercula. It is not difficult to understand how the two valves might be opened out, as in figure 3, *i*, and attached to a fleshy lobe, or some of the soft parts of the animal, so as to perform the offices of an operculum; but it seems impossible to conceive how the third jaw-like piece could have been in any way connected with an operculum.

"In examining this curious third piece, one can scarcely fail to be impressed with its resemblance to a jaw or beak. Indeed, so striking is this analogy that I have been strongly inclined to adopt the conclusion that it is such, notwithstanding the fact that this would seem to require that the two enveloping valves should be viewed as forming together the opposing mandible, for which their form would seem to be badly adapted. The opinion that these bodies may be jaws, instead of opercula—first suggested by von Bréda, I believe—receives additional support from the entire absence, so far as known, of anything else representing jaws or beaks within the thousands of *Ammonitoid* shells that have been broken in various parts of the world; while all of the known existing Cephalopods are found to be provided with such oral organs. Again, it will be remembered that in the existing species of *Nautilus* (the beaks of which are partly calcareous and partly corneous), the upper mandible is received within and enveloped by the lower, much as the third appendage here described lies between the two valves of our specimen."*

* I should explain here, that the figure 3, *d*, of this fossil on our plate was drawn and arranged many years back, when the periphery, or outer edge, of an Ammonite or other similar shell, was considered the dorsum; consequently, that side of figure 3, *d*, was placed upward, which really brings the ventral side above, as the figure stands.

Since the foregoing remarks were originally published nearly as here written, another entirely new view of the functions of these bodies, has been published. (See remarks at the end of the description of the genus *Scaphites* on page 419).

Locality and position.—Fox Hills, Moreau and Cheyenne Rivers, Dakota; from the Fox Hills group of the Upper Missouri Cretaceous series.

Scaphites abyssinus, Morton (sp.).

Plate 35, figs. 2, *a*, *b*, and 4.

Ammonites abyssinus, Morton (1841), Jour. Acad. Nat. Sci. Philad., VIII, 209, pl. 10, fig. 4.
Scaphites Mandanensis?, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 281.
Scaphites abyssinus, Meek and Hayden (1860), *ib.*, XII, 420.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 23.

Shell short-oval, or subcircular, much compressed; inner volutions deeply embraced within the dorsal groove of each succeeding turn; last whorl flattened on the sides and periphery, having a more or less distinct subnodose angle around the umbilicus, and on each side of the periphery; non-septate portion short, not widened or straightened along its upper margin, and deviating so little from the regular curve of the inner whorls as to become but slightly disconnected from them at the aperture; umbilicus rather small; aperture oval or subcordate; surface ornamented by rather distinct, straight, or slightly flexuous costæ, which increase chiefly by the intercalation of shorter ones between the longer, so as to number from two to three times as many at the periphery as near the umbilicus; those on the inner whorls often supporting some three or more rows of very small nodes on each side, in addition to the larger series on each side of the narrow flattened periphery.

Septa divided into three or four lobes and as many sinuses on each side of the siphonal lobe, which is of an oblong form, being a little longer than wide, with two principal branches on each side, the two terminal of which are slender, larger than the others, nearly parallel, obscurely bifid, and provided with a few obtuse short digitations or crenulations; while the lateral branches are short and spreading, the larger pair being merely obtusely tridentate, and the others simple; first lateral sinus as long as the siphonal lobe, and near one-fourth wider, with a nearly quadrangular form, and provided with two large unequal, irregular branches, with short, obtusely crenate subdivisions; first lateral lobe a little shorter than the siphonal, and of nearly the same

breadth, with two branches on each side, the two terminal of which are of moderate length, spreading, bifid, and provided with obtusely crenate or dentate margins, while the two lateral branches are much smaller, directed out at right angles from the margins, and each obtusely tridentate at the end; second lateral sinus scarcely half as large as the first, and bearing two unequal, shortly bipartite or tripartite, deeply sinuous, and obtusely dentate terminal branches, and one or two unequal, short, nearly simple, lateral branchlets; second lateral lobe much like the first, but scarcely more than half as long and wide; third lateral sinus about one-third as large as the second, with two short, spreading, obtusely dentate, terminal branches; third lateral lobe very small, and merely obscurely bilobate at the end; fourth lateral sinus as long as the third lateral lobe, but wider and faintly bilobate at the end; fourth lateral lobe slightly wider and longer than the third, but more distinctly trilobate at the end.

Length, 2.09 inches; height, 1.65 inches; convexity, 0.63 inch.

The angle around the inner side of the non-septate part of the outer volution in this species is not always well marked, and varies a little in its distance from the umbilical margin. It is apparently always provided with a row of low prominences, like transversely-elongated nodes, that never exist on the inner volutions. The angle on each side of the narrow, flattened periphery, with its row of nodes, seems to be always well defined on the outer volution, excepting near the aperture, where both angles and nodes usually fade away, and the costæ become finer and crowded. On the inner volutions, also, the peripheral angles become obscure or obsolete, though their place is occupied by the rows of nodes reduced in size. The little nodes seen on the sides of the inner volutions, and sometimes on the inner half of the last turn, are placed on the costæ so as to form about three nearly equidistant, revolving rows on each side of the shell.

This form is very closely allied to the following species, and may possibly be only a variety of the same. The points of difference will be noticed in connection with the description of that shell. There is little or no room for doubts in regard to this being the form to which Dr. Morton applied the name *Ammonites abyssinus*. It is true his type-specimen showed none of the little nodes on the costæ of the sides of the shell; but these are not always present, as may be seen by our figure 2, *a*, and those near the margin of the umbilicus only occur on the outer volution, while his type-specimen

consisted only of the inner turns. The perforated character of the umbilicus, mentioned by Dr. Morton, is merely due to the accidental breaking-through of the small, slender, inner volutions of his specimens.

Locality and position.—Dr. Morton's type-specimens of this form were from the Missouri River, Dakota; exact locality not mentioned. Ours were found on Moreau River, Dakota, where they occur in the Fox Hills group of the Upper Missouri Cretaceous series.

Scaphites Mandanensis, Morton (sp.).

Plate 35, figs. I, *a*, *b*, *c*.

Ammonites Mandanensis, Morton (1841), Jour. Acad. Nat. Sci. Philad., VIII, 208, pl. 10, fig. 2.
Ammonites? Mandanensis, Owen (1852), Report Wisconsin, Iowa, and Minnesota, tab. 7, fig. 5.
Scaphites Mandanensis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 281.

Shell short-oval, or subcircular, much compressed; volutions six to six and a half, increasing rather gradually in size from within; last one not much enlarged, and scarcely deviating from the curve of the others, flattened on the sides and periphery, and angular and ornamented by a row of very small crenatures around the umbilicus, and another of little nodes on each side of the periphery, excepting near the aperture; each inner whorl partly received within the rather deep dorsal groove of the succeeding turn; umbilicus rather wide, and exhibiting a part of each inner whorl; aperture oval-subcordate, being longer than wide; surface ornamented by small, slightly flexuous costæ, which increase by intercalation and division so as to number about three times as many at the periphery as around the umbilicus; costæ becoming much finer and more closely arranged near the aperture.

Length, 1.84 inches; height, 1.43 inches; convexity, 0.59 inch.

Usually, each one of the costæ of this shell terminates at one of the little nodes along the angular margins of the narrowly-flattened periphery; but where the nodes become larger and more distant, along this part of the last or body volution, sometimes two of the costæ coalesce at one of these marginal nodes, while others pass between them. In crossing the narrow periphery of the last whorl, all the costæ arch a little forward.

The sutures of the septa in this species are so very similar to those of that last-described form, that it would be almost an exact repetition of the same words used in the description of that form, to describe them in detail. Yet slight differences in the details of the lobes and sinuses might be men-

tioned, such as the more slender and less digitate branches of the lobes in his species, and the differences in the relative sizes of its third and fourth lateral lobes; but these are by no means greater than we often see in different individuals of one and the same species, among shells of this kind.

Externally, however, there are more important differences between these shells; that under consideration having much finer costæ, with a decidedly wider umbilicus, showing portions of all the inner volutions. The inner or umbilical edge of its outer volution is more rectangular, and merely finely crenate, while there seem to be no traces of small nodes on the sides of any of its volutions. As already intimated, I am not entirely sure that these shells may be more than mere varieties of one species; but the almost exact identity of their septa does not demonstrate this, because there are clearly distinct species among the *Ammonitidæ* that show scarcely any constant differences in the lobes and sinuses of the septa.

This is another of the Scaphite types, with the deflected part of the outer volution so short, and departing so very slightly from the regular curve of the inner volutions, that it can scarcely be distinguished from *Ammonitoid* forms. Hence, Dr. Morton and Dr. Owen both referred it to the genus *Ammonites;* and, so far as regards its general aspect, it may be regarded as forming a transition from *Scaphites* to *Ammonites.* When we find, however, that it is so closely allied to *S. abyssinus*, Morton, both externally and in even the details of its septa, as to leave doubts whether they may not be even varieties of the same species, while in *S. abyssinus* the Scaphite form is sometimes unmistakable (see fig. 4 of pl. 35), and both have septa of the Scaphite type, there seems little or no reason for separating either from that genus.

As in the case of *Scaphites Nicolletii*, this form also wants the lateral tubercles of the *Discoscaphites* section. Its near relations, however, to *S. abyssinus*, in which that character does sometimes occur, seems to forbid its separation from the subsection (*b*) including that species. It seems to bear very nearly the same relations to *S. abyssinus* that *S. Nicolletii* bears to the form I have ranged as var. *intermedius* of *S. Conradi.*

Locality and position.—Dr. Morton's type-specimen of this species came from the same locality as the last. Those here described and figured came from Moreau River, Dakota, where they occur in the Fox Hills group of the Upper Missouri Cretaceous series.

AMMONITIDÆ.*

Genus AMMONITES, Brug.

Synon.—*Cornu Ammonis, Ammonites, Hammonites, Harmonites*, &c., wholly or in part of pre-Linnæan authors.

Ammonites, Bruguière (1789), Encyc. Méth. I, xvi, and 28.—Lamarck (1799), 79; and (1801) Syst. An., 100.—Blainv. (1824), Dict. Sci. Nat., XXX, 185.—D'Orbigny (1826), Tab. Méth.; and (1841) Paléont. Fr., Terr. Crét., I, 369; also (1842) *ib.*, Terr. Jurass., I, 185.—Deshayes (1830), Encyc. Méth., II, 226.—Roemer (1836), Verst. Nordd. Ool., 180.—Owen (1838), Trans. Geol. Soc., II, part 2d.—Geinitz (1846), Grundr. d. Verst., 285; and of numerous later authors.

Argonautites, Montfort (1802), Hist. Moll., III, 394.

Pelagus?, Planulites, Simplegades, &c., Montfort (1808), Conch. Syst., I.

Ammonita, Gray (1821), London Medical Repository.—Fleming (1828), Brit. An., 240.

Coronoceras, Hyatt (1868), Bull. Mus. Comp. Zoöl. (5), 77.

Etym.—*Ammon*, a name of Jupiter.
Type.—*Ammonites bisulcatus*, Brug.

Shell discoid, or more or less convex, with periphery rounded, flattened, concave, cuneate, or keeled with or without furrows; keel, when present, simple or crenate; volutions all regularly coiled on the same plane, and contiguous, or to a greater or less degree embracing; umbilicus varying greatly in breadth and depth with the species; surface smooth, striated, or costated, and often nodose, or rarely subspiniferous; aperture differing much in form; lip simple, thickened, hooded, or with variously-formed lateral appendages; septa with lobes and sinuses varying in number, and more or less branched and digitate.

The foregoing synonymy and diagnosis are intended to conform to the old comprehensive views in regard to the limits of the genus *Ammonites;* not by any means, however, because I believe that, as thus defined, it represents a homogeneous group, but because I have to dispose of a species here, which, from such specimens as are available for study, it is only possible to refer, in a general way, to that group as formerly understood.

The old genus *Ammonites* has of late years been carefully studied by Professor Hyatt of this country, and Professor Suess, Dr. Zittel, Dr. Laube, and others of Europe, and divided into numerous distinct genera; but as their labors have been mainly confined to Jurassic and Triassic types, it is not probable that any of the shells here described would properly fall into their newly-established genera. With one exception, I have not cited any of their new names in the synonymy of this genus here, because I really do

* I am under obligations to Prof. Alpheus Hyatt of the Boston Society of Natural History, who has devoted much attention to the study of the *Ammonitoid* types, for suggestions in regard to some of the forms I have here ranged under the family *Ammonitidæ*.

not believe them strictly congeneric with *Ammonites* as properly restricted; though their types are necessarily, in part, included in the citations I have made. The exception to which allusion is made above, is *Coronoceras*, which, according to the most generally accepted rules of nomenclature, I regard as an exact synonym of *Ammonites* as restricted by Lamarck's cited example in 1801. This will be more clearly understood by the following history of this genus, as formerly understood.

The name *Ammonites* was, I believe, first used by Breynius in 1732; but as he dates before the commencement of the binomial system, and therefore did not use the words genus and species in the Linnæan sense, I do not think that he can be properly regarded as the founder of the genus. It was also subsequently adopted by Wallerius, Martini, Linnæus, Gmelin, and others, but not in a binomial sense as the name of a genus. Even Linnæus and Gmelin, *after* the introduction of the binomial system, merely used it as a kind of specific term, under the name *Helmintholithus*, which was made to include fossils of many kinds. Consequently, it is to Bruguière, in 1789, that we have to come as the founder of the name *Ammonites*, in a binomial sense, as the name of a genus. He, however, included species belonging to several genera, according to the prevalent classification of such shells at this time, without stating what species he regarded as the type of the genus. This left it for some of his successors to select, from his included species, the one to be regarded as the typical representative form of the genus. Lamarck, who was the first to follow him in the use of the name, in his Prodr., 1799, cited no particular species by name at that date; but two years later, in his little Syst. An., 1801, he again adopts the name, with the same diagnosis, and cites as his only example of the genus, *A. bisulcatus*, Bruguière. Consequently, I should certainly think that this citation fixes that species as the typical form of the genus; and that the name *Ammonites* should be retained for the group to which *A. bisulcatus* belongs, however the original genus may be divided or subdivided. For these reasons, it seems to me that *Coronoceras* becomes an exact synonym of *Ammonites* as restricted to typical forms.

In its original comprehensive sense, this genus dates back to the Trias, and ranges through all succeeding formations to the top of the Cretaceous. As restricted, however, to what I regard as the typical group, it is probably confined to the Lias. In the latter sense, of course, none of the Cretaceous

forms properly belong to it. Yet, even authors who are fully aware of this fact, still use it as a receptacle for Cretaceous species belonging to groups that have not yet been separated under other names; that is, when they either have not the necessary specimens, or do not desire to propose new groups for the reception of species that they have to notice.

Ammonites complexus, H. & M.

Plate 24, figs. 1, *a*, *b*, *c*.

Ammonites complexus, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci. Boston, V (n. s.), 394, pl. iv, fig. 1.—Gabb (1861), Synop. Moll. Cret. Formation, 9.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 24.

Shell compressed-subglobose; periphery broadly rounded; umbilicus rather small and deep; volutions five or more, broader than high, inner ones about half hidden within the dorsal groove of each succeeding turn, ornamented near the umbilicus by a row of small transversely-elongated nodes, which, on the outer whorls of larger specimens, extend outward and bifureate, so as to form a series of rather distant, obscure costæ, which, with others intercalated between, pass over the periphery; surface, so far as known, otherwise smooth, or only marked by obscure lines of growth.

The largest specimen found (which wants the outer non-septate portion), measures about 1.60 inches in its greatest diameter, by about 1 inch in convexity. Adult examples must have been at least 2 inches broad, and may have attained a considerably larger size.

Septa crowded and complex; siphonal lobe somewhat longer than wide, with its body forming about one-third of its breadth, and bearing three opposite, more or less divided, and digitate branches, the two terminal of which are larger than the others, and show a tendency to bifurcate; first lateral sinus as long and nearly as wide as the siphonal lobe, with a narrow, somewhat zigzag body, provided with one or two more or less digitate, alternately-arranged, lateral branchlets, and two much larger, unequal, tripartite and digitate terminal branches; first lateral lobe of the same length as the siphonal, with a narrow body and three or four more or less deeply-divided and variously digitate lateral branches, and a terminal trifid central branch; second lateral sinus a little smaller than the first, but very similar to it in all its details, excepting that its corresponding branches are on opposite sides; second lateral lobe about three-fourths as long, and nearly as wide as the first, which it nearly resembles in its branches, excepting that it has one

lateral branch less on each side; third lateral sinus shorter than the second, and bearing about the same relations to it in its branchings that the second lateral lobe does to the first; third lateral lobe about two-thirds as long, and nearly as wide as the second, with three subequal, spreading, and digitate terminal branches: fourth lateral sinus less than half as large as the third, oblique, and usually tripartite at the end, the branches being nearly simple. Beyond this there are one or two very small, oblique, nearly simple lobes near the umbilical margin.

As I only know small, imperfect specimens of this species, which may, in the adult larger examples, develop very different characters, I have not the means of making very satisfactory comparisons with published forms from other localities.

It is perhaps hardly necessary to add here, that this shell is not a true *Ammonites*, as that genus is properly restricted; and that it is here only referred to that group as understood in its old comprehensive signification. This is done merely because its characters cannot be made out, from the few imperfect known specimens, with sufficient clearness to determine the limits and development of the group to which it belongs. It is evidently not more nearly related to *Ammonites* proper than others I have placed under other names; indeed, not as nearly so as one I have referred to *Mortoniceras*.

Locality and position.—Both the original type-specimen, and that from which our figures were drawn, were found at the Great Bend of the Missouri, below Fort Pierre, at the base of the Fort Pierre group of the Upper Missouri Cretaceous series. Mr. Gabb also cites it from New Jersey; and I have seen a single specimen, seven or eight inches in diameter, from Miser station, on the Union Pacific Railroad, Wyoming, that appears to be nearly allied to this species. It seems to be a rare shell in the Upper Missouri country.

Genus MORTONICERAS, Meek.

Synon.—Ammonites (sp.), of authors; not of Bruguière, as restricted.
Etym.—Dedicated to Dr. Samuel George Morton, deceased.
Type.—*Ammonites vespertinus*, Morton (= *A. Texanus*, Roemer).*

Shell discoid; periphery with a simple, low, central keel, and a more or less defined sulcus on each side of it; the sulci being generally each mar-

* Mr. Gabb, who has compared specimens of *A. Texanus*, Roemer, from the same locality as Morton's original type of his *A. vespertinus*, says that they are in all respects identical, Morton's figure being very defective.

gined externally by a row of compressed nodes; umbilicus wide; volutions narrow, slightly embracing, and ornamented by regular, simple, straight, tuberculated costæ. Septa in the typical species with three lateral lobes on each side, the first one being longer than the siphonal lobe, with tripartite extremity, the terminal division being deeply bifid; second and third lobes much smaller and more or less tripartite or dentate; first and second lateral sinuses more or less nearly equally bipartite or bilobate at the ends.

Shells of this genus will be distinguished from the restricted genus *Ammonites* by their always single peripheral keel, straighter and differently-tuberculated costæ, and differences in the forms and proportions of its septa lobes and sinuses. It is apparently restricted to the Cretaceous system, while the genus *Ammonites*, as represented by its typical forms, is probably confined to the lower members of the Jurassic system.

Compared with the types for which I have proposed the names *Prionocyclus*, it will be found even more strongly separated by its simple (non-crenate) peripheral keel, straight, more regular, and differently-tuberculated costæ, &c. It will include, in addition to the type-species *T. respertinus* (= *A. Texanus*), one, if not both, of the species hereinafter referred provisionally to it; also, perhaps, *Ammonites Leonensis*, Conrad; and possibly an East Indian form, referred by Dr. Stoliczka to *A. inflatus*, Sowerby, as well as some other Cretaceous species. It seems to be confined to the Cretaceous system.

Mortoniceras Shoshonense, Meek.

Plate 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 half-way across the sides, while the outer near the peripheral margins is more prominent, rounded, and directed laterally; keel less prominent than the row of compressed nodes on each side about half-way between it and the rounded nodes along the margins of the periphery; compressed nodes on the periphery of each

* Figure 3, *b*, of this species, was by error numbered 6, *b*, on plate 6; while a figure of a small *Scaphites* farther down on the same plate is also numbered 6 *b*.

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 than the second, with a bipartite end and serrated margins; third lateral lobe nearly as long as the second, but 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 merely represented by two nodes, and these of different forms, I cannot believe it the same species.

Locality and position.—Head of Wind River Valley, Wyoming Territory; from the Fort Benton group of the Upper Missouri River Cretaceous series.

Mortoniceras? Vermilionense, M. & H.

Plate 7, fig. 2, *a*, *b*.

Ammonites Vermilionensis, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 177.

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 obtusely 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 lateral 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 few very 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 its 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.

Genus PRIONOCYCLUS, Meek.

Synon.—*Ammonites* (sp.), of authors; not of Bruguière, as restricted to typical forms.
Prionocyclus, Meek (1872), in Hayden's Ann. Report U. S. Geological Survey of the Territories, 298 (foot-note).

Etym.—πρίων, a saw; κύκλος, a circle; in allusion to the circular form of the shell and its serrated keel.
Type.—*Ammonites serrato-carinatus*, Meek (not Stoliczka).*

Shell discoid, with periphery more or less depressed, and provided with a central keel defined by a shallow depression or concavity on each side; keel in the young simple, but at a later stage of growth strongly crenate, very prominent and compressed, and in large adult shells again depressed, or sometimes merely represented near the aperture by a row of separate, elongated nodes; umbilicus open; volutions more or less compressed, and but slightly embracing; surface costated and tuberculated; costæ in the young simple, smooth, and strongly curved forward as they approach the keel, near which, at a later state of development, they each, or in part, produce two nodes, the outer of which is compressed, with its longer diameter parallel to the keel, while the umbilical end projects so as to form a compressed node;

* At the time I indicated this species in one of Dr. Hayden's reports (1872), I was not aware that Dr. Stoliczka had previously used that name for a similar Indian species. I know nothing in regard to the septa of his species; but, from its external characters, it seems to belong to the same genus as that for which I had used the name *A. serrato-carinatus*. If so, it will be necessary to designate the American shell by another specific name; in which case I would propose to call it *Prionocyclus Wyomingensis*, since it is the most abundant and largest shell of the kind yet known from that Territory.

on the last turn of large adults, the outer compressed node sometimes becomes obsolete, and the other near it much enlarged, or produced as a short, thick spine.

Septa with about three lateral lobes on each side, the first of which is longer than the siphonal lobe and tripartite at the end, while the others are much smaller and trifid, or the middle one sometimes bifid; first lateral sinus broad and bilobed, the outer lobe lapping partly upon the peripheral side.

The above diagnosis is intended to include two types, which would, according to the most restricted of the late classifications of such shells, probably represent two distinct genera, but would doubtless be both included in one group by European authors, who have of late years undertaken the subdivision of the old genus *Ammonites*. For the present, at least, I prefer to treat these two types as sections of one genus They may be separately defined as follows:

1. **PRIONOCYCLUS**, Meek (typical).

Shell, when very young, with costæ obscure, but soon after becoming well developed, the larger tuberculated ones being separated by several smaller, usually without tubercles, even on the last turn of large adults, where none of them become greatly increased in size, or develop large tubercles; keel continued prominent, and not broken up into isolated nodes on any of the volutions.—(Type as already stated.)

2. **PRIONOTROPIS**, Meek.

Shell, when very young, with costæ sharply defined, and as the whorls increased in size, becoming more distant, without having the intervening spaces occupied by smaller ones; on the last turn, costæ and their nodes becoming very prominent, and the keel depressed and broken into a series of isolated, elongated nodes.—(*Ammonites Woolgari*, Mantell.)*

The type-species of this genus so nearly resembles some species of Professor Hyatt's genus *Pleuroceras* (not *Pleurocera*, Raf.), that I have been much inclined to think it might belong to the same, although that genus was founded entirely on Liassic species. On comparison with *Ammonites spinatus*,

* I cite Mantell's species as the type of this group, because I believe the following-described form to be identical with the same. As I know nothing, however, of the septa of Mantell's type, it is still barely *possible* that it may be distinct from our shell, in which case the latter, from which the foregoing description was drawn up, would be the type of the group.

Bruguière, for instance, which Professor Hyatt includes in his genus *Pleuroceras*, our type is found to present the same general features; the chief difference being that its periphery is less flattened, not so deeply furrowed, and its keel more prominent, while it has another series of smaller costæ between those corresponding to the costæ of *A. spinatus*; and those of the latter also differ in not being tuberculated at the inner ends as in our type. There are also some differences in the septa, but not, I should think, if taken alone, of generic importance.

Nevertheless, as Professor Hyatt, who has given more attention to the study of the *Ammonitoid* types than any other person in this country, is quite positive in the opinion that the genera of this great group of shells are very restricted in their geological range, and that probably none of the Liassic groups range up into the Cretaceous, I have concluded to view the differences mentioned as generic, and retain my name *Prionocyclus*, originally provisionally proposed as a subgeneric name, in a generic sense here.

The other section, for which I propose here the name *Prionotropis*, represented by such forms as *Ammonites Woolgari*, Mantell, is more decidedly distinct in its development, though at certain stages of growth the two forms are less strongly separated than in the adult. These two groups, whatever may be the relations of the first to *Pleuroceras*, probably represent two distinct genera; but as I have not at hand a sufficiently complete series of species to be able to characterize them fully as such, I have preferred to keep them together for the present.

I am not altogether sure that any other species can be cited as belonging to the *Prionotropis* group than the type, but would merely mention *A. Braraisianus* and *A. Carolinus*, d'Orbigny, as very closely resembling specimens of our typical form of the same size; also *A. serrato-carinatus* of Stoliczka. The latter, however, if included, would require slight modifications of the diagnosis, as it has deeper furrows on the periphery, and a few additional nodes along the middle of the costæ.

Compared with *Ammonites* proper, as typified by *A. bisulcatus*, and restricted to the group including that species, this genus is distinguished by having but one peripheral keel, and that strongly crenated, instead of three smooth keels and two well-defined furrows between them. There are also strongly-marked differences in the development of these types, *Ammonites* proper, in the very young condition, having the costæ represented by rows of

nodes that afterward elongate to form the costæ. *Ammonites* proper also presents differences in its septa, and never develops the characters seen in the adult *Prionotropis*. In short, it would belong to an entirely distinct family according to Professor Hyatt's classification.

I have the impression that both sections of this group are confined to the horizon of the Middle and Lower Chalk series.

Subgenus **PRIONOTROPIS**, Meek.

Prionocyclus Woolgari, Mantell (sp.).

Plate 7, figs. 1, *a–h*; and plate 6, fig. 2.

Ammonites Woolgari, Mantell (1822), Geol. Sussex, 197, tab. xxi, fig. 16; and pl. xxii, figs. 6 and 7.—Sowerby (1829), Min. Conch., VI, 25, tab. 587, fig. 1.—D'Orbigny (1850), Prodr., II, 190 (not Paléont. Fr. Terr. Crét., I, pl. 108, figs. 1, 2, and 3).—Sharpe (1853), Fossil Rem. Moll. found in the Chalk of England, 27, pl. xi, figs. 1 and 2.—Meek and Hayden (1861), Proceed. Acad. Nat. Sci. Philad., 421.—Gabb (1861), Synop. Fossils Cret. Form., 14.

Ammonites percarinatus, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci. Boston, V (n. s.), 396, pl. IV, fig. 2 (young).

Compare *A. Bravaisianus*, and *A. Carolinus*, d'Orbigny (1840), Paléont. Fr. Terr. Crét., I, pl. 91.

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 two and a half to three 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 four

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 distantly-separated, low, elongated nodes; and, when the shell has attained a diameter of seven 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 than 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 plate 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 non-septate 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.

In regard to the different features developed by this shell at different stages of its growth, already described, it is probably hardly necessary to remark that the changes mentioned are not at any point abrupt, but that the

peculiarities of one stage of development pass gradually into those of the next.

As I am not acquainted with the septa of the Englisl typical specimens of *A. Woolgari*, which were not illustrated either by Mantell or Sharpe, it is of course possible that they may be specifically different from those of our shell. Mr. Sharpe remarks that he had not clearly seen the septa of his specimens, but adds that "they appear to have four or five trifid lateral lobes." If he meant that they appeared to have that many lateral lobes *on each side*, and the appearance was not deceptive, then, of course, our specimens would belong to a distinct species. As he did not pretend, however, to have clearly seen the septa in his specimens, I can hardly believe that shells so very similar in all external characters could be so different in their internal structure; and hence I can scarcely doubt that they are really specifically identical.

As already suggested, it is more than probable that *Ammonites Bravaisianus* and *A. Carolinus*, d'Orbigny, are both synonyms of this species; that is, that these names may have been both proposed for young specimens of this species in different states of development. Sharpe cites *A. Carolinus* doubtfully in the synonymy of *A. Woolgari;* and it seems quite as probable that the shell for which d'Orbigny proposed the name *A. Bravaisianus* may be only a smaller specimen of the same. At any rate, I have before me specimens of the same size, showing the same simple keel and other characters, and yet have others showing an unbroken series from these to the fully-developed *A. Woolgari*, or, at least, to the species here identified with the same.

Locality and position.—Our figured specimens are from the southeast base of the Black Hills, Dakota, where it occurs in the Fort Benton group of the Upper Missouri Cretaceous series. The specimens described by Professor Hall and the writer under the name *Ammonites percarinatus* came from the same horizon on the Missouri, five miles below the mouth of Vermilion River. It also occurs at this horizon in Northeastern Nebraska; and I am informed by Dr. White that he has found loose specimens of it in the Drift of Northwestern Iowa. Dr. Newberry likewise brought specimens of it from New Mexico, and Dr. Palmer found it eight miles north of Fort Lyon, Colorado. I am not aware that it has been found *in situ* at any other horizon than that above stated, in this country.

Genus PHYLLOCERAS, Suess.

Synon.—*Ammonites* (sp.), of authors; not of Brug., as restricted.
Phylloceras, Suess (1865), der k. k. Akad. der Wissensch., Wien, LII, 76.—Zittel (1868), Palæont. Mittheil. aus dem Mus. des königl.-bayer. Staats., 56 and 153.
Rhacoceras (Agassiz, MS.), Hyatt (1868), Bulletin V, Cambridge Museum of Compar. Zoölogy, 86.

Etym.—φύλλον, a leaf; κέρας, a horn.
Type.—*Ammonites heterophyllus*, Sowerby.

Shell discoid; periphery rounded; volutions compressed, each embracing from about two-thirds to the whole breadth of the next within, often provided with distantly-separated internal ridges, leaving constrictions on casts of the interior; umbilicus small to very small, or closed; surface generally with mere striæ of growth, or small costæ; body-chamber long; septa often crowded, provided with from about six to nine lateral lobes, and as many sinuses on each side, all of which diminish regularly in size from the peripheral to the umbilical margins; lobes much branched, generally all tripartite at their extremities, with alternating lateral branches, the first lateral lobe being longer than the siphonal; sinuses deeply divided and foliaceous.

This genus was founded by its author on Jurassic forms; *Ammonites heterophyllus*, Sowerby, being cited as its type. He also stated, however, that it would include some Cretaceous species. Whether the latter can be properly included may perhaps be a question in regard to which there will be different opinions, though it seems to me that it would be rather difficult to point out any satisfactory reasons why such Cretaceous species as *A. Guettardi*, Raspail, *A. semisulcatus*, *A. thetys*, *A. Morelianus*, *A. picturatus*, and *A. Terverii*, d'Orbigny, should be excluded from this genus.

Phylloceras? Halli, M. & H.

Plate 24, figs. 3, *a*, *b*, *c*.

Ammonites Halli, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., 70; and (1860) *ib.*, XII, 420.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 24.

Fig. 64.

A septum of *Phylloceras? Halli* (two diameters), given to show some of the details more accurately than figure 3c on plate 24.

Shell attaining a rather large size, moderately compressed-discoidal; volutions with their convexity about equaling two-thirds their diameter from the ventral side to the rather narrowly rounded periphery, in young and medium-sized examples, each embracing nearly the entire breadth

of the next within, but the last one in the adult becoming proportionally less deeply embracing; umbilicus very narrow, and rather deep in the young, but proportionally wider in the adult; surface ornamented with numerous small, bifurcating, slightly flexuous costæ, that are larger near the umbilical side, and on the last turn of medium and large sized specimens become proportionally somewhat more prominent, more curved, and suddenly bifurcate near the umbilicus, and again divide and subdivide into numerous smaller ones, so that their number, including others intercalated between, amounts to from five to seven times as many where they pass straightly over the periphery, as near the umbilical side; body-chamber forming at least the entire outer volution.

Septa crowded, and divided into five lobes and five sinuses on each side;* siphonal lobe longer than wide, truncato-suboval in form, with three principal branches on each side, the two terminal of which are larger than either of the other pairs, nearly parallel, and somewhat bifurcating and digitate, the terminal subdivisions being long and slender, while of the lateral branches the middle pair are larger, and more or less subdivided; first lateral sinus about as wide as the siphonal lobe, but shorter on the umbilical side, and very deeply divided into two unequal branches, of which that on the siphonal side is larger, and also deeply bipartite, with its branchlets deeply subdivided and obtusely digitate, while the other main branch is very slender, with alternating, clavate and sinuous branchlets; first lateral lobe narrower and shorter than the siphonal,† bipartite at the end, but with the two slender bifid and digitate terminal branches unequal, the inner division of that on the umbilical side being longer than the corresponding one of the other, and when crowded over more nearly on a line with the middle of the body, giving a decided tendency to a tripartite arrangement of the whole; second lateral sinus scarcely more than half as long and wide as the first, and nearly equally bipartite at the end, the two divisions being bifid, and, like the one or two alternately-arranged lateral branches on each side, with sinuous margins; second lateral lobe about two-thirds as wide and long as the first, with more or less tendency to a tripartite arrangement at the end, the divisions being slender, digitate, and so arranged that one of the three might with almost as much propriety be viewed as a lateral, alternating with a smaller

* The fifth *very* small lobe is not represented in fig. 3*c* of plate 24 (see foregoing cut).

† The difference in the lengths of these two lobes is not in all the septa so marked as in that figured on plate 24.

simple lateral branchlet on the other side; third lateral sinus about half as large as the second, and unequally bipartite at the end, nearly in the same way as the first, but with all its divisions much shorter and less deeply subdivided and sinuous; third lateral lobe very much smaller than the second on one side of the type-specimen, and bifid at the end, and on the other more slender and distinctly tridigitate; fourth lateral sinus very small, and merely bi- or trilobate; fourth lateral lobe as seen on one side of the type-specimen scarcely half as large as the third, with merely slightly digitate margins, and a more or less truncated or indented extremity; fifth lateral sinus (not shown in the septum figured on our plate) broader than long, and equaling the length of the fourth lobe, with its broadly-truncated end dentate; fifth lateral lobe (not shown in the figure on the plate) about half as long and wide as the fourth, oblique, and showing a tendency to become tridentate at the end.

A comparatively small specimen, with perhaps at least half of its outer volution broken away, measures 4.70 inches in its greatest diameter, and about 1.50 inches in convexity. Another crushed specimen shows that it attains a diameter of twelve inches or more.

It is not without considerable doubt that I have ventured to refer this shell to the genus *Phylloceras*, although there seems to be good reason, as already suggested, for believing that group to have been represented during the deposition of the Cretaceous as well as the Jurassic rocks. In general form (at least in medium-sized specimens), as well as in the roundness of its periphery and the general characters of its septa, it agrees pretty well with that genus. Its septa, however, differ in some details, such, for instance, as the proportionally smaller size of its first lateral lobe as compared with the siphonal lobe, and the more nearly bipartite termination of the former; also, in the less obtusely-rounded terminations of the subdivisions of the lateral sinuses. As already remarked, however, the difference between the size of the siphonal and first lateral lobes is not generally so great as in the septum represented on our plate; while, on the opposite side of the same specimen from which that drawing was made, the first lateral lobe shows more of a tendency to tripartite division, and the little third lateral is distinctly tripartite. On scraping away the shell from the internal cast, close in at the inner margin of the volutions, after the diagram of the septum on our plate 24 was lithographed, there was found a very small fifth lateral sinus, wider than

long, with a serrated end, and a still smaller, narrow, oblique, nearly simple, fifth lateral lobe. These additional smaller divisions at the umbilical margin, together with the more obtuse subdivisions of its sinuses, as more correctly made out in the foregoinig cut, give the septa slightly more the aspect of those of *Phylloceras* than as represented by our figure on plate 24.

Some peculiarities, however, observed in a large distorted specimen of this shell now before me, also seem to present additional reasons for doubting its exact generic identity with *Phylloceras*. This specimen is nearly ten inches in diameter, with apparently at least the whole outer volution non-septate. It is accidentally compressed and otherwise distorted; but I am strongly impressed with the belief that its outer volution naturally made two deflections from the regular curve of those within, much as seen in *Ammonites bullatus*, d'Orbigny, though the shell is of course otherwise very different from that species. This deflection, or departure, from the regular curve, makes the outer volution *much* less deeply embracing than the inner, and the umbilicus consequently much larger proportionally in the adult, than in the young and medium-sized specimens.

I would be more inclined to attribute this irregularity in the large specimen of this species mentioned above to accidental distortion, were it not for the fact that the smaller individual figured on our plate 24 (see fig 3, *a*) also gives some evidence of the commencement of a similar irregularity of the curve of the outer volution, a part of which turn has been broken away. This specimen, too, has been subjected to some distortion from compression; but it seems hardly possible that this could have produced the deviation from the regular curve of the inner volutions mentioned. At one time, this peculiarity led me to suspect that this shell might really be a Scaphite; but the apparent repetition of the irregularity in the curve seen in the larger specimen (only the two examples are known), apparently without the body volution becoming free, is unlike the deflections of the outer volution of that genus, and, as above suggested, more like those seen in shells of the type of *Ammonites bullatus*, to which group, however, our species certainly does not belong.

I have, therefore, only referred this species to *Phillocerας*, rather as a nearer approximation to its true position, than from a decided conviction that it really belongs to that group; or, in other words, because it is brought by its known characters much nearer that genus than to *Ammonites* as restricted

to typical forms. Should complete undistorted specimens show, as I think very probably will be the case, that it differs generically or subgenerically from *Phylloceras* proper, I would propose for the group into which it would in that case naturally fall, the name *Rhæboceras*.

Locality and position.—One hundred and fifty miles above the mouth of Milk River, on the Missouri, in Montana Territory; from the Fort Pierre group of the Upper Missouri Cretaceous series.

Genus PLACENTICERAS, Meek.

Synon.—*Ammonites* (sp.), Dekay, Morton, and others (not Brug., as restricted).
Placenticeras, Meek (1870), Proceed. Philos. Soc. Philad., XI, 429; and (1872) in Hayden's Second Ann. Rep. U. S. Geol. Survey of the Territories, 297 (proposed as a section of *Ammonites*).
Sphenodiscus, Meek (1872), *ib.* (proposed as a section of *Ammonites*).

Etym.—*Placenta*, a cake; *Ceras*, a horn.
Type.—*Ammonites placenta*, Dekay.

Shell usually of large size at maturity, lenticular or discoid in form, with sides converging more or less gradually to the periphery, which is either very narrowly truncated, or cuneate-carinate, and, when truncated, flattened or slightly concave, with its margins angular and smooth, or more frequently each provided with a row of small, compressed, and generally alternating nodes, arranged with their longer diameters in the direction of the peripheral curve; volutions much broader on a line with the plane of the shell than convex, all deeply embracing; umbilicus small, or very small; aperture sagittate, or nearly so; lip unknown; surface in young examples nearly smooth, or only with sigmoid lines of growth, and in adult shells often one or two rows of small, low, lateral nodes on each side, sometimes also provided with obscure, undefined lateral ridges or undulations; septa with from about ten to fourteen, comparatively short, generally not very deeply-divided lateral lobes, and as many sinuses, arranged in somewhat undulated rows across each side of the volutions; siphonal lobe generally a little shorter than the first lateral lobe on either side; lateral lobes increasing regularly in length to the third one inclusive, and beyond this diminishing in size to the umbilical margin.

The foregoing diagnosis is intended to include two sections, which, according to the late methods of classification of such shells, might be arranged as distinct genera, if not even more widely separated. These groups may be each defined as follows:

1. PLACENTICERAS, Meek (typical).

Shell with the very narrow periphery truncated, and often provided with a row of compressed alternating nodes along each margin; volutions each about three-fourths embraced by the next succeeding outer one; septa with the lateral sinuses provided with more or less branched and digitate terminal divisions; umbilicus small or moderate.—(Type as already stated.)

2. SPHENODISCUS, Meek.

Shell with periphery cuneate; umbilicus very small; volutions each almost entirely embraced by the succeeding one; septa with the first five or six lateral sinuses provided with only a few short, nearly simple, obtuse divisions; while the others are simple, and usually broadly reniform at the ends.—(*Ammonites lobatus*, Tuomey).

The most marked features of this genus are its lenticular form, very narrowly-truncated or sharply-cuneate periphery, broad, deeply embraeing volutions, sagittate aperture, small umbilicus, and numerous, not very large or very deeply-divided lobes and sinuses, arranged in undulating series across each side, the lateral lobes increasing in size to the third one inclusive (which is always the longest of the entire series), and those beyond in all cases regularly decreasing in size to the umbilical margin.

In addition to the type-species *P. placenta*, the typical section of this group will include the Indian species *P. Andoorensis* (= *A. Andoorensis*, Stoliczka), as well as two other Indian Cretaceous forms referred by him to *A. Guadaloupæ*, Roemer, and *A. Orbignyanus*, Geinitz; also, the typical Texas form of *A. Guadaloupæ*, which may be distinct from the Indian shell referred to it. The Texas form is perhaps an extremely aberrant example of the group, having much more convex and less widened volutions, with also more strongly-developed nodes than usual. The greater convexity of its volutions also causes the truncation of its periphery to be much less apparent; but still it exists with its marginal rows of compressed, alternately-arranged nodes; while its septa clearly agree in the number, proportions, and arrangement of the lobes and sinuses with the more typical forms of this group.

The *Sphenodiscus* group, in addition to the type-species *P. lenticularis* (= *A. lenticularis*, Owen), will include apparently *A. Pierdenalis*,* von Buch, as well as a European form referred to it by Binkhorst, from the Upper Chalk

* Von Buch wrote this name *Pierdenalis*, but Roemer always writes it *Piedernalis*.

of Limbourg; also, perhaps, *A. Requienanus*, d'Orbigny, from the Upper Greensand of France, and probably others. The last-mentioned species has exactly the form and surface-characters of the type of this group, and also shows the undulated character of the rows of lobes and sinuses: but, according to d'Orbigny's description, it would only have six lateral lobes on each side. It is evident, however, from analogy, that what he has described as three large terminal branches of the first lateral (superior lateral) lobe, really correspond to the first three lateral lobes of the type under consideration. Consequently, if we count these as three lobes, instead of merely three large divisions of the first lateral lobe, we would at least have eight lateral lobes on each side of this shell, which would bring it very nearly, if not quite, within this group.

Some of the species included by Mojsisovics in his genus *Pinacoceras*, published in 1873 in his work on the *Cephalopoda* of the Zlambach and Halstätt Shales, seem to be nearly related to this genus, both as to form and the nature of the septa. His *P. trochoides*, for instance, has almost exactly the form of the type of the *Sphenodiscus* section of *Placenticeras*, and, like the types of both sections of this group, it has a large number of lateral lobes, the third lateral being the largest, but still its fourth and fifth laterals are also large; while its siphonal lobe is proportionally much larger than in either of our types. Again, its whole series of lateral lobes, instead of running in an undulated line across the sides of the volutions, form one continuous, broad, forward sweep, all the way across. Others of the species illustrated by him approach more or less nearly our group, but present similar or other differences in the nature of the septa. It seems to me that his group *Pinacoceras* is made too comprehensive, or, in other words, includes forms representing several generic groups, strictly speaking. That any of his included species, however, if all their characters and their development from the young to the old are considered, would fall into our genus, is very improbable, in view of their widely different geological position. Whatever opinions, however, may be entertained on this point, our names, having priority of date, would have to stand.

My present opinion is that both sections of this genus are confined to the Cretaceous system, and mainly to the upper members of the same.

Placenticeras placenta, Dekay (sp.).

Plate 24, figs. 2, *a*, *b*.

Ammonites placenta, Dekay (1828), Ann. N. Y. Lyceum of Nat. Hist., II, 278, pl. v, fig. 2 (3 by mistake).—Morton (1829), Jour. Acad. Nat. Sci. Philad., VI, 195; and Am. Jour. Sci. and Arts, XVIII, pl. 2, figs. 1, 2, and 3; also (1834) Synop. Org. Rem. Cret. Formation U. S., 36, pl. ii, figs. 1 and 2.—Gabb (1861), Synop. Moll. Cret. Form., 15 (not *A. placenta*, Leckenby (1858), Jour. Geol. Soc. Lond., XV, 10, pl. 2, fig. 1).

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 nearly 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 near the umbilicus—in young exfoliated shells, also usually showing small, faintly-defined, divaricating corrugations, directed backward around the outer half of each side.*

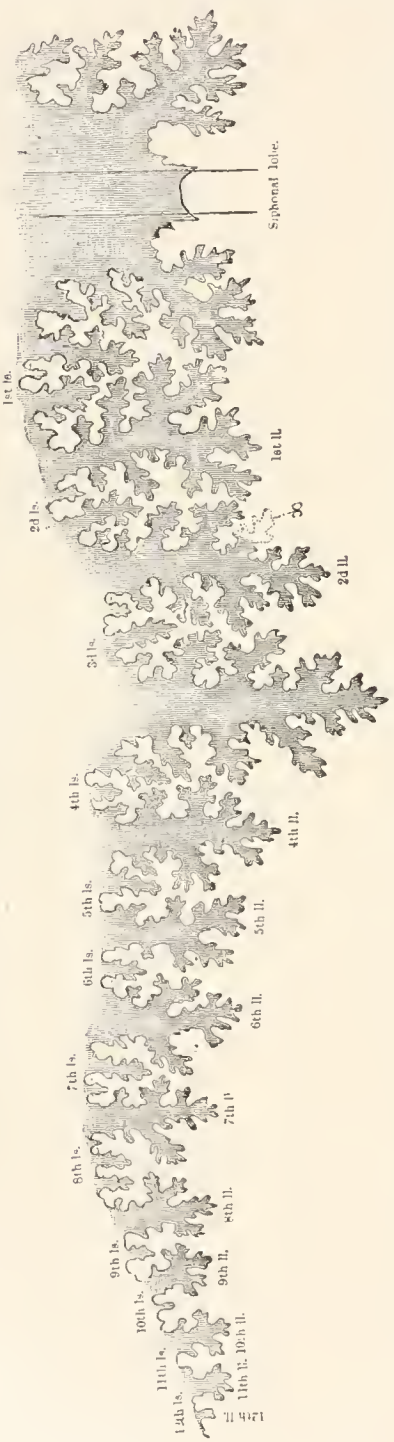
Large examples attain two feet or more in their greatest diameter. Young specimens, 3.70 inches in breadth, show a thickness of about 0.90 inch; while large individuals are proportionally thicker, and, on the periphery, become more obtuse.

Septa with twelve lateral lobes and as many sinuses on each side, in large examples crowded and very complex; as made out from a specimen measuring 6.50 inches in its dorso-ventral diameter at the point crossed by the suture illustrated by the annexed cut, presenting the following characters: Siphonal lobe nearly one-third wider than long, and provided with two principal branches on each side, the two terminal of which are much larger than the others, widely separated, diverging, and divided into four or five short, palmately-spreading, sharply digitate branchlets, of which the three at the end are usually so arranged as to give the extremity a trifid appearance; first lateral sinus as long as the siphonal lobe, but narrower, with a *very* slender body, and two very large, slender, deeply-divided, unequal terminal branches, with deeply and irregularly sinuous margins, while its narrow, zigzag body also supports several unequal, alternating, lateral branchlets and smaller projections; first lateral lobe about as long as the siphonal, but much narrower, oblique, and bearing two unequal bipartite, or tripartite, and digi-

* These last-mentioned markings are made to look too much like sharp lines on fig. 2, *a*, pl. 24.

tate terminal branches, with two smaller oppositely-arranged lateral branchlets on each side; second lateral sinus as long as the first, but narrower, and similarly divided, excepting that its larger terminal branch is on the siphonal side; second lateral lobe about one-third longer than the first, which it does not quite equal in breadth, provided with three or four rather short, more or less sinuous and digitate, alternately-arranged, lateral branches on each side, and a larger terminal division with five small sinuous branchlets; third lateral sinus of very nearly the same size and form as the second; third lateral lobe about one-fourth larger than the second, and nearly similar in its details; succeeding lateral sinuses gradually diminishing in size and complexity toward the umbilical margin, all bifurcating at the end excepting the eighth and tenth, which are tripartite, and the eleventh and twelfth, which are merely trilobate; fourth lateral lobe about half as large as the third, but similar in its details, while the succeeding ones become gradually smaller toward the umbilicus, and all show a more or less tendency to a tripartite arrangement of their terminal branches, excepting the very small twelfth one, which is merely obscurely bilobed, or nearly simple.

Fig. 65.



A septum of a large specimen of *Placenticeras placenta*, slightly less than natural size, with the lateral lobes and sinuses numbered consecutively from the siphonal lobe on the right to the umbilical margin on the left. One of the branches of the second lateral lobe at (*x*), restored in outline, is hidden in the septum figured, by crowding against a branch of next second lateral sinus.

In comparing the annexed cut and the foregoing description of a septum of this shell with the septa of other specimens of the species, it should be remembered that it was made out

from a fragment of a large example; and that smaller specimens always have much less complex lobes and sinuses; while still larger ones may have them even more complex. There are also often considerable differences in the details of the branches of the lobes and sinuses, even, in some instances, between those of different septa of the same individual specimen. Sometimes the septa are also more, and sometimes less crowded, even in specimens of the same size. When much crowded, this causes differences in the details of the branches, some of which are, as it were, pushed aside so as to give a somewhat different general form to a lobe; while in other cases one of the branches may be almost entirely hidden, as seen at (*x*) in the second lateral lobe of the annexed cut. In the specimen from which this figure was made out, this branch of the second lateral lobe, which I have restored in dotted lines, has the appearance of being cut off, owing to crowding against one of the branches of the second lateral sinus of the next septum behind it.

On comparing authentic specimens from New Jersey with others of nearly equal sizes from the Upper Missouri Cretaceous, they are found to agree well in form as well as in all essential specific characters of the septa. The New Jersey specimens generally have the septa less crowded, and the lobes and sinuses proportionally somewhat shorter; but it is evident that no specific, or even subspecific, distinctions can be based on such trivial differences.

In this connection, it is perhaps hardly necessary to remark that Dekay, in originally describing this species from a New Jersey specimen, was mistaken in describing the siphuncle as being funnel-shaped, and "placed on the margin nearest the center of the shell." It is evident that he mistook the antisiphonal or inner central lobe for the siphuncle, which was probably not exposed in his specimen. The fact that he also refers to figure 3, instead of 2, of his plate, in the Annals of the New York Lyceum, might also lead one to doubt whether he intended the name *A. placenta* to apply to this species, were it not for the fact that his description under this name was evidently intended to apply to this shell, and not to his figure 3, which represents a fragment that may belong to some other shell; while he refers to figure 2 in connection with his *A. hippocrepis*, the description of which clearly agrees with figure 5 of his plate, and certainly not with figure 2.

Dr. Stoliczka (in his Palæont. Indica, I, 90) places both *A. placenta*, Dekay, and *A. syrtalis*, Morton, doubtfully in the synonymy of *A. Guada-*

loupæ, Roemer. That both Roemer's species and the Indian form referred by Dr. Stoliczka to *A. Guadaloupæ* are clearly distinct, I have no doubt whatever; and I think Dr. Stoliczka would have readily concurred in this opinion had he been well acquainted with the latter. It seems to me also very doubtful whether his Indian shell is identical with *A. Guadaloupæ*. It is evidently much more nearly related to *A. syrtalis*, Morton, though it presents marked differences in the form of the siphonal lobe, which has its two branches very slender, and projecting obliquely from the *sides* of its body, instead of being broader and terminal, as in *A. syrtalis*, Morton, represented in our cut No. 66, from Morton's type-specimen.

Locality and position.—Dr. Dekay's type-specimen of this species came from the Cretaceous Greensands of New Jersey. It also occurs at the same horizon on the Chesapeake and Delaware Canal in the State of Delaware; and has likewise been found in the States of Texas, Alabama, and Tennessee. The small specimen figured on our plate 24 came from Cheyenne River, Dakota; where it occurs in the Fort Pierre group of the Upper Missouri Cretaceous series. Specimens nearly two feet in diameter, as well as of smaller sizes, have also been found on Bear Creek, a small tributary of Cheyenne River. The large specimen from which our cut No. 65, of a septum of this species was drawn, came from North Red River, Minnesota. I have also seen a specimen of it in Professor Hind's collection, from Saskatchewan River, British America.

Placenticeras placenta, var. intercalare.

Plate 23, figs. 1, *a*, *b*, *c*.

? *Ammonites syrtalis*, Morton (1834), Synop. Org. Rem. Cret. Group U. S., 40, pl. xvi (xiv by mistake), fig. iv.—Gabb (1861), Synop. Moll. Cret. Form., 17.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 25.

Ammonites placenta, var. *intercalaris*, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 117.—Gabb (1861), Synop. Moll. Cret. Form., 15.—Meek (1864), Smithsonian Check-List, 25.

? *Ammonites Tamulicus*, Blansford (1862), Mem. Geol. Surv. India, IV, 118 (without figure or description).

? *Ammonites Guadaloupæ*, Stoliczka (1865), Palæont. Indica, I, 90, pl. xlvii, figs. 1 and 2; also pl. xlviii, fig. 1 (not Roemer).

Shell attaining a large size, lenticular in form; umbilicus small; volutions with greatest convexity near the inner side, about three-fourths the breadth of each inner turn embraced within the deep sinus at the umbilical side of the next succeeding outer one, all with sides converging, with slight convexity, from near the umbilical margin to the *very* narrowly-truncated and slightly concave periphery, which is bounded on each side by a

row of small, laterally-compressed nodes, or slight prominences, alternately arranged with their longer diameters parallel to the direction of the peripheral curve; aperture compressed-sagittate; outline of lip unknown; surface showing obscure sigmoid lines of growth, with a row of very small nodes or tubercles, about one-third of the way across from the peripheral margin, and another of somewhat larger ones, near the umbilicus, on each side, those of the former series numbering about two to each one of the latter.

Size of mature, fully-developed specimens unknown. Greatest diameter of an imperfect example, consisting entirely of septate volutions, 6 inches; convexity of same, 1.72 inches.

Septa crowded, in large specimens complex, with comparatively rather short branches; siphonal lobe a little wider than long, but with body slightly longer than wide, provided with three oppositely-arranged lateral branches on each side, the two terminal of which are much larger than the others, and each ornamented with some five or six palmately-spreading, more or less sinuous and digitate branchlets; first lateral sinus as long as the siphonal lobe, but narrower, with an extremely narrow body, and deeply divided at the end into two nearly equal bi- or trilobate terminal branches, with sinuous margins, and provided with two principal, more or less sinuous, lateral branchlets, one of which on the siphonal side is much larger than the others; first lateral lobe about as long as the siphonal lobe, and still narrower than the first lateral sinus, a little obliquely curved, and tripartite at the extremity, the divisions being short, with sinuous and digitate margins, while it also supports two or three similar short lateral divisions on each side; second lateral sinus shorter and narrower than the first, with a very contracted, zigzag body, provided with two short, alternately-disposed, sinuous, lateral branches on each side, and two short, diverging, bifid, and sinuous terminal divisions; second lateral lobe a little wider and longer than the first, trifid at the extremity, with three alternating lateral branches, of which the two next to the terminal ones are larger and more deeply divided than the others; third lateral sinus of much the same size and form as the second, excepting in minute details; third lateral lobe longer than the second, but of about the same breadth and very similarly branched; succeeding lateral lobes and sinuses becoming at first abruptly, and then gradually and regularly smaller and less complex in their divisions toward the umbilical margin; the sinuses being all much contracted near the middle, and more or less bifid at their

anterior ends, and the lobes more or less distinctly tripartite at their posterior ends, excepting the last or twelfth one, which is very small and nearly or quite simple.

This shell seems to be almost exactly intermediate, in most of its characters, between *Ammonites placenta* of Dekay, and *A. syrtalis* of Morton; that is, it has the same form as *A. placenta*, with which it also agrees in showing no tendency to form costæ, or obscure ridges, on the sides; while it differs from that species, and agrees with *A. syrtalis*, in having a row of small compressed nodes along each margin of the periphery, and two rows of tubercles, or prominences, around each side, though the lateral tubercles are more rounded than they are represented on Dr. Morton's figure of *A. syrtalis*.

In first publishing a notice of this shell, in the Proceedings of the Academy of Natural Sciences, in 1860, we referred it to *A. placenta*, but at the same time called attention to its intermediate characters between the typical form of that species and *A. syrtalis*, Morton, and proposed for it the name *intercalaris*, as a variety of *A. placenta*.

On subsequently working out the details of one of its septa, as represented by the figure on plate 23, it was found to present some rather important differences from the septa of *A. placenta*, as may be seen by comparing figure 1, *c*, of plate 23, with the cut of a septum of the latter given in connection with the description of the same on a preceding page; that is, the first lateral lobe of the form here under consideration is tripartite, and narrow at its posterior end, instead of being bipartite, with the two terminal branches spreading. Some other less marked differences might also be pointed out, but these, at least in part, might be accounted for by the differences in the sizes of the specimens from which the drawings of the septa were made out; that of the form here under consideration being less than half as large as the specimen from which the cut of the septum of *A. placenta*, given on a preceding page, was made.

At that time I had no means of comparing the septa of this shell with those of *A. syrtalis*; Dr. Morton's figure of the sutures of his species not being sufficiently accurate for such purposes. On writing to Philadelphia, however, my friend Mr. Gabb was kind enough to work out a very careful drawing of one of the septa from Dr. Morton's type-specimens. This I have had photographed on a block of wood, and engraved twice the natural diameter, and inserted here.

Fig. 66.

A septum of *Placenticeras syrtalis*, magnified to twice the natural size; drawn by William M. Gabb, from Morton's original specimen, for comparison with our figure at the top of plate 23.

On comparing this with the septum of the form under consideration, it will be seen that, while there are other differences, the two agree in the tripartite character of the first lateral lobe. From this fact, and the nodiferous character of both, I was at first inclined to think that the other differences might, to a great extent, be due to the much larger size of the specimen from which the septum of our shell had been made out; and, therefore, that the latter might perhaps with greater propriety be considered a variety of *A. syrtalis*.

A specimen, however, from Texas, recently loaned to me by Prof. D. S. Martin of Rutgers Female College, New York, agreeing in its noded periphery and sides, and indeed in very nearly all other external characters, curiously enough differs in having its first lateral lobe bipartite at the end, and its septa throughout agreeing well with those of *P. placenta*, in shells of the same size. The compressed nodes along the margins of the narrowly-flattened periphery have the same alternating arrangement, and the little low, rounded nodes near the umbilicus, also exactly as in the form here under consideration. Another row of lateral nodes, however, on the form here described, between the middle and periphery of each side, is very nearly obsolete on the Texas shell.

From all that is now known of these forms, I am still led to regard the shell here under consideration as more properly a variety of *P. placenta* than of *P. syrtalis*. On comparing it, however, with the Indian form for which Blanford proposed the name *A. Tamulicus*, but which Dr. Stoliczka figures on plates xlvii and xlviii of his Palæont. Indica under Roemer's name *A. Guadaloupæ*, it will be seen that our shell agrees almost exactly in form and other external characters, excepting that it shows no traces of the obscure ridges seen on some, but not all, individuals of the Indian species.

The septum of the latter, however, as made out by Dr. Stoliczka from a smaller specimen than that of the form under consideration, figured on our plate 23, shows marked differences in the form of its siphonal lobe, that at least can hardly be due to the smaller size of the specimen. These differences consist in the much more slender branches of this lobe, and their

projection from its sides, some distance from its posterior end, instead of being broader, deeply divided, and terminal, as in our shell. There are also differences in the details of the other lobes and sinuses, but these are such as might more probably be due to the different ages and sizes of the specimens.

Quite as strongly-defined differences may also be observed between the septa of the Indian shell and those of *P. syrtalis*, particularly in the nature of the siphonal lobe, as may be seen by comparing our cut of the latter with Dr. Stoliczka's figure. The differences are also here more worthy of consideration, because both figures were made out from specimens not differing to so great an extent in size.

Whatever may be the relations, however, between these shells, I cannot agree with Dr. Stoliczka that his Indian form is identical with the Texas species, for which Dr. Roemer proposed the name *A. Guadaloupæ;* which latter is not only a very much more convex form, but differs as strongly in the nature of its septa from the Indian shell as our form and the typical *P. syrtalis* do. I also regard both of the latter as distinct from Roemer's Texas species, whatever may be their relations to each other, notwithstanding the fact that Dr. Stoliczka quotes *A. syrtalis* doubtfully as a synonym of the form he refers to *A. Guadaloupæ.*

I should also add here, that my friend Mr. Gabb, whose attention I called to this subject, informs me that, after a critical comparison of Dr. Stoliczka's figures and description of the Indian shell referred by him to *A. Guadaloupæ*, with Dr. Morton's type of *A. syrtalis*, fully concurrs with me in the opinion that these forms are specifically distinct from each other as well as from the true *Guadaloupæ.* We therefore agree that Blansford's name *Tumulicus* should be retained for the Indian species, if it is specifically distinct from the form here described, and both can be separated specifically from *P. placenta.*

Locality and position.—The form I have here with considerable doubt referred as a distinct variety to *P. placenta* came from Cheyenne River, at the mouth of Sage Creek, Dakota; where it occurs in the Fort Pierre group of the Upper Missouri Cretaceous. The Texas specimen, loaned to me by Professor Martin, of New York, came from the Cretaceous rocks of Tarrant County of that State.

Subgenus SPHENODISCUS, Meek.

Placenticeras lenticulare, Owen (sp.).

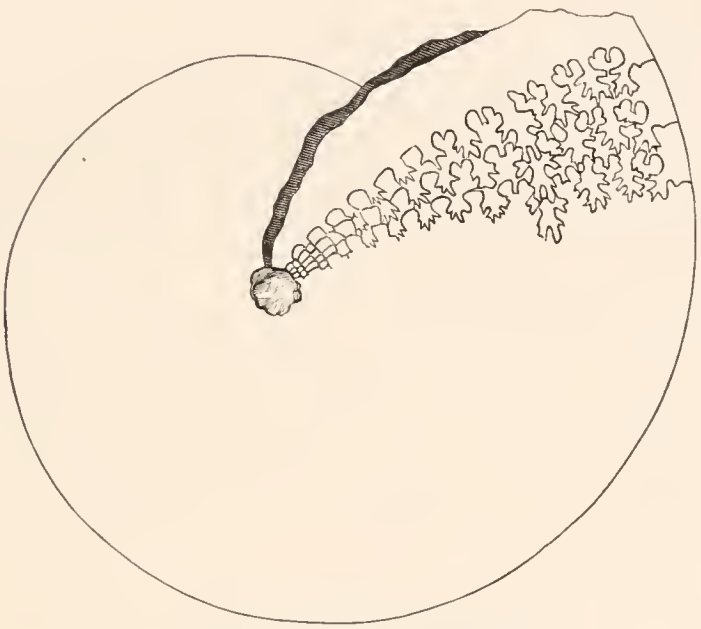
Plate 34, figs. 1, *a*, *b*, *c*.

Ammonites lenticularis, Owen (1852), Report U. S. Geol. Survey Iowa, Wisconsin, and Minnesota, 579, tab. viii, fig. 5 (not *A. lenticularis*, Phillips, 1825, nor von Buch).

Ammonites lobatus, Tuomey (1854), Proceed. Acad. Nat. Sci. Philad., VII, 168.—Meek and Hayden (1856), *ib.*, VIII, 280.—Gabb (1861), Synop. Moll. Cret. Group. 13.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 24.

Ammonites Pierdenalis, Binkhorst (1861), Monogr. des Gastéropodes et des Céphalopodes de la Craie supér. du Limbourg, 21 (not von Buch (1849), Ueber Ceratiten, 31, tab. vi, figs. 8, 9, 10).

Fig. 66.



Placenticeras (Sphenodiscus) lenticulare.

A small specimen, photographed on wood, and cut natural size, to show the appearance and crowding of the septa in shells of this size.

Shell attaining a large size, compressed-lenticular; umbilicus very small, or nearly closed; volutions very broad in their dorso-ventral diameter, which is twice and a half that of their greatest convexity near the middle, from near which their sides converge with very slight convexity, to the more or less acutely cuneate periphery; each of the inner turns entirely embraced and hidden within the profound sinus on the umbilical side of the next succeeding outer one; aperture narrow-sagittate; lip unknown; surface smooth, or with about fourteen very obscure, radiating, slight prominences or ridges, around the outer half of each side of each turn; ridges very rarely each showing a slight tendency to develop an obscure tubercle at its inner end.

Greatest diameter of the largest specimen seen (consisting entirely of

septate volutions), 10 inches; convexity of same, 2.30 inches. Young examples are proportionally more compressed.

Septa crowded, and each provided with eleven or twelve rather short, not very deeply divided, lateral lobes and as many sinuses, on each side; siphonal lobe twice as wide as long, and bearing two widely-separated, diverging, terminal branches, each of which has three very short, palmately-spreading branchlets, which, in large specimens, show a tendency to bifurcate; first lateral sinus about half as wide as the siphonal lobe, which it equals in length, while its body is very much contracted, and its anterior or free end bi- or tripartite, the division being merely broadly-bilobate, with otherwise nearly simple margins; first lateral lobe nearly or quite as long as the siphonal, but less than half as wide, and bipartite, the divisions being short, equal, and shortly-bifid, while its narrow body also bears two short, opposite, slightly-bifid lateral branches; second lateral sinus a little longer than the first, very contracted in the middle, and broadly trilobate or bilobate at the extremity; second lateral lobe a little longer, but otherwise very similar to the first; third lateral sinus agreeing more or less nearly in size and form with the second; third lateral lobe about one-fourth longer and somewhat wider than the second, but agreeing nearly in its branches with the same; fourth lateral sinus of nearly the same size and form as the first.

The succeeding lobes and sinuses at first diminish abruptly, and then gradually and regularly in size, toward the umbilical margin, the fourth and fifth lobes showing generally much similarity in form to the others, excepting that they are more or less tripartite at the end, with much shorter divisions, while the sixth and seventh are in large examples shortly bifid, and the others merely dentate. The fifth and sometimes the sixth sinuses are merely bilobate at the ends, and the others each terminate in a single broad, transversely-reniform cell, with entirely simple margins.

I have scarcely a doubt that the shell referred by Binkhorst to *Ammonites Pierdenalis*, von Buch, belongs to this species. One of his figures shows more tendency to develop lateral nodes than is common in the species here described, but I have seen specimens from Colorado, evidently belonging to this species, showing the same character; while the other specimens figured by Binkhorst agree well with ours in only showing very obscure, undefined, radiating ridges around the outer half of each side, produced rather by intervening depressions than by the elevation of the ridges themselves above the general surface.

His diagram of one of the septa has two or three more of the smallest inner lobes than I have seen in our specimens; but his figures of the entire shell show the same number as in ours; and besides, I should not think this a specific difference in shells agreeing so very closely in all other characters. However this may be, I cannot believe that either are identical with *A. Pierdenalis*, von Buch, if we go to his typical figure for comparison, because it shows distinctly on the larger half of the outer turn a row of compressed nodes, arranged around each side near the periphery; these rows being also represented around each side of the smaller part of the outer volution by a ridge or revolving carina, from which the sides are abruptly beveled to the periphery. Nothing of this kind, however, is seen on any of the specimens of our shell, or those figured by Binkhorst. In addition to this, von Buch's figure shows his type to have the septa lobes and sinuses much less divided than they are in parts of the shell of the same size in our specimens, or in those figured by Binkhorst. Again, von Buch represents the siphonal lobe of his species as having merely two *very* short, closely approximate, bi- or tridentate branches, instead of being provided with two very widely-separated, branching, terminal divisions.

Dr. Binkhorst, however, seems to have made his comparisons rather with a specimen sent by Mr. Schott from the Rio del Norte, Western Texas, than with von Buch's figures of his type from near Fredericksburgh, farther eastward, and possibly specifically distinct. The latter suggestion seems also to receive some support, from the fact that Dr. Roemer figures another specimen referred by him to *A. Pierdenalis*, from near the latter place (Kreid. von Texas, pl. 1, figs. 3, *a*, *b*, *c*), which, although of larger size than von Buch's type, and agreeing in form with that figured by Binkhorst, still shows the siphonal lobe to be altogether different in proportional size and form from that of Binkhorst's specimens, as well as from ours, being very decidedly smaller and merely composed of two diverging, contiguous, simple divisions, that give it a cordate form. Roemer's specimen also shows the lateral lobes much less deeply divided than in the Limbourg shell, or any of our specimens of corresponding size.

From the means of comparison now within my reach, I am, for the reason already stated, unable to agree with Dr. Binkhorst in his identification of his specimens with von Buch's species, and believe them to be identical with the form here under consideration, which seems to me to be equally distinct from the Texas shell described by von Buch.

A critical comparison of our specimens with Professor Tuomey's very brief description of his *A. lobatus* might lead to doubts whether it can be the same, since he describes the lateral lobes as "terminating in large bilobed cells." I think, however, that it is almost certain that he mistook the lateral sinuses for lobes; a mistake that might have been inadvertently made, his specimen being a mere fragment; while if we read it "lateral sinuses," instead of lobes, the description would agree exactly with the medium-sized specimens of the form under consideration. In addition to this, no species of the old genus *Ammonites*, so far as my knowledge extends, ever has lobes of the form described by him. His description of the siphonal (dorsal) lobe as being "finely serrated" is also inapplicable to this shell. Still, I must think this due to some oversight, or to the imperfection of his specimen, because, of all the collections that I have yet seen from the Southern States, no form agrees so well with his description as this, if we read 'lateral sinuses" for "lateral lobes." I likewise have the impression that Professor Tuomey identified one of our Upper Missouri specimens with his species, on seeing it at Albany many years since.

A careless observer might, on a hasty examination, mistake this shell for *P. placenta*, Dekay (sp.); but its sharp periphery, smaller umbilicus, and the differences in the nature of its septa will at once distinguish the two forms on comparison. It is true that in large specimens the periphery becomes less acutely angular; but it is never narrowly flattened, as in young and medium-sized specimens of Dekay's species, nor nearly so obtuse as we see in very large examples of that shell, with the flattening nearly obsolete.

Locality and position.—Professor Tuomey's type of his species *A lobatus* was from the Cretaceous rocks of Noxubee County, Mississippi. I have also seen a large, fine specimen of it ten inches in diameter, from Pontotoc, Mississippi, in the Smithsonian Museum at Washington City. Dr. Owen figured a very small, young example of it, under the name *Ammonites lenticularis*, from the Fox Hills, Dakota. The small specimen figured on our plate 24, as well as another larger one in the Smithsonian collections, measuring ten inches in its greatest diameter, came from Moreau River, not far from the same locality, where it occurs in the Fox Hills group of the Upper Missouri Cretaceous series. It also occurs in the Cretaceous beds of New Jersey, and at the foot of the Rocky Mountains west of Greeley, Colorado.

TURRILITIDÆ.

Genus HETEROCERAS, d'Orbigny.

Synon.—*Turrilites* (sp.), of authors; not Lamarck.
Heteroceras, d'Orbigny (1849), Cours Élem., 1, 291; and (1850) Prodr., 102; also (1851) Jour. Conch. (Paris), 217.—Pictet (1854), Traité de Paléont., II, 714.—Chenu (1859), Man. Conch., I, 96.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 25.

Etym.—ἕτερος, different; κέρας, a horn.
Type.—*Heteroceras Emericianum*, d'Orbigny.

Shell at first spiral, with volutions rounded, and contiguously coiled around a rather large umbilical cavity; but at a later stage of growth with the body-part free, extended more or less nearly straight, or with a much broader curve, away from the spire, and at last apparently with the free end curving backward again, somewhat as in *Ancyloceras;* surface ornamented with annular costæ, sometimes bearing nodes on the ventral or outer side of the curve; siphon passing around the middle of the outer side; septa with six branching, unequal lobes, and as many intervening sinuses, both of which are unsymmetrical in the spiral part, but nearly or quite symmetrical on opposite sides of the siphuncle, as far as they extend along the deflected body-part of the shell.

Much uncertainty exists in regard to the limits of this genus, and its relations to several allied types. Formerly, the species were referred to *Turrilites*, while even yet some include them in *Helicoceras*. They differ from the former in having the volutions at last becoming free and deflected; while from the latter they differ in having them wholly or in part in contact above the deflected part. They are also larger and more robust shells than the types for which the genus *Helicoceras* was originally proposed, and have the volutions not only in contact in the whole or a part of the spire, but coiled so as to form a smaller, though large umbilical cavity.

Again, this genus is allied to *Helicancyloceras*, Gabb, from which it appears to differ mainly in having a much more elevated spire, with volutions more decidedly in contact. The great difficulty in distinguishing these groups from each other is the fact that we nearly always have mere fragmentary specimens to deal with. In fact, I am not sure that entire specimens showing the whole shell, including the aperture with unbroken margins, of any of these genera, have yet been found; consequently, in most cases the characters of the entire shell have been partly inferred from detached portions, *supposed*, from their ornamentation and association in the same beds, to belong to different parts of the same types.

The species here provisionally referred to this genus are only known in the condition of mere fragments, evidently of spiral shells. Some of them have the turns in contact, and some free. The former are supposed to have belonged to the spire, others to the part where the deflection was just commencing, and still others to the deflected body-portion of the shell. All would apparently go into the genus *Turrilites* as formerly understood, as well as into the genus *Helicoceras* as extended by Mr. Sharpe and Dr Stoliczka, but not as originally founded by d'Orbigny. The changing and unsettled state of opinion in regard to the limits of the genera *Turrilites*, *Helicoceras*, and *Heteroceras*, together with the fragmentary condition of our specimens of the Upper Missouri species, have caused their provisional reference at different times in part to each of these genera. The weight of evidence, however, seems to favor the conclusion that they belong to the genus *Heteroceras* as now understood, though better specimens may yet show them to belong wholly, or in part, to some other group. None of them have the peculiar ornamentation of *Anisoceras* and *Helicancyloceras*.

So far as yet known, the genus *Heteroceras* seems to be entirely confined to the Cretaceous system.

Heteroceras? cochleatum, H. & M.

Plate 22, figs. 2, *a*, *b*.

Turrilites (Helicoceras) cochleatus, Meek and Hayden (1858), Proceed. Acad. Nat. Sci. Philad., X, 55.
Helicoceras cochleatum, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 25.

Shell sinistral, very thin, and composed of rounded, nearly or quite contiguous whorls, which gradually increase in size from the smaller to the larger extremity; umbilicus slightly wider than the largest whorl; surface ornamented by numerous rather regular, bifurcating annular costæ, which first pass obliquely backward and outward from the umbilicus above, then curve so as to cross the ventral or outer side obliquely downward and forward; but, on reaching the under side, they curve backward again as they approach the umbilicus. There are also two irregular rows of obscure, flattened, or depressed oval nodes, one of which rows passes around nearly over the siphuncle, which is located near the middle of the outer side of the whorls, while the other is placed less than one-fifth the circumference of the whorl lower.

The septa are rather distant, and divided into complex lobes and sinuses, which are a little unsymmetrical in their subordinate details, but about of

the same size and general form on opposite sides of the siphuncle. The siphonal lobe is comparatively small, and ornamented at the extremity by four small branches, the two terminal of which are a little larger than the others, slightly dissimilar, and each provided with five or six unequal, sharp digitations; the other two branches are not exactly opposite, differ slightly in form, and are each armed with from three to five or six unequal serrations; in advance of these principal terminal divisions, there are, along the sides of the lobe, a few very small, alternating, subordinate, lateral branchlets and sinuosities. The first lateral sinus is small, very oblique, much contracted at its base, and divided at the extremity into two unequal, variously-subdivided, sinuous branches. The first lateral lobe is much larger than the siphonal one, and very deeply divided into two great spreading, subequal branches, the larger of which is on the ventral side, and unequally subdivided into three bifurcating branchlets, the two terminal of which are much larger than the others, and more or less digitate, while the other main branch has two principal bifurcating branchlets, with many smaller digitations and sinuosities. The second lateral sinus is not so oblique, but in other respects very similar to the first; while the second lateral lobe is smaller than the first, and very much like it in its mode of branching.

The largest and best specimen of this species that has been found, consists of a little more than the half of one volution, the greatest transverse breadth of which is 2.34 inches; diameter at larger end (which is a little oval), 0.73 by 0.64 inch; breadth of umbilical space, 0.85 inch.

Since writing the foregoing description, the only specimen of this species that we had, showing the septa, was lost, consequently I am unable to give an enlarged view of its lobes and sinuses as was intended. It will be seen, however, from the description, that in their general characters they are like those of *Helicoceras Mortoni*, H. & M.

In form and other external characters, even fragments of this shell will be at once distinguished from the *H. Mortoni*, by its shorter curve and proportionally thicker whorls, which also differ in being nearly or quite in contact. Its costæ are also smaller in proportion to the diameter of the whorls, and more regular.

Locality and position.—Great Bend of the Missouri, below Fort Pierre, Dakota; from the lower part of the Fort Pierre group.

Heteroceras? Nebrascense, M. & H.

Plate 22, figs. 1, *a*, *b*, *c*.

Ancyloceras? Nebrascense, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 71.
Turrilites Nebrascensis, Meek and Hayden (1856), *ib.*, VIII, 280.
Helicoceras? Nebrascense, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 25.

Our specimen of this species consists of about the half of one volution, and measures near 2.80 inches in length around the outer side. It is subcylindrical, or tapers but slightly, its diameter at the larger end being about one inch, and at the smaller extremity 0.95 inch, and forms a short dextral, spiral curve, so as to leave an umbilical cavity within, equaling the greatest diameter of each surrounding whorl. The volutions seem to have been in contact, and are ornamented by small annular costæ, which pass very obliquely around, and sometimes appear to bifurcate on the outer side, where there are some remains of small nodes. The siphuncle occupies the middle of the outer side, and is quite small.

The specimen is unfortunately not in a condition to show all the ramifications of the lobes and sinuses; but they are seen to be very complex, and do not differ materially in size or form on opposite sides of the whorls. The siphonal lobe is longer than wide, and has two principal branches on each side, the two terminal of which are much larger than the others, and each subdivided into two or three unequal, sharply digitate branchlets; the other two principal branches are opposite, spreading, and bifurcated; one of the subdivisions of each being larger than the other, and armed by about seven or eight sharp digitations. The first lateral lobe is a little longer and much wider than the siphonal lobe, and very deeply divided into two great spreading, variously subdivided, and sharply digitate branches. The second lateral lobe seems to be rather smaller, but, as far as can be determined, very similar to the first; while the antisiphonal lobe is comparatively large, though slender, and tripartite at the extremity, the middle division being largest, bifurcating, and, like the other two principal divisions, variously digitate. The details of the sinuses are not clearly visible in our specimen, though the third lateral one on both sides of the whorls is very deeply divided by a large auxiliary lobe.

This species will be readily distinguished from either of the foregoing, even when found in fragments, by its smaller umbilical cavity in proportion to the diameter of its whorls, as well as by the differences in its septa. It seems to have had, like most of the species, two rows of nodes around the

outer side of the whorls, though our specimen is so worn that they are nearly obliterated.

Locality and position.—Near the forks of Cheyenne River, Dakota; in the upper part of the Fort Pierre group of the Upper Missouri Cretaceous series.

Heteroceras tortum, M. & H

Plate 22, figs. 4, *a*, *b*, *c*.

Helicoceras tortum, Meek and Hayden (1858), Proceed. Acad. Nat. Sci. Philad., X, 54.
Heteroceras tortum, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 25.

Of this species, we have one entire septate volution, which evidently belonged to a sinistral spiral shell, the whorls of which are rounded, and increase so as nearly to double their diameter each turn. They are coiled in such a manner as to be disconnected by a free space, equaling from one-third to one-half the diameter of each succeeding whorl below; while the umbilical cavity left within the coil is less than the diameter of the largest volution. The surface is ornamented by two rows of rather depressed nodes, passing around below the middle of the outer side, and small annular costæ, which sometimes bifurcate at the nodes.

The siphuncle is small, and presents the remarkable peculiarity of gradually changing its position in passing from the smaller to the larger extremity of the fragment studied; that is to say, that at the smaller end of the specimen it occupies exactly the middle of the outer side, but, in passing around, it gradually curves upward, so that, by the time it reaches the larger extremity, it comes out on the summit of the whorl. It is also worthy of note that the lobes and sinuses of the septa, as might be expected, follow this curve of the siphuncle, so that it would seem that this whorl not only forms an ascending spiral curve, but is also apparently twisted upon an imaginary axis within itself; this, however, was almost certainly not the case throughout the entire length of the shell, but probably occurred only in this particular whorl, preparatory, as it were, to the peculiar deflection of the succeeding, or non-septate portion.

The septa are not very closely crowded, though rather complex; the lobes and sinuses (which scarcely differ in size and form on opposite sides of the siphuncle) being variously branched and subdivided. The siphonal lobe is comparatively small, oblong, about one-third longer than wide, and ornamented at the extremity by two nearly equal branches, each of which has two or three small, more or less digitate, subdivisions. The first lateral sinus

is rather larger than the siphonal lobe, a little oblique, narrow at its base, and very deeply divided into two equal, bifurcating, variously subdivided, and digitate branches. The first lateral lobe is very large, and has at the extremity, two great spreading, unequal branches, each of which bifurcates twice, and is provided with various subordinate divisions, with sinuous and serrated margins. The second lateral sinus is larger and more erect than the first, but similar in its mode of branching. The second lateral lobe is about one-fourth smaller than the first, and divided in much the same way; while the third lateral sinus is smaller than the first, very oblique, narrow at its base, and deeply divided at the extremity into two nearly equal, sinuous branches. The antisiphonal lobe is comparatively large, being about half the size of the siphonal lobe, and tripartite at the extremity, with a tridentate middle division.

The greatest transverse diameter of the whorl is 2.43 inches; breadth of umbilical cavity, 0.65 inch; diameter of larger end of the whorl, 1.04 inches; diameter of the smaller end, 0.74 inch; diameter of siphuncle at its larger end, 0.06 inch.

This species will be distinguished from all the otherwise similar forms known in these rocks by the smaller size of its umbilical cavity, in proportion to the diameter of its whorls, and by its more rapidly ascending spiral curve. Its volutions are also more tapering, and differ in their peculiar twisted character, indicated by the curve of the siphuncle; there are likewise corresponding differences in the details of the septa. If it really belongs to the genus *Heteroceras*, it would seem to be from the base of the spire, just where the deflection of the body-part was commencing.

Locality and position.—Great Bend of the Missouri below Fort Pierre, Dakota; from the lower part of the Fort Pierre group of the Upper Missouri Cretaceous series.

Heteroceras? umbilicatum, M. & H.

Plate 22, fig. 5.

Turrilites? umbilicatus, Meek and Hayden (1858), Proceed. Acad. Nat. Sci. Philad., VIII, 56.
Helicoceras umbilicatum, Meek and Hayden (1860), *ib.*, 185.

Our specimen of this species consists of one entire volution, about half of which is septate, though not in a condition to show the form and details of all the lobes. It belonged to a sinistral shell, the volutions of which are rounded, very gradually tapering, and coiled in an ascending spiral, so as at

least at this part, to come nearly or quite in contact, and leave an umbilical cavity within the coil, almost equaling the greatest diameter of each surrounding whorl The surface is ornamented by distinct, oblique, annular costæ, which sometimes bifurcate on the lower outer side of the whorls, where they support two rows of rather small nodes. The siphuncle occupies the middle of the outside of the whorls, near the upper row of nodes.

Although it is not possible to follow out the ramifications of the septa in the specimen of this shell studied, they are evidently moderately distant, and the principal lobes provided with long, very slender, branching, and sharply digitate divisions.

The whorl in our possession measures 3.27 inches across; the breadth of the umbilicus being 1.10 inches; diameter at the larger extremity, 1.16 inches, and at smaller end, 1.01 inches.

This form seems to be similar in some respects to our *H. tortum;* but the fact that the type-specimen (although larger, and consequently, if it belongs to that species, would apparently represent a lower part of the spire) has its volutions in contact, would seem to show that it cannot be identical with that species. The only other shell I have yet seen among the Upper Missouri collections resembling it in the size of the umbilicus compared with the diameter of the whorls, is *H. Nebrascense*, from which it differs in having much larger and more distant costæ, and in being sinistral instead of dextral. It also holds a lower geological position, where nearly all its associates, so far as known, differ from the species occurring with *H. Nebrascense.* If a *Heteroceras*, our type-specimen must belong to the spiral part of a large species

Locality and position.—Same as last.

Heteroceras? Cheyennense, M. & H.

Plate 21, figs. 2, *a*, *b*.

Ancyloceras? Cheyennense, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 71.
Turrilites Cheyennensis, Meek and Hayden (1856), *ib.*, 280.
Heteroceras? Cheyennense, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 25.

The best specimen of this species we have obtained is a non-septate fragment, about 2.50 inches in length, with a diameter of 1.55 inches. It is a comparatively rather thick shell, with nearly cylindrical, disconnected whorls, and forms a broad (dextral?) spiral curve in such a manner, that if continued around, there would be left within the coil a great umbilical cavity, apparently not less than four times the diameter of each surrounding volu-

tion. The surface is ornamented by distinct, rounded, oblique, flexuous, annular costæ, which sometimes bifurcate on the lower outer side, where they support two parallel rows of obtuse nodes.

This fragment is referred provisionally to this genus, upon the supposition that it belongs to the deflected portion of the shell, which view is sustained by its large size, very broad curve, and non-septate condition. It may be the free part of the species we have described under the name *H. umbilicatum*, or some of the others, but we have no direct evidence of this. At some future time, when more complete specimens have been found, these doubtful points will be more satisfactorily settled. Its spiral curve shows that it cannot belong to *Ancyloceras* or *Hamites;* and the fact that it belongs to a shell with the volutions partly or entirely free shows that it cannot be properly included in the genus *Turrilites* as restricted by the separation of the genus *Heteroceras.*

This shell seems to be related to *Ammonites? Cooperi*, Gabb (Cal. Geological Rep., I, 69, pl. xiv, fig. 23), which I think must be at least congeneric.

Locality and position.—Mouth of Big Cheyenne River, Dakota; from the upper part of the Fort Pierre group of the Upper Missouri Cretaceous series.

Heteroceras? angulatum, M. & H.

Plate 21, fig. 3, *a*, *b*, *c*.

Helicoceras angulatum, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 176.
Heteroceras? angulatum, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 25.

Of this shell we have a single non-septate fragment, 2.78 inches in length, with a diameter of 1.50 inches at the larger end, and 1.37 inches at the smaller extremity. It is rounded, or subcylindrical, and makes a broad (dextral?) spiral curve, in such a manner that if continued around, the volutions would be disconnected, and encircle an umbilical cavity apparently more than three times their own breadth. The surface is ornamented by distinct angular costæ, which pass around the whorls obliquely, and support two rows of nodes on the lower outer side, where they sometimes bifurcate.

I have not yet seen the septa of this species, but its large size and very broad curve will distinguish it from any other known species of this type in these rocks, excepting the last, from which it differs in having angular instead of rounded costæ, and in being coiled in the opposite direction. Its angular costæ will equally distinguish it from any of the others, even should

they be found attaining as large a size, and in such short fragments as not to show the exact nature of the curve. Like the last, it is only referred provisionally to this genus upon the supposition that it belongs to the deflected part of the body of the shell.

Locality and position.—Head of South Branch of Cheyenne River, Dakota; from the upper part of the Fort Pierre group of the Upper Missouri Cretaceous series.

Genus HELICOCERAS, d'Orbigny.

Synon.—*Turrilites, Hamites,* &c. (sp.), of authors.

Helicoceras, d'Orbigny (1840), Paléont. Fr. Terr. Crét., I, 611; and (1850) *ib.*, Terr. Jurass., I, 598; also (1850) Prodr., I, 263; and *ib.*, II, 103 and 127.—Morris (1843), Cat. Brit. Fossils, 181.—Baugier and Sauzé (1843), Notice sur Quelques Coq., 15.—Deshayes (1845) in Lamarck (2d ed.), XII, 266.—Quenstedt (1852), Handb. der Petref. (index), 772.—Pictet (1854), Traité Paléont. II, 713.—Chenu (1859), Man. Conch., I, 96.—Meek and Hayden (1860), Proceed. Acad. Nat. Sci., XII, 21.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 25.—Gabb (1864), Palæont. California, I, 71.

Helicocerus, King (1844), Ann. Mag. Nat. Hist., XIV, 278.

Etym.—ἕλιξ, twisted; κέρας, a horn.

Examp.—*Helicoceras annulatum,* d'Orbigny.

Shell slender, terete, spiral; volutions few, widely disconnected, and coiled so as to leave a very broad umbilical space within, and form a much depressed spire; surface ornamented with simple, or bifurcating, annular costæ, which are either continuous, or interrupted on the siphonal side; septa each provided with six unequal, branching, and digitate lobes, the second lateral and antisiphonal ones of which are often divided into unpaired branches, while the six intervening sinuses have their branches in pairs; siphuncle on the outer or ventral side.

As here defined, the genus *Helicoceras* includes two sections that may be distinguished as stated below:

1. **HELICOCERAS**, d'Orbigny (typical).

   Shell with the annular costæ passing uninterruptedly over the rounded siphonal side.—(*H. annulatum*, d'Orbigny.)

2. **PATOCERAS**,* Meek.

   Shell differing from the typical form in having the costæ suddenly and completely interrupted on the siphonal side, so as to leave a narrow, smooth, path-like space along the whole length of the same.—(*H. Teilleuxi*, Baugier.)

Pictet and some others also refer to this genus *Turrilites Robertianus,*

* πάτος, a path (in allusion to the smooth path-like space along its siphonal side); κέρας, a horn.

d'Orbigny, which was only known to the latter author in the condition of fragments, from which he was led to regard it as having its volutions in contact, as in *Turrilites*. Pictet, however, has figured a specimen, referred by him to d'Orbigny's species, that shows the volutions to be clearly disconnected, more nearly as in *Helicoceras*. If it really belongs to this genus, however, it would represent a third, very distinct section, on account of its more closely-coiled volutions, more produced spire, and particularly in consequence of having the costæ that cross its siphonal side, with nodes placed between them, so as to form three longitudinal rows along this outer surface. It is also a much larger and more robust shell than d'Orbigny's types of *Helicoceras*.

Owing to these differences, I do not feel warranted in including this shell in the same genus with d'Orbigny's original typical forms of *Helicoceras*. It seems to me rather to form the type of a distinct genus; but whether this view is correct, or it ought to be included as a section of that genus, it should most probably receive a distinct name. Hence, I would propose to call the group into which it falls *Spiroceras*.

From the foregoing, it will be seen that I adopt this genus in its most restricted sense, as represented by d'Orbigny's original typical species *H. annulatum* and *H. gracile*. Mr. Daniel Sharpe proposed, in his valuable memoir on the English Chalk Cephalopoda, to extend its characters so as to make it include a part of the species usually referred to the genus *Turrilites*, notwithstanding the fact that these shells (d'Orbigny's section *Rotundati* of the genus *Turrilites*) have their volutions in contact. They differ, however, from the other section of that genus (the *Angulati*), not only in their shorter and broader form, wider umbilicus, and rounded volutions, but in having their siphon on the outer side of the curve, instead of near the suture above; while none of them are known to have their aperture hooded, as in the other section. Still, they differ widely from *Helicoceras* as here understood, and as originally founded by d'Orbigny.

Although I at one time fully adopted Mr. Sharpe's views in regard to these shells, and still concur with him in the opinion that they should most probably be separated entirely from the genus *Turrilites*, as represented by d'Orbigny's group *Angulati*, a further consideration of the subject has led me to doubt the propriety of including them in the same genus with those little shells such as d'Orbigny originally founded the genus *Helicoceras* upon; char-

acterized by very slender, widely-disconnected volutions, forming so broad a curve as to give origin to a *very* wide umbilical cavity. As all of these generally much larger shells, with rounded, connected volutions, forming d'Orbigny's section *Rotundati* of the genus *Turrilites*, are, I believe, yet only known in the condition of specimens with the terminal portion broken away, it seems quite as probable that they may, when entire, have the body-part deflected so as to conform to the characters of the genus *Heteroceras*. Consequently, I think we are not justifiable yet in making *Helicoceras* so comprehensive as proposed by Mr. Sharpe.

Dr. Stoliczka gives this genus the same limits that Mr. Sharpe did, and yet makes the singularly inconsistent remark that, "when d'Orbigny first established the genus *Helicoceras* (Paléont. Fr., I, 611), he described under it two species, which very probably do not belong to this genus, and which may prove to be coiled fragments of *Anisoceras*."* He therefore seems to ignore the fact that these two species which he thinks may "not belong to this genus" are the typical forms on which it was alone founded originally; and that the name must always adhere to the group to which *they* belong, and cannot be transferred to a different group, even if d'Orbigny and others did, *at later dates*, include in it species of this extraneous type. If d'Orbigny's original types are congeneric with the group for which Pictet subsequently proposed the name *Anisoceras* (which may or may not be the case), then the latter name would be only a synonym of *Helicoceras:*

As here understood, the genus *Helicoceras* seems to have been introduced during the Oolite period, ranges into the Cretaceous, and, if the following-described species really belongs to this genus, it must have continued on until the deposition of the upper part of the latter series.

Helicoceras Mortoni, var. tenuicostatum.

Plate 22, figs. 3, *a*, *b*, *c*.

Hamites Mortoni, Hall and Meek (1854), Mem. Am. Acad. Arts and Sci. Boston, V, 396, pl. iv, fig. 3.
Ancyloceras, Hall and Meek, *ib.*, 411.
Helicoceras tenuicostatum, Meek and Hayden (1858), Proceed. Acad. Nat. Sci. Philad., X, 56.
Helicoceras Mortoni, Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 25.

The only specimens of this species that have yet been seen are fragments, the largest of which is 1.39 inches in length, with a diameter of 0.49 inch at one end, and 0.44 inch at the other. It makes a broad, sinistral,

* Palæont. Indica, I, 182.

ascending spiral curve, in such a manner that if continued around, there would be left between the whorls a free space apparently equal to their own breadth, and an umbilical opening within more than three or four times the diameter of each whorl. The siphuncle is quite small, and passes around a little above the middle of the outer side. The surface is ornamented by rather irregular, moderately distinct, annular costæ, which occasionally bifurcate, and extend nearly straight around the whorls. On the outer side, they are stronger than within, and show a disposition to develop small nodes.

Septa rather complex; siphonal lobe not more than half as long, and about half as wide as the first lateral lobe, with two principal divisions on each side, the two terminal of which are much larger than the others, and each distinctly bifid, with digitate margins; first lateral sinus longer than the siphonal lobe, but much more contracted at its base, very oblique, and at its extremity divided into two unequal, spreading, branched, and digitate subdivisions; first lateral lobe very large, and deeply divided into two great, spreading branches, with each four or five unequal, digitate smaller divisions; second lateral sinus much like the first, excepting that it is not oblique; second lateral lobe a little smaller, but in other respects scarcely differing from the first; third lateral sinus smaller, though much like the first, with its obliquity in the opposite direction; antisiphonal lobe about as long, and near half as wide as the siphonal, and tripartite at the end, with more or less digitate margins.

The fragmentary condition of the specimens of this shell that have been found, is not altogether satisfactory in regard to its generic characters, though they clearly show that it was not coiled in a plane, as in *Hamites* and *Ancyloceras*, but spirally curved as in *Helicoceras*. On comparison with the typical species of *H. Mortoni*, our shell will be seen to agree pretty nearly in form and size, but seems to make a somewhat shorter curve. In the details of the lobes and sinuses of its septa, there are also some differences, particularly in the form and mode of division of the antisiphonal lobe. These differences at one time led to the conclusion that it was a distinct species, and, if constant, would certainly warrant its separation under another specific name. As further examinations, however, show it to vary more or less in the details of its lobes and sinuses, particularly those of the antisiphonal lobe, which in some cases shows a tendency to assume the form of that of the typical *H. Mortoni*, I have elsewhere ranged it under that name; and,

until we can have an opportunity to study and compare additional specimens in a better condition, it may as well be viewed, at least as a variety of that species.

Locality and position.—The original specimen of this species was found at the Great Bend of the Missouri River below Fort Pierre; in the lower part of the Fort Pierre group of the Upper Missouri Cretaceous series; and the specimen figured by us also came from the same locality and horizon.

NAUTILIDÆ.

Genus NAUTILUS, Linnæus.

Synon.—*Nautilus*, Linnæus (1758), Syst. Nat. (ed. 10), 709.—Bruguière (1789), Encyc. Méth., 1, xiv.—Cuvier (1798), Tab. Élém., 382.—Lamarck (1799), Prodr., 79; and (1801) Syst., 99; also (1805) Ann. Mus., V, 179; also (1809) Phil. Zoöl., and (1822) Hist., VII, 630.—Montf. (1808), Conch. Syst., I, 2.—J. Sowerby (1812), Min. Conch., 1, 13.—Blainville (1822), Dict. Sci. Nat., XXXII, 183; and (1825) Malac., 387.—Deshayes (1824), Coq. Foss. Env. Paris, II, 767; and (1866) Suppl. to same, III, 622.—Owen (1832), Memoir on the Pearly Nautilus, London, 4.—Bronn (1837), Leth., 104, 176, and 1122.—Agassiz and Desor (1840), German transl. Sowerby's Min. Conch., 27.—D'Orbigny (1840), Paléont. Fr., I, 70.—Pictet (1854), Traité de Paléont. II (2e éd.), 622.—Gabb (1864), Palæont. Cal., I, 59.—Meek (1865), Palæont. Upper Missouri, 64.—Blanford (1866), Palæont. Indica, I, 6.—Stoliczka (1866), *ib.*, 202.—Zittel (1868), Palæont. Mitth. aus dem Mus. des Koenigl.-Bayer. Staates, 41; and of many others.

Angulites, *Bisiphites*, *Oceanus*, and *Ammonites*, Montfort (1808), Conch. Syst., I, 6, 54, 58, and 74 (not *Ammonites*, Breynius, and others).

Simplegas (sp.), Blainville (1824), Dict. Sci. Nat., XXXII, 185; and (1825) Malac., 385; also (1827) Dict., XLIX, 248 (not *Simplegades*, Montfort, 1808).

Omphalia, De Haan, Monogr. Ammon., &c., 51.

Discites, De Haan (1825), *ib.*—McCoy (1844), Synop. Carb. Fossils Ireland, 54 (not *Discites*, Schloth., 1820; nor Goldfuss, 1830).

Temnochilus, McCoy (1844), Synop. Carb. Fossils Ireland, 20.—Meek and Worthen (1866), Illinois Geol. Survey Reports, II, 162 (adopted as a subgenus under *Nautilus*).

Discus, King (1844), Ann. and Mag. N. H., XIV (old ser.), 274.—Meek and Worthen (1860), Proceed. Acad. Nat. Sci. Philad., XII, 469 (adopted as a subgenus under *Nautilus*); not *Discus*, Fitzinger, 1833; nor Haldeman, 1840.

Cryptoceras, d'Orbigny (1850), Cours Élément., I, 286.—White and St. John (1869), Trans. Chicago Acad. Sci., 1, 124 (as a subgenus under *Nautilus*); not *Cryptoceras*, Latreille, 1804; nor Barrande, 1846.

Trematodiscus, Meek and Worthen (1861), Proceed. Acad. Nat. Sci. Philad., XIII, 147; and Illinois Geol. Survey Reports, II, 161 (proposed as a subgenus under *Nautilus*).

Endolobus, Meek and Worthen (1865), Proceed. Acad. Nat. Sci. Philad., XVII, 259; and Illinois Geol. Survey Reports, II, 307 (proposed as a subgenus under *Nautilus*).

Hercoglossa, Conrad (1866), Am. Jour. Conch., II, 101.

Solenochilus, Meek and Worthen (1870), Proceed. Acad. Nat. Sci. Philad., XXII, 47; also (1873) Illinois Geol. Survey Reports, V, 524, and 544 (proposed as a subgenus under *Nautilus*).

Etym.—ναυτίλος, a sailor.

Type.—*Nautilus pompilius*, Linnæus.

Shell involute, globose, discoid or variously compressed; umbilicus closed, or more or less widely open, sometimes perforated in the middle; volutions oval, rounded, compressed or angular, all coiled on the same plane,

and more or less deeply embracing, or merely in contact; septa concave on the surface, facing the aperture, with their margins nearly straight, arched, a little waved, or sometimes flexed into a simple rounded or angular backward extension, or lobe, on each lateral surface, or sometimes on the inner, and very rarely also on the outer or peripheral side*; siphuncle simple, cylindrical, and most usually central or nearly so, very rarely placed nearly against the peripheral side; surface smooth, striated, costated, or with revolving carina and furrows, sometimes also ornamented with nodes; aperture reniform, sublunate, cordate, subsagittate, or varying from oval to subcircular or quadrate; lip thin, generally sinuous on the outer side and inner lateral margins, each of which latter is sometimes, though rarely, drawn out into a spout-like projection.

The foregoing diagnosis and synonymy are drawn up so as to include, along with the typical species, a rather wide range of extinct forms, generally believed by high authorities to belong to this genus. Some of the latter, however, differ so materially from the typical *Nautili* that they ought to be at least entitled to rank as distinct subgenera. A review of the numerous fossil forms of various ages shows that there are other equally marked but unnamed sections; though only the following will be especially noticed here:

1. NAUTILUS, Linnæus (typical).

Shell subglobose, discoid, or more or less compressed; umbilicus often closed, or comparatively small; volutions generally deeply embracing and rounded, oval, or rarely subangular on the periphery, or near the umbilicus; septa merely arcuate, nearly straight, or waved on each side, and sometimes on the periphery; surface smooth, striated, or with small transverse costæ that are arched or divaricating on the sides and periphery.—(Type as already cited.)

2. TEMNOCHILUS, McCoy.

Shell subdiscoid, with a large, generally deep umbilicus, and a broad flattened or moderately convex periphery; volutions usually little embracing, much widened transversely, and angular, and sometimes subnodose around each prominent lateral margin; septa merely a little arcuate on the margins; surface with only marks of growth.—(*Nautilus coronatus*, McCoy.)

* Still more rarely there are two angular lateral lobes on each side.

3. **TREMATODISCUS**, Meek and Worthen.

Shell discoid, with umbilicus very wide, usually shallow, and showing all of the inner turns, generally perforated; volutions narrow, increasing gradually in size, very little or not at all embracing, and provided with several revolving angles and furrows, usually both on the sides and periphery, sometimes also marked with revolving striæ; septa merely a little arched.—(*Nautilus stygialis*, de Koninck.)

4. **DISCITES** (De Haan), McCoy.

Shell discoid, with umbilicus usually wide, shallow, and showing all the inner turns; volutions narrow, increasing gradually in size, quadrangular, sometimes nodiferous, not embracing; septa straight or arcuate on their lateral margins and the flattened or concave periphery; surface showing marks of growth.—(*Nautilus planiturgatus*, McCoy.)

5. **SOLENOCHILUS**, Meek and Worthen (= *Cryptoceras*, d'Orbigny).

Shell generally presenting the form and surface-characters of *Nautilus* proper, but with siphuncle very nearly against the periphery, and the lip on each side near the umbilicus drawn out into a narrow, spout-like projection.—(*Nautilus* (*Cryptoceras*) *spiniger*, White and St. John.)

6. **HERCOGLOSSA**, Conrad (= *Aganides*, Montfort ?).

Shell more or less discoid, with umbilicus closed or small, and periphery usually rather narrowly rounded; volutions deeply embracing, surface nearly smooth, or with lines of growth; septa deflected backward in crossing each side, so as to form a deep, usually angular lateral lobe.*—(*Nautilus orbiculatus*, Tuomey; *N. Parkinsoni*, Edwards, &c.)

7. **PSEUDONAUTILUS**, Meek.†

Differs from the last in having the septa also provided with a well-defined peripheral and antiperipheral lobe, and the siphuncle placed near the outer margin.—(*Nautilus Geinitzi*, Oppel.)

* In some Triassic species that seem to fall into this group, such as *N. noricus*, Mojsisovics, there are, as already intimated, two of these lobes on each side.

† This type presents very curious and interesting intermediate characters between the *Nautilus* and *Goniatites* groups; that is, it has not only the lateral lobes of the septa of the latter, as we see in some other *Nautiloid* groups, but also the peripheral, or so-called dorsal lobe of *Goniatites*, while its

Professor McCoy's section *Temnochilus* was originally made by him to include species belonging to the *Trematodiscus* group; but as the shells of the latter section differ materially in form and ornamentation from some of the other species included by him, such as his *N. coronatus* (the first of his figured species), it seems desirable to restrict the name *Temnochilus* to that and allied species. Consequently, Professor Worthen and the writer proposed to separate the peculiar Carboniferous group of discoid species with a wide, shallow umbilicus, narrow, non-embracing, generally more or less rounded or oval volutions, ornamented with distinct revolving carinæ and furrows, under the name *Trematodiscus*, which name was suggested by the fact of most of the species having the umbilicus perforated in the middle. This character, however, sometimes occurs in other ancient types of *Nautili*, and cannot be considered peculiarly characteristic of this section. Still, as these shells form a rather marked group, apparently confined to the Carboniferous rocks, it is certainly desirable, from a palæontological point of view, to range them as a distinct section. G. B. Sowerby, jr., figured, in his Conchological Manual (fig. 475), a typical *Trematodiscus* under the name *Simplegas* (intended for *Simplegades*, Montfort). This, however, was inadmissible, because Montfort's type of his *Simplegades*, as he wrote it, belongs to some section of the old genus *Ammonites*, and could not be retained for a *Nautiloid* type, although Blainville had improperly proposed to do so.

Some time back, Professor Worthen and the writer proposed, as a subgeneric name, *Endolobus*, for a large *Nautilus* not differing very materially in form from species that seem to fall into the group *Temnochilus* as here understood; but which is provided with a kind of lobe, or flexure, of the septa on the inner side. Having since observed, however, that this character occurs in other species, which, upon all other characters, would fall into several of the different sections, I do not believe now that the section *Endolobus* can be sustained; and, even if it could, Montfort's name *Bisiphites* would probably have to be retained for it.

The group for which Professor Worthen and the writer used the name *Solenochilus* is almost certainly the same for which d'Orbigny proposed the

siphon is removed from the peripheral margin as in the *Nautiloid* forms. Still it is so near the outer margin that it would only have to be placed about two or three times its own breadth farther out, to bring it against the periphery, and thus make the shell a Goniatite, as that genus is usually understood. Such examples show how gradually the distinctions between genera and larger groups are found to fade away as our knowledge of the intermediate types extends.

name *Cryptoceras* in 1850; but d'Orbigny's name cannot stand, because Barrande had used it for a genus of *Cephalopoda* in 1846. It is true that Barrande subsequently changed the name of his genus to *Ascoceras*, because Latreille had, in 1804, used *Cryptocerus* for a genus of insects. If this was a sufficient reason, however, for changing Barrande's name, Latreille's *Cryptocerus* would be equally in the way of d'Orbigny's *Cryptoceras;* and, if not, then Dr. Barrande's genus would have to retain his original name, which would render d'Orbigny's name equally untenable.

It is very probable that Professor King intended his name *Discus* to apply to shells that would fall into the groups *Temnochilus*, *Discites*, and *Trematodiscus*, as well as perhaps other sections of the older *Nautili*. He did not define it, or cite any particular species as an example; but it is evident that he had in view discoid shells with volutions merely in contact, as he alludes to *Crioceras* as only differing in having volutions not in contact. At one time, Professor Worthen and I adopted his name *Discus* for the same group that we subsequently called *Trematodiscus;* but it is evident that Professor King's name cannot stand, for the reason that it had been previously used for other genera by Fitzinger in 1833 and by other authors at different dates; while he published no diagnosis and cited no type.

The name *Discites* had also been used by some older authors than De Hann; but, as it has not been retained for the types to which they applied it, I think there is no reason why it may not be used for the section of *Nautilus* to which De Hann and McCoy applied it.

The type for which Mr. Conrad proposed the name *Hercoglossa* forms a transition from *Nautilus* proper to *Aturia;* that is, it agrees exactly with the former in all respects excepting in the lobed character of its septa, in which, as well as in form, it agrees still more nearly with the latter; but it nevertheless differs from *Aturia* in having its siphuncle cylindrical and more nearly central, as in *Nautilus*, and not large and funnel-shaped.

It is not always possible to group objects of natural history in a linear series, so as to bring types most intimately related nearest to each other, because forms that most nearly agree in some characters will often be found to differ widely in others. In most characters, *Hercoglossa* certainly seems to approach the true *Nautili* more nearly than any of the other sections that I have placed nearer the latter; but, in the lobed character of its septa, it diverges as widely from the typical forms of the genus as any of the

other sections do. Indeed, this character is so strongly marked in this type that I would scarcely hesitate to admit the section as a distinct genus, if it were not that we find among extinct species many intermediate gradations in this character of the septa.

I am now much inclined to believe that the shell for which Montfort proposed the name *Aganides* in 1805 is identical with *Hercoglossa*, Conrad, 1866. At one time, I was strongly inclined to adopt the conclusion maintained by some, that the type of Montfort's genus *Aganides* is a Goniatite, which latter name would, in that case, be only a synonym. In the only copy of Montfort that I had then seen, his figure of the type of his proposed genus *Aganides* does not show the position of its siphuncle clearly, though there is some appearance of an attempt to represent it in a central position (he does not mention in his description the position of the siphuncle). In another copy, however, belonging to the Congressional Library, the siphuncle is plainly seen, in the same figure, in a central position. I have also since ascertained that the original figure in Sonini's edition of Buffon, from which Montfort's illustration of the type of his *Aganides* was copied, shows clearly a very nearly central siphuncle. Consequently, if correctly drawn, the fossil represented cannot be a Goniatite, but might be a *Hercoglossa*, or *possibly* an *Aturia*. The locality (Namur) cited both by Sonini and Montfort, however, would be much against the conclusion that it belongs to either of the latter two genera, and favors the opinion maintained by d'Orbigny and some others that it is a Goniatite, the rocks at Namur being, if I am correctly informed, of Carboniferous age. Until the question in regard to Montfort's type can therefore be definitely settled, it would be improper to make his name replace any one of those mentioned.

The genus *Nautilus*, as here understood, dates far back into the Silurian epoch, ranges through all succeeding formations, and is still represented by a few living species in our existing seas. Since the origin of the group, however, during the Silurian period, it has developed at different times markedly different characters, sending off as it were branches and subbranches in various directions, until, in some cases, these sections have diverged so far from the original central idea, so to speak, of the genus, as to give origin to serious doubts whether the whole should be included in one genus. Although these different characters were from time to time developed, the typical section of the genus never entirely died out; and it is somewhat remarkable

that, as a whole, the Silurian species fall more properly into the typical section, including the existing species, than into any of the other subdivisions that were developed in the Carboniferous, Triassic, and some later periods.

In the Carboniferous rocks, we meet with the *Temnochilus*, *Trematodiscus*, *Discites*, *Solenochilus*, and other aberrant sections, along with species falling into the typical division. In the true Permian rocks, the genus *Nautilus* seems to be little developed, and the known species most nearly conform in general to the typical section.*

The Triassic rocks contain quite a diversity of types of this genus. Here we find, with the typical section, *Discites* still represented; but *Temnochilus*, *Trematodiscus*, and *Solenochilus* seem to have died out before the commencement of this epoch. Here we also apparently meet with the *Hercoglossa* section for the first time, or at least with nearly allied types; and also several aberrant forms that apparently do not fall properly into any of the foregoing sections.

Again, in the Jurassic rocks, the typical section of *Nautilus* is well developed, along with forms approaching *Discites*, and others with strongly-waved septa, more or less nearly like *Hercoglossa*. In the Cretaceous, we also have typical *Nautilus* still more extensively developed, along with *Hercoglossa*, *Pseudonautilus*,† and a very few forms like *Discites;* while nearly all of the other sections seem to have died out. In the Lower Tertiary, we still meet with *Hercoglossa*, but it also soon disappears, to be replaced by the genus *Aturia*, which mainly differs in its funnel-shaped, larger, and more nearly internal siphuncle. Both of these types, however, died out near the close of the Eocene, leaving the typical section of the genus as its sole representative through the more recent formations, and in our existing seas; in which latter it is represented by so few known species as to lead to the conclusion (in view of its former great development) that the genus may probably be regarded as approaching its end.

* This remark is, of course, not intended to apply to a very peculiar type described by Professor Geinitz, from the Permian rocks of Germany, under the name *Nautilus Seebachianus*. This shell has the very small, globose, involute portion without an open umbilicus, and the very large body, or outer chamber, straight, with its inner side open, and its lateral margins spread out like great wings on each side. This I have elsewhere proposed to call *Pteronautilus*. It forms a very marked and distinct genus.

† This type, I believe, only occurs in the Neocomian, the oldest member of the Cretaceous.

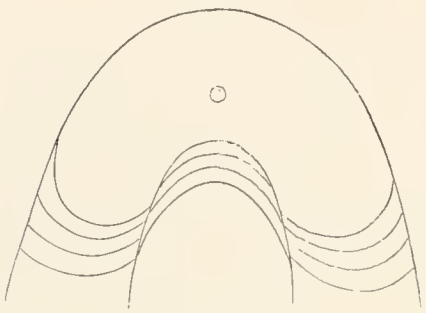
Nautilus Dekayi, Morton.

Plate 27, figs. 1, *a*, *b*, *c*, *d*, *e*.

Nautilus Dekayi, Morton (1834), Synop. Org. Remains, 33, pl. 8, fig. 4.—Hall and Meek (1856), Memoirs Am. Acad. Arts and Sci. Boston, V (n. s.), 406.—Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 280.—Conrad (1860), Jour. Acad. Nat. Sci. Philad., IV (n. s.), 276 (not *N. Dekayi* as figured by Ernest Favre in Moll. Foss. Craie Env. de Lemberg, pl. iii, fig. 1 to 3).

? *Nautilus perlatus*, Morton (1834), Synop., pl. 13, fig. 4.

Fig. 67.



Nautilus Dekayi.

An outline from Morton's type-specimen, showing the position of the siphon and the form of the aperture, as indicated by one of the inner septa.

Shell subglobose, broadly rounded on the periphery and sides; umbilicus closed; volutions increasing rapidly in size, or more than doubling their diameter each turn, about half as wide again as high, all hidden but the last or outer one; aperture much wider than long, transversely reniform, the lateral extremities being rounded, and the inner side deeply sinuous for the reception of the inner whorls; lip having a wide shallow sinus along the peripheral side, prominently rounded on the lateral margins, and again sinuous near each umbilicus; septa moderately concave, and about sixteen or eighteen to each turn; siphuncle small, located one-fourth to one-third of the distance across toward the periphery, from the margin of the inner side; surface of adult or medium-sized specimens nearly smooth, or having very obscure lines of growth, crossed by faint traces of longitudinal striæ; on young individuals, or the inner volutions of larger ones, these lines are quite distinct in both directions, and form a very neat, cancellated style of ornamentation; internal casts sometimes showing a slender longitudinal line on the center of the periphery.

The proportions are shown by the following measurements of a young individual: length, 1.84 inches; breadth of aperture, 1.70 inches; diameter of aperture in the direction of the length or greater diameter of the shell, 0.72 inch. Some imperfect adult individuals before me, too much broken to afford exact measurements, were evidently as much as three times the linear dimensions of that from which the foregoing measurements were taken.

This common species has been wrongly identified with several foreign forms. D'Orbigny, in his Prodr. de Paléont., expresses the opinion that his

own *N. lævigatus*, published in 1846* (not his *N. lævigatus*, 1840), is synonymous with it; also the Indian *N. sphæricus* and *N. Obignyanus*, Forbes, and a Chilian form referred by Professor Forbes to *N. lævigatus*. Mr. Blanford, however, considers both of the Indian shells merely varieties of *N. Bouchardianus*, d'Orbigny, and entirely distinct from *N. Dekayi*, Morton. I have not the necessary specimens at hand to express any decided opinion in regard to the Indian shells figured by Mr. Blanford all belonging to the one species *N. Bouchardianus;* but I can fully concur with him in the opinion that they are certainly distinct from *N. Dekayi*, Morton. The latter differs, as stated by Mr. Blanford, in having its umbilicus always filled with a solid shelly kind of columella, formed by the thickening of the lip at its connection with the body of the shell on each side, instead of being perforated. *N. Dekayi* also has its aperture constantly more transverse, and its siphuncle always nearer the inner side, as may be seen by our figure 1, *a*, plate 27, which represents very nearly the typical form of the species, as I know from a direct comparison with Dr. Morton's type-specimen, now in the Museum of the Academy of Natural Sciences at Philadelphia; from which type-specimen the foregoing outline-cut showing the position of the siphuncle was drawn.

It is true that Dr. Morton also referred doubtfully to *N. Dekayi*, under the provisional name *N. perlatus*, a more compressed form from Alabama, that would doubtless agree more nearly in the outline of its aperture, and in several other respects, with some of the Indian forms, as well as with the Chilian *N. Orbignyanus*, Forbes. I have not seen specimens of the Alabama shell showing the position of its siphuncle, but I very much doubt its identity (judging from its form only) with *N. Dekayi* proper, as I have seen no tendency among our specimens (that do not differ also in the position of the siphuncle) to assume this more compressed form.

Dr. Ernest Favre, in his "Moll. Foss. Craie des Env. de Lemberg," refers to *N. Dekayi* a shell that is evidently quite decidedly distinct; while he also cites in the synonymy forms not only distinct from Dr. Morton's species, but not identical with the species he figures, which has a more dilated aperture than *N. Dekayi*, while it shows little ribs on the inner volu-

* His figures of this shell given in the Voyage of the Astrolabe, agree very closely in form, as well as in the outline of the aperture and the position of the siphuncle, with *N. Dekayi;* but as they were drawn from an internal cast only, we have not the means of knowing certainly whether or not the small umbilical perforation seen in the cast was entirely filled with a solid columella-like callosity on ea[illegible]r side, as in Morton's species. If it has this character, it may be identical with that form.

tions, somewhat as in *N. elegans* and *N. pseudo-elegans*, never seen on *N. Dekayi* at any stage of growth. His figure also represents the siphuncle proportionally more nearly central than in Dr. Morton's species.

Locality and position.—Dr. Morton's original type-specimens of *N. Dekayi* were from Monmouth and Burlington Counties, New Jersey, where it occurs in the Greensand-Marls of the Cretaceous. It also occurs at various other localities in that State at the same horizon. Our figured specimens on plate 27 came from Sage Creek and Yellowstone River, of the Upper Missouri Cretaceous; where they were found in the upper part of the Fort Pierre group.

Nautilus Dekayi, var. Montanaensis.

Plate 27, figs. 2, *a*, *b*, *c*, *d*, *e*.

This shell agrees exactly with *N. Dekayi* in the nature of its closed umbilicus, and does not differ materially in general form, being only a little more compressed laterally, which also gives a shorter transverse diameter and somewhat different outline to its aperture. The most important difference, however, is to be seen in the position of its siphuncle, which is very nearly central, instead of being only about one-fifth the dorso-ventral diameter of the septa from the inner side. A difference of this latter kind is generally regarded as specific, and I am much inclined to think that this shell will be found specifically distinct from *N. Dekayi*. Still, Mr. Blanford, of the Indian survey, refers to the single species *N. Bouchardianus*, d'Orbigny, forms differing as much in the position of the siphuncle, as well as in other respects, as this differs from the typical form of *N. Dekayi*, and still states that all of the Indian forms shade together by imperceptible gradations in all of these characters.

For the present, I therefore place this shell as a variety of *N. Dekayi*, though suspecting that it will be found to present sufficiently-marked and constant differences to rank as a distinct species.

Locality and position.—Yellowstone River, Montana, one hundred and fifty miles from its mouth; where it occurs in beds containing a blending of the fossils of the Fort Pierre and Fox Hills groups of the Upper Missouri Cretaceous series.

Nautilus elegans, Sowerby.

Plate 8, figs. 2, *a*, *b*, *c*.

Nautilus elegans, Sowerby (1816), Min. Conch., II, 33, pl. 116.—Mantell (1822), Geol. Sussex, 112, tab. xx, fig. 1.—Sharpe (1853), Monogr. Chalk Ceph. of England (Palæontogr. Soc.), 12, pl. iii, fig. 3; and pl. iv, fig. 1 (probably not of d'Orbigny, Paléont. Fr., Terr. Crét., I, 87, pl. 19, and some others).

Nautilus elegans, var. *Nebrascensis*, Meek and Hayden (1862), Proceed. Acad. Nat. Sci. Philad., XIV, 25.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 25.

Shell subglobose, broadly rounded over the periphery, and on each side to the umbilicus, which is closed in young and medium-sized specimens, but becomes a little open in the adult; 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 over 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.

In originally publishing a notice of this shell, in the Proceedings of the Academy, as a variety of *N. elegans*, Sowerby, we remarked that it agrees almost exactly in form and surface-markings with Sharpe's figures of *N. elegans* (Sowerby's figure being less satisfactory because it shows only an oblique lateral view), but that it seemed to differ in having its umbilicus closed at all ages, and its siphuncle slightly more nearly central. At that time, we were under the impression that a peculiar rounded projection shown on the left side of figure 2, *a*, of plate 8, was a kind of columella formed by the thickening of the lip, thus completely filling the umbilicus as in *N. Dekayi*.

A more critical examination, however, and the removal of some adhering laminæ of shell, have led to the conclusion that this round columella-

like mass is much more probably no part of the shell itself, but merely a portion of the same inorganic rocky material from which the specimen was broken, filling a small umbilical opening of the outer volution. This suggestion is also apparently sustained by an examination of the other side of the specimen, illustrated by fig. 2, *c*, of the same plate. Here it will be seen that there is also, as it were, a little plug in the umbilicus. Most of this, however, is clearly layers of shell; but a careful examination of its broken end on the right, seems to show that there is passing into it a minute umbilical cavity, filled with rock so nearly of the same color as the partly-metamorphosed shell itself that it requires very careful looking to see the line of separation between the two. On this side, however, as examined much farther in than can be seen on the other, the filled cavity is so *very* small as to show that the umbilicus must be completely closed in young and medium-sized specimens; while the apparently inorganic plug on the other side seems likewise to show that there is a small, deep umbilical opening in the outer volution of the adult shell.

From these facts, I am led to believe that our shell will be found to agree so closely with Sowerby's species that there may be no necessity for separating it, even as a variety—that is, if Mr. Sharpe's illustrations can be relied upon. From Sowerby's application of the words "indistinctly sagittate," however, to the aperture, it would seem that his type-specimen must be much more compressed than ours, which, as already stated, agrees well with Sharpe's figures in form.* As Sharpe ought to have been well acquainted, however, with Sowerby's species, I infer that the latter's original type may have been *accidentally* compressed.

On comparing our shell with the form figured by d'Orbigny in the Palæontology of France, and referred by him to *N. elegans*, Sowerby, it will be seen that the latter is also rather decidedly more compressed, and has its siphuncle a little farther from the middle of the septa; while he describes its umbilicus as being not open, but only provided with a slight depression.

These differences, or more properly the position of the siphuncle, has led Pictet, in his review of the costate forms of *Nautili*, to regard *N. elegans* of Sowerby, and *N. elegans* of d'Orbigny, as belonging to two distinct species; and this conclusion has also been adopted by Blanford in his report on the

* Sowerby says that the cross-diameter of his species about equals two-thirds of its height; but I am not sure in regard to how he applied the words "cross-diameter" and "height"; and his single figure being an oblique view does not show the form of the aperture.

Cretaceous *Nautili* of India (Palæont. Indica, I, 29). Yet it is a little singular that they both retain the name *N. elegans* for d'Orbigny's type, and cite d'Orbigny as the author of the name, although he merely referred it to Sowerby's species published long before. Blanford protests against this application of Sowerby's name to forms like that figured by d'Orbigny, but still follows Pictet in it. If *N. elegans*, d'Orbigny, is specifically distinct from the previously-published *N. elegans*, Sowerby (which seems very probable), of course d'Orbigny's shell will have to receive some other name, as two species of the same genus cannot retain the same name.

Dr. Shumard, some years back, described a shell of this type in the Transactions of the Saint Louis Academy, vol. I, page 590, from the Cretaceous rocks of Texas. As he mentioned, however, that its siphuncle is situated between the middle and the *ventral* (inner) sides of the septa, it must differ from that here under consideration, and agree more nearly with *N. pseudo-elegans*, d'Orbigny, which, with this exception, is very closely allied to *N. elegans*, Sowerby, as well as to that figured by d'Orbigny under Sowerby's name.

Locality and position.—Chippewa Point, Montana; from the Fort Benton group of the Upper Missouri Cretaceous series.

DIBRANCHIATA.

BELEMNITIDÆ.

Genus BELEMNITELLA, d'Orbigny.

Synon.—Belemnites (part), Lamarck (1799); and of many later authors, but not as restricted by d'Orbigny and others.

Belemnitella, d'Orbigny (1840), Paléont. Fr., Terr. Crét., I, 59 (as a subgenus under *Belemnites*); and (1842) Dict. Univ. d. Sci. Nat., II, 531; also (1845) Geol. Russ., II, Paléont., 489; and (1850) Prodr. Paléont., II, 211 (as a distinct genus).—Agassiz (1840), Germ. Transl. Sowerby's Min. Conch., 633.—Woodward (1856), Man. Moll., 74.—Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 70; and (1860) *ib.*, XII, 419.—Chenu (1859), Man. Conch., I, 50.—Binkhorst (1861), Monogr. Gastérop. et Céphalop. Craie Sup. de Limbourg, 1.—Favre (1869), Descrip. des Moll. Foss. de la Craie des Environs de Lemberg, 1.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 26.—Roemer (1870), Geol. von Oberschlesien, 357; and of many others.

Etym.—βέλεμνον, a dart.

Type.—*Belemnites parillosus*, Lam. (= *B. mucronatus*, Schloth.).

Guard cylindrical or more or less clavate, provided with a deep conical cavity in the anterior end for the reception of the phragmacone, and usually more or less pointed behind; wall of the conical cavity divided by an open,

longitudinal, linear slit down the ventral side; surface ornamented on the ventral side by distinct vascular (?) markings, and having on the dorsal side a broad flattened ridge; phragmocone nacreous, and provided with a single dorsal ridge and a ventral process, and often with a minute bulb at the apex.*

The guards of this genus are mainly distinguished from those of *Belemnites* by their ventral slit and vascular markings. There were probably other differences in the anterior termination of the phragmocone, as well as in the structure of the animal, in regard to which nothing is known.

There are some reasons for doubting whether or not d'Orbigny's name *Belemnitella* can be properly retained for this genus. At one time, I was inclined to believe that this type, instead of the similar group, might have to inherit the older name *Belemnites*, because Lamarck, who was the first regular binomial author that used it in a binomial sense as the name of a genus, cited as his first examples figures of Breynius, that clearly represent *Belemnitella*, and not the genus *Belemnites*, as now understood. He, however, also cites, in the same connection, figures of Klein's *Tubulis marinis*, t. 8, figs. 2–13. I have not had an opportunity to consult the old work of Klein's to which he refers; but my friend Mr. Gabb, after examining the figures in a copy of it at Philadelphia, informs me that those cited by Lamarck in part represent *Belemnitella* and in part forms belonging to the genus *Belemnites* as restricted. Herrmannsen also cites *Tubulis marinis*, Klein, as in part equivalent to *Belemnites*. Consequently, Lamarck had both types included, and could not be regarded as restricting the name *Belemnites* exclusively to either group.

In 1826, Miller proposed (Trans. Geol. Soc. Lond., II (2d ser.), page 63) the name *Actinocamax* for a genus which he supposed to differ from *Belemnites* in having no alveolar cavity at the anterior end. It is evident, however, from the figure of his type, that it is simply a guard broken off just behind the termination of this cavity, and then with the broken end worn, as has been suggested, probably during the life of the animal. Sowerby, Daniel Sharpe, and Dr. Gray, maintain that Miller's type (*A. verus*, Miller) is really neither more nor less than the *B. mucronata*, Schloth., the type of *Belemnitella*, d'Orbigny; and this seems to be confirmed, at least so far as regards its

* The phragmocone of this genus is only known from natural casts of the alveolus, which show that it was chambered as in *Belemnites*. Whether or not it was produced in the form of a long anterior-dorsal expansion, as in that genus, is, I believe, unknown. Thin laminæ of the phragmocone left in the alveolus of some of our specimens show that it was pearly.

generic characters, by the fact that Miller mentions in his specific description the presence of "branching impressions of blood-vessels," one of the most marked characters of *Belemnitella*, and one never seen in *Belemnites*. From these facts, it seems almost certain that *Belemnitella* is a synonym of *Actinocamax*, Miller, which has priority of date over *Belemnitella*. Miller's name, however, has been generally rejected, because—not perceiving the condition of his type—he did not understand its true characters. This, however, ought not, I should think, to set aside the claims of his name for the genus, if there is no room for the least doubt in regard to the type-species really belonging to the same genus as d'Orbigny's; because, as every one knows, a large proportion of the generic names now in general use, proposed by the early naturalists, might in the same way, be set aside to give place to later names published by authors having far more accurate knowledge of the real characters of the genera named than the original founders of the same.

For the reasons above stated, I should not hesitate to retain the name *Actinocamax* for this genus, were it not for the fact that, according to Herrmannsen, Linck had, as far back as 1807, proposed the name *Atractites* for a type identical with Miller's *Actinocamax*. This, therefore, complicates the matter, and, until these questions can all be cleared up, I have preferred, for the present, to follow those who use d'Orbigny's name *Belemnitella* for this genus, especially as it is still an open question whether Linck's work can properly be regarded as a *published* document, since it is said that only two or three copies of it were distributed before the destruction of the whole edition by fire.

This genus appears to be entirely confined to the horizon of the true Chalk and the Upper Greensand of English geologists, and has an almost world-wide geographical range, wherever beds of these horizons occur. Like *Belemnites*, these mollusks seem to have been gregarious in their habits; great numbers of their guards being often found together in the same beds. At some localities in New Jersey, I have seen thousands of the guards of the common species *B. mucronata* lying about the Greensand Marl pits, mingled with the marl that had been thrown out of the same.

Belemnitella bulbosa, M. & H.

Plate 33, figs. 2, *a*, *b*, *c*, *d*, *e*.

Belemnitella bulbosa, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 70; and *ib.*, 280.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 26.

Shell or guard small, slender, subcylindrical, sometimes slightly expanded at the open anterior end, and pointed at the other extremity; vascular markings not very strongly defined, and rather irregular; dorsal ridge moderately distinct; alveolar cavity apparently less than half the length of the guard, terminating behind in a minute bulb. Phragmocone tapering regularly at an angle of 20°; section slightly oval; substance extremely thin, distinctly pearly, and marked on the surface by scarcely visible, very fine lines of growth, which curve abruptly forward on the dorsal side; septa separated by spaces about one-sixth their greater diameter, faintly waved forward on the dorsal side.

Length of a specimen, retaining apparently less than half the alveolar cavity, 2.30 inches; breadth at the larger (anterior) end, 0.29 inch.

This species resembles young specimens of *B. mucronata*, Schloth, but is smaller and more slender than the average-sized adult individuals of that species. It is also more regularly tapering at the lower extremity, though never abruptly attenuated at the immediate point, as we usually see in *B. mucronata*. The conical cavity in its anterior end seems to be likewise proportionally shorter, and differs in having a minute bulb at the extremity. This latter character occurs in other species, though I have not been able to find it in any of the specimens of *B. mucronata*, from New Jersey or elsewhere, yet examined. Again, the axial line in our species seems to be always very nearly central, while in *B. mucronata* it is eccentric. Ours is also an extremely rare species, while *B. mucronata* is very abundant at most localities where it occurs.

I am indebted to the Academy of Sciences of Saint Louis, Missouri, for the use of the specimen figured on plate 33, none of our own being in a condition to show very clearly the form and surface-markings of the guard. It was presented to the academy by Colonel Vaughan, United States Indian Agent.

Locality and position.—Near Moreau trading-post, Dakota; from the Fox Hills group of the Upper Missouri Cretaceous series. It is very rare, only a few specimens having been brought in among all the extensive collections from the Northwestern Territories.

TEUTHIDÆ.

Genus PHYLLOTEUTHIS, M. & H.

Synon.—Phylloteuthis, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 175.—Gabb (1861), Synop. Moll. Cret. Form., 32.—Meek (1864), Smithsonian Check List N. Am. Cret. Fossils, 26.

Etym.—φύλλον, a leaf; τευθίς, a cuttle-fish.
Type.—*Phylloteuthis subovata*, M. & H.

Gladius flat, thin, subovate, being obtusely angular behind, widest posteriorly, narrowing forward, and apparently corneous in texture; midrib narrow; alations only marked by fine, straight, parallel striæ, which pass from the midrib obliquely backward and outward to the lateral and posterior-lateral margins.

This genus seems to be related to the Liassic group *Belotеuthis*, Münster, but differs from the typical forms of the same in not having the lateral alations suddenly contracted, or shouldered, as it were, in outline near the middle, nor marked with a few furrows, ridges, or striæ, radiating forward from the posterior extremity; also in having the striæ of its alations perfectly straight and parallel. At least one of the species, however, sometimes referred by authors to *Belotеuthis*, seems hardly generically distinct from our type—that is, *Loligo Bollensis*, Schoubler. It has also been referred to *Belopeltis* by d'Orbigny, and *Belemnosepia* by Pictet, to neither one of which it appears to me properly to belong.

Unless the last-mentioned species can be correctly included in this genus, it would seem to be, so far as known, a Cretaceous group; the type-species being from the Upper Cretaceous. If Schoubler's species, however, is congeneric, that would make the genus both Cretaceous and Liassic.

Phylloteuthis subovata, M. & H.

Plate 33, fig. 3.

Phylloteuthis subovata, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 175. (For other citations, see synonymy of the genus.)

The specimen on which this species and the genus to which it belongs were founded, consists only of an impression of the expanded part of the gladius in a mass of rock. It was evidently thin, or leaf-like; the space between the two halves of the rock, the separation of which exposed the fossil, being very thin. None of its original substance remains, which fact seems to indicate that it was more probably corneous than calcareous, as

other fossils, such as shells, &c., composed of calcareous matter, embedded in the same matrix, retain their original substance.

The only specimen discovered unfortunately had its shaft broken away and lost at the time the mass of rock in which it was found was broken open. The expanded part is about 1.60 inches in length and 0.90 inch in breadth; its greatest breadth being slightly behind the middle. Posteriorly, it is obtusely angular, while its lateral alations have their margins converging with convex outlines from the central region, or slightly behind it, forward. The midrib is quite slender, and the striæ of the alations are fine, rather obscure, closely arranged, straight, parallel, and directed backward and outward at an angle of about 70° from the midrib.

As already mentioned, this fossil seems allied to *Loligo Bollensis*, Schoubler, especially in the surface-striations and general form of its expanded part. It wants the lateral sinuosities of that species, however, and evidently had a more slender midrib.

Locality and position.—Moreau River, Dakota; from the Fox Hills group of the Upper Missouri Cretaceous series.

ARTICULATA.

ANNULATA.

TUBICOLA.

SERPULIDÆ.

Genus SERPULA, Linnæus.

Synon.—Serpula, Linnæus (1758), Syst. Nat. (ed. 10), 1767.—Brug. (1792), Encyc. Méth., I, xiv.—Cuvier (1798), Tab. Élém., 622.—Lamarck (1801), Syst. An., 325.—Blainv. (1827), Dict. Sci. Nat., XLVIII, 549.

Etym.—Serpo, to creep.
Examp.—Serpula vermicularis, Linnæus.

Tube calcareous, procumbent, variously curved, or spirally coiled, growing singly or in groups, attached to marine bodies, and capable of receiving the entire animal; aperture at the larger extremity simple, rounded, and provided with a discoid or funnel-shaped operculum.

This genus is nearly related to *Spirorbis*, which some authors include as a mere section of the same group. As these two types, however, differ in

their branchiæ, as well as in the regularly-coiled, *Planorbis*-like form of the tube of *Spirorbis*, they seem to be sufficiently distinct to be separated generically.*

The shells of these annelids were long supposed to be those of true mollusks; but as soon as naturalists examined the animal inhabiting them, it was found to belong to the *Articulata*. Where we only know the shelly tubes, however, as is of course always the case with extinct species, it is very difficult to distinguish species of this genus, not merely from the allied genera, but even from *Vermetus*, a true mollusk. Consequently, much uncertainty exists in the classification of the fossil species, and for the same reason the geological range of the genus is not certainly known. Some authors refer to it Devonian and even Upper Silurian species; but it is quite probable that if we had the means of ascertaining the nature of the animal once inhabiting these shelly tubes from the older rocks, they would be found to differ generically from the more modern and existing Serpulas. The number of species supposed to belong to this genus is found to increase as we ascend through the Carboniferous and later formations, and the genus appears to attain its maximum development at the present time. The recent species are numerous, and attach themselves to stones, shells, pieces of wood, the bottoms of ships, &c., and are widely distributed.

Serpula? tenuicarinata, M. & H.

Plate 6, fig. 1.

Serpula tenuicarinata, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 134; and (1860) *ib.*, 419.—Meek (1864), Smithsonian Check-List N. Am. Cret. Fossils, 26.

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.

* Dr. Stoliczka has proposed (Palæont. Indica, II, 237, 1868), a genus *Tubulostium* for the reception of a group of planorbicular and spirally-coiled shells which have the aperture somewhat produced and contracted. He regards them as the shells of mollusks, which their structure, as seen in sections, seems to warrant, though their general appearance is much like that of the articulate genus *Spirorbis*. However this may be, I think the name *Tubulostium* superfluous, as I have the impression that Bronn had long since named the same group *Spirulæa*, and Defrance, I think, had also called it *Rotularia*—both being founded upon *Serpula spirulæa*, Lamarck.

Not having seen entire specimens of this species, it is with some doubts 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, Dakota, on the Missouri; in the Fort Benton group of the Upper Missouri Cretaceous series.

SPECIES OF THE FRESH- AND BRACKISH-WATER LIGNITE BEDS.*

MOLLUSCA.

LAMELLIBRANCHIATA.

MONOMYARIA.

OSTREIDÆ.

Genus OSTREA, Linnæus (see page 10).

Ostrea glabra, M. & H.

Plate 40, figs. 2, *a*, *b*, *c*, *d*.

Ostrea glabra, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 146.

Shell usually subovate, slightly arcuate laterally, narrowing toward the beaks, and rounded at the other extremity; generally moderately thin; surface nearly smooth, or only marked by small, very obscure, irregular, concentric wrinkles of growth. Lower valve deep, and provided with a small, rather short, ligament-area; beak angular, sometimes pointed, often a little deformed by the scar of attachment, generally abruptly curved to one side; muscular impression obliquely oval. Upper valve flat or a little concave, and truncated at the extremity of the beak.

Length, 3 inches; breadth, about 1.50 inches; concavity of lower valve, 0.75 inch.

This species presents very few distinguishing features. It is rather thin and subovate in general form, with its under valve comparatively deep, and the upper flat, or a little concave. The beak and area of the former are

* Owing to the conflicting nature of the evidence in regard to the age of these deposits, I have concluded to describe here together, in one separate section, all of the known invertebrate remains from the whole of the Fresh- and Brackish-water Lignite beds of the Upper Missouri. Having already, in the general introductory remarks, discussed the question respecting the probable relations of these strata to the Cretaceous and Tertiary epochs, it is unnecessary to add anything further on that subject here.

short, and usually curved to the left; the area being small and rather deep. The surface of both valves is entirely free from radiating plications or costæ, or projecting concentric laminæ; though it shows obscure striæ, and a few irregular, faintly-marked ridges of growth.

Locality and position.—Judith River beds, at the mouth of Judith River, Montana, on the Upper Missouri; probably belonging to the closing period of the Cretaceous.

Ostrea subtrigonalis, E. & S.?

Plate 40, figs. 1, *a*, *b*, *c*, *d*.

Ostrea subtrigonalis, Evans and Shumard (1857), Trans. Acad. Sci. St. Louis, 40.

Shell small, rather depressed, narrow-subovate in outline, generally slightly arcuate laterally; beaks rather pointed when not distorted by the scar of attachment, while the opposite extremity is compressed and more or less rounded. Lower valve rather shallow, with lateral margins crenate and sometimes a little furrowed, but not thickened or expanded; ligament-area moderate, triangular, and with the usually pointed beak turned a little to the left; surface merely showing concentric striæ and furrows. Upper valve nearly flat, or much compressed, with beak more truncated than that of the lower; surface much as in the other valve.

Length of a mature specimen, 1.82 inches; breadth, about 0.87 inch; convexity, about 0.40 inch.

This is the form that we have always identified with Evans and Shumard's *O. subtrigonalis;* but as they never figured their species, and I have had no opportunity to compare our specimens with authentic examples of it, the identification cannot be regarded as entirely beyond question. Indeed, it is quite probable that a direct comparison might show our shell to be specifically distinct, especially as we have no other evidence that the same formation occurs at the two localities. In case our specimens may be found to belong to a different species, I would propose to call it *O. Shumardi*, in honor of my lamented friend, the late Dr. B. F. Shumard.

This species will be readily distinguished from the last by its smaller size, narrower and more regular form, shallower lower valve, and its greater thickness in proportion to its size.

Locality and position.—Same as last.

DIMYARIA.

UNIONIDÆ.

Genus UNIO, Retzius.

Synon.—*Unio*, Retzius (1788), Diss. Phys., 16.—Brug. (1792), Jour. Hist. Nat., I; and Encyc. Méth., tab., 247.—Cuvier (1798), Tab. Élém., 425.—Lamarck (1801), Syst., 114 (not Prodr., 1799).—Say (1816), Art. Conch. in Nicholson's Encyc., 1st Am. ed.; and (1818 and 1819) in subsequent editions of same; also (1822) Jour. Acad. Nat. Sci. Philad., II, part 2; (1824) in Report of Long's Expedition, II, 265; and (1830 to 1834) Am. Conch., parts 1 to 7.—Lea (1827 to 1874), Observations on the Genus *Unio*, I to XIII, 4to; and (1836 to 1870) Synop. Fam. *Unionidæ;* also in numerous smaller papers in Proceed. Acad. Nat Sci. Philad., at various dates.—Conrad (1834), Am. Jour. Sci., XXV, 338; and (1835 to 1843) Monogr. Fam. *Naïades* N. Am., &c., &c.

Proptera, Raf. (1819), Jour. Phys., LXXXVIII, 426 (as a subgenus under *Unio*).

Eurynia, Raf. (1819), *ib.* (as a subgenus under *Unio*).—Agassiz (1851), Stimpson's Shells of New England, 13 (as a genus).

Ellipto, Raf. (1819), Jour. Phys., LXXXVIII, 426 (as a subgenus under *Unio*).

Plagiola, Raf. (1819), *ib.* (as a subgenus under *Unio*).—Agassiz (1852), Arch. f. Nat., XVIII, 46 (as a genus).

Obovaria, Raf. (1819), Jour. Physics, LXXXVIII, 426 (as a subgenus under *Unio*).—Agassiz (1852), Arch. f. Nat., XVIII, 46 (as a genus).—H. and A. Adams (1857), Genera Recent Moll., II, 492 (as a subgenus under *Unio*).

Truncilla, Raf. (1819), Jour. Physics, LXXXVIII, 427 (as a subgenus under *Unio*).—Agassiz (1852), Arch. f. Nat., XVIII, 44 (as a genus).

Amblema, Raf. (1819), Jour. Phys., LXXXVIII, 427 (as a subgenus under *Unio*).

Pleurobema, Raf. (1819), *ib.*—Agassiz (1852), Arch. f. Nat., XVIII, 49 (as a genus).

Scalenaria, Raf. (1820), Ann. Gen. Sci. Phys. Bruxelles, 309 (as a subgenus under *Obliquaria*).

Leptodea, Raf. (1820), *ib.*, 295 (as a subgenus under *Unio*).

Aximedia, Raf. (1820), *ib.*, 297 (as a subgenus under *Unio*).

Lampsilis, Raf. (1820), *ib.*, 298 (as a genus).—Agassiz (1852), Arch. f. Nat., XVIII, 44 (as a genus).—H. and A. Adams (1857), Genera Recent Moll., II, 495 (as a subgenus under *Unio*).

Metaptera, Raf. (1820), Ann. Gen. Sci. Phys. Bruxelles, 299.—Agassiz (1851), in Stimpson's Shells New England, 14; and (1852) Arch. f. Nat., XVIII, 45 (as a genus).—Conrad (1853), Proceed. Acad. Nat. Sci. Philad., VI, 260 (as a genus).—H. and A. Adams (1857), Genera Recent Moll., II, 498 (as a subgenus under *Unio*).

Truncilla, Raf. (1820), Ann. Gen. Sci. Phys., 300 (as a genus).

Obliquaria, Raf. (1820), *ib.*, 301.—H. and A. Adams (1857), Genera Recent Moll., II, 497.

Ellipsaria, Raf. (1820), Ann. Sci. Phys., 303 (as a genus).

Quadrula, Raf. (1820), *ib.*, 305 (as a subgenus under *Obliquaria*).—Agassiz (1852), Arch. f. Nat., XVIII, 48 (as a genus).—H. and A. Adams (1857), Genera Recent Moll., II, 497 (as a subgenus under *Unio*).

Rotundaria, Raf. (1820), Ann. Sci. Phys. Bruxelles, 308 (as a subgenus under *Obliquaria*).—Agassiz (1852), Arch. f. Nat., XVIII, 48 (as a genus).

Sintoxia, Raf. (1820), Ann. Sci. Phys. Bruxelles, 310 (as a subgenus under *Obliquaria*).

Epiloblasma, Raf. (1820), Monogr. Bivalves Ohio River, 2 (as a genus).

Toxolasma, Raf. (1820), *ib.* (as a genus).

Bariosta, Raf. (1820), *ib.* (as a genus).—H. and A. Adams (1857), Genera Recent Moll., II, 491 (as a subgenus under *Unio*).

Mysca, Turton (1822), British Bivalves, 244.

Diplodon, Spix (1827), Test. Brasil., 26–28.—H. and A. Adams (1857), Genera Recent Moll., II, 497 (as a subgenus under *Unio*).

Nicea, Swainson (1837).—H. and A. Adams (1857), Genera Recent Moll., II, 496.

Margarita (part), Lea (1838), Trans. Am. Phil. Soc., VI (not Leach and others).

Crenodonta, Schlüt. (1838), Verz., 33.

Lymnadia, *Theliderma*, *Cunicula*, *Legumia*, and *Potamida*, Swainson (1840), Malac., 365 to 378.

Naidea, Swainson (1840), *ib.*, 378 (as a subgenus under *Æglia*).—H. and A. Adams (1857), Genera Recent Moll., II, 492 (as a subgenus under *Unio*).
Naïa, Swainson (1840), Malac., 284 and 379 (as a subgenus under *Castalia*).
Megadomus, Swainson (1840), Malac., 27 and 378.
Æglia, Swainson (1840), Malac., 275 and 378 (as a genus).
Cauthyria, Swainson (1840), *ib.*, 276 and 378 (as a subgenus under *Æglia*).—H. and A. Adams (1857), Genera Recent Moll., II, 496 (as a subgenus under *Unio*).
Iridea, Swainson (1840), Malac., 283 and 379 (as a genus).—H. and A. Adams (1857), Genera Recent Moll., II, 496 (as a subgenus under *Unio*).
Micromya, Agassiz (1852), Arch. f. Nat., XVIII, 47 (as a genus).
Tritogonia, Agassiz (1852), *ib.*, 48 (as a genus).
Dysnomya, Agassiz (1852), Arch. f. Nat., XVIII, 1 and 43 (as a genus).—H. and A. Adams (1857), Genera Recent Moll., II, 497 (as a subgenus under *Unio*).
Orthonymus, Agassiz (1852), Arch. f. Nat., XVIII, 48 (as a genus).
Cyprogenia, Agassiz (1852), *ib.*, 47 (as a genus).
Nodularia, *Lanceolaria*, *Calatura*, *Glebula*, and *Uniomeris*, Conrad (1853), Proceed. Acad. Nat. Sci. Philad., VI, 268 (as subgenera under *Unio*).
Rhipidodonta, Mörch (1853), Cat. Yoldi, II, 47 (as a subgenus under *Unio*).
Loxoplenrus, Meek (1872), in Hayden's Second Annual Report U. S. Geological Survey of the Territories, 294 (as a subgenus under *Unio*).

Etym.—*Unio*, a single large pearl
Type.—*Mya pictorum*, Linn.

Shell varying in form, according to the species and subgenera, from transversely-oval, elliptical, oblong, or lanceolate, to subtrigonal, trapezoidal, subcircular, &c.; surface covered with a thin olivaceous epidermis, sometimes striped with greenish and olive bands, and either smooth, striated, costated, plicated, tubercular, or nodular—very rarely bearing a few spines; beaks often eroded; nacre white, yellowish, flesh-colored, or various shades of purple;* hinge generally with two anterior teeth in one valve, and one in the other; posterior teeth elongated and laminar, usually single in one valve and double in the other.

From the foregoing diagnosis, and the long and tedious list of names mentioned in the synonymy, it will be understood that I have given somewhat wide limits to this genus. This has not been done, however, so much from a decided conviction that *all* of the proposed sections are really congeneric with *Unio* proper, as from the great difficulty in applying most of these distinctions in the classification of fossil species. Professor Agassiz, some years back, proposed to separate many of the sections named by Rafinesque and Swainson, as well as some named by himself, as distinct genera.

* The entire substance of the shell in this genus, excepting a thin outer fibrous layer, is pearlaceous. This outer fibrous layer may have been previously noticed by others; but the first published notice of it that I can remember was by Dr. C. A. White, in the American Journal of Science, in 1868. It is most readily seen in fossil shells, or those in a decomposing condition, in which it presents, under a magnifier, very much the appearance of the fibrous external layer in the genus *Inoceramus*. It is probably rather a family character than a peculiarity of the genus *Unio*, though it may not be so well developed in the other genera of the family.

He based the distinctions, however, almost entirely on anatomical characters, observed in the soft parts of the animal. At a later date, Dr. Lea, of Philadelphia, who has given more attention to the study of this family of mollusks than any other person, after dissecting the animals of many of the same species, as well as of others, maintains that the characters given by Professor Agassiz are not constant, sometimes even in different individuals of the same species, and therefore argues that they cannot be relied upon in distinguishing genera in this family. However this may be, it must be evident that characters of this kind, unless accompanied by some visible peculiarities of the shell, are of little or no use to the palæontologist in classifying fossil species.

For the above-mentioned reasons, I have preferred to define this genus here in its more comprehensive sense. Many of the names, however, quoted in the synonymy, may be conveniently used for sections or subgenera, even in palæontology; that is, such of them as can be distinguished by characters of the shell alone.

Widely different views in regard to the subgenera that should be admitted under this genus are maintained, even among the most respectable authorities, who have devoted much time and study to the group. Dr. Lea, of Philadelphia, has proposed to reduce *Unio* proper to the rank of a subgenus, under a comprehensive genus, to which he applies the name *Margaron*, including the following groups as subgenera, viz, *Triquetra*, *Prisodon*, *Unio*, *Margaritana*, *Plagiodon*, *Monocondylæa*, *Dipsais*, *Anodonta*, *Columba*, and *Byssanodonta*; while many other authorities regard these names as representing so many distinct genera.

H. and A. Adams, in their work on the Genera of Recent *Mollusca*, admit a number of subgenera under the genus *Unio;* and, although not entirely satisfied that their arrangement is the best that might be devised, I think it will be found as convenient as any yet proposed by those who view the sections they include as representing a single genus. Their arrangement is as follows, viewing the first or typical section as represented by *U pictorum*, Linn. (sp.):

2. BARIOSTA, Raf. (= *Potamida*, Swainson).

Shell not winged, arcuated; surface of valves smooth.—(*Unio emarginatus*, Lea.)

3. NAIDEA, Swainson.

Shell not winged, obovate; surface of valves smooth.—(*Unio amygdalum*, Lea.)

4. OBOVARIA, Raf. (= *Rhipidodonta*, Mörch).

Shell not winged, subrotund; surface of valves smooth.—(*Unio circulus*, Lea.)

5. NIÆA, Swainson.

Shell not winged, oblong; surface of valves smooth.—(*Unio depressus*, Lamarck.)

6. HYRIDELLA, Swainson.

Shell not winged, oval; surface of valves smooth.—(*Unio Batavus*, Lamarck.)

7. LAMPSILIS, Raf. (= *Truncilla*, *Pleurobema*, *Syntoxia*, *Scalenaria*, and *Plagiola*, Raf.; *Crenodonta*, Schlüt.; and *Æglia*, Swainson).

Shell not winged, more or less triangular or oblique, and truncate at one end; surface of valves smooth.—(*Unio trigonus*, Lea.)

8. CANTHYRIA, Swainson.

Shell not winged, subtrigonal; surface of valves spiniferous; cardinal teeth long, compressed.—(*Unio spinosus*, Lea.)

9. IRIDEA, Swainson (= *Tritigonia* and *Orthonymus*, Agassiz).

Shell not winged, wide; surface of valves nodulous.—(*Unio cylindricus*, Say.)

10. ROTUNDARIA, Raf. (= *Cyprogenia*, Agassiz).

Shell not winged, subrotund or oblique; surface of valves nodulous.—(*Unio nodulosus*, Wood.)

11. QUADRULA, Raf. (= *Theliderma*, Swainson).

Shell not winged, quadrate or triangular; surface of valves tuberculated.—(*Unio apiculatus*, Say.)

12. DIPLODON, Spix (= *Cucumaria*, Conrad, and *Naïa*, Swainson).

Shell not winged, oval or oblong; surface of valves plicated.—(*Unio ellipticus*, Spix.)

13. DYSNOMYA, Agassiz.

Shell not winged, quadrate or triangular; surface of valves plicated.—(*Unio atrocostatus*, Lea.)

14. METAPTERA, Raf. (= *Proptera*, Raf., and *Lymnadia* and *Megadomus*, Swainson).

Shell with hinge-margin elevated and winged, the valves connate, and the surface plicate or smooth.—(*Unio alatus*, Say.)

To the foregoing may be added a subgenus proposed by me under the name *Loxopleurus*, for the reception of a very peculiar species, from near the junction of the Cretaceous and Lower Tertiary of Wyoming Territory.* It is an elongate-subovate, somewhat arcuate, shell, without wings, and ornamented with two sets of very regular, well-defined costæ, those of one of which start from the margin just in front of the beaks, and radiate obliquely backward and downward; while those of the other set start from the dorsal margin behind the beaks, and extend downward, in a direction that would cause them to intersect those of the other series at rather acute angles along the posterior umbonal slopes, somewhat as in *Goniomya*.

Species have been referred to the genus *Unio*, even from the Coal-Measures of Europe; but it is now believed that they all belong to the genus *Carbonocola* and other distinct genera. Nor have we any satisfactory evidence yet of the existence of true Uniones during the Permian epoch. I have described a few species, however, from a bed in New Mexico, in which Professor Cope found vertebrate remains, that lead him to refer the rock to the Triassic period. Another species that appears to belong to this genus was some years back described by the writer, in connection with Dr. Hayden, from Jurassic beds near the Black Hills, Dakota. The genus is well known to be represented in the Wealden deposits of Europe, and occurs in beds in the Far West, belonging to the Upper Cretaceous. It is also abundantly represented at various horizons in the fresh-water Tertiary deposits of the Western Territories, as well as in various other parts of the world.

At the present time, this genus is widely extended, in Europe, Asia, Africa, New Holland, and America. The streams and lakes of the United States, however, seem to be, as it were, the home of the Unioues; the number of species here exceeding all of those known from all other parts of the world, while they assume a greater diversity of forms and other characters than have been observed elsewhere.

* The type of this section (*U. belliplicatus*) is figured in the Palæontological Report of Mr. King's Geological Survey of the Fortieth Parallel.

Unio priscus, M. & H.

Plate 43. figs. 8, *a*, *b*, *c*, *d*.

Unio priscus, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 117.

Shell transversely-subovate, thin, apparently moderately compressed; anterior side regularly rounded; posterior side long, and abruptly rounded or subangular below; cardinal outline arcuate, forming a broad descending curve behind the beaks to the posterior basal extremity; basal margin straight behind, convex in advance of the middle, and rounding up regularly in front; beaks very small, rising little above the cardinal border, located nearer the anterior end than the middle, and ornamented by small, very regular, concentric wrinkles; other portions of the surface only marked by very obscure, irregular lines of growth.

Length, 2.99 inches; height, 1.57 inches; convexity unknown.

This shell has much the aspect of an *Anodonta* externally: but several fragments found associated with it, presenting the same external characters, and apparently belonging to the same species, show enough of the hinge to prove it to be provided with teeth as in the genus *Unio*. Some of these fragments show the concentric wrinkling of the beaks very distinctly, and also have one or two small, raised, radiating lines, which extend from the back part of the beaks obliquely backward and downward across the postero-dorsal region of the immediate umbones. These markings, however, are only seen on the beaks, excepting in young shells. The only entire adult specimen yet seen is unfortunately flattened by pressure, so as to leave some doubts in regard to the extent of its original convexity; though it appears to have been but moderately gibbous (see fig. 8, *d*, pl. 43).

In form and general appearance, it is somewhat similar to *U. Duboquii* of Coquand, from the Upper Eocene deposits of the Province of Constantine (Mem. Geol. Soc. of France, V (see. ser.), part 1, pl. v, figs. 5 and 6), but differs in being higher in proportion to its length, and entirely destitute of concentric undulations excepting on the immediate beaks. It is more nearly related to a species described by me in 1860 from the brackish-water beds at Bear River, Wyoming, under the name *U. vetustus*. Indeed, these forms are so very similar that I was led at one time to think that they might be identical.

Locality and position.—On Yellowstone River, forty miles above its mouth; from the Fresh- and Brackish-water Lignite series, apparently at the

horizon of the Judith River beds; also at that horizon near the mouth of Judith River, Montana. The type-specimen from the Yellowstone is represented by our figure 8, *d*, of plate 43; while the other specimens from near the mouth of Judith River are represented by figures 8, *a*, *b*, *c*, of the same plate. Figures 8, *a*, and 8, *b*, were made out by tracing the lines of growth near the umbones of imperfect larger specimens, to get the outlines of young shells of the sizes represented.

Unio Danæ, M. & H.

Plate 41, figs. 3, *a*, *b*, *c*.

Unio Danæ, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 145.

Shell transversely elongated, or with length more than twice the height, moderately convex, thick, arcuate; anterior side rounded; base most prominent in the anterior region, distinctly sinuous at or a little behind the middle; posterior side long, narrow, and rather narrowly rounded at the extremity; dorsal margin declining with a long, gently convex outline, from near the beaks posteriorly, and sloping or rounding much more abruptly in front; beaks depressed, oblique, located nearer the anterior extremity than the middle; ligament very long; flanks more or less concave from the most arched part of the base, obliquely up toward the umbones; surface (the epidermis being always removed) marked by rather distinct lines of growth, and, on the exposed laminæ, obscure radiating striæ.

Length, 3.30 inches; height, 1.48 inches; breadth, about 1.13 inches.

The only specimen yet seen, showing the hinge, is a left valve, in which the posterior cardinal tooth is rather prominent and somewhat compressed, and the anterior one smaller. The lateral teeth are very long and laminar, while the cicatrices are deep and distinctly corrugated. The beaks, in all our specimens, are too much worn and exfoliated to show whether they were concentrically wrinkled, though they seem not to have been.

In speaking of this and the following species, Mr. Lea, to whom we submitted our specimens, remarked that "they are all characterized by an obliqueness not usual in the genus. The beaks are nearly terminal in all of them, and they have a general massive character, which causes a disposition to enlarged cardinal and lateral teeth. This enlargement is more particularly noticeable in the cardinal teeth, which are all massive and very much corrugated. It is evident from the deep corrugations of the great cicatrices that the muscular power of the animal was very great."

This species will be readily distinguished from the last by its thicker, more depressed shell, more attenuated posterior and sinuous base and flanks; and probably also by having smooth instead of delicately-wrinkled beaks. Its specific name was given in honor of the distinguished scientist, Prof. James D. Dana, of New Haven.

Locality and position.—Fresh- and Brackish-water Lignite series of the Judith River. Among the collections from near the mouth of Yellowstone River, there are also some larger internal casts of a *Unio* agreeing in general form, arcuate base, and sinuous flanks with this. The impressions of the anterior hinge-teeth and muscular cicatrices in these specimens are also very strongly defined, and show that the former are deeply corrugated and the latter quite strong. The posterior hinge-teeth are also seen to be very long. The largest of these specimens measure nearly 5.40 inches in length, and, making allowance for the indicated thickness of the shell in the umbonal region, must have been 2.20 inches in height, and nearly the same in convexity. These, I am inclined to believe, belong to the species here described; but good specimens of the shell itself may show them to be entirely distinct; if so, they might be called *Unio permusculosus*.

Unio subspatulatus, M. & H.

Plate 41, figs. 1, *a*, *b*.

Unio subspatulatus, Meek and Hayden (1857), Proceed Acad. Nat. Sci. Philad., IX, 146.

Shell transversely elongate-subovate, or nearly subspatulate in outline, compressed, most convex near the anterior end, cuneate behind; substance rather thick; anterior side subtruncated, but rounding into the base below; base most convex in outline anteriorly, and nearly straight or slightly sinuous farther back; posterior side very long, and narrowly rounded at the extremity; dorsal outline slightly arcuate, nearly parallel to the base, or declining with a very gentle curve behind; beaks small, oblique, rising little above the dorsal margin, and located at the anterior extremity; surface (the epidermis and outer fibrous layer being destroyed) having rather obscure marks of growth, crossed by indistinct radiating striæ; hinge and interior unknown.

Length, 2.83 inches, height, 1.34 inches; breadth, 0.75 inch.

It is barely possible that this may be a variety of the last, though it differs decidedly in having its beaks more prominent and almost terminal, as well as in being more compressed. Although as great differences of form

are sometimes presented by different varieties of a species among the existing Uniones, with the materials yet available for comparison, I do not feel warranted in uniting these two forms under one specific name.

Locality and position.—Judith River group; mouth of Judith River, Montana. Probably belonging to the closing part of the Cretaceous epoch.

Unio Deweyanus, M. & H.

Plate 41, figs. 2, *a*, *b*, *c*.

Unio Deweyanus, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 145.

Shell very thick, transversely narrow-subovate or subelliptical, rather convex in the anterior region; extremities rounded; base semi-elliptic, or nearly straight along the middle, and rounding up to the extremities; dorsal margin straight, or declining very gradually from the beaks posteriorly; beaks small, depressed, located near the anterior end; surface (the epidermis and outer fibrous layer being mainly removed) having obscure marks of growth, crossed by very fine, indistinct, radiating striæ; ligament long; cardinal teeth very thick and strong; lateral teeth long, slightly arched; muscular cicatrices rather deep and strongly corrugated; concavity of the beaks shallow.

Length, about 2.60 inches; height, 1.33 inches; breadth, about 1.18 inches.

The specimens yet obtained being all worn, and more or less mutilated, do not show very clearly the form of the adult shell; but the curves of the marks of growth exhibit the outline of young and medium-sized individuals quite satisfactorily. In some instances, the interior still retains a peculiar tinge, indicating that the nacre was originally purple or flesh-colored.

Although somewhat related to the last, this species differs in being much thicker and more gibbous in the umbonal region, less elongated, and in having the basal border more convex in outline. Its dorsal margin is also straighter, while its beaks are removed a little farther from the anterior extremity. As suggested by Mr. Lea, it is evidently similar in form and obliqueness, as well as in its rather unusual thickness, to the recent *U. truncatus*, Swainson, although not more than half the size which that species generally attains. It was named in honor of our esteemed friend, Prof. Chester Dewey, deceased, of Rochester University, Rochester, New York.

Locality and position.—Same as last.

CYRENIDÆ.

Genus CORBICULA, Mühfeldt (see page 160).

Corbicula cytheriformis, M. & H.

Plate 40, figs. 5, *a*, *b*, *c*, *d*, *e*.

Cyrena (Corbicula?) cytheriformis, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 176.
Corbicula cytheriformis, Meek and Hayden (1860), *ib.*, 432.

Shell attaining a large size, transversely ovate-subtrigonal, or varying to subcircular, but always a little longer than high, moderately convex, rather thick and strong; extremities more or less rounded, or the posterior sometimes faintly subtruncated; basal outline forming a semi-ovate curve, the most prominent part of which is generally in advance of the middle; dorsal margin sloping unequally from the beaks, the anterior slope being more abrupt and slightly concave in outline, and the posterior convex; beaks moderately prominent, and placed more or less in advance of the middle; surface only marked with lines of growth, without distinct concentric furrows.

Length of a medium-sized rather transverse specimen, 1.20 inches; height, 1.05 inches; convexity, 0.77 inch.

This species varies more or less in form, some individuals being more transverse, and having the beaks placed farther forward; but it seems impossible to separate these varieties, on account of intermediate forms. The form represented by figures 5, *a*, *c*, plate 40, may be regarded as the typical one. Others, such as those represented by our figures 5, *b* and *d*, are the shorter varieties. These latter approach more nearly the following-described species, but are still proportionally more transverse, and have less prominent beaks.

The specimen represented by our figure 5, *e*, is a very thick shell, of larger size, that I have sometimes thought might be distinct. It is not in a condition to show its entire outline; but on following the outlines of its marks of growth, it seems to have agreed nearly in form with the typical specimens of this species when of the same size.

It is barely possible that this species may not be distinct from the following; but I have seen no intermediate forms connecting them.

Like that shell, it more nearly resembles Paris-basin Eocene species than any Wealden or other foreign Cretaceous forms known to me. It is an interesting fact that specimens now before me from Black Butte station

on the Union Pacific Railroad, Wyoming, seem to be in all respects undistinguishable from this species by any external characters. They do not show the hinge, but I am strongly inclined to believe them identical with this species. It is a coincidence also worthy of note here, that at this Black Butte station, and in the same bed from which the specimens here mentioned were obtained, the remains of a Dinosaurian were found; while Saurian remains of Cretaceous affinities also occur in the same beds with the type-specimens of the species here described, in the Upper Missouri country.

I also have now before me numerous fine specimens of a *very* similar form, from a much lower horizon than the Black Butte station, some twelve miles farther westward on the Union Pacific Railroad, near Point-of-Rocks, Wyoming. The only differences that I can see between these specimens and the species here under consideration are, that they have the beaks somewhat more elevated and gibbous, and the substance of the shell thinner. With the exception of the latter character, a slightly more forward curvature of the beaks, and a very little greater proportional length of the valves, this last mentioned Wyoming form is almost as nearly related to the first of the following-described species. It holds a position in the Upper Cretaceous*

Locality and position.—The type-specimens of *C. cytheriformis*, came from the Bad Lands of Judith River, on the Upper Missouri, in Montana. Others in the collection are from the mouth of Muscleshell River; from near Fort Benton; and from one hundred and twenty-five miles below the same. The geological horizon is the same as the last—that is, probably the latest of the Cretaceous, or possibly the oldest Eocene.

Corbicula occidentalis, M. & H.

Plate 40, figs. 6, *a*, *b*, *c*.

Cyrena occidentalis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 116.
Corbicula occidentalis, Meek (1860), *ib.*, XII, 432.

Shell attaining a moderately large size, subtrigonal in form, with height and length about equal, rather gibbous, thick and strong; dorsal margins sloping nearly equally from the beaks, the anterior slope being almost straight, or slightly concave in outline, and the posterior a little convex; anterior and posterior margins rounding into the base, or the latter sometimes slightly

*This form from near Point-of-Rocks, Wyoming, if found to be specifically distinct from the others, might be designated as *C. Wyomingensis*.

truncated below; basal margin forming a semi-oval, or semicircular curve, the most prominent part of which is generally near the middle; beaks rather elevated, gibbous, and very nearly central; surface merely marked by lines of growth, without regular furrows; pallial line with a small, shallow, rounded, or subangular sinus.

Length and height of a medium-sized specimen, each 1 inch; convexity of same, 0.71 inch. Some imperfect specimens seem to have attained nearly twice the size of that from which these measurements were taken.

This is a remarkably thick, strong shell, especially in the umbonal regions. None of the specimens that I have seen show its hinge; but, judging from its association with fresh- and brackish-water types, we have little reason to doubt that it belongs either to the genus *Corbicula* or *Cyrena*, more probably to the former.

The specimen from which our figure 6, *b*, was drawn has the valves accidentally compressed below, so as to give it an unnaturally cuneate appearance.

Locality and position.—Bad Lands of the Judith River, Montana, on the Upper Missouri River; probably belonging to the Upper Cretaceous.

Corbicula Nebrascensis, M. & H.

Plate 43, figs. 2, *a*, *b* (not 2, *c*).

Cyrena intermedia, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 116. (Not *Cyrena* [*Corbicula*] *intermedia*, Mellville, 1843.)

Corbicula Nebrascensis, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 423.

Shell ovate, moderately compressed, rather thin; extremities rounded; base semi-elliptical or semi-ovate, the most prominent part being usually in front of the middle; cardinal margin rather thin, forming an angle of about 110° at the beaks, the anterior slope being slightly concave in outline, and more abrupt than the posterior, which forms a broad, convex, descending curve; beaks of medium height, rather small, and located a little in advance of the middle; surface marked by fine lines of growth, and sometimes having a few somewhat stronger concentric furrows.

Length, 0.77 inch; height, 0.63 inch; convexity, 0.34 inch.

This species agrees with our *C. cytheriformis* nearly in general form, excepting that it is more compressed. It is also a smaller, proportionally thinner shell.

Locality and position.—Moreau River, Dakota; from the horizon of the Judith River group, or the base of the Fort Union group.

Subgenus LEPTESTHES (see page 161).

Corbicula subelliptica, M. & H.

Plate 43, figs. 9, *a*, *b*, *c*.

Tellina subelliptica, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 83.

Shell small, compressed, transversely subelliptic, thin; anterior margin narrowly rounded, posterior faintly subtruncated; base forming a semi-elliptic or semi-ovate curve; beaks rather depressed and placed slightly in advance of the middle, when not worn abruptly pointed; dorsal margin sloping rather gradually from the beaks, the anterior slope being slightly concave in outline, and the posterior nearly straight; surface with only obscure marks of growth; interior of valves showing an obscure ridge, extending downward from the beaks, and leaving a corresponding shallow sulcus on internal casts; muscular impressions well defined; pallial line with a shallow, rounded sinus.

Length of the type-specimen, 0.44 inch; height, 0.32 inch; convexity, about 0.10 inch.

Some casts from the original locality indicate a size about one-fourth larger than that from which the above measurements were taken.

The specimen represented by figure 9, *a*, of our plate 43, is the type of this species. It gives no idea of the hinge or internal characters; and, as we originally had no other fossils from the same locality and position, we had no means of determining whether it came from a marine or brackish-water formation; but from its general external appearance supposed that it might belong to some section of the genus *Tellina*, to which we referred it provisionally. Subsequently, a few internal casts, from near the same locality, and evidently belonging to the same species, were brought in; and these at once showed that it cannot belong even to the *Tellinidæ*, as it has a very shallow pallial sinus. On cutting away some portions of the shell remaining about the hinge of one of these casts, I found that it has the hinge-teeth of *Corbicula*, or rather of the transverse section of that group, in which the elongated lateral teeth are often nearly smooth, or but obscurely striated.

The discovery of this fact led me to compare it with specimens of a very similar form, that I have long had under consideration, from Bijou Creek, Colorado; and on doing so they were found to be specifically identical.* As

* Associated with these Colorado specimens, two upper valves of an *Anomia* were found, which I believe to be the same species that I have described under the name *A. micronema*, from a shaft on the Kansas Pacific Railroad; at a locality two hundred miles east of Denver, Colorado.

the casts of our type-specimens showing the hinge and muscular impressions are not in a condition to illustrate these parts in a drawing very satisfactorily, although sufficient for identification when directly compared, I have represented, by figure 9, *b*. of our plate 43, one of those from the Colorado locality. This figure is natural size, and gives an accurate idea of the shell, excepting that the hinge-margin is represented rather too thick, and the posterior cardinal teeth are made to converge too abruptly to a point. The magnified figure of the hinge of the same (fig. 9, *c*) gives a better representation of this hinge, but makes the posterior cardinal tooth a little too narrow, and does not show distinctly enough a little projection in the pit between it and the middle tooth.

Of the specific identity of our type and the specimens from Colorado, I think there can be scarcely any reasonable doubt.

Locality and position.—Brackish-water Lignite series of the age of the Judith River or Fort Union group, on Cherry Creek, Dakota; and apparently from the same horizon on Bijou Creek, Colorado.

Corbicula subelliptica, var. Moreauensis.

Plate 43, figs. 1, *a*, *b*, and 2, *c*.

Cyrena Moreauensis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 125.
Corbicula Moreauensis, Meek and Hayden (1860), *ib.*, XII, 432.

Since discovering that the type of the last-described species really belongs to the transverse section of the genus *Corbicula*, and is not at all related to *Tellina*, I have been led to compare the shells here under consideration very carefully with it, and now believe that they may belong to a more robust variety of the same species. The specimens of this shell yet seen are not, it is true, in a very satisfactory condition for comparison, all being more or less broken, and having the points of the beaks worn off; while none of them show the pallial line. They evidently have the same transverse form and general outline, the same character of hinge, muscular impressions, surface-markings, and even show the same obscure internal ridge extending downward from beneath the beaks. So there would seem, as far as can be seen, little left to distinguish them but their larger size, somewhat thicker and more convex valves, and perhaps rather broader hinge-plate. Consequently, I am led to place them provisionally as a variety of *C. subelliptica*.

Locality and position.—Moreau River, Dakota: from the same horizon as the last.

Genus SPHÆRIUM, Scopoli.

Syn.—*Sphærium*, Scopoli (1777), Introd. Hist. Nat., 397.—Gray (1847), Zoöl. Proceed., 184.—H. and A. Adams (1857), Genera of Recent Moll., II, 449.—Prime (1860), Synop. Family *Cyclades*, Proceed. Acad. Nat. Sci. Philad., XII, 2: and Monogr. Species *Sphærium*, 3; also Monogr. Am. *Corbiculidæ*, 32.—Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 175.—Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Moll., 6.—Gould (1870), Invertebrata Mass. (Binney ed.), 101.

Cyclas (part), Brnguière (1792), Encyc. Méth., pl. 301 and 302.—Lamarck (1799), Prodr., 84; also (1801) Syst. An. sans Vertebr., 123; and (1818) Hist. Nat., V, 557.—Blainv. (1825), Malac., 551.—Fleming (1828), Brit. An., 409 and 452.—Swainson (1840), Malac., 369.—Gould (1841), Invertebrata Mass., 72.—G. B. Sowerby, jr. (1842), Conch. Man. (2d ed.), 130; and of numerous others (not of Klein, 1753).

Nux, Humphrey (1797), Mus. Col.

Musculum, Link (1807), Rost. Samml., III, 152 (not Gray, 1851).

Cornea, Mühlf. (1811), Entwurf, 56.

Corneocyclas (Féruss.), Blainv. (1818), Dict. Sci. Nat., XII, 278.

Amesoda, Raf. (1820), Mon. Biv, 319.

Cycladites, Krüg. (1823), Urw., II, 469.

Etym.—σφαιρίον, a little ball.

Type.—*Tellina cornea*, Linnæus.

Shell thin, oval-cordate, nearly equilateral, more or less gibbous; smooth or concentrically striated; hinge usually with two small, moderately diverging cardinal teeth in each valve, or sometimes one in one valve and two in the other, or one in each valve, rarely with both nearly obsolete; lateral teeth more or less elongated, smooth, double in the right valve and single in the left; ligament narrow, and placed on the longer side of the shell; muscular and pallial impressions faintly marked, the latter being nearly or quite simple.

The species of this genus inhabit fresh-water lakes, ponds, and streams of cold and temperate latitudes, especially of North America and Europe. Their habits are very similar to those of *Pisidium*, which they nearly resemble in form and general appearance. They differ, however, in having the beaks and cardinal teeth more nearly central, and the ligament on the longer side. The animal of this genus also differs from that of *Pisidium* in having its siphons longer and disunited at their free ends.

The genus *Sphærium* dates back to the Wealden epoch. It also occurs in this country in beds that may belong to the latest members of the Cretaceous, as well as in others of the Tertiary system. According to Prime, about one hundred species are known to exist at the present time.

The following-described species are referred to this genus rather than to *Pisidium* from general form; none of the specimens being in a condition to give any clear information in regard to the characters of the hinge, beyond the fact of the existence of moderately-elongated, smooth, lateral teeth in a few of the specimens.

Sphærium planum, M. & H.

Plate 43, figs. 6, *a*, *b*.

Sphærium planum, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., 175

Shell rather small, broad-oval or subcircular, much compressed; extremities more or less regularly rounded, the posterior margin being sometimes faintly subtruncated; base semi-oval in outline; cardinal margin somewhat straightened, or sloping gently from near the middle; beaks very small, compressed, scarcely extending beyond the hinge-margin, and nearly central; surface marked by fine, irregular, obscure, concentric striæ; lateral teeth well developed.

Length, 0.38 inch; height, 0.32 inch; convexity, 0.08 inch.

This species will be distinguished at a glance from all the others known in these formations, by its remarkably-compressed form and small beaks, which characters give it much the appearance of a little *Lucina*. I have not seen any specimens showing the hinge very satisfactorily; but some internal casts retain distinct impressions of the lateral teeth, which seem to be well developed. The cardinal teeth appear to be very small.

Locality and position.—Near Grand Island, on the Upper Missouri; from the Judith River, or Brackish-water Lignite series: probably belonging to the closing period of the Cretaceous.

Sphærium formosum, M. & H.

Plate 43, figs. 4, *a*, *b*, *c*.

Cyclas formosa, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 115.
Cyclas fragilis, Meek and Hayden, *ib.*
Sphærium formosum, Meek and Hayden (1860), *ib.*, 185.

Shell small, rhombic-orbicular, moderately convex; cardinal margin nearly straight, and of medium length; anterior side rounded; posterior side broader than the other, and truncated a little obliquely above, rounding abruptly into the base below; ventral margin semi-ovate, most prominent behind, and rounding up more gradually in the front; beaks obtuse, a little tumid, rising somewhat above the hinge, nearly touching, and located a little in advance of the middle. Surface marked by small, rather distinct, regular, concentric striæ.

Length, 0.17 inch; height, 0.14 inch; convexity, 0.08 inch.

This species seems to be closely allied to *S. corneum*, Linn. (sp.), as figured by Dr. Reuss in Dunker and von Meyer's Palæontographica (II, pl.

iv, fig. 13), from the Fresh-water Tertiary beds of Northern Bohemia. A careful comparison, however, of specimens, would doubtless show constant differences, since the *S. corneum* is not known among our existing American species. Its nearest representative among the existing species of this country is probably *S. rhomboideum*, Say (= *Cyclas elegans*, Adams), at one time supposed to be a variety of *S. corneum*. Our species has, however, more tumid beaks than that shell, and never has its valves so flattened or compressed in the middle.

Locality and position.—Ten miles below Fort Union; Fort Union group: probably Lower Eocene.

Sphærium subellipticum, M. & H.

Plate 43, figs. 5, *a*, *b*.

Cyclas subelliptica, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., 115.
Sphærium subellipticum, Meek and Hayden (1860), *ib.*, 185.

Shell small, transversely elliptic-subovate, rather convex, thin and fragile; extremities rounded, the posterior end being narrower than the anterior, which seems sometimes to be a little truncated; base semi-ovate, being more prominent in the central and anterior regions than behind; cardinal margins nearly straight in the middle, and rounding gradually toward the extremities; beaks rather depressed, but rising above the hinge, moderately convex, scarcely oblique, and located slightly in advance of the middle; surface marked by fine, rather obscure, concentric striæ.

Length, 0.24 inch; height, 0.14 inch; convexity, 0.13 inch.

This form differs from the last in being more transverse, with a more ovate outline, and a narrower and more rounded posterior margin, as well as less elevated beaks.

Locality and position.—Same as last.

Sphærium recticardinale, M. & H.

Plate 43, figs. 3, *a*, *b*.

Sphærium recticardinale, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., VIII, 176.

Shell of medium size, transversely subelliptical, rather compressed, very thin; anterior side rounded; base forming a regular semi-elliptic curve; posterior extremity obliquely subtruncated above, and rather narrowly rounded below; hinge-margin long and straight; beaks very small, and projecting

little above the cardinal edge, located nearly half-way between the middle and the anterior end; surface marked by rather obscure, irregular lines of growth; lateral teeth well developed, the posterior being longer than the anterior.

Length, about 0.55 inch; height, 0.36 inch; breadth, 0.24 inch.

The most striking peculiarities of this shell, are its long straight hinge and small compressed and depressed beaks. These characters alone will prevent it from being confounded with any of the species yet obtained from these formations. In the straightness of the hinge-line, it resembles the young of the recent *S. sulcatum*, Lam. (sp.), from which it differs in having its beaks located farther forward, and smaller, as well as more compressed. From the adult *S. sulcatum*, of its own size, it differs materially in the straightness of its hinge, less nearly central beaks, and more compressed form.

Locality and position.—Near Grand Island, on the Upper Missouri; from the Judith River group of the Fresh- and Brackish-water Lignites: probably belonging to the closing part of the Cretaceous period.

CORBULIDÆ.

Genus CORBULA, Bruguière (see page 240).

Subgenus PACHYODON, Gabb (see page 241.)

The following species, although not agreeing in all respects with the typical forms of the *Pachyodon* group, seem to correspond in the forward obliquity of their beaks, and some other characters, more nearly to that than to any of the other sections of the genus yet proposed.

Corbula mactriformis, M. & H.

Plate 43, figs. 7, *a–f*.

Corbula mactriformis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 117.
Corbula (*Potamomya*) *mactriformis*, Meek and Hayden (1860), *ib.*, XII, 432.—Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Invert. Fossils, 8.

Shell ovate-subtrigonal, moderately convex; right valve a little shorter, thicker, and more gibbous than the other; anterior side of both valves obliquely subtruncated, slightly concave in outline above, and narrowly rounded into the base below; posterior side longer, and narrowing toward the extremity, which is narrowly rounded, or very obscurely subtruncated; base semi-ovate, being most prominent a little in front of the middle; beaks

rather elevated, pointed, and incurved with a forward obliquity; posterior umbonal slopes having an obscure ridge extending obliquely from the beaks to the postero-basal margin; surface ornamented by moderately distinct lines of growth, which are most strongly defined behind the oblique umbonal ridge.

Length, 0.64 inch; height, 0.54 inch; breadth, about 0.34 inch

The tooth of the right valve is rather small, obtuse, and located immediately under the point of the beak, while the process in the other valve is oblique, compressed, and bears on its upper surface a distinct scar, left by the attachment of the cartilage. The pit in the opposite valve for the reception of the cartilage, and this compressed process of the left valve, is comparatively large, trigonal, and deep. Just in front of the tooth in the right valve, and along the entire length of its posterior cardinal margin, there is a distinct groove for the reception of the sharp cardinal edge of the other valve. A similar, but less distinctly-marked groove is seen a little within the basal margin of the right valve, which groove is occupied by the edge of the left, when the valves are closed. The muscular impressions are faintly marked, though I have been able to see that the anterior one is narrow-ovate, and the posterior larger and proportionally broader. The pallial line is provided with a broad shallow sinus.

I am aware that the name *mactriformis*, at first inadvertently selected for this species, is faulty in construction; but I do not think it a matter of sufficient importance, even if it were quite clear that the rules of nomenclature would permit such a change, to attempt the substitution of a less objectionable name now.

Locality and position.—Fort Clark, Dakota, on the Upper Missouri; from the Fresh- or Brackish-water Lignite beds of that region: probably Lower Eocene.

Corbula subtrigonalis, M. & H.

Plate 40, figs. 3, *a*, *b*.

Corbula subtrigonalis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 116.
Corbula (*Potamomya*) *subtrigonalis*, Meek and Hayden (1860), *ib.*, XII, 432.—Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Invert. Fossils, 8.

Left valve longer than high, trigonal-ovate, very convex; anterior side rather abruptly rounded below; base semi-ovate, the most convex part being near the front; posterior side longer than the other, and angular, or very

narrowly rounded at the extremity; dorsal outline declining from the beaks at an angle of about 90°, the anterior slope being more abrupt than the other: beak moderately prominent, incurved, gibbous, and located in advance of the middle; posterior umbonal slope very prominent, or subangular from the beak obliquely backward and downward to the posterior basal extremity; surface marked by fine lines of growth, with a few rather distinct concentric wrinkles below the middle.

Length, 0.75 inch; height, 0.55 inch; convexity, 0.23 inch.

The type-specimen of this species is a left valve; but a few very imperfect right valves were found associated with it, that probably belong to the same species. These, however, seem to present the unusual appearance of being less convex and thinner than the right valve. One of them shows the tooth of the hinge to be moderately strong, obtuse, and curved upward.

Compared with the last, this species will be seen to be readily distinguished by having its left valve decidedly more convex, its beak much less pointed, and not directed so obliquely forward. If the right valves discovered with it really belong to the same species, they also will be found to differ materially, being much *less* convex than that of the last.

It is, however, more nearly related to the form described by me under the name *Corbula tropidophora*, from one of the Upper Cretaceous sandstones near Point of Rocks, Wyoming, on the Union Pacific Railroad. The latter, however, has its posterior umbonal slope much more distinctly angular, and its beak less convex and not so incurved, while its surface has more distinct concentric markings. These forms, however, are evidently closely-allied species.

Locality and position.—Judith River group, or Brackish-water Lignite series at the mouth of Judith River, Montana: probably belonging to the latest division of the Cretaceous.

Corbula perundata, M. & H.

Plate 40, figs. 4, *a*, *b*, *c*, *d*.

Corbula perundata, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 116.

Shell small, longer than high, transversely ovate-subtrigonal, rather compressed; dorsal side sloping toward the extremities at an angle of about 80° from the beaks: anterior side rather abruptly rounded below; base

semi-ovate, being more prominent before than behind the middle; posterior side longer and narrower than the other, angular at the extremity below; beaks located in advance of the middle, rather elevated, particularly that of the right valve, which is higher than the other; posterior umbonal slopes angular from the beaks to the posterior basal extremity; surface ornamented by a few strong, very regular, elevated, concentric undulations, which are somewhat less than the spaces between on the right valve, and proportionally larger on the left.

Length, 0.33 inch; height, 0.25 inch.

The strong regular undulations, or concentric costæ, on this little shell, give it a peculiar appearance, and at once distinguish it from either of the foregoing. The distinctly angular character of the posterior umbonal slope of its valves, particularly that of the left valve, and its trigonal general outline, indicate affinities to the Wyoming species from near Point of Rocks, already mentioned; but its distinct, regular, concentric costæ and smaller size readily distinguish it. I was for some time in doubt whether it really belonged to this genus; but a view of the hinge and interior of the worn and macerated left valve represented by our figure 4, *d*, reveals enough of its generic characters to leave little room for doubts in regard to its belonging to this group.

Locality and position.—Same as last.

GASTEROPODA.

PULMONATA.

LIMNÆIDÆ.

Genus LIMNÆA, Lamarck.

Synon.—Limnæa, Lamarck (1799), Prodr. d'un Nouv. Class. Coq., —; and (1801) Syst. An., 91; also (1822) Hist., VI, 2, 157.—Cuvier (1806), Ann. du Mus., VII, 185.—Stiebel (1815), Diss. Inaug. Syst. *Limnei Stagnalis* anat.—Schum. (1817), Essai, 199.—Férnss. (1821), Tab. Syst., xxxiii.—Blainv. (1825), Malac., 448.—Fleming (1828), Hist. Brit. An., 273.—Say (1832), Am. Conch. (Binney ed., 60).—Fitzinger (1833), Syst. Verz., 113.—Beck (1837), Ind., 110.—Swainson (1840), Malac., 183, 338.—Gray (1840), Turton's Man. (2d ed.), 230 and 231.—G. B. Sowerby, jr. (1842), Conch. Man. (2d ed.), 174.—H. and A. Adams (1855), Genera Recent Moll., II, 252.—Binney (1865), Land and Fresh-water Shells N. Am., 24; and of numerous others (not of Poli, 1791 = *Unio*, &c.).

Limnæus, Limneus, Limnea, Lymnæus, and *Lymnæa*, Auct.

Galba, Schranck (1803), Fauna Boic., III, 2, 285.

Radix, Montf. (1810), Conch. Syst., II, 266.—Blainv. (1825), Malac., 449 (subgenus under *Limnæa*).—Gray (1840), Turton's Man. (2d ed.), 232 (as a subgenus).—Binney (1865), Land and Fresh-water Shells N. Am., 30 (as a subgenus under *Limnæa*).

Limnus, Montf. (1810), Conch. Syst., II, 262.
Omphalia, Raf. (1819), Jour. Phys., LXXXVIII, 423.
Limnula, Raf. (1819), *ib.*
Gulnaria, Leach, MS. (1820, Syn. Brit. Moll., 146).—Turton (1831), Man., 117.—Hartm. (1830), Syst. Uebers.; and (1844) Erd- und Süssw. Gast., I, 63.
Stagnicola, Leach, MS. (1820, Syn. Brit. Moll., 142).—Gray (1840), Turton's Man. (2d ed.), 239 (as a subgenus under *Limnæa*).—Beck (1846), vid. Amtl. Ber. Vers. in Kiel, 123 (as a subgenus under *Limnæa*).
Limnophysa, Fitzinger (1833), Syst. Verz., 112.—Beck (1837), Ind., 110 (as a subgenus under *Limnæa*).—H. and A. Adams (1855), Genera Recent Moll., II, 254 (as a subgenus under *Limnæa*).
Leptolimnea, Swainson (1840), Malac., 338 (as a subgenus under *Limnæa*).
Bulimnea, Haldeman (1842), Fresh-water Univalves U. S., 14 (as a subgenus under *Limnæa*).—H. and A. Adams (1855), Genera Recent Moll., II, 254 (as a subgenus under *Limnæa*).
Acella, Haldeman (1842), Fresh-water Univalves U. S. 14 (as a subgenus under *Limnæa*).—H. and A. Adams (1855), Genera Recent Moll., II, 255 (as a subgenus under *Limnæa*).
Pleurolimnæa, Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Invert. Fossils, 9 and 34.

Etym.—λιμναῖος, marshy, or from the water.
Type.—*Helix stagnalis*, Linn.

Shell dextral, subovate, or more or less elongated, horn-colored; spire acute, short, or variously produced; volutions convex, last one most generally ventricose, rarely all flattened; aperture usually large, wide, nearly always rounded anteriorly; outer lip simple; inner lip generally with an oblique fold; surface very rarely with little ridges parallel to the lines of growth.

The above diagnosis includes eight sections or subgenera, six of which are adopted by H. and A. Adams and some other conchologists; and two others I have proposed for the reception of peculiar fossil species. These groups may be severally distinguished as follows:

1. **LIMNÆA**, Lamarck (typical).

Shell with spire more or less produced; last whorl ventricose; fold of inner lip well developed.—(Type as stated above.)

2. **RADIX**, Montfort (= *Gulnaria*, Leach).

Shell subovate; last whorl and aperture very large, the latter being greatly expanded, and more than half the length of the shell.—(*Limnæa auricularia*, Linn.)

3. **POLYRHYTIS**, Meek.

Much like the last in form, but bearing distinct, regular, vertical costæ.—(*L. Kingi*, Meek.)

4. **BULIMNEA**, Haldeman.

Shell thick; spire short; outer lip expanded.—(*L. megasoma*, Say.)

5. LIMNOPHYSA, Fitzinger (= *Stagnicola*, Leach, and *Galba*, Schrauck).

Shell subovate; spire conical and about as long as the aperture; volutions convex; lip not expanded.—(*L. palustris*, Müller.)

6. OMPHISCOLA, Raf. (= *Leptolimnea* Swainson).

Shell subcylindrical; spire produced, thick; aperture comparatively small.—(*L. glabra*, Müller.)

7. ACELLA, Haldeman.

Shell very slender; spire acuminate, longer than the aperture; volutions flattened; suture very oblique, aperture expanded; inner lip without a fold.—(*L. gracilis*, Say.)

8. PLEUROLIMNÆA, Meek.

Shell differing from the last in having small, regular, surface-costæ parallel to the lines of growth, and aperture narrowed or subangular, instead of rounded anteriorly.—(*L. tenuicostata*, Meek and Hayden.)

As is well known to all conchologists and collectors of shells, the species of the genus *Limnæa* are entirely confined to fresh waters, being found in ponds and other bodies of still water. They are vegetable-feeders, and have a curious habit of floating at times, with the expanded foot upward, even with the surface of the water, and the shell downward, during which they move along slowly by an undulatory motion of the foot. As noticed by H. and A. Adams and others, when the ponds in which they live become dried up by evaporation during droughts, they bury themselves in the mud, secrete a kind of rib within the outer lip, and close the aperture by a sort of false operculum, like the *Helicidæ* during certain seasons of inactivity.

The aperture of the curious type of the section *Pleurolimnæa* has not yet been seen, and we cannot be positively sure that this shell will certainly fall within the genus *Limnæa*. It differs from all the other forms undoubtedly belonging to it in the possession of costæ, and in having the aperture (judging from the form of the body-volution) narrowed, or subangular in front.

This genus is widely distributed at the present time, being found in this country as well as in Europe, China, and various other parts of the world. Its geographical distribution was also apparently as great during the Tertiary period. The oldest species yet known, I believe, occurs in the Upper Oolite of England. It has also been found in the Wealden beds, and in the fresh-water deposits throughout the Tertiary rocks.

Subgenus PLEUROLIMNÆA, Meek.

Limnæa tenuicostata, M. & H.

Plate 44, figs. 13, *a*, *b*, *c*.

Limnæa tenuicostata, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., 119.
Limnæa (*Acella*) *tenuicostata*, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., 431.

Shell very small, slender, thin, and fragile; spire turreted, acute, about equaling the length of the aperture; volutions four to four and a half, convex, increasing rather rapidly in length, but not in breadth; last one not ventricose, narrowing and produced below; suture deep; surface-costæ regularly disposed, a little flexuous, arranged parallel to the minute striæ of growth, and numbering about eight to twelve on the last turn.

Length, 0.30 inch; breadth, 0.08 inch; apical angle regular, divergence about 21°.

This species will be distinguished at a glance from all the others known in our Upper Missouri rocks. Indeed, I am not acquainted with any other form, either among recent or fossil shells, with which it is liable to be confounded. Its most marked features are its small size, slender form, and costate surface. With the exception of the last-mentioned character, it is evidently related to *Limnæa subulata* of Sowerby, which, however, is described as having the surface smooth.

It is possible that a distinct genus should be established for the reception of this little shell, though I have concluded to range it provisionally as the type of a subgenus under *Limnæa*.

Locality and position.—Three miles below Fort Union; from the Fort Union Lignite group, probably Lower Eocene.

Genus PLANORBIS, Müller.

Synon.—Planorbis, Müller* (1776), Verm. Terrest. et Fluv., 152; and Zoöl. Dan., 238.—Brug. (1789), Encyc. Méth., I, xvi.—Cuvier (1798), Tab. Élém.—Drap. (1805), Hist., 15, 28, and 42.—Moutf. (1810), Conch. Syst., II, 270.—J. Sowerby (1816), Min. Conch., tab., 140.—Goldf. (1820), Hdb. Zoöl., 659.—Blainv. (1824), Dict. Sci. Nat., XXXII, 244; and (1825) Malac., 450; also (1826) Dict. Sci. Nat., XL., 222.—Flem. (1828), Hist. Brit. An., 277.—Gray (1840), Turton's Man. (2d ed.), 256.—Deshayes (1824), Coq. Foss. Env. Paris, II, 81; and (1864) Suppl. to same, II, 734.—Fleming (1828), Hist. Brit. An., 277.—H. and A. Adams (1855), Genera Recent Moll., II, 260.—Meek and Hayden (1865), Palæont. Upper Missouri, 106; and of many others, but not Lam., 1799.

Vortex, Humphrey (1798), Mus. Col. (2d ed., 58); not Oken, 1815, nor Beck, 1837.

Anisus, Fitzinger (1833), Verz., III.—H. and A. Adams (1856), Genera of Recent Moll., II, 263 (as a subgenus under *Planorbis*).

* Guttard first described and named this genus in 1756; and he is often cited as its author. According to the rule that I have adopted, however, I do not cite to authors dating before the introduction of the binomial system of nomenclature, as the founders of genera.

Bathyomphalus, Agassiz, MS., Charp. (1837), Catal., 20 (as a subgenus under *Planorbis*).—Meek and Hayden (1865), Palæont. Upper Missouri, 105 (used as a subgenus under *Planorbis*).

Helisoma, Swainson (1840), Malac., 337.—H. and A. Adams (1856), Genera Recent Moll., II, 262 (as a subgenus under *Planorbis*).

Spirorbis, Swainson (1840), Malac., 337.—H. and A. Adams (1856), Genera Recent Moll. 263 (as a subgenus under *Planorbis*); not *Spirorbis* of Lamarck.

Planorbulina, Haldeman (1842), Fresh-water Univalves U. S., 14.

Planorbella, Haldeman (1842), *ib.*—H. and A. Adams (1856), Genera Recent Moll., II, 261 (as a subgenus under *Planorbis*).

Nautilina, Stein. (1850), in Schneck. et Mus. Berl., 80.—H. and A. Adams (1856), Genera Recent Moll., II, 262 (as a subgenus under *Planorbis*).

Tropidiscus, Stein. (1855), in Schneck. et Mus. Berl., 76.

Taphius, H. and A. Adams (1856), Genera Recent Moll., II, 264 (as a subgenus under *Planorbis*).—Meek and Hayden (1865), Palæont. Upper Missouri, 107 (as a subgenus under *Planorbis*).

Menetus, H. and A. Adams (1856), Genera Recent Moll., II, 262 (as a subgenus under *Planorbis*).—Meek and Haydén (1865), Palæont. Upper Missouri, 107 (as a subgenus).

Etym.—*Planus*, flat; *orbis*, an orb.
Type.—*Helix cornea*, Linnæus.

Shell apparently dextral;* discoid or subdiscoid, the whorls being nearly or quite coiled on the same plane; right side generally flat, but sometimes either a little elevated or concave; left side more or less excavated; volutions rounded, compressed, or angular; aperture crescentic or suboval, sometimes dilated; peristome thin, incomplete, right margin projecting.

The typical forms of this genus have the shell much depressed, and the volutions numerous, rounded or without angles, and visible on both sides, while the mouth is not dilated. As above defined, however, it is made also to include several subordinate groups, which depart more or less from the typical species, though placed here by nearly all conchologists.

The subordinate groups or sections of this genus adopted and proposed by H. and A. Adams in their valuable work on the Genera of Recent Mollusca are the following:

1. **PLANORBIS**, Müller (typical).

Shell with spire depressed, many-whorled, volutions generally rounded; aperture not dilated.—(Type as already stated.)

2. **HELISOMA**, Swainson.

Shell ventricose, concave on both sides; volutions few, generally angular on one or both sides; broadly rounded on the periphery.—(*P. bicarinatus*, Say.)

* Conchologists generally regard these depressed shells as being dextral; but O. A. L. Mörch offers some reasons for viewing them as properly sinistral forms (Conch. Jour. (Paris), XI, 2d ser., 235). This conclusion seems to be partly sustained by the form of the young of some American species, one of which was described by Dekay as a truncated *Physa*. On the other hand, however, monstrosities of some foreign species with an elevated spire are generally dextral.

3. PLANORBELLA, Haldeman.

Shell with whorls few, and aperture campanulate.—(*Planorbis campanulatus*, Say.)

4. TAPHIUS, H. and A. Adams.

Shell ventricose, somewhat irregular; whorls rounded on the outer side, prominent or subangular around the rather small, deeply-excavated umbilicus of the left side; aperture large, obovate, straight within.—(*Planorbis Andecolus*, d'Orbigny.)

5. MENETUS, H. and A. Adams (= *Anisus*, Beek, not Fitz.).

Shell depressed, volutions increasing rapidly in size; aperture suboval; periphery more or less angular.—(*P. angulatus*, Phil.)

6. ANISUS, Fitzinger (= *Tropidiscus*, Stein.).

Shell strongly depressed; volutions very numerous; periphery angular.—(*P. carinatus*, Müller.)

7. BATHYOMPHALUS, Agassiz (= *Spirorbis*, Swainson, not Lamarek).

Shell discoid, rounded on the periphery; whorls numerous, closely embraeing on the left side, exposed on the right; aperture narrow, crescentic; umbilical cavity on the left side narrow and profound.—(*Helix contracta*, Linn.)

8. GYRAULUS, Agassiz (= *Nautilina*, Stein.).

Shell discoid, slightly convex on the right side, flat or broadly concave on the left; volutions few, rapidly increasing in size, obliquely depressed, but not angular.—(*P. albus*, Müller.)

So far as at present known, the genus *Planorbis* seems to have been first introduced during the Liassic epoch; it is also known to have been represented during the deposition of the Wealden formation. Many species have likewise been found in the fresh-water Tertiary deposits of various countries; while the genus seems to attain its greatest development at the present time, and is widely distributed, particularly in northern temperate regions.

Planorbis convolutus, M. & H.

Plate 42, figs. 12, *a*, *b*.

Planorbis convolutus, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 120.

Shell attaining a large size, discoidal, the whorls being all coiled very nearly in the same plane; upper and lower sides moderately and nearly equally concave, and exhibiting about four-fifths of each whorl; volutions

five and a half or more, increasing rather gradually in size, rounded on the outer side, concave within, and slightly more broadly rounded above than below; sutures well defined.

Greatest diameter of largest specimen (which is not complete at the aperture), 1.10 inches; height or convexity, 0.33 inch.

All the specimens of this species in the collection are smooth silicious casts of the interior, retaining scarcely any traces of the surface-markings. On some of the larger individuals, a few obscure undulations of growth are sometimes seen, passing around the whorls very obliquely backward from the suture on the upper side, apparently parallel to the direction of the lines of growth, so as to indicate that the lip extended considerably forward above. The aperture, as near as can be determined from transverse sections of the whorls, is generally a little oblique, and approaching an obovate form, the lower side being narrower than the upper, and the inner side more or less sinuous.

This species bears considerable general resemblance to *P. rotundatus*, Brard (Deshayes, An. sans Vertèb. Env. Paris, Suppl.. II, pl. 47, figs. 1–5), but presents several well-marked differences, being more concave on the upper side, and having its whorls more rounded above, while they appear to be always destitute of the revolving striæ of that species, and want the angle sometimes seen on the lower side of those of *P. rotundatus*. The form of its aperture is also quite different, being more oblique, and higher than wide instead of wider than high.

It seems to be more nearly related to a Wyoming species described by me many years since, under the name *P. spectabilis*, from near Fort Bridger (see plate 17 of the Palæont. of King's Survey of the Fortieth Parallel, figs. 13, *a–f*, not yet published), and at one time I had concluded that the Wyoming shell might belong to the same species. A more critical comparison, however, leads me to think them distinct; the *P. spectabilis* having constantly a deeper umbilicus, and differing somewhat in the form of its aperture, and some other details.

Locality and position.—Little Horn and Powder Rivers, Montana; the specimens were brought by traders, and seem to have been found loose; but they probably either belong to the Judith River or Fort Union beds. They agree most nearly in their state of preservation with the fossils from the Judith River beds.

Planorbis convolutus, var.

Plate 42, figs. 11, *a–c*.

This form differs from the typical specimens of *P. convolutus* chiefly in having its whorls less compressed, especially on the upper side. It is also more concave on both sides, and its aperture appears to be proportionally higher and less oblique. It may possibly be specifically distinct; but with the specimens yet at hand for comparison, I am inclined to believe it only a variety of the last.

Locality and position.—Same as last.

Planorbis (Bathyomphalus) planoconvexus, M. & H.

Plate 44, figs. 9, *a, b, c*.

Planorbis fragilis, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 136. (Not *P. fragilis*, Dunker, 1843.)

Planorbis planoconvexus, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 185.

Shell rather large, thin, plano-convex, the upper side being nearly or quite flat, and the under side convex; umbilicus nearly one-third wider than the outer whorl, deep, and showing a part of each inner whorl; sutures linear, most distinct on the upper side; volutions about five or six, flat above, angular around the upper outer margin, and convex and sloping inward below from the periphery to the margin of the umbilicus, which is also very prominent or obtusely angular; inner side forming the walls of the umbilicus distinctly concave, each whorl rather more than three-fourths hidden by the succeeding turn on the under side; aperture subtrigonal, or unequally four-sided, the upper side being nearly straight and horizontal, the lower outer side (which is oblique and about of the same length) convex, and the two shorter inner sides next the umbilicus and the succeeding whorl, concave; surface marked by moderately distinct lines of growth.

Greatest breadth, 1.26 inches; height, 0.38 inch.

This shell is remarkably distinct from all the other known species of this country, either living or fossil. Among foreign fossil species, its nearest representative known to me is *P. euomphalus* of Sowerby, from the English Eocene deposits. It may be readily distinguished, however, by its less compressed form, and smaller as well as deeper umbilicus. Its whorls are also more angular around the margins of the umbilicus, and more concealed on the under side; while their inner sides forming the walls of the umbilicus are more concave.

As the name *fragilis*, under which we first indicated this shell, had been previously applied by Dr. Dunker to a recent *Planorbis*, it became necessary to give our species another name, consequently we changed it to *P. planoconvexus* in the paper cited at the head of this description.

The only specimen of this species yet seen, consists mainly of a cast of the interior, with portions of the thin shell attached. It has evidently suffered some accidental flattening and erosion above, which has also perhaps given greater angularity to its upper peripheral margin than is natural; but it doubtless had these characters naturally more or less marked.

Locality and position.—Fort Berthold, Dakota, on the Missouri River; from the Fort Union division of the Brackish- and Fresh-water Lignite series.

Planorbis (Bathyomphalus) amplexus, M. & H.

Plate 42, figs. 16, *a*, *b*, *b*, *d*, *e*.

Planorbis amplexus, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 21.
Helix (*Polygyra*) *amplexus*, Meek and Hayden (1860), *ib.*, 185.

Shell planorbicular; spire flat, or very nearly so; umbilicus deep, conical, and about as wide as the under side of the last turn; volutions about six, closely coiled, and increasing very gradually in size, very narrow and a little convex above, more broadly rounded on the outer side, and convex and broad below, where they distinctly overlap each other, and become obtusely subangular around the umbilicus; suture well defined; aperture and lip unknown; transverse section of the whorls obliquely semi-lunar, very narrow, and deeply arcuate on the inner side; surface obscurely striated.

Greatest breadth, 0.43 inch; height, 0.15 inch; breadth of outer whorl on the upper side, 0 08 inch; breadth of same on the under side, 0.14 inch.

Although at one time inclined to believe that this shell might be a *Polygyra* with the lip broken away, a more careful examination of specimens showing more clearly the umbilicus and some of its other characters, leads me to think that we were nearer correct in first referring it to *Planorbis*; or, in other words, that it more probably belongs to the group *Bathyomphalus*. Indeed, it seems to be very nearly allied to the existing type of that section, B. *contortus* (= *Helix contortus*, Linn.).

Locality and position.—From the Judith River group, near the mouth of that stream, on the Missouri, in Montana; probably belonging to the closing part of the Cretaceous period.

PHYSIDÆ.

Genus BULINUS, O. F. Müller.

Synon.—*Bulinus*, Müller (1781), in Naturforsch. Stuck., XVI, 1.—Beck (1837), Ind., 116 (as a subgenus).—H. and A. Adams (1855), Genera Recent Moll., II, 259.—Binney (1865), Land and Fresh-water Shells N. Am., part II, 97.—Tryon (1865), Am. Jour. Conch., II, 9 (as a subgenus under *Physa*).—Dall (1870), Ann. Lyc. Nat. Hist. N. Y., IX, 356 (not *Bulinus*, Studer, Hartm., and others).

Aplexa, Fleming (1828), British An., 276.—Beck (1837), Ind., 116 (as a subgenus).

Aplexus, Gray (1840), in Turton's Man. (2d ed.), 255.

Diastropha (Guild.), Gray (1840), *ib.*, 16.

Nauta (Leach, MS.), Gray (1852), in Leach's Synop. Moll. Brit. Mus., 110.

Etym.—*Vocab. barb.*

Examp.—*B. hypnorum*, Linn.

Shell sinistral, elongate-subovate, and thin; spire produced, acuminate; aperture narrow and more or less produced anteriorly; inner lip generally nearly or quite simple; outer lip sharp; surface polished.

This genus includes species nearly like some of those of the genus *Physa*, with which it agrees in the sinistral character and general appearance of the shell, as well as in the habits of the animal—both inhabiting the fresh-water ponds of this country and Europe. The shells of *Bulinus*, however, are more elongated, and have a more acuminate spire than those of *Physa*, while the animal of this group differs from that of *Physa* in having its mantle-margin simple instead of digitate. Some conchologists, however, only regard these differences as being of subgeneric importance.

This genus probably dates back to the Wealden epoch, if not to somewhat earlier times. We find forms agreeing with it in this country in beds either belonging to the latest Cretaceous or the oldest Tertiary age. Similar species are also found in the Lignite formation at the mouth of the Rhone in France. Some of these, such as *Physa Galloprovincialis*, *P. Gardanensis*, and *P. Drapernaudii* of Matheron, attain quite large sizes.

Bulinus subelongatus, M. & H.

Plate 42, figs. 13, *a*, *b*.

Physa subelongata, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 120.

Physa (Aplexa) subelongata, Meek and Hayden (1860), *ib.*, 431.

Aplexa subelongata, Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Invert. Fossils, 9.

Shell rather large, elongate-subovate or subfusiform; spire elevated, pointed at the apex; volutions six to six and a half, nearly flat, suture oblique, linear, and but slightly impressed; surface smooth, or with very obscure

lines of growth; aperture apparently rather narrow; columella twisted so as apparently to form a moderately distinct fold below.

Length, about 1.16 inches; breadth, near 0.53 inch.

I have seen but a single specimen of this shell which unfortunately has most of the outer lip broken away, and the columella not well exposed. Its surface is also somewhat worn, so that it is possible that the description may require some modifications when better specimens are obtained. There can, however, be no difficulty in distinguishing it from all of the other shells yet known in these rocks.

It is evidently related to several elongated species figured by M. Matheron from the Lignite Tertiary formations of the southeast of France (Cat. Méthod., pl. 36), being apparently most nearly like his *P. Gardanensis*, but differing in having a proportionally narrower body-whorl and a more faintly-impressed suture. It seems to have a rather more prominent fold on the columella than is common in this genus.*

Locality and position.—Judith River group, at the mouth of Judith River, on the Missouri, in Montana; probably belonging to the closing part of the Cretaceous period.

Bulinus longiusculus, M. & H.

Plate 43, figs. 16, *a*, *b*.

Physa longiuscula, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 119.
Physa (*Aplexa*) *longiuscula*, Meek and Hayden (1860), *ib.*, 431.

Shell narrow-subovate; spire rather elevated, pointed at the apex; volutions six to six and a half, nearly flat or slightly convex; suture distinct, though not deep; surface marked by rather obscure lines of growth; aperture apparently narrow-subovate, acutely angular above, and narrowly rounded below.

Length, about 0.56 inch; breadth, near 0.27 inch; apical angle nearly regular, divergence about 0.47°.

Our specimens of this species are more or less compressed, and have the aperture distorted, so that I am not able to characterize it as fully as might be desired. The aperture seems to be quite narrow, and the body-whorl

* This species agrees in size and pretty nearly in form with one I have described from the Tertiary of Wyoming, under the name *Physa Bridgerensis* (more properly *Bulinus Bridgerensis*), in Hayden's Report of the United States Geological Survey of the Territories for 1872, page 516. Still it has a less ventricose body-volution, and a more pointed spire, as well as more flattened upper volutions.

so tapering below as to give the shell almost a fusiform outline; this, however, may be to some extent due to distortion.

This species seems to be related to the recent *Bulinus hypnorum*, but has a proportionally broader body-volution, and not quite so produced a spire. These differences, however, are not near so marked as would appear from our figures, which are represented as having the body-whorl too wide and the spire too short.

Locality and position.—Lignite series of the Fort Union group, three miles below Fort Union, Dakota; probably Lower Eocene.

Bulinus? rhomboideus, M. & H.

Plate 43, fig. 17.

Physa rhomboidea, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 119.

Shell small, rhomboid-subovate, narrowing abruptly from the middle to the apex of the spire, which is rather short and pointed; volutions four and a half to five, convex, last one rather large, and moderately ventricose; suture well defined; aperture narrow-subovate, angular above, and narrowly rounded below; columella tortuous, and apparently forming a small fold; surface marked by fine, obscure lines of growth.

Length, 0.26 inch; breadth, 0.15 inch; length of aperture, 0.16 inch; breadth of same 0.07 inch; apical angle slightly convex, divergence about 60°.

This may possibly be only a distorted specimen of the last-described species; but it seems to have a shorter, more abruptly-attenuated spire, and a rather more decidedly ventricose body-volution. Both specimens are distorted, however, so that the means of comparison are by no means satisfactory.

There is in the collection, from the same locality and bed, a much larger, broken, and distorted specimen, that may possibly belong to this species; but additional collections are necessary to clear up the question of its relations to the species here described.

Locality and position.—Same as last.

ANCYLIDÆ.

Genus ACROLOXUS, Beck.

Synon.—*Ancylus* (sp.), of some, not of Geoffroy.
Acroloxus, Beck (1837), Ind., 127.—H. and A. Adams (1855), Genera Recent Moll., II, 266.—Chenu (1859), Man. Moll., I, 483.—Binney (1865), Land and Fresh-water Shells of N. Am., part II, 147.
Velletia (1840), Gray, in Turton's Man. (2d ed., 250); and (1842) Synon. Moll. Brit. Mus., 71 and 91.

Etym.—ἄκρα, apex; λοξος, oblique.
Type.—*Ancylus lacustris*, Linn.

Shell small, thin, oval, limpet-shaped, non-spiral, dextral; apex usually near the middle, and directed to the left; aperture large; lip thin.

The little shells of this genus are much like those of *Ancylus*, with which they agree in their habits, being fresh-water mollusks, found inhabiting streams and ponds, where they are usually seen attached to the stems and leaves of aquatic plants. They differ from that genus, however, in being always dextral instead of sinistral, as well as in the details of their lingual dentition. But few existing species are known, and only two of these occur in this country—one in Oregon (*A. Nuttallii*, Haldeman) and one in Alabama (*A. filosus*, Conrad, sp.).

This genus probably dates back to the Cretaceous, or oldest Eocene, and a few species apparently belonging to it have been figured from later Tertiary rocks.

Acroloxus minutus.

Plate 44, fig. 10.

Velletia minuta, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., 120.
Ancylus (*Acroloxus*) *minutus*, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., 432.

Shell minute or very small, depressed, extremely thin and fragile; extremities rounded, the anterior end being usually a little wider than the other. Apex moderately prominent, obtuse, located between the middle and the left posterior side, toward which it is directed. Anterior slope convex; left posterior slope sometimes slightly concave; surface smooth, or only marked by extremely fine, obscure, concentric striæ.

Length, 0.09 inch; height, 0.03 inch; breadth, 0.06 inch.

The specimens of this species yet seen, are very small, and generally distorted or otherwise imperfect. They seem to present some slight differences of form, and may possibly belong to more than one species; but shells

like these present so few characters upon which we can base specific distinctions, that it would require better specimens than those at hand to establish beyond doubt more than one species.

Locality and position.—Three miles below Fort Union, in the Fort Union Lignite group of the Upper Missouri; probably Lower Eocene.

VITRINIDÆ.

Genus VITRINA, Drapernaud.

Synon.—*Vitrina*, Drap. (1801), Tabl., 33 and 98; and (1805) Hist., 23, 30, and 119.—Roissy (1805), Moll., V, 391.—Cuvier (1812), Annales du Mus., XIX; and (1817) Règne An., II, 405 (as a subgenus).—Gray (1821), London Med. Rep., XV, 231; and (1840) in Turton's Man. (2d ed.), 118; also (1842) Synon. Moll. Brit. Mus., 90 (as a genus).—Fleming (1828), Hist. Brit. An., 255 and 267.—Deshayes (1830), Encyc. Méth., III; and (1832) *ib.*, 1133.—Sowerby, jr. (1839), Conch. Man., 114.—Thompson (1840), Land and Fresh-water Moll. Ireland, 5.—Gray (1840), Turton's Man. (2d ed.), 118.—H. and A. Adams (1855), Genera Recent Moll., II, 120.—Binney (1869), Land and Fresh-water Shells N. Am., part I, 26.—Tryon (1866), Monogr. Terrest. Moll. Am. Jour. Conch., II, 243; and of numerous others.

Helicolimax (part), Férussac (1801), Mém. Soc. Méd., IV, 390.
Semilimax, Férussac (1802), Naturf., XXIX.
Vitrinus, Montfort (1810), Conch. Syst., II, 238.
Hyalina, Studr. (1820), System. Verzeich., 11 (not Schum.).
Limacina, Hartm. (1821), Neue Alpina, I, 206 (not Cuvier and others).
Pagana, Gist. (1848), Natg., 168.

Etym.—*Vitrum*, glass.
Type.—*Helix pellucida*, Müller.

Shell depressed, imperforated, thin, glassy, transparent, with a short spire composed of two to three volutions, which increase rapidly in size, the last one being dilated; aperture wide; peristome thin, simple, and often membranaceous.

The shells of this genus are small in comparison with the animal. In the recent state, they are very thin and transparent, and the animal has much the same habits as many other land-shells, being found in damp places among loose earth, grass, moss, dead leaves, &c. The animal is active, and said by H. and A. Adams to be capable of leaping several inches from the ground when suddenly alarmed. The existing species are numerous, and widely distributed over the world. Pfeiffer enumerates in his Monograph eighty-four recent species from Australia and South America alone. They are very much less numerous in North America, only three species being admitted in Mr. Binney's Smithsonian Monograph.

The geological range of the genus is not well known. In the Old World, only some four or five fossil species have been described, and all of these

from Quaternary or the latest Tertiary beds. A single fossil species, apparently of this genus, described here, came from the latest Cretaceous or the oldest Tertiary of the Upper Missouri. If it really belongs to this genus, it would be the most ancient species yet described, so far as I am informed.

Vitrina? obliqua, M. & H.

Plate 42, figs. 10, *a*, *b*.

Vitrina? obliqua, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 134.
Helix obliqua, Meek and Hayden (1860), *ib.*, 431.

Shell obliquely subovate, or depressed-subglobose; spire depressed; volutions four, increasing rapidly in size, especially the last one, convex above and below, and more narrowly rounded on the outer side; suture well defined; umbilical region (in casts) impressed, or very slightly perforated; aperture subcircular; surface unknown.

Height, 0.48 inch; breadth, 0.66 inch.

The only specimens yet seen of this shell are mere sandstone-casts, and all more or less distorted. The typical figured specimen has much the general aspect of a *Vitrina*; but other more distorted specimens, apparently of the same species, unquestionably have the aperture somewhat contracted, the lip reflexed, and the spire more elevated. If these really belong to the same species, it would not agree with the genus *Vitrina*. As it is not possible, with such specimens as have yet been found, however, to determine satisfactorily its generic characters, it is here retained doubtfully under that genus.

The figured specimen of this species probably has its spire a little depressed accidentally. Indeed, I have sometimes suspected that all of the specimens referred more or less confidently to this species may possibly be only distorted examples of the form described in another place under the name *Helix vetusta*.

Locality and position.—Mouth of Judith River; from the Judith River group; probably belonging to the closing part of the Cretaceous period.

Genus HYALINA, Férussac.

Synon.—Hyalina, Férussac* (1819), Prodr., 40.—Rang (1829), Man., 163 (section of *Helicella*).—Gray (1840), Turton's Man. (2d ed.), 165; and (1842) Synon. Brit. Mus., 90.—Albers (1850), Die Heliceen, 66; and (1866) *ib.* (von Marten's ed.), 67.—Bland (1864), N. Y. Lyc. Nat. Hist., VIII.—Morse (1864), Jour. Portland Soc. N. Hist., I, 12.—Tryon (1866), Am. Jour. Conch., II, 241 and 246.—Binney (1869), Land and Fresh-water Shells N. Am., 29.—Gould (1870), Invert. Mass. (Binney ed.), 394; and of many others (not of Schum., 1817, or Studer, 1820).

* Férussac, I believe, at first wrote the name *Hyaline*.

Polita, Held. (1837), Isis, 916.
Vitrea, Fitz. (1833), Verz., 99.
Hyalinia, Agassiz (1837), Nouv. Mém. Soc. Helv., I, ap. Charp., 13.
Lucilla, Lowe (1852), Ann. and Mag. N. H., IX, 115.

Etym.—ὑάλινος, glassy.
Examp.—*Helix cellaria*, Müller.

Shell small, or attaining a medium size, shining and vitreous, varying from subdiscoidal to depressed-subglobose; axis perforated, more or less umbilicated, or with umbilicus closed; volutions from four to about six, increasing regularly in size, not angular on the periphery, last one not declining at the aperture, which is generally lunate or rounded-sublunate.

The species of this genus, like those of several allied groups, are generally rather small, and have a thin, shining, vitreous shell, with a thin, simple lip, and a more or less rounded-lunate aperture. Like many other land-mollusks, the existing species are found in damp, shady places.

Very widely different opinions exist in regard to the limits of this genus, and the groups that ought or ought not to be included as sections or subgenera under it. Mr. Tryon, who has published a valuable monograph of the Terrestrial Mollusca of the United States, only admits two sections among our species. These are *Hyalina* proper, and *Omphalina*, Rafinesque; while some other authors place the latter group as a section of the distinct genus *Zonites*, Montfort.

Mr. Binney, however, who has also devoted much attention to the study of the North American land-shells, includes as subgenera, under the genus *Hyalina*, the following groups among our species: *Hyalina* proper, *Mesomphix*, Raf., *Conulus*, Fitzinger and *Gastrodonta*, Albers; while Mr. Tryon and some others range *Mesomphix* as a distinct genus, including under it *Conulus* and *Gastrodonta* as subgenera. Professor Morse has also (as I would think correctly) separated two of the species included by Mr. Binney as types of new genera. On the other hand, Dr. Albers, a distinguished German Conchologist, not only includes, as sections of this genus, *Hyalina* proper, *Mesomphix*, and *Gastrodonta*, but three other sections (*Mörchia* and *Edusa*, Albers, and *Ammonceras*, Pfeiffer).

I have not studied the *Helicillidæ*, however, with sufficient care to pretend to decide where others with far better facilities have differed so widely; but, judging from all analogy, I am rather inclined to concur with those who restrict the genera to the narrowest limits.

In regard to the distribution of the species among the various groups above mentioned, as well as other allied sections, whether viewed as genera or subgenera, equally divergent views are entertained among high authorities, the same species being in some cases placed by the same author under groups that he considers different genera. This is more especially the case with regard to the distribution of American species by European authors, as has been shown by Mr. Bland, of New York.

Where such discordant views exist in regard to the classification of existing species, of which not only perfect specimens of the shells, but even where the living animals can be examined, it will be readily understood that the study of imperfect fossil specimens is very far from satisfactory. In such cases, we can only dispose of species provisionally, as may *seem* most probably correct, with the consciousness that a few additional collections in a better state of preservation may, at any moment, show our classifications of species in such groups to be faulty.

The difficulty in distinguishing this from several allied groups (especially among fossil species) renders it very doubtful at what exact geological period the genus *Hyalina* was introduced. I have the impression, however, that it occurs in the far West in beds belonging to the latest division of the Cretaceous. It is certainly represented in Tertiary rocks, but seems to attain its maximum development at the present time. The existing species are rather widely distributed, being found in Europe, North America, and the West Indies.

Hyalina? occidentalis, M. & H.

Plate 42, figs. 6, *a, b, c, d.*

Helix occidentalis, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 135.
Helix Nebrascensis, Meek and Hayden (1860), *ib.*, 431.

Shell depressed-orbicular; volutions three and a half to four, narrow and convex above, prominently rounded or subangular around the superior outer margin, and ventricose below; suture well defined; surface marked with fine, regular, obscure, transverse lines, apparently not crossed by revolving striæ; umbilicus deep, conical, and about half as wide as the under side of the outer whorl at the aperture, which is subcircular or obliquely ovoid, and moderately sinuous on the inner side for the reception of the penultimate whorl.

Greatest breadth, 0.33 inch; height, 0.21 inch; greatest diameter of the aperture, 0.16 inch; breadth of same, 0.14 inch.

It is not possible to determine beyond doubt, from the specimens we have yet seen, whether this species is a true *Hyalina* or a member of some of the allied groups. As near as can be determined from our specimens, it agrees rather nearly in form and size, though the transverse striæ on the upper side of the whorls are rather stronger and more regular than we usually see in that genus. Impressions left upon internal casts show that the lip is thin and simple.

In its general appearance, this species resembles *Helix omphalus* of F. E. Edwards (Monograph Eocene Moll., part ii, p. 69, pl. x, fig. 5, Palæont. Soc.), but its spire is rather more depressed, and the volutions more prominent near the umbilicus, while its aperture is broader and less sinuous on the inner side. It seems not to be very nearly allied to any of our recent species, and is quite unlike any of the other fossil forms yet known from the Upper Missouri rocks.

Locality and position.—Mouth of Judith River, Montana; from the Judith River estuary beds, probably belonging to the latest member of the Cretaceous.

Hyalina? Evansi, M. & H.

Helix Evansi, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 175.

Fig. 68. Fig. 69. Fig. 70.

Hyalina Evansi.

Fig. 68. A side view, showing aperture and spire.
Fig. 69. Upper side.
Fig. 70. Under side, showing umbilicus.

Shell small, depressed-subglobose; volutions four and a half to five, narrow, and a little convex above, rounded on the outer side, and ventricose below; each turn slightly embracing on the upper side, and below covering nearly the whole breadth of the next one within; umbilicus moderate, or in some instance appearing as if it had been covered; surface apparently smooth; aperture obliquely lunate-semicircular.

Height, 0.18 inch; breadth, 0.30 inch.

This species may be readily distinguished from the last by its more deeply embracing whorls. This latter character gives quite a different form to the aperture, which is much narrower and more arcuate than that of *H. occidentalis*. The shell under consideration also has a rather more prominent spire, and about one whorl more, although smaller than the last. The only three specimens seen are casts of the interior, with some of the thin shell remaining. Two of these show some appearance of having the umbilicus occupied by a lump or callus; but this may be merely some foreign body,

accidentally placed there, as nothing of the kind is seen in the third. If this is a natural callus, however, the species would of course belong to some widely removed genus from *Hyalina*.

Locality and position.—Same as preceding.

HELICIDÆ.

Genus HELIX, Linnæus.

Synon.—*Helix*, Linn. (1758), Syst. Nat., 768.—Müller (1774), Hist. Verm., II, 12; and (1776) Zoöl. Dan. Prodr., xxx and 239.—Brug. (1789), Encye. Méth., I, xvi.—Cuvier (1798), Tab. Élém., 396.—Lam. (1801), Syst. An., 93 (not 1799).—Montfort (1810), Conch. Syst., II, 230.—H. and A. Adams (1855), Genera of Recent Moll., II, 188; and of numerous other authors, at various dates, and with various limits.

Pomatia, Bolten (1798), Mus. (ed. 2a, 1819, 52).—Beck (1837), Ind., 43.—Gray (1840), in Turton's Man. (2d ed.), 137.—Albers (1860), Die Heliceen, 140 (as a subgenus under *Helix*).

Lucena, Hartm. (1821), in Neues Alp., I, 208 (not Oken 1815).

Cantareus, Risso (1826), Hist., IV, 64.—Beck (1837), Ind., 44.

Cœnatoria, Held (1837), in Oken's Isis, 910.

Galaxias, Beck (1837), Ind., 42.—H. and A. Adams (1855), Genera Recent Moll., II, 189 (as a subgenus under *Helix*).

Camœna, Albers (1850), Hel., 85.—H. and A. Adams (1855), Genera Recent Moll., II, 189.

Etym.—ἕλιξ, spiral.

Examp.—*Helix pomatia*, Linnæus.

Shell more or less globose or subturbinate, imperforate or umbilicate, the umbilical perforation being sometimes covered in the adult by the expansion of the inner lip; spire depressed or sometimes moderately prominent; volutions convex, the last one being ventricose, and generally deflected at the aperture, which is more or less lunate-suborbicular; peristome generally thick and reflexed, rarely thin and simple; columellar margin dilated, and not dentate.

The above diagnosis and synonymy are intended to include the following sections:

1. **HELIX**, Linn. (typical).

   Shell more or less nearly globose, imperforate, or with perforation covered; peristome patulous or reflexed; columellar margin dilated and callous.—(Type as already cited.)

2. **GALAXIAS**, Beck.

   Shell globose, umbilicate; aperture generally shining within; peristome thick, expanded, reflexed, or rarely simple, obtuse with margins approximated, and often united by a callus; columella dilated, and somewhat covering the umbilicus.—(*Helix globulus*, Müller.)

3. CAMÆNA, Albers.

> Shell varying from subturbinate to more or less depressed-subglobose, umbilicated; spire obtuse, moderately prominent; last turn often angulated; peristome thin or a little thickened, and expanded with contiguous margins, and base expanded or reflexed.—(*Helix asperella*, Pfr.)

From the foregoing, it will be seen that I adopt this genus and its sections almost precisely as used by the Messrs. H. and A. Adams in their work on the Genera of Recent Mollusca. This, however, is not done from an entire conviction that no better arrangement could be devised, but because I prefer to follow reliable authority, in the absence of the necessary material and time to enter upon an especial study of a great family of shells, which, although immensely developed at the present time, played a comparatively unimportant part among extinct forms; while, even of the latter, I have but few species to dispose of.

It should be stated, however, here, that very widely different views in regard to the limits of this genus are entertained among high authorities on recent Conchology. This will be the better understood when it is stated that, while H. and A. Adams only admit the three sections already mentioned, Albers, who has devoted especial attention to the study of this and allied groups, includes as sections or subgenera under the genus *Helix* alone, an almost interminable list of about eighty-eight subordinate groups, designated by as many different names. Without pretending, however, to have devoted much time to the study of the existing forms of this group, I would merely state that it seems more philosophical, and more in accordance with the views of the best systematists in other departments of natural history, as well as much more convenient, to treat a considerable portion of the groups included as sections of this genus by Albers, as separate genera and sections of the same, more nearly in accordance with the arrangement adopted by H. and A. Adams. This has already been done by Professor Morse, Mr. Tryon, and, to a less extent, by some others, in classifying American types.

In regard to which particular one of the allied groups should inherit the old generic name *Helix*, or, at any rate, which should be regarded as the typical section of this genus, some differences of opinion exist. As originally used by Linnæus in 1758, the genus can hardly be said to have had any

definite limits, as his diagnosis was far from satisfactory, while he included numerous species belonging to a number of widely distinct genera, according to modern classifications, without mentioning any one as the type. In 1774, and again in 1776, Müller used the name *Helix* to include nearly as wide a range of types. Cuvier, however, in 1798, only ranged three species under it, the first of which was *Helix pomatia*, Linnæus, the typical form of the genus as here understood; but as his other two species belong to two distinct genera, according to later classifications (though Albers includes all three of these types as sections of this genus), he can hardly be regarded as having restricted the genus to exact limits, or, in other words, as having settled the question in regard to what particular species is to stand as the type of the genus. In 1799, however, Lamarck adopted this genus in his Prodromus, and cites but the single example *Helix nemoralis*, Linnæus; though two years later he again used it with *H. pomatia* as his only example.

I am not sure of having seen all the works necessary to settle the question whether or not any other author had used this genus in a way to restrict it to any one properly-limited genus, before Lamarek's citation of *H. nemoralis* as his typical example in 1799; but if this had not been done, I should think, according to the most generally-accepted rules of nomenclature, that the name *Helix* ought to adhere to the group including *H. nemoralis*, which group is now generally known under Montfort's name *Acavus*. This change, if it should be made, would therefore require the group here under consideration to take the name *Pomatia*, or some one of the later names cited in the synonymy. Not having at hand all the necessary facilities, however, for tracing out fully the complicated synonymy and history of this genus, of course no such innovation will be proposed here.

Although this genus is here defined in a restricted sense, it must be confessed that practically, in classifying fossil species in the mutilated and distorted condition in which specimens are usually found, we are often compelled to refer to it forms which probably could not be properly included in it as here restricted, and thus we have to give it provisionally wider limits.

It is not, I believe, positively known that this genus dates back further than the Tertiary epoch, though we may have to refer, at least provisionally to it, forms from beds in the far West that may prove to belong to the Upper Cretaceous.

Helix vetusta, M. & H.

Plate 42, figs. 7, *a*, *b*.

Helix vitrinoides, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 135 (not *H. vitrinoides*, Deshayes, 1830).
Helix vetusta, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 431.

Shell subglobose, breadth and height nearly equal, or the former somewhat greater than the latter; spire rather prominent; volutions about four, increasing rather rapidly in size, last one ventricose, rounded, and slightly constricted at the aperture; umbilical depression (in casts) small, probably closed by the spreading of the inner lip; aperture higher than wide, apparently subovate, a little oblique, and somewhat declining; lip reflexed; suture well defined. (Surface unknown.)

Height, 0.40 inch; breadth, 0.43 inch; length of aperture, 0.26 inch; breadth of same, 0.20 inch. Other specimens of apparently the same species are nearly twice as large as the figured and measured example.

I have only seen casts of this species, and consequently know nothing of its surface-markings. The constriction mentioned in the body-whorl near the aperture may possibly have been produced in the cast by an internal thickening of the lip, though it has the appearance of having been accompanied by a corresponding constriction of the exterior, around the reflected margin. There are also on the cast apparently some indications of an obscure mesial linear angle on the outer side of the body-whorl, which angle, however, becomes obsolete near the aperture.

As stated in another place, it is barely possible that the form described in this report under the name *Vitrina obliqua* may be an accidentally-depressed specimen of this species; though I think not, as that type seems to have its body-volution more rapidly expanded.

The shading on our figure 7, *b*, plate 42, of this species, gives an appearance of obscure revolving striæ, that do not exist on the specimens, all of which are mere internal casts.

Locality and position.—Mouth of Judith River, on the Missouri; from the Judith River Fresh- and Brackish-water beds; probably belonging to the closing period of the Cretaceous.

Genus THAUMASTUS, Albers.

Synon.—*Bulimus* (sp.), of many authors.
Thaumastus, Albers (1860), Die Heliceen, von Marten's ed., 215 (proposed as a subgenus under *Bulimulus*).—Tryon (1866), Am. Jour. Conch., III, 167 and 170 (as a genus).—Binney (1869), Land and Fresh-water Shells of N. Am., part I, *Pulmonata*, 199 (as a subgenus under *Bulimulus*).

Etym.—θαυμαστός, strange.
Type.—*Bulimus Hartwegi*, Pfeiffer.

Shell narrow-subovate to ovate-subfusiform, imperforate or rimate; surfaee nearly smooth, in the recent state whitish, sometimes variegated with brown dashes or stripes; aperture ovate; outer lip obtuse, straight or slightly expanded; inner lip reflexed, and more or less appressed; columella twisted.

This group is generally regarded as a subgenus under *Bulimulus*, where it was ranged by Albers as the sixth of nineteen seetions reeognized by him under that group. I do not pretend to have thoroughly investigated these groups; but it seems to me, praetically at least, more convenient to use this section as a distinct genus, as has been done by Mr. Tryon.

In regard to the geological range of this genus, little can be said. The species hereinafter deseribed came from beds apparently of older Eocene age. Several speeies resembling this group have been figured from rocks of that and later Tertiary ages at different foreign localities. The genus, however, seems to attain its greatest development at the present time. Albers enumerates under it fourteen recent species, exelusive of three or four others included by Mr. Tryon, who ranges six North American species in this group. The recent speeies seem to be all American, and oecur in both North and South America; those found in North Ameriea oecur in Mexico, Texas, and California

Thaumastus limnæiformis, M. & H.

Plate 44, figs. 8, *a*, *b*, *c*, *d*.

Bulimus limnæiformis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 118.
Bulimus Nebrascensis, Meek and Hayden (1856), *ib.*

Shell small, narrow-subovate, rather solid; spire moderately elevated, a little obtuse at the immediate apex; volutions five to six, moderately convex; suture distinet; surface polished, and only marked by very fine, nearly obsolete lines of growth; aperture narrow-subovate, a little oblique, angular above and narrowly rounded below, usually a little shorter than the spire;

inner lip very slightly thickened and reflected below, extremely thin above; outer lip sharp; columella imperforate, and somewhat twisted.

Length (of a medium-sized specimen), 0.55 inch; breadth, 0.26 inch; length of aperture, 0.25 inch; breadth of same, 0.12 inch; apical angle convex, divergence varying with age, from about 38° to 45°.

This species bears some general resemblance to *Bulimus Floridanus* of Conrad (Am. Jour. Conch., I, 144, pl. 11, fig. 11), from the Upper Eocene at Tampa Bay; but it is less elongated, and has a less elevated spire, and less angular aperture than Mr. Conrad's species, while it also differs in its smoother surface.

I have seen a recent shell much more nearly resembling our species, figured under the name *Spiraxis limnæiformis*, Shuttleworth; but it has a more ventricose body-volution and proportionally longer aperture than our species, and differs in having its columella twisted in the form of a prominent fold.

Locality and position.—Opposite the mouth of Yellowstone River, Northwestern Dakota; from the Fort Union Lignite group; probably Eocene.

Genus COLUMNA, Perry.

Synon.—Columna, Perry (1811), Conch., pl. 51*;—Schum. (1817), Ess., 188.—Möller (1832), in Oken's Isis, 129.—Beck (1837), Ind., 76.—H. and A. Adams (1855), Genera Recent Moll., II, 134.—Tryon (1866), Am. Jour. Conch., II, 297.—Binney (1869), Land and Fresh-water Shells of North America, part I, 189.

Acicula (*les Aiguilles*), Blainv. (1825), Malac., 456 (as a section of *Achatina*); not *Acicula* of Hartmann or Risso.

Rhodea, H. and A. Adams (1855), Genera Recent Moll., II, 135 (as a subgenus under *Columna*).—Binney (1869), Land and Fresh-water Shells of North America, part I, 190.

Etym.—Columna, a pillar or column.
Type.—Achatina columna, Müller.†

Shell much elongated, cylindrical or terete, dextral or sinistral; surface nearly smooth, or decussately granular; apex obtuse; volutions convex or flattened, lower ones generally constricted at the suture, last sometimes angular below; aperture auriculiform, comparatively small; columella not properly perforated, but spirally twisted so as to form an open canal all the way up the spire, and abruptly truncated at the base; lip simple, straight, and acute.

* Perry's Conchology is not paged, and consequently I cannot cite the particular page on which his description occurs.

† Perry's type was *Achatina columna*, Müller, which is, I believe, considered a synonym of *C. flammea*, Martyn.

H. and A. Adams have divided the recent species of this genus into the following two subgenera:

1. COLUMNA, Perry (= *Acicula*, Blainv.).

   Shell sinistral, with volutions generally convex, last turn not angular or excavated below.—(Type as already cited.)

2. RHODEA, H. and A. Adams.

   Shell dextral, very slender and elongate-cylindrical; last turn flattened, carinated below the middle, and excavated below the carina; columella thickened, and subtruncated at the base.—(*C. Californica*, Pfeiffer.)

These two sections, looking at the recent species only, would seem to present sufficiently well-marked differences to rank as distinct genera. When we come to compare some of the intermediate extinct species, however, such as *C. columnella*, Deshayes (sp.), and *C. Rillyensis*, Boissy (sp.), from the Paris-basin Tertiary, in which forms the lower volutions are flattened, and the last one subangular below, the *Rhodea* group will be seen to be less strongly separated from the typical form of the genus than would appear from a mere comparison of the living species only.

Unless the following-described species may belong to the upper beds of the Cretaceous, this genus would seem to have been introduced during the Eocene epoch. The three living typical species are found on Prince's Isle, west coast of Africa, and another in Madagascar. The type of the section *Rhodea* occurs in California, and was described by Pfeiffer under the name *Achatina Californica*.

Columna teres, M. & H.

Plate 44, figs. 11, *a*, *b*.

Bulimus ? teres, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 117 (not *B. teres*, Oliv., Voy., 417, tab. 17, fig. 6).

Columna ? teres, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., VIII, 431.

Shell small, sinistral, much elongated, terete; volutions twelve to thirteen, compactly coiled and increasing very gradually in size, a little convex near the upper extremity of the spire, but flattened farther down; suture linear, and rather faintly marked between the lower whorls, but more distinct above; surface marked by fine obscure lines of growth, which cross the whorls nearly at right angles to the suture. (Aperture unknown.)

Length, 0.72 inch; breadth, 0.17 inch.

The figured specimen is the only one in the collection certainly known to belong to this species. It has been distorted somewhat by compression, which gives slightly greater breadth to the lower volutions than is natural. It may be compared with *Achatina Rillyensis*, Boissy, from the Inferior Lacustrine beds of the Paris basin, which species seems to be a true *Columna*. Our shell, however, when not distorted, has its lower volutions merely flattened or slightly convex, and not concave, and the suture between them much more oblique. Judging from the form of its last volution, its aperture would also seem to have had a quite different outline.

I have not had a very satisfactory view of the aperture of this or the following forms, and consequently only place them provisionally in the genus *Columna*. In working out one of the specimens, however, I had a partial view of its aperture before it broke to pieces; and its columella was seen to be twisted as in that genus, and apparently provided with a single prominent, oblique ridge, as in the same. Before seeing this, I had once doubtfully placed these shells in the genus *Clausilia*. This character of the existing columella, however, and the fact that the latter genus is not known among the mollusks of the continent (proper) of North America, are the reasons that lead me to retain them here under the genus *Columna*. It is true that the typical forms of the latter genus are equally foreign to this country; but the section *Rhodea*, of the same, occurs in California, while our shells appear to present intermediate characters between that group and the typical forms of the genus *Columna*.

Locality and position.—Fort Union group, near Fort Union, Dakota, on the Upper Missouri; probably Lower Eocene.

Columna vermicula, M. & H.

Plate 44, figs. 12, *a*, *b*.

Bulimus vermiculus, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 118.
Columna ? vermicula, Meek and Hayden (1860), *ib.*, XII, 431.

Shell small, sinistral, very slender, or elongate-subcylindrical; volutions about thirteen, narrow, closely coiled, and increasing very gradually in size, slightly convex near the summit of the spire, but nearly flat farther down; suture merely linear between the lower whorls, but becoming more distinct nearer the apex; surface marked by fine obscure lines of growth, crossing the volutions at right angles to the suture. Aperture unknown.

Entire length unknown; length of a specimen consisting of twelve whorls, 0.60 inch; greatest breadth of same, 0.13 inch; apical angle a little convex above, divergence about 15°.

This shell agrees nearly in many respects with the last, especially when we take into consideration the fact that the type-specimen of that form has suffered some accidental compression, which makes its lower volutions appear broader than natural. It should also be mentioned that the specimen from which our figure 12, *b*, was drawn is likewise a little compressed, so as to make the spire appear somewhat less attenuated above than it would otherwise do. The two forms may belong to one species, but I can hardly think that any amount of distortion by compression could produce the differences seen in the obliquity of the suture, and the length of the lower volutions, represented in our figures 11, *b*, and 12. *b*.

The form here under consideration seems to be more nearly related to a shell described by Matheron, from the Lower Lignite formation of Southern France, than to any other with which I am acquainted.* It, however, has not near so many volutions, which are also a little more convex, while its spire is less attenuated above. Matheron called his species *Melania acicula*, but there is no probability that it belongs to that genus. As nothing is known in regard to its aperture, however, it may belong to an entirely different group from our species.

Locality and position.—Same as last.

Columna vermicula, var. contraria, M.

Clausilia contraria, Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Invert. Fossils, 10.

Along with the foregoing species there were found a few imperfect specimens, apparently, so far as can be determined, agreeing almost exactly with that last described in every respect, excepting that they are dextral. These may represent a distinct species, but I am now inclined to believe that they only belong to a dextral variety of one or the other of the foregoing species—more probably the last.

* See Matheron's Cat. Méth. Corps Org. Foss. du Depart. de Bouches-du-Rhône, 219, pl. 36, fig. 25.

PECTINIBRANCHIATA.

CERITHIIDÆ.

Genus CERITHIDEA, Swainson.

Synon.—*Cerithium* (sp.), of authors; not of Brug. as restricted by Lamarck and others.
Cerithidea, Swainson (1840), Malac., 203 and 324.—Gray (1847), Zoöl. Proceed., 154.—H. and A. Adams (1854), Genera Recent Moll., I, 292.—Chenu (1859), Man. Conch., I, 286 (as a subgenus under *Cerithium*).
Pirenella, Gray (1847), Zoöl. Proceed, 154.—H. and A. Adams (1854), Genera Recent Moll., I, 293 (as a subgenus under *Cerithidea*).—Chenu (1859), Man. Conch., I, 285 (as a subgenus under *Cerithium*).

Etym.—*Cerithium.*
Examp.—*C. decollata*, Linnæus.

Shell elongate-conical, many-whorled, more or less decollated at the apex; volutions regularly or irregularly costated, or granular; aperture rounded, slightly emarginated, or with a short anterior canal; outer lip with an expanded and thickened margin, or thin and sinuous.

As proposed by Swainson, this genus was made to include species belonging to several distinct groups; but I adopt it here as used by H. and A. Adams, who admit the following two subgenera under it:

1. **CERITHIDEA**, Swainson (typical).

   Shell with volutions longitudinally ribbed; aperture slightly notched or emarginate anteriorly; outer lip with a dilated thickened margin.—(Example as already stated.)

2. **PIRENELLA**, Gray.

   Shell irregularly ribbed, or granular; aperture with a short anterior canal; outer lip thin and sinuate; inner lip simple.—(*Cerithium mamillatum*, Philippi.)

The species of this genus are capable of living either in brackish- or fresh-waters, or on land near the same, being frequently found crawling about mangrove-swamps in southern countries. They live so much out of water that they have even been supposed to be true land-shells. During continued dry seasons, they suspend themselves to branches of trees by a kind of threads formed by glutinous matter secreted for that purpose, the mouth of the shell being at the same time closed by the operculum.

This genus is known to occur in the Eocene of the Old World, and possibly may date as far back as the closing part of the Cretaceous period in the Upper Missouri and Rocky Mountain regions of this country.

Cerithidea (Pirenella)? Nebrascensis, M. & H.

Plate 43, figs. 9, *a*, *b*, *c* (*bis*).*

Cerithium Nebrascense, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 125.
Cerithium (*Cerithidea?*) *Nebrascense*, Meek and Hayden (1860), *ib.*, XII, 430.
Cerithidea (*Pirenella*) *Nebrascensis*, Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Invertebrate Fossils, 12.

Shell elongate-conical, or subterete; volutions apparently eight and a half to nine when the spire is complete, convex, and ornamented by three revolving rows of small, sharply-elevated, regularly-disposed granules; last or body-whorl rounded below; suture distinctly defined; surface marked by fine, rather obscure lines of growth, crossed by more distinct, thread-like, revolving lines, about three or four of which may usually be counted between each two of the rows of granules; aperture a little oval, or nearly circular, but terminating, on the inner side below, in a small, rather oblique sinus, or short canal.

Length of a specimen consisting of six of the lower whorls, 0.49 inch; breadth, 0.18 inch; length of aperture, including the short canal, 0.14 inch; breadth, 0.10 inch; apical angle regular, divergence 19°.

On the lower part of the body-whorl, several of the revolving lines are much larger than on other parts of the shell, and the upper two are sometimes studded with granules, so as to make on this whorl four or five, instead of three rows. Occasionally, one or more of the subordinate intermediate revolving lines on the lower part of the body-whorl also become minutely granular. All the specimens yet seen have a few of the upper whorls, and most of the lip broken away, and some of the succeeding turns eroded, apparently as if the shell had been decollated during the life of the animal. Until better specimens can be examined, the generic characters of this shell cannot be determined beyond doubt.

It should be stated here, for the information of Conchologists, who are accustomed to examining perfect specimens of shells, that our figures do not show the aperture and lip entire, but only as seen in broken specimens. So far as known, its associates are fresh- and brackish-water types; otherwise, I should have been inclined to refer it to *Cerithium*, from all of its known characters.

Locality and position.—Head of Little Missouri, in apparently the lower part of the Fort Union Lignite group (probably Eocene).

* By an oversight, in adding some figures to this plate after it was made up, both this species and a bivalve on the same plate were each numbered 9, *a*, *b*, *c*.

CERIPHASIIDÆ.

Genus GONIOBASIS, Lea.

Synon.—Goniobasis, Lea (1862), Proceed. Acad. Nat. Sci. Philad., XIV, 262; and (1863) Jour. Acad. Nat. Sci., V, 217; also (1865) Am. Jour. Conch., I, 118.—Tryon (1866), *ib.*, 14; and (1873) Land- and Fresh-water Shells N. Am., part IV, 138.—Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Invert. Fossils, 12; and (1872) in Hayden's Second Ann. Report United States Geological Survey of the Territories, 298; and (1873) *ib.*, Sixth, 515.

Melania (part) of many authors (not of Lamarck).

Ceriphasia (sp.), *Pachychilus* (sp.), *Potadoma* (sp.), *Elimia* (sp.), *Hemisinus* (sp.), and *Juga* (sp.), of authors.

Etym.—γωνία, an angle; βάσις, a base

Examp.—*G. quadricincta*, Lea.

Shell varying with the species from subovate to elongate-conoidal, or subfusiform; apex often eroded; volutions flattened, more or less convex, or sometimes angular; aperture usually ovate-rhomboidal, and generally angular, but without a canal below; outer lip without a slit or sinus, columella rarely slightly thickened above; surface smooth, or variously ornamented with revolving lines, ridges, or vertical costæ, sometimes tubercular.

Until comparatively recently, the species of this extensive genus were very generally referred by American and European authorities to the genus *Melania*. H. and A. Adams, in their valuable work on the Genera of Recent Mollusca, however, separated many of them under different sections of that and several allied groups, placing them in connection with foreign types, belonging, according to later classifications, to different genera from all of our American species, which are now, by high authorities, even ranged as a distinct family from the foreign Melanians. Their subgenus *Elimia* (under *Io*) was largely made up of species of *Goniobasis*, but also included other types.

Some of the existing species closely resemble *Pleurocera* of Rafinesque, another American fresh-water genus, standing, as it were, between this group and *Io*, Lea. *Pleurocera*, however, differs in usually having a distinctly more rhombic aperture, with the outer lip more prominent below, and the base generally (sometimes decidedly) more inclined to be produced in the form of a short canal, than in *Goniobasis*, though not so much so as in *Io* proper.

According to Mr. Tryon's elaborate Monograph of the Strepomatidæ, published by the Smithsonian Institution, there are more than two hundred and fifty known existing species of *Goniobasis*, a large proportion of which

occur in the streams of the Southern and Western States, northward to the region of the Great Lakes, while a few are found in the streams of the Pacific shores, northward into Oregon. It is a strictly American group, none of the species being known to occur in the European or Oriental districts.

Professor Haldeman first noticed the fact that all of the American types of so-called Melanians, including this and several allied genera, differ from the true *Melaniidæ* of Eastern countries, in having the mantle-margin not fringed. This character was also noticed at a later date by Professor Gill, who proposed to separate the American genera, as a distinct subfamily of Melanians, under the name *Ceriphasinæ*.* Professor Haldeman also proposed in 1863 to separate the American types, but as a distinct family, under the name *Strepomatidæ*, which has been adopted by Mr. Tryon in his Monograph, already mentioned.

It is often very difficult to separate the species of this genus from each other, as well as to decide to which one of several allied genera particular species should be referred, even among recent types, both the shell and animal of which are well known. Hence it may readily be understood that the classification of battered, worn, and distorted fossil shells of this kind must long remain merely provisional. In these cases, we can only adopt such conclusions as may, with the material at hand for study, seem to be most probably correct, feeling at the same time perfectly conscious that additional collections may show forms that seem to be distinct to be mere varieties of one species.

We have pretty good evidence that the genus *Goniobasis* dates back as far as the latest Cretaceous period in the Rocky Mountain region, where it also occurs in Tertiary beds of different ages. In this elevated interior part of the country, these fossil shells often occur in very great numbers of individuals, though, so far as yet known, the *species* would seem not to have been so numerous as those now living in the streams of the Southern and Western States. It is a little remarkable that no existing species have yet, so far as I am informed, been found in the streams of this distant internal region, where the remains of fossil species are so abundant.

* Proceed. Acad. Nat. Sci. Philad., XV, 33, 1863.

Goniobasis convexa, M. & H.

Plate 42, figs. 2, *a*, *b*.

? *Turritella convexa*, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 70.
Melania convexa, Meek and Hayden (1856), *ib.*, 125.

Fig. 71.

Goniobasis convexa (type).
To show the curves of the lines of growth more correctly than figures 2, *a*, *b*, of plate 42.

Shell rather large, much elongated, terete; volutions about nine or ten, flat, compactly wound, and increasing gradually in size from the apex, last one rounded below and not enlarged beyond the regular increase of the others; suture linear; surface marked by rather fine lines of growth, crossed by regular equidistant, often obsolescent, thread-like revolving lines, with sometimes between the latter traces of minute striæ; aperture apparently rhombic-ovate; lip sharp, broadly sinuous above, and prominent below.

Length, about 1.60 inches; breadth, 0.47 inch; length of aperture, 0.40 inch; apical angle convex, divergence near the summit of the spire 30°, but not more than 20° below.

The best specimen of this interesting species that I have seen, consists of seven volutions, and appears to have lost two or three others from the apex, while its aperture is a little distorted. The larger revolving lines (about seven to ten of which may be counted on the second volution) are quite distinct, and nearly one-third as wide as the spaces between; but the fine revolving striæ are closely crowded, and so small and obscure as to be only seen by the aid of a good lens on perfectly-preserved specimens. On the upper turns of the spire, the surface-sculpturing appears to differ somewhat from that of the lower, the revolving lines being very faintly marked, and the lines of growth between them sometimes assume the appearance of microscopic granules. These smaller markings, however, are very minute and obscure, and consequently will only be seen when carefully looked for, on well-preserved specimens, by the aid of a magnifier.

This shell has the general appearance of some of the elongated species of *Goniobasis*; but the curves of its lines of growth show that the outer lip must have presented the prominence below, characteristic of the *Trypanostoma* (or *Pleurocera*) group. This curvature of the lines of growth, however, is not well shown in our figures on plate 42, but is correctly represented in the foregoing cut, figure 71.

Originally we described a shell from a locality one hundred and fifty miles up the Yellowstone River, under the name *Turritella convexa*, which seems to resemble this very closely in all of its known characters, though the specimens are not in a condition to show surface-markings. These specimens were supposed to have come from marine beds, and the shell was, from this fact and its general form, referred provisionally to the genus *Turritella*. On subsequently receiving the species above described from the fresh- and brackish-water beds near the mouth of Judith River, their similarity of form to the specimens from the Yellowstone was noticed; but from their associations, they were believed to be different. In order to avoid making a synonym, however, in case that they should be found to be the same, the specific name *convexa* was also applied to the Judith River species, under the generic name *Melania*. The relations of these shells still remain undetermined, owing to the condition of the specimens from the Yellowstone River, which are merely casts with inner layers of the shell, showing only traces of the lines of growth. In order to facilitate comparison as far as possible, the annexed cut of the latter shell is added. The name *convexa* was given from the convex slopes of the spire, and not with reference to the volutions, which are flat.

Fig. 72.

Turritella? convexa (type). The apparent truncation of the columella and lip is merely due to an accidental break.

Locality and position.—Judith River Fresh- and Brackish-water Lignite beds, at the mouth of Judith River, Montana; probably belonging to the latest division of the Cretaceous.

Goniobasis convexa, var. impressa.

Plate 42, figs. 2, *c*, *d*.

Melania convexa, var. *impressa*, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 138.

This form differs from the typical *G. convexa* in being more slender, in having the lower whorls much more convex, and the suture more strongly impressed between the whorls below the middle. Its lip also seems to have been more sinuous above, judging from the curves of the lines of growth on the convex whorls. In all other respects, it agrees so nearly with *G. convexa* that I am inclined to regard it as merely a variety of that species; should it prove distinct, however, it may be designated as *G. impressa*, in allusion to its non-compressed volutions.

It is possible that these shells may be found, owing to the prominence of their outer lip below, and its sinuous character above (not well represented in any of our figures on plate 42), to fall into the group *Trypanostoma* (= *Pleurocera*), and thus have to be called *Pleurocera* or *Trypanostoma convexa*. The name *Pleurocera*, Raf., has priority over *Trypanostoma*, Lea; but it would seem to me that the two sections might be both retained in a subgeneric sense with convenience, though Mr. Tryon, who has given much attention to the study of these and allied groups, thinks them undistinguishable, owing to the gradual blending of the two types through intermediate species.

Locality and position.—Same as last, at the mouth of Judith River, Montana.

Goniobasis invenusta, M. & H.

Plate 42, figs. 1, *a*, *b*, *c*, *d*, *e*.

Melania invenusta, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 137.

Shell thin, conical-subovate, spire moderately elevated, not eroded; volutions about seven to seven and a half, very slightly convex, increasing rather gradually from the apex; suture nearly linear, and not very strongly impressed; surface generally almost smooth on the upper whorls, but having fine obscure lines of growth, which become more distinct on the lower volutions, where they are somewhat sigmoid, and crossed by nearly obsolete revolving striæ, usually most distinct on the upper part of the last whorl; aperture subovate, more or less oblique, narrowly rounded, but not distinctly angular below.

Length, about 0.90 inch; breadth, nearly 0.40 inch; apical angle regular, divergence variable, but most generally about 27°.

It is rather difficult to determine from our imperfect specimens whether or not this species presents the characters of the genus *Goniobasis*. Unfortunately none of them are in a condition to convey a very clear idea of the nature of the aperture; but, as nearly as can be determined from the lines of growth, the outline of the lip is not quite so strongly sinuous as in *Trypanostoma*. The base of its aperture, however, is not so angular as in the more typical species of that genus, though it differs from that of true *Melania*.

Specifically, this shell is similar in some respects to immature specimens of our *Goniobasis convexa*. It differs, however, from the adult form of that species in having one or two whorls less, while its surface is smoother and

the entire shell shorter in proportion to the breadth of the body-whorl. It is also a rather decidedly thinner shell.

Locality and position.—Same formation as last, at the mouth of Judith River, Montana.

Goniobasis Nebrascensis, M. & H.

Plate 43, figs. 12, *a–h.*

Melania Nebrascensis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 124.

Fig. 73.

Goniobasis Nebrascensis.

Showing more accurately the form of the aperture, as well as the general outline, than figure 12, *b*, of plate 43.

Shell conical-subovate; spire moderately prominent, acute, and not eroded at the apex; volutions about six, compressed-convex, last one comparatively large and prominent, but not angular around the middle; suture well defined; surface marked by fine, more or less distinct, lines of growth, crossed by numerous small revolving lines, which vary in their size and prominence on different specimens, but are generally largest near the middle of the whorls of the spire, where one of them is sometimes larger than the others; aperture ovate, angular above, moderately produced and rather narrowly rounded, or obtusely subangular and faintly sinuous below, a little straighter on the inner than the outer side; outer lip slightly sinuous above the middle; inner lip reflexed, and moderately arched, sometimes scarcely covering a minute umbilical slit.

Length, about 1 inch; breadth, 0.52 inch; length of aperture, 0.36 inch; breadth of same, 0.23 inch; apical angle convex, or nearly regular, divergence varying with age from 50° to 37°.

Mature specimens of this species have the spire proportionally more elevated, the whorls less convex, and the aperture comparatively smaller than young individuals. It also varies much in the surface-markings, even on specimens of the same size. Sometimes the revolving lines are quite distinct on all parts of the surface, and a few of them near the middle of the whorls become more prominent than the others, while in other instances all these lines are very faintly marked or even entirely obsolete. In some old specimens, the inner lip is a little thickened and slightly prominent, so as to leave a small umbilical crevice, though not a distinct perforation, while in most cases this lip is closely reflexed upon the columella.

This shell will be readily distinguished from the last by its proportion-

ally larger and more ventricose body-whorl, less acutely conical spire, and less flattened whorls, more impressed suture, &c. I am not quite sure that it is a true *Goniobasis*, as it has its aperture rather less angular at its base than is common in that genus. Our figure 12, *b*, however, represents a specimen with its aperture rather unusually large, and more than naturally rounded below. The foregoing wood-cut gives more nearly the genera appearance of the aperture and other characters of this shell.*

Locality and position.—Fort Clarke, and at mouth of Yellowstone River; from the Fort Union Lignite group.

Goniobasis tenuicarinata, M. & H.

Plate 43, figs. 14, *a*, *b*, *c*.

Melania tenuicarinata, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 137.
Goniobasis? tenuicarinata, Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Invertebrate Fossils of N. Am., 12.

Shell narrow-subovate; spire conical, of medium height, pointed and not eroded at the apex; volutions six, very convex, obliquely flattened above and angular around the middle; suture well defined; surface ornamented by fine obscure lines of growth, which are crossed on the middle of the whorls by from three to four or five prominent revolving lines, or narrow carinæ, and on all parts of the shell excepting near the apex of the spire, by traces of very fine, indistinct, revolving striæ; aperture ovate, angular above, narrowly rounded, and very faintly sinuous below; lip sharp, slightly prominent below the middle; columella gently arcuate.

Length, 0.53 inch; breadth, 0.30 inch; length of aperture, 0.23 inch; breadth of same, 0.18 inch; apical angle variable with age, mean divergence about 45°.

The upper of the revolving keels is a little larger than the others, and generally so prominent as to give the whorls a shouldered appearance. Near the apex of the spire, these carinæ become obsolete, and on the lower whorl all those below the upper two diminish in size from above downward, so that the fourth and fifth ones are scarcely larger than the other revolving lines seen on the lower part of this volution. Like the foregoing species, this shell varied much in form at different ages, young specimens having the

* In some respects this species resembles *Pachychilus*, Lea; and possibly I would be nearer right to call it *Pachychilus Nebrascensis*. None of the specimens, however, seem to have the outer lip thickened as in that genus, though in some of the larger ones the inner lip is thick.

spire much less elevated and the body-whorl proportionally larger than adult individuals.

Some varieties of the last-described species, on which a few of the revolving lines near the middle of the whorls are larger than the others, bear so much resemblance to this shell as to leave some doubts whether this may not also prove to be only an extreme variety of that species. I have, however, been able to separate all the specimens yet seen of these forms without much difficulty.

Locality and position.—Near Fort Union, Montana, on the Missouri; from the Fort Union Lignite group.

Goniobasis sublævis, M. & H.

Plate 42, figs. 5, *a*, *b*.

Melania sublævis, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 136.
Goniobasis sublævis, Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Invertebrate Fossils, 12.

Shell elongate-conical; volutions about seven or eight, slightly convex; suture rather shallow; surface apparently smooth, but, when examined under a lens, seen to be marked by very fine, nearly obsolete lines of growth, which are sometimes crossed on the lower whorls by obscure traces of fine revolving striæ; aperture oval, very narrowly rounded below; columella faintly sinuous.

Length, about 1.04 inches; breadth, 0.38 inch; apical angle regular, or slightly concave, divergence from 22° to 24°.

The polished surface and more attenuate spire of this species, together with the entire absence of revolving lines visible without the aid of a lens on any part of its surface, are characters that will distinguish it from all the other forms resembling it in other respects yet known from these rocks. It differs from all the otherwise similar recent species with which I am acquainted, in not having the upper whorls costate or carinate, and in its almost polished surface. The specimen represented by figure 5, *a*, has the outer lip broken so as to give an unnatural angularity to the base of the aperture. That represented by figure 5, *b*, shows more nearly the natural form of the aperture. It may not belong properly to the genus *Goniobasis*.

Locality and position.—Mouth of Judith River, Montana; from the Fresh- and Brackish-water Lignite beds of that locality.

Goniobasis? omitta, M. & H.

Plate 42, figs. 4, *a*, *b*, *c*.

Melania omitta, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 136.

Shell very small, slender, and elongated; spire attenuate, acute at the apex; volutions about seven and a half to eight, flattened or very slightly convex, increasing gradually in size from the apex; last one prominent, but not distinctly angular around the middle; suture linear, moderately distinct; surface apparently nearly smooth; aperture rhombic-subovate, rather narrow, somewhat produced and subangular below.

Length, about 0.34 inch; breadth, 0.11 inch; apical angle regular, divergence about 24°.

This is a delicate slender little shell, resembling somewhat the last-described species, but it is much smaller, although having the same number of whorls. It is also proportionally more slender, and has its whorls more flattened. It is the smallest and most slender species referred to this group from the Upper Missouri rocks. None of the specimens have the surface of the shell preserved.

Among foreign fossil species, this shell may be compared with *Melania nitida*, Lamarck, and *M. distorta*, Defrance, from the Paris basin. It agrees most nearly with the latter in size, but seems never to be bent like that species, which also has about two more whorls and a more angular aperture. It is smaller than the *M. nitida*, and has scarcely more than two-thirds as many whorls, while its aperture is not so rounded below. I am far from being satisfied that it belongs to the genus *Goniobasis*, or even that it is a fresh-water shell, as it is directly associated with *Corbula perundata*, and apparently a cast of a small *Lucina*. It also has much the form of a *Eulima*, and may yet have to be called *Eulima omitta*.

Locality and position.—Same as last; or possibly in a somewhat lower bed at that place. It occurs in a pebbly sandstone, the pebbles being very small, black, and silicious.

Goniobasis gracilenta, Meek.

Plate 42, fig. 3.

Shell small, slender, elongate-conoidal; volutions about seven, increasing gradually in size, convex but not rounded, last one a little produced

below, but not proportionally much enlarged, and without a well-defined mesial angle; suture rather deeply impressed; surface very nearly smooth, or only showing under a magnifier very faint lines of growth, which are moderately sigmoid on the body-volution; aperture narrow-subovate, being somewhat obtusely angular above, and narrowly rounded and apparently a little effuse or sinuous below.

Length, about 0.65 inch; breadth, 0.24 inch; slopes of spire nearly straight, with a divergence of about 25°.

Fig. 74.

Goniobasis? gracilenta.
Magnified to about one and a half diameters, to show the form of the aperture, &c., more correctly than the figure on plate 42.

This little shell resembles somewhat the last, but differs materially in having more convex whorls, a deeper suture, and a differently-formed aperture and body-volution. Our figure on plate 42 gives an incorrect outline of its aperture, and, consequently, the annexed cut is added with the view of conveying a more accurate idea of this part and some of its other characters. Like most of the other species here referred to *Goniobasis*, this is only provisionally placed in that group, as no entire well-preserved specimens of it have yet been seen; while traces of its obscure lines of growth show by their curves, as indicated on the body-volution in the cut, that its outer lip possessed rather more the prominence below, seen in *Pleurocera*.

Locality and position.—Same as last.

Goniobasis? subtortuosa, M. & H.

Plate 42, figs. 17, *a*, *b*.

Melania subtortuosa, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 136.
Goniobasis? subtortuosa, Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Invertebrate Fossils, 12.

Fig. 75. Fig. 76.

Goniobasis? subtortuosa.
Fig. 76. Showing aperture.
Fig. 77. An opposite view.

Shell conoid-screw-shaped, thin; spire rather low; volutions about five, very convex, and strongly carinate around the middle, increasing rather rapidly in size from the apex; suture deep in consequence of the prominence of the angular whorls; surface with moderately distinct lines of growth; aperture rhombic-suboval, about as long as wide.

Length, 0.39 inch; breadth, 0.21 inch; slopes of spire nearly straight,

with a divergence of 47°. Some crushed specimens show that it attained nearly twice the linear dimensions of that from which the above measurements were taken.

The strongly angular character of the whorls in this species is so conspicuous a character as at once to distinguish it from all the other known forms of the Upper Missouri country. The angle seems to be well defined on all the whorls, particularly on the last or body-volution. Above the angle, all the whorls are flattened with an outward slope, and below it the under side of each slopes inward to the suture at an angle of about 90° from the superior flattened side. The under side of the last turn slopes inward from the angle, with a moderately convex outline.

It is only provisionally that I refer this shell to the genus *Goniobasis*, none of the specimens yet seen being in condition to show much more than the mere form of its volutions. In its rather short conical form, and the strongly angular character of its volutions, it does not agree well with the known species of that genus, particularly in having the strong angularity continued upon the body-whorl. Still, *G. tortulosa*, Anthony (sp.), regarded by Mr. Tryon as only a variety of *G. acutocarinata*, Lea, does not differ very materially in this respect.

Mr. Tryon, to whom I sent plate 43, containing the figures of this species, wrote that he thought it possibly a scalariform monstrosity of a *Planorbis*. The fact, however, that we have several imperfect specimens, all agreeing in their characters, seems rather opposed to this view. A single fragment exposing the under side of the body-volution of one specimen shows the lines of growth to be strongly arcuate below the mesial angle, in such a manner as to indicate a prominence of the outer lip below the middle, somewhat as in *Trypanostoma*, Lea, or *Lioplax*, Troschel. Indeed, I am not sure that it might not be more properly called *Lioplax subtortuosa*. Its true position, however, can only be satisfactorily determined when more nearly complete specimens can be examined.

The foregoing wood-cuts give a more correct idea of the shell than the figures on our plate. The specimen, however, has the lip broken so that we cannot be quite sure that the aperture is represented exactly correct.

Locality and position.—Mouth of Judith River, Judith River group; probably belonging to the closing period of the Cretaceous.

RISSOIDÆ.

Genus HYDROBIA, Hartmann.

Synon.—*Hydrobia*, Hartmann (1821), in Sturm's Fauna Deutschl., Abth. VI, Heft V, 46; and in Steinm. Neue Alpen, I, 258; also (1840) Syst. Uebers., 258 (as a subgenus under *Paludina*).—Gray (1840), Turton's Man. (2d ed.), 87 and 88.—H. and A. Adams (1855), Genera Recent Moll., I, 335.—Chenu (1859), Man. Conch., I, 308.—Stimpson (1865), Researches upon the *Hydrobiinæ*, in Smithsonian Miscellaneous Contributions, 43.

Paludinella, Lovén (1846), Öfv. af K. Vet.-Akad. Förh., III, 157 (not Pfeiffer).

Littorinida, Souleyet (1852), Voy. Bonite, Zoöl., II, 536.

Etym.—ὕδωρ, water; βιόω, to live.

Type.—*Turbo ulvæ*, Penn. (= *Hyd. ulvæ*, H. and A. Adams).

Shell small, subovate or more or less elongated, with axis generally perforated or subperforated; spire conical; volutions flattened or convex; apex acute; aperture ovate; inner lip thin; outer lip acute, simple; surface smooth; operculum corneous and subspiral.

This genus includes a group of very small brackish-water species that are generally difficult to distinguish from several other allied genera by the shell alone. From *Bythinella* and *Paludistrina*, they differ in their brackish-water habits. *Littorinella*, however, is also a brackish-water type, with a shell very similar to that of *Hydrobia*, but usually has more convex or ventricose whorls. There are also differences in the dentition and some of the anatomical details of the animal, but such characters are of no use to the Palæontologist.

The geological range of this genus is not well determined. Species have been referred to it from the Wealden and some older rocks; and others apparently belonging to it occur in the Tertiary strata of various ages. It probably attains its greatest development at the present time.

Hydrobia Anthonyi, M. & H.

Plate 43, figs. 10, *a*, *b*, *c*, *d*.

Melania Anthonyi, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 124; and (1860) *ib.*, XII, 430.

Hydrobia Anthonyi, Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Invertebrate Fossils, 12.

Shell small, conic-ovate; spire rather short, pointed at the apex; volutions five and a half to six, a little convex, and increasing rather gradually in size, last one not much enlarged, subangular near the middle; suture rather well defined, but not deep; surface nearly smooth, or usually only marked by very small obscure lines of growth; aperture ovate, approaching rhombic-

ovate, obtusely angular above, and very narrowly rounded or subangular at the base; outer lip straight in outline; inner lip free from the columella below, so as to leave a small, deep, umbilical perforation, very slightly produced and sinuous at its connection with the outer lip at the base of the aperture

Length, 0.18 inch; breadth, 0.10 inch; length of aperture, 0.06 inch; breadth of same, 0.04 inch; apical angle slightly convex, divergence 40°.

On some of the specimens, by the aid of a good lens, in a favorable light, faint traces of exceedingly minute revolving striæ are seen. This character, however, is so faintly marked that it might be readily overlooked, and, indeed, can rarely be seen even on well-preserved specimens.

Locality and position.—Yellowstone River, thirty miles above its mouth; from the Fort Union group of the Brackish- and Fresh-water Lignite series; probably Eocene.

Hydrobia Warrenana, M. & H.

Plate 43, figs. 11, *a*, *b*, *c*.

Melania Warrenana, Meek and Hayden (1857), Proceed. Acad. Nat. Sci. Philad., IX, 137.
Melania? Warrenana, Meek and Hayden (1860), *ib.*, XII, 130.

Shell small, conical; axis not perforated; spire moderately elevated, pointed at the apex; volutions about seven, nearly flat or but slightly convex, closely coiled and increasing gradually in size; body-whorl not large, rather prominent or subangular around the middle; suture moderately well defined, though not deep; surface apparently smooth, but showing under a good magnifier very obscure lines of growth, and exceedingly faint traces of minute revolving striæ; aperture subovate, a little oblique, narrowly rounded or obscurely subangular, and faintly sinuous below; lip nearly straight above, and scarcely prominent in outline below the middle.

Length, 0.29 inch; breadth, 0.14 inch; apical angle slightly convex, divergence 32°.

This little shell may not be a true *Hydrobia*, but I have concluded to place it provisionally in this genus until other specimens can be examined. It is a neat symmetrical shell, resembling the last more nearly than any other form with which I am acquainted from these rocks. It is considerably larger, however, and has about one and a half to two more whorls, with a proportionally longer spire, and differs in not having its axis perforated. Among foreign Tertiary species, it seems to be most nearly represented by a

shell described by Lamarck, from the Paris-basin Eocene, under the name of *Bulimus terebellatus*, which agrees with it almost exactly in form, but differs in being considerably larger, in having two or three more whorls, and in being perforated or slightly umbilicated. The resemblance between these shells is, however, not due to any near affinities between them, as they probably belong to widely distinct genera.

Locality and position.—Thirty miles below Fort Clarke, Dakota; from the summit of Square Butte. Fort Union Fresh- and Brackish-water Lignite group; probably Eocene.

Hydrobia subconica, Meek.

Fig. 77.

Hydrobia subconica.

Shell of medium size, conoid-subovate; volutions about five, slightly convex, or almost flattened to the slope of the spire, last one rather large, and prominent or subangular around the middle, and somewhat produced below; suture not strongly impressed; aperture less than the length of the spire, rhombic-oval, angular above, and subangular and a little effuse below; umbilical region excavated and provided with a small perforation; surface smooth.

Length, 0.25 inch; breadth, 0.16 inch; length of aperture, 0.12 inch, breadth of same, 0.08 inch; slopes of spire nearly straight, with a divergence from the apex of about 40°.

This little shell is rather more nearly related to the last than to any of our other Upper Missouri forms, but will be at once distinguished by its shorter spire, broader body-whorl, smaller number of volutions, proportionally larger aperture, perforated axis, &c. Its reference to the genus *Hydrobia* is only provisional.

Locality and position.—Mouth of Judith River, Montana; from the Judith River group; probably Eocene.

Hydrobia? culimoides, Meek.

Fig. 78.

Hydrobia? culimoides.

Shell small, subterete; spire elongate-conical, acute at the apex; volutions seven to eight in mature examples, very slightly convex or flattened nearly on a line with the slopes of the spire; last one moderate and prominently rounded, or obscurely subangular around the middle; suture linear, but rather deep; aperture ovate, angular above, narrowly rounded below, and equaling rather more than one-third the entire

length; inner lip reflexed and appressed in the non-perforate umbilical region; outer lip broadly retreating above, and prominent below; surface nearly smooth, but showing under a good lens very fine, slightly sigmoid lines of growth, crossed by microscopic revolving striæ.

Length of a medium-sized adult, 0.38 inch; breadth, 0.17 inch; length of aperture, 0.14 inch; breadth of same, 0.08 inch; slopes of spire nearly straight, with a divergence of about 30°.

The flattened, rather numerous volutions, nearly smooth surface, pointed apex, and general physiognomy of this little shell give it more the appearance of a *Eulima* than of a *Goniobasis*. It certainly occurs, however, with decidedly fresh-water types, such as *Viviparus* and *Goniobasis*, without, so far as known, any admixture of marine forms. I have concluded to refer it doubtfully to *Hydrobia;* though it probably does not belong to that genus. Mr. Tryon, on examining a specimen sent to him, thought that it might belong to the genus *Assiminia*. Possibly I should call it *A. eulimoides*. It was evidently gregarious, as a single piece of the rock in which it occurs, not more than three inches long by one and three-quarters wide, and less than an inch in thickness, seems to contain not less than one hundred specimens.

Locality and position.—Clear Fork of Powder River, Montana; from the Fort Union Fresh- and Brackish-water Lignite group (probably Eocene).

Genus MICROPYRGUS, Meek.

Synon.—*Melania* (sp.), Meek and Hayden (1856); not Lamarck and others.
Micropyrgus, Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Invertebrate Fossils, 12 and 35.

Etym.—μικρός, small; πύργος, a tower.
Type.—*Melania minutula*, Meek and Hayden.

Shell very small, subcylindrical, imperforate, obtuse at the apex; body-volution small, or less than half the entire length; aperture rhombic-oval, very narrowly rounded, and more or less effuse; peristome apparently not continuous; outer lip thin, simple, most prominent below the middle.

This genus is probably nearly related to *Hydrobia*, but differs from that group, as defined and restricted by Dr. Stimpson, in its more slender form, obtuse apex, convex volutions, and entirely imperforate axis.

I am not sure that any other species with which I am acquainted belongs

to this group, though I have seen in the Smithsonian collection from the Isle of Wigit a Tertiary species apparently nearly related to it.

In regard to the geological range of this type, we at present only know certainly, that it occurs in the Fort Union group of the Upper Missouri Lignite series.

Micropyrgus minutulus, M. & H.

Plate 43, figs. 18, *a*, *b*.

Melania minutula, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 123.
Micropyrgus minutulus, Meek (1866), in Conrad's Smithsonian Check-List N. Am. Invertebrate Eocene Fossils, 12.

Shell very small, subcylindrical; spire about twice the length of the aperture, with its obtuse apex smooth; volutions seven and a half to eight, convex, and increasing gradually in size from the apex, each compressed or a little flattened above, with an oblique outward slope for about two-thirds of its breadth down from the suture, thence rounding inward rather abruptly to the suture below, so as to form a subangular revolving prominence, which is continued around the middle of the body-whorl; surface smooth, or only showing very obscure traces of minute lines of growth; aperture rhombic-ovate, angular above, and subangular and a little produced at the slightly effuse base.

Length, 0.18 inch; breadth, 0.07 inch; apical angle regular, divergence 20°.

This little shell differs materially from either of the foregoing, not only in its smaller or minute size, but also in its elongate slender form, and the peculiar manner in which its flattened whorls project just above the suture. In this latter character, as well as in its slender elongated form, it resembles an Eocene Tertiary shell described by Deshayes under the name *Auricula spina* (Coq. Foss., II, pl. 8, figs. 10–11); but it is considerably smaller, with not near so many whorls, while it shows no traces of a tooth on the columella. Its resemblance to Deshayes's species is probably a mere similarity of form only, since the two shells seem to be generically, if not more widely, distinct.

Locality and position.—Three miles below Fort Union, Dakota; in the Fort Union Fresh- and Brackish-water Lignite group; probably Eocene.

VIVIPARIDÆ.

Genus VIVIPARUS, Montfort.

Syn.on.—*Vivipare*, Lamarck (1809), Phil. Zoöl.; and (1812) Extr. d'un Cours (both times without example, diagnosis, or figure).

Viviparus, Montfort (1810), Syst., II, 247.—Gray (1847), Proceed. Zoöl. Soc., part XV, 155; and (1857) Guide to Syst. Distrib. Moll. Brit. Mus., I, 112.—Beck (1847), Amtl. Ber., 24, Vers. Deutsch. Nat., 123.—Gill (1863), Proceed. Acad. Nat. Sci. Philad., 37.—Meek (1865), Palæont. Upper Missouri, 114.

Henterum, Hübn. (1810), Epist., 1.

Paludina, Lamarck (1812), Extr. d'un Cours; and Hist. (1822), 172.—Deshayes (1830), Encyc. Méth., III, tab.; and (1832) *ib.*, 689.—Goldf. (1820), Naturg., 736.—Hartm. (1821), Sturms Fauna, Abth. VI, Heft 5, 47.—Blainv. (1824), Dict. Sci. Nat., XXXII, 230; and (1825) *ib.*, XXXVII, 300; also (1825), Malac., 435.—Gray (1840), Turton's Man. (2d ed.), 90; and (1842), Synon. Moll. Brit. Mus., 90; also of numerous others.

Viripara, Sowerby (1813), Min. Conch., I, 71.—Desor and Agassiz (1840), German transl. same, 54.—H. and A. Adams (1854), Genera Recent Moll., I, 38.—Binney (1865), Land- and Fresh-water Shells N. Am., part III, 16.

Etym.—*Viviparus*, that brings forth its young alive.
Type.—*Helix viripara*, Linnæus.

Shell ovate or conoid-subovate, thin, usually with a small umbilical perforation; volutions rounded or more or less flattened; surface smooth, or with revolving lines or carinæ; epidermis olivaceous, often with revolving bands of color; aperture more or less regularly oval; outer lip thin, straight in outline, and continuous on a plane with the inner.

Operculum corneous, entirely annular.

Animal with lateral teeth of lingual ribbon oblong, arched, somewhat pointed below, truncated and serrated above; median tooth shorter, curved, more or less rounded and serrated above, the middle denticle being larger than the others.

These mollusks inhabit rivers, lakes, and other bodies of fresh water, and are widely distributed in the Northern Hemisphere. The genus is related to *Tulotoma*, *Lioplax*, and *Campeloma*. It may be distinguished, however, from the latter two groups by its thinner shell, and by having its outer lip straight in outline, and continuous on a plane with the inner, instead of being sigmoid.* More important differences, however, although not available in palæontology, are to be observed in the lingual teeth, which in *Campeloma* and *Lioplax* have their upper margins smooth, or only very minutely serrated, and the outer two on each side pointed and claw-shaped, instead of truncated. *Lioplax* is also distinguished by having a subspiral opercular

* Attention was first called to this well-marked character of the outline of the lip in this genus by Professor Gill.

nucleus. From *Tulotoma*, these shells are distinguished by being thinner and not nodular; while the animal of the latter genus is said to have more the habits of *Anculosa*, being found adhering to stones in running water, instead of crawling on muddy bottoms of sluggish streams.

One or two species of this genus exist in such great numbers in Florida that their bleached shells are used in Jacksonville and some other towns to form walks in gardens and ornamental grounds. A few other species also occur there less abundantly, while the genus is well known to range far northward to and beyond the great lakes.

This genus is believed to date back as far as the Jurassic epoch. It also occurs in the Wealden deposits, and was well represented during the deposition of the Tertiary rocks, at which time it was apparently more abundant in species than at present. We already know a dozen or so extinct species from the Upper Missouri and Rocky Mountain regions.

Viviparus Leai, M. & H.

Plate 44, figs. 6, *a*, *b*, *c*, *d*.

Paludina Leai, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 121.
Viripara Leai (1860), *ib.*, XII, 185.
Viviparus Leai, Meek and Hayden (1863), in Gill's Arrang. Fam. *Viviparidæ*, 6.

Shell conical-subovate; spire moderately elevated, and pointed at the apex; volutions six to six and a half, convex, those of the spire regularly rounded; last one composing generally slightly more than half the entire length of the shell, sometimes prominent, or approaching subangular below the middle; suture well defined; surface marked by fine lines of growth, which are crossed by traces of extremely fine, nearly obsolete, revolving striæ (only visible under a good lens), and at regular intervals by revolving rows of minute shallow punctures; aperture broad-ovate, rather obtusely subangular above, and rounded below; inner lip a little reflexed, but not quite covering the very small, nearly obsolete, umbilical perforation.

Length, 1.04 inches; breadth, 0.78 inch; length of aperture, 0.57 inch; breadth of same, 0.42 inch; apical angle convex, varying from 65° to 80°.

This shell varies considerably in the comparative elevation of its spire at different ages, young individuals being proportionally much more depressed than large specimens. These differences are also more or less distinctly marked sometimes in shells of the same size, and might be regarded of specific importance, were it not for the fact that we find all intermediate gra-

dations connecting these different forms. In some specimens, the upper part of the upper whorls is slightly compressed, while in others they are all regularly rounded. Sometimes all the volutions are faintly compressed on their upper outer slopes, so as to give the shell a very slightly subtrochiform aspect. Generally, the minute revolving striæ and small punctures are entirely obsolete, and they are never visible without the aid of a magnifier.

This species is somewhat similar to *V. semicarinatus*, Brard, as figured by Deshayes (Coq. Foss., II, pl. 5), from the Paris basin; but its aperture is more ovate in form, and its umbilical perforation smaller. It seems to bear about the same relations to the following species that *V. semicarinatus* does to *V. Desnoyesii* of Deshayes.

Among recent American species, it may be compared (in form) with the *V. subpurpura*, Say, from which, however, it will be readily distinguished by its more depressed spire, and more ventricose and more rounded whorls. It is also a thicker shell, and approaches more nearly some East Indian forms.

Locality and position.—Three miles below Fort Clarke, Dakota; in the Fort Union Lignite group (probably Eocene).

Viviparus retusus, M. & H.

Plate 44, figs. 5, *a*, *b*, *c*, *d*, *e*, *f*.

Paludina retusa, Meek and Hayden (1856), Procced. Acad. Nat. Sci. Philad., VIII, 122.
Viripara retusa, Meek and Hayden (1860), *ib.*, XII, 185.
Viriparus retusus, Meek and Hayden (1863), in Gill's Syst. Arrang. Fam. *Viviparidæ*, 6.

Shell of medium size, obliquely subovate in outline; spire rather depressed-conical, obtuse at the summit; volutions five to five and a half, more or less convex; last one generally more than equaling the height of the spire, obliquely flattened or sometimes a little concave near the suture, prominently rounded or obscurely subangular a little below the middle; suture well defined; surface marked by distinct oblique lines of growth, with sometimes on the upper whorls very faint traces of extremely minute revolving striæ; aperture broad-ovate, somewhat angular above, and rounded below; inner lip a little thickened, and closely flattened upon the deeply arcuate, imperforate columella; outer lip very oblique in outline.

Length, 1.13 inches; breadth, 0.90 inch; apical angle convex, divergence varying with age from 90° to 70°.

This species resembles the last somewhat, but will be at once distinguished by always having its upper whorls more depressed, so as to make the

apex of its spire much more obtuse.* It also has generally about one whorl less, and its body-volution is usually more compressed above just below the suture, and less regularly rounded, or more nearly subangular below the middle, while its columella differs in being imperforated, and its lines of growth are stronger and more oblique.

It is also somewhat analogous to *P. Desnoyesii*, Deshayes (Coq. Foss., II, pl. 15, figs. 7–8), but its spire is more depressed, and its aperture more angular above, where its inner lip does not present the peculiar thickening characteristic of that species. It also differs in the imperforate and more deeply arcuate character of its columella, as well as in the obscurely subangulated character of its body-whorl. I am not acquainted with any nearly allied recent species.

Locality and position.—Same as last.

Viviparus Conradi, M. & H.

Plate 42, figs. 15, *a*, *b*, *c*, *d*.

Paludina Conradi, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 122.
Vivipara Conradi, Meek and Hayden (1860), XII, 185.
Viviparus Conradi, Meek and Hayden (1863), in Professor Gill's paper on the Family *Viviparidæ*, 6.

Shell conoid-subtrochiform; spire distinctly conical, of medium height, pointed at the apex; volutions six, flattened on a line with the slope of the spire, last one more or less distinctly angular a little below the middle; suture linear; surface marked by fine obscure lines of growth; aperture varying from subquadrate to subcircular; columella deeply arcuate, not perforated.

Length, 1 inch; breadth, 0.66 inch; length of aperture, 0.45 inch; breadth of same, 0.33 inch.

In young specimens, the angle on the lower outer part of the body-whorl is very strongly defined, and imparts a subquadrate form to the aperture; but as the shell advanced in size, the angle became less distinct, and the aperture more rounded. Some of the specimens show apparently very obscure traces of fine revolving striæ; but I am not sure that these are really surface-markings.

This species is quite distinct from all those yet known in these formations, though more nearly related to our *V. trochiformis* than to any of the others. It will be readily distinguished from that shell, however, by its more

* This character is not very well expressed in our figures on plate 44.

flattened whorls, and the absence of distinct revolving ridges on the middle of its volutions. It also never has the distinct revolving lines generally seen on that shell. Like several of our other Upper Missouri fresh-water shells, it has some living analogues among Asiatic species, of which *P. Francisci* (= *Turbo Francisci*, Wood) is an example.

From the fresh- and brackish-water beds at Bear River City on the Union Pacific Railroad, in Wyoming, I have seen a single imperfect specimen of the middle and upper volutions of a *Viviparus* that I am much inclined to believe belongs to this species. So far as can be seen, it presents no reliable differences; but possibly perfect specimens might show it to be distinct.

Locality and position.—Mouth of Judith River, Montana; from the Judith River brackish-water beds; probably belonging to the closing period of the Cretaceous.

Viviparus peculiaris, M. & H.

Paludina peculiaris, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 122.

Fig. 79.

Viviparus peculiaris.

Of this form I have only seen very imperfect specimens; but so far as can be determined from those yet found, about the only differences that can be seen between it and the last consist in the rather decidedly less flattened form of its upper volutions, which also indicate a rather greater proportional breadth for the upper part of the shell. I am much inclined to think it only a variety of that species; but as it comes apparently from a different horizon, I have concluded to keep it separate until we can have better materials for comparison.

The foregoing cut represents the best specimen seen, with the upper volutions restored in dotted lines. None of the specimens show the aperture very satisfactorily.

Locality and position.—Fort Clarke, Dakota; from the Fort Union Lignite group (probably Eocene).

Viviparus trochiformis, M. & H.

Plate 44, fig. 2, *a*, *b*, *c*, *d*, *e*.

Paludina trochiformis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 122.
Vivipara trochiformis, Meek and Hayden (1860), *ib.*, XII, 185.
Viviparus trochiformis, Meek and Hayden (1863), in Professor Gill's paper on the *Viviparidæ*, 6.

Shell conoid-subtrochiform, rather thin; spire moderately elevated, pointed at the apex; volutions six, obliquely compressed, though not quite

flattened, each having around the middle two small revolving ridges; last one, especially in young and medium-sized specimens, distinctly angular below the two revolving ridges; suture distinct, but generally not very deeply impressed; surface marked by rather fine lines of growth, which are crossed by exceedingly delicate, obscure, revolving hair-lines; aperture broad rhombic-ovate, or subcircular, very slightly oblique; inner lip rather thin, a little reflected upon the deeply arcuate columella, so as nearly, or sometimes quite to close the very small, oblique, umbilical pit.

Length, 1.20 inches; breadth, 0.90 inch; length of aperture, 0.52 inch; breadth of same, 0.46 inch; apical angle convex, divergence about 67°.

The two revolving ridges mentioned on the middle of the whorls, although moderately distinct, are not sharply elevated, and generally become nearly or quite obsolete near the summit of the spire and on the body-whorl of large specimens. They are usually about equidistant from each other, and from the suture above and below; sometimes a third smaller ridge is developed near one of the others. The fine revolving hair-lines are scarcely visible without the aid of a lens, and often become obsolete on the lower whorls. The angle around the middle of the body-whorl is always well defined; but it is never exposed on the volutions of the spire, because the upper edge of each turn abuts directly against it on the succeeding one above.

Like some others of our Lignite fossils, this species far more nearly resembles certain Oriental forms than any of our existing North American species. Probably its nearest existing representative is *V. Bengalensis* of Lamarck, some of the angular varieties of which it closely simulates. It differs, however, in having its whorls more flattened, its spire more depressed, and its body-volution proportionally broader and more constantly angular around the middle. I have before me, from the surface-loam near Hevey-leyhein, China, some specimens sent to the Smithsonian Institution by Professor Pumpelly, marked *Paludina lineata*, Valenciennes (a variety, I believe, of *V. Bengalensis*), some of the younger of which strikingly resemble the form under consideration. They are all, however, more particularly the adult examples, more slender, with a more produced spire, and more convex as well as more rounded volutions.

It will be at once distinguished from all of the other known Upper Missouri species by its very obvious differences of form and other characters.

In Dr. Hayden's Annual Report of the United States Geological Survey of the Territories for 1872 (published in 1873), I mentioned on page 476, that I had found at Black Butte station on the Union Pacific Railroad, in Wyoming Territory, associated with the bones of a large Dinosaurian, specimens consisting of the upper turns of the spire, as I believed, of examples of this species. The specimens are mere distorted casts, but certainly closely resemble the corresponding part of this shell. Since that time, Professor Powell and Dr. White have found much better specimens of the Black Butte shell at that locality, which show that it develops nodes on the lower or body-volution (which part I had not seen), and is therefore quite decidedly different specifically, if not even a member of the distinct group *Fulotoma*.

A single distorted specimen, found by Professor Lesquereux at the Carbon coal-mines on the Union Pacific Railroad in Wyoming, is evidently more nearly allied to this; but it is not well enough preserved to show its surface-markings. It has the same trochiform outline, but appears to have its spire a little more pointed, and the angle of its body-volution less defined. If distinct, it may be called *Viviparus carbonarius*.

Locality and position.—Fort Union group, ten miles below Fort Union, Montana. There are also casts of it among collections marked one hundred and fifty miles below Fort Union (probably Eocene).

Viviparus Leidyi, M. & H.

Plate 44, fig. 4.

Paludina Leidyi, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 123.
Viripara Leidyi, Meek and Hayden (1860), *ib.*, XII, 185.
Viviparus Leidyi, Meek and Hayden (1863), in Professor Gill's Syst. Arrang. of the *Viviparidæ*, 6 (Proceed. Acad.).

Shell attaining a large size, thin, subovate; spire rather prominent, conical, about equaling the length of the aperture; volutions six to six and a half, flattened near the summit of the spire, and becoming convex below; last one angular around the middle in young shells, but rounded and produced below in the adult; suture well defined between the lower whorls, and merely linear above; aperture ovate, rather angular above, somewhat produced and rounded below; inner lip thin, and more or less reflexed; umbilical perforation small, somewhat spiral; surface marked with small obscure lines of growth, which are crossed on the upper flattened whorls by two nearly obsolete, equidistant, revolving ridges and minute revolving striæ.

Length of an adult, about 1.86 inches; breadth, 1.30 inches; apical angle convex, divergence 70°.

Young shells of this fine species must be almost exactly like the last in form, size, and surface-markings; but at maturity it attains double the size of that shell, and differs in having its last turn rounded instead of angular. It also differs in having its aperture more oval in outline and more produced below. At one time I was inclined to think it might be the adult form of the last, and the specimens upon which that species was found only young shells. Collections subsequently obtained, however, show that the average size of the *V. trochiformis* at maturity (among hundreds of specimens) is only about half that of the species under consideration, as may be seen by reference to figure 3, *c*, of plate 44, which represents a fully-developed adult example of that shell.

Locality and position.—Ten miles below Fort Union, Dakota, and near the mouth of Powder River, on the Yellowstone, in Montana; from the Fort Union group (probably Eocene).

Viviparus Leidyi, var. formosus.

Plate 44, figs. 3, *a*, *b*.

It is quite probable that this form may belong to a distinct species from *V. Leidyi;* but as I have seen but one specimen of this shell and only two of *V. Leidyi*, I have no means of ascertaining to what extent they may vary. It differs from the typical form of *V. Leidyi* in having its spire less elevated, and in being proportionally broader, while its lower whorls are much more flattened, and its suture between not near so deep. In the flattening of its volutions, the more angular character of its body-whorl, as well as in its surface-markings, it agrees exactly with our *V. trochiformis;* but it attains a much larger size than that shell, and is proportionally broader, while its aperture is narrower in proportion to its height, as well as more produced and more angular below. Its umbilical perforation is also proportionally larger. But the strongest reason for believing it distinct from *V. trochiformis* is the fact that that species became proportionally narrower as it increased in size, as may be seen by our figure 2, *c*, of plate 44.

Length, 1.52 inches; breadth, 1.20 inches; apical angle a little convex, divergence about 74°.

Locality and position.—Mouth of the Yellowstone River; in the same position as last.

Viviparus Raynoldsanus, M. & H.

Plate 44, figs. 7, *a*, *b*.

Vivipara Raynoldsana, Meek and Hayden (1861), Proceed. Acad. Nat. Sci. Philad., XIII, 446.

Shell attaining a large size, rather thick; spire elevated, and pointed at the apex; volutions about six and a half, increasing moderately in size, distinctly convex, but sometimes obscurely compressed around the middle, so as to present a very slightly-shouldered appearance above; last one prominently rounded, or faintly subangular a little below the middle; suture deep, owing to the convexity of the volutions, all the way up; aperture rounded-subovate, a little oblique; columella slightly perforated and regularly arcuate; surface of upper volutions usually smooth, or only marked by very obscure lines of growth, which generally become quite strong on the last whorl near the aperture; while more or less distinct (in some examples well-defined) revolving lines are also sometimes seen, two or three of which are stronger than the others on the middle of the volutions, where they show a tendency to develop into little ridges.

Length of a large adult specimen, 1.60 inches; breadth of same, 1.15 inches; slopes of spire more or less convex, with a divergence from the apex of about 60° to 65°.

This is a very fine species, readily distinguished from all of the other Upper Missouri forms. It perhaps more nearly resembles *V. Leai*, than any of the others from that region, but differs in its larger size, proportionally greater thickness, more produced spire, and more convex volutions, as well as by its revolving lines, which show a tendency to develop into ridges. This latter character, however, is not near so well defined on our figured specimen as on some of the others.

Among recent species, this shell seems to be most nearly related to *V. multicarinata*, Haldeman (= *V. carinata*, Valenciennes), which was originally supposed to occur in Mexico, I believe. Mr. Binney, however, states that he saw Valenciennes's type-specimen in Paris, with a label in that author's own handwriting, saying that it came from the Philippines. His figure represents a shell *very* similar to some of the specimens of the form under consideration, that have three or four of the revolving lines developed into little ridges, or carinæ. Our species, however, seems to have its spire nearly always more elevated, and composed of one more volution, while its revolving markings are *usually* more obscure.

Named in honor of Capt. William F. Raynolds, of the United States Topographical Engineers, who brought in the first specimens of this species we had for study.

Locality and position.—Clear Fork of Powder River, Montana; from the Fort Union group of the Lignite series. We also have it from the Lower Fork of the same stream, from doubtless the same horizon.

Genus CAMPELOMA, Rafinesque.

Synon.—Campeloma, Raf. (1819), Jour. Phys., 422.—Gill (1864), Proceed. Acad. Nat. Sci. Philad., XVI, 422 (as a genus).—Meek (1865), Palæont. Upper Missouri, 114 and 115; and (1871) Proceed. Acad. Nat. Sci. Philad., XXIII (as a genus); also (1872) in Hayden's Second Annual Report United States Geological Survey of the Territories, 299.

Paludina and *Viripara* or *Viriparus* (sp.), of most authors; but not *Paludina*, Lamarck, or *Viriparus*, Montfort, as restricted.

Melantho, of several authors; but not of Bowdich.

Etym.—κάμπη, a bending; λῶμα, a margin.

Examp.—*Paludina ponderosa*, Say.

Shell ovate or subovate, thick and solid; spire more or less produced, and often eroded at the apex; volutions rounded or convex; aperture ovate; peristome simple, continuous; inner lip often thick above; outer lip broadly retreating in outline along and above the middle, prominent farther down, and again slightly sinuous around the base of the aperture; axis not distinctly perforated; surface smooth, or only showing lines of growth, with sometimes minute revolving striæ, and covered by an olivaceous epidermis.

This genus was long confounded with *Viriparus* under the name *Paludina*. As stated in connection with the description of that genus, however, it is readily distinguishable by its more solid, thick shell, thickened inner lip, and the waved or sigmoid outline of its outer lip, as well as by marked differences in the form of its lingual teeth. Like that genus, it inhabits fresh water only, being found in the streams of this country from the Rio Grande to Nova Scotia, and perhaps farther northward. It seems to be strictly an American type; and we have reason for believing that in the Rocky Mountain region, it ranges back to the latest Cretaceous deposits. It is also found abundantly represented in the Tertiary rocks of that region; but curiously enough, it seems not to be represented there by living species.

We are indebted to Professor Gill for having first called attention to the fact that Rafinesque had described this genus as long back as 1819 under the name *Campeloma*. Rafinesque's diagnosis is brief, but it seems to me impossible, after an attentive reading of his description—bearing in mind

that it was founded on one of our western fresh-water shells—to doubt that his type was a reversed specimen of *C. ponderosa* or *C. decisa*. Even the etymology of the name *Campēloma* seems to confirm the conclusion that he had before him a species of this genus, one of the most marked characteristics of which is the waved or sigmoid outline of the margin of its outer lip.

After it was found necessary to separate this genus from *Viviparus*, Bowdich's name *Melantho* has been generally used for it; but as Bowdich plainly states that the type of his genus is a marine shell, and does not even hint that it is an American species, there appears to be no reason for applying his name to this genus.

Campeloma multilineata, M. & H.

Plate 44, figs. 1, *a*, *b*.

Paludina multilineata, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 120.
Viripara multilineata, Meek and Hayden (1860), *ib.*, XII, 85.
Viripara Nebrascensis, Meek and Hayden (1860), *ib.*, 430.
Melantho multilineatus, Meek (1863), in Professor Gill's paper on the *Viviparidæ*, Proceed. Acad. Nat. Sci. Philad., XV, 7.
Campeloma multilineata, Meek (1866), in Conrad's Smithsonian Eocene List, 12.

Shell subovate; spire moderate; volutions six, convex, increasing gradually in size, last one rather large and rounded; suture deep; surface marked by fine obscure lines of growth, and numerous stronger revolving thread-like striæ; aperture comparatively small, obliquely ovate; inner lip thin and reflexed below, so as nearly to cover the small, deep, umbilical perforation.

Length, 1 inch; breadth, 0.64 inch; apical angle convex, divergence about 55°.

In some of the specimens, the lower whorl shows faint traces of an obscure revolving ridge just below the suture; this, however, is not a constant character, many of the specimens being entirely without any indications of it. On the upper part of the volutions, the revolving lines are generally separated by spaces greater than their own breadth, but they diminish in size, and become more crowded below, excepting near the umbilicus, where they are larger and more distant. Immediately below the suture, there is usually a narrow space, on which the revolving striæ are not defined.

This and the following species or variety are the only forms yet seen from the Upper Missouri rocks that seem certainly to fall into the genus *Campeloma*. They are not so ponderous as the larger living examples of this group, but still evidently belong to it, as they possess the peculiar

form of aperture, with its produced narrow base, and the same sigmoid outer lip seen in the characteristic living species.

Among our existing American species, this shell may be compared with *C. decisa*, Say, *C. regularis*, Lea, and *C. lima*, Anthony. It will be easily distinguished from them all, however, by its revolving lines and small, deep umbilical perforation.

At the time we proposed to change the name of this species to *V. Nebracensis*, we were under the impression that the name *multilineata* would have to be retained for a recent species described by Say. As conchologists, however, have decided that the form to which he applied that name is most probably an introduced variety of *V. Bengalensis*, and the *Campeloma* (= *Melantho*) group is also now regarded as a distinct genus, the original name *multilineata* is here restored.

Locality and position.—Fort Clarke, Dakota, on the Missouri; from the Fort Union group (probably Eocene).

Campeloma vetula, M. & H.

Plate 44, figs. 14, *a*, *b*.

Paludina vetula, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 121.
Viripara vetula, Meek and Hayden (1860), *ib.*, XII, 430.
Melantho vetulus, Meek (1863), in Professor Gill's paper on the *Viviparidæ*, Proceed. Acad. Nat. Sci. Philad., XV, 7.
Campeloma vetula, Meek (1866), in Conrad's Smithsonian Eocene List, 12.

Shell of medium size, conoid-ovate, rather thin; spire moderate; volutions about five and a half, moderately convex, increasing rather gradually in size from the apex, last one somewhat ventricose; suture deep, and only slightly oblique; surface marked by fine, indistinct lines of growth, sometimes crossed by nearly obsolete revolving striæ; umbilical region indented, but scarcely perforated; aperture ovate, equaling generally a little less than half the entire length.

Length, 0.88 inch; breadth, 0.60 inch; length of aperture, 0.47 inch; breadth of same, 0.37 inch.

This shell varies to some extent in form; the smaller individuals having the spire proportionally less elevated and the body-volution more ventricose. I have long been nearly satisfied that it is only a variety of the last; but having already separated it under another name, it is perhaps better to continue this arrangement until we can have more extensive collections for

comparison, especially as they seem to come from quite different horizons. The principal differences observed are the much more obscure, or nearly obsolete, revolving striæ, and apparently imperforate axis, of the form here under consideration.

Locality and position.—Mouth of Judith River, Montana; from the Judith River beds; probably of latest Cretaceous age.

Campeloma multistriata, M. & H.

Plate 43, figs. 15, *a, b, c, d, e.*

Melania multistriata, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 124.
Limnæa? multistriata, Meek and Hayden (1860), *ib.*, XII, 431.
Campeloma multistriata, Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Invertebrate Fossils, 12.

Fig. 80.

Campeloma multistriata. Showing aperture, &c. (natural size of one of the largest specimens), more clearly than the figure on plate 43.

Shell small, moderately solid, narrow-subovate; spire much elevated, pointed at the apex, which is not eroded; volutions six and a half to seven, rounded-convex, increasing rather gradually in size; suture deep; surface apparently smooth, but when examined under a lens seen to be marked by very faint lines of growth, crossed by numerous obscure, very minute revolving striæ; aperture narrow-subovate, angular behind, produced and very narrowly round or subangular and faintly sinuous in front, usually about equaling the length of the spire; inner lip not thickened; margin of outer lip slightly prominent below, and faintly contracted above.

Length of a medium-sized specimen, 0.45 inch; breadth, 0.25 inch; apical angle nearly regular, divergence varying with age, usually about 48°.

I have long been much puzzled in regard to the generic relations of this species, which, so far as can readily be determined from the shell alone, would seem to present characters almost intermediate between several groups. In first indicating it from imperfect specimens, its similarity in some respects to certain American forms of *Melaniidæ*, at that time generally referred to *Melania*, caused its reference to that genus. Subsequent examinations of better examples clearly showed that it could not be a true *Melania*; and although far from being convinced that it is a *Limnæa*, we placed it provisionally, with a query, under that name.* It differs, however, from

* It was only referred provisionally to the genus *Limnæa* on the supposition that it might possibly be related to *L. humilis* of the *Lymnophysa* group.

Limnæa in not having the columella twisted or provided with a fold, as well as in solidity and texture, and the form of the aperture. In size and general appearance, it agrees rather nearly with *Bithinia;* but its aperture differs in being produced, very narrow, and slightly sinuous in front, instead of regularly rounded, as well as in wanting an opercular ridge just within the edge of the lip. It is also a rather thicker shell than the typical Bithinias, and has the margin of its outer lip more prominent below the middle.

From all its characters yet known, it would seem most probably to belong to the genus *Campeloma.* The only objections to this conclusion are the comparatively small size and slender form of the shell, which, however, may probably only be strongly-marked specific characters. Still, even in size, the larger specimens agree better with *Campeloma* than with *Bithinia.*

The revolving striæ mentioned in the description are so very minute and obscure that they can only be seen by very careful looking with a good magnifier.

Locality and position.—Fort Clarke, Dakota, on the Missouri River; and near the mouth of Yellowstone River, Montana, in the Fort Union Lignite group.

VALVATIDÆ.

Genus VALVATA, Müller.

Synon.—*Valvata,* Müller (1774), Hist. Verm., II, 198; and (1776) Zoöl. Dan. Prodr., 239.—Studer (1789), Coxe Trav., III, 391.—Draparn. (1801), Tabl., 30, 42; and (1805) Hist., 26, 28 and 41.—Gray (1821), Lond. Med. Rep., 231; and (1840) Turton's Man. (2d ed.), 97.—Lamarck (1822), Hist., VI, 2, 171, and (2d ed.) VII, 505.—Deshayes (1832), Encyc. Méth., III, 1106.—Blainv. (1824), Dict. Sci. Nat., XXXII, 229; and Malac. (1825) 434; also (1828) Dict. Sci. Nat., LVI, 462.—Swainson (1840), Malac., 169, and 339.—Menke (1845), Monogr. in Zeitschr. f. Malak., 115.—H. and A. Adams (1854), Genera Recent Moll., I, 343.—Binney (1865), Land and Fresh-water Shells of N. Am., part III, 8.—Meek (1865), Palæont. Upper Mo., 112.

Valvearius, Dum. (1806), Zoöl. Anal., 164.

Gyrorbis, Fitzing. (1833), Verz., 117.

Planella, Schlüt. (1838), Vz., 13 (subgenus *Valvata*).

Tropidina, H. and A. Adams (1856), Genera Recent Moll., I, 344 (as a subgenus under *Valvata*).—Meek (1865), Palæont. Upper Missouri, 112 (as a subgenus under *Valvata*).

Etym.—*Valva,* the wing, or fold of a door.

Type.—*Valvata cristata,* Müller.

Shell small, discoid or more or less turbinate, umbilicate, thin; volutions rounded, simple or keeled, and provided with a corneous epidermis; aperture circular, with a continuous peristome.

H. and A. Adams propose to divide this genus into three subgenera—that is, into *Valvata* proper, *Gyrorbis,* and *Tropidina.* As *Gyrorbis,* how-

ever, was, according to Herrmannsen, founded on *V. cristata*, Müller, it becomes an exact synonym of the typical section of the genus, and cannot be retained as a separate subgeneric name. Consequently, as here used, the genus is understood to include only two sections, as follows:

1. VALVATA, Müller (typical, = *Gyrorbis*, Fitz., and *Planella*, Schlüt.).
   Shell discoid; volutions rounded; umbilicus very large.—(Type as already cited.)

2. TROPIDINA, H. and A. Adams.
   Shell turbinate; volutions rounded, with or without carinæ.—(*Valvata tricarinata*, Say.)

Although the section *Tropidina* was only proposed by H. and A. Adams for the reception of *V. tricarinata*, Lesueur, and *V. bicarinata*, Say (which latter is now generally regarded as only a variety of the first), there seems to be no good reason why it may not include all of the turbinate species; because the carinate character of the volutions cannot be regarded as being of much importance, since it is not always well marked, even in the *V. tricarinata*.

This genus of small shells has much the habits of *Limnæa*, being found living in fresh-water ponds and ditches, and occurs both in Europe and North America. According to Dr. Lea, the animal in this genus has the habit of swimming inverted at the surface of the water, like *Limnæa*, *Planorbis*, and *Physa*.

The geological range of the genus *Valvata* is not very well determined; but forms apparently nearly resembling it have been found in Jurassic rocks, and it is said to occur in the Wealden of England. It is found in the Tertiary rocks both of this country and Europe. As at the present time, the species do not appear to have ever been very abundant during past geological periods.

Valvata subumbilicata, M. & H.

Plate 43, figs. 13, *a*, *b*, *c*.

Planorbis subumbilicata, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 120.
Valvata subumbilicata, Meek and Hayden (1860), *ib.*, XII, 185.

Shell small, subdiscoidal; spire much depressed, or rising but slightly above the last whorl; volutions two and a half to three, rounded and increasing rather rapidly in size; suture strongly defined; umbilicus from one-half

to two-thirds as wide as the outer whorl, and rather deep; aperture transversely oval; surface obscurely marked by very fine lines of growth.

Greater diameter, 0.12 inch; height, 0.04 inch.

When somewhat distorted by pressure, or partly embedded in the matrix, this little shell, in consequence of its depressed spire, presents almost exactly the appearance of a *Planorbis*, to which genus we at first referred it. When entirely detached from the matrix, however, it is found to possess the characters of a true *Valvata*. It seems to be nearly related to some of the depressed forms of *V. tricarinata*, Say, particularly the variety *simplex*, which like our shell is not *carinated*. Yet it is uniformly smaller, more depressed, and appears to be always entirely destitute of the slightest traces of carinæ.

Locality and position.—Three miles below Fort Union, Dakota; from a ferruginous band of impure lignite, in the Fort Union group of the Fresh- and Brackish-water Lignite series; probably Lower Eocene.

Valvata parvula, M. & H.

Valvata parvula, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 123.

Shell very small, depressed or subdiscoidal; spire rising little above the body-whorl; volutions about three, rounded, and having, near the middle of the upper and lower sides, a distinct linear carina; surface marked by strong, regular lines of growth; suture distinct; umbilicus wide and deep, showing all the volutions to the apex; aperture rounded or transversely oval.

Greatest breadth, 0.10 inch; height, 0.05 inch.

The only specimen of this shell found was unfortunately lost soon after it was described, so that I have been unable to give any figures of it. My present impression, however, is, that it is possibly only an angular variety of the last, though it may be found to be distinct.

Locality and position.—Same as last.

Valvata? Montanaensis, Meek.

Fig. 81. Fig. 82. Fig. 83.

Valvata Montanaensis. Three views, about one and a half diameters.

Shell attaining a rather large size, depressed-subglobose; volutions three, rather rapidly increasing in size, particularly in breadth; compressed-convex, both above and below; periphery in young and medium-sized specimens angular, but becoming narrowly rounded in the adult; suture deep; umbilicus small; aperture about as wide

as high in young and medium-sized specimens, angular on the outer side, but becoming more rounded in large examples; surface unknown.

Height of largest specimen seen, 0.30 inch; greatest breadth of same, 0.40 inch.

I only refer this species doubtfully to the genus *Valvata*, not having seen any good specimens of it. It has its volutions more compressed on the upper and lower slopes, and its periphery more angular than is common in that genus; while its umbilicus is comparatively small for a *Valvata*.

Locality and position.—Judith River Fresh- and Brackish-water Lignite beds, at the mouth of Judith River, on the Upper Missouri, Montana; probably belonging to the latest member of Cretaceous.

FOSSILS OF THE WIND RIVER TERTIARY.

MOLLUSCA.

GASTEROPODA.

PULMONATA.

VITRINIDÆ.

Genus MACROCYCLIS, Beck.

Synon.—*Macrocyclis*, Beck (1837), Ind., 24 (proposed as a subgenus under *Helix*).—H. and A. Adams (1855), Genera of Recent Moll., II, 202 (as a genus).—Chenu (1859), Man. Conch., I, 461 (as a subgenus under *Helix*).—Morse (1864), Jour. Portland Soc. Nat. Hist., I, 12 (as a genus).—Tryon (1866), Monogr. Terrest. Moll. U. S., in Am. Jour. Conch., II, 244.—Binney (1869), Land and Fresh-water Shells of N. Am., part I, *Pulmon. Geophila*, 55.

Ampelita, Beck (1837), Ind., 30 (as a subgenus under *Helix*).—H. and A. Adams (1855), Genera of Recent Moll., II, 203 (as a subgenus under *Macrocyclis*).—Chenu (1859), Man. Conch., I, 461 (as a subgenus under *Macrocyclis*).

Etym.—μακρός, large; κύκλος, a circle.
Type.—*Helix laxata*, Féruss. (= *H. Peruviana*, Lam.).

Shell thin, widely umbilicated, depressed-orbicular, or subdiscoid; volutions four to six, generally rather rapidly increasing in size, the last one being inflated and declining at the aperture, which is transversely round-oval; peristome simple, thin, with margins approximated, and at the base shortly reflexed, or contiguous and united by a thin callus.

It will be seen that I accept this genus with two subgeneric sections, as follows:

1. MACROCYCLIS, Beck (typical).

Shell with last volution rounding into the umbilicus; peristome thin, with margins approximated, and at the base shortly reflexed.—(Type as stated above.)

2. AMPELITA, Beek.

Shell with last volution subangular around the umbilieus; peristome reflexed, with margins eontiguous, and united by a thin eallus.—(*Helix Madagascarensis*, Lam.)

H. and A. Adams admit the following three other subgenera under this genus, viz, their own *Lysinoë*, *Eurystoma*, Albers, and *Vallonia*, Risso, all of whieh, with the group *Ampelita*, Beek, are ranged by Albers as subgenera under *Helix*.

Not having studied these groups to any considerable extent, no great weight is claimed for the eonelusions here adopted with regard to their relations; but so far as I have had an opportunity to do so, the evidenee would seem to favor the conelusion that *Lysinoë*, *Eurystoma*, and *Vallonia*, as well as possibly even *Ampelita*, should be kept entirely distinet from *Macrocyclis*.

In regard to the geological range of the genus *Macrocyclis*, little can be said. If the species hereinafter referred to this genus really belongs to it, it may probably be said to date baek to the Eocene epoch. Although the known existing speeies are not very numerous, it seems probable, from the small number of fossil speeies yet diseovered (ineluding apparently a few European Tertiary speeies), that it may not have been more abundantly represented at any past time. It is possible, however, that a number of Tertiary speeies may yet be diseovered in the Rocky Mountain region and along the Pacific slope.

This genus has a wide geographical range, the typical seetion oeeurring in Australia and Valdivia, and in this eountry from the Pacific slope to Georgia. Mr. Tryon enumerates six speeies as oeeurring in the United States and Territories, though Mr. Binney refers two of these to *Zonites*. The speeies belonging to the group *Ampelita* are said all to oeeur in Madagascar.

Macrocyclis spatiosa, M. & H.

Plate 42, figs. 9, *a*, *b*, *c*.

Helix spatiosa, Meek and Hayden (1861), Proceed. Acad. Nat. Sei. Philad., XIII, 446.
Macrocyclis spatiosa, Meek (1866), in Conrad's Smithsonian Check-List N. Am. Eocene Invertebrate Fossils, 10; also (1869), in Binney's Land and Fresh-water Shells of N. Am., part I *Pulmon. Geophila*, 188.

Shell attaining a large size, thin, depressed-suborbieular, or subdiscoidal, the spire being low, but not flat; voluttions five and a half to six,

moderately convex above, those of the spire being slightly covered above, and almost entirely hidden below; last turn a little depressed, with an outward slope above, rather distinctly declining at the aperture, narrowly rounded or (in the young shell) subangular around the periphery, flattened-convex and rounding abruptly into the umbilicus below, where it is more or less inflated toward the aperture; umbilicus wide and deep; suture distinct; aperture transversely round-oval, being a little wider than high, narrowly rounded on the outer side, and only very slightly modified by its connection with the volution on the inner side; lip so much produced above as to give a very oblique outline to its margin, which is nearly straight above, but becomes more reflexed below, where it is a little constricted; surface marked by moderately distinct, very oblique, lines of growth.

Greatest breadth, 1.82 inches; height about 1 inch; breadth of aperture, 0.77 inch; height, measuring vertically, about 0.50 inch, but measuring obliquely from the advanced upper margin to its retreating lower edge, about 0.88 inch.

This is a noble species, that will be distinguished at a glance from the other land-shells yet known from the Upper Missouri country, or, indeed, from all of the Rocky Mountain region, by its large size, wide, deep umbilicus, and general form. It seems to present all of the characteristics of a typical *Macrocyclis*, such as its depressed form, wide open umbilicus, the ventricose character of its body-volution near the aperture below, and its declining character at the same above, as well as its shortly reflexed lip on the lower side and the constriction of its aperture there.

It seems to have exceeded the typical *M. laxata* in size, and is readily distinguished from it by its more prominent spire and its more narrowly-rounded (or in the young) subangular periphery, caused by greater compression of its volutions above and below, particularly the latter.

Locality and position.—From the Wind River Valley, where it was found in the Wind River group; probably of Eocene age.

HELICIDÆ.

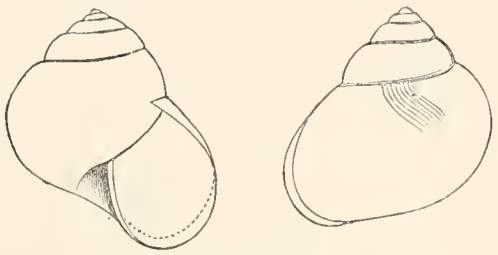
Genus HELIX, Linn. (see page 549).

Helix? veterna, M. & H.

Plate 42, figs. 8, *a*, *b*.

Helix veterna, Meek and Hayden (1861), Proceed. Acad. Nat. Sci. Philad., XIII, 447.

Fig. 84. Fig. 85.



Helix? veterna.

Cuts of casts, given to show more clearly some characters not well represented in the figures on the plate.

Fig. 84. A view of an internal cast, showing aperture; the dotted line indicating the reflexed part of the lip.

Fig. 85. An opposite view of same.

Shell thin, above medium size, ovate-subglobose; volutions five and a half, convex, and increasing rather rapidly in size, the last one being large, ventricose, and forming about three-fifths the entire length, with its greatest convexity below the middle, rounded on the outer side, and somewhat obliquely produced below; spire depressed; umbilicus small or closed; suture distinct, but apparently not very deep; aperture ovate, rounded below and more or less angular above; surface marked by rather strong, very oblique marks of growth; lip appearing, judging from internal casts, somewhat reflexed below.

Height, 1.24 inches; breadth, 1.05 inches; height of aperture, 0.75 inch; breadth of same, 0.57 inch; slopes of spire very convex, with a divergence of 85° to 90°.

I am in considerable doubt in regard to the affinities of this species, which is only known in the condition of internal casts, with some fragments of the shell attached. These casts certainly present very much the appearance of having the lip shortly reflexed below, and the last turn a little declining at the aperture above. These characters, and the apparently distinct, regular, thread-like striæ of growth, seen on some fragments of the shell, led to the conclusion, when it was first studied, that it might belong to some of the very elevated types of the genus *Helix*, as understood in its most comprehensive signification. In this case, however, it would seem to belong to a section or group differing from any of the existing American forms; and, from this fact, as well as from the outline of its aperture, the elevation of the spire, and downward extension of the body-volution, I am still far from

being entirely satisfied with its reference to the genus *Helix*. Until we can have more satisfactory collections for comparison, however, I prefer to leave it provisionally under that name.

In most of its characters, this shell seems to resemble a Wyoming form that I have described under the name *Viviparus Wyomingensis*, from the Bridger group of the Tertiary series in that region. It evidently has a less elevated spire, however, and a more decidedly perforated axis.

The foregoing cuts represent casts, and consequently the exact nature of the connection of the inner lip with the umbilical region could not satisfactorily be made out.

Locality and position.—Wind River Valley, Montana; from the Wind River group. Tertiary; probably of the same horizon as the Bridger group in Wyoming.

FOSSILS OF THE WHITE RIVER TERTIARY.

MOLLUSCA.

GASTEROPODA.

PULMONATA.

LIMNÆIDÆ.

Genus LIMNÆA, Lamarck (see page 531.)

Limnæa Meekiana, E. & S.

Plate 45, figs. 5, *a*, *b*, *c*.

Limnæa Meekiana, Evans and Shumard, MS.
Limnæa Meekiana, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., XII, 431.—Meek (1864), Smithsonian Check-List North American Tertiary Invertebrate Fossils, 13.

Shell rather large, conical-subovate; spire less than half the length of the shell, acutely pointed at the apex; volutions five and a half to six, convex, last one ventricose, and comparatively large; suture well defined. Aperture rather narrow-ovate, angular above and rounded below; lip slightly dilated at the lower part of the columella; surface marked by moderately distinct lines of growth.

Length, 1.15 inch; breadth, 0.66 inch; apical angle nearly regular, divergence 54°.

This fine *Limnæa*, is quite similar to several of the species figured by Edwards in his Monograph of the Eocene Mollusca of England, published by the Palæontographical Society, but seems to present well-defined specific differences from them all.

Dr. Evans and Dr. Shumard had specimens of this species that they intended to publish. We also had others from the same locality, and not wishing to name species that they desired to describe, I wrote to Dr. Shu-

mard that, if he would send me brief descriptions with the names of his new species, I would adopt them. He then informed me that he had called this one *L. Meekiana* in his manuscript, which I believe he never published.

Locality and position.—Pinots' Creek, upper part of the White River group.

Limnæa Shumardi, Meek.

Plate 45, figs. 6, *a*, *b*.

Shell rhombic-subovate; spire less than half the entire length, very acute at the apex; volutions five and a half, convex, last one not ventricose, rather oblique; suture moderately well defined; surface marked by distinct lines of growth, and sometimes having, on the upper part of the body-whorl, a few broad, obscure, vertical or oblique folds; aperture ovate, rounded below, and angular above.

Length, 0.81 inch; breadth, 0.51 inch; length of aperture, 0.49 inch; breadth of same, 0.26 inch; apical angle nearly regular, divergence 54°.

It is possible that this may not be distinct from the last, though I have not yet seen intermediate gradations between these forms. The shell here under consideration differs from the preceding in being smaller and proportionally more slender; while its body-whorl is much less ventricose and more oblique. It also differs in sometimes showing a tendency to form obscure folds on the upper part of the last volution. It is named in honor of the late Dr. B. F. Shumard, formerly State geologist of Texas.

Locality and position.—Same as last.

Genus **PLANORBIS**, Müller (see page 534).

Planorbis Leidyi, M. & H.

Plate 45, figs. 3, *a*, *b*, *c*, *d*.

Planorbis Leidyi, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., IX, 175.—Meek (1864), Smithsonian Check-List N. Am. Tertiary Fossils, 13.

Shell small, subdiscoidal; spire flat, or a little concave; volutions scarcely three, increasing rather rapidly in size, not embracing on the upper side; inner ones almost entirely hidden by the last turn below, all convex above, rather narrowly rounded on the upper outer side, and ventricose and rounded below; suture well defined; umbilicus small, or less than half the breadth of the outer whorl, deep, and scarcely permitting the inner volutions to be counted. Surface marked by fine, delicate lines of growth; aperture

subcircular, oblique, a little oval, flattened or somewhat concave on the inner side.

Greatest breadth, 0.22 inch; height, 0.09 inch.

The more rounded, ventricose whorls, and small, deep umbilicus of this species will serve to distinguish it at a glance, from either of the following two forms. It will also be found, on comparison, to have an entirely differently-formed aperture, and to be destitute of the more or less distinctly-defined angle characterizing those shells. It is likewise much less compressed than either of them, and has a narrower, deeper umbilicus.

In form, it bears considerable general resemblance to our *Valvata subumbilicata* from the Lignite basin, but is a larger shell, and differs in having the spire slightly concave, instead of rising a little above the body-whorl; while the form of its aperture, as might be expected, is quite different. The specific name was given in honor of Professor Joseph Leidy, the distinguished comparative anatomist of Philadelphia.

This shell is rather remarkable for its very narrow, deep umbilicus, which seems to separate it from the typical section of the genus.

Locality and position.—Head of White River, Dakota; in the upper part of the White River group; Upper Eocene or Lower Miocene.

Subgenus **MENETUS**, H. and A. Adams? (see page 536).

Planorbis Nebrascensis, E. & S.

Plate 42, figs. 2, *a*, *b*.

Planorbis Nebrascensis, Evans and Shumard (1854), Proceed. Acad. Nat. Sci. Philad., VI, 161.
Planorbis (*Segmentina?*) *Nebrascensis*, Meek and Hayden (1860), *ib.*, IX, 431.—Meek (1864), Smithsonian Check-List North American Tertiary Fossils, 13.

Shell small, depressed-discoid, with upper and lower sides nearly equally and moderately concave, the umbilical concavity being slightly narrower than that above; periphery angular; volutions about three, convex both above and below, all coiled almost exactly on the same plane, more or less angular around the outer side, and deeply sinuous within for the reception of the next inner turn—each covering a little less than half of the next within, on the upper side, and slightly more below; aperture cordate-subsagittate; surface showing very obscure lines of growth.

Greatest diameter about 0.19 inch; height or convexity about 0.06 inch.

Our specimens of the form referred with some little doubt to the above species are from the same locality and position as those described by Doctors

Evans and Shumard, and agree very nearly with their description, excepting in apparently never having more than about three volutions. They are planorbicular in form, the spire being a little concave, and the umbilicus, which is slightly narrower and deeper than the concavity on the upper side, very nearly of the same breadth as the outer whorl. The volutions are nearly equally convex above and below, obtusely angular on the outer side near the middle, and deeply grooved within for the reception of the inner whorls, each of which is from one-third to one-half embraced by the succeeding turn. The aperture is subcordate, not oblique, and slightly wider than high. The marks of growth are obscure.

This and the following species seem to have the external characters of the genus *Segmentina;* but it is impossible to determine whether or not they possess the internal teeth of that genus. My present impression is that they may belong to the subgenus *Menetus*, H. and A. Adams.

Locality and position.—Pinots' Creek, upper part of White River group, of the Tertiary series.

Planorbis vetustus, M. & H.

Plate 45, figs. 1, *a*, *b*, *c*.

Planorbis vetustus, Meek and Hayden (1860), Proceed. Acad. Nat. Sci. Philad., IX, 175.
Planorbis (*Segmentina?*) *vetustus*, Meek and Hayden (1860), *ib.*, XII, 431.
Planorbis vetustus, Meek (1864). Smithsonian Check-List N. Am. Tertiary Fossils, 13.

Shell small, discoidal, much depressed; spire slightly concave; umbilicus shallow, very little broader than the concavity on the upper side, and rather more than one-third wider than the outer whorl, showing about half of each inner turn; volutions three and a half to four, compressed-convex above and below, the upper side being a little more convex than the other, and sloping slightly outward from near the inner margin; all rather distinctly angular around the outer side somewhat below the middle, and deeply grooved within for the reception of each succeeding inner whorl; sutures well defined, though not very deep; aperture narrow-subcordate, approaching an irregular hastate outline, very slightly oblique, having its longer axis in the direction of the greatest breadth of the shell; surface apparently nearly smooth, or only showing obscure marks of growth.

Greatest breadth, 0.23 inch; height, 0.05 inch.

This shell might be confounded with the last on a hasty examination, but may always be distinguished by its more depressed form and more dis-

tinctly angular whorls. The angle is also not so nearly central, and the whorls are much less convex on the upper and lower sides, while its umbilicus is proportionally much wider.

It bears considerable resemblance to *P. Ungeri* of Reuss and von Meyer (Palæontographica, II, 37, taf. 4, fig. 10), from the Miocene fresh-water limestone in the northern part of Bohemia, but is not so distinctly angular around the periphery, and its angle is not so near the middle of the outer side. It also has usually about one whorl less, and more obscure surface-markings.

In the Eocene of the Old World, there are also some very closely-allied forms, among which may be mentioned *P. lens*, Bong., *P. tropis*, Edwards, and *P. Sowerbyi* of Bronn. From the first, it differs in being a smaller shell, in having about one whorl less, and a proportionally larger umbilicus. It also differs in being a little more concave on the under than the upper side, instead of the reverse. From *P. Sowerbyi*, which it very nearly resembles, it appears to differ in being less sharply carinate, while its whorls are not so flat on the under side, and increase less rapidly in size. It seems to be even more closely related to *P. tropis*, but differs from Edwards' figures of that species given in his Monograph of the Eocene Mollusca of England (published by the Palæontographical Society), in the greater convexity of its whorls on the under side, and in having a less distinctly-defined angle around the periphery. It is desirable, however, that this Dakota shell should be compared with authentic specimens of the above foreign forms, in order to settle beyond doubt the question in regard to its relations to the same; though, with the present means of comparison, as well as from its geographical position, I can but regard it as distinct from them all.

Our shell has also some near representatives among recent species, being very similar in size and form to *P. vermiculus* of Gould from Oregon. Still it differs in being slightly more compressed and subangular instead of rounded on the periphery, while its umbilicus is a little wider and shallower than in the Oregon species.

Locality and position.—Same as last.

PHYSIDÆ.

Genus PHYSA, Draparnaud.

Synon.—*Physa*, Draparn. (1801), Prodr.; and (1805) Moll., 25, 28, and 54.—Lam. (1812), Extr. d'un Cours; and (1822) Hist., VI, 2, 155 (2e éd., 398).—Féruss. (1821), Tabl. Syst., xxxiii.—Blainv. (1824), Dict. Sci. Nat., XXXII, 244; and (1825) Malac., 450.—Defr. (1826), Dict. Sci. Nat., XL, 145.—Fitzinger (1833), Syst. Verz., 110.—Charp. (1837), Cat. Moll. Suisse, 29.—Gray (1840), in Turt. Man. (2d ed.), 251; and (1842) Synon. Moll. Brit. Mus., 91; also (1844) Rev. Zoöl., 405.—Haldeman (1842), Mon. Fresh-water Univ. United States, *Physidæ*, 20.—Swainson (1840), Malac., 338.—Gould (1841), Invert. Mass., 211; and Binney ed. same (1870), 483.—H. and A. Adams (1855), Genera Recent Moll., II, 256.—Binney (1865), Land and Fresh-water Shells United States, 75; and of many others.

Physa, Risso (1826), Hist., IV, 96.—Verany (1846), Cat. An. Invert., 15.

Anissus (part), Studer (1820), Syst. Verzch., 23 (not of Fitzinger).

Isidora, Ehrenb. (1831), Symb. Phys.—H. and A. Adams (1855), Genera Recent Moll., II, 260 (as a subgenus under *Bulinus*).

Rivicola, Fitzinger (1833), Syst. Verz., 110.

Physella, Haldeman (1842), Monogr. Fresh-water Univalves of the United States, 14 (proposed as a subgenus under *Physa*).—H. and A. Adams (1855), Genera Recent Moll., II, 25 (as a subgenus under *Physa*).

Physodon, Haldeman (1842), Mon. Fresh-water Univalves United States, 14 (proposed as a subgenus under *Physa*).—H. and A. Adams (1855), Genera Recent Moll., II, 258.

Costella, Dall (1870), Ann. Mag. N. Y. Lyc. Nat. Hist., IX, 355 (as a subgenus under *Physa*).

Etym.—φῦσα, a leather bag, or bellows.

Examp.—*Physa fontinalis*, Linn. (sp.).

Shell ovate, elliptic, or subglobose, thin and polished, or moderately thick; spire short; aperture subovate, or more or less elongated; outer lip thin, or rather thick, and not dilated; inner lip spread over the columella, which has a more or less developed fold, or slight tooth-like projection.

As defined above, this genus includes, along with the typical forms, four other subgenera, among recent species; and probably others will have to be established for some extinct forms. The separate subgenera alluded to were established by Professors Haldeman and Ehrenberg and by Mr. Dall, and may be distinguished from each other and the typical section as stated below:

1. **PHYSA**, Draparnaud (typical).

   Shell subovate or subelliptic; outer lip thin; columella with fold small or nearly obsolete.—(Type as already stated.)

2. **PHYSELLA**, Haldeman.

   Shell subglobose; spire very short; aperture comparatively large; columella with a well-defined fold.—(*P. globosa*, Haldeman.)

3. **PHYSODON**, Haldeman.

   Shell comparatively thick, smooth, subovate; columella with two tooth-like projections; outer lip thick.—(*P. microstoma*, Haldeman.)

4. ISIDORA, Ehrenb. (= *Diastropha*, Guilding).

Shell ovate, with volutions ventricose; axis slightly umbilicated; columella without a fold.—(*Physa contorta*, Mich.)

5. COSTELLA, Dall.

Shell rounded, with vertical undulations or costæ.—(*Physa costata*, Newcomb.)

The existing species of this genus usually live in clear running streams, or springs, though they also inhabit clear ponds. They are widely distributed, being found in North America, Europe, India, Southern Africa, the Philippine Islands, &c.

This genus seems to have been introduced near the close of the Oölitic period, species being found in the Purbec beds of England. It also occurs in the Wealden of Europe, and in the Tertiary rocks of this country and Europe. Several very fine, large species are already known from the Tertiary rocks of Wyoming. Our eastern coast Tertiary beds, being almost exclusively of marine origin, have consequently no species of this genus, so far as known.

Physa secalina, E. & S.

Plate 45, figs. 4, *a*, *b*.

Physa secalina, Evans and Shumard (1851), Proceed. Acad. Nat. Sci. Philad., VI, 156.

Shell small, narrow-oval, or subelliptical; volutions three and a half to four, last one comparatively large, but not ventricose, composing about three-fourths of the entire length; spire comparatively small; suture moderately distinct; aperture very narrow-subovate, acutely angular above, and narrowly rounded below; surface apparently smooth.

Length, 0.17 inch; breadth, 0.08 inch.

Locality and position.—Pinots' Creek, upper beds of the White River Tertiary, Dakota Territory.

HELICIDÆ.

Genus **HELIX**, Linn. (see page 549).

Helix Leidyi, H. & M.

Plate 45, figs. 7, *a*, *b*.

Helix Leidyi, Hall and Meek (1851), Mem. Am. Acad. Arts and Sci. Boston, V (n. s.), 394, pl. 3, fig. 12.

Shell subglobose, wider than high; spire rather prominent; volutions moderately convex, last one large and ventricose, rounded; suture distinct;

surface unknown; aperture broad lunate-subovate, rather oblique; outer lip apparently reflexed; umbilicus small or closed.

Length, 1.05 inches; breadth, 1.12 inches; length of aperture, 0.77 inch; breadth of same, 0.54 inch; apical angle convex, divergence about 105°.

This species resembles in form a shell described by Matheron under the name *Cyclostoma Lunelii* (Cat. Méth. Fos. Depart. des Bouches-du-Rhône, 209, pl. 35, figs 12–13), though its outer lip appears not to have been thickened as in that species. As all the specimens we have seen of our shell are casts, we have no means of ascertaining the nature of its surface-markings, nor are we quite sure it would fall within the genus *Helix* as restricted by some of the more recent writers; though there can be no doubt in regard to its belonging to that genus as generally defined.

Locality and position.—Bad Lands of White River; from the White River group.

APPENDIX.

The descriptions of the following two species, accidentally omitted in their proper places in the body of the work, are added here.

Tellina (Arcopagia)? Cheyennensis, M. & H.

Plate 17, fig. 16.

Tellina? Cheyennensis, Meek and Hayden (1856), Proceed. Acad. Nat. Sci. Philad., VIII, 82.

Shell transversely ovate, compressed, very thin; anterior margin rounded; posterior margin faintly subtruncated, or rounding from above to the very narrowly rounded or subangular posterior basal extremity; basal outline semiovate; beaks rather prominent, placed a little in advance of the middle; umbonal slopes prominently rounded from the umbones to the posterior basal extremity; surface ornamented with fine lines of growth, and somewhat stronger little ridges and furrows near the lower margins.

Length, 0.88 inch; breadth, 0.36 inch; height, 0.67 inch.

This shell was originally referred (with a mark of doubt) to the genus *Tellina*, merely because its hinge was unknown, and it resembles certain forms from the Cretaceous rocks usually described under that name by some reliable authorities, and not because it was really believed it to be a true *Tellina*. In form and general appearance, it more nearly resembles *Arcopagia*; but as no specimens have been seen showing its hinge and interior, it is not possible to determine whether or not it even belongs to the *Tellinidæ*. It is certainly not a true *Tellina*.

Locality and position.—Forks of Cheyenne River, Dakota; from the Fort Pierre group of the Upper Missouri Cretaceous series.

Ammonites?? Mullananus, M. & H.

Plate 8, figs. 1, *a*, *b*, *c*.

Ammonites Mullananus, Meek and Hayden (1862), Proceed. Acad. Nat. Sci. Philad., XIV, 23.

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 with 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.

In the number and arrangement of the lobes and sinuses of its septa, as well as in their mode of branching, this species agrees very nearly with *Phylloceras? Halli*, pl. 23, figs. 4 *a*, *b*, *c* (=*Ammonites Halli*, Meek and Hayden, Proceed. Acad. Nat. Sci. Phila., March, 1856, p. 70). It has, however, one more lateral branch on each side of its dorsal lobe, and one less on each side of its superior lateral lobe, than *P.? Halli;* while all the divisions of its lobes and sinuses are more spreading Although rather closely allied in their internal characters, these two shells present marked differences in form, as well as in their external markings; the species now under consideration being much more ventricose and more coarsely ribbed than *P.? Halli*.

It agrees much more nearly in form with *Ammonites Barnstoni*, Meek (Professor Hind's Report, Assiniboine and Saskatchewan Exploring Expedition, plate 11, figs. 1 and 2), from far up north, on Mackenzie's River, but differs in having a smaller and more acutely conical umbilicus, and less broadly-rounded periphery. Its costæ are also more rounded, and it presents well-marked differences in its septa.

The only specimen of this species yet seen consists entirely of septate whorls, the non-septate outer portion having been broken away. It measures in its greatest diameter 4 inches, and 2.57 inches in breadth at the widest part of the outer whorl. It is scarcely necessary to add that this is not a true Ammonite, as that genus is restricted to typical forms by the late classifications.

Named in honor of Lieut. John Mullan, United States Topographical Engineers, in charge of the expedition for the location and construction of the Pacific wagon-road.

Locality and position.—Chippewa Point, near Fort Benton, on the Upper Missouri; Fort Benton group of the Upper Missouri Cretaceous series.

INDEX.

Names simply referred to are italicized

PLATE 1.

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FIG. 1. CYRENA DAKOTENSIS 159

1, *a*. Dorsal view of an internal cast.

1, *b*. Posterior view of same.

1, *c*. Side view of a larger specimen of the shell.

1, *d*. Dorsal view of another specimen of the two valves partly opened.

1, *e*. Side view of another smaller specimen.

1, *f*. Side view of a small internal cast.

FIG. 2. ARCOPAGELLA ? MACRODONTA 202

An eroded internal cast of the type-specimen, apparently the right valve. [The impressions of the lateral teeth are not near long enough in the lithograph.]

FIG. 3. PHARELLA DAKOTENSIS 251

A cast of the two valves opened out (type-specimen).

FIG. 4. Cast of the burrow of some unknown mollusk.

FIG. 5. MARGARITANA NEBRASCENSIS 114

5, *a*. Side view of the large, nearly entire, type-specimen.

5, *b*. A dorsal view of same.

5, *c*. A side view of a smaller internal cast of same species.

FIG. 6. TRIGONARCA SIOUXENSIS 92

A cast of the interior of the left valve (from the original typical figure by H. & M.).

FIG. 7. MACTRA SIOUXENSIS 206

7, *a*. A side view of the middle and posterior portions of the shell, showing surface-striæ, etc.

7, *b*. A side view of an internal cast, showing muscular and pallial impressions.

7, *c*. A posterior end view of the two valves united; taken from an artificial cast made in a natural mould of the shell left in the rock (both being type-specimens).

1a

4

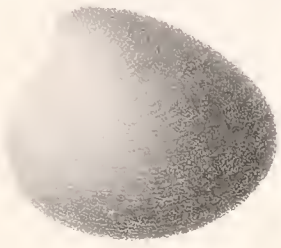
3

2

1b

1d

5c



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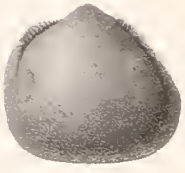

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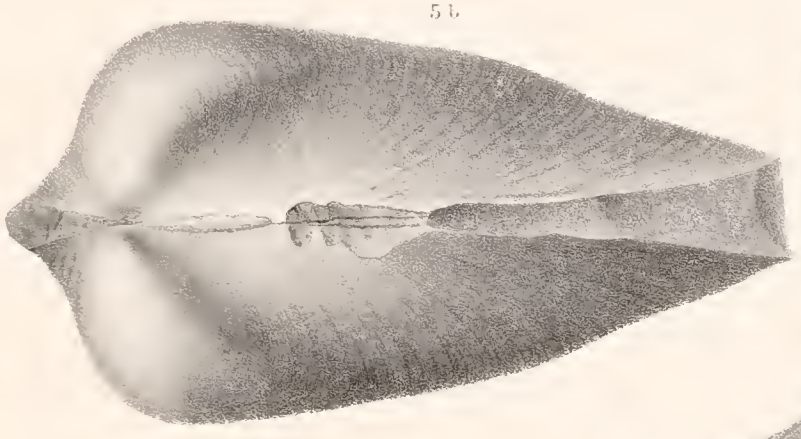

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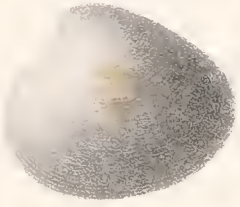
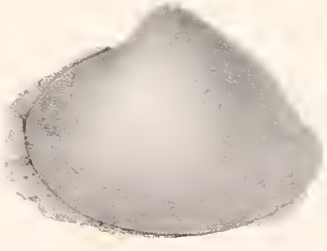


1e

7a



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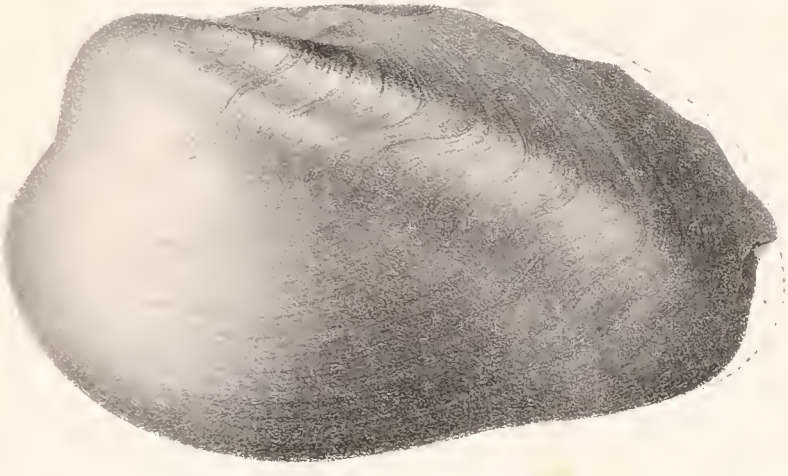
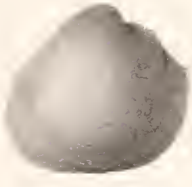


5a



1f

7c

PLATE 2.

Page.

FIG. 1. TRIGONARCA SALINAENSIS 92

1, *a*. A side view of an internal cast, natural size (type-specimen).

1, *b*. The same magnified to show hinge-teeth, muscular impressions, etc.

1, *c*. An outline profile view, to show the convexity of the shell.

FIG. 2. YOLDIA MICRODONTA 109

An internal cast, magnified two diameters, to show the minute hinge-crenulations (type-specimen).

FIG. 3. CRASSATELLINA OBLONGA 120

3, *a*. Side view of an internal cast, natural size.

3, *b*. Dorsal view of same.

3, *c*. Side view of cast of exterior, natural size (type-specimen).

3, *d*. A magnified view of right valve, showing hinge, muscular, and pallial impressions. [The furrow along the middle of the obliqne posterior cardinal tooth is too distinctly and sharply defined in the lithograph.]

3, *e*. Magnified view of hinge, muscular, and pallial impressions of left valve. [The small, compressed, posterior cardinal tooth is represented too short, and not straight and oblique enough.]

FIG. 4. ARCOPAGELLA MACTROIDES 202

4, *a*. An internal cast of left valve (natural size), showing muscular and pallial impressions of type-specimen.

4, *b*. An outline figure, showing hinge, muscular, and pallial impressions of the left valve.

4, *c*. Same view of right valve.

FIG. 5. CORBICULA ? NUCALIS 163

5, *a*. Cast of the interior of the right valve of type-specimen, showing muscular and pallial impressions and imprints of the lateral hinge-teeth.

5, *b*. An outline profile view, natural size, to show convexity.

5, *c*. A magnified view of the specimen represented by fig. 5, *a*.

FIG. 6. CORBICULA ? SUBTRIGONALIS 164

A cast of the interior of a left valve (type-specimen), showing muscular and pallial impressions, and an imperfect impression of the hinge, apparently as eroded before being imbedded in the arenaceous material now forming the enveloping rock.

FIG. 7. MESALIA ? KANSASENSIS 333

7, *a*. Dorsal view of an artificial cast made in a natural mould of the shell, natural size (type-specimen).

7, *b*. A side view of a cast of a larger specimen, showing the outline of the outer lip, with its sinuous margin. [The sinus is not deep enough in the lithograph.]

FIG. 8. OSTREA (undt. species) 12

8, *a*. An internal cast of the under valve.

8, *b*. An outside view of the flat upper valve.

FIG. 9. MARGARITA MUDGEANA 300

9, *a*. Cast of the interior of type-specimen.

9, *b*. An aperture view, drawn from a gutta-percha cast made in a natural mould, of the exterior of same.

FIG. 10. BARBATIA PARALLELA 80

A cast of the interior of a right valve (type-specimen.)

FIG. 11. TELLINA SUBSCITULA 195

11, *a*. An internal cast of left valve of type-specimen (natural size), showing muscular and pallial impressions.

11, *b*. Same, magnified about two diameters.

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FIG. 12. LEPTOSOLEN CONRADI 253

12, *a*. A cast of the exterior of a right valve magnified as above (type-specimen).

12, *b*. A cast of the interior of the right valve (with the anterior end broken away), magnified to about one and a half diameters, and showing the furrow left by the internal ridge represented too pointed below.

FIG. 13. PROTOCARDIA SALINAENSIS 174

13, *a*. A cast of the exterior of a left valve, natural size (type-specimen).

13, *b*. A profile internal cast, showing convexity.

13, *c*. A view of internal cast of left valve, natural size, showing muscular and pallial impressions, costæ, etc.

13, *d*. Same specimen as 13, *a*, magnified three diameters.

FIG. 14. CARDIUM? KANSASENSE 170

14, *a*. An imperfect cast of the exterior, showing remains of the small radiating costæ.

14, *b*. An internal cast of a right valve, showing muscular and pallial impressions, and traces of marginal crenulations.

14, *c*. The same view of a larger internal cast of a right valve, showing the casts of the cavities for the reception of the posterior and anterior lateral teeth (*p t* and *a t*) of the other valve, as well as that for the reception of the principal cardinal tooth of the other valve at *c t* (type-specimen).

14, *d*. An anterior view of same, also showing a projecting point at (*p*), apparently left by a scar for the attachment of a pedal muscle, near the beak.


1b
1c
1a
2
2 1
3b
3a
4d
4c
4b
5b
7b
7a
5a
3d
3c
5c
4a
6
8a
9a
10
9b
11b
13b
11a
8b
14a
13a
12b
14c
14d
12a
13d
3 1

PLATE 3.

Page.

FIG. 1. INOCERAMUS UMBONATUS 44

1, *a*. An inner view of the type-specimen, consisting of an internal cast of the umbonal region, with some portions of the coarsely fibrous shell attached, showing the great thickness of the latter.

1, *b*. An anterior side view of same, without the attached portion of the shell (natural size).

1, *c*. An interior view of a large internal cast of the left valve, reduced to one-half the natural diameter.

FIG. 2. INOCERAMUS UNDABUNDUS. 60

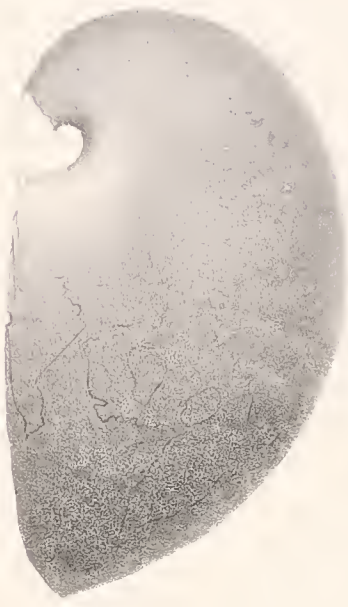
2. *a*. Side view of type-specimen, consisting of an internal cast of the left valve. [The hinge-margin of this specimen is not exactly placed horizontally as the figure stands on the plate, but ranges a little obliquely forward and downward.]

2, *b*. An anterior view of same (both natural size).

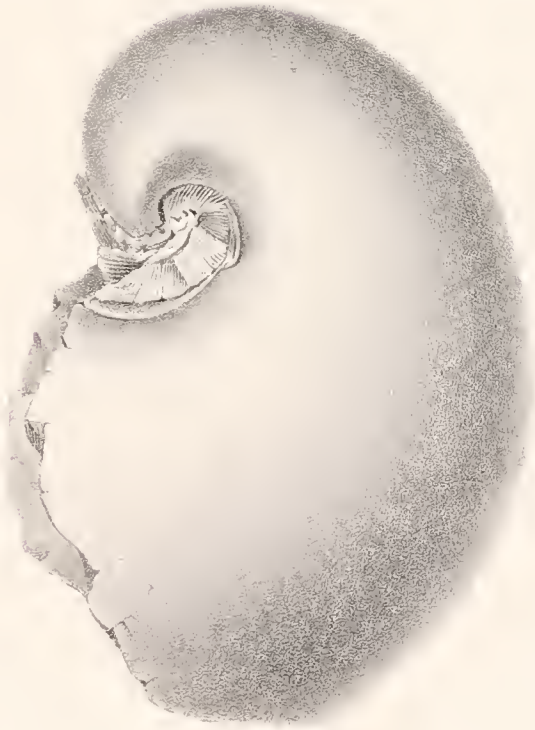
1a

2b

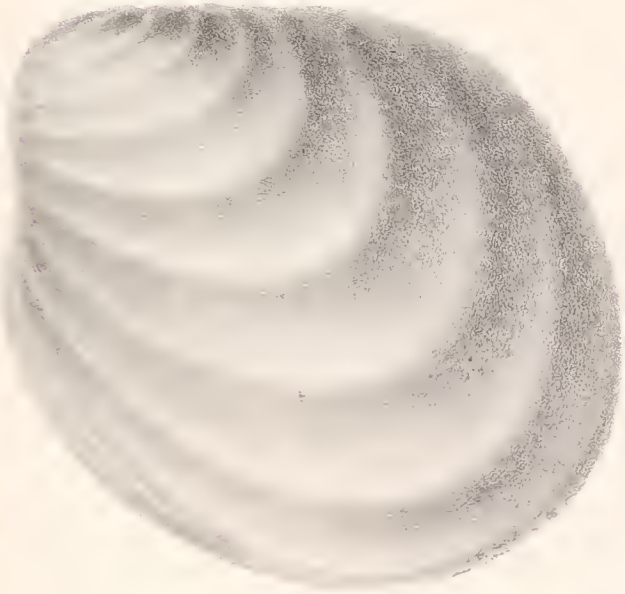
1b



1c



2a.



½ nat. diam.

PLATE 4.

Page.

FIGS. 1 and 2. INOCERAMUS UMBONATUS 44

1, *a*. An imperfect cast of a right valve, supposed to belong to this species.

1, *b*. An anterior profile view of the same.

2, *a*. An anterior view of an internal cast of the left valve, with portions of the external fibrous layer seen in the umbonal region.

2, *b*. Another view of a cast of a left valve, reduced in size.

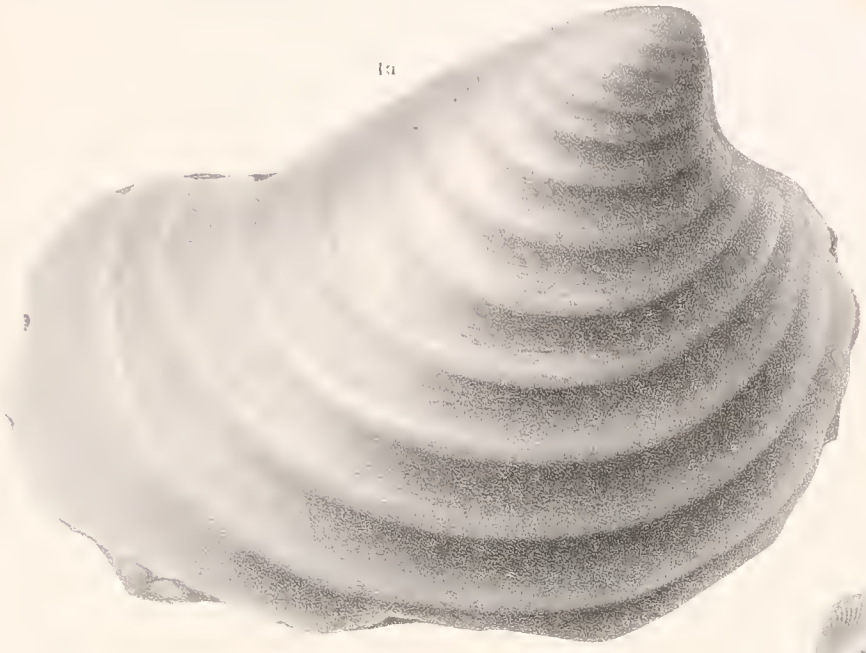
FIG. 3. VENIELLA MORTONI 154

3, *a*. A right-side view of type-specimen.

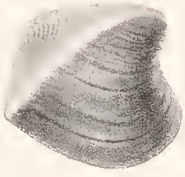
3, *b*. A posterior dorsal view of same.

FIG. 4. VENIELLA GONIOPHORA 152

A right-side view of the type-specimen, consisting mainly of a cast of the interior.


1a


1b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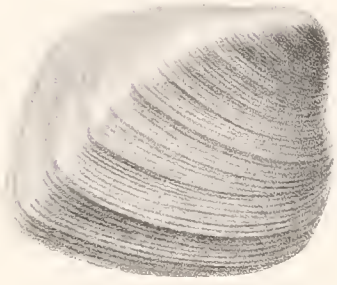
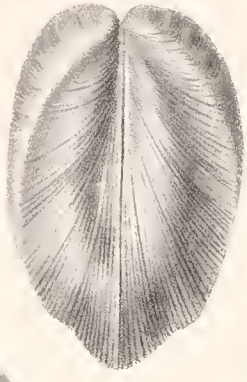

3a


3b


2b


2a

PLATE 5.

U. S. Geological Survey of the Territories.

(Fort Benton Group.)

PLATE 6.

Page.

FIG. 1. SERPULA TENUICARINATA 507

A mass of rock, with portions of the shell-tubes exposed by the weathering away of the surface (type-specimen).

FIG. 2. PRIONOCYCLUS WOOLGARI 455

An outline of a transverse section of an outer volution near the aperture, showing the wing-like lateral extensions of the costæ. (See also plate 7.)

FIGS. 3, *a*, *c*, AND 6, *b*. MORTONICERAS SHOSHONENSE 449

3, *a*. A side view of the type-fragment.

3, *b*. A peripheral view of the same. [By mistake numbered 6, *b* on the plate.]

3, *c*. One of the septa, slightly more than natural size.

FIG. 4. SCAPHITES VERMIFORMIS 423

4, *a*. A side view of an internal cast, natural size (type-specimen).

4, *b*. Another view of same, showing aperture, etc.

FIG. 5. SCAPHITES WARRENI 420

A side view of the type-specimen, which is imperfect, and does not give an entirely clear idea of the species. [See remarks and further illustrations in text.]

FIG. 6. SCAPHITES LARVÆFORMIS 418

6, *a*. Side view, natural size, of the type-specimen.

6, *b*. A peripheral view of same, turned a little obliquely.

6, *c*. A septum of same, magnified to a little more than two diameters.

FIGS. 7 AND 8. SCAPHITES VENTRICOSUS 425

7, *a*. View of periphery and aperture, natural size, of type-specimen.

7, *b*. A side view of same specimen.

8, *a*, *b*. Two views of a specimen, consisting of inner volutions, and believed to belong to the same species.

8, *c*. A septum of same, slightly enlarged.


1


2

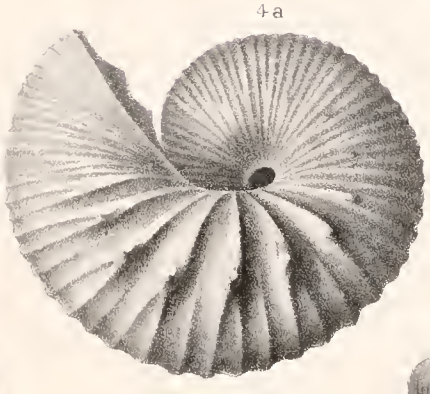

3a


6b


6c


3c


4b


4a


5


6a


6b


8


7a


8a


8b

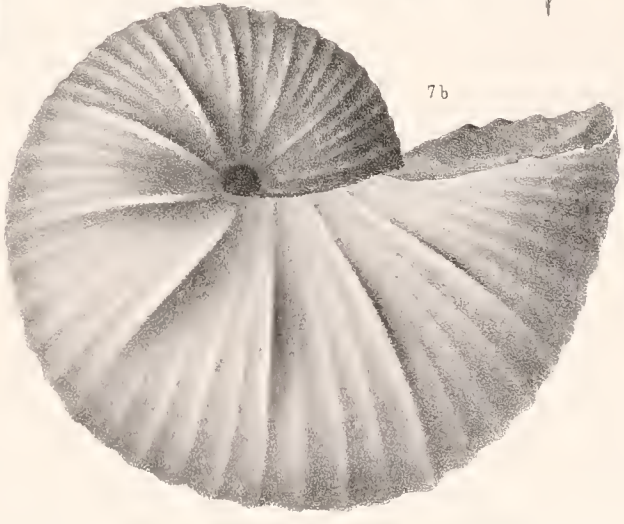

7b

PLATE 7.

Page.

FIGS. 1 AND 3. PRIONOCYCLUS WOOLGARI 455

1, *a*. A side view of an imperfect specimen, somewhat less than half grown, showing the large crenulations of the keel, etc.

1, *b*. A peripheral view of the same; one side being defective.

1, *c*. A side view of a smaller specimen, with the crenulations of the keel and the nodes of the costæ less strongly defined.

1, *d*. A peripheral view of the same.

1, *e*. A septum, magnified about two and a half diameters, from a specimen intermediate in size between the last two.

1, *f*. A still smaller specimen, with the crenulations of the keel and the nodes of the costæ only just beginning to be developed.

1, *g*. A large specimen, showing the modifications of the keel, costæ, and nodes in the adult shell.

1, *h*. A part of a septum, consisting of the siphonal lobe and the first and second lateral lobes and sinuses, magnified about one and a half diameters from the large specimen represented by fig. 1, *g*.

3. A fragment of non-septate part of an adult specimen, apparently of this species, showing the keel merely represented by low, isolated, elongated nodes, and the nodes at the outer ends of the costæ developed into large spine-like projections.

FIG. 2. MORTONICERAS VERMILIONENSE 450

2, *a*. A side view of apparently a young individual (type-specimen).

2, *b*. A septum of the same, magnified to a little more than four diameters.

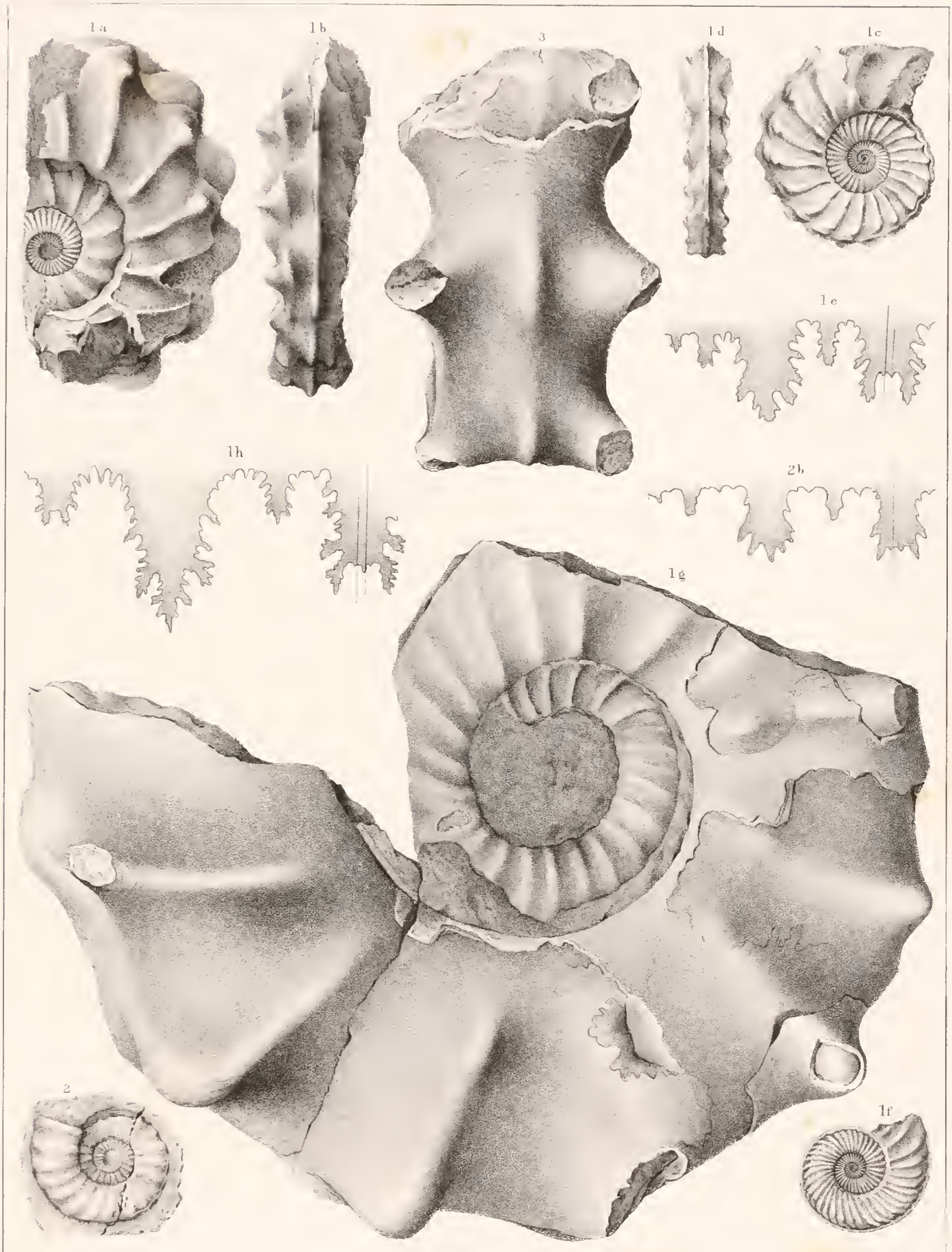

1a
1b
3
1d
1c
1e
1h
2b
1g
2
1f

PLATE 8.

Page.

FIG. 1. AMMONITES ? ? MULLANANUS. (See Appendix.)

1, *a*. A profile view of the type-specimen, consisting of an internal cast of a part of the septate turns, showing the rounded periphery and the form of the aperture as indicated by a section of one of the volutions.

1, *b*. A side view of the same specimen.

1, *c*. A septum of the same, magnified one and a half diameters. [First lateral lobe sometimes more nearly bipartite.]

FIG. 2. NAUTILUS ELEGANS 499

2, *a*. An aperture view of a partly exfoliated specimen, with the lip all broken away.

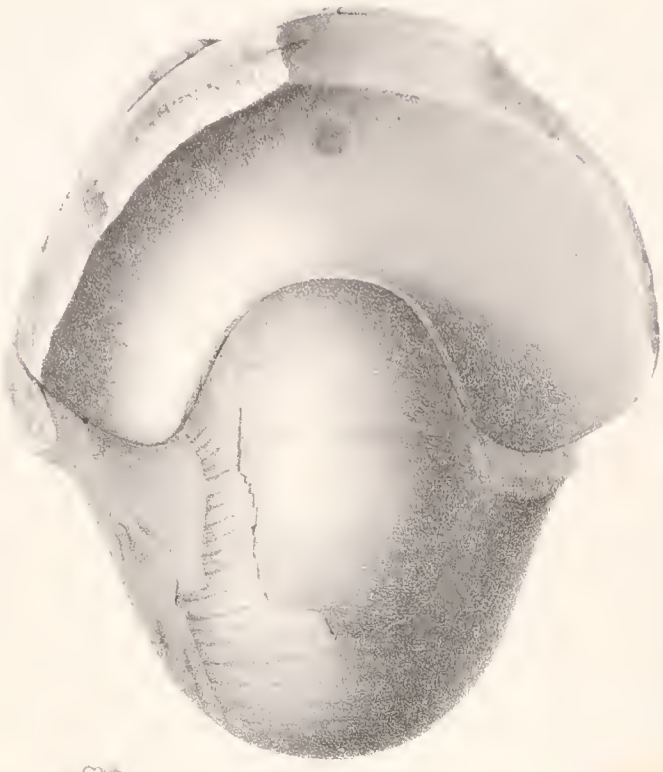
2, *b*. A peripheral view of the same.

2, *c*. A side view of same.

1a

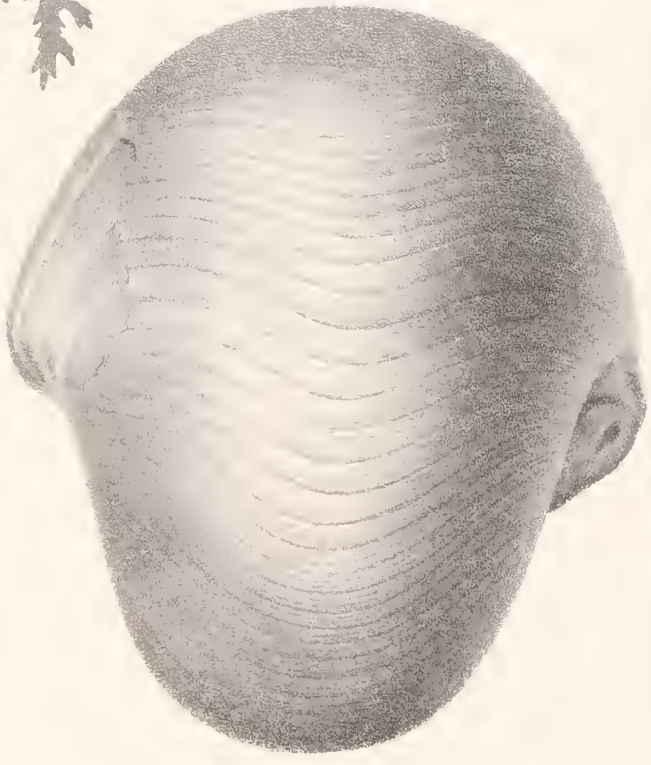
1b

2a



1c

2b



2c

PLATE 9.

Page.

FIG. 1. OSTREA CONGESTA 13

1, *a*. A lateral view of a lower valve, growing on others, with its sides ascending nearly vertically.

1, *b*. Several lower valves partly imbedded in the marly rock, showing their truncated originally attached ends or bases, with lateral walls produced so as to present the appearance of short cylindrical tubes; also internal views of some upper valves.

1, *c*. Internal views of lower valves, growing on fragments of the outer-shell layer of *Inoceramus*, showing the appearance of this valve before its lateral margins had grown so as to rise much above the surface of attachment.

1, *d*. Internal view of one of the lower valves, somewhat magnified.

1, *e* and *f*. Upper valves; the latter magnified, and showing very faint traces of radiating markings very rarely seen on the inner surface.

FIG. 2. ANOMIA? OBLIQUA 22

An upper valve (if really an *Anomia*) of the type-specimen.

FIG. 3. INOCERAMUS PROBLEMATICUS 62

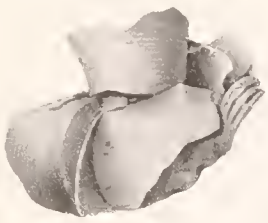
3, *a*. A left view of a small ovate specimen.

3, *b*. A right view of an elongated specimen.

FIG. 4. INOCERAMUS PROBLEMATICUS, *var.* AVICULOIDES 63

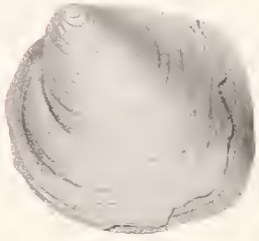
An internal cast of a right valve of the type of the *var.*


1d.


1a

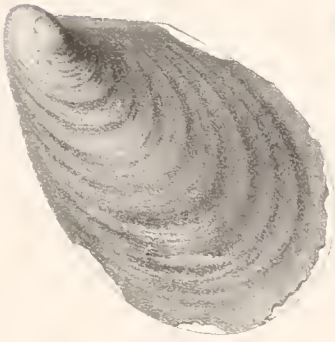

1c

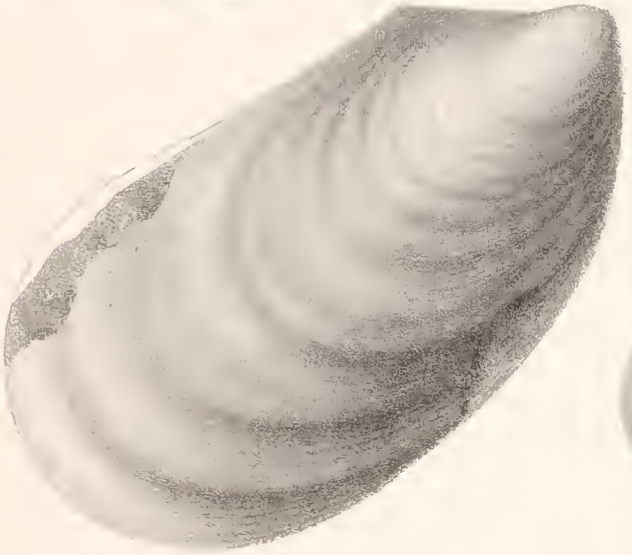

1f.


2.


1b


1c


3a


3b.

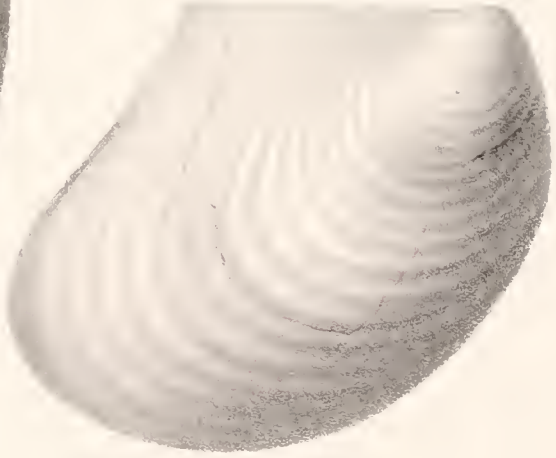

4

PLATE 10.

Page.

FIG. 1. HEMIASTER HUMPHREYSIANA 5

1, *a*. A side view of the type-specimen, the surface-markings of which were destroyed in breaking it from the rock.

1, *b*. An upper-side view of the same.

1, *c*. A posterior view of same, showing anal opening.

1, *d*. Under side of same, showing oral aperture.

1, *e*. A small part of the anterior ambulacrum, with two of the interambulacral plates on each side, all magnified.

1 *f*. A few of the ambulacral pieces more highly magnified.

1, *g*. A small part of one of the short posterior ambulacra from the lower termination of its petaloid area, with a few of the interambulacra on each side, all magnified.

FIG. 2. OSTREA PATINA 16

2, *a*. A hinge-area view of the upper valve of type-specimen.

2, *b*. An outside or upper view of same.

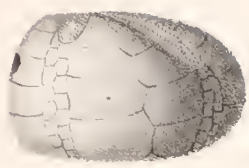
2, *a*, *b* (*bis*). Internal and external views of lower valve of type-specimen. (See bottom of plate.

FIG. 3. OSTREA PATINA, *var. A* 18

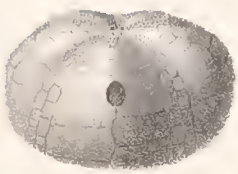
3, *e*, *f*. An internal and external view of the lower valve of the type of this *var.* (For upper valve of same, see fig. 1, *a*, *b*, of plate 11.)

FIG. 4. OSTREA INORNATA 14

The type-specimen, showing the upper side of the shell with the two valves united.


1a.


2a


1c


1b

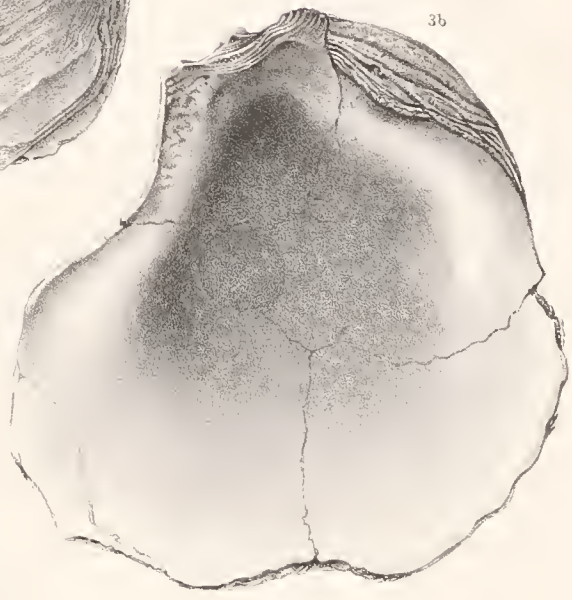

1f

1e


1d.


2b


3a


3b


1g.


2a


4


2b

PLATE 11.

(Fort Pierre Group.)

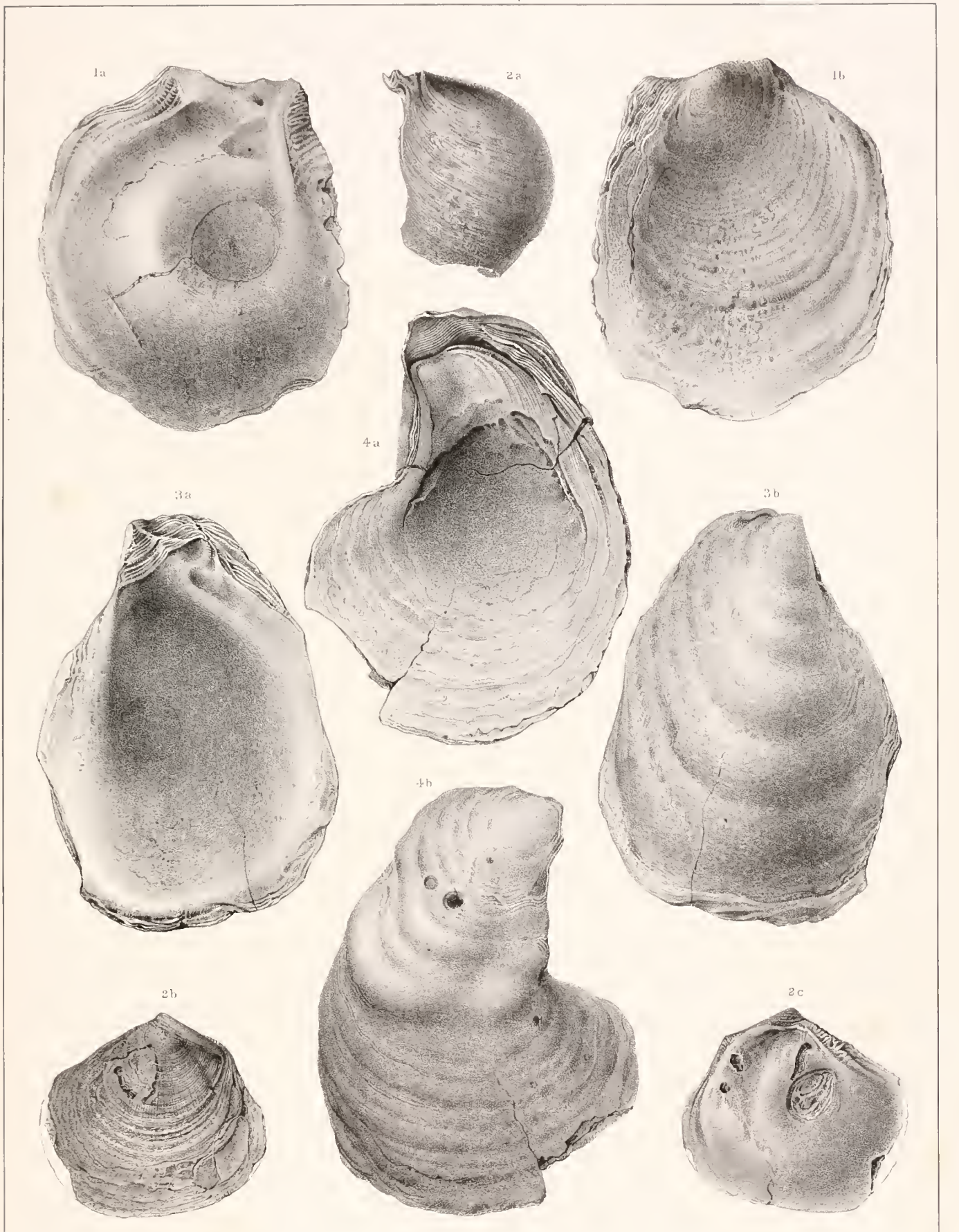


PLATE 12.

Page.

FIG. 1. INOCERAMUS SUBLÆVIS 58

1, *a*. Left view of a young specimen, retaining only the inner pearly layer.

1, *b*. A dorsal view of same.

FIG. 2. INOCERAMUS PROXIMUS, *var.* SUBCIRCULARIS 55

2, *a*. A left view of a specimen, retaining the inner pearly layer (type of the *var.*).

2, *b*. A dorsal view of the same.

FIG. 3. INOCERAMUS CRIPSII, *var.* BARABINI 49

A right-side view of a small specimen.

FIG. 4. INOCERAMUS INCURVUS 61

4, *a*. A dorsal view of the type-specimen, with the opposite (but imperfect) valves lying together and retaining portions of the inner layer.

4, *b*. A somewhat different view of same.

FIG. 5. INOCERAMUS CONVEXUS 51

5, *a*. Side view of an imperfect left valve, retaining portions of inner layer.

5, *b*. A dorsal view of same. (Both copies of the original figures.)

FIG. 6. INOCERAMUS TENUILINEATUS 57

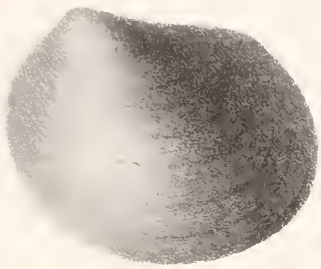
View of an imperfect cast of the left valve, retaining portions of inner laminæ. (From original type-figure.)

FIG. 7. INOCERAMUS PROXIMUS 53

7, *a*. View of an imperfect cast of a right valve, retaining portions of inner laminæ.

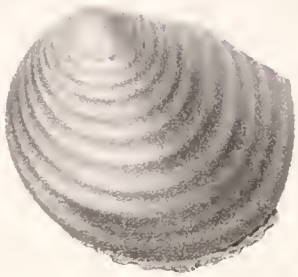
7, *b*. An outline dorsal view of same, to show its compressed form.

1a

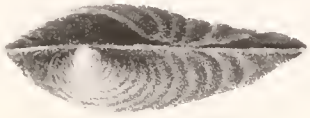


1b

2a

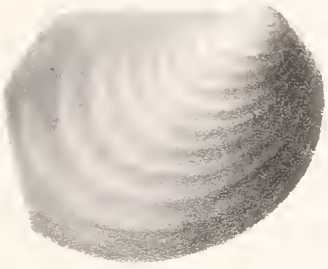


2b



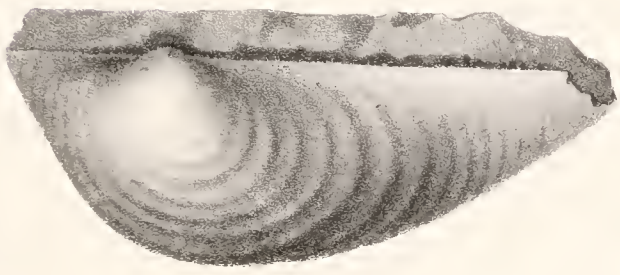
4a

3

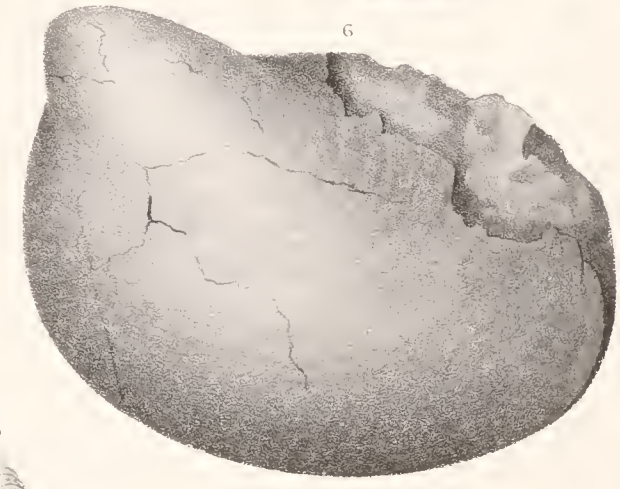


4b

5b

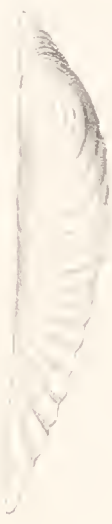


6



5a

7b



7a

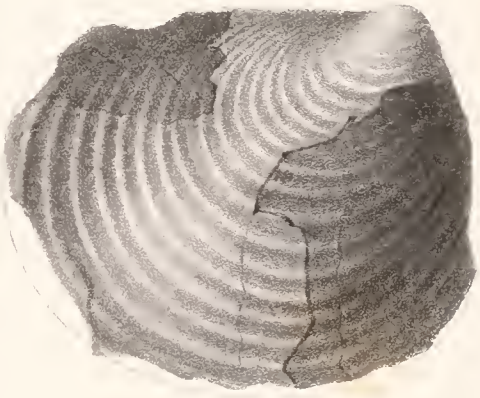


PLATE 13.

Page.

FIG. 1. INOCERAMUS CRIPSII ?, *var.* BARABINI 49

1, *a*. Right-side view of the rather transverse type-specimen, of the variety, natural size; retaining portions of the inner pearly layer.

1, *b*. A left-side view of a proportionally shorter, smaller specimen.

1, *c*. A dorsal profile view of the last, to show its compressed form.

FIG. 2. INOCERAMUS SAGENSIS, *var.* NEBRASCENSIS 52

2, *a*. A right-side view of the type-specimen of the variety, with portions of the posterior and posterior-basal margins broken away.

2, *b*. An outline dorsal view of same, to show convexity.

FIG. 3. PHOLADOMYA (PROCARDIA) HODGII 219

3, *a*. A left-side view of the type-specimen, which is an internal cast, natural size.

3, *b*. An interior view of same, showing the strongly-incurved character of the beaks, and large, impressed, cordate lunule, as well as a kind of false area under the beaks.


1a
1c
1b
3a
2b
3b
2a

PLATE 14.

Page.

FIG. 1. INOCERAMUS ALTUS 43

1, *a*. Left-side view of the type-specimen, with the basal and posterior margins broken away, and the anterior inflected and accidentally pressed backward to some extent (reduced to half the natural diameter).

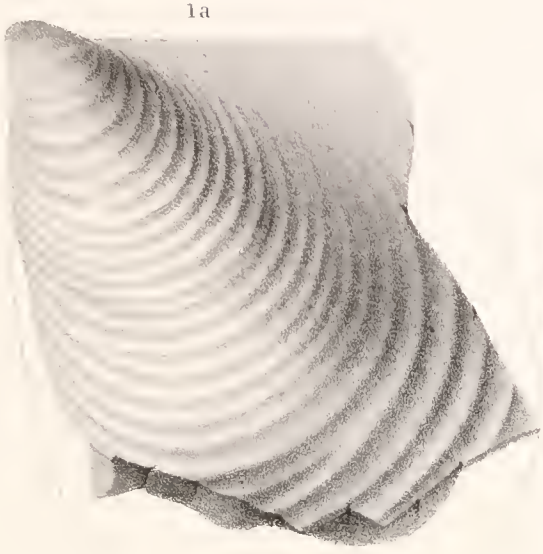
1, *b*. An anterior view of same, reduced in the same way.

FIG. 2. INOCERAMUS VANUXEMI 57

2, *a*. Side view of type-specimen, consisting of left valve, with lateral and basal margins broken away, but dimly restored from the curves of the undulations (natural size).

2, *b*. A profile outline dorsal view of same, to show its compressed form.

1a



1b

2b

2a

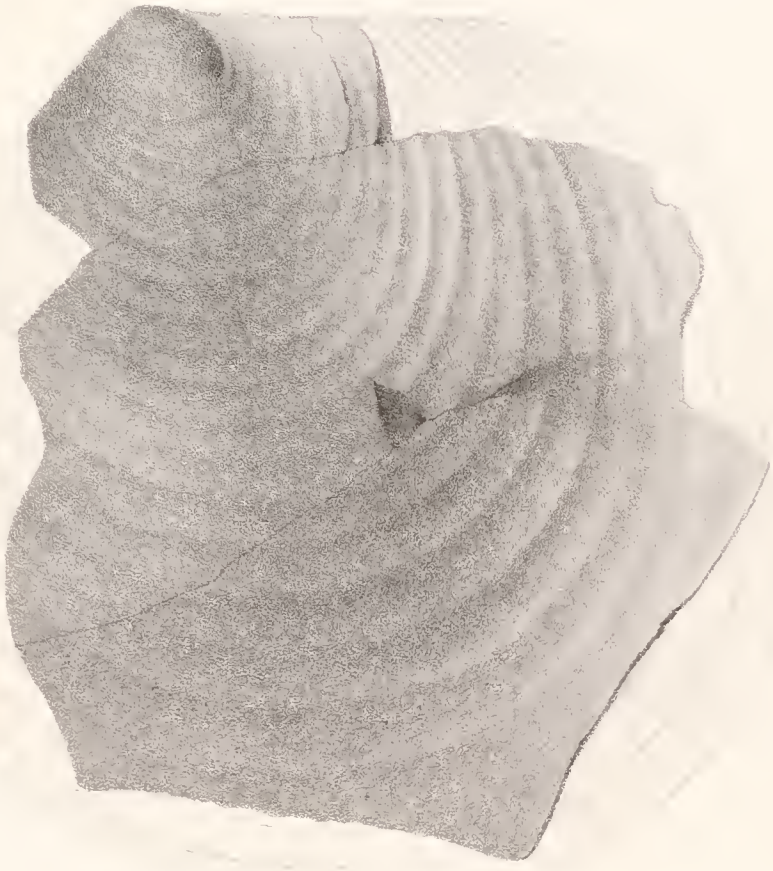


PLATE 15.

Page.

FIG. 1. INOCERAMUS BALCHII 56

1, *a*. An imperfect cast of left valve (type-specimen).

1, *b*. An outline dorsal view, to show its compressed form.

FIG. 2. TRIGONARCA (BREVIARCA) EXIGUA 93

2, *a*. An anterior view of the two valves attached and a little parted, natural size (type-specimen).

2, *b*. A left-side view of same.

2, *c*. An internal cast of a left valve, showing impressions of the hinge-denticles on each side.

2, *d*. View of left valve, magnified.

2, *e*. Surface-striæ more highly magnified.

2, *f*. Hinge-area of same, magnified.

FIG. 3. VOLSELLA MEEKII 72

3, *a*. Dorsal view of a specimen, with the beaks a little broken.

3, *b*. Side view of an internal cast.

3, *c*. An internal cast of a young specimen.

FIG. 4. NUCULANA BISULCATA 104

4, *a*. A right-side view of the type-specimen, magnified to two diameters.

4, *b*. A dorsal view of the same.

FIG. 5. YOLDIA VENTRICOSA 112

5, *a*. Right-side view, natural size, copied from the figure of the type-specimen.

5, *b*. Same, magnified.

FIG. 6. NEMODON SULCATINUS 82

6, *a*. An internal cast, natural size.

6, *b*. Same, magnified. (Mesial sulcus not deep enough.)

FIG. 7. NUCULANA ? EQUILATERALIS 106

7, *a*. Right-side view of the type-specimen, consisting of an internal cast, magnified two diameters.

7, *b*. Dorsal view of same.

FIG. 8. NUCULA PLANIMARGINATA 101

8, *a*. A right view of the type-specimen, consisting of an imperfect cast, retaining a part of the shell.

8, *b*. Dorsal view of same.

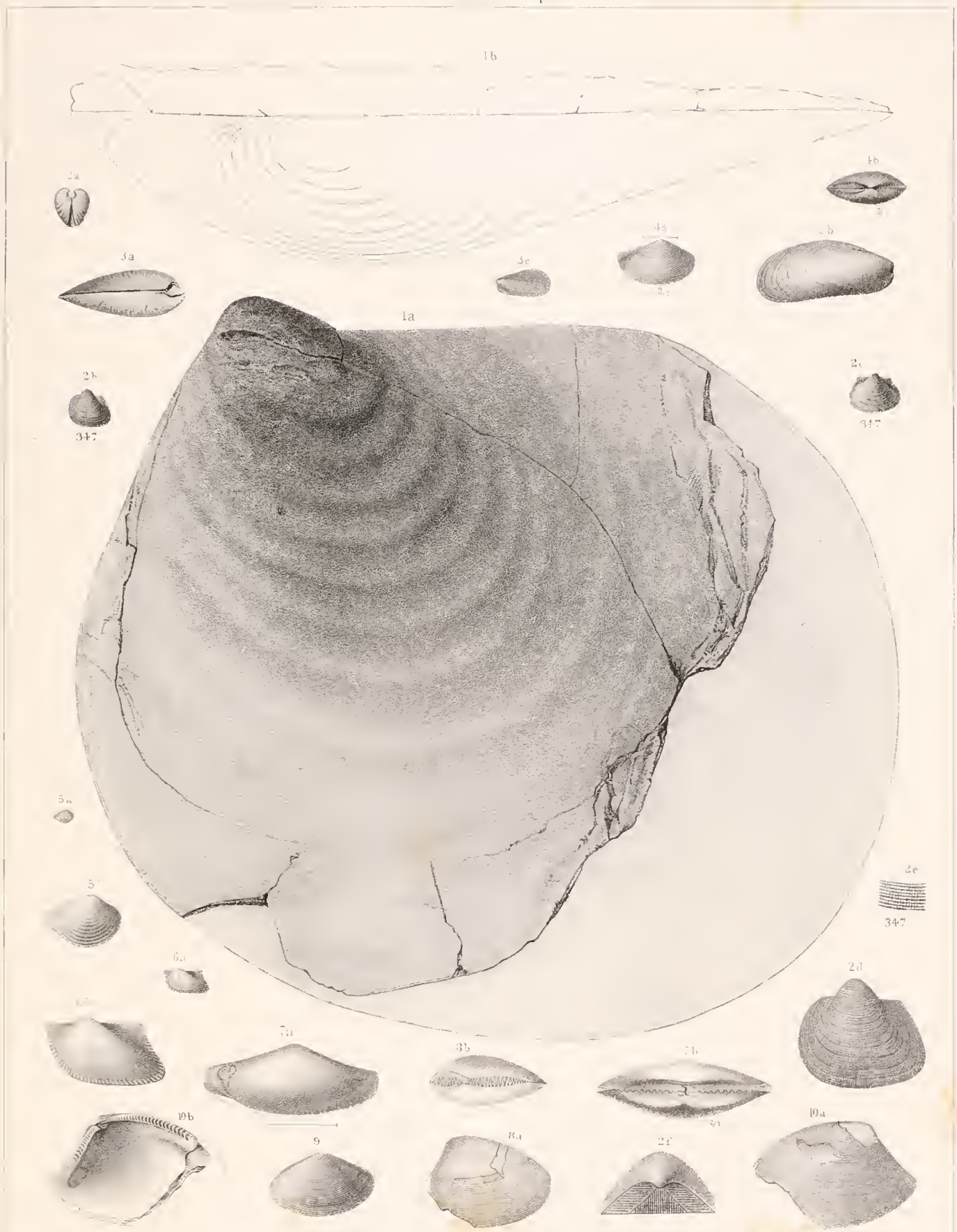
FIG. 9. NUCULANA SUBNASUTA 105

A left-side view, natural size.

FIG. 10. NUCULA OBSOLETISTRIATA 100

10, *c*. Outside view of type-specimen, consisting of an imperfect left valve.

10, *d*. Inside and hinge view, of same.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2e
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5
6a
2d
3a
3b
7b
10b
9
8a
2f
10a

PLATE 16.

Page.

FIG. 1. PTERIA LINGUIFORMIS 32

1, *a*. A right-side view of an internal cast, with the projecting extremity of the posterior wing broken away.

1, *b*. A still more imperfect cast of a left valve.

1, *c*. A right-side view of a very small, young specimen.

1, *d*. A left-side view of a larger example.

FIG. 2. PTERIA HAYDENI 33

2, *a*. A left-side view, natural size, copied from the original figure of the type-specimen (probably a young shell).

2, *b*. The same, somewhat magnified.

FIG. 3. PTERIA (OXYTOMA) NEBRASCANA 34

3, *a*. A left-side view of a medium-sized specimen.

3, *b*. The same, of a large, imperfect specimen.

3, *c*. Surface-markings, magnified.

FIG. 4. ANOMIA? SUBTRIGONALIS 22

4, *a*. An external view of the type-specimen, consisting of a cast of the upper valve.

4, *b*. A different view of parts of both valves, perhaps of the same shell.

FIG. 5. SYNCYCLONEMA RIGIDA 27

5, *a*. A medium-sized left valve.

5, *b*. An internal cast of a somewhat larger right valve.

FIG. 6. CHLAMYS NEBRASCENSIS 25

6, *a*. A left? valve of one of the largest type-specimens, with one of its auricles broken away.

6, *b*. A side view of the same, showing its convexity.

6, *c*. A smaller, proportionally narrower specimen of same, with auricles broken.

FIG. 7. GERVILLIA SUBTORTUOSA 65

7, *a*. A dorsal view of the broken and exfoliated type-specimen, with the two valves united, and the wanting posterior portion restored in dim, flat shade.

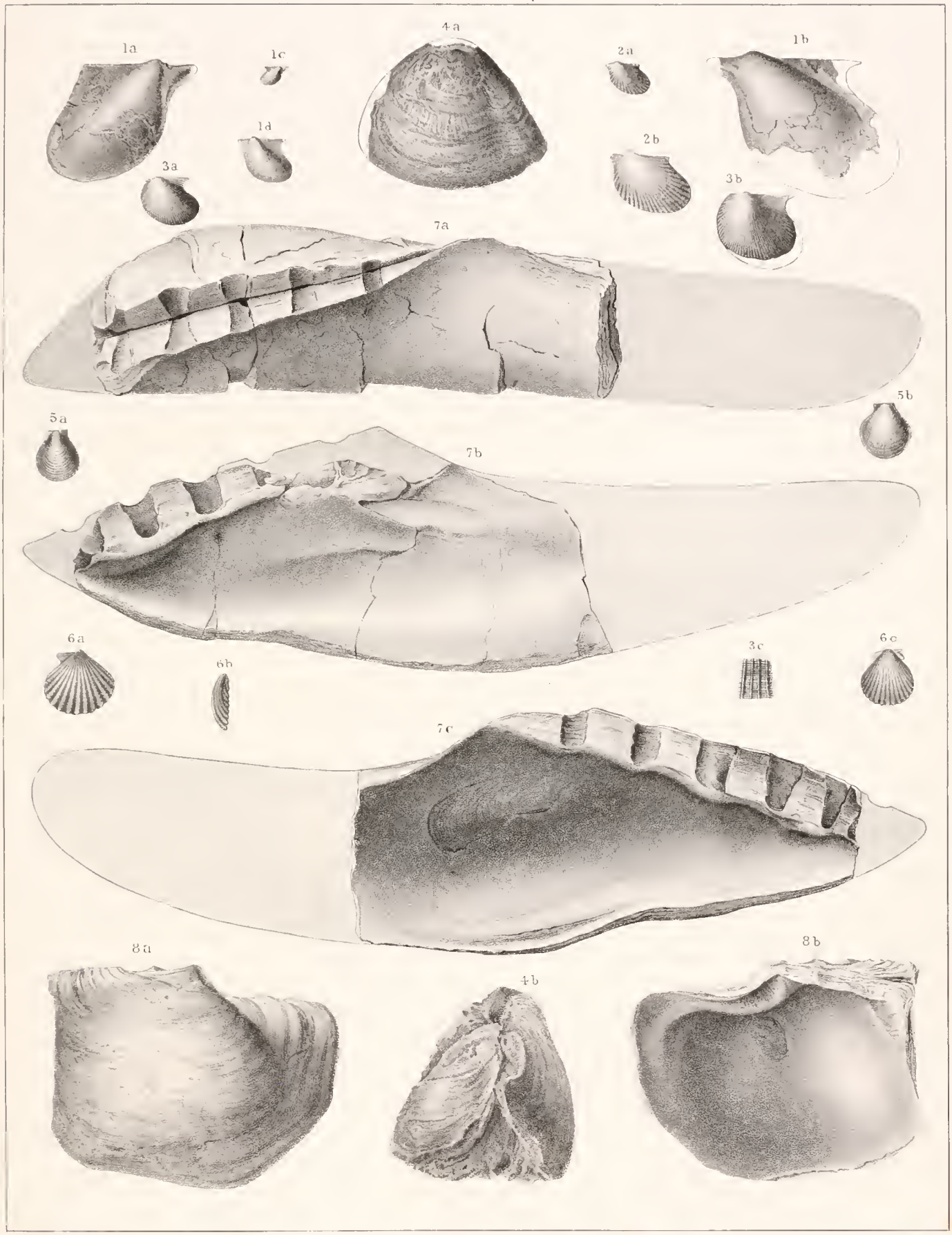
7, *b*. An internal and hinge view of right valve of same.

7, *c*. The same view of the left valve.

FIG. 8. GRYPILÆA VESICULARIS? 20

8, *a*. Exterior of lower valve.

8, *b*. Internal view of same.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7a
5b
5a
7b
6a
6b
3c
6c
7c
8a
8b
4b

PLATE 17.

Page

Fig. 1. Protocardia rara 176

1, *a*. A right-side view of an adult specimen, natural size.

1, *b*. A posterior view of an internal cast, magnified.

1, *c*. A left-side view of same, showing the muscular impressions and the doubly-waved or sinuous character of the pallial line.

Fig. 2. Lucina subundata 133

2, *a*. A rather small subquadrangular specimen, right side.

2, *b*. Dorsal view of same.

2, *c*. A smaller individual, left-side view, with anterior dorsal sulcus wanting.

2, *d*, Dorsal view of same.

2, *e*. A large, somewhat differently-formed, specimen, with the anterior dorsal sulcus well defined, left side.

2, *f*. A large specimen, right side, with the anterior dorsal sulcus broad and shallow.

Fig. 3. Lucina subundata, *var.* ventricosa 135

3, *a*. A right-side view of the type-specimen of this variety, with lower margin broken away.

3, *b*. Dorsal view of same.

3, *b*, (*bis.*) A left side of a larger internal cast, showing muscular and pallial impressions. [This figure is directly under fig. 3, *a*.]

Fig. 4. Lucina occidentalis 134

4, *a*. A dorsal view of an adult specimen.

4, *b*. A right-side view of same.

4, *c*. Same view of an internal cast, showing muscular and pallial impressions.

4, *d*. A fragment of a right valve, showing cardinal teeth.

Fig. 5. Veniella subtumida 154

5, *a*. Dorsal side of an internal cast (type-specimen).

5, *b*. Right side of same, showing muscular and pallial impressions.

Fig. 6. Crassatella Evansi 117

6, *a*. Right side of a perfect specimen.

6, *b*. Anterior side of same.

6, *c*. Dorsal view of same.

6, *d*. Left side of an internal cast, showing muscular and pallial impressions, as well as the finely crenate character of the free margins.

Fig. 7. Nucula subplana 99

7, *a*. Left side of the type-specimen, consisting of an internal cast, showing muscular and pallial impressions.

7, *b*. Dorsal view of same, showing impressions of the hinge-denticles.

Fig. 8. Thetis circularis 190

8, *a*. Left side of the type-specimen, which is a medium-sized, perfect example.

8, *b*. Right side of a larger internal cast, showing the pointed, vertically-ascending pallial sinus.

8, *c*. An anterior view of the same. (See also wood-cuts in text.)

Fig. 9. Eriphyla gregaria 121

9, *a*. Right side of the perfect type-specimen, magnified two diameters.

9, *b*. Dorsal view of same. (See also wood-cuts in test.)

Figs. 10 and 12. Callista pellucida 187

10, *a*. Right side of the partly-exfoliated oval type-specimen.

10, *b*. Left side of an internal cast, showing muscular and pallial impressions.

10, *c*. Right side of a more rounded specimen.

10, *d*. An outline dorsal view of specimen represented by fig. 10, *b*.

Page.

10, *c*. Right side of a proportionally more elevated variety.
12, *a*. Right side of a short, compressed variety, with a part of the shell removed to show the pallial sinus.
12, *b*. An opposite side view of a somewhat differently-formed specimen.
12, *c*. Dorsal view of last.

Fig. 11. Nelera Moreauensis 239
11, *a*. Right valve, natural size (type-specimen).
11, *b*. Dorsal view of same.
11, *c*. Same valve, magnified, to show more clearly the concentric costæ.

Fig. 13. Corbulamella gregaria 247
13, *a*. Left view, showing the unequal sizes of the valves, magnified about four diameters (type-specimen).
13, *b*. Anterior view of same, magnified.
13, *c*. A right-side view, magnified.
13, *d*. Hinge and interior of a left valve, magnified so as to show the strongly-projecting lamina of the posterior muscular attachment.

Fig. 14. Corbula crassimarginata 244
14, *a*. A right-side view, magnified nearly three diameters.
14, *b*. A ventral view of same, showing the thickened margins (type-specimen).
14, *c*. A posterior view of same.

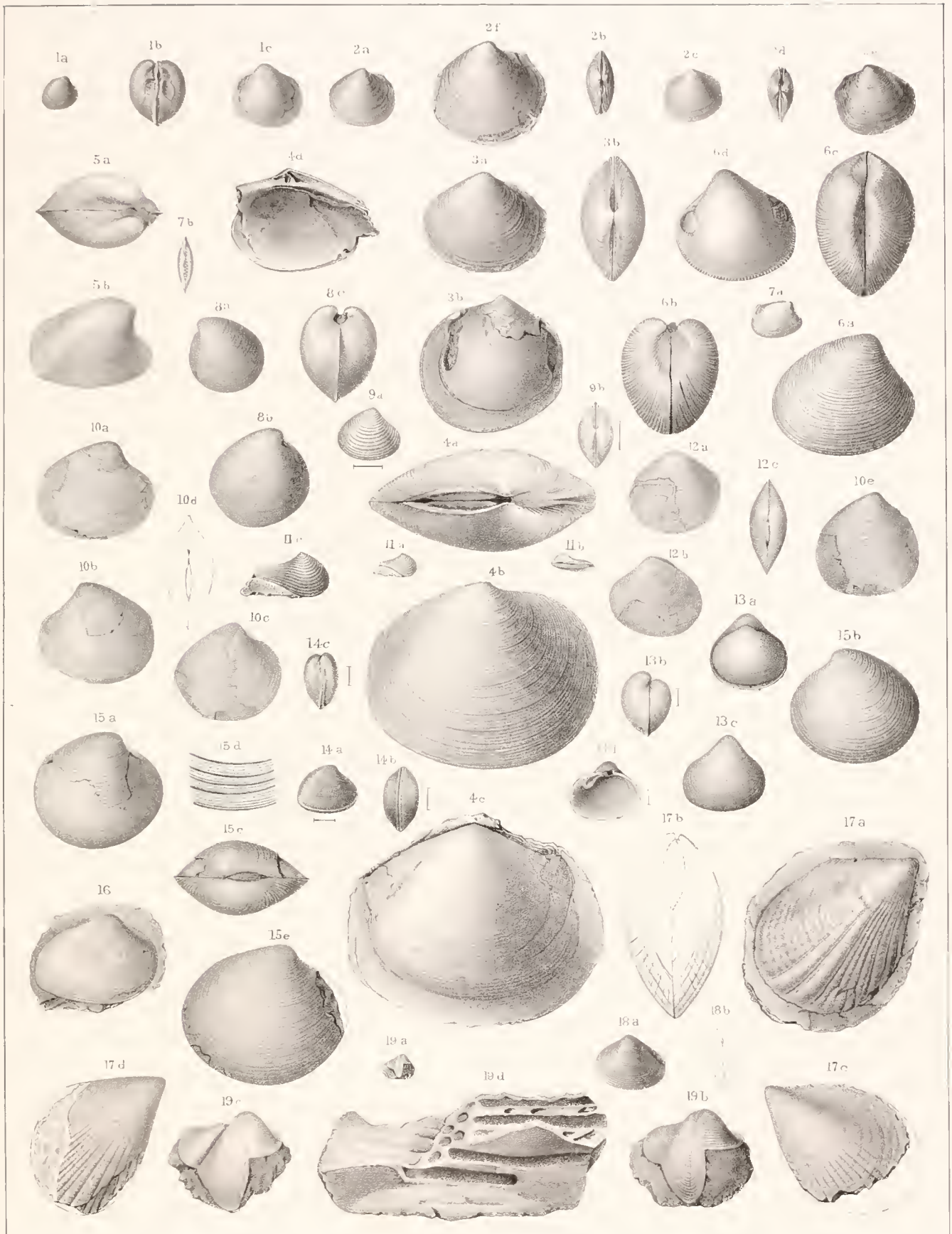
Fig. 15. Callista Deweyi 182
15, *a*. Right side of a specimen with portions of the shell removed, to show the muscular and pallial impressions on the internal cast.
15, *b*. Left-side view of a perfect specimen.
15, *c*. A dorsal view of the specimen, represented by fig. 15, *a*.
15, *d*. Surface-striæ, somewhat magnified.
15, *e*. Right side of a larger, somewhat more oval, example.

Fig. 16. Tellina? Cheyennensis. (See Appendix.)
A left-side view of the type-specimen.

Fig. 17. Pteria (Pseudoptera) fibrosa 36
17, *a*. An internal cast of a right valve. (Type of species.)
17, *b*. An outline of the two valves united, as made out from opposite, detached valves.
17, *c*. An imperfect left valve.
17, *d*. An imperfect right valve, with somewhat different costæ.

Fig. 18. Mactra gracilis 209
18, *a*. Left-side view of type-specimen.
18, *b*. A dorsal view, in outline.

Fig. 19. Teredo selliformis 262
19, *a*. A right-side view, natural size, of type-specimen.
19, *b*. Same, magnified, to show the surface-markings.
19, *c*. Internal cast, magnified, to show the deep posterior sulcus left by an internal ridge.
19, *d*. Burrows, supposed to have been made by this species.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15a
15d
14a
14b
4c
13c
17b
17a
15c
16
15e
18a
18b
19a
17d
19d
19b
17c
19c

PLATE 18.

FIGS. 1 AND 2. ACMÆ? PARVA 296

1, *a*. Upper side of an internal cast, natural size, of type-specimen.

1, *b*. A lateral view of same.

1, *c*. Interior of the shell of same.

2. Internal cast, magnified, to show the small, horseshoe-shaped, muscular scar.

FIG. 3. ACMÆA OCCIDENTALIS 295

3, *a*. An internal cast, natural size, showing the muscular scar and obscure radiating lines of the interior.

3, *b*. A side view of same.

3 *c*. An upper-side view of internal cast, magnified, to show more clearly the muscular scar and other markings.

FIG. 4. ANISOMYON ALVEOLUS 292

4, *a*. An internal cast, with some remaining portions of the shell around the margins and the peculiar muscular scar seen nearly inclosing the apex (type-specimen).

4, *b*. A side view of same.

FIG. 5. ANISOMYON PATELLIFORMIS 290

5, *a*. A side view of a testiferous specimen, showing the immediate minute apex abruptly curved backward.

5, *b*. An anterior view of same.

5, *c*. The type-specimen, with a part of the thin shell removed, to show the peculiar muscular scar with its characteristic break on the right posterior side.

5, *e*. Another more elliptic form, possibly belonging to this species.

5, *f*. An upper view of a large internal cast, showing muscular scars, etc.

FIGS. 5, *d*, AND 6. ANISOMYON SUBOVATUS 291

5, *d*. A side view of the type-specimen, consisting of an internal cast, with the immediate apex broken away.

6. An upper view of same.

FIG. 7. ANISOMYON SHUMARDI 289

7, *a*. A side view of the testiferous type-specimen, with the apex wanting.

7, *b*. An upper view of the same.

7, *c*. An anterior view of same.

FIG. 8. ANISOMYON SEXSULCATUS 293

8, *a*. An imperfect internal cast, side view (type-specimen).

8, *b*. An upper-side view of same, showing obscurely the muscular scar.

FIG. 9. ANISOMYON BOREALIS 288

9, *a*. An upper-side view of an imperfect, partly testiferous specimen, with the little apex broken away.

9, *b*. A side view of the same, the apex being restored in outline.

9, *c*. An anterior view of same.

9, *d*. An upper view of a larger internal cast, on which the muscular impression is obsolete.

9, *e*. A side view of same.

FIG. 10. HAMINEA? SUBCYLINDRICA 272

10, *a*. An aperture view of the type-specimen, consisting of an internal cast, broken so as to give an unnatural truncated appearance to the columella and lower part of the lip.

10, *b*. An opposite view of the same.

FIGS. 11 AND 12. HAMINEA? OCCIDENTALIS 271

11, *a*. An internal cast, natural size.

11, *b*. An aperture view of another internal cast, broken about the base of the aperture (type-specimen).

12, *a*. Another cast, also with lip broken.

12, *b*. The same, magnified; the truncated appearance of the columella being due to a break.

FIG. 13. DENTALIUM GRACILE 266

13, *a*. A specimen, with the larger part broken away.

13, *b* The larger part of another specimen, on which the longitudinal striæ are nearly obsolete.

13, *c*. Surface-markings, from fig. 13, *a*, magnified.

13, *d*. An outline section of the larger end of the specimen, represented by fig 13, *b*.

FIG. 14. ENTALIS? PAUPERCULA 269

A part of the shell, natural size (type-specimen).


1a
1b
1c
3c
3a
3b
4a
13a
2
5a
14
13b
4b
13c
6
13d
7b
5e
5b
7a
5c
5d
7c
8a
9a
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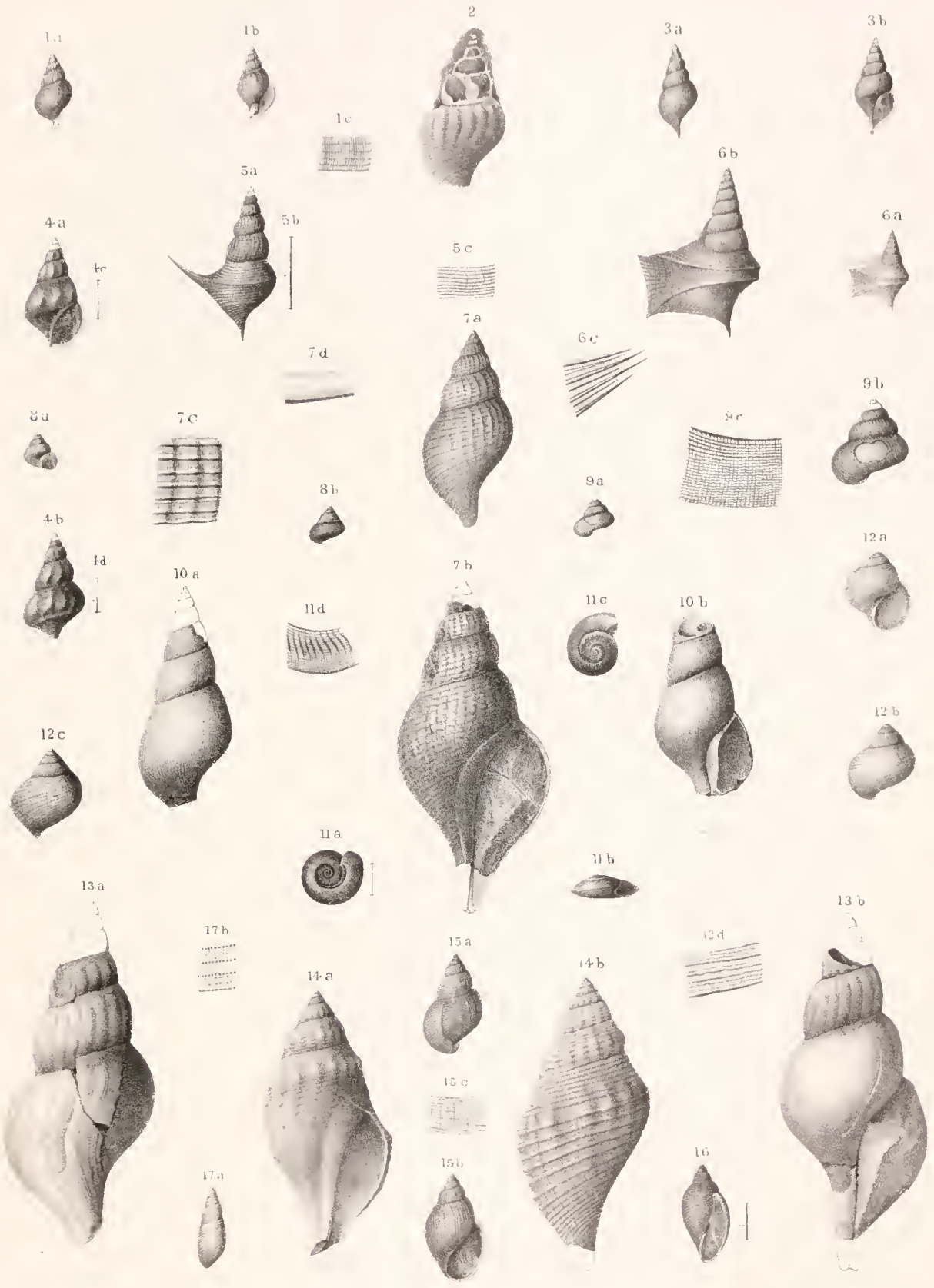
11a
11b
12a
9c
9d
9b
9e

PLATE 19.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9c
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11c
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12a
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12c
13a
13b
14a
14b
15a
15b
15c
16
17a
17b

PLATE 20.

Page.

FIG. 1. BACULITES OVATUS, broad variety 394

1, *a*. A septum, much magnified.

1, *b*. A transverse section of shell of the same variety.

FIG. 2. BACULITES OVATUS, slightly more compressed variety 394

2, *a*. A fragment, consisting of an internal cast, with some remaining portions of the shell. [The outline above is intended to illustrate only the form of the margin of the lip as seen in a side view, and does not indicate the entire length of the non-septate portion.]

2, *b*. A section of same, showing its more narrow-ovate form.

2, *d*. A septum of same, magnified. Its little antisiphonal lobe (on the left) being abnormally bifid at the end.

FIG. 3. BACULITES COMPRESSUS 400

3, *a*. A septate fragment of a small specimen, side view, with the outline of lip indicated by the line above, which does not, however, show the *length* of the non-septate body-chamber, for want of room on the plate.

3, *b*. A section showing the strongly-compressed form of shells of this size. [See also cuts in text.]

3, *c*. A septum of this species, showing the differences from the foregoing species in the form of its first lateral lobe and more pointed character of the subdivisions throughout.

FIG. 4. PTYCHOCERAS MORTONI 412

4, *a*. The type-specimen, imperfect at both extremities, natural size.

4, *b*. Same, magnified.

4, *c*. A transverse section, magnified.

4, *d*. A magnified view of the siphonal side of the larger limb. [Too flat between the rows of nodes.]

4, *e*. A magnified diagram of one of the septa.


1a
2c
4a
4b
4c
3c
3b
4e
2a
3a
2b
4d
1b

PLATE 21.

1a

1b.

2a

2b

3a

3b.

3c

4b

4a

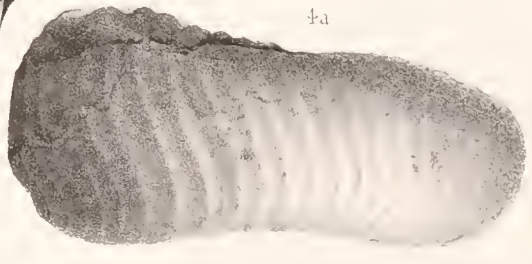


PLATE 22.

4c

1a

3c

1c

1b

2a

3a

2b

3b

4a

3

4b

PLATE 23.

Page.

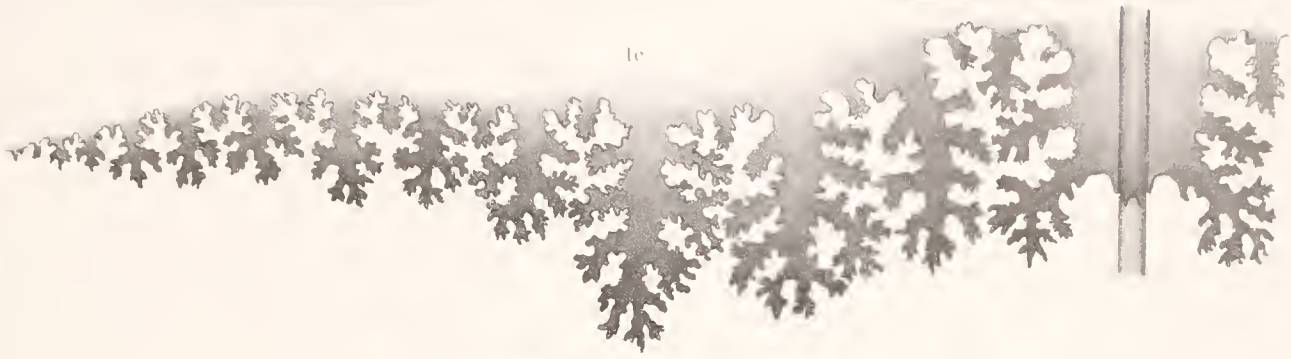
FIG. 1. PLACENTICERAS PLACENTA, *var.* INTERCALARIS 468

1, *a*. A side view of the septate type-specimen of the variety.

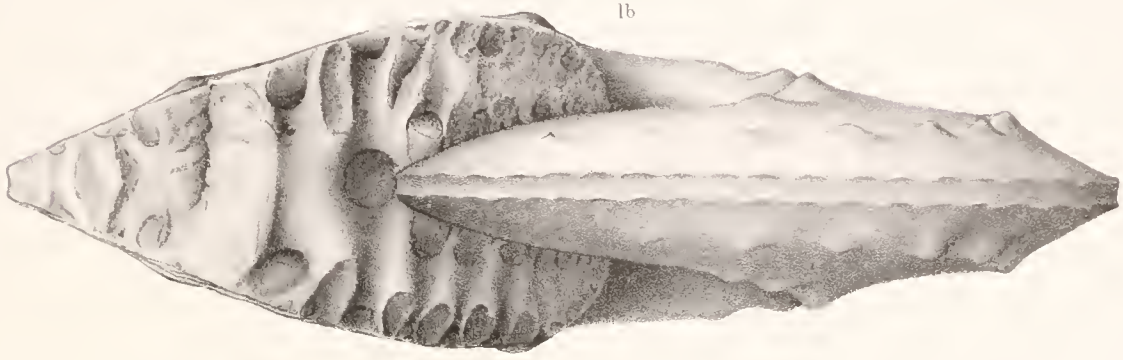
1, *b*. A different view of same, showing the narrowly truncated and flattened, or slightly concave, periphery, and the sagittate form of the aperture, as indicated by a section of one of the volutions.

1, *c*. A septum, magnified about one and a half diameters.

1c



1b



1a

PLATE 24.

Page.

FIG. 1. AMMONITES COMPLEXUS 447

1, *a*. A side view of a small specimen, consisting entirely of septate volutions.

1, *b*. An outline peripheral and aperture view of same.

1, *c*. A septum of same, magnified.

FIG. 2. PLACENTICERAS PLACENTA 465

2, *a*. A side view of a small specimen, consisting of the inner septate volutions.

2, *b*. Another view of same, showing the very narrowly truncated periphery, the sagittate form of the aperture as indicated by a section of one of the inner volutions, and the surface of a septum, with its numerous lobes.

FIG. 3. PHYLLOCERAS? HALLI 458

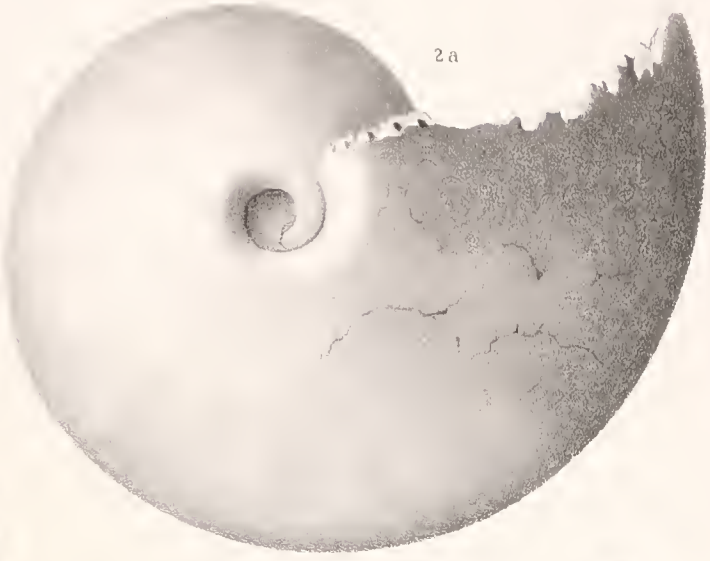
3, *a*. A side view of the type-specimen, which retains a part of the distorted outer volution.

3, *b*. A peripheral view of the same, with the outer volution too much distorted by pressure to show the form of the aperture accurately by its section.

3, *c*. A septum of the same, magnified to about one and a half diameters


2b


1b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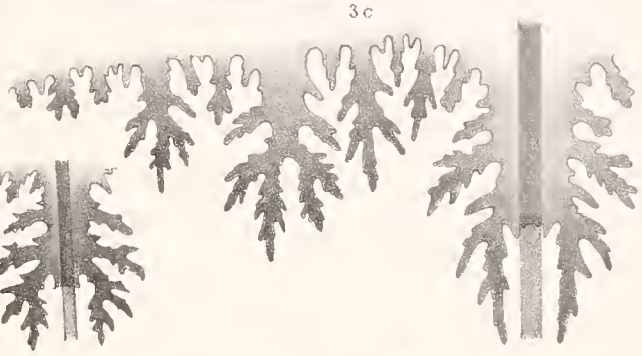
1a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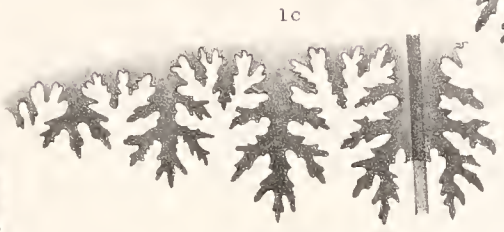

1c


3b


3a

PLATE 25.

Page.

FIG. 1. SCAPHITES NODOSUS, *var.* BREVIS 426

1, *a*. A peripheral and aperture view of the type of this variety.

1, *b*. A side view of same.

1, *c*. A septum of same, magnified about two diameters.

FIGS. 2, 3, AND 4. SCAPHITES NODOSUS, *var.* QUADRANGULARIS 428

2, *a*. A side view of a rather compressed specimen.

2, *b*. A peripheral and aperture view of same.

2, *c*. A septum of same, magnified to about three diameters.

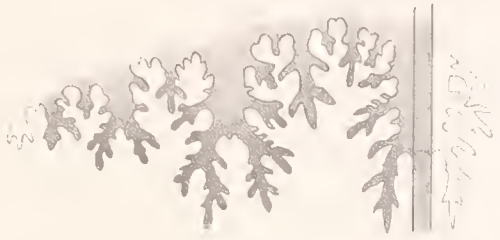
3, *a*. A side view of the more convex type-specimen of this variety.

3, *b*. A peripheral and aperture view of same.

3, *c*. A septum of same, magnified a little more than three diameters.

4. A side view of a larger imperfect specimen.

2c



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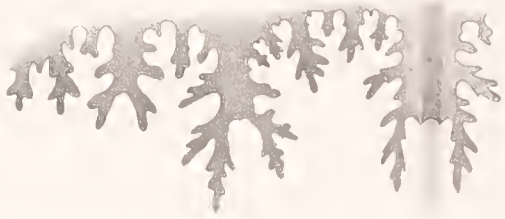
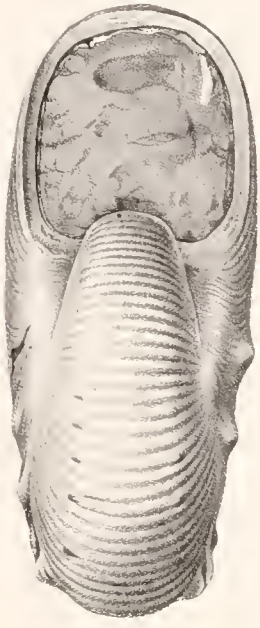


1c

2a

1a



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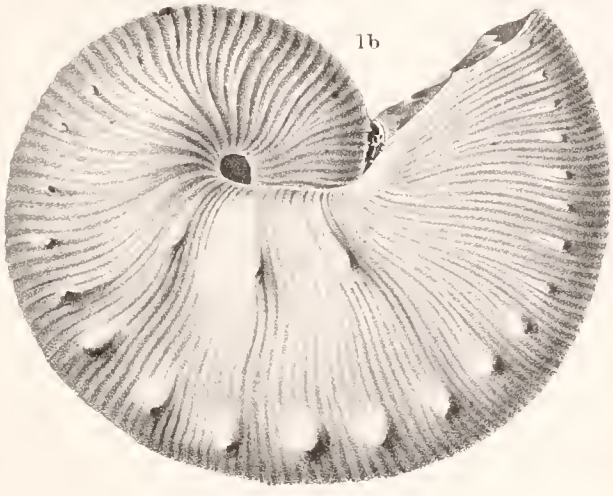


2b

3b

3a

4

PLATE 26.

Page.

FIG. 1. SCAPHITES NODOSUS, *var.* PLENUS 429

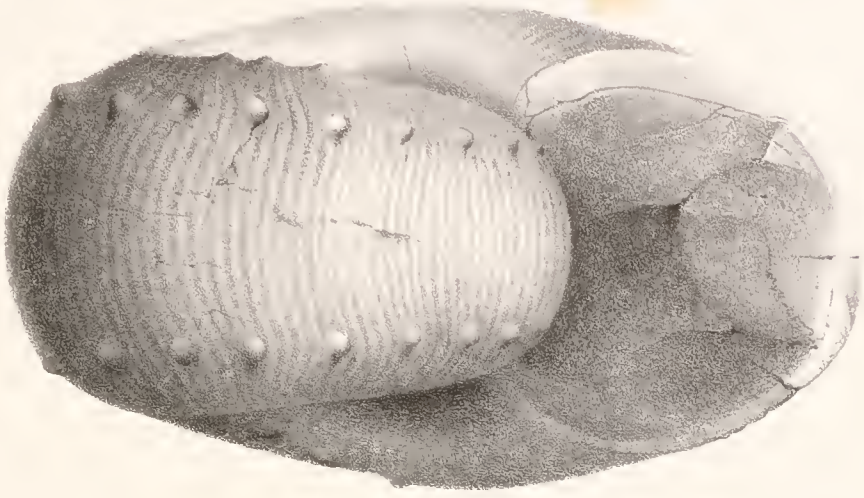
1, *a*. A side view of the perfect large type-specimen of this variety.

1, *b*. A peripheral and aperture view of same.

1, *c*. A septum of same, magnified to about one and a half diameters.

1c

1b



1a

PLATE 27.

Page.

FIG. 1. NAUTILUS DEKAYI 496

1, *a*. A peripheral and aperture view of a small specimen, consisting of the inner septate volutions.

1, *b*. A side view of same.

1, *c*. A peripheral view of another specimen, showing the sinuosity of the lip.

1, *d*. A side view of a younger specimen.

1, *e*. Surface-markings of last, magnified.

FIG. 2. NAUTILUS DEKAYI, *var*. MONTANAENSIS 498

2, *a*. A side view of a large specimen of septate part, being mainly an internal cast (type of the variety).

2, *b*. A peripheral and aperture view of same.

2, *c*. A peripheral and aperture view of a young shell.

2, *d*. A side view of same.

2, *e*. Surface-markings of same, magnified.

2, *f*. A side view of a larger specimen.

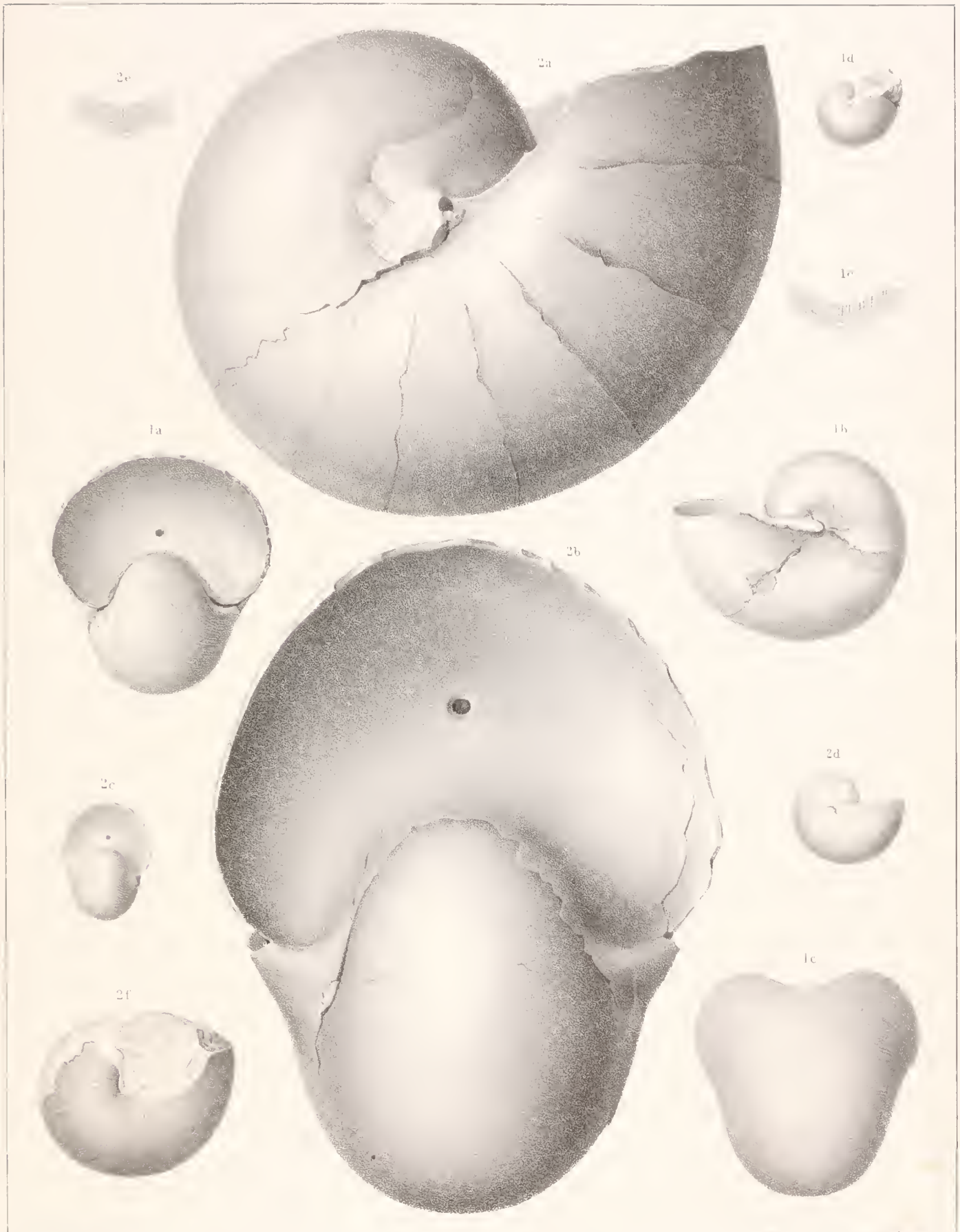

2e
2a
1d
1e
1a
1b
2b
2d
2c
1c
2f

PLATE 28.

Page.

FIG. 1. MICRABACIA AMERICANA 1

1, *a*. A view of the under side, natural size (type-specimen).
1, *b*. The same, magnified.
1, *c*. A vertical section, in outline, a little more magnified.
1, *d*. A partial side view, magnified to show crenated edges of the septa, etc.

FIG. 2. MICROSTIZIA MILLEPUNCTATA 4

2, *a*. A fragment, natural size (type-specimen).
2, *b*. The same, magnified.
2, *c*. One of the bars, or dissepiments, between the fenistrules, highly magnified to show the numerous, crowded, minute punctures.

FIG. 3. WEBSTERIA CRETACEA 3

3, *a*. Some of the branches, natural size (type-specimen).
3, *b*. A bifurcating portion of one of the same, magnified.
3, *c*. A simple branch, a little more magnified.

FIG. 4. OSTREA PELLUCIDA 15

4, *a*. An under-side view of lower valve, showing its large scar of attachment (type-specimen).
4, *b*. Interior of same.

FIG. 5. OSTREA (GRYPHÆOSTREA?) SUBALATA 15

An upper side view of the two valves united (type).

FIG. 6. CRENELLA ELEGANTULA 75

6, *a*. Exterior of a right valve, natural size (type-specimen).
6, *b*. Anterior of same.
6, *c*. Exterior of right valve, magnified to show the fine radiating striæ more distinctly.

FIG. 7. VOLSELLA GALPINIANA 73

7, *a*. A left-side view of an internal cast.
7, *b*. A dorsal view of same.

FIG. 8. VOLSELLA ATTENUATA 74

8, *a*. A right-side view of a cast (type-specimen).
8, *b*. Dorsal side of same.

FIG. 9. YOLDIA SCITULA 110

A left-side view of the complete type-specimen, natural size.

FIG. 10. YOLDIA EVANSI 111

10, *a*. A dorsal view.
10, *b*. A left view of the larger complete type-specimen.
10, *c*. An internal cast showing pallial sinus and hinge-denticles.

FIG. 11. PTERIA (OXYTOMA) NEBRASCANA 34

Left valve of a medium-sized specimen.

FIG. 12. PTERIA LINGUIFORMIS, *var.* SUBGIBBOSA 33

An internal cast of a left valve (type of variety).

FIG. 13. NUCULA CANCELLATA 102

13, *a*. A left-side view, natural size, of the perfect type-specimen.
13, *b*. Dorsal view of a partly exfoliated specimen.
13, *c*. Left-side view of 13, *a*, magnified.
13, *d*, *e*. Two views of an internal cast.

Page.

Fig. 14. Axinæa subimbricata 95

14, *a*. Exterior view of the broken right valve of type-specimen.

14, *b*. An interior and hinge view of apparently a young specimen of same.

14, *c*. Exterior of same.

14, *d*. An interior and hinge view of an imperfect large valve.

Fig. 15. Cucullæa (Idonearca) Shumardi 86

15, *a*. A left-side view of a young shell showing the free margin of the left valve projecting beyond that of the right (type-specimen).

15, *b*. A hinge view of a larger specimen.

15, *c*. An external left-side view of still larger specimen, with radiating markings obsolete.

15, *d*. An internal cast showing muscular and pallial impressions.

15, *e*. A posterior view of the same, internal cast, showing the furrows left by the projecting margins of the posterior muscular scars.

15, *f*. A smaller less oblique specimen, the left valve of which has been bored by some Gasteropod.

15, *g*. An anterior view of the same.

Fig. 16. Nucula planimarginata 101

A left-side view of an internal cast, showing the muscular and pallial impressions, hinge-denticles, etc.

Fig. 17. Limopsis parvula 97

17, *a*. A right-side view of the type-specimen (almost entirely destitute of radiating markings), magnified nearly two diameters.

17, *b*. A dorsal view of another specimen, showing cardinal area, magnified in the same way.

17, *c*. Another specimen, showing a part of the shell, with the radiating markings, also magnified.

Fig. 18. Lingula nitida 9

18, *a*. One of the valves, magnified a little more than two diameters (type-specimen).

18, *b*. A side view of same, to show convexity.

Fig. 19. Solemya subplicata 129

A specimen consisting of the two valves opened out and lying together in the rock; their posterior margins being broken away, and the umbonal portions partly exfoliated (type-specimen).

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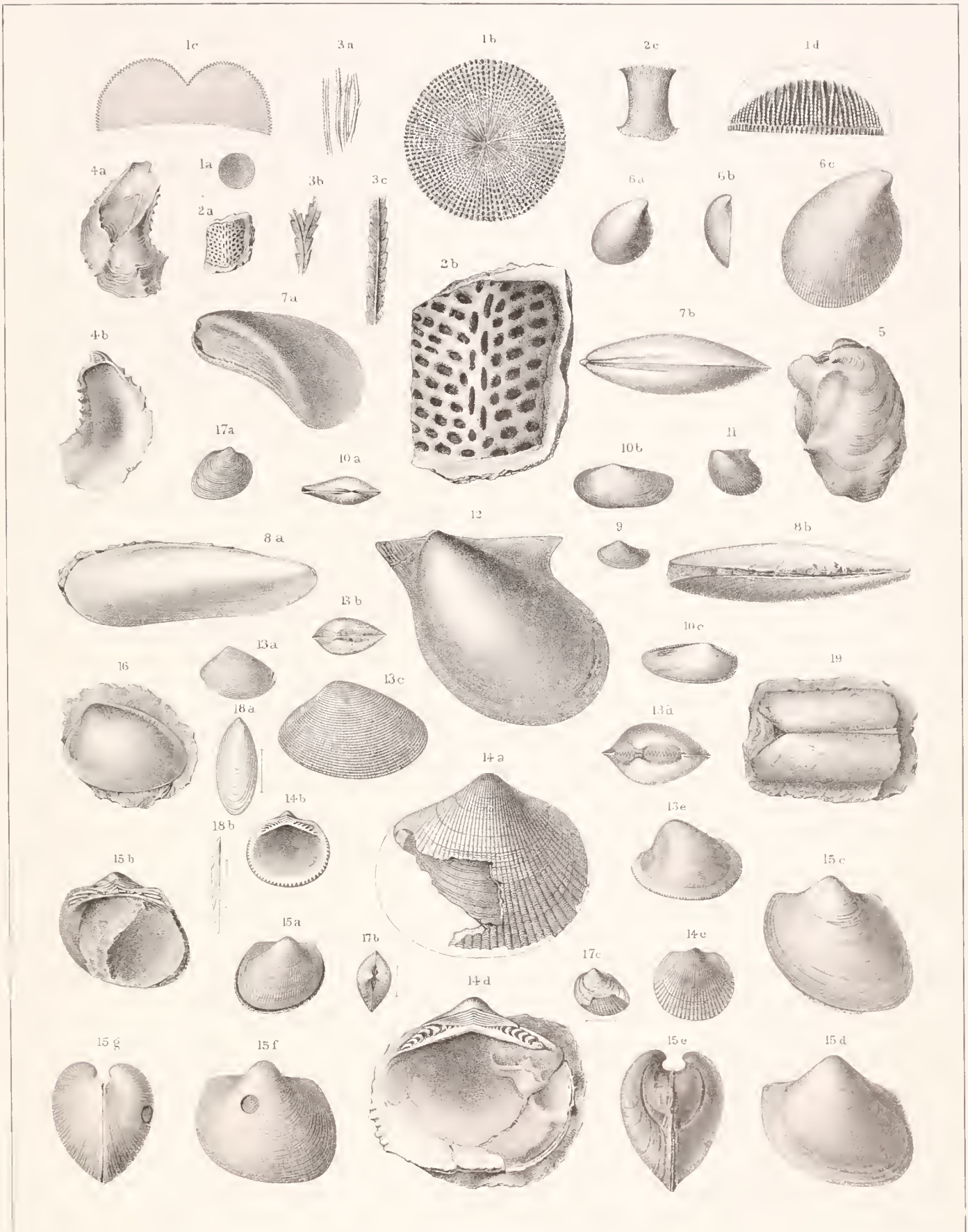


F. Meek & F. Sterrett del.

PLATE 29.

Page.

FIG. 1. GERVILLIA RECTA 66

1, *a*. A left-side view of the type-specimen, consisting mainly of an internal cast, with some of the inner layers of the shell remaining. [The extremity in front of the beaks being a little broken away.]

1, *b*. A dorsal view of same, to show the unequal convexity of the valves.

FIG. 2. SPILERIOLA? ENDOTRACHYS 139

A left-side view of the type-specimen, consisting of an internal cast. [Muscular impressions represented too large and round, and the asperities of the interior too regular and too scattering.]

FIG. 3. SPILERIOLA? CORDATA 137

3, *a*. A posterior view of an internal cast, retaining portions of the shell (type-specimen).

3, *b*. A right-side view of same.

3, *c*. Left view of same.

FIG. 4. CUCULLÆA (IDONÆARCA) SHUMARDI 86

A left side view of a large specimen that has been drilled by some Gasteropod.

FIG. 5. CUCULLÆA (IDONÆARCA) NEBRASCENSIS 88

5, *a*. A right-side external view of a mature specimen.

5, *b*. View of interior, hinge, and cardinal area of same.

FIG. 6. CUCULLÆA (IDONÆARCA?) CORDATA 89

6, *a*. A left-side view (type-specimen).

6, *b*. A dorsal view, showing cardinal area, etc.

FIG. 7. CYPRINA OVATA 146

7, *a*. Interior and hinge view of right valve of type-specimen. [For a more correct view of hinge, see wood-cut in text.]

7, *b*. An anterior profile view of same.

7, *c*. An outside view of same.

FIG. 8. PROTOCARDIA SUBQUADRATA 175

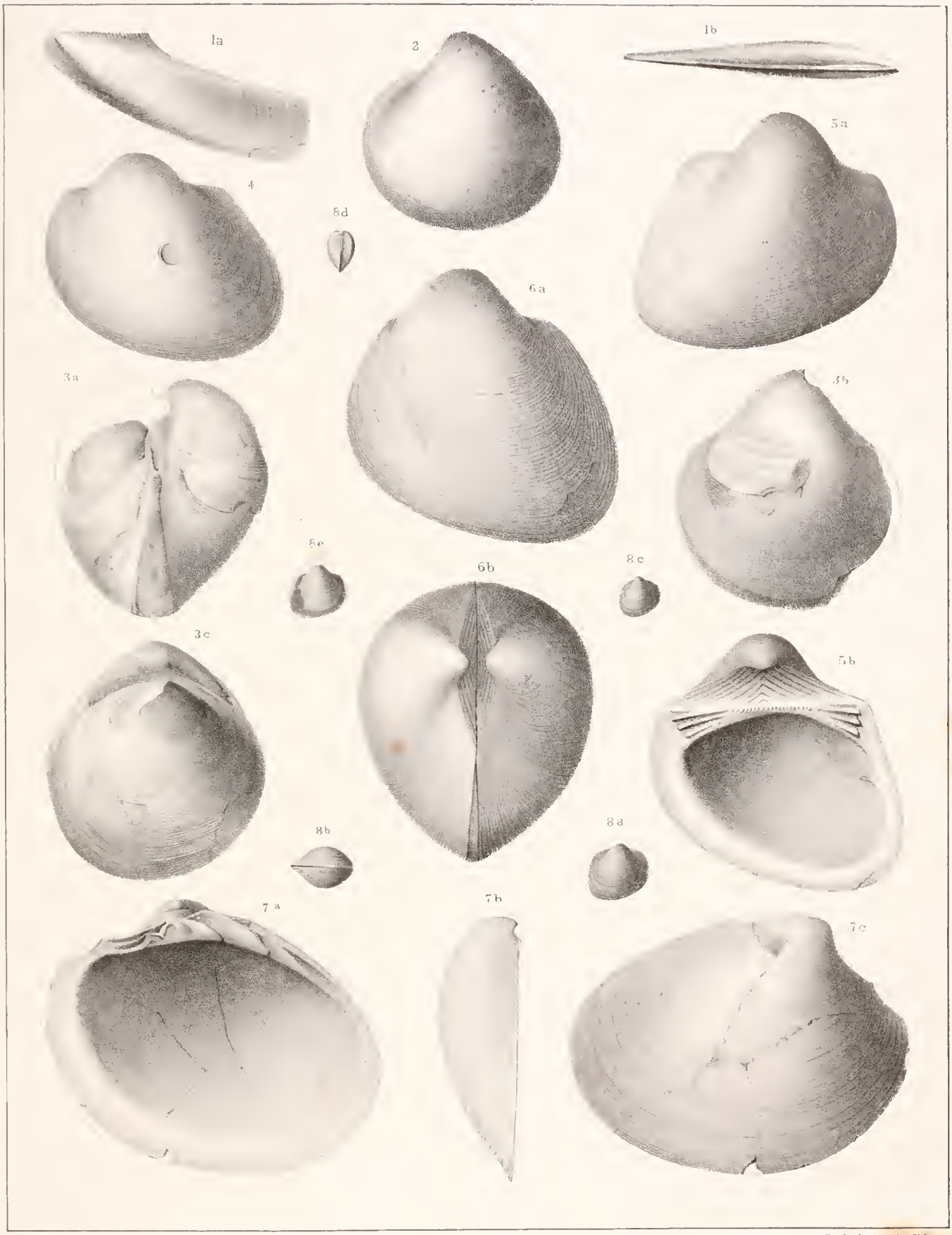
8, *a*. A right-side view of a mature specimen. [The crenulations of the basal margin, as well as those on the marks of growth, are too fine and carried too far forward in this figure.]

8, *b*. A ventral view of same, with the posterior marginal crenulations correctly represented.

8, *c*. A right-side view of a smaller specimen.

8, *d*. A posterior view of same.

8, *e*. A internal cast of a larger specimen, showing a small double pallial sinus, seen on casts of this species.



Th^s Sinclair & Son. lith. Phila

PLATE 30.

Page.

FIG. 1. TELLINA SCITULA 197

1, *a*. A dorsal view of tho two valves united and partly open (type).

1, *b*.* Right-sido view of the same, with the shell partly removed, so as to expose partly tho internal cast.

FIG. 2. LINEARIA? FORMOSA 199

A right-side external view of a valve attached to a piece of rock (type-specimen).

FIG. 3. NEERA VENTRICOSA 238

3, *a*. Left side of the perfect type-specimen, natural size.

3, *b*. Dorsal view of same.

3 *c*. Left exterior view magnified.

3, *d*. Interior and hinge views of a right valve, natural size

3, *e*. The same, magnified.

FIGS. 4 AND 1, *b* (*bis*). CORBULA INORNATA 245

4, *a*. Left view of the type-specimen, with the two valves united (natural size).

1, *b* (*bis*). A right-side view of same, magnified.

4, *c*. Left side, with valves united, magnified about two diameters.

4, *d*. A posterior view of the two valves united, magnified as above.

FIG. 5. VENIELLA HUMILIS 155

5, *a*. Anterior view of the type-specimen, consisting of the two valves united, but exfoliated about the beaks. [The spiral appearance of one of the beaks of this figure is not natural.]

5, *b*. A side view of same.

5, *c*. An internal cast of same species, showing muscular and pallial impressions.

FIG. 6. MACTRA? NITIDULA 211

6, *a*. A right-side view of type. [Margin slightly too much truncated behind.]

6, *b*. An under or ventral side view of the valves united.

6, *c*. Dorsal view of same.

FIG. 7. MACTRA WARRENANA 208

7, *a*. A left view of the perfect type-specimen, adult size.

7, *b*. An anterior view of same. [Lunule represented too small.]

7, *c*. A posterior view.

7, *d*. Left side of an internal cast, showing the muscular and pallial impressions.

FIG. 8. MARTESIA CUNEATA 259

8, *a*. Left-side view, natural size (type-specimen).

8, *b*. An opposite view of same, magnified.

FIG. 9. TURNUS STIMPSONI 256

9, *a*. An internal cast, natural size.

9, *b*. Exterior of left valve, magnified (type-specimen).

FIG. 10. TURNUS (XYLOPHAGELLA) ELEGANTULA 257

10, *a*. Left side of an interval cast, natural size (type-specimen).

10, *b*. Same view of exterior, magnified.

10, *c*. A magnified anterior view.

10, *d*. A less magnified posterior view of the two valves united, showing them to be closed behind.

10, *e*. A side view of an internal cast, magnified.

10, *f*. Posterior view of same.

FIG. 11. CYPRINA OVATA, *var.* COMPRESSA 147

An internal cast of a right valve (with some fragments of the shell attached), showing muscular and pallial impressions (type of the variety).

FIG. 12. GONIOMYA AMERICANA 221

12, *a*. The imperfect type-specimen, left-side view. [Some of the basal as well as the posterior margin seems to have been broken away.]

12, *b*. Granules of the surface, magnified.

FIG. 13. TEREDO GLOBOSA 264

Burrows in fossil wood.

*This figure occupies the right upper corner of the plate, and should not be confounded with another figure accidentally numbered 1, *b* on the same.


1a
3a
2
3c
1b
3d
4a
3b
8a
5a
3c
1b
4c
7c
6c
6b
8b
5b
4d
7d
10a
7b
10c
6a
5c
10e
10d
7a
9a
10b
9b
11
10f
13
12b
12a

PLATE 31.

* Not. 4, *a*, *b*. † Left margin of plate. ‡ Bottom of plate § Right margin of plate.

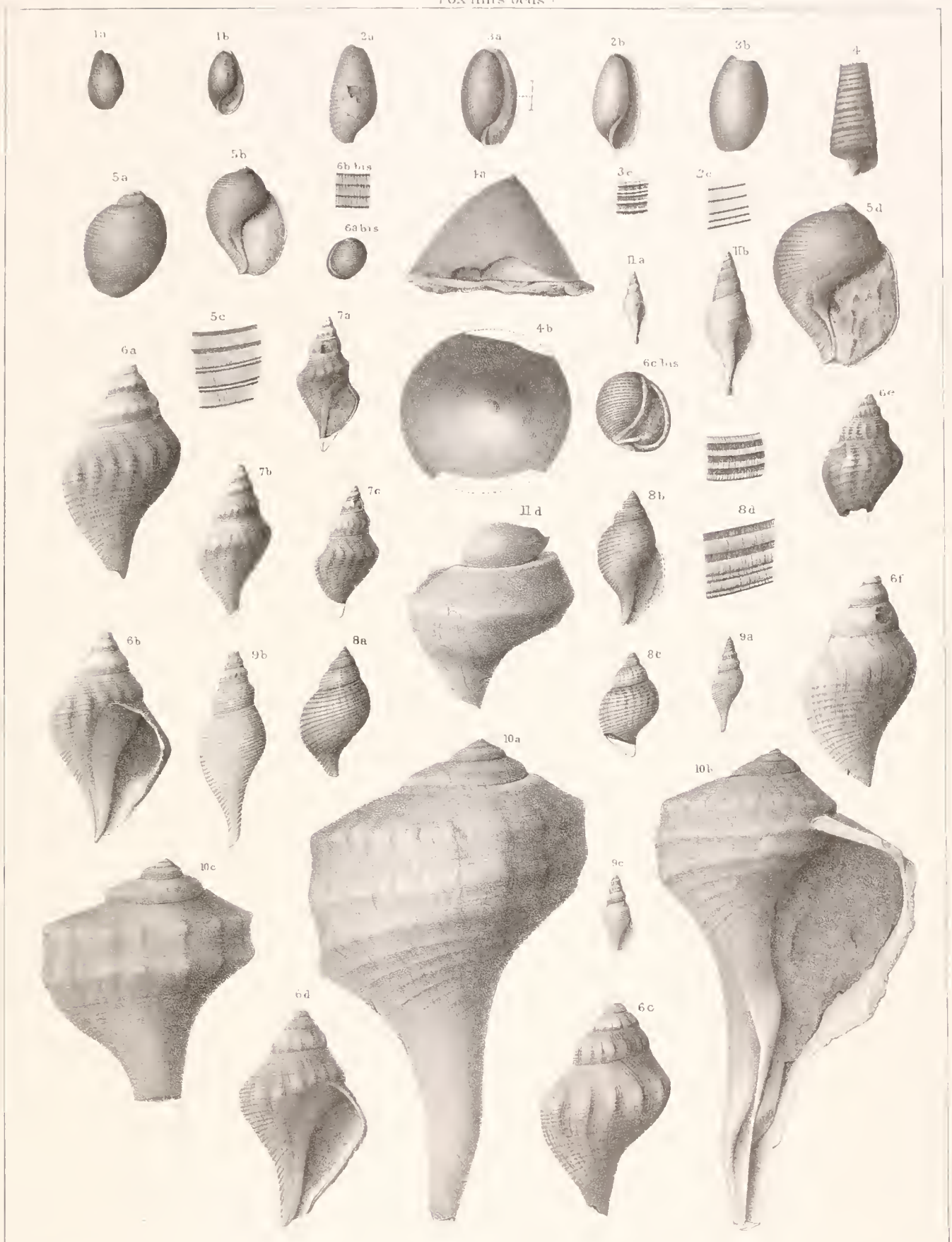

1a
1b
2a
3a
2b
3b
4
5a
5b
6b bis
6a bis
1d
3c
2c
5d
11a
11b
5c
7a
4b
6c bis
6a
6e
7b
7c
11d
8b
8d
6f
6b
9b
8a
8c
9a
10a
10b
10c
9c
6d
6c

PLATE 32.

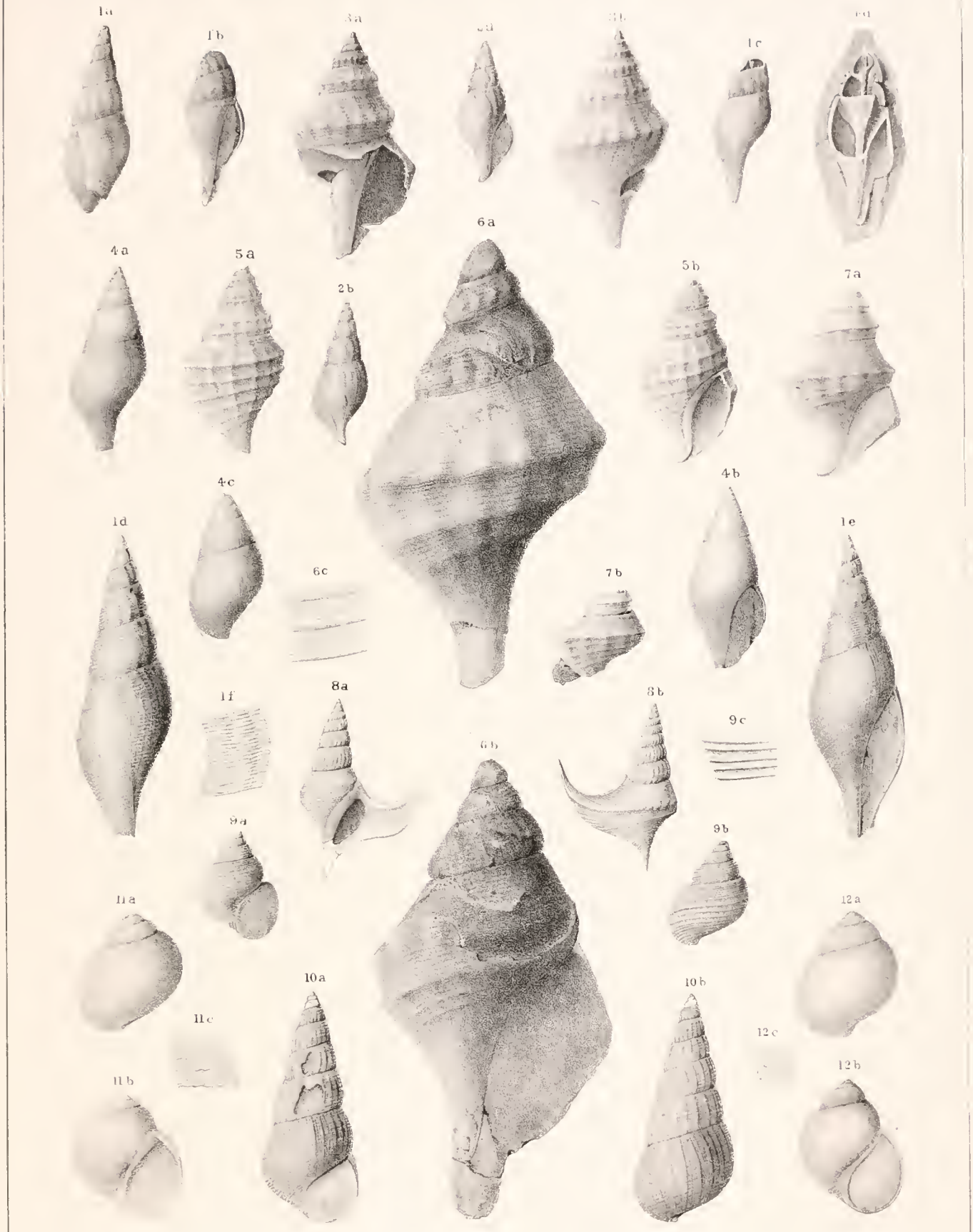

1a
1b
3a
3c
3b
1c
3d
4a
5a
2b
6a
5b
7a
4c
4b
1d
6c
7b
1e
1f
8a
8b
9c
6b
9a
9b
11a
10a
10b
12a
11c
12c
11b
12b

PLATE 33.

Page

FIG. 1. BACULITES GRANDIS?..... 398

1, *a*. A side view of a septate fragment, consisting mainly of a cast of the interior of a small specimen.

1, *b*. An end view of same.

1, *c*. One of the septa magnified.

FIG. 2. BELEMNITELLA BULBOSA..... 504

2, *a*. The type-specimen, somewhat imperfect at both extremities, dorsal view.

2, *b*. Another view of same.

2, *c*. Another specimen, split longitudinally.

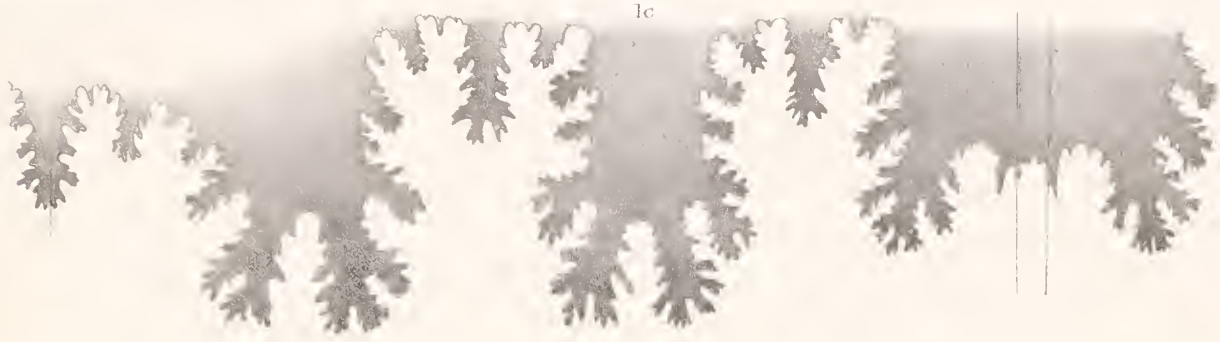
2, *d*. A fragment showing a cast of the alveolus.

2, *e*. An outline of the lower part of the cast of the phragmocone, magnified to show the minute bulb at its extremity.

FIG. 3. PHYLLOTEUTHIS SUBOVATA..... 505

The expanded part of the gladius, with the shaft broken away (type-specimen).

1c



1a

2a

2c

2d

2e

2b

1b

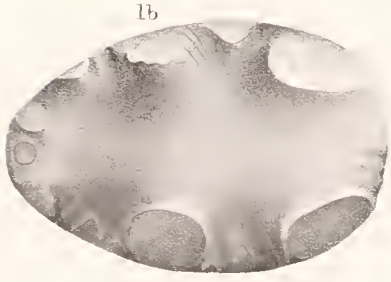


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PLATE 34.

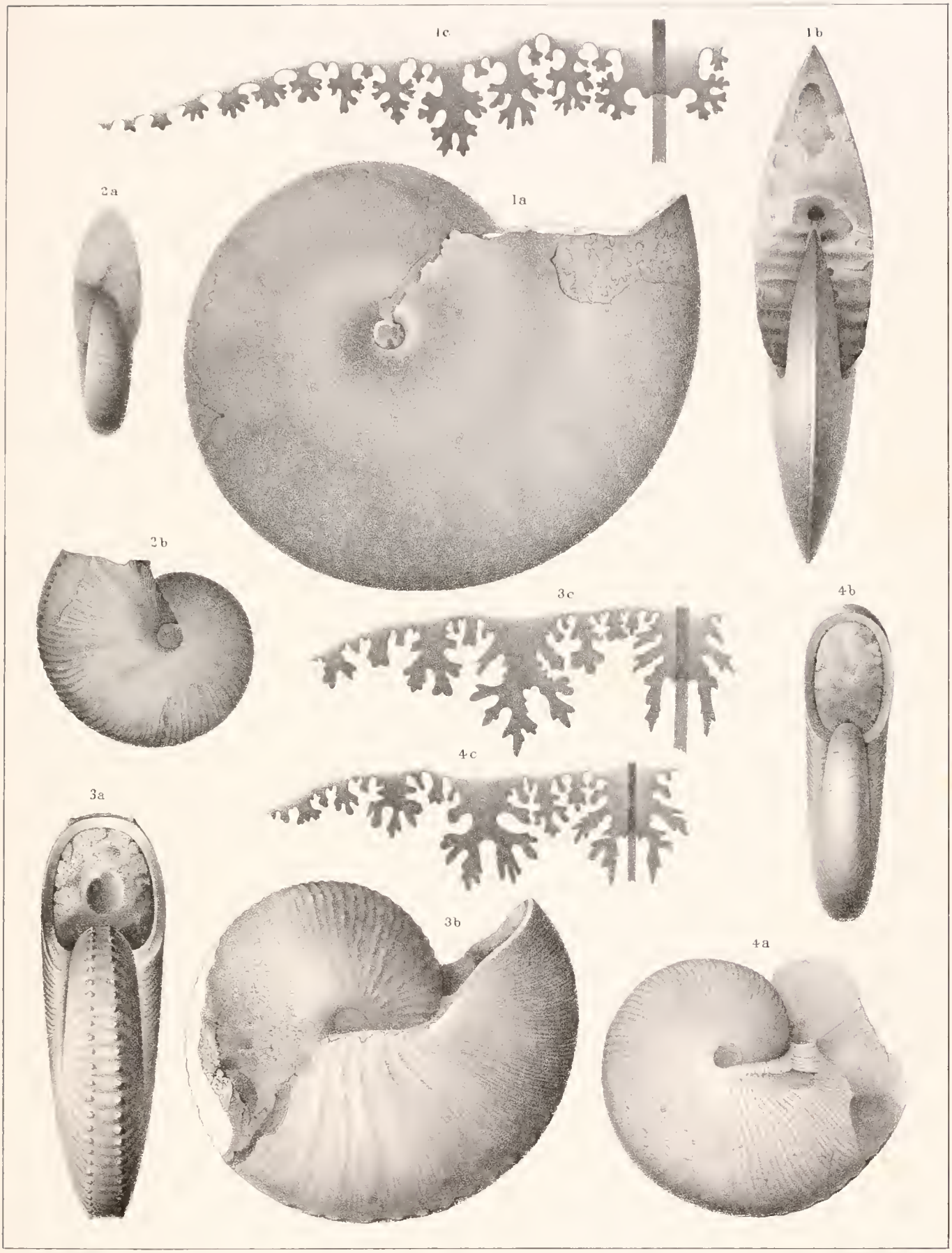

1c
1b
2a
1a
2b
3c
4b
4c
3a
3b
4a

PLATE 35.

Page.

FIG. 1. SCAPHITES MANDANENSIS 443

1, *a*. A side view of a nearly perfect specimen.

1, *b*. A peripheral and aperture view of same.

1, *c*. A septum of same, magnified two and a half to three diameters.

FIG. 2. SCAPHITES ABYSSINUS 441

2, *a*. A side view of a specimen, with portions of the matrix attached.

2, *b*. A septum, magnified two and a half to three diameters.

FIG. 3. SCAPHITES CHEYENNENSIS 437

3, *a*. A side view of a perfect internal cast.

3, *b*. A peripheral and aperture view of same.

3, *c*. A part of the inner volutions of the same.

3, *d*. A fragment of the outer volution, containing one of those curious bodies usually called an *Aptichus*, a part of one valve of which is broken away, so as to expose a jaw-like different part of the same organ between the two valves.

3, *e*. A septum of this species, magnified to between two and a half and three diameters.

3, *f*. An under-side view of the jaw-like piece of the *Aptychus*, seen between the two valves of the same in fig. 3, *d*.

3, *g*. A side view of the same piece.

3, *h*. An upper view of the same.

3, *i*. The *Aptychus*, represented as it would appear with the two valves opened out upon the same plane; one of the valves being represented merely in outline to show the position of the third jaw-like piece between; also represented in outline.


2b


3c


1c

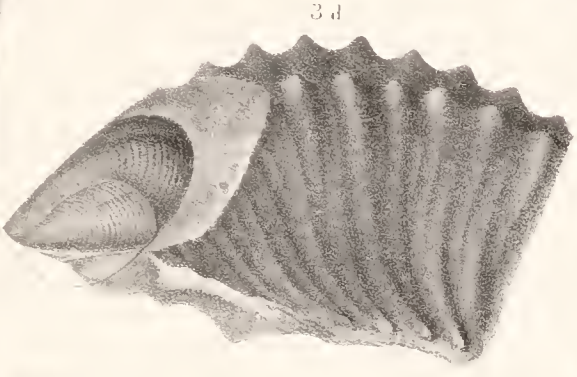

1a


2a


3h


1b

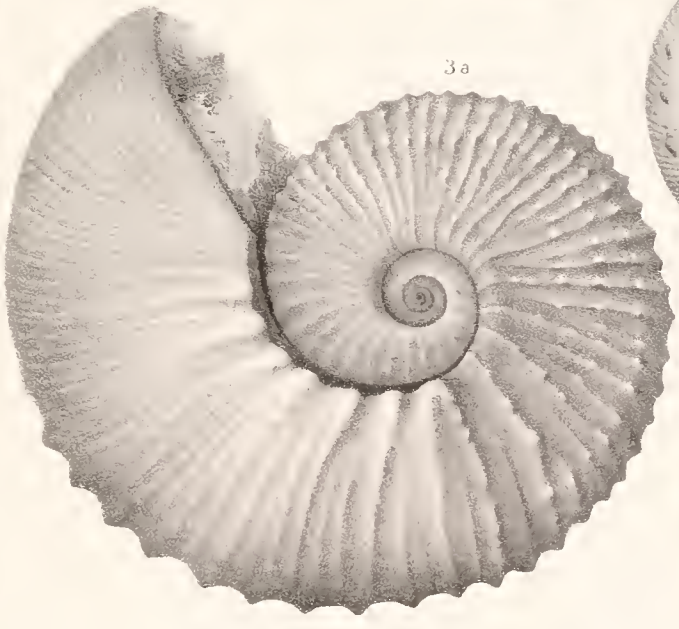

3g


3d


1


3f


3b


3a


4


3c

PLATE 36.

Page.

FIG. 1. SCAPHITES CONRADI, *var.* GULOSUS 432

A side view of a perfect specimen of this variety.

FIG. 2. SCAPHITES CONRADI 430

2, *a*. A peripheral and aperture view of an imperfect internal cast, consisting of septate volutions only of the typical variety.

2, *b*. A side view of same.

2, *c*. A smaller imperfect specimen of same, side view.

2, *d*. A different view of last.

2, *e*. A side view of an unusually large specimen.

2, *f*. A septum from the specimen represented by fig. 2, *a* and *b*, magnified to one and three-quarter diameters.

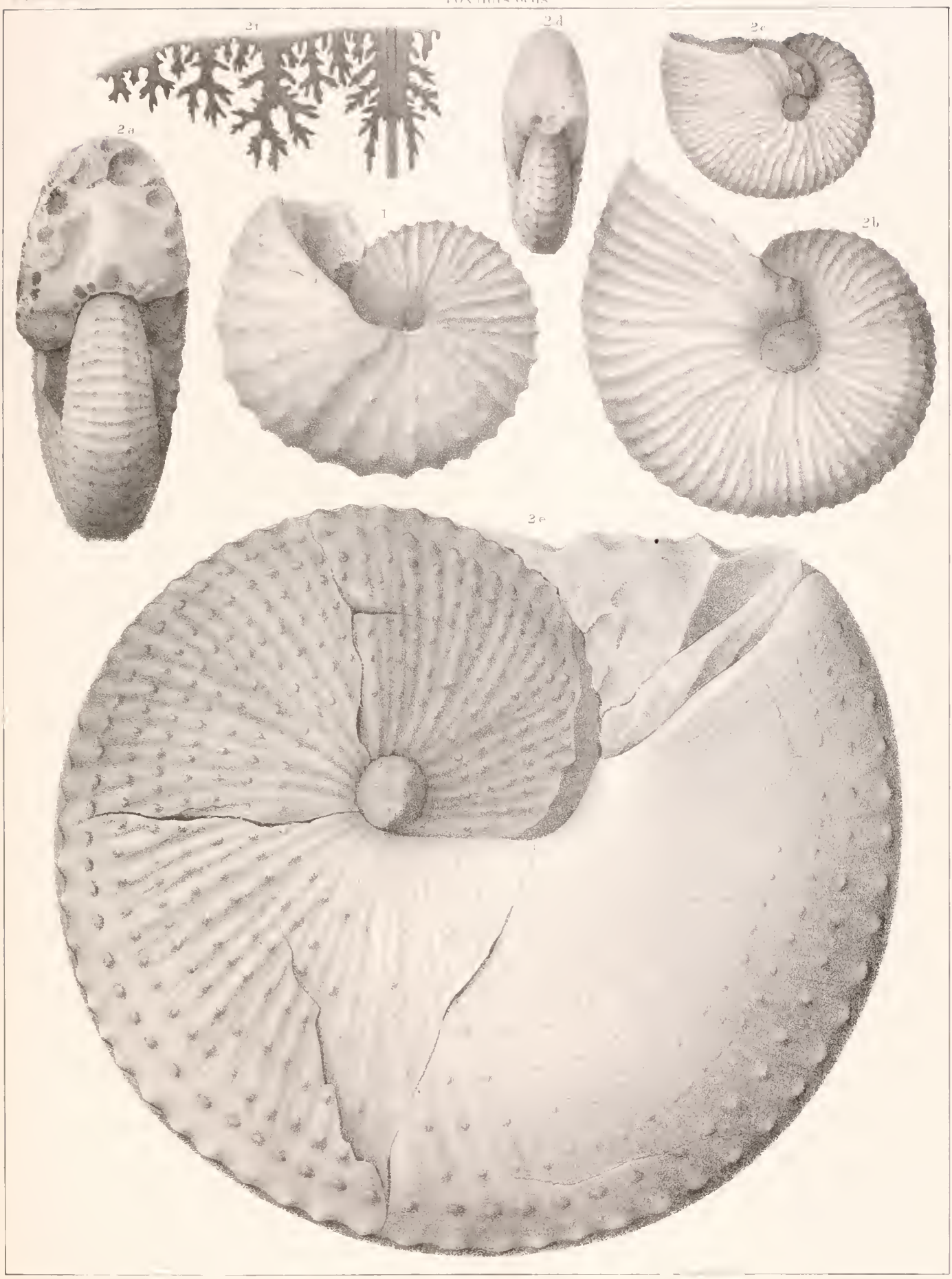

2f
2d
2c
2a
1
2b
2e

PLATE 37.

Page.

FIG. 1. CALLISTA (DOSINIOPSIS) OWENANA 183

Cast of the interior of the left valve, showing the posterior muscular impression and pallial sinus (type-specimen).

FIG. 2. MACTRA (CYMBOPHORA) ALTA 210

2, *a*. Hinge of right valve, showing the peculiar, large, spoon shaped cartilage-cavity, with elevated margins, and the strong lateral teeth. [The small cardinal tooth connected with the cardinal margin just in front of the cartilage-pit is not well shown.]

2, *b*. An outside view of right valve of the type-specimen.

FIG. 3. INOCERAMUS PERTENUIS .....

3, *a*. An imperfect cast of a left valve, retaining some of the inner layer of the shell on the constricted umbo.

3, *b*. Another specimen, of same valve.

FIG. 4. CARDIUM (CRIOCARDIUM) SPECIOSUM 169

4, *a*. Left valve, being mainly an internal cast.

4, *b*. A right valve of the larger type-specimen, in same condition.

4, *c*. An enlarged portion of one of the same, to show the peculiar appearance sometimes presented by the surface of casts, retaining the thin inner layer of the shell, a little abraded over the small projections, apparently representing spine-bases, in the furrows between the costæ. [These little projections, however, should have been darker instead of lighter than the surrounding spaces.]

FIG. 5. THRACIA SUBTORTUOSA 223

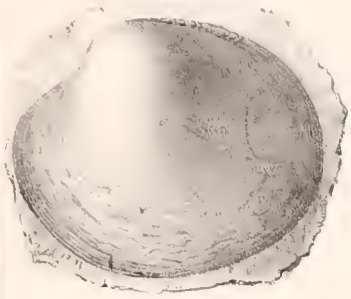
An internal cast of the left valve of the type-specimen, showing the muscular and pallial impressions. [The former, particularly the anterior scar, should be pointed instead of rounded above.]

FIG. 6. THRACIA? PROUTI 225

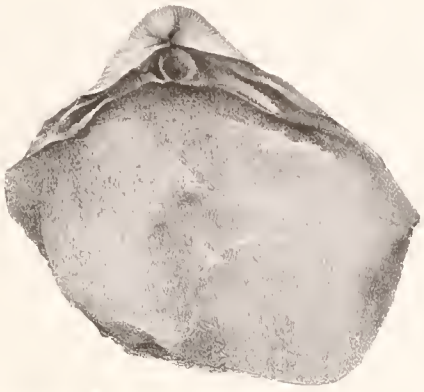
6, *a*. A dorsal view of the type-specimen, consisting of an internal cast retaining portions of the shell.

6, *b*. A left-side view of same, showing the posterior muscular scar and the sinuous pallial line.

1



2 a



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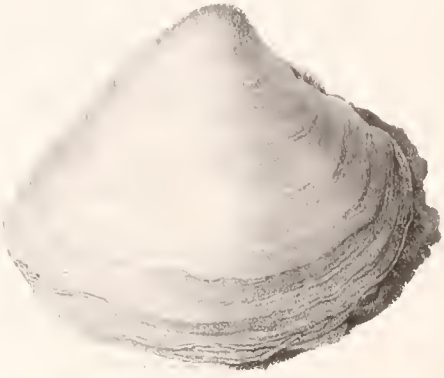


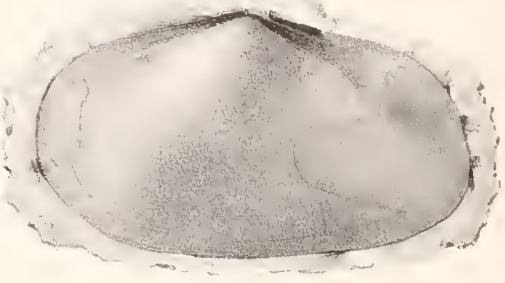
3 a

4 c

4 a

4 b

5



3 b

6 a

6 b

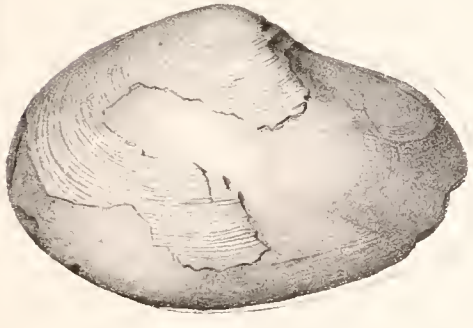


PLATE 38.

Page.

FIG. 1. TANCREDIA AMERICANA 142

1, *a*. An outside view of a large right valve, the central portion of which has been broken out so as to expose the internal cast and show the thickness of the shell.

1, *b*. An outside view of the left valve of the type-specimen, with the anterior extremity broken away.

1, *c*. A hinge view of another very imperfect specimen of a left valve, considerably worn, so as to blunt the teeth, and give a rather unnatural appearance to the beak and the pit for the reception of the principal cardinal tooth of the other valve.

1, *d*. A dorsal view of same. [The posterior margin behind the lateral tooth is not represented by the straight edge seen there, which is merely the broken edge of the rock filling the shell, the margin of which is seen above this, making a curve corresponding to the left edge of the posterior hiatus.]

1, *e*. An internal cast of a large right valve, showing dimly the pallial line, which, however, is made to appear too slender.

1, *f*. An outside view of an imperfect small left valve.

1, *g*. A dorsal view of same, showing the hinge-teeth in profile.

1, *h*. An inner view of same, showing hinge-teeth and pit, the latter not represented quite triangular enough.

FIG. 2. MYTILUS SUBARCUATUS 69

2, *a*. A dorsal view of the internal cast of the type-specimen.

2, *b*. A left-side view of same.

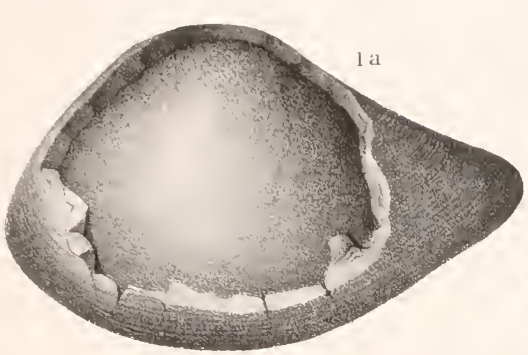
FIG. 2 (*bis.*) INOCERAMUS CRIPSI, *var.* SUBCOMPRESSUS 48

An internal cast of a left valve. [Type of the variety.]

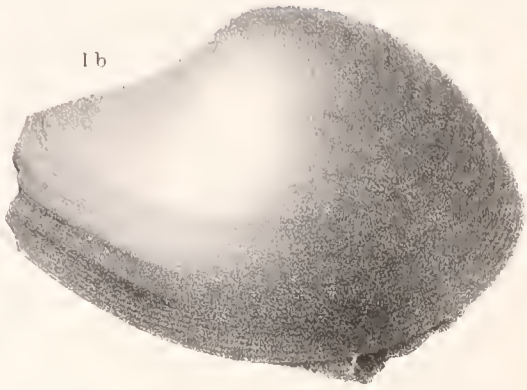
FIG. 3. INOCERAMUS PERTENUIS 47

3, *a*. An anterior view of a specimen, with the two valves united; portions of the shell about the umbones being worn away.

3, *b*. A right-side view of the type-specimen of same.

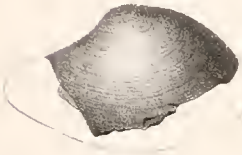

1a

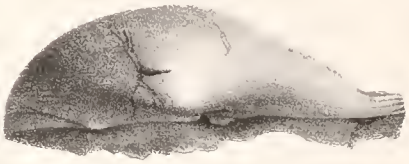

2a

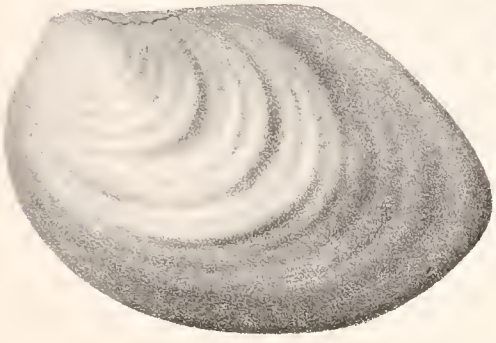

1b


2b

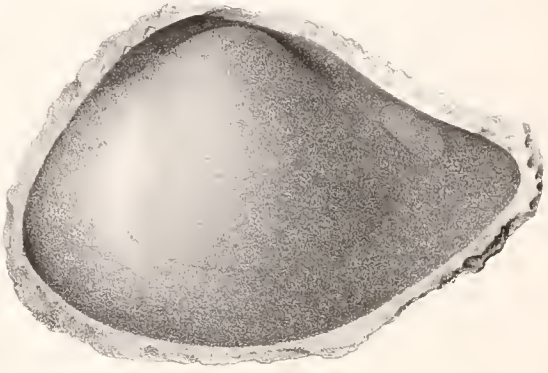

1c


1f

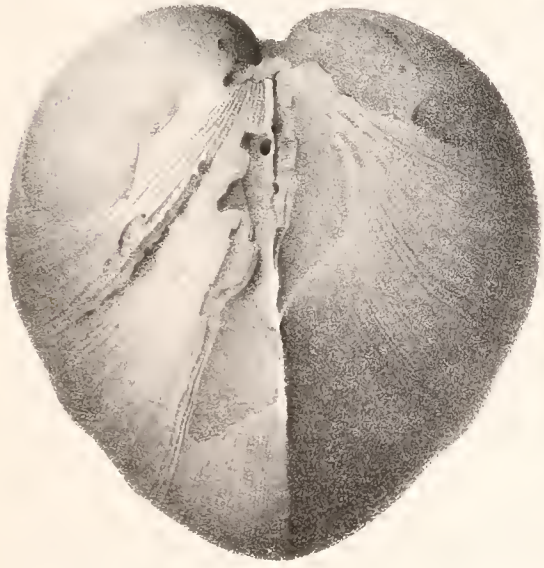

1d


2bis


1g


1e


1h


3a

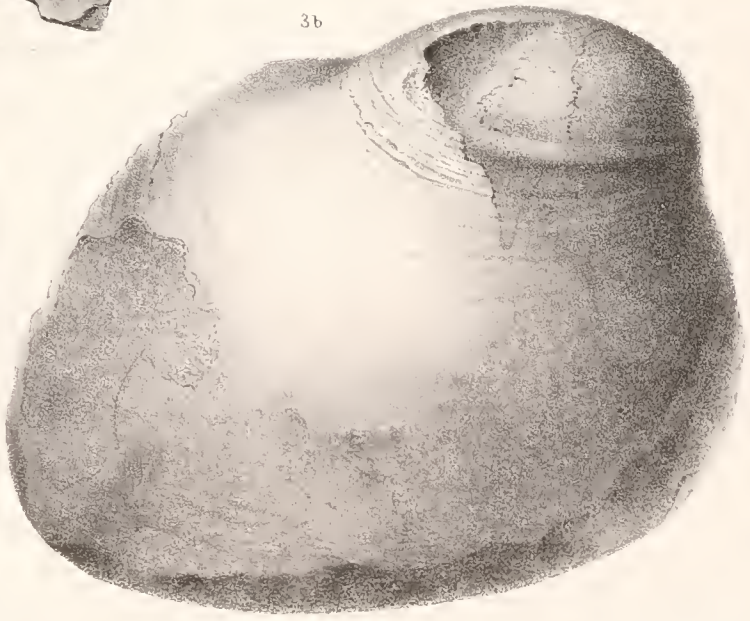

3b

PLATE 39.


1a
2a
1b
3a
4a
2b
3c
3b
5a
5b
6a
5c
6b
7.
10d.
8b.
10c.
10a.
8a
10b.
9a
9b

PLATE 40.

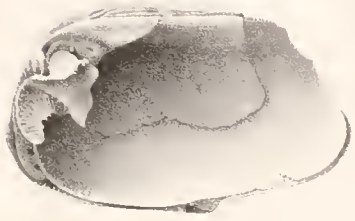

1a
1b
2a
1c
1d
2c
3a
3b
2d
4b
4a
4c
5a
5b
6b
2b
5c
5d
6a
4d
5e
6c

PLATE 41.

1a

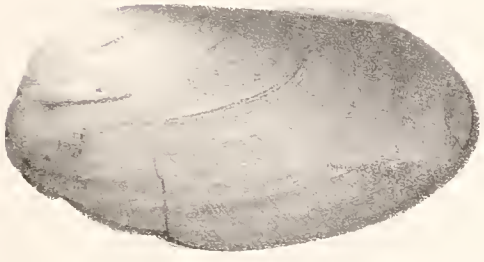
1b

2c



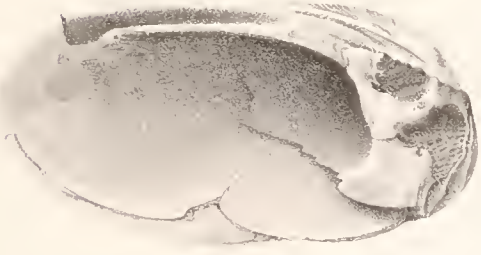
3a

2a



3b

2b



3c

PLATE 42.

Page.

FIG. 1. GONIOBASIS INVENUSTA 564

1, *a*. A dorsal view of the type-specimen, with the apex of the spire broken away. [Lines of growth too strong and regular.]

1, *b*. An aperture view of another individual, with lip a little broken.

1, *c*. A smaller individual, dorsal view.

1, *d*. Same view of a still smaller specimen.

1, *e*. An aperture view of the last.

FIG. 2. GONIOBASIS CONVEXA 562

2, *a*. An aperture view of the type-specimen, which has the lip broken so as not to show the form of the base of the aperture quite correctly.

2, *b*. Another view of the same specimen, which, as in 2, *a*, has the lines of growth not represented curved enough.

2, *c*. A figure of the variety *impressa*, showing its more convex volutions and deeper suture.

2, *d*. Another view of the same, the lip being broken so as to give an unnaturally angular appearance to the base of the aperture.

FIG. 3. GONIOBASIS? GRACILENTA 568

An aperture view of the type-specimen, a little magnified. [Aperture too much produced below. See wood-cut in text.]

FIG. 4. GONIOBASIS? OMITTA 568

4, *a*. Dorsal side of the type-specimen, magnified nearly two diameters.

4, *b*. An aperture view of the same.

4, *c*. Surface-markings, magnified.

FIG. 5. GONIOBASIS SUBLÆVIS 567

5, *a*. An aperture view of the type-specimen, which has its lip broken so as to give an unnatural angularity to the base of the aperture.

5, *b*. Another specimen, a little enlarged, showing more accurately the form of the aperture.

FIG. 6. HYALINA OCCIDENTALIS 547

6, *a*. An aperture view of one of the largest type-specimens.

6, *b*. Under or umbilical view of the same.

6, *c*. Upper side of the same.

6, *d*. Upper side of a small specimen.

FIG. 7. HELIX? VETUSTA 552

7, *a*. An aperture view of an internal cast of type-specimen. [Other specimens show the lip to be dilated and the aperture constricted.]

7, *b*. An opposite view of same.

FIG. 8. HELIX? VETERNA 596

8, *a*. An aperture view of an internal cast.

8, *b*. An opposite view of the type-specimen, also an internal cast. [Not drawn in a proper posture to show the slightly-reflexed character of the lip. See cuts in text.]

FIG. 9. MACROCYCLIS SPATIOSA 594

9, *a*. An upper view of the type-specimen, consisting of an internal cast, natural size.

9, *b*. An under-side view of the same, showing the umbilicus.

9, *c*. An aperture view of the same.

FIG. 10. VITRINA OBLIQUA 545

10, *a*. An upper-side view of the type-specimen, consisting of an internal cast, not complete at the aperture.

10, *b*. An aperture view of the same.

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(Judith River Beds, mainly)

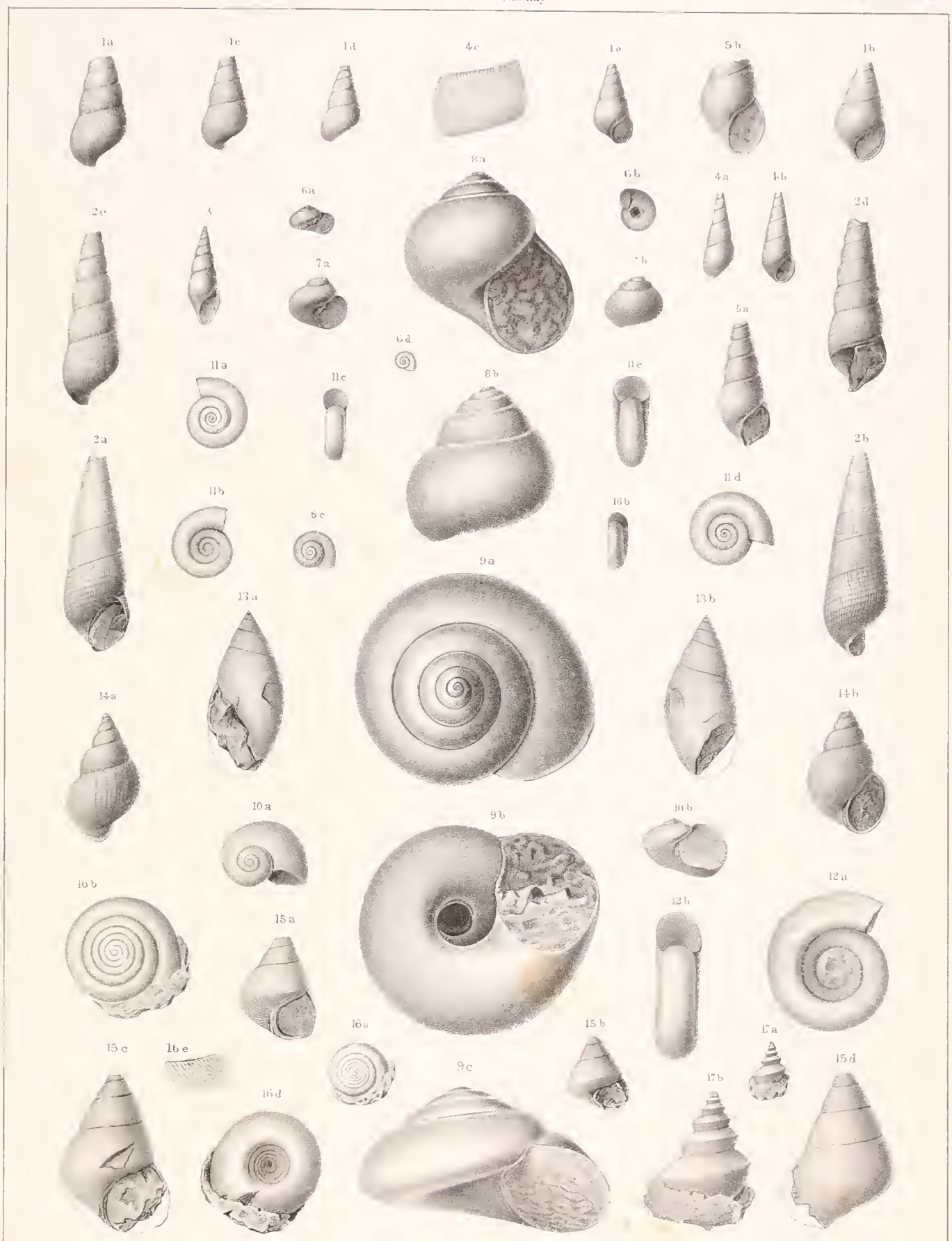

PLATE 43.


1a
1b
2a
2c
3b
3a
4c
5a
6b
5b
2b
4b
4a
6a
7e
7d
7a
7b
7c
8a
7f
9a
9b
10b
12g
10a
8b
10c
11c
12f
12e
12h
8c
9c
12d
12c
13a
9a
13b
12a
11b
14a
12b
9c
11a
13c
9b
14b
16a
17
15a
15b
16b
15c
15d
8d
14c
18a
18b
15d

PLATE 44.

Page.

FIG. 1. CAMPELOMA MULTILINEATA 586

1, *a*. A dorsal view of type-specimen, which has the lip broken.

1, *b*. An aperture view of same.

FIG. 2. VIVIPARUS TROCHIFORMIS 580

2, *a*. A dorsal view of type-specimen.

2, *b*. An aperture view of same. [Lip partly broken away.]

2, *c*. A dorsal view of a larger individual, with spire proportionally more produced and body-volution less angular.

2, *d*. A small specimen, with body-volution distinctly angular.

2, *e*. Finer surface-markings, magnified.

FIG. 3. VIVIPARUS LEIDYI, *var.* FORMOSUS 580

3, *a*. A dorsal side view.

3, *b*. An aperture view, the lip being broken.

3, *c*. Surface-markings, magnified.

FIG. 4. VIVIPARUS LEIDYI 582

A dorsal view of the type-specimen, the apex and much of the lip of which are broken away.

FIG. 5. VIVIPARUS RETUSUS 578

5, *a*. A side view of the type-specimen, showing the obliquity of the outer lip. [The bluntness of the apex of the spire is not well represented in this and the other figures.]

5, *b*. A dorsal view of the same.

5, *c*. An aperture view of a slightly larger specimen.

5, *d*. A dorsal view of a smaller specimen.

5, *e*. An aperture view of the last.

5, *f*. Surface-markings, magnified.

FIG. 6. VIVIPARUS LEAI 577

6, *a*. An aperture view of the type-specimen. [Compare with 5, *c*, of the last species.]

6, *b*. An opposite or dorsal view of same.

6, *c*. The same view of another specimen.

6, *d*. An aperture view of a smaller individual.

FIG. 7. VIVIPARUS RAYNOLDSANUS 584

7, *a*. Dorsal view of type-specimen.

7, *b*. Aperture view of same. [Revolving-markings should be slightly indicated.]

FIG. 8. THAUMASTUS LIMNEIFORMIS 558

8, *a*. Dorsal side of type-specimen.

8, *b*. Aperture view of same; the thin inner lip being broken away above.

8, *c*. A dorsal view of a somewhat narrower specimen.

8, *d*. An aperture view of same; its thin inner lip above the middle being broken away.

FIG. 9. PLANORBIS PLANOCONVEXUS 538

9, *a*. An upper or right-side view of the type-specimen, which is mainly an internal cast.

9, *b*. An aperture view of same.

9, *c*. An under or umbilical view of same.

FIG. 10. ACROLOXUS MINUTUS 543

Type-specimen, magnified about four diameters.

FIG. 11. COLUMNA TERES 555

11, *a*. Type-specimen, dorsal view, natural size.

11, *b*. The same, magnified.

FIG. 12. COLUMNA VERMICULA 556

12, *a*. Type-specimen, natural size.

12, *b*. The same, magnified.

FIG. 13. LIMNÆA (PLEUROLIMNÆA) TENUICOSTATA 534

13, *a*. Dorsal view of type-specimen, natural size.

13, *b*. The same, magnified.

13, *c*. Body-volution of same, more highly magnified, to show surface-markings.


1a
2a
2c
13a
2b
13c
2d
2e
10
13b
5f
6d
3a
5d
1b
5a
6c
5e
8a
8b
1c
3b
5c
5b
6a
6b
7a
7b
11a
8c
3c
8d
12a
4
12 b
11b
9a
9b
9c

PLATE 45.

Page.

FIG. 1. PLANORBIS VETUSTUS 601

1, *a*. Left side of the type-specimen, natural size.

1, *b*. Right side, same, magnified.

1, *c*. An aperture view of same, a little more enlarged.

FIG. 2. PLANORBIS NEBRASCENSIS 600

2, *a*. Right side of type-specimen, magnified about two diameters.

2, *b*. An aperture view of the same, more highly magnified. [Not represented quite angular enough around the periphery.]

FIG. 3. PLANORBIS LEIDYI 599

3, *a*. An under or left-side view of type-specimen, natural size.

3, *b*. An upper-side view of same.

3, *c*. An aperture view of same, magnified.

3, *d*. An umbilical view of same, less magnified.

FIG. 4. PHYSA SECALINA 604

4, *a*. An aperture view, magnified about three diameters.

4, *b*. An opposite view of same.

FIG. 5. LIMNÆA MEEKIANA 598

5, *a*. An aperture view of a cast.

5, *b*. An opposite view of same.

5, *c*. A dorsal view of an imperfect larger specimen.

FIG. 6. LIMNÆA SHUMARDI 599

6, *a*. A dorsal view of type-specimen, which is a cast.

6, *b*. An aperture view of same.

FIG. 7. HELIX LEIDYI 604

7, *a*. An aperture view of a cast.

7, *b*. An upper-side view of same.


1a
1b
1c
2b
2a


4a
3c
5a
3d
4b


6a
3a
5b
3b
6b


5c
7a
7b