NORTH AMERICAN INDEX FOSSILS

INVERTEBRATES

BY

AMADEUS W. GRABAU, S.M., S.D.

PROFESSOR OF PALÆONTOLOGY IN COLUMBIA UNIVERSITY

AND

HERVEY WOODBURN SHIMER, A.M., PH.D.

ASSISTANT PROFESSOR OF PALÆONTOLOGY IN THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME I

PROTOZOA, PORIFERA, HYDROZOA, ANTHOZOA, BRYOZOA, BRACHIOPODA, PELECYPODA, SCAPHOPODA AND GASTROPODA

NEW YORK

A. G. SEILER & COMPANY

1909

Press of
The New Era Printing Company
Lancaster, Pa.

PREFACE.

This work is essentially a treatise on North American index fossils, *i. e.*, on those fossils best adapted for the determination or geologic horizons. Its aim is to render possible in the laboratory or field, ready identification of faunas and the correlation of horizons. It is to some extent also a text-book of palæontology, and the needs of the student in this respect have been kept in mind in its preparation; but the student of index fossils, who is preparing himself for work in stratigraphic palæontology, will find this work especially planned for him; to meet his needs has been the principal aim of the authors.

The zoölogical rather than the stratigraphical arrangement of the material seems most in harmony with this aim. Brief discussions of the classes included in the book are followed each by its own included genera. The description of each genus is followed by its included species, with brief characterizations to distinguish them. It is hoped that the generic keys at the beginning of each class and the specific keys accompanying the fuller genera may make relationships and differences more clear. The arrangement of the species of any one genus is, as a rule, in chronologic succession from the lower to the higher formations. In some cases, as in the Bryozoa, it has been possible to keep the species and genera of the Palæozoic and Mesozoic eras distinct, since in America they are separated by a wide gap owing to the relative incompleteness of the basal Mesozoic marine series.

By this zoölogical arrangement attention is called to closely similar genera and to still more closely similar species of one genus and to the distinctions between them, in a manner not possible when species are grouped wholly on a stratigraphic basis. Repetition of generic characters is likewise thus avoided. A trial of both methods of treatment in class-room and laboratory work has convinced the authors that it is the comparative method, made possible by a zoölogical arrangement, which gives the student of fossils the best grasp of the subject. The first requisite in the training of a stratigraphic palæontologist is careful attention to details such as is necessary in the identification of species. From this arises the ability to discriminate between closely allied species of one genus but of different geologic horizons, and the association, in this book, of all the more important species of one genus is hence not only desirable but necessary. The field geologist who may use the book for the determination of his fossils and his horizons, will likewise appreciate the value of a zoölogical arrangement, as the stratigraphic method would require a previous knowledge of his horizons.

The faunal summary at the end of the work is especially addressed to the needs of the student of faunas. Such faunal summaries need no pictorial or graphic accompaniment. The student qualified to use them will form mental images of the species on seeing them listed, and it is only when the name stands for the species in the mind of the student that he will be able to appreciate faunal geography and chronology.

Little attempt has been made at a classification and grouping into divisions of less than ordinal rank. In some cases even the orders have been omitted, especially where such classification is based solely upon anatomical characters of the soft parts of the animals and is not in full agreement with the fossil remains. The authors believe that a classification should be founded upon a basis of phyletic principles and a thorough appreciation of anatomical details and of the relationships of hard as well as of soft parts.*

A fair grasp of the diagnostic characteristics of a large number of genera and species can not be other than helpful in the more special study of genetic relationships, and such an acquaintance as will be given by a study of American as well as foreign index fossils, may well precede the more detailed anatomical and comparative studies which are the especial field of the professional student of palæontology and zoölogy.

Much thought has been given to the selection of material from the wealth of American species, it being manifestly impossible to include all known species. Selection has been based on three criteria. First to be included were the species most characteristic

* For a discussion of the interrelationships of the hard and soft parts of invertebrates and a comparison of fossil with living forms, see the forthcoming introduction to the study of fossils by H. W. Shimer.

of the important stratigraphic divisions, *i. e.,* those of wide horizontal (geographic) but of limited vertical (stratigraphic) distribution. Secondly those species which have a wide horizontal distribution even though their vertical range is also great, in other words, the very common American species (*e. g., Atrypa reticularis*) have been selected. Thirdly such species or representatives of genera have been considered as desirable additions which, though limited in distribution and in stratigraphic importance, yet furnish illustration of characters needed to be understood by the student of structural or anatomical palæontology. That many species which should be included have probably been omitted and others included which could well be omitted, few will realize so well as the authors.

Only a minimum of pages of the present work are devoted to a discussion of the anatomical characters of the classes, for in a general study of index fossils a knowledge of only the larger structural features is absolutely necessary.

No descriptions of plants or of vertebrates are included. They are so important and have such numerous representatives that separate treatises are needed for their discussion. Certain groups, as the arachnids, insects, etc., are treated only in a general way, as their remains are so fragmentary as to be intelligible only to specialists. Likewise other groups of limited distribution or of little value as index fossils, owing to their rarity or poor preservation, have here received only slight attention.

The nomenclature of geologic formations advocated by the International Congress of Geologists is here adopted, since this embodies a uniform system of endings for terms of the same value.

The authors will deem it a favor if users of this work will inform them of errors when detected, for errors are sure to be present in a work of this character, even though carefully guarded against. Especially is this the case in the distribution ranges given for the species. Discoveries, which are constantly made, will subject this part of the work especially to modification from time to time.

In the preparation of the book the authors have enjoyed the sympathetic helpfulness of many American palæontologists who, as authorities in their special fields, have rendered invaluable aid. While making special acknowledgments to only a few of them,

the authors wish to thank all who, in one way or in another, by furnishing material, suggestions, illustrations, etc., or by criticism have furthered this work. They can not forbear to mention their special indebtedness to Professor John M. Clarke, who has generously loaned illustrations and in other ways has been helpful; to Mr. E. O. Ulrich and Dr. R. S. Bassler; to Professors Cumings, Sardeson and Stuart Weller; to Dr. C. P. Berkey and to Dr. Percy E. Raymond, who has furnished a number of illustrations and some descriptions, as well as lists of species. Special acknowledgments are further gladly made to Florence Henry Shimer, A.M., and to former and present students of the senior author, especially Elvira Wood, A.M., and Fred. K. Morris, A.B. The generous manner in which American state geologists and boards of surveys have illustrated their palæontological publications has made possible the full illustration of this work; constant and free use has been made of all such publications with the full confidence that their authors and editors sanctioned such usage. In all cases (except where omitted by oversight) the source of the illustrations has been given. The descriptive material has been largely adapted from the original descriptions and figures, published in the volumes of the various surveys, societies, universities, etc., aided and checked, as far as possible, by examination of material from type localities.

The earlier chapters through the brachiopods appeared during the years 1906 and 1907, being published serially in the Columbia University *School of Mines Quarterly*. The remainder of the work now makes its first appearance. The authors trust that it may serve the needs of American students of palæontology and stratigraphy, to whom it is cordially dedicated.

New York and Boston,
October 1, 1909.

CONTENTS OF VOLUME I.

NORTH AMERICAN INDEX FOSSILS.

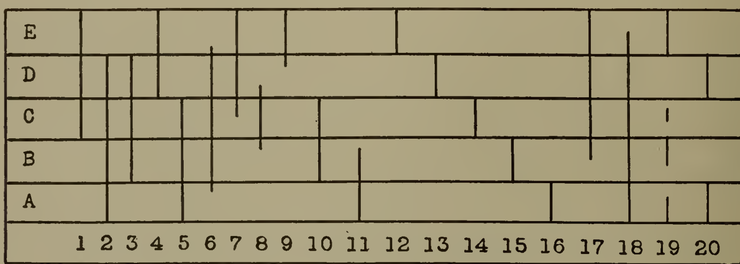
Introduction.

Fossils are the remains of animals or plants, or the direct record of their presence, preserved in the rocks of the earth's crust from the earliest to the present time. They are the only reliable means by which the age of any geologic formation can be determined, and, as such, are of the utmost importance to all geologists dealing with the non-igneous rocks. Not all fossils are equally good indices of the age of the formation in which they occur, for some are of very great vertical, and others of very limited horizontal distribution. It is evident that neither will serve as a good index type. The best index fossils are those which combine a wide horizontal with a limited vertical distribution, such as the graptolites or the ammonites.

In general it may be said that the more precise the required identification of a horizon the more limited must be the range of the fossil or fossils which are relied upon to indicate that age. Thus while trilobites as a class may be relied upon as indicators of Palæozoic age, being unknown above this, a certain group of trilobites alone will serve to indicate Cambric age, while a genus (*Olenellus*, or *Paradoxides*) serves to indicate the lower or middle Cambric respectively. Furthermore, a certain group of species of *Paradoxides*, as for example the species of the *P. eteminicus* type, serve to indicate a certain horizon in the Middle Cambric.

It often happens that the fossils of a certain formation in a given region include no species of a restricted type, such as would indicate the exact equivalency of this formation with the ascertained horizon characterized by such a species in the type section. Under such circumstances it is necessary to determine the position of the formation in question by its assemblage of animal remains or *fauna* or the assemblage of plant remains or *flora*.

For example we may assume twenty species of organisms ranging through five formations, *A* to *E*, in the type section, as shown in the annexed diagram. It is evident that species 12 to 16 are the special indices of the formations *E* to *A*, respectively. We will now assume that a formation in another, not too far removed, region, contains none of these but has the following species generally abundantly represented: 2, 3, 6, 8, 17, 18, 19, while more rarely represented are: 1, 5 and 10. It is clear that this assemblage or fauna is most like that of formation *C* of the type section, even though species 14, the special index species of that formation, is wanting.



Influence of the Character of the Bottom and Sediment. — In the above illustration, the application is most reliable if the character of the sediment is similar to that of the type section, indicating similar conditions of existence. It is well known that with the change in sedimentation occurs a change in fauna, whole classes of organisms disappearing and new ones appearing. Thus nothing can be more distinct than the calcareous beds of the Beekmantown horizon of some parts of the Champlain Valley, with their trilobites, cephalopods and gastropods, and the black shales of the same age in the Hudson Valley, which contain only graptolites. It thus becomes necessary that the fossils of the formations of the type section should be determined for the different phases of occurrence. This is necessary because each formation has normally an off-shore or pure water (generally calcareous) facies and a shore facies consisting commonly of quartz sands or even conglomerates, while between these two are various transition facies. * Furthermore a marine formation may in another region be largely represented

* The principles here touched upon are fully treated in the forthcoming "Principles of Stratigraphy" by the senior author.

by a continental formation, *i. e.*, a lake, river, or wind deposited formation. Examples of such more or less equivalent marine and non-marine formations are the Chemung and Catskill, the Pierre and Belly River, and the marine Tertiaries of the Atlantic and Gulf Coasts and the non-marine Tertiaries of the plains and Great Basin region.*

Types of Fossils. — Four types of fossils may be recognized, namely: (1) Actual remains and their impressions; (2) trails and tracks made by organisms in transit, and burrows; (3) artificial structures; (4) coprolites.

1. *Actual Remains.* — Generally only the hard parts of animals will be preserved but occasionally the fleshy parts also remain. Examples of this are the mammoths and other animals preserved in Siberian ice and the Tertiary insects of the amber found on the shores of the Baltic. The hard parts most readily preserved are the bones of vertebrates, the plates and spines of the external armor of fishes and reptiles, the exoskeleton of crustacea, the plated armor or test of echinoderms, the shells of mollusks and brachiopods, the "coral" structures of Bryozoa, corals, and hydrocorallines, and the shells of Protozoa. The horny covering of hydroids is also more resistant than other soft animal tissue and is commonly preserved in the form of carbonaceous films. Plant tissue is more readily preserved than animal tissue; especially is this true of wood, which is commonly preserved by being variously impregnated or replaced.

Molds and Casts.—Frequently the actual remains of the organism decays or is dissolved, leaving only a mold behind; when the structure was hollow, as in the case of shells, both external and internal molds (the latter often called casts) remain. Occasionally, by the infiltration of mineral matter into the mold, a *cast* of the original shell is produced. In the study of molds artificial casts must frequently be made.†

2. *Trails, Tracks and Burrows.* — Foot-prints of vertebrates on soft mud or sand and trails of worms, mollusks, or crustacea are often preserved. Here no part of the animal remains, nor is this the only

---

* See the table of formations in the appendix (published with the last installment).

† For processes of making these see appendix.

impression made by the animal, as in case of the molds of a shell. Burrows of worms or other animals are more or less permanent homes, and are often reënforced by walls made of agglutinated sand particles. They then partake of the character of artificial structures, and they may be considered as intermediate between classes 2 and 3.

3. *Artificial Structures.* — Here belong the tubes built of agglutinated sand grains by worms, the " shells " built of similar foreign particles by many Foraminifera, and more especially the implements, habitations and other structures left by primitive man in the later rocks of the earth's crust, as well as the structures buried in historic times.

4. *Coprolites.* — The excrements of many animals are characteristic, serving to determine their presence in the formation in question. Typical examples of these are the coprolites of Jurassic and Cretacic reptiles.

Mode of Preservation.*

Under this heading we need to consider only the preservation of the actual remains (hard parts) of animals and plants.

Burial and Removal of Organic Matter. — The first step in fossilization is of course burial, for without that even the hard parts will soon be destroyed. This is well illustrated by the disappearance, largely through decay, of the bones of the American bison, which were left unburied in countless numbers on the western plains. It is also illustrated by the annual decay of the fallen leaves. After burial the organic tissue which forms the framework of all hard animal structures is removed by decay, thus rendering the remains more or less porous. This is well seen when a fresh bone is compared with one buried for some time. Tertiary shells often show the porosity due to the removal of the organic framework. This porosity is indicated by adhesion to the tongue, to the touch of which fresh shells feel perfectly smooth.

Infiltration. — Sooner or later the pores left by the removal of the organic matter are infiltrated with lime, silica or other mineral matter, the organism thus becoming completely petrified or turned to stone. When silica infiltrates it tends to replace the original

* For a full discussion of this see Grabau, A. W., " Principles of Stratigraphy."

lime of the fossil, and in the end completely silicify it. Such silicification is commonly indicated by the formation of "Beekite rings," numerous small rings scattered over the surface of the shell or coral, and having at their centers a tubercle of silica. Silicified fossils commonly weather out in relief (though this is true also of calcified fossils), and they may be separated from calcareous rock matrix by acid. Silicification commonly destroys the minute structure of the organism while preserving its form. Many other minerals replace organisms, most common next to silica being iron pyrites. Wood may be partially or wholly silicified. In the first case the silica merely fills the cells and ducts, while in the second case the woody tissue is also replaced. Leaves may leave a picture of themselves in precipitated iron oxide, or they may be replaced by various minerals, or merely remain behind as a film of carbon.

Distortion often results from silicification, while crystallization frequently accompanies calcification, especially among the echinoderms.

Mechanical Deformation. — When rocks have suffered compression, fossils are commonly distorted. When the pressure is vertical the fossils are flattened out. This is frequently the case in undisturbed shales, where the compression of the beds, through pressure of overlying rocks, flattens out the shells, which in intercalated limestones or sandstones retain their normal form and rotundity. Where lateral compression has affected the strata various distortions result, which often may make the determination of the fossil a matter of difficulty. Brachiopod shells may in this way be made to resemble pelecypod shells.

The Naming of Fossils.

Each fossil is designated by a binomial term, the first part of which is the *generic* and the second the *specific* name. Generic names are written with an initial capital letter, specific names always begin with a small letter, even if derived from proper names. Thus *Heliophyllum halli* is correct, while *Heliophyllum Halli* is incorrect. The ending of the specific name (except nouns) must correspond to the gender of the generic name. The common endings are *us*, *a*, *um*, or *is*, *is*, *e*, for masculine, feminine and neuter gender, respectively. Specific names derived from proper nouns remain the same for all genders and commonly terminate in *i*. The Greek ending *oides* remains the same in all genders. A generic name becomes a *synonym* when it is found that the same name has previously been used for an organism of another genus. It must then be replaced by another name. A specific name becomes a synonym when the genus in which it belongs already has a species of that name. Different genera may have species of the same name. Sometimes an author describes and figures under the same name several forms which are subsequently found to belong to distinct species or even genera. In all such cases new names must be used, the old names becoming synonyms for that species or genus, though holding good for the forms to which they were originally applied. In some cases a species or genus already named or a form belonging to a species or genus already established is given a new name by a later author. This new name then becomes a synonym and unless restored to rank subsequently *for the type for which it was proposed*, has no value whatever, but is dead. It can never be used again.

Table of the Animal Kingdom.

The following table of the animal kingdom takes account only of those classes which are represented among fossils, or, in other words, only such which have hard parts capable of preservation. The classes and subclasses in italics will be omitted in the succeeding discussions :

Phylum.	Branch.	Class.	Subclass.
IX. Vertebrata		*Mammalia.*	
		Aves (Birds).	
		Reptilia.	
		Amphibia.	
		Pisces (Fishes).	
VIII. Echinodermata..	Echinozoa.	*Holothuroidea* (Holothurians.)	
		Echinoidea (Sea Urchins).	
	Asterozoa.	*Asteroidea* (Starfish).	
		Ophiuroidea (Brittle stars).	
	Pelmatozoa.	Crinoidea.	
		Blastoidea.	
		Cystoidea.	

Phylum.	Branch.	Class.	Subclass.
VII. Arthropoda		Insecta.	
		Myriopoda.	
		Acerata	*Arachnida* (Spiders).
			Merostomata (Eurypterids, etc.).
		Crustacea	Malacostraca (Lobsters, Crabs).
			Cirripedia (Barnacles).
			Ostracoda.
			Phyllopoda.
			Trilobita.
VI. Annulosa		Annelida.	
V. Mollusca		Cephalopoda.	
		Pteropoda.	
		Conularida.	
		Gastropoda.	
		Amphineura.	
		Scaphopoda.	
		Pelecypoda (Lamellibranchiata).	
IV. Molluscoidea*		Brachiopoda.	
		Bryozoa.	
III. Cœlenterata		Anthozoa (Corals).	
		Hydrozoa (Hydroids and Hydrocorallines).	
II. Porifera		(Sponges.)	
I. Protozoa		Rhizopoda	Radiolaria.
			Foraminifera.

General reference works:

Miller, S. A. North American Geology and Palæontology 1889 and appendices (lists all Palæozoic species with reference to literature).

Boyle, C. B. Catalogue and bibliography of North American Mesozoic Invertebrates, 1893 (with reference to literature), Bull. U. S. Geol. Surv., 102.

Weller, Stuart. Bibliographic index of North American Carboniferous invertebrates, 1898 (with synonymy and reference to literature), Bull. U. S. Geol. Surv., 153.

Phylum I. PROTOZOA.

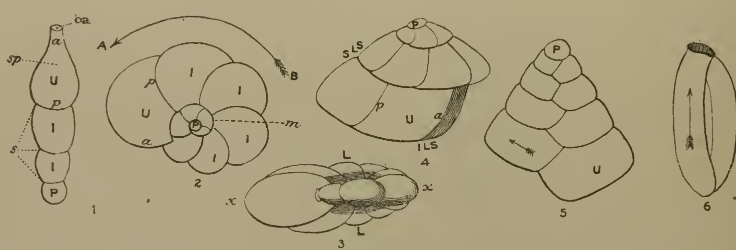
These are the simplest types of animals, with a body consisting of a single cell. Only two subclasses build hard structures which may be preserved as fossils. These are the Foraminifera and the Radiolaria. The first build external shells of lime, chitin or agglutinated sand particles; the second secrete more or less internal skeletal elements of silica and generally of an open lattice-like structure.

---

*Placed here for convenience so as to bring the Bryozoa and Corals together, many fossil forms of which are superficially alike.

Subclass I. **Foraminifera** d'Orbigny.

The shell may consist of a single chamber (unilocular) or of many chambers (multilocular). The chambers may be arranged in a straight line (nodosarian type, Fig. 1), wound in a horizontal manner (nautiloid type, Figs. 2, 3), in a spiral manner (trochoid



FIGS. 1–6. Diagrams illustrating types of Foraminiferal Shell (after Bagg).

type, Fig. 4), alternating in a double series (textularian type, Fig. 5), regularly embracing the preceding chamber (milioloid, Fig. 6), irregularly clustered (globigerinoid, Fig. 14), simple globular (orbulinoid, Fig. 13), or wrapped about an imaginary axis — either disk-like (orbitoid, Fig. 19) or spindle-shaped (fusoid, Fig. 18). The shell is either pierced by numerous pores or foramina (perforate) or is imperforate. A terminal or oral opening is generally present. The shell is a secretion of lime or results from cementation of sand grains (Fig. 11).

Owing to the fact that the Foraminifera vary but slightly from the upper Paleozoic to the present, they are of very little use as index fossils. A few of the more abundant genera are here given in order that they may be recognized as such. A few species which are restricted in their geological range and are found in great abundance are described.

LITERATURE.

1876. **Brady, W. B.** Monograph of Carboniferous and Permian Foraminifera, Palæontographical Society Monographs.

1884. **Brady, W. B.** Report on Foraminifera, Scientific Results, Challenger Expedition. Zoölogy, XI.

1893. **Woodward, A.**, and **Thomas, B.** Cret. Foraminifera, Minn., Neb. and Ill. Minn. Geol. Surv., III., 28.

1898. **Bagg, R. M.** Cret. Foraminifera, N. J. Bull. U. S. G. S., no. 88.

1900. **Chapman, F.** Foraminifera from the Tertiary of California. Proc Cal. Acad. Sci., Ser. 3, Vol. I., pp. 241–260, pls. XIX., XX.
1901. **Bagg, R. M.** Eocene Foraminifera. Md. Geol. Surv. Rept.
1904. **Bagg, R. M.** Miocene Foraminifera. Md. Geol. Surv. Rept.
1905. **Bagg, R. M.** Miocene Foraminifera of California. Bull. U. S. G. S., no. 268.

Synopsis of Important Genera and Species.

I. Peneroplis Montford.

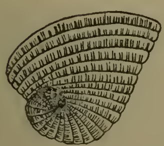


Fig. 7. *Peneroplis planatus*, greatly enlarged.

Shell a flattened cornucopia, with the small end spirally enrolled and chambers extending the entire width of the shell. Tertiary–Recent.

1. **P. planatus** Montf. (Fig. 7.) Recent.

II. Cristellaria Lam.

Shell regularly spiral with coils completely enveloping one another. Oral opening round. Trias–Recent.

2. **C. cultrata** Montf. (Fig. 8.) Cret.–Recent. 3. **C. cretacea** Bagg. (Fig. 9.) Cretacic.

Fig. 9*a–b*, *Crystellaria cretacea*; 15, *Anomalina ammonoides*; 11, *Verneuilina triquetra*; 8, *Crystellaria cultrata* (all after Bagg), greatly enlarged.

III. Textularia Defrance.

Chambers in two rows, alternating with each other and gradually increasing in size. Aperture usually an arched slit at the base of the inner wall of the last chamber. Carbonic–Recent.

4. **T. globulosa** Ehr. (Fig. 10.) Cret.–Recent. 5. **T.** (**Verneuilina**) **triquetra** (Münst.). (Fig. 11.) Cret.–Recent.

FIG. 10. *Textularia globulosa* (Minn. Geol. Surv.), much enlarged.

NODOSARIA.

Chambers in a single row, smooth or ornamented. Siluric (?)–Recent.

6. **N. communis** (d'Orb.). (Fig. 12*a*.) Perm.–Recent. 7. **N. bacillum** Defrance. (Fig. 12*b*.) Eocenic. 8. **N. zippei**, Reuss (Fig. 12*c*.) Cretacic.

V. ORBULINA d'Orbigny.

Shell a simple sphere with a large oral opening and numerous foramina. (Cambric ?) Trias–Recent.

9. **O. universa** d'Orb. (Fig. 13.) Trias–Recent.

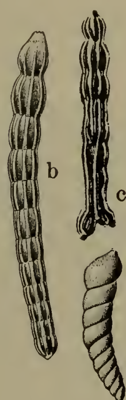


FIG. 12. *a*, *Nodosaria communis*; *b*, *N. bacillum*; *c*, *N. zippei* (*a–b*, Md. Geol. Surv.; *c*, Bagg), greatly enlarged.

FIG. 13. *Orbulina universa.*

FIG. 14. *Globigerina bulloides* (Minn. Geol. Surv.), much enlarged.

FIG. 16. *Truncatulina lobatula* (Md. Geol. Surv.), enlarged.

VI. GLOBIGERINA d'Orbigny.

Free, calcareous, perforated by coarse tubules. Composed of several globular chambers, which are irregularly arranged or in an imperfect spiral. (Cambric ?) Triassic–Recent.

10. **G. bulloides** d'Orb. (Fig. 14.) Cret.–Recent.

Globigerina, *Textularia*, etc., are very abundant in the American chalk (Niobrara) and also in the Atlantic and Gulf Tertiary.

FIG. 17. *Endothyra baileyi* (after Whitfield), much enlarged.

VII. Anomalina d'Orbigny.

VIII. Truncatulina d'Orbigny.

Nautiliform or trochiform shells, the first nearly uniformly coiled, the second flat on one side, while on the other side the last volution covers most of the preceding ones. Carbonic–Recent.

11. **A. ammonoides** (Reuss). (Fig. 15.) Cret.–Recent; 12. **T. lobatula** (Walk. & Jacob) (Fig. 16) Carb.–Recent.

IX. Endothyra Phillips.

Free, calcareous, irregularly spiral. Chambers numerous. General aperture porous.

Abundant in Carbonic and continuing doubtfully to Recent.

13. **E. baileyi** Hall. (Fig. 17.) Lower Carbonic.

Fig. 18. *Fusulina secalica* (Ind. Geol. Surv.), natural size and enlarged.

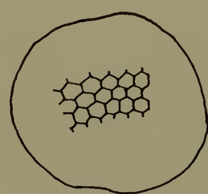


Fig. 19. *Orbitoides mantelli.* Outline and enlargement of peripheral portion.

Shell compressed, usually consisting of two or three oblique convolutions of which little more than the last is visible on the exterior. Margin thick, rounded, lobulate. Chambers inflated, separated by depressed septal lines, variable in number from seven to ten in each whorl. Diameter $\frac{1}{45}$ to $\frac{1}{20}$ inch or more.

Very abundant in Mississippian of southern Indiana.

X. Calcisphæra Williamson.

Free, consisting of two thin-walled concentric chambers with terminal apertures. Inner chamber smooth with tubular prolongations at the ends. Outer chamber spirally marked. Texture arenaceous compact. Resembles organs of fructification of *Chara* with which it has been identified. Devonic–?

14. **C. robusta** Williamson. Dev.–Carb.

Shell nearly globular, about 1 mm. in diameter, with polar apertures. Wall composed of minute calcareous grains, smooth interiorly. Outside banded by nine strongly defined regular spiral ridges.

Onondaga limestone of Indiana, Kentucky and Ohio.

XI. FUSULINA Fischer.

Fusiform, laterally elongated and furrowed, coarsely perforate. Chambers subdivided by numerous septa.

Exceedingly abundant in the Carbonic of North America, Europe and Asia. Carbonic–Permic.

15. **F. secalica** (Say). (*F. cylindrica* Fischer.) (Fig. 18.) Carbonic.

Spindle-shaped, with rounded extremities, which generally have the appearance of being slightly twisted. Volutions six to eight and closely coiled. Sometimes one half inch long.

Widely distributed throughout the Middle and Upper Carbonic.

XII. ORBITOIDES d'Orbigny.

Discoidal. Exterior smooth or ornamented with radial striæ. Composed of numerous concentric rings, which are divided by transverse partitions into small rectangular chambers. A median series of main chambers occurs. Upper Cretacic and Tertiary.

16. **O. mantelli** (Morton). (Fig. 19.) Oligocenic.

Discoidal, flattened, thin, thickest at center and tapering from there to the sharp margin. Diameter ½ inch to 1½ inches.

Very abundant in the lower Oligocene (Vicksburg) beds throughout the Gulf states, often forming beds of limestone.

Subclass 2. **Radiolaria** Müller.

The siliceous skeletons of these Protozoa are usually too much broken for identification. In exceptional cases, as in the Miocene of the Barbadoes, they are exceedingly numerous and well preserved. (Fig. 20.)

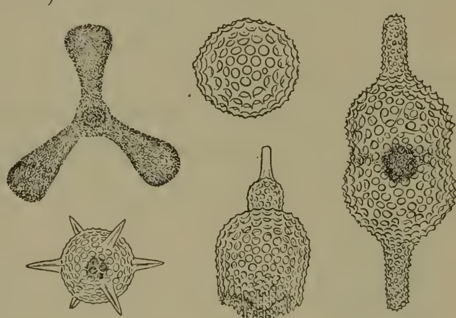


FIG. 20. Radiolaria. *a–b* (upper left), *Rhopalodictyum marylandicum ; Cœnosphæra porosissima ; c*, *Hexalonche microsphæra ; d*, *Anthocyrtium doronicum ; e*, *Cannartiscus amphicylindricus.* All Miocenic (Maryland Geol. Surv.), much enlarged.

PHYLUM II. PORIFERA (SPONGES).

Multicellular animals, chiefly marine; body penetrated by a complex series of canals, into which the water enters by the pores of the wall. These canals widen out into, or give off at intervals digestive chambers, and finally converge into one or more large canals which open on the upper side of the sponge in large craters or oscula. (Fig. 21.) Most modern sponges secrete a skeleton of horny fibers, which is frequently reënforced by silicious spicules of various forms. In many extinct types these spicules were the most prominent structure, and frequently became thickened and united to form a solid trellis or framework which retained the form of the sponge on fossilization. In some sponges this framework is regularly reticulated, in others it consists of very irregular branching spicules, while in still others it is apparently a solid mass of spicules. Some forms (*Dictyospongia*, etc.) were apparently delicate nets of siliceous fibers, the form and impression of these being preserved by the infiltrated sand as an internal mold.

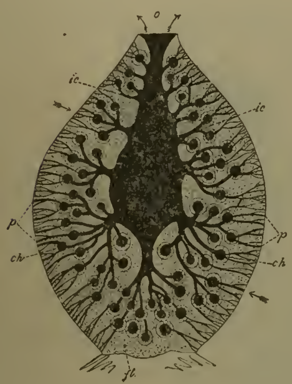


FIG. 21. Diagrammatic figure showing the structure of a simple sponge in vertical section. The sponge substance (*fl*) is lightly shaded. The canal system is black, the arrows showing the direction of the currents. *fp*, are the pores or openings of the inhalant canals (epirrhysa) which lead to the flagellate chambers, *ch*. From the latter depart the exhalant canals (aporrhysa), *ic*, which open into the general cavity or paragaster. *o*, is the osculum or aperture through which the water is discharged. (Haeckel, in Hall and Clarke.)

Sponges as a rule are poorly preserved and difficult of determination. They have been but little studied in this country.

LITERATURE.

1860. **Roemer Ferd.** Silurische Fauna des Westlichen Tennessee.

1889. **Beecher, C. E.** Brachiospongidæ, Mem. Peabody Mus. Yale Univ., II, pt. I.

1898. **Hall, J.**, and **Clarke, J. M.** Palæozoic reticulate sponges. Mem. II. N. Y. State Museum. Also papers by Whitfield Hall and others.

SYNOPSIS OF IMPORTANT GENERA AND SPECIES.

I. ASTYLOSPONGIA Roemer.

Free, spherical, with a shallow depression on top. Base evenly rounded. Surface furrowed by large canals and pitted with pores,

FIG. 22. *Astylospongia præmorsa*, with enlarged section (Roemer).

which terminate many fine radial canals. Spicules four-rayed and branching, with their nodes enlarged into knots. Siluric.

1. **A. præmorsa** Goldfuss (Fig. 22). Siluric.

Summit shallow and pierced with many large holes. From the edge of this depression radiate shallow furrows irregularly over the sides.

Niagara of Indiana, Tennessee, etc.

2. **A. inciso-lobata** Roemer. Siluric.

Differs from *A. præmorsa* in the absence of large pores above and in that the furrows number but six to eight and are deeply incised, thus dividing the surface into large, rounded lobes.

Niagara of Tennessee.

II. HINDIA Duncan.

Free, spheroidal. Spicules form a series of bifurcating, straight canals radiating from the center and opening at the surface. Siluric.

3. **H. fibrosa** Goldfuss. Ordovicic-Siluric.

Ball-shaped, about one inch in diameter. Surface covered with very small, irregular, polygonal openings.

Reported from the middle and upper Ordovicic, the Siluric and even the Helderbergian.

III. DICTYOSPONGIA Hall and Clarke.

Subcylindrical, very gradually expanding. Smooth, with no ornamentation except the reticulated meshwork of spicular threads.

Prism faces sometimes very obscurely developed toward the summit. Occurs as internal molds.

Characteristic of the Chemung and occurs also in the upper Portage and Keokuk.

4. **D. sceptrum** Hall. (Fig. 23.) Upper Devonic.

Elongate, usually abnormally compressed. Surface covered with coarse, transverse spicular bands from 10 mm. to 15 mm.

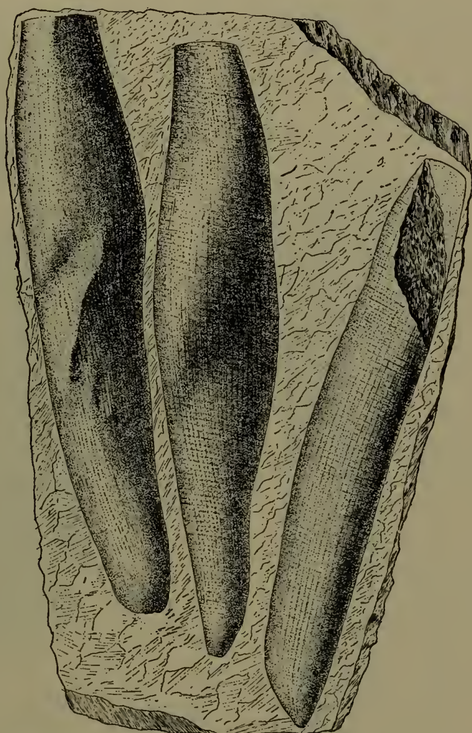


FIG. 23. *Dictyospongia sceptrum* × ½ (Hall & Clarke, N. Y. State Mus.).

apart and crossed by less conspicuous vertical bands about 5 mm. apart.

In the shaly sandstones of the upper part of the Chemung group in New York.

IV. PRISMODICTYA Hall & Clarke.

Elongate, usually slender, gradually expanding from the acute base. Surface sharply prismatic, with eight faces reticulated by spicular threads and rarely ornamented with inconspicuous nodes Found as internal molds.

Characteristic of the Chemung and occurs also in the upper Portage and the Keokuk.

5. **P. prismatica** Hall. (Fig. 24.) Upper Devonic

Often without perceptible expansion for a considerable distance but usually expanding to an aperture whose diameter is the greatest

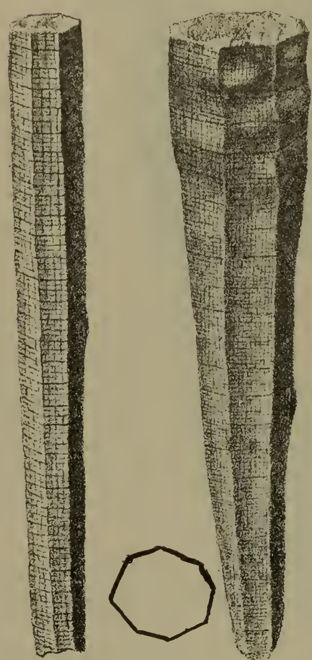


FIG. 24. *Prismodictya prismatica* (after Hall).

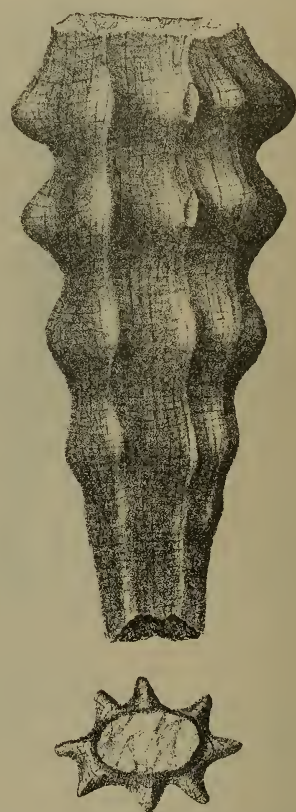


FIG. 25. *Hydnoceras tuberosum* (after Hall).

width of the sponge. Sometimes curved or twisted. Prism faces flat and each marked with one or two clearly defined spicular threads and other minor ones.

Chemung of New York, Pennsylvania.

V. Hydnoceras Conrad.

Obconical, more or less rapidly expanding from an acute base. Surface at first smooth except for the reticulated spicular threads, but soon developing eight prism faces and prominent nodes in horizontal and vertical rows. These nodes usually lie at the intersection of adjoining prism faces and are connected with one another in vertical rows by short prominent lameliæ. Occurs only as internal molds.

Characteristic of the Chemung. Occurs also in the Portage and Waverly.

6. **H. tuberosum** Conrad. (Fig. 25.) Upper Devonic.

Large. Transverse section usually subelliptical from compression. Horizontal rows of nodes not exceeding four or five in maturity and separated by broad concavities. Vertical rows eight and separated by concavities. Surface regularly reticulated by vertical and horizontal series of spicular bands.

Lower and Middle Chemung sandstones in New York.

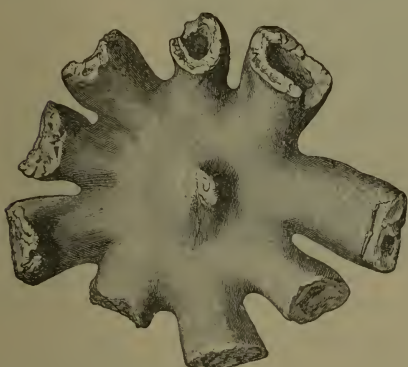


Fig. 26. *Brachiospongia digitata*, reduced (Beecher's mem.).

VI. Brachiospongia Marsh.

Skeleton enclosing a hollow central cavity which sends out large hollow arms, closed distally. Wall thin and bearing a net-work of spicules. Ordovicic.

7. **B. digitata** (Owen). (Fig. 26.) Ordovicic.

Arms eight to eleven, radiating from circumference of body; at first they pass off horizontally, then turning at right angles they rise nearly vertically. Size from six inches to one foot in diameter.

Trenton of Kentucky.

VII. Astræospongia Roemer.

Thick-walled, bowl-shaped. Upper surface concave, lower convex, without traces of attachment. Skeleton composed of relatively large, eight-rayed spicules, six of which are disposed in the same plane while the two projected at right angles to these are reduced to button-like prominence. Siluric.

8. **A. meniscus** Roemer. (Fig. 27.) Siluric.

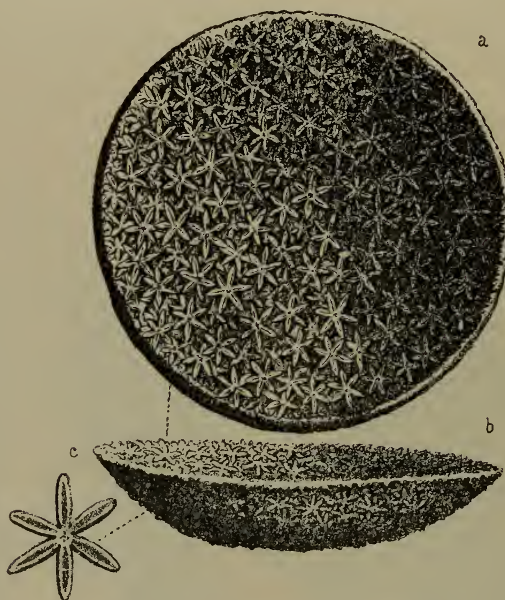


FIG. 27. *Astræospongia meniscus* with enlargement of spicule *c* (Roemer).

Vertical section crescent- (meniscus) shaped. Star-shaped spicules very conspicuous, especially on the concave surface.

Upper Siluric of Tennessee.

VIII. RECEPTACULITES Defrance.

Globular to platter-shaped bodies, containing a central cavity whose calcareous wall is composed of five-rayed spicules. Ord. to Dev.

9. **R. oweni** Hall. (Fig. 28.) Ordovicic.

Broad, varying in diameter from a few inches to two feet. Consisting of a flat, circular disc with a small, funnel-shaped central depression above, corresponding to the narrow projecting base of attachment on the under side. Cell rows curving strongly as they radiate from the center. Cell apertures quadrangular at surface, becoming circular and decreasing in diameter towards the center.

The characteristic fossil throughout the lead region, of the Galena limestone in Illinois, Iowa and Wisconsin.

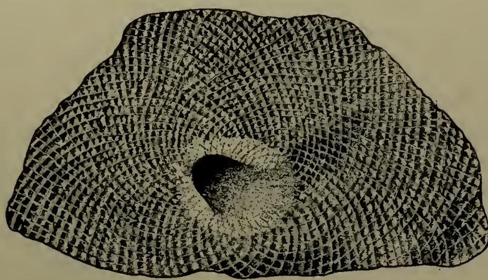


FIG. 28. *Receptaculites oweni* (Minn. Geol. Surv., Schuchert & Winchell).

10. **R. hemisphericus** Hall. Siluric.

Small, rarely exceeding two inches in diameter. Hemispherical or subglobular with truncated base. Cells in rows obliquely radiating from a sub-central point, minute near point of origin but rapidly increasing in size over the upper surface and again decreasing down the sides.

Niagara of Wisconsin.

11. **R. ohioensis** Hall & Whitfield. (Fig. 29.) Siluric.

Differs from *R. hemisphericus* in its smaller size, not exceeding one and one fourth inches in diameter, and in its smaller cells.

Niagara of Ohio.

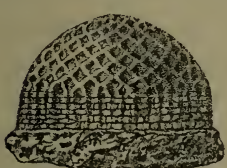


FIG. 29. *Receptaculites ohioensis* (Ohio Geol. Surv.).

12. **R. mamillaris** Walcott. Ordovicic.

Usually in form of an inverted cone with a deep depression above. In more expanded forms the center of the otherwise broadly rounded base extends as a short-pointed projection.

In upper portion of the Pogonip group (= Chazy) in Nevada.

13. **R. (Ischadites) iowensis** (Owen). (Fig. 30.) Ordovicic.

Base concave, upper surface, flatly dome-shaped, with an opening into the hollow cavity. Small rhomboidal cells opening on surface in curved rows, intersecting in arches.

Galena limestone of Iowa, Wisconsin and Minnesota.

Phylum III. CŒLENTERATA.

Class **Hydrozoa** Huxley.

This class comprises the modern hydroids, delicate moss-like animals, mostly growing in branching clusters or colonies having a common stem or a common base. A few simple forms occur in fresh water (*Hydra*), but with only one exception, the branching and clustered species are all marine. They are commonly found attached to the seaweed fringing our rocky shores, or growing in the deeper waters, though many also grow on rocks, where they are attached by a network of delicate root-like stolons, while others again are attached to shells or live partly buried in the mud.

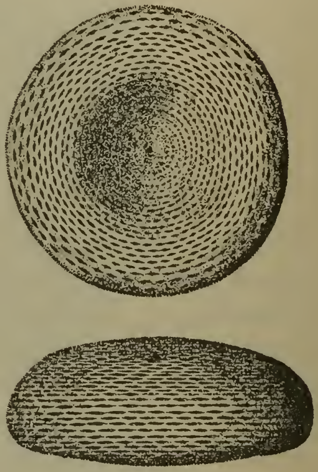


Fig. 30. *Ischadites iowensis* (Minn. Geol. Surv.).

Hydroids of the modern type are rare in the fossil state, but two aberrant groups the *Graptolites* and the *Hydrocorallines* are abundantly represented in American strata. It will be necessary, however, to briefly consider the characters of a modern hydrozoan in order to understand the essential characteristics of the extinct species. For this purpose, *Sertularia pumila* (Fig. 31), a type abundant on the rock-weed all along the north Atlantic coast, will be selected, since in its general form it suggests the characteristics of the *Graptolites*, though in reality quite distinct from them.

Fig. 31. *Sertularia pumila* Recent (after Nutting). *p*, *polyp*; *ht*, *hydrotheca*; *g*, *gonotheca* (much enlarged).

In general appearance this species resembles a delicate plant, consisting of branching stems furnished with a double row of opposite teeth, like those of a saw. Under the microscope it is seen that the organism consists of two essential parts, easily distinguished if the specimen is properly stained and well mounted. In the center is the animal proper, consisting of an elongated hollow stem,from which at regular intervals arise a pair of opposite flower-like heads or *polyps*, connected with the stem by a narrow "neck." The polyps form the swollen end of each tube, which at the summit is contracted into a narrow opening, the mouth, and furnished some distance below the summit with a ring of *tentacles*. The hollow internal space or stomach cavity of each polyp is continuous through the "neck" with that of the main stem, which in turn through the hollow tube of the rootstock is continuous with that of other stems of the colony. At intervals peculiar large polyps without mouth or tentacles occur, which serve the function of reproduction. In some types of hydroids free-swimming medusæ or "jelly-fish" are produced by these reproductive or *gonopolyps*. Enveloping the rootstock, stems and branches, is a transparent membrane composed of the organic substance "chitin," which is similar to the material of which sponges consist. This envelope or *periderm* widens around the polyps into cups or *hydrothecæ*, into which the polyps can withdraw by muscular contraction, after which the opening is closed by a lid or *operculum*. In the figure one of the polyps is expanded, the others are contracted or not shown. The gonopolyps are surrounded by a bottle-shaped cup or gonotheca, which has a short neck and broad opening. The substance of the periderm is such that it may be preserved in the form of a carbonaceous film.

Graptolites.

The simplest groups of Graptolites (*Axonolipa*), characteristic of the highest Cambric and lower half of the Ordovicic, are derived by a succession of buddings from a primal hydrotheca known as the *sicula*. If the first two buds extend in opposite directions, the result is a type with branches composed of a single row of hydrothecæ. These may be strung out in long rows, where each succeeding hydrotheca buds from near the margin of the preceding one (Fig. 46), or they may bud rapidly so as to overlap each other. In the former case the serrations are far apart; in the latter, which is the more specialized, they are close together. When the first two buds give off two buds each, four branches result (*Tetragraptus*) instead of two (*Didymograptus*). If later buds again give off two instead of one bud, a larger number of branches is produced (*Staurograptus*, *Dichograptus*, etc.). When the branches are numerous and united by cross-bars or *dissepiments* a net-like structure is produced (*Dictyonema*). When the original buds from the sicula are completely turned back upon themselves, so as to open in the opposite direction from the sicula, and grow together, back to back, a double-rowed structure is produced with hydrothecæ on opposite sides of the median line. Types of this kind (*Diplograptus*, *Climacograptus*) are reënforced by a median axis or rod, the *virgula*, which extends the entire length of the branch and beyond the last-formed hydrothecæ. It generally appears as a shining, solid rod, extending beyond the hydrothecæ. A number of types with a single row of hydrothecæ also possess a virgula. Types possessing this structure are classed in a division by themselves (*Axonophora*). In all cases the colony derived by budding from a single sicula is called a *rhabdosome*, whether consisting of one (single- or double-rowed) or many (single-rowed) branches. In many cases a number of rhabdosomes may be united by the ends of their virgulæ (that farthest away from the sicula), forming a compound rhabdosome, which in some cases is provided with a float or air-bladder-like structure, from the base of which also depend the gonangia or reproductive sacs (*Diplograptus*). (Fig. 54.)

While some of the *Graptolites* were probably attached to seaweeds like modern hydroids, others were free-floating or *planktonic* organisms. This and the fact that sea weeds when torn from their anchorage would also float, explains the wide distribution of the *Graptolites* and their presence in rocks of the same age in widely separated parts of the world. They are best preserved in fine mud-rocks, especially the black shales. They have, however. been found in limestones (calcilutytes) and even in sandstones, They are excellent index fossils of the lower Palæozoic rocks.

Literature.

Some of the more important works on American *Graptolites* are:

1865. **Hall, James.** Graptolites of the Quebec group. Canadian Organic Remains Decade II., Geol. Surv. Canada.

1868. **Hall, James.** Introduction to the Study of the Graptolites. N. Y. State Cab. Nat. History, 20th Ann. Report.

1879. **Spencer, J. W.** Graptolites of the Niagara Formation. Can. Naturalist, 1878–79, p. 457.

1884. **Spencer, J. W.** Graptolites of the Upper Silurian System. Mus. Univ. Missouri Bulletin.

1892. **Gurley, R. R.** The Geologic Age of the Graptolite Shales of Arkansas. Ark. Geol. Surv. Ann. Rep., 1890, 3: p. 401.
1895. **Matthew, G. F.** Two New Cambrian Graptolites with Notes on Other Species of Graptolitidæ of That Age. N. Y. Acad. Sci. Trans., Aug., 1895.
1896. **Gurley, R. R.** North American Graptolites. Jour. Geol., Vol. 4, no. 1, p. 63; no. 3, p. 291.
1904. **Ruedemann, R.** Graptolites of New York. Part 1. N. Y. State Museum Memoir, 7.

[This is the most comprehensive and most important work that has appeared in this country since Hall's Graptolites of the Quebec Group.]

Key to the Genera.

I. DENDROIDEA. Rhabdosomes irregularly branching in a shrub-like funnel or fan-like manner. Hydrothecæ mostly in the form of pits, rarely prominent.. *A.*

- *A.* Branches joined at frequent intervals .... 1.
  - 1. Branches joined by cross-bars or dissepiments............ I. *Dictyonema.*
  - 1. Branches flexuous, coalescing at points of contact; dissepiments rare. II. *Desmograptus.*
- *A.* Branches not joined, or only at great intervals .... 2.
  - 2. Branches diverging .... *aa.*
    - *aa.* Branches stout, bifurcating, irregularly dendroid. III. *Dendrograptus.*
    - *aa.* Branches plumose, with branchlets arranged alternately on opposite sides .... IV. *Ptilograptus.*
  - 2. Branches parallel, bifurcating at intervals .... Callograptus.

II. GRAPTOLOIDEA. Rhabdosomes simple or branching but not shrub-like. Hydrothecæ commonly distinctly marked .... *B.*

- *B.* Axonolipa. Virgula absent............ 3.
  - 3. Branches with single row of hydrothecæ (monoprionidian)............ *bb.*
    - *bb.* Branches of rhabdosomes bifurcating at irregular intervals, numerous .... *k.*
      - *k.* Branches apparently four at center, making a cross. V. *Staurograptus.*
      - *k.* Branches two at center............ *x.*
        - *x.* Primary branches S-shaped .... VI. *Cœnograptus.*
        - *x.* Primary branches not S-shaped............ Bryograptus.
    - *bb.* Branches of rhabdosome regularly bifurcating............ *l.*
      - *l.* Branches more than 8............ *y.*
        - *y.* Three bifurcations (sometimes more) producing 16 branches. VII. *Loganograptus.*
        - *y.* Numerous bifurcations, regularly alternating. VII. *Goniograptus.*
      - *l.* Branches 8 or less .... *z.*
        - *z.* Branches 8, sometimes 6 .... VII. *Dichograptus.*
        - *z.* Branches 4............ VIII. *Tetragraptus.*
        - *z.* Branches 2............ X. *Didymograptus.*

3. Branches leaf-like, four rows of hydrothecæ, generally appearing as two rows from compression ....IX. *Phyllograptus.*

B. AXONOPHORA. Virgula present .... 4.

4. Branches with a single row of hydrothecæ or only partly with double row *cc.*

cc. Branches entirely distinct, only a single row of hydrothecæ (Monoprionidian) opening in a direction opposite to the sicula. XV. *Monograptus.*

cc. Two branches, more or less united .... *m.*

m. Branches united only at base, V-shaped with hydrothecæ generally on outside.......................... XIII. *Dicellograptus.*

m. Branches united for some distance, above the base, Y-shaped. XII. *Dicranograptus.*

4. Branches with double row of hydrothecæ throughout (Diprionidian).. *dd.*

dd. Periderm solid... *n.*

n. Hydrothecæ sharp .. .. XIV. *Diplograptus.*

n. Hydrothecæ blunt....... .... XI. *Climacograptus.*

dd. Periderm a fine meshwork..... .... XVI. *Retiolites.*

SYNOPSIS OF GENERA AND SPECIES.

ORDER I. DENDROIDEA Nicholson.

I. DICTYONEMA Hall.

Rhabdosomes forming funnel or fan-shaped fronds, composed of numerous bifurcating branches arising from an acute base, and united at intervals by thin cross bars or dissepiments. Hydrothecæ seldom well preserved, of several types, appearing occasionally as teeth or as pits on the side of the branches turned toward inside of the funnel. Camb.–Dev.

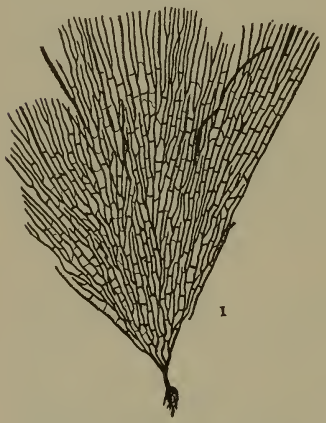


FIG. 32. *Dictyonema flabelliforme* (after Matthew).

1. **D. flabelliforme** (Eichwald). (Fig. 32.) Upper Cambric.

Rapidly expanding cones up to ten or twelve inches in length. Branches about .4 mm. wide, subparallel, rigid, bifurcating at long intervals, separated by a little over 1 mm. Dissepiments about half as thick as the branches.

In the shales forming the uppermost Cambric beds of eastern North America (especially in eastern Canada) and widely distributed in Europe.

2. **D. retiforme** Hall. (Fig. 33.) Mid-Siluric.

Broadly funnel-shaped. Branches rather coarse, frequently bifurcating, marked externally by flexuous striæ. Dissepiments

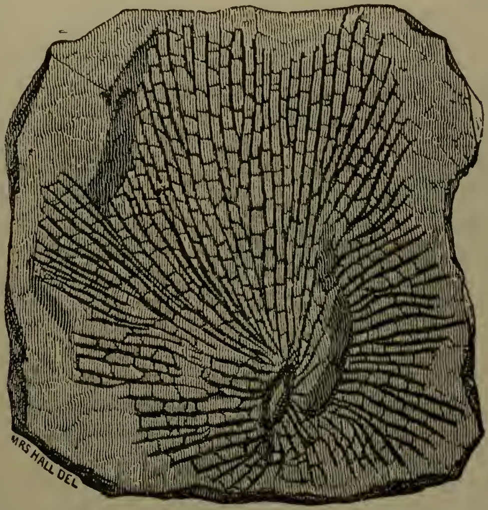


FIG. 33. *Dictyonema retiforme* (N. Y. State Mus. Rep.).

thin, diameter about a fourth that of the branches; rather oblique and numerous.

In the Rochester shale (Niagaran) of New York and Canada.

3. **D. gracilis** Hall. (Fig. 34.) Mid-Siluric.

FIG. 34. *Dictyonema gracilis* (N. Y. State Mus. Rep.).

Branches very slender, bifurcating and slightly diverging, irregularly striated or indented. Dissepiments slender and distant.

Occurs with the preceding.

4. **D. hamiltoniæ.** Hall. (Fig. 35.) Mid-Devonic.

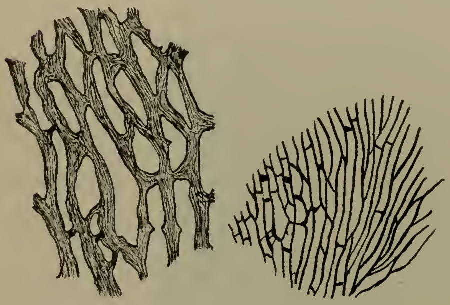


FIG. 35. *Dictyonema hamiltoniæ* with enlargement.

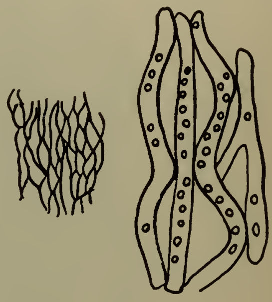


FIG. 36. *Desmograptus cancellatus* (Ruedemann, N. Y. State Mus. Mem.).

Branches slender, bifurcating, somewhat flexuous and uniting as in *Desmograptus.* Dissepiments scattered. (This may belong to the next genus.)

In the Hamilton shales of New York and in similar beds in Michigan.

II. DESMOGRAPTUS Hopkins.

Differs from *Dictyonema* in the flexuous character of the branches, which unite at intervals when they come in contact. Dissepiments chiefly in lower part of frond. Ord.–Dev.

5. **D. cancellatus** Hopkins. (Fig. 36.) Lower Ordovicic.

Branches 12 to 14 in 10 mm. forming long narrow meshes, twice as long as wide. Thecal apertures circular.

In shales of the age of the Lower Chazy in New York and Canada (?).

III. DENDROGRAPTUS Hall.

Rhabdosome with a strong main stem supporting a broad, spreading, shrub-like, variously ramifying frond. Hydrothecæ commonly obscure, or in the form of pits, sometimes well marked. Ordovicic.

6. **D. flexuosus** Hall. (Fig. 37.) Lower Ordovicic.

An inch or more in length, branches broadly and rather regularly diverging.

In shales of age of Beekmantown (*Tetragraptus zone*) of Canada and New York.

FIG. 37. *Dendrograptus flexuosus* (Ruedemann, N. Y. State Mus. Mem.).

IV. PTILOGRAPTUS Hall.

Rhabdosome with branches provided with two rows of alternate branchlets. No traces of thecal apertures have been found. Ord.–Sil.

7. **Pt. plumosus** Hall. (Fig. 38.) Lower Ordovicic. Branchlets slender, filiform and close set, diverging at about 40°, and about 3.5 mm. long.

In shales of the age of Lower Chazy, in Canada and New York.

ORDER II. GRAPTOLITOIDEA Lapworth.

Suborder AXONOLIPA Frech.

V. STAUROGRAPTUS Emmons. (*Clonograptus* Hall.)

Rhabdosome cruciform at the center, owing to the rapid budding of the early hydrothecæ. Repeated bifurcations produce a large number of branches, hydrothecæ long and but slightly overlapping. Camb.–Ord.

FIG. 38. *Ptylograptus plumosus* (Hall, Can. Org. Rem.).

8. **S. dichotomus** Emmons. (Fig. 39.) (*Clonograptus proximatus* Matthew). Upper Cambric. Branches upward of forty, the result of repeated bifurcation. Thecæ from 11 to 13 in 10 mm., in contact for a little over a third of their length. Apertures nearly vertical to axis.

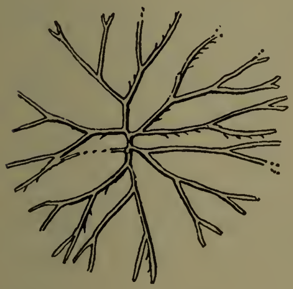


FIG. 39. *Staurograptus dichotomus* (after Matthew).

In the upper Cambric shales of eastern Canada and United States (*Dictyonema* shales).

VI. Cœnograptus Hall.

Bilaterally symmetric rhabdosome, the main stem (of tubular hydrothecæ) bent into an S with simple unicellular branches of similar structure given off from the convex side. The sicula appears at the center of the principal stem. Ordovicic.

9. **C. gracilis** Hall. (Fig. 40.) Middle Ordovicic.

Slender stem, branches with fine serrations from crowding of the hydrothecæ, Normanskill shales, Hudson Valley, etc.

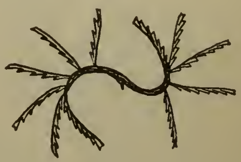


Fig. 40. *Cœnograptus gracilis.*

VII. Dichograptus Salter. (Including *Loganograptus* and *Goniograptus*.)

Rhabdosome of eight (typical) or more (*Loganograptus* and *Goniograptus*) large and narrow branches, united by a common stem in center which with the lobes of the branches lies within a central membranaceous disc. Branches with single row of hydrothecæ, becoming prominent some distance from center. When branches occur separated, they can only be determined by the form of their hydrothecæ. Ordovicic.

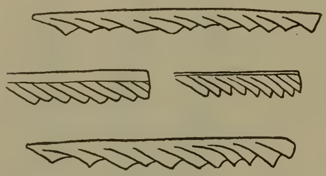


Fig. 41. *a* (upper), *Loganograptus logani; b* (middle left), *Tetragraptus quadribrachiatus; c, Dichograptus octobrachiatus; d* (lower), *Goniograptus thureaui* (all enlarged).

10. **D. octobrachiatus** Hall. (Fig. 41.) Lowest Ordovicic.

Eight, large and coarse branches often a foot long — central disk eight-angled.

Lower shales, Point Levis and Hudson River Valley, Beekmantown horizon. Also European.

11. **D. (Loganograptus) logani** Hall. (Fig. 41, *a*.) Lowest Ordovicic.

Numerous (thirteen to twenty-five, normally sixteen) slender branches up to nine inches long, symmetrically branching at base. Hydrothecæ become prominent only at some distance from base. Central disk many-angled.

Lower graptolite shales (Beekmantown), Point Levis and Hudson River Valley. Also European.

12. **D. (Goniograptus) thureaui** McCoy. (Fig. 41, *d*, 42.) Lower Ordovicic.

Four nearly rectangular main branches of a zigzag outline with regularly alternating secondary branches.

FIG. 42. *Goniograptus thureaui.*

Lower graptolite shales of Quebec and Hudson Valley (Beekmantown). Also European.

VIII. Tetragraptus Salter.

Typically of four short and broad branches with large hydrothecæ. A common transverse stem (funicle) occurs. A group still classed here is like a *Dichograptus* with only four arms, and a quadrangular central disk. It really belongs to a distinct genus. Ordovicic.

13. **T. bigsbyi** Hall. (Fig. 43.) Lower Ordovicic.

Of four short broad arms, with narrow but long hydrothecæ mucronate at the margin. Strong central stem.

Lowest graptolite beds (Beekmantown) of Point Levis and Hudson Valley.

FIG. 43. *Tetragraptus bigsbyi.*

14. **T. quadribrachiatus** (Hall). (Fig. 41, *b.*) Lower Ordovicic.

Like half a *Dichograptus octobrachiatus* — long slender branches with small hydrothecæ and a quadrate central disk.

Lower graptolite beds (Beekmantown) of Canada and Hudson Valley. Also Europe.

IX. Phyllograptus Hall.

Like *Tetragraptus* with the four branches grown together, each two back to back, forming a cross in section — generally preserved in flattened form so as to appear as a single leaf-like body. Ordovicic.

15. **P. typus** Hall. (Fig. 44.) Lower Ordovicic.

Broad, oval to lanceolate, as appearing on shale, with 24 (22–26) hydrothecæ to an inch. Broad axis or midrib, often crenulate or serrate.

Lower graptolite shale (Upper Beekmantown) Canada and Hudson Valley.

16. **P. ilicifolius** Hall. (Fig. 45.) Lower Ordovicic.

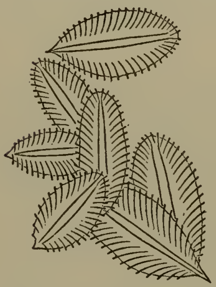


FIG. 44. *Phyllograptus typus* (after Roemer), enlarged.

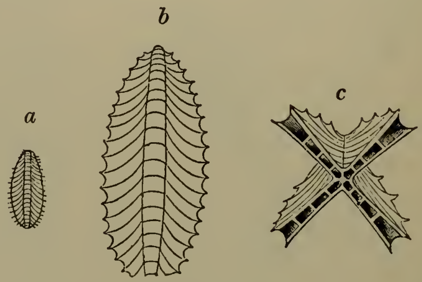


FIG. 45. *Phyllograptus ilicifolius*. *a*, natural size; *b*, enlarged; and *c*, restored crosssection (after Roemer).

Differs from the preceding in its thicker substance, proportionally shorter and broader form, more closely arranged hydrothecæ (29–32 to an inch) and strongly mucronate or spinous lower lip of hydrothecæ.

Shales of Middle Beekmantown age, Canada and New York.

17. **P. angustifolius** Hall. (Fig. 46.) Lower Ordovicic.

Narrow elongate form, generally a little broader at the base. Thecæ strongly mucronate on lower sides. Lower shales (Beekmantown) of Point Levis and Hudson Valley.

18. **P. anna** Hall. Lower Ordovicic.

More nearly rounded, often truncated, numerous thecæ. Higher Beekmantown and Lower Chazy horizon.

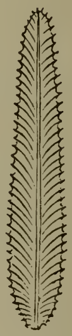


FIG. 46. *Phyllograptus angustifolius*, enlarged (after Roemer).

X. DIDYMOGRAPTUS McCoy.

Rhabdosome consisting of two symmetrical branches diverging from the basal cell (sicula) at angles from 10° to 180° or over, with oblique hydrothecæ opening inwards. Ordovicic.

19. **D. bifidus** Hall. (Fig. 47, *c*, 48.) Lower Ordovicic.
Divergence of branches 15° to 20°, gradually widening through increase in length of hydrothecæ to about two thirds distance from

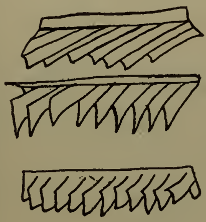


FIG. 47. *a* (upper), *Didymograptus nitidus*; *b*, *D. patulus*; *c* (lower), *D. bifidus* (all enlarged).

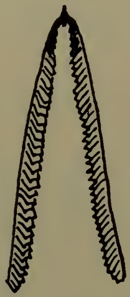


FIG. 48. *Didymogaptus bifidus.*

base, then narrowing again to apex. Shales of upper Beekmantown age (Deep Kill), Point Levis and Hudson Valley.

20. **D. nitidus** Hall. (Fig. 47, *a*, 49, *a*.) Lower Ordovicic.
Thecæ closely arranged, margin slightly concave, rectangular to axis of theca. Branches with wide angle of divergence (nearly or quite 180°). Lower Ordovicic of Point Levis and Hudson Valley (Beekmantown).

21. **D. patulus** (Hall). (Fig. 47, *b*, 49, *b*.) Lower Ordovicic.

FIG. 49. *a* (upper), *Didymograptus nitidus*; *b*, *Didymograptus patulus.*

Differs from *D. nitidus* in its wider and more rapidly widening branches, with ends of hydrothecæ concave and strongly acute instead of rectangular.

Lower graptolite shales (Beekmantown) of Point Levis and Hudson Valley.

Suborder AXONOPHORA Frech.

XI. CLIMACOGRAPTUS Hall.

Simple rhabdosomes, with parallel hydrothecæ, their outer margin straight and parallel to the axis of the stem. Ordovicic.

22. **C. bicornis.** (Fig. 50, 51, *a.*) Middle Ordovicic.

Gradually widening upwards, hydrothecæ approaching rectangular outline, base with two diverging mucronate points.

Normanskill shales (Trenton) of Hudson Valley, and equivalent beds of the Cincinnati region.

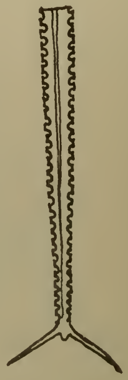


FIG. 50. *Climacograptus bicornis* (slightly enlarged).

23. **C. typicus** Hall. (Fig. 51, *b.*) Upper Ordovicic.

Differs from preceding in narrow almost horizontal incisions between, and small mucronate point at base of hydrothecæ.

Utica Slate of New York and Cincinnati region.

XII. DICRANOGRAPTUS Hall.

Lower portion of hydrosome biserial, upper portion dividing into two uniserial branches.

Form Y-shaped. Hydrothecæ as in *Climacograptus.* Ordovicic.

24. **D. ramosus** Hall. (Fig. 52.) Middle Ordovicic.

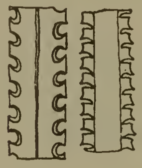


FIG. 51. *a* (left), *Climacograptus bicornis*; *b*, *C. typicus* (enlarged).

Undivided portion long, incisions between hydrothecæ deep, the latter with mucronate points.

Normanskill shales (Trenton), Hudson Valley. Europe.

XIII. DICELLOGRAPTUS Hopkins.

Like the preceding, but divided to the base. V shaped. Ordovicic.

25. **D. complanatus** Lapworth. (Fig. 53, *a*, *b.*) Middle Ordovicic.

Diverging at angle of 30–50 degrees. Hydrothecæ narrow and very oblique; non-mucronate.

Normanskill shales (Trenton), Hudson Valley.

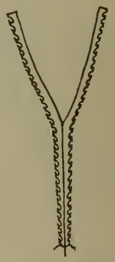


FIG. 52. *Dicranograptus ramosus* (slightly enlarged).

26. **D. divaricatus** Hall. (Fig. 53, *c.*) Middle Ordovicic

Diverging at angle of over 90°, up to 130°;

hydrothecæ furnished with slightly incurved hook-like projections on the upper outer region; 3 basal spines.

Normanskill shales (Trenton), Hudson Valley.

27. **D. sextans** Hall. (Fig. 53, *d, e.*) Middle Ordovicic.

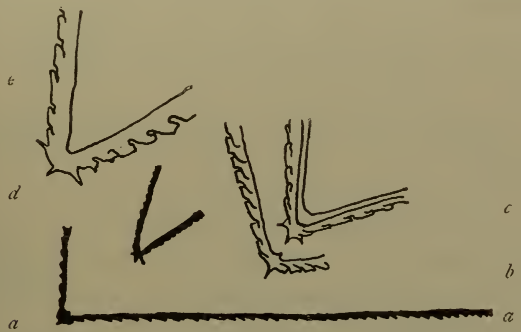


FIG. 53. *a, Dicellograptus complanatus*; *b*, same, enlarged; *c, D. divaricatus* (enlarged); *d, D. sextans*; *e*, same enlarged.

Similar to preceding, but basal spines turned up and outward.

Normanskill shales (Trenton), Hudson Valley.

XIV. DIPLOGRAPTUS McCoy.

Rhabdosomes linear to leaf-like, with two rows of alternating oblique hydrothecæ. Virgula prolonged beyond the proximal end and in perfect colonies attached with others to a floating (?) central disk. Ordovicic.

28. **D. pristis** Hisinger. (Fig. 54.) Upper Ordovicic.

Large oblique, acute serrations, pointed exteriorly, three basal spines, the central one usually longest.

Utica slate of New York and other states and Canada. Europe.

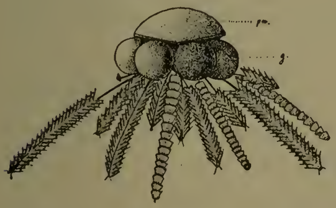


FIG. 54. *Diplograptus pristis.* Restoration of colony by Ruedemann. *pn*, pneumatophore or swimming bladder; *g*, gonangia (N. Y. St. Geol. Rept.).

29. **D. foliaceus** Murchison. Middle and Upper Ordovicic.

Hydrothecæ more oblique, smaller and more numerous than *D. pristis.*

Normanskill shales (Trenton), Hudson Valley. Europe.

30. **D. whitfieldi** Hall. Middle Ordovicic.

Like *D. pristis*, but hydrothecæ with spinose prolongations, and base with a single spine.

Normanskill shales (Trenton) of Hudson Valley.

31. **D. dentatus** Brongniart. (= *D. pristiniformis* Hall.) Lower Ordovicic.

Narrow slender stipes with closely crowded, very oblique hydrothecæ.

Graptolite shales of Point Levis and Hudson Valley. Lower Chazy. Europe.

XV. Monograptus Geinitz.

Rhabdosomes with only a single row of hydrothecæ, which in the American form are drawn out into bent points, at the apices of which are the openings. Silur.–Dev.

32. **M. clintonensis** Hall. (Fig. 55, *b.*) Middle Siluric.

Stipes straight with well-marked virgula. Ends of hydrothecæ bent over so that apertures open downward. Clinton shales of Rochester, N.Y.

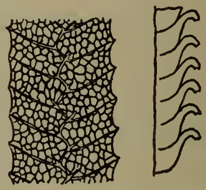


Fig. 55. *a* (left), *Retiolites venosus*; *b*, *Monograptus clintonensis* (both enlarged).

XVI. Retiolites Barrande.

Rhabdosome with the periderm attenuated and supported on a meshwork of fibers. Hydrothecæ in two rows, opening outward. Two virgulæ attached to opposite sides, in the median plane. Ord.–Sil.

33. **R. venosus** Hall. (Fig. 55, *a.*) Mid-Siluric.

Hydrothecæ slightly oblique; apertural margin concave; periderm very tenuous.

In the Clinton shales of western New York, associated with the preceding.

Hydrocorallines.

Stromatoporoidea Nicholson and Murie.

The Stromatoporoids are extinct organisms practically confined to the Palæozoic, where they were extremely important reef-builders, much of the limestone of the Siluric and Devonic resulting from the destruction of reefs of these fossils. They are most closely related to the modern Hydrocorallines (Millepora) and to Hydractinia, an aberrant type of Hydroid. This latter will serve to elucidate the structure of the Stromatoporoids.

Hydractinia (Fig. 56) commonly grows as an incrustation on the shells of dead gastropods, which have been seized as a habitation by hermit crabs. It is also found, however, encrusting rocks. The polyps are naked, *i. e.*, not protected by hydrothecæ, and of several kinds. The ordinary feeding polyp or nutritive zoöid has a mouth and tentacles. A second type of polyps has short, club-shaped tentacles and bears a cluster of reproductive buds or gonangia. These are the gonopolyps. A third and sometimes a fourth order of polyps occur, scattered about or confined to certain regions. These have an offensive and defensive function and apparently warn the colony of approach of danger.

FIG. 56. *Hydractinia* (Recent), showing 3 types of polyps arising from spinous hydrophyton (enlarged).

The colony secretes a basal horny or calcareous structure, the *hydrophyton*, which consists of successive, slightly separated, horizontal laminæ, supported by numerous vertical columns known as *radial pillars* (Fig. 57). From the surface arise hollow spines and tubercles, which serve as a protection when the polyps are contracted below their summits. The spaces between the laminæ communicate with the surface by means of tubes, and branching grooves or *astrorhizæ* are commonly present on the surface. In *Millepora* the colony secretes a calcareous structure (*cœnosteum*) not unlike some coral masses. This consists of a network of calcareous fibers and is traversed at frequent intervals by large tubes surrounded by a ring of smaller ones. The larger tubes (gastropores) lodge feeding polyps, and the smaller (dactylopores) lodge fighting polyps. Both sets of tubes are divided in the older part by horizontal partitions or tabulæ.

FIG. 57. *Hydractinia.* Cross-section of hydrophyton through a spine, showing horizontal laminæ and radial pillars.

The extinct Stromatoporoids combine the characteristics of the two types outlined above. They consist of hemispherical, spreading, encrusting, columnar, or nearly globular calcareous structures sometimes attaining a diameter of five feet or over, or a length of ten feet (*Beatricea*). The base is generally covered by a concentrically wrinkled calcareous crust or *epitheca*. In structure these bodies recall the hydrophyton of *Hydractinia* as described above, consisting of numerous concentric undulating calcareous laminæ, separated by interspaces, and supported by *radial pillars*. Both laminæ and supporting pillars are traversed in most cases by minute canals, and in some types vertical "zoöidal tubes" with tabulæ occur, as in *Millepora*. The surfaces of the laminæ are marked by numerous pores, the openings of canals, and by tubercles, blunt rounded prominences or "mamelons," or blunt spines, and shallow furrows radiating from a center (*Astrorhizæ*). In some types (*Actinostroma*) the laminæ are composed of a network of calcareous rods disposed in a horizontal series. In some cases the horizontal and vertical elements are so fused as to form a dense reticulated tissue, when the separate components are with difficulty distinguishable (*Stromatopora*). Frequently the horizontal laminæ are combined into strata or "latilaminæ" of some thickness, separated from each other by a slight interspace.

Several species of Stromatoporoids encrust cylindrical corals (*Aulopora*, *Syringopora*, *Ceratopora*, etc.) which become completely immersed in the Stromatoporoid, opening only on the surface in circular orifices. These orifices were formerly thought to be a structural part of the Stromatoporoid and the name Caunopora was applied to these types. Similar commensalism occurs in some Bryozoa.

Literature.

1866. **Winchell, Alexander.** On the structure and affinities of the Stromatoporoids. Proc. Amer. Assoc. Adv. Science, 1866, p. 91.

1873. **Hall, James, and Whitfield, R. P.** Description of new species of fossils. 23d Ann. Report N. Y. State Cabinet, pp. 226–228, pl. 9.

1874. **Nicholson, H. A.** Palæontology of the Province of Ontario.

1875. ——— Palæontology of Ohio, Vol. II.

1878. **Nicholson & Murie.** The minute structure of the skeleton of Stromatopora and its allies. Journ. Linn. Soc., Vol. 14.

1878. **Quenstedt.** Petrefacten Kunde Deutschlands. Schwämme, pl. 141 and 142.

1884. **Spencer, J. W.** Stromatopoids. Bull. Mus. University of State of Missouri, 1, 43–52.

1886. **Nicholson, H. A.** On some new or imperfectly described species of Stromatoporoids. Ann. and Mag. of Nat. Hist., Ser. 5, Vol. 17, p. 225; Vol. 18, p. 8, Vol. 19, p. 1.

1891. Same, part IV., do , ser. 6, Vol. 7, p. 309.
1886–92. **Nicholson, H. A.** A monograph of the British Stromatoporoids. Palæontographical Society monograph.
1894. **Girty, G. H.** Revision of the sponges and cœlenterates of the Lower Helderberg Group of New York. 14th Ann. Rept. N. Y. State Geol., p. 289, Stromatoporoidea.

Two keys are herewith given. The first is based on the microscopic structure and requires thin sections. It is believed that by its means most species may be traced to their proper genus. The other is based on external characters and is given to make possible field determination of the more important species of "Stromatopora" in the old sense. It applies only to the species described.

I. Key to the Genera.*

A. Calcareous tissue a meshwork of horizontal and vertical rectangular elements..... I.

I. Structure an open meshwork, radial pillars distinct, horizontal laminæ of calcareous anastomosing bars.. *.

*. Radial pillars continuous through a number of laminæ and interlaminar surfaces.. I. *Actinostroma.*

*. Radial pillars discontinuous.. II. *Clathrodictyon.*

I. Structure an open meshwork, radial pillars very large, horizontal elements thin irregular plates.. VII. *Labechia.*

I. Structure a dense reticulate meshwork in tangential section, but more open in vertical section, the radial pillars distinguishable.......................... **.

** Form spherical, massive or expanding .... *aa.*

aa. Laminæ bending upwards at regular intervals, forming a series of vertical rod-like structures passing through the mass.
III. *Stylodictyon.*

aa. Laminæ not bending upwards, short irregular zoöidal tubes.
IV. *Stromatoporella.*

** Form cylindrical and commonly branching, numerous well developed tabulate zoöidal tubes opening by circular pores .... V. *Idiostroma.*

I. Structure a dense reticulate meshwork in both tangential and vertical sections, radial pillars generally not distinct.. ***.

*** Structure reticulate, tabulate zoöidal tubes well developed.
VI. *Stromatopora.*

*** Structure very dense, but vertical and horizontal elements distinguishable.
VI. *Syringostroma* under *Stromatopora.*

B. Calcareous tissue of concentric laminæ, no vertical pillars..... .... II.

II. With vertical tubes.. VII. *Stromatocœrium.*

II. Without vertical tubes.. VIII. *Cryptozoön.*

C. Calcareous tissue a single layer covered with a basal epitheca and with numerous blunt tubercles on the surface...................................... IX. *Labechia* (young).

D. Calcareous tissue a series of vesicles, form columnar..................... X. *Beatricea.*

---

* Based on microscopic structure.

II. Key to the Species of "Stromatopora" in the Old Sense Based Chiefly on External Characters.*

A. Form a flattened or undulating expansion, generally with a basal epitheca........ *.

  * Free or only attached at initial point.. *a.*

    a. Surface with mamelons.. *aa.*

      aa. Mamelons prominent ; astrorhizæ present though inconspicuous, surface granulate................................... 9. *S. granulata* Dev.

      aa. Mamelons low, astrorhizæ absent .... 1. *S. expansa* Dev.

    a. Surface sometimes undulated, with tubercles instead of mamelons ; no astrorhizæ.. *bb.*

      bb. Tubercles of two sizes, the larger with pores. 10. *S. tuberculata* Dev.

      bb. Tubercles minute, in rows, with pores between rows. 5. *S. striatella* Sil.

      bb. Tubercles scattered, meshwork very coarse....... 7. *S. cellulosa* Dev.

    a. Surface without mamelons or tubercles.. *cc*

      cc. Astrorhizæ well developed........................ 2. *S. fenestrata* Dev.

      cc. Astrorhizæ small .... 4. *S. vesiculosa* Sil.

  * Encrusting other fossils. Tubercles instead of mamelons ; astrorhizæ present. 11. *S. incrustans* Dev.

B. Form massive, hemispheric or spherical.. **.

  ** Divided into strata or latilaminæ.. *b.*

    b. Surface with mamelons .... *cc.*

      cc. Astrorhizæ well developed.................... 14. *S. monticulifera* Dev.

      cc. Astrorhizæ small .... 1.

        1. Mamelons sharp and conical .... 3. *S. nodulata* Dev.

        1. Mamelons low and rounded ; astrorhizæ minute. 17. *S. centrota* Lower Dev.

    b. Surface with pustules instead of mamelons... *dd.*

      dd. Astrorhizæ small................................... 15. *S. pustulifera* Dev.

    b. Surface without mamelons or pustules.. *ee.*

      ee. Astrorhiza present .... 2.

        2. Vertical section shows only dense tissue ...... 16. *S. densa* Dev.

        2. Vertical section shows minute tabulate tubes traversing the entire stratum.. 13. *S. antiqua* Sil.

      ee. Astrorhiza absent .... 18. *S. barretti* Lower Dev.

  ** Not divided into strata, or but imperfectly so......... .... *c.*

    c. Surface without true mamelons .... *ff.*

      ff. Astrorhiza absent .... 3.

        3. Surface finely granulated with pores between rows of granules. 5. *S. striatella* Sil.

        3. Surface with pustules, formed by the ends of large vertical rods. 8. *S. columnaris* Dev.

        3. Surface with pustules in regular diagonal lines, and large irregular nipple-like elevations .... 6. *S. ostiolata* Sil.

    c. Surface with conical mamelons, astrorhizæ small...... 3. *S. nodulata* Dev.

C. Form cylindrical or branching .... ***.

  *** Surface with prominent pointed tubercles.. *d.*

    d. Branches with rounded ends, surface porous .... 12. *S. cæspitosa* Dev.

---

* This is adapted only to the species here described. It does not include *Stromatocærium*, *Cryptozoön*, *Labechia* or *Beatricea*. Endings become feminine.

SYNOPSIS OF GENERA AND SPECIES.

I. Actinostroma Nicholson.

Laminæ consisting of a meshwork of fibers. Radial pillars more or less continuous throughout, subequally spaced and generally

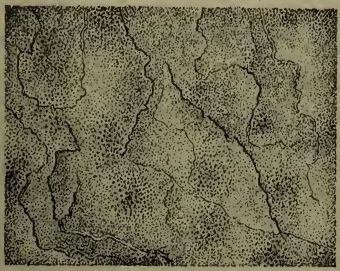


Fig. 58. *Actinostroma expansum*, surface. (N. Y. State Cab. Rep.)

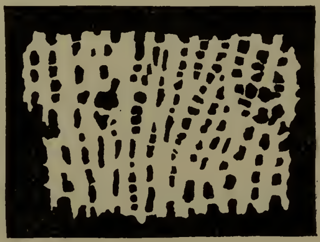


Fig. 59. *Actinostroma fenestratum*. Vertical section × 8. (After Nicholson.)

projecting on the surface in the form of granules or tubercles. In vertical section the pillars and laminæ form a more or less regular series of rectangular meshes. Astrorhizæ present or absent. Siluric (rare)–Dev.

1. **A. expansum** (Hall & Whitfield). (Fig. 58.) Devonic.
Large expanding masses sometimes many feet in diameter,

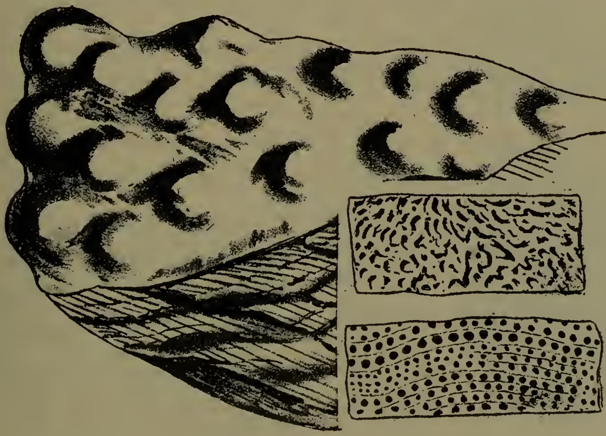


Fig. 60. *Actinostroma nodulatum* with horizontal and vertical sections. (Nicholson, Pal., Ohio.)

slightly undulating surface with low broad mamelons, three eighths to one half inch from center to center. Astrorhizæ absent.

In Upper Devonic rocks of Iowa and Canada.

2. **A. fenestratum** Nicholson. (Fig. 59.) Devonic.

Skeleton fibers coarser than preceding species — surface without the prominences (mamelons); astrorhizæ well developed.

In Devonic limestones of Manitoba, etc. Also European.

3. **A. nodulatum** (Nicholson). (Fig. 60.) Devonic.

In large expanding masses, with large sharp conical mamelons 12 mm. apart and small astrorhizæ.

Onondaga of Ohio.

II. Clathrodictyon Nicholson.

Laminæ a meshwork similar to preceding genus. Radial pillars discontinuous, extending only from lamina to lamina. Astrorhizæ

Fig. 61. *a*, *Clathrodictyon vesiculosum*, × 8; *b*, *Clathrodictyon striatellum*, × 8; *c*, *Stromatoporella granulata*, × 8. (All vertical sections.)

present. Vertical section often appearing vesiculose. Siluric (common)-Devonic (rare).

4. **C. vesiculosum** Nicholson & Murie. (Fig. 61, *a*, 62, 63.) Siluric.

Laminar expansions covered by a concentric basal epitheca; adult half a foot or more in diameter by an inch or more in greatest thickness. No rounded prominences; small astrorhizæ with centers from 3 to 5 mm. apart. Nine to eleven lam næ to 1 mm.

In the Clinton and Niagara of Ohio, Canada, New York and Anticosti. Also European.

Fig. 62. *Clathrodictyon vesiculosum*, × 60. (After Nicholson.)

5. **C. striatellum** d'Orbigny. (Fig. 61, *b*.) Siluric.

Laminar or hemispheric with concentrically wrinkled epitheca. Surface undulating but no "mamelons,' generally exfoliating concentrically around elevated areas. Numerous minute rounded tubercles, alternating with minute pores on well preserved surfaces. No astrorhizæ. Coarse (5 laminæ to 1 mm.) radial pillars like spines growing downward from bottom of laminæ.

FIG. 63. *Clathrodictyon vesiculosum* under or epithecal portion.

This is, according to Nicholson and Hinde, the common species of the Niagara of Canada, usually referred to as *Stromatopora concentrica.*

6. **C. ostiolatum** Nicholson. Siluric.

Differs from the preceding in the presence of nipple-like elevations of the entire mass at intervals, and in the occurrence of small perforated tubercles at regular intervals in diagonal lines.

In the Guelph of Canada and New York.

7. **C. cellulosum** Nicholson & Murie. (Fig. 64.) Devonic.

Differs from *C. vesiculosum* in the coarser meshwork (about 2 laminæ to 1 mm.) and in having the surface covered with tubercles or granules; and from *C. striatellum* in the coarser meshwork.

Onondaga limestone of Canada, New York, etc.

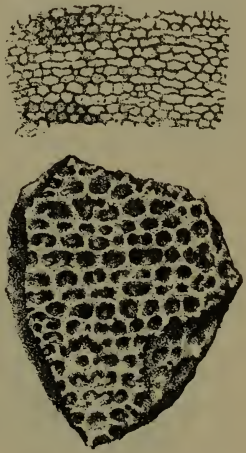


FIG. 64. *Clathrodictyon cellulosum.* (After Nicholson.)

III. STYLODICTYON Nicholson & Murie.

Cœnosteum a dense tissue traversed by numerous closely set circular vertical columns of large size, formed by the upward bending of the concentric laminæ. They terminate on the surface in small pointed eminences. Between the columns the tissue is more open, consisting of horizontal laminæ and vertical (radial) pillars, the latter often imperfect. Devonic.

8. **S. columnare** Nicholson. (*S. wortheni* Quenstedt.) (Fig. 65.) Devonic.

A large mass readily recognized by the vertical rods of dense tissue formed by the upward bending of the laminæ, and the small rounded knobs in which the rods terminate on the surface, these being separated by a little more than half their diameter. Middle Devonic limestones of Ohio and Michigan (Traverse group).

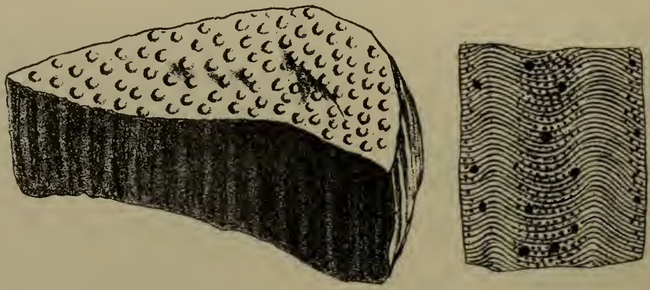


FIG. 65. *Stylodictyon columnare* with enlarged vertical section (Nicholson, Pal. Ohio).

IV. STROMATOPORELLA Nicholson.

Coralline mostly a lamillar expansion, furnished with a basal epitheca. Latilaminæ imperfect or not developed. In vertical section concentric lamellæ and radial pillars distinguishable. In tangential sections the ends of the pillars are distinguishable, while the general character of the tissue is reticulate; short irregular zoöidal tubes present. Devonic.

9. **S. granulata** Nicholson. (Fig. 61, *c*, 66.) Mid-Devonic.

FIG. 66. *Stromatoporella granulata* enlarged vertical section.

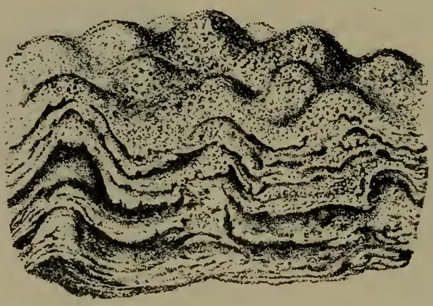


FIG. 67. *Stromatoporella tuberculata* (after Nicholson).

Laminar expansions with concentrically wrinkled and striated epitheca. Thickness from 2 mm. up to 2 or 3 cm. Rather distant rounded mamelons pierced by apical pores, and with astrorhizæ inconspicuous. Surface covered with granules.

Common in the Hamilton formation of Canada.

10. S. **tuberculata** Nicholson & Murie. (Fig. 67, 68.) Mid-Devonic.

Differs from the preceding in absence of mamelons, the surface being undulating and covered only with tubercles of two sizes, and in coarser meshwork (about 6 laminæ to 2 mm.).

FIG. 68. *Stromatoporella tuberculata*, enlarged surface and section (after Nicholson).

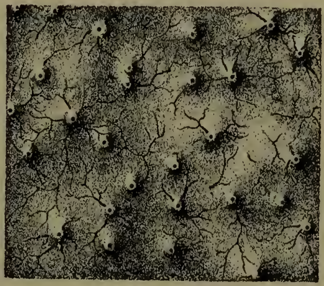


FIG. 69. *Stromatoporella incrustans* (N. Y. State Mus. Rep.).

In the Onondaga limestone of Canada and New York.

11. **S. incrustans** Hall & Whitfield. (Fig. 69.) Devonic.

Encrusting other fossils. Astrorhizæ with central tubercles pierced by pore.

Upper Devonic of Iowa and elsewhere.

V. Idiostroma Winchell.

Form typically cylindrical, branching or growing in fascicles. Each branch has generally a tabulate tube, while other smaller tabulate zoöidal tubes with rounded openings are abundant. Radial pillars and concentric laminæ distinct. Surface with prominent pointed tubercles often arranged in ridges, or nearly smooth. Devonic.

12. **I. cæspitosum** Winchell. Mid-Devonic.

Branching irregularly; branches club-shaped.

Abundant in the limestones of the Traverse group (Hamilton) in Michigan.

VI. STROMATOPORA Goldfuss.

Massive or laminar. Laminæ grouped in strata or "latilaminæ"; radial pillars numerous, extending across a stratum and uniting with the laminæ to form a finely reticulated tissue as seen in vertical section. Tabulate zoöidal tubes, and astrorhizæ present. *Syringostroma* differs chiefly in its denser structure and somewhat more distinct horizontal and vertical elements. Silur. (rare)–Devonic.

13. **S. antiqua** Nicholson & Murie. (Fig. 70.) Siluric.

Massive, spheroidal or hemispheric, with well-marked strata or latilaminæ 5 or 6 to 1 cm. Delicate zoöidal tubes traversing entire stratum. Astrorhizal centers 4–5 mm. apart, mamelons absent.

Niagara limestone of Canada and New York.

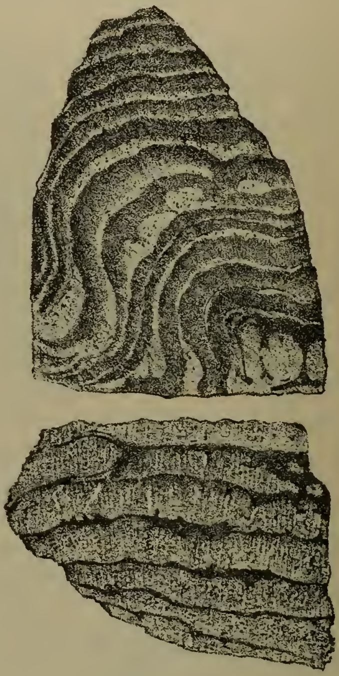


FIG. 70. *Stromatopora antiqua*, vertical sections, the lower, × 2 (after Nicholson).

14. **S. (Cœnostroma) monticulifera** Winchell. Devonic.

In large hemispheric or globular masses, surface with large mamelons and astrorhizæ; centers 7.6 to 10 mm. apart. Extremely abundant in the Traverse (Hamilton) group of Michigan.

15. **S. pustulifera** Winchell. Devonic.

Similar to preceding, but surface with pustules instead of mamelons and smaller astrorhizal centers, 4 mm. apart.

Occurs with the preceding.

16. **S. (Syringostroma) densa** Nicholson. (Fig. 71.) Mid-Devonic.

Surface without mammillæ but well developed astrorhizæ. Structure exceedingly dense.

Onondaga of Ohio and probably elsewhere.

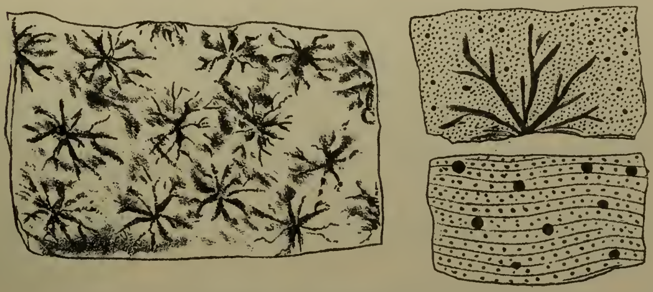


FIG. 71. *Syringostroma densum* with horizontal and vertical sections, enlarged (Nicholson, Pal. Ohio).

17. **S. (Syringostroma) centrota** Girty. (Fig. 72, *a*, upper sections.) Lower Devonic.

Spheroidal, surface with rounded mamelons and minute astrorhizæ.

Lower Helderberg of New York.

18. **S. (Syringostroma) barretti** Girty. (Fig. 72, *b*, lower sections.) Lower Devonic.

Hemispheric with flat base, surface without mamelons or astrorhizæ. Laminæ flexed in wave-like manner.

Lower Helderberg of New York.

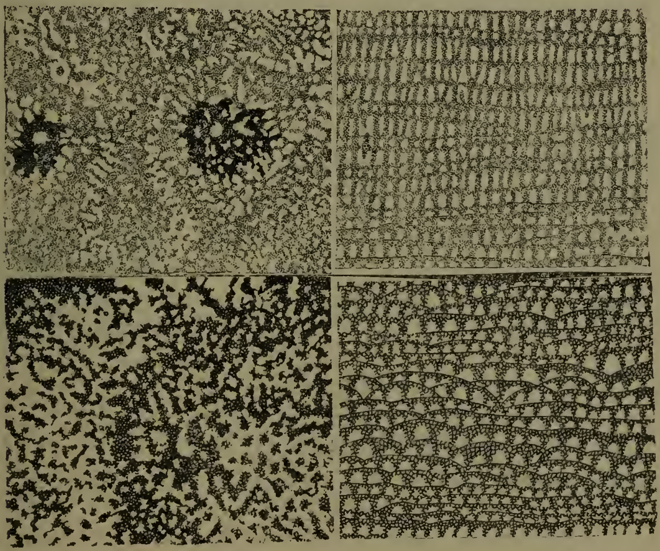


FIG. 72. *a* (upper two), *Syringostroma centrotum*, tangential and vertical sections; *b* (lower two), *Syringostroma barrètti*, tangential and vertical sections (Girty in N. Y. State Mus. Report), enlarged × 10.

VII. Stromatocœrium Hall.

Cœnosteum massive, of dense, thick horizontal and concentric discontinuous laminæ, separated by very narrow interspaces. No radial pillars. Small vertical tubes penetrate the several laminæ, connecting interlaminar spaces. No astrorhizæ. Ordovicic.

19. **S. rugosum** Hall. Middle Ordovicic.

Hemispheric, with wrinkled concentric laminæ, and faint indications of vertical tubes.

Black River limestone, New York, Canada, etc.

20. **S. eatoni** Seely. Lower Ordovicic.

Expanding masses two inches or more in thickness, surface with mamelons. On weathered surfaces numerous concentric rings appear around the mamelons.

Chazy of Lake Champlain.

VIII. Cryptozoön Hall.

Cœnosteum of irregular concentric laminæ, traversed by minute canals which branch and anastomose irregularly. No astrorhizæ. Camb.–Ord.

21. **C. proliferum** Hall. Lower Ordovicic.

Grows in compressed spherical cakes a foot or more in diameter.

In the Beekmantown horizon of New York, etc.

IX. Labechia E. & H.

Expanded, with a basal epitheca, vertical pillars a series of blunt tubercles in the young form, connected in adult by thin calcareous plates. Differs from *Actinostroma* in the large size of the pillars which are connected by plates instead of fibers. Ord.

22. **L. ohioensis** Nicholson. (Fig. 73.) Ordovicic.

Laminar or encrusting. Surface often with mamelons and with minute tubercles. Radial pillars distant, interspaces vesicular.

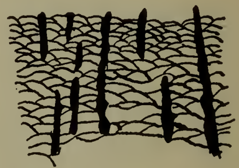


Fig. 73. *Labechia ohioensis*, × 9.

Upper Cincinnati beds of Ohio, Indiana, Canada, etc.

X. Beatricea Billings.

Cylindrical or angulated stems, often fluted and ranging in size to over ten feet in length and a foot in diameter. A central tube with cystose tabulæ and a peripheral vesicular structure characterize the fossil. Ordovicic.

23. **B. nodulosa** Bill. (Fig. 74.) Ordovicic.

Cylindrical, with oblong, oval or subtriangular blunt-pointed tubercles, sometimes arranged in vertical rows.

Trenton and Cincinnati groups Anticosti and Kentucky.

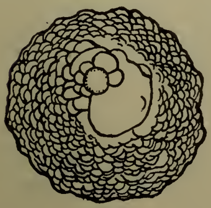


FIG. 74. *Beatricea nodulosa*, transverse section showing inner tube and cystose character (after Nicholson).

24. **B. undulata** Bill. Ordovicic.

Surface sulcated longitudinally by short, irregular, wave-like furrows, from two lines to one inch across, according to size of specimen.

Cincinnati group of Anticosti.

Class **Anthozoa** or **Actinozoa** (Corals).

Marine animals ranging from low water to depths of 1,500 fathoms, but chiefly at home in tropic seas above the fifty fathom line. The animal or polyp may be simple, or give rise by budding or division to a compound polyparium, in which the individuals or polypites may be distinct or confluent.

The corallum or hard structure secreted by these animals is simple or compound. Typically each coral is furnished with a circumferential wall, and radiating lamellæ or *septa*, though either the one or the other may be much reduced or even absent. The wall may be an independent structure, growing up like the septa from the bottom of the corallum (theca), or it may be formed of the thickened and fused outer ends of the septa (pseudotheca). The outer ends of the septa are frequently continued beyond the wall as *costæ*. Often an outer more or less wrinkled envelope or *epitheca* occurs, which shows concentric lines of growth. Between the septa are various endothecal structures, such as cross plates or *dissepiments*, cross-bars or *synapticulæ*, or continuous floors or *tabulæ* which extend across the whole coral. In some cases the interior consists of a spongy mass, the septa being very rudimentary (*Cystiphyllum*). The septa may be smooth, or furnished with granules, or reinforced by vertical beams, which on cross section or in the calyx of the coral, look like short regular bars (*carinæ*) crossing the septum, and extend a short distance on each side (*Heliophyllum*). The upper edges of the septa in the calyx may be spinous, or smooth. A central rod or *columella* is frequently present, and varies in form and texture. The twisting of the septa at the center may give the appearance of such a structure (pseudocolumella).

In Palæozoic corals the arrangement of the septa is often clearly seen to be in four groups (*Tetracoralla*) distributed in corresponding quadrants. This arrangement is frequently well marked by the course of the lines which on the exterior indicate the division between the septa. A main or cardinal septum is distinguishable, from which at either side branch off secondary septa in a pinnate fashion (Fig. 75, *h*). These occupy the two cardinal quadrants, and are limited by the *alar* septa on the sides of the corallum (Fig. 75, *s*). From the alar septa branch off other secondary septa in a pinnate fashion on the side away from the cardinal septum, these filling the two *counter quadrants* which are divided from each other by the counter septum, which lies directly opposite the cardinal septum (Fig. 75, *g*). The cardinal septum is frequently reduced so as to leave a marked groove or *fossula*. The secondary septa are often united to each other in such a manner that their united ends form a continuous wall around the fossula, or they may unite in groups, one on either side of the cardinal septum and one near each alar septum. The apparent grooves thus produced are the *pseudofossulæ*. This wall may sometimes close completely so as to form an inner tube, into which the septa do not extend. Tertiary septa often not reaching the center occur. In most Mezozoic and later corals the septa occur in multiples of six, and are often very numerous, most of the cycles of septa reaching the center.

FIG. 75. Kunth's diagram of tetrameral coral. *h*, cardinal; *g*, counter; *s*, *s*, lateral or alar septa.

In compound forms the corallites may be crowded, when they are generally prismatic in form, or they may be far apart, remaining either entirely dissociated at the upper surfaces, or being connected by a dense or coarse calcareous tissue — the *cœnenchyma*. Sometimes the corallites are connected merely by their strongly developed costæ. In a few cases they become confluent by incomplete division, and present the character of winding grooves with the septa pointing to the center of the groove. When the septa are absent tabulæ are generally well developed (*Favosites*) which in some forms may be funnel-shaped (*Syringopora*). The walls of such corallites are frequently pierced by a more or less regular series of round holes or *mural pores*. A series of small shelves or *squamæ* are generally found on the inside of the wall near these mural pores. In form the compound coral mass may be a hemispheric or spherical "head," a plate-like expansion, or variously branching with cylindrical branches.

Literature.

1851. **Milne-Edwards, H., et Haime, J.** Monographie des Polypiers Fossiles des Terraines Paléozoiques. Arch. du Museum, Paris, Vol. V. (describe many American species).

1874. **Nicholson, H. A.** Palæontology of the Province of Ontario, Toronto.

1876. **Rominger, C.** Fossil Corals. Geol. Surv. Michigan, Vol. III., pt. II., pls. 1–55.

1843–87. **Hall, James.** Palæontology of New York. Vols. 1, 2, 3, 6, and Illustrations of Devonian Fossils.

1879. **Nicholson, H. A.** Tabulate Corals of the Palæozoic Period. Blackwood & Sons.

1882. **Hall, James.** Fossil Corals of the Niagara and Upper Helderberg Groups. 12th Report Indiana Geol. Surv.

1885. **Davis.** Kentucky Fossil Corals. Geol. Surv. Kentucky.

1900. **Vaughan, T. Wayland.** The Eocene and Lower Oligocene Coral Faunas of the United States. Mon. U. S. Geol. Surv., 39.

1898 to date. **Green, G. K.** Contributions to Indiana Palæontology.

1899–01. **Lambe, Lawrence M.** A Revision of the Genera and Species of Canadian Palæozoic Corals. Geol. Surv. Canada, Contr. to Canad. Pal., Vol. 4.

Key to the Genera.

A. Coral simple.......... *.

* Surface covered by a wrinkled epitheca which extends to the edge of the calyx.. †.

† Coral conical, cylindrical, or compressed conical not composed of invaginated cups or funnels.......... *a.*

a. Septa well developed, the longer reaching to center.......... *aa.*

aa. Central columella well developed, not formed by the septa..... I.

I. Coral compressed, columella spongy, septa numerous in multiples of six, earlier ones much larger than later ones. LIII. *Flabellum.*

I. Coral conical columella projecting and solid.......... II.

II. Columella compressed......... XXVII. *Lophophyllum.*

II. Columella round.......... Cyathaxonia.

aa. Columella absent, pseudocolumella sometimes formed by twisting of septa.......... 2.

2. Coral conical (cylindrical), the tetrameral arrangement of the septa visible in the calyx or in the external septal grooves.......... ‡.

‡ Epitheca normally wanting in basal portion.
XXVI. *Duncanella.*

‡ Epitheca complete (except when denuded)............... 22.

22. Septa radial in calyx, rarely uniting or twisted at the center, fossula well developed .... *x.*

x. Septa smooth, tabulæ well developed.
(Compare *Streptelasma.*) II. *Zaphrentis.*

x. Septa carinate.
40. (*Heliophyllum corniculum*).

22. Septa radial, twisted or united in the center, fossula rarely developed.
(Compare *Zaphrentis.*) I. *Streptelasma.*

22. Septa radial, not twisted at the center. Fossula absent *xx.*

xx. Septa smooth .... XIV. *Cyathophyllum.*

xx. Septa carinated............... XVI. *Heliophyllum.*

22. Septa arranged in a bilateral manner................ *xxx.*

xxx. Strong fossula to which the adjoining septa converge.................... IV. *Aulacophyllum.*

xxx. Fossula occupied by large cardinal septum, septa uniting into four groups.
1. *Streptelasma profundum.*

2. Coral cylindrical, the tetrameral arrangement obscure... 33.

33. Fossula and tabulæ well developed .... *xxxx.*

xxxx. Septa twisted at the center and with the tabulæ elevated tent-like .... V. *Acrophyllum.*

xxxx. Septa not twisted or faintly so, sometimes not quite reaching center....... II. *Zaphrentis.*

33. Fossula weak or absent, tabulæ in central portion only. *xxxxx.*

xxxxx. Septa carinated, fossula occasionally developed.......... .... XVI. *Heliophyllum.*

xxxxx. Septa smooth........... .... *y.*

y. Septa reaching to center, fossula absent or partly developed and faint.
XIV. *Cyathophyllum.*

y. Septa not fully reaching center, fossula present and faint................ XV. *Campophyllum.*

a. Septa well developed, not reaching to center........................... *bb.*

bb. Septa, short strong vertical ridges, tabulæ well developed.
VII. *Pycnostylus* (single branch).

bb. Septa normal, reaching part way to center........................ 3.

3. Fossula present (rarely absent).............................. 44.

44. Cylindrical, with numerous often sharp constrictions and well developed tabulæ......... III. *Amplexus.*

44. Cylindrical without constrictions, well developed tabulæ onto which the septa extend to within a short distance of center .... II. *Zaphrentis.*

44. Conico-cylindrical not constricted, often abruptly bent, tabulæ in central vesicular tissue in peripheral area.
XV. *Campophyllum.*

3. Fossula absent, coral cylindrical, tabulæ well developed. 20. *Blothrophyllum promissum.*

a. Septa faint or absent, interior cystose................. X. *Cystiphyllum.*

† Coral conical or cylindrical, composed of a series of invaginated cups or funnels .... *b.*

b. Septa well developed, interior not cystose .... *cc.*

cc. Cylindrical, of invaginated cups, tabulæ well developed, center of calyx smooth. Fossula present or absent. VI. *Blothrophyllum.*

cc. Cylindrical or top-shaped, consisting of invaginated funnels, septa low, reaching center .... 4.

4. Septa twisted in center into pseudo-columella. IX. *Ptychophyllum.*

4. Septa often weak, not twisted, no pseudo-columella. VIII. *Chonophyllum.*

b. Septa faint or absent, interior wholly composed of cystose tissue arranged in a series of funnel-shaped layers. (Compare Chonophyllum where septa may be weak.)............... X. *Cystiphyllum.*

† Coral disk-shaped, with flat or slightly convex base covered by a wrinkled epitheca .... *c.*

c. Septa carinated or crenulate, the larger ones reaching the depressed center, no fossula.......................... .... XI. *Palæocyclus.*

c. Septa smooth, fossula present .... *dd.*

dd. Disk shaped, one fossula .... XII. *Microcyclus.*

dd. Cushion or top-shaped, septa uniting into four groups, giving the appearance of two lateral fossulæ besides the cardinal one. XIII. *Hadrophyllum.*

† Coral with one side flat, and the other arched; operculated and with the septa in low ridges.. XXIX. *Calceola.*

* Wrinkled epitheca on lower part only, or rudimentary .... *d.*

d. Structure of coral porous.............................. LIX. *Balanophyllia.*

d. Structure solid, center with spongy columella... XLIX. *Parasmylia.*

* Surface free from epitheca.. ††.

†† Structure minutely porous .... *e.*

e. Compressed often with lateral wings................. LXI. *Endopachus.*

e. Conical, pointed at base, free.................. .... LX. *Eupsammia.*

e. Conical with broad base of fixation, septa more or less united near center................ .... LIX. *Balanophyllia.*

†† Structure not porous.. .... *f.*

f. With basal scar of attachment, conical, septa granular, columella spongy.. XLIX. *Parasmylia.*

f. Without scar of attachment, strong costæ, and alternate septa uniting.

ee. Form conical .... LVI. *Turbinolia.*

ee. Form wedge-shaped .... LIV. *Platytrochus.*

ee. Form disk-shaped .... LV. *Discotrochus.*

B. Corals compound, of loosely branching cylindrical stems each with a terminal opening .... **.

** Septa fully developed .... †††.

††† Central columella present .... *g.*

g. Epitheca present, columella rudimentary or wanting. LI. *Cladophyllia.*

g. Epitheca wanting, columella papillose.................. L. *Pleurocora.*

††† Columella absent.. *h.*

h. An inner wall present .... *ff.*

ff. Wall often incomplete, septa carinated.
XXV. *Craspedophyllum.*

ff. Wall complete, septa not carinated...... .... 4.

4. Inner tube small, stems uniting by epithecal prolongations.
XXII. *Eridophyllum.*

4. Inner tube rather large, stems without epithecal prolongations
XXIV. *Diplophyllum.*

h. Inner wall wanting... *gg.*

gg. With epithecal proliferations, septa extending to near center.
XXIII. *Synaptophyllum.*

gg. Without epithecal proliferations, septa in form of short vertical ridges.. VII. *Pycnostylus.*

gg. Without epithecal proliferations, septa well developed.
XLIX. *Cladophyllia.*

** Septa absent or represented by spines or faint ridges......................... ††††.

†††† Encrusting or attached by whole under side................................ *i.*

i. Pipe-like, buds regular, single or double from near end of parent colony . ... XXX. *Aulopora.*

i. Cylindrical, irregular branching, on crinoid stems.
XXXIII. *Monilopora.*

†††† Free or only basally attached... *k.*

k. Branches in numerous parallel bundles of thin cylindrical tubes *hh.*

hh. Branches distinct but united by hollow cross tubes at intervals. Interior with funnel-shaped tabulæ. XXXIV. *Syringopora.*

hh. Tubes united by their sides, forming a chain work. Septa sometimes quite strong......................... XLIV. *Halysites.*

k. Branches thin, regular or irregular, but not in parallel bundles..... *ii.*

ii. Branches in verticils, remote tabulæ and occasional mural pores.
XXXI. *Romingeria.*

ii. Branching by bifurcating, dendroid or irregular ; wall reinforced by coarse cysts................................. XXXII. *Ceratopora.*

ii. Branching dendroid or irregular, wall dense, under high power appears reticulate.......................... XXXIII. *Monilopora.*

k. Branches coarse, commonly irregular; interior coarsely cystose.
28. *Cystiphyllum aggregatum.*

C. Coral compound forming heads, expansions or branching stems of numerous contiguous corallites... ***.

*** Heads of cylindrical tubes .... 5†.

5† Tubes without septa or with septal ridges or spines......................... *l.*

l. Tubes united by porous cross branches........ XXXIV. *Syringopora.*

l. Tubes united by vesicular cœnenchyma .... XLV. *Lyellia.*

l. Tubes united by their sides and forming chains..... XLIV. *Halysites.*

l. Tubes united by their own expansions at intervals.
XXXVIII. *Chonostegites.*

5† Tubes with well developed septa.. *m.*

m. Tubes united by epithecal proliferations.................................. *kk.*

kk. Tubes with inner wall .... XXII. *Eridophyllum.*

kk. Tubes without inner wall .... XXIII. *Synaptophyllum.*

m. Tubes not united by proliferations, sometimes angular .... *ll.*
ll. Tubes with inner wall complete, septa smooth.
XXIV. *Diphyphyllum.*
ll. Tubes with inner wall often incomplete, septa carinated.
XXV. *Craspedophyllum.*
*** Heads, expansions or branching stems of prismatic tubes closely crowded. 6†.
6†. Corallites with well-developed septa.................................. .... *n.*
n. With well-marked styliform pseudo-columella.
XXVIII. *Lithostrotion.*
n. Without columella............... .... *mm.*
mm. Septa carinated .... 5.
5. Head of numerous, comparatively small prismatic corallites.
XVII. *Acervularia.*
5. Head of a few large corallites.................... .... 55.
55. Corallites separated by definite walls.
38. *Heliophyllum confluens.*
55. Corallites confluent, not separated by definite walls.
XVIII. *Phillipsastræa.*
mm. Septa smooth.............. .... 6.
6. Corallites prismatic with expanding calices, 12 strong septa uniting in adjoining calices. Mural pores regular.
XXXIX. *Thecia.*
6. Corallites slender prisms, 12 septa, numerous tabulæ, no mural pores................................. XXI. *Columnaria.*
6. Corallites minute, 4 primary septa ......XLVII. *Tetradium.*
6. Corallites prismatic, septa of 2 kinds, the longer extending to the center, no tabulæ ....LII. *Septastræa.*
6. Corallites with central part of calyx elevated above peripheral part................................ XIX. *Pachyphyllum.*
6† Corallites with septa absent, or represented by low ridges or rows of spines... *o.*
o. Corallites regular prisms, with numerous tabulæ .... *nn.*
nn. Septa in form of low ridges, with costæ; no mural pores.
XXI. *Columnaria.*
nn. Septa represented by spines or absent, mural pores in definite rows .... XXXV. *Favosites.*
nn. Septa represented by faint ridges; tabulæ convex upward; mural pores irregularly scattered..... XXXVII. *Michelinia.*
nn. Tubes opening obliquely, openings crescentic on one side, mural pores large, scattered........................ XXXIX. *Alveolites.*
o. Corallites prismatic, of varying size, tabulæ few .... *oo.*
oo. Small hemispheric heads with basal epitheca. Mural pores irregularly scattered .... XXXVI. *Pleurodictyum.*
o. Corallites contracting at regular intervals. Tabulæ convex upward. Septa rows of spinules....................... XXXVIII. *Chonostegites.*
o. Corallites thick-walled, elongate conical, opening obliquely, mural pores present, tabulæ few. Commonly branching stems.
XLI. *Cladopora.*
*** Heads of superimposed strata or layers which are divided into depressed or elevated pentagonal areas, with septal ridges extending over them. Basal epithecæ generally preserved .... XX. *Strombodes.*

*** Heads with larger round corallites scattered among smaller angular, often minute ones. Tabulæ numerous.. 7†.

7† Septa absent; mural pores present .... XXXV. *Favosites.*

7† Septa present in large corallites, 12 in number; no mural pores......... *p.*

p. Septa 12 infoldings of wall, short .... XLVI. *Heliolites.*

p. Septa well developed, spinulose, smaller corallites imperfect, vesiculose in tissue........... .... XLVII. *Plasmopora.*

D. Corals compound, forming branching stems or expansions with numerous calices scattered over the surfaces... ****

**** Cœnenchyma separating calices.. 8†.

8† Calices regular, septate.. *q.*

q. Columella papillose, cœnenchyma dense .... 7.

7. Branches cylindrical, calices spirally arranged. LVII. *Oculina.*

7. Branches irregular, often flattened and expanded. Calices scattered.. LVIII. *Astrohelia.*

**** Branching; cœnenchyma absent... 9†.

9† Calices distinct, with septal striæ surrounding the orifice.

r. Thick-walled with circular openings, distant superficially. XLIII. *Trachypora.*

r. Thick-walled, circular orifices in polygonally depressed calices. XLII. *Striatopora.*

9† Corallites without septal striæ .... *s.*

s. Corallites thin-walled, openings oblique, crowded, generally curved on one side .... XL. *Alveolites.*

s. Corallites thick-walled, orifices irregular, distant.... XLI. *Cladopora.*

s. Corallites opening regularly with polygonal or rounded crowded apertures. Mural pores in regular rows, tabulæ numerous. XXXV. *Favosites.*

Tetrameral Corals.

I. Streptelasma Hall.

Simple conical corals, generally curved, with a funnel-shaped calyx, which is generally deep and furnished with numerous septa, the longer of which are in some species twisted at the center. Fossula present in later types. Tetrameral arrangement of septa shown by their external ends. Epitheca thin. Interior marked by tabulæ. Ord.–Dev.

1. **S. profundum** (Owen). (Fig. 76, *a–b.*) Lower Ordovicic.

Deep calyx and few septa, the septa not twisted at the center, and strongly crenulated in their margins. Primary septa strong and three pseudo-fossulæ well developed, formed by union of ends of septa next to cardinal and alar septa. Cardinal one double and divided by cardinal septum.

In beds of Black River, Chazy, and doubtfully Beekmantown age, Michigan, Wisconsin, Iowa, New York, Canada, etc.

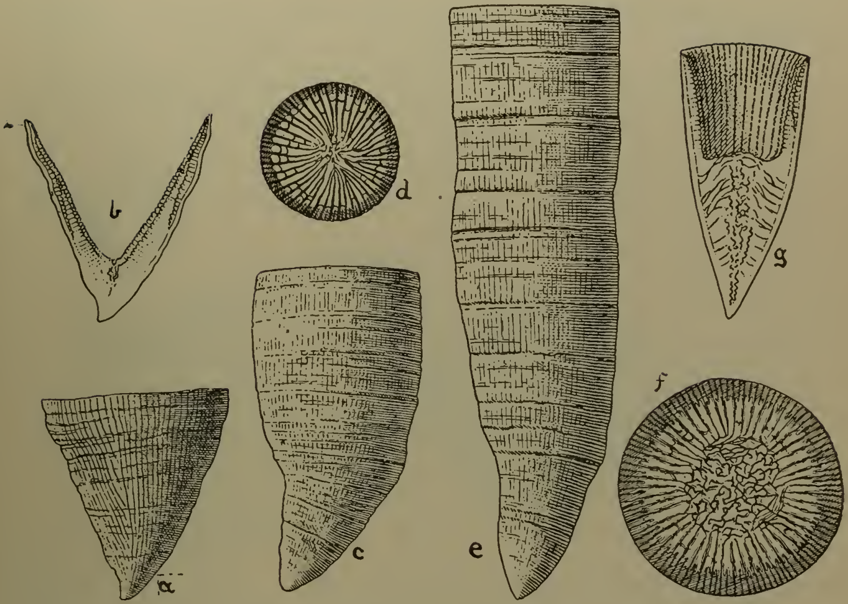


FIG. 76. *a–b*, *Streptelasma profundum*; *c–d*, *S. corniculum*; *e–f*, *S. rusticum*; *g*, *Enterolasma calicula* (Lambe-Contr. Pal.).

2. **S. corniculum** Hall. (Fig. 76, *c–d.*) Middle Ordovicic.

Corallum curved, calyx moderate, septa numerous, twisted at the center.

Trenton and Galena limestone, New York, Canada, Iowa Minn., etc.

3. **S. rusticum** Billings. (Fig. 76, *e–f.*) Upper Ordovicic.

FIG. 77. *Streptelasma* (*Enterolasma*) *calicula* (N. Y. State Geol. Surv.).

FIG. 78. *Stereolasma rectum*, (*a*) cardinal and (*b*) alar views.

Larger than preceding (2½–3½ inches), septa coarser and more strongly twisted, forming a vesicular pseudocolumella at the center.

Lorraine and Richmond beds of Minnesota, Iowa, Indiana, Ohio and Canada.

4. **S. (Enterolasma) caliculum** Hall. (Fig. 76, *g*, 77.) Middle Siluric.

Small, slender, uniformly tapering corals with moderately deep cup, and comparatively few (20–50) septa separated by twice their width, and epitheca thin, showing costal grooves. Septal ends unite into a reticulate pseudo-columella.

Niagara beds of New York, Canada, etc.

5. **S. (Stereolasma) rectum** Hall. (Fig. 78, 79.) Middle Devonic.

Generally larger and more robust than preceding, with strongly wrinkled and often irregular surface, owing to strong epitheca. Septa comparatively few, uniting at the center. A well marked fossula is present.

Hamilton group of NewYork, etc.

FIG. 79. *Stereolasma rectum*, transverse and longitudinal sections (after Simpson).

II. ZAPHRENTIS Rafinesque.

Simple, conical or turbinate corals, becoming conico-cylindrical in some large species. Calyx deep, with well developed septa, the primary ones generally reaching to the center. Dissepiments and tabulæ occur, the latter usually well developed and bent downwards at the periphery. A deep fossula marks the abortion of the cardinal septum. Epitheca thin. Sil.–Carb.

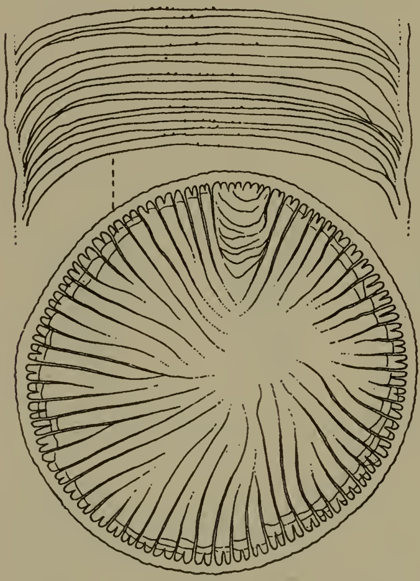


FIG. 80. *Zaphrentis gigantea*, longitudinal and transverse sections (Lambe).

6. **Z. gigantea** Lesueur. (Fig. 80.) Middle Devonic.

Generally of large size becoming cylindrical in the adult. Length sometimes 2½ feet with a diameter of three inches. Bottom of calyx often shows a tabulum, the septa not reaching the center. Fossula large and deep. Epitheca strongly wrinkled.

Found in the Onondaga limestone of New York, Canada, Michigan, Ohio. Abundant at the Falls of the Ohio.

7. **Z. prolifica** Billings. (Fig. 81.) Middle Devonic.

Conical and generally curved, expanding rapidly. Septa meet at the center of the deep calyx, where they unite more or less. Broad fossula formed by abortion of cardinal septum.

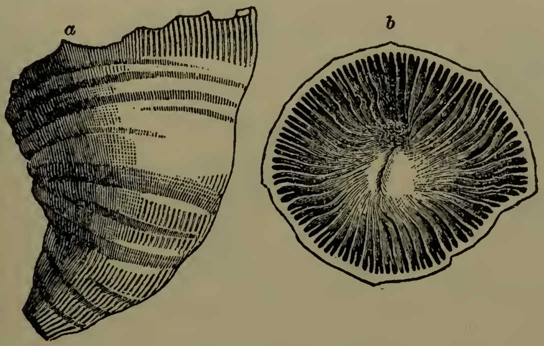


FIG. 81. *Zaphrentis prolifica*, lateral (*a*) and calicinal (*b*) views (after Billings).

Found in the Onondaga limestone of Michigan, Canada, Ohio, Kentucky, etc., and in the Hamilton group of Michigan, Canada, etc.

8. **Z. convoluta** Hall. Middle Devonic.

Conical and rapidly expanding. The septa unite before reaching the center and become more or less twisting.

In the Onondaga limestones of the Falls of the Ohio.

FIG. 82. *Zaphrentis simplex* (Pal. N. Y., Hall).

9. **Z. simplex** Hall. (Fig. 82.) Middle Devonic.

More cylindrical than the preceding, regularly tapering, septa scarcely reach the center.

In the Hamilton shales of New York.

10. **Z. stokesi** E. & H. Siluric.

Conical and curved with moderately deep calyx, in which the septa unite in the center and become twisted as in *Streptelasma*. A stong fossula and tabulæ are present.

In the Niagara of Canada, Michigan, Iowa, etc., and in equivalent beds of Anticosti aud Lake Temiscaming.

11. **Z. cliffordana** Edwards & Haime. Lower Carbonic.

Corallum a curved cone, with a deep calyx, the septa of which are all nearly equal in strength, becoming thinner towards the center. Fossula generally on the side of least curvature.

In the Kinderhook beds of Illinois, the Chester beds of Ohio, etc.

Fig. 83. *Hapsiphyllum calcareforme* (Ind. Geol. Surv.).

Fig. 84. *H. calcareforme.* Transverse section (Simpson).

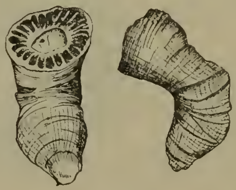


Fig. 86. *Amplexus hamiltoniæ.*

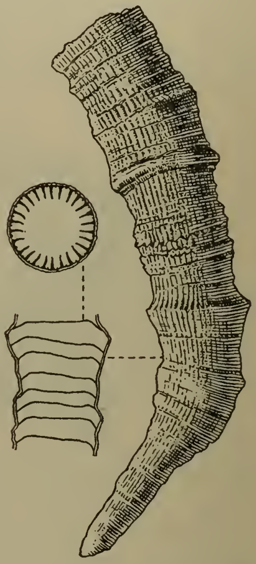


Fig. 85. *Amplexus yandelli* with transverse and longitudinal sections (Lambe Contr. Can. Pal.).

12. **Z. (Hapsiphyllum) calcareformis** Hall. (Figs. 83, 84.) Lower Carbonic.

Small, slender and uniformly tapering, sometimes curved. Fossula narrow, outlined by a compressed horseshoe-shaped wall formed of septa united at the center. Shorter septa joining the longer which in turn unite with the wall of the fossula.

In the St. Louis limestone of Spergen Hill, Lanesville, Indiana, and other localities.

13. **Z. (Hapsiphyllum) spergenensis** Worthen. Lower Carbonic.

Like the preceding, but with two rudimentary pseudofossulæ, and short epithecal spines.

Occurs with the preceding.

III. Amplexus Sowerby.

Generally cylindrical or conico-cylindrical corals, with structure much like *Zaphrentis* but with the septa only reaching a short way out onto the well developed horizontal tabulæ. A strong fossula is generally present. Ord. ?–Carb.

14. **A. shumardi** (E. & H.). Middle Siluric.

Subcylindrical with numerous subregular constrictions all covered by a thin epitheca. Fossula well developed.

In the Niagara group of Michigan, Iowa, Kentucky, Tennessee, etc.

15. **A. yandelli** (E. & H.). (Fig. 85.) Middle Devonic.

Irregularly cylindrical, often bent, constrictions irregular ; tabulæ more or less irregular.

In the Onondaga limestone of Indiana, Kentucky, Michigan and Canada.

16. **A. hamiltoniæ** Hall. (Fig. 86.) Middle Devonic.

Small, cylindrical, often abruptly bent and constricted. Strong distant septa reach about a third to the center, and stop abruptly. Tabulæ flat.

Abundant in the Hamilton shales of New York.

IV. AULACOPHYLLUM E. & H.

Like *Zaphrentis*, but the septa on either side of the fossula converging toward it. Ord. ?–Dev.

17. **A. sulcatum** d'Orbigny. (Fig. 87.) Middle Devonic.

FIG. 87. *Aulacophyllum sulcatum* (Ind. Geol. Survey).

Regularly curved, with oblique calyx, most of the septa converging to either cardinal or alar septa.

Onondaga of Falls of the Ohio and other localities.

V. ACROPHYLLUM Thompson & Nichols.

Similar to *Zaphrentis* but with the tabulæ elevated tent-like in the center of the calyx, the septa running out on them and twisted at the center. Dev.

18. **A. oneidaense** (Billings). (Fig. 88.) Middle Devonic.

Turbinate or subcylindrical, with periodic constrictions. Sides of calyx nearly vertical, bottom of cup nearly half the diameter of the coral. Fossula strong, extending from base of elevation to the margin of the calyx.

Onondaga limestone, Falls of Ohio, etc.

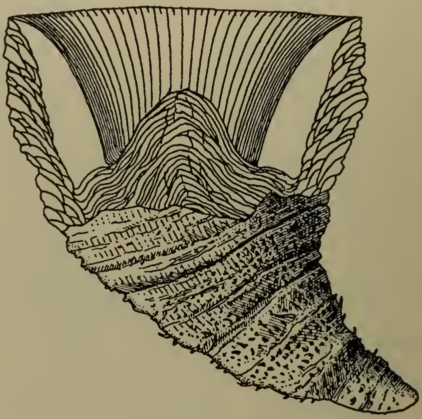


FIG. 88. *Acrophyllum oneidaense* with calyx partly sectioned (Lambe).

VI. BLOTHROPHYLLUM Billings.

Cylindrical corals, consisting of a series of invaginated cups which are like that of *Zaphrentis* in structure, with well-developed tabulæ, and generally a marked fossula. Projecting margins of the older cups covered by the epitheca, when not worn away. Sil.–Dev.

19. **B. decorticatum** Billings. Middle Devonic.

Large, with margins of old cups strongly projecting, generally denuded of epitheca. In the calyx a deep fossula and smooth central space are characteristic.

In the Onondaga limestones of Michigan, Canada and the Falls of the Ohio.

20. **B. promissum** Hall. (Figs. 89–90.) Middle Devonic.

Slender cylinders with margins of old cups generally subdued, the calyx with a flat central area free from septa, and no fossula.

In the Onondaga beds of the Falls of the Ohio.

VII. Pycnostylus Whiteaves.

Corallum of cylindrical tubes increasing by calicular budding of three or four branches at distant intervals. Septa in form of short vertical ridges, tabulæ well developed, horizontal. Siluric.

Fig. 89. *Blothrophyllum promissum* (Ind. Geol. Survey).

Fig. 90. *Blothrophyllum promissum.* Sectioned (Ind. Geol. Survey).

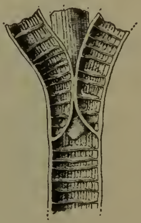


Fig. 91. *Pycnostylus guelphensis* with 2 buds sectioned (Lambe).

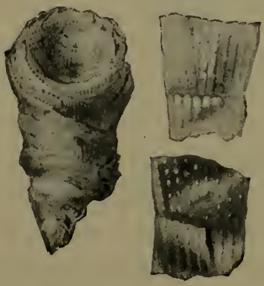


Fig. 92. *Chonophyllum niagarense* (N. Y. Geol. Survey).

21. **P. guelphensis** Whiteaves. (Fig. 91.) Siluric.

Long slender corals from 3 to 7 mm. in diameter. Epitheca with transverse constrictions and reëlevations at irregular intervals, but no longitudinal ribs.

Common in the Guelph beds of Canada, Wisconsin, Ohio, etc.

VIII. Chonophyllum E. & H.

Generally top-shaped or subcylindrical corals composed of invaginated funnels. Calyx large with numerous uniform septa. Margins of old funnels not projecting. Sil.–Dev.

22. **C. niagarense** (Hall.). (Fig. 92.) Siluric.

Cylindrical in the upper portion with frequent constrictions, septa subdued, spiniform, with notched margins, extending to the center of the deep calyx.

In the Niagara formation of Western New York, Kentucky, etc.

23. **C. magnificum** (Billings). Middle Devonic.

Large, top-shaped, with a spreading basin-shaped calyx. Septa thickening outward.

In the Onondaga beds of Michigan, Indiana and the Falls of the Ohio.

IX. Ptychophyllum E. & H.

Similar to *Chonophyllum* but with the septa twisted into a pseudo-columella, at the center. Sil.–Dev.

24. **P. stokesi** E. & H. Middle Siluric.

Conical with a deep spreading calyx, furnished with low, broad septa and a large pseudo-columella. Epitheca with root-like processes.

In the Niagara beds of Drummond Island, Mich., and Louisville, Ky.

X. Cystiphyllum Lonsdale.

Simple or compound corals, varying from depressed turbinate to cylindrical or irregular growth. Entire interior of coral filled with vesiculose tissue with a cone arrangement of the vesicles. Calyx without septa or with only faint ridges as in *Chonophyllum*, from which genus it is probably derived. A strongly wrinkled epitheca is present. Sil.–Dev.

25. **C. vesiculosum** Goldfuss (= *C. americanum* E. & H.). (Fig. 93.) Devonic.

Large, cylindrical, frequently constricted, covered by a thin but strongly wrinkled epitheca. Calyx with a faint simulation of septa. Vesicular tissue coarsest near the center.

FIG. 93. *Cystiphyllum vesiculosum.*

FIG. 94. *Cystiphyllum conifollis* (Pal. N. Y.).

FIG. 95. *Cystiphyllum varians* (Pal. N. Y.).

Abundant in the Onondaga and Hamilton strata of New York, Canada and Michigan, Ohio, etc., also at the Falls of the Ohio.

26. **C. conifollis** Hall. (Fig. 94.) Devonic.

Slender, cylindrical, with periodic constrictions. Cysts arranged radially at the base of the calyx.

Common in the Hamilton group of New York, Canada, etc.

27. **C. varians** Hall. (Fig. 95.) Devonic.

Shorter and stouter than preceding, with stronger septal ridges and coarser cysts arranged cup in cup.

Hamilton group of New York, etc.

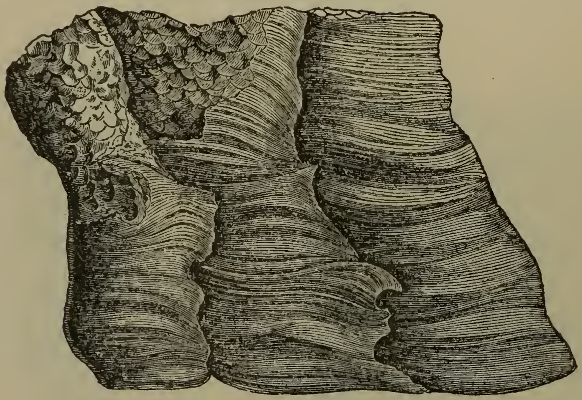


Fig. 96. *Cystiphyllum aggregatum* (after Billings).

28. **C. sulcatum** Billings. Devonic.

Short conical and curved form (zaphrentoid) with a deep cardinal fossula, and septa represented by coarse plications of the calyx floor. Cystoid structure not visible in calyx.

In the Onondaga beds of New York, Canada, Michigan and the Falls of the Ohio.

29. **C. aggregatum** Billings. (Figs. 96–97.) Devonic.

Compound, of cylindrical stems more or less closely crowded.

In the Onondaga limestone of Canada and the Hamilton of Michigan.

Fig. 97. *Cystiphyllum aggregatum* var. (after Lambe).

XI. Palæocyclus E. & H.

Corallum simple, disk-shaped with flat base, or depressed topshaped, the base covered with a strong epitheca. Septa numerous, radial, in several cycles the larger ones reaching the center. Siluric.

30. **P. rotuloides** Hall. Siluric.

Center with a strong depression. About 20 thick crenulated primary septa and an equal number of secondary ones. Base with sharp costal ridges.

In the Clinton beds of New York.

XII. Microcyclus Meek & Worthen.

Disk-shaped coralla, with a flat base covered by an epitheca, with numerous radiating septa and a septal fossula. Devonic.

31. **M. discus** M. & W. (Fig. 98.) Devonic.

Fig. 98. *Microcyclus discus* (enlarged, × 2).

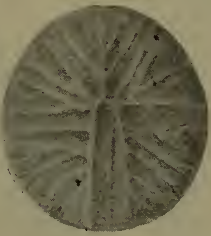


Fig. 99. *Hadrophyllum d'orbignyi* (enlarged × 2).

Center depressed, smooth, adjoining septa uniting half way to center, fossula well marked. Base flat and with a concentrically striate epitheca.

In the Hamilton beds of Canada and Illinois.

XIII. Hadrophyllum E. & H.

Cushion-shaped to top-shaped coralla, the base covered by an epitheca. A large cardinal fossula and two small lateral pseudo-fossulæ occur. Devonic.

32. **H. d'orbignyi** E. & H. (Fig. 99.) Devonic.

Flat cushion-shaped, the septa uniting before reaching center; pseudo-fossulæ sometimes wanting.

In the Onondaga beds of the Falls of the Ohio region.

XIV. Cyathophyllum Goldfuss.

Corallum simple in primitive species but becoming compound in more specialized types. Corallites conical, generally cylindrical in the later stages of growth. Septa simple, without carinæ, extending to the center of the calyx where they are more or less twisted. One or more fossulæ present in some species. Tabulæ in central, cystose structure in peripheral areas. Ord.?–Carb.

33. **C. robustum** Rom. Middle Devonic.

Generally large, growth irregular, calyx deep, septa low, thin and sharp, the longer reaching the center and uniting. Fossula faint.

Hamilton group of western New York, Ontario and Michigan. Also at the falls of the Ohio.

34. **C. conatum** Hall. (Fig. 100.) Middle Devonic.

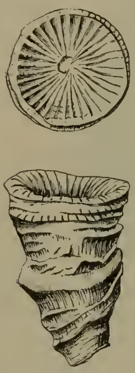


FIG. 100. *Cyathophyllum conatum* (Pal., N. Y.).

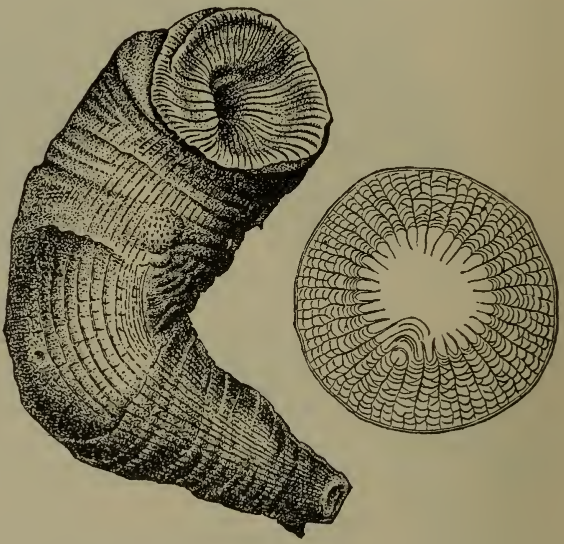


FIG. 101. *Campophyllum torquium* with cross section (Ind. Geol. Surv.).

Cylindrical, generally small, and of irregular growth. Septa strong and regular reaching the center. No fossula. Has many characters of *Blothrophyllum*.

In the Hamilton group of New York and Ontario.

35. **C. alpenense** Winch. Devonic.

Cylindrical to conico-cylindrical, rather smooth; calyx deep with steep sides marked by septa of a triangular cross-section. Tabulæ well developed in central portion.

Abundant in the Hamilton beds of Michigan.

XV. Campophyllum E. & H.

Differs from *Cyathophyllum*, in that the septa stop short some distance from the center. The central area with well developed tabulæ, the interseptal space with dissepiments. Dev.–Carb.

Fig. 102. *Heliophyllum halli* (Pal., N. Y.).

36. **C. torquium** (Owen). (Fig. 101.)
Middle Carbonic.

Cylindrical, often very long (9 inches or more) and abruptly bent. Epitheca very thin generally denuded. Calyx deep with a moderate fossula, principal septa extending one half to two third distance to center, secondary ones very short.

In the coal measures of Illinois, Iowa, Kansas, Missouri and Nebraska.

XVI. Heliophyllum Hall.

Like *Cyathophyllum*, but the septa with transverse plates or carinæ which are few and weak in young or primitive species, but numerous and strong in others. A fossula is frequently developed. Dev.

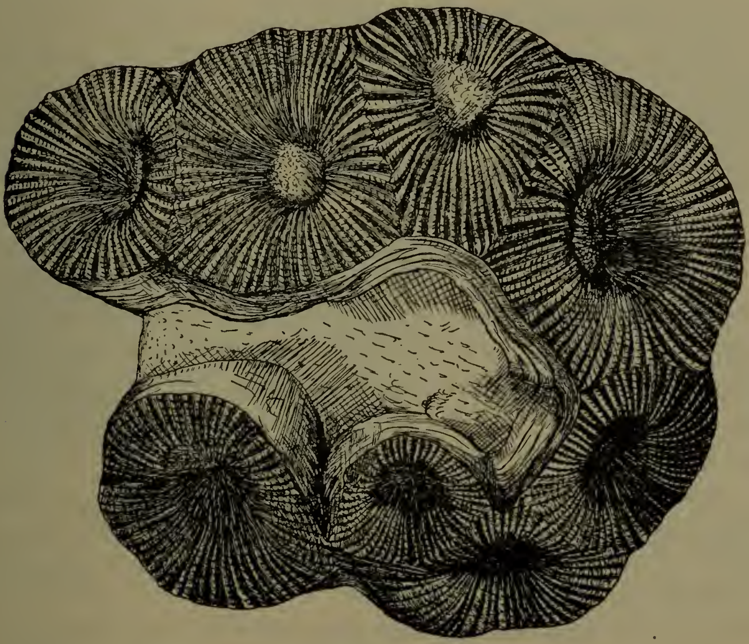


Fig. 103. *Heliophyllum confluens.*

37. **H. halli** E. & H. (Fig. 102.) Middle Devonic.
Broadly turbinate at the base or in young specimens, becoming cylindrical in old individuals, frequently with irregular constrictions showing rejuvenescence. Epitheca strongly wrinkled.

Abundant in the Hamilton group of New York, Ontario, Ohio, etc., and at the Falls of the Ohio.

38. **H. confluens** Hall. (Fig. 103.) Middle Devonic.

Likethe preceding but compound, the corrallites large, and polygonal from crowding.

In the Hamilton group of New York, Canada, Ohio, etc.

39. **H. tenuiseptatum** (Billings). Middle Devonic.

Generally small, more or less cylindrical, with numerous fine and thin septa, strongly carinated.

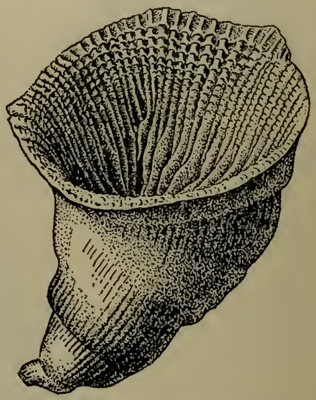


Fig. 104. *Heliophyllum corniculum* (Ind. Geol. Surv.).

Common in the Hamilton group of New York, Ontario, etc.

40. **H. corniculum** (Lesueur). (Fig. 104.) Middle Devonic.
Conical and curved at the base, general aspect like *Zaphrentis*. Calyx deep, with steeply sloping sides; broad nearly flat bottom, numerous alternating carinated septa and a well marked fossula.

Common in Onondaga limestones of New York, Ontario, Indiana, etc., and at the Falls of the Ohio.

XVII. Acervularia Schweigger.

Coral heads astræiform, composed of prismatic corallites with numerous septa, the longer of which reach the center. The appearance of an inner wall is caused by crowded dissepiments at the same level. Base of colony covered with a strong peritheca. Sil.–Dev.

41. **A. rugosa** (E. & H.). (Fig. 105.) Devonic.
Corallites from 10 to 15 mm. in diameter, individuals ribbed longitudinally on the exterior and with transversely wrinkled epitheca. Larger septa meeting and sometimes twisting in the center, carinæ moderately developed.

In the Onondaga beds of Michigan, the Falls of the Ohio, etc.

42. **A. davidsoni** E. & H. (Fig. 106.) Devonic.

Centers of calices abruptly depressed, diameter about 10 mm. Septa alternating in length but equal in thickness at the margin of the calyx, carinæ abundant.

Common in strata of Hamilton age in Michigan, Iowa, etc., and also found in strata of somewhat earlier age at the Falls of the Ohio and elsewhere.

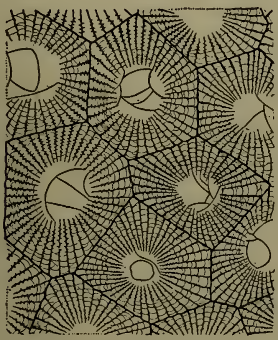


FIG. 105. *Acervularia rugosa* (after Simpson).

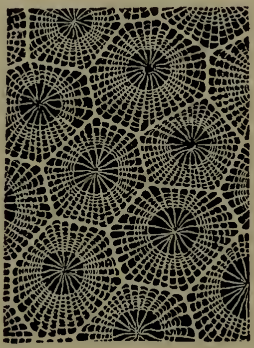


FIG. 106. *Acervularia davidsoni* (after Simpson).

XVIII. PHILLIPSASTRÆA D'Orbigny.

Coral heads composed of large confluent corallites, similar to compound *Heliophyllum*, but without the dividing walls. Calicular surfaces flat, except at the center, where an abrupt depression, usually surrounded by an elevated rim occurs. Longer septa uniting at the center, shorter stop at the central pit. Dev.–Carb.

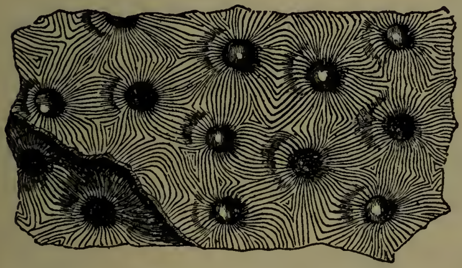


FIG. 107. *Phillipsastræa verneuilli* (after Billings).

43. **P. gigas** Owen. Devonic.

Large, the calices over 20 mm. in diameter and their outlines defined; central pit large.

In the Onondaga limestone of New York, Canada, Michigan and the Falls of the Ohio. Hamilton of Michigan.

44. **P. verneuilli** E. & H. (Fig. 107.) Devonic.

Smaller, corallites from 10–15 mm. in diameter.

Onondaga of Canada, Michigan, etc.

XIX. Pachyphyllum E. & H.

Compound corallites bounded by polygonal walls, each with a central conical elevation, at the top of which is a crater-like pit. Septa extending over the outside of the cone as low ridges or costæ. The longer septa extend to within a short distance of the center. Dev.

45. **P. woodmani** (White). (Fig. 108.) Upper Devonic.

Growing in convex or hemispheric masses from 1 to 6 inches in diameter; crater rims strongly elevated, sometimes more than an eighth of an inch. Crater deep and variable in diameter.

In the Upper Devonic of Iowa, etc.

XX. Strombodes Schweigger.

Coral composed of superposed layers or laminæ, on the surfaces of which are polygonal depressions representing the calices with

Fig. 108. *Pachyphyllum woodmani* (N. Y. State Mus. Rep.).

Fig. 109. *Strombodes pentagonus* (after Lambe).

the central part marked by an abrupt circular pit. Calicinal surface with radial septal ridges, which unite in the center in a papillose projection. Sil.–Dev.

46. **S. pentagonus** Goldfuss. (Fig. 109.) Siluric.

Calices shallow from 10 to 15 mm. in diameter; center with a styliform columella, septa sharp at the pit, becoming low rounded ridges at the margins.

In the Niagara beds of Michigan, the Falls of the Ohio, etc.

47. **S. striatus** Owen. Siluric.

Much larger than the preceding, the calices ranging to 40 mm. in diameter. Elevation around central pit pronounced.

Occurs with the preceding.

48. **S. mamillatus** Owen. Siluric.

Margins of calices depressed, center strongly elevated with a pronounced crater-like pit at the top from 4 to 5 mm. in diameter. Distances between centers of pits of adjoining corallites 10 to 20 mm.

In the Niagara beds of Michigan, Iowa, Kentucky, Indiana, etc.

XXI. Columnaria Goldfuss.

Heads consisting of prismatic corallites, like that of *Favosites*, but without mural pores, and with the septa either well marked or indicated by vertical ridges. Tabulæ well developed. Ord.–Dev.

49. **Columnaria halli.** (= *C. alveolata* of most authors.) Middle Ordovicic.

Septa represented by from 20 to 40 vertical ridges. Tabulæ flat, close and smooth in the centers. Tubes variable in diameter from 2 to 5 mm.; sometimes 10 mm. tubes, occur among the smaller ones.

In the Black River limestones of New York, Canada and Michigan, and in strata of the same age in Wisconsin, Illinois and Iowa, etc.

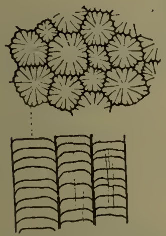


Fig. 110. *Columnaria alveolata.* Horizontal and vertical sections (Lambe).

50. **C. alveolata** Goldfuss. (= *Favistella stellata* Hall.) (Fig. 110.) Upper Ordovicic to Siluric.

Tubes varying from 3 to 6 mm. in diameter. Septa from 20 to 30, alternatingly larger and smaller, the former extending to the center. Center of tabulæ marked by the septa. Common in the beds of the age of the Cincinnati group throughout the central west Also recorded by Rominger from the Niagara Group of Point Detour.

XXII. Eridophyllum E. & H.

Heads composed of loosely aggregated cylindrical corallites each surrounded by a wrinkled epitheca, from one side of which prolongations extend uniting adjoining corallites. An inner wall enclosing a narrow tabulate area is present. Sil.–Dev.

51. **E. rugosum** E. & H. (Figs. 111; 113, *a*.) Siluric.

Corallites less than 10 mm. in diameter, with prolific calicinal budding, outline cylindrical with subregular constrictions, epi-

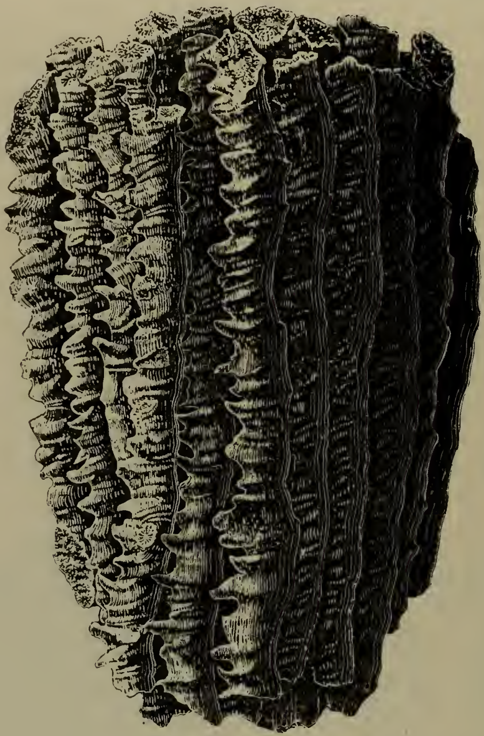


FIG. 111. *Eridophyllum rugosum* (Ind. Geol. Survey).

thecal prolongations spiniform. Septa extending to within a short distance of the center, which is occupied by tabulæ.

Common in the Niagara beds of Indiana, Kentucky, etc.

52. **E. vernuillianum** E. & H. (Fig. 112.) Devonic.

Tubes 7 to 10 mm. in diameter, distant about their own diameter. Strong epithecal proliferations. A sharp thin inner wall enclosing a space about 2 mm. in diameter not crossed by septa.

In the Onondaga beds of northern Ohio and adjacent regions.

53. **E. colligatum** (Billings). Devonic.

Cylindrical stems expanding at regular and uniform intervals so as to unite in polygonal outlines, after which they contract and again become round. Septa crenulate alternating, the longer abutting against the inner wall.

FIG. 112. *Eridophyllum vernuillianum* (after Billings).

FIG. 113, *a*. *Eridophyllum rugosum*; *b*, *c*. *Synaptophyllum simcoense* (after Simpson).

In the Onondaga beds of Canada, Michigan and the Falls of the Ohio.

XXIII. SYNAPTOPHYLLUM Simpson.

Like *Eridophyllum* but without the central wall, the septa extending across the tabulate area to near the center. Proliferations from all sides of the tubes. Dev.

54. **S. simcoense** Billings. (Figs. 113*b*–115.) Devonic.

Similar in form to *Eridophyllum vernuillianum* but smaller in diameter, *i. e.*, from 4 to 6.5 mm. and distant the same amount or somewhat less. Septa from 40 to 50.

FIG. 114. *Synaptophyllum simcoense* (after Billings).

In the Onondaga limestone of New York, Canada, Michigan and the southwest.

55. **S. stramineum** Billings. (Fig. 116.) Devonic.

Tubes from 4 to 5 mm. in diameter varying from almost in contact to more than twice their width apart. Central tabulate area large, septa about 40, extending to near center.

In the Onondaga limestone associated with the preceding.

XXIV. DIPLOPHYLLUM Hall.

Corolla similar to *Synaptophyllum* but without the connecting epithecal expansions. Tabulate area large. Sil.–Dev.

56. **D. cæspitosum** Hall. (Fig. 117.) Siluric.

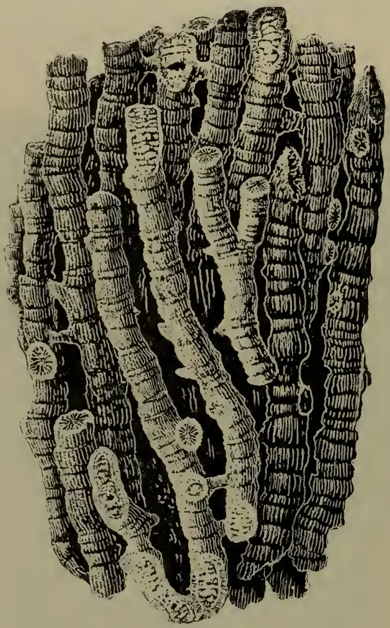


Fig. 115. *Synaptophyllum simcœnse* (Ind. Geol. Surv.).

Fig. 116. *Synaptophyllum stramineum* (Ind. Geol. Surv.).

Slender cylindrical stems with a broad central tabulate, and a narrow peripheral zone. Septa thin, reaching the center.

In the Niagara and Guelph beds of New York, Canada, Wisconsin, etc.

57. **D. panicum** (Rominger). Devonic.

Large stems, about 10 mm. in diameter and multiplying by prolific calycinal gemmation. About a third of the tubes occupied by the rather vesiculose compound tabulæ, the outer zone by the carinate septa.

In the Hamilton beds of Michigan.

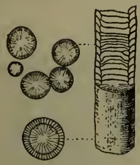


FIG. 117. *Diplophyllum cæspitosum* (after Lambe).

58. **D. arundinaceum** (Billings). Devonic.

Differs from the preceding by the narrower vesicular zone, and regular tabulæ. Septa not reaching center. Diameter of tubes 6–10 mm.

In the Onondaga limestone of New York, Canada, etc.

XXV. CRASPEDOPHYLLUM Dybowsky.

Heads of cylindrical corallites as in *Eridophyllum*, but without the epithecal prolongations and with the inner wall open on one side, rarely closed, not crossed by the carinated septa. Devonic.

FIG. 118. *Craspedophyllum archiaci.*

59. **C. archiaci** (Billings). (Fig. 118.) Devonic.

Stems nearly or quite in contact, sometimes becoming prismatic from crowding, diameter from 10 to 20 mm. Calices deep. Septa of the first cycle joining the horseshoe-shaped inner wall.

In the Hamilton beds of New York, Canada, Michigan, etc. Also in Devonic limestones of Ohio.

60. **C. subcæspitosum** (Nicholson). Devonic.

Smaller than the preceding, of long slender stems increasing chiefly by lateral gemmation. Septa more numerous and more closely crowded than in the preceding, strongly carinated. Inner wall often closed in the adult.

Common in the Hamilton beds of New York, Canada and Michigan.

XXVI. Duncanella Nicholson.

Coral slender, resembling *Streptelasma*, with radial septa, and a strongly developed epitheca which, however, is absent at the base of the corallum, where the septa are visible. Siluric.

61. **D. borealis** Nicholson. Siluric.

Small, slender, and scarcely over half an inch in length. Costæ well developed.

In the Niagara group of Indiana and elsewhere.

XXVII. Lophophyllum E. & H.

Corallum zaphrentoid, but with a central compressed columella often continuous on one side with the cardinal septum. Carbonic.

62. **L. profundum** (E. & H.). (Fig. 119.) Carbonic.

Fig. 119. *Lophophyllum profundum* (Ind. Geol. Survey).

Curved, horn-like corallum, with septa from 30 to 50 alternating in length. Columella striated. Length of average individual 30 mm., width of calyx 9 mm.

In the coal measures of Iowa, Illinois, Kansas, Nebraska, Texas, etc.

XXVIII. Lithostrotion Lhwyd.

Heads composed of prismatic or cylindrical corallites, each enveloped by an epitheca and all by a peritheca. Central portion occupied by tabulæ which are inverted funnel-shaped, terminating in the calyx in a pseudo-columella. Septa well developed, outer area with numerous dissepiments. Carbonic.

63. **L. mamillare** E. & H. (Fig. 120.) Lower Carbonic.

Prismatic corallites, with moderately deep calices marked by the conical elevation which is carinated by the septa and terminates in a compressed pseudo-columella.

In the lower Carbonic (St. Louis) limestone of Michigan, the Mississippi Valley and Southern Appalachians generally.

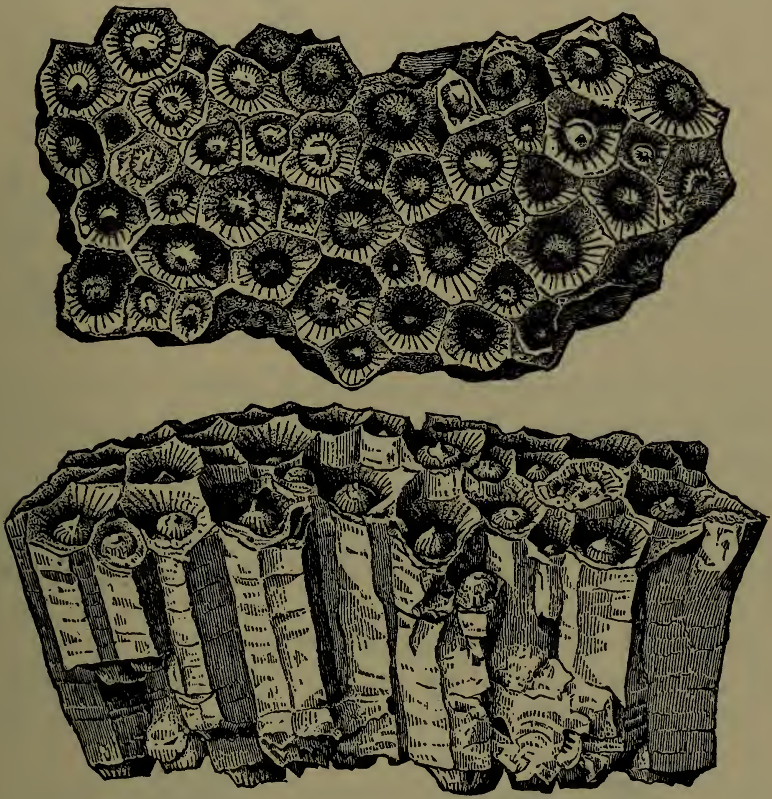


FIG. 120. *Lithostrotion mamillare* (Ind. Geol. Survey).

XXXIX. CALCEOLA Lamarck.

Coral simple with one side flattened and a deep calyx opening obliquely and furnished with an operculum; septa in the form of low ridges. Structure densely cystoid. Sil.–Carb.

64. **C. tenneseenensis** Rom. (Fig. 121.) Siluric.

Strongly curved, with a high arched operculum and interior largely occupied by vesicular tissue.

In the upper Niagara beds of Tennessee.

Tabulate Corals.

XXX. Aulopora Goldfuss.

Compound corals attached for the greater part to shells, corals or other foreign bodies and consisting of a number of simple cornucopia-shaped to cylindrical tubes, each arising by budding from

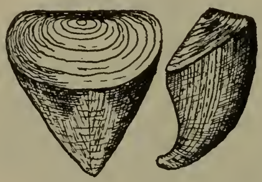


Fig. 121. *Calceola tenneseenensis.*

Fig. 122. *Aulopora subtenuis* enlarged (Pal., N. Y.).

below the calyx mouth of its parent, with which it remains united by a persistent pore. Tabulæ seem to be present in some species. Septa represented by vertical ridges. Ord.–Carb.

65. **A. subtenuis** Hall. (Fig. 122.) Devonic.

Slender curving tubes very gradually enlarging. Generally a single bud only. Length of tubes about 8 mm., diameter at aperture 1 mm.

Common in the Helderbergian of New York, etc.

66. **A. serpens** Goldf. (Fig. 123.) Middle Devonic.

Attached by whole under surface; calices oblique upward, buds

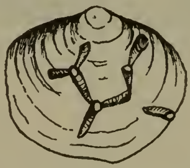


Fig. 123. *Aulopora serpens* on brachiopod shell.

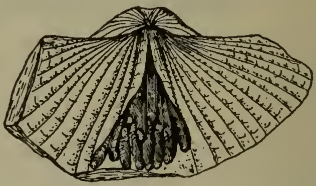


Fig. 124. *Aulopora tubæformis* on Spirifer.

one or two, commonly reuniting so as to form meshwork. Commonly attached to brachiopods.

In the Hamilton shales of New York, Ontario and Michigan.

67. **A. tubæformis** Goldf. (Fig. 124.) Devonic.

Larger than preceding, with corallites crowded and occasionally uniting laterally.

In the Hamilton beds of New York, Canada, etc.

68. **A. cornuta** Bill. (Fig. 125.) Devonic.

Less crowded, mouths of corallites about twice as large as preceding.

Onondaga and Hamilton of Canada, etc.

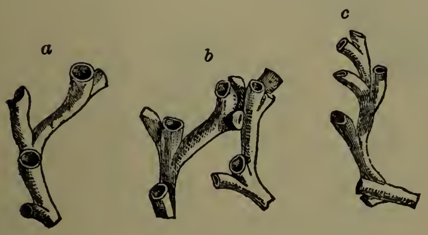


FIG. 125, *a–c*. *Aulopora cornuta* (after Billings).

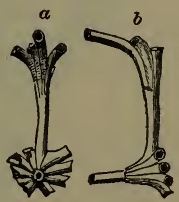


FIG. 126. *Romingeria umbellifera* (after Billings).

XXXI. ROMINGERIA Nicholson.

Auloporoid tubes with the buds given off in a verticil. Remote tabulæ, and occasional mural pores present, growth erect. Sil.–Dev.

69. **R. umbellifera** (Billings). (Fig. 126.) Devonic.

Tubes about 1 mm. in diameter, delicately annulate by growth lines. Verticils from 6 to 12 buds, remaining at first close together, then bent rather abruptly outward radially.

Onondaga limestone of New York, Canada, Michigan, etc., and Hamilton group of Michigan.

XXXII. CERATOPORA Grabau.

Coral like *Aulopora* in appearance, but tubes often much larger, and never attached except at the base. Walls thickened by the formation of coarse cysts, from the surfaces of which sharp spines arise. Central space commonly open, the individual corallites remaining connected. Epitheca generally well marked. Devonic.

70. **C. jacksoni** Grabau. (Figs. 127, 128.) Middle Devonic.

Branches budding at irregular intervals, tubes large and coarse, with longitudinal striation, marking the epitheca. Cysts coarse and irregular.

In the Hamilton group of New York, Michigan, etc.

71. **C. dichotoma** Grabau. (Fig. 129.) Middle Devonic.
Prostrate, tubes with flattened lower and carinated upper portion, and abruptly up-bent circular calices. Buds in pairs, at right angles to each other. Cysts small.

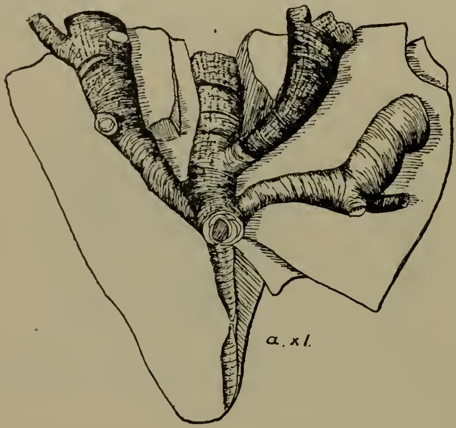


FIG. 127. *Ceratopora jacksoni.*

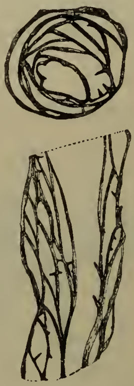


FIG. 128. *Ceratopora jacksoni.* Transverse and longitudinal section, × 2.

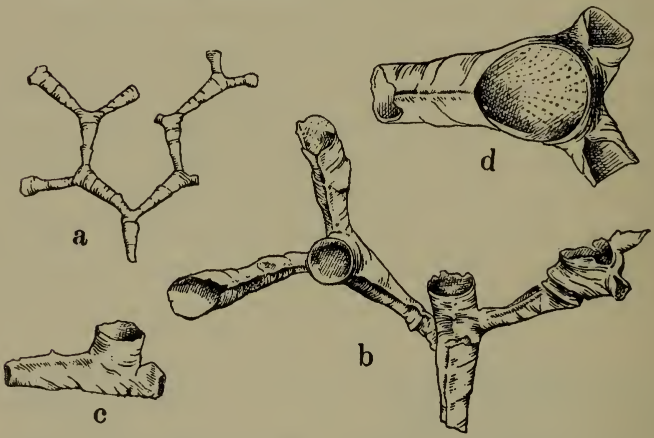


FIG. 129. *Ceratopora dichotoma.* Nat. size (*a*) and enlarged (*b–d*).

In the Hamilton beds of New York, Ontario, Michigan and the Falls of the Ohio.

72. **C. intermedia** (Nicholson). Middle Devonic.
Small cylindrical, loosely branching corallites forming a colony which probably grew erect. Epitheca smooth with only growth lines.

In the Hamilton group of New York, Ontario, Michigan, etc. Other species are abundant at the Falls of the Ohio.

XXXIII. MONILOPORA Nicholson & Etheridge.

External form similar to *Ceratopora*, but wall composed of parallel layers separated slightly, and connected by numerous

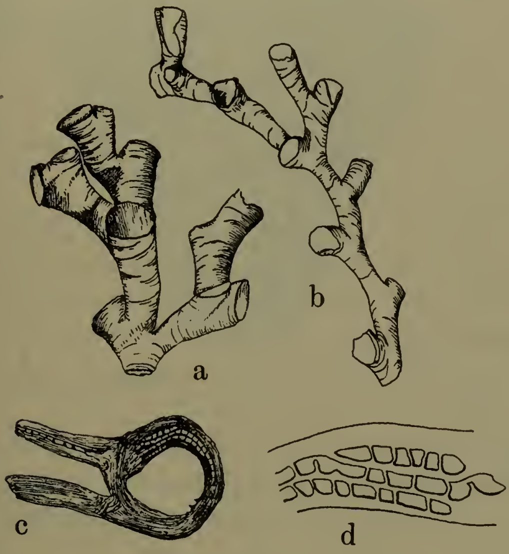


FIG. 130. *Monilopora beecheri.* *a*, *b*, nat. size ; *c*, enlarged cross-section ; *d*, portion of *c* still further enlarged.

transverse bars or trabeculæ, which, in section, give a regular net-like appearance. Dev.-Carb.

73. **M. antiqua** Whiteaves. Devonic.

Slender branches, surface reticulate. Free, or encrusting crinoid stems.

Hamilton beds of Canada and the Falls of the Ohio.

74. **M. beecheri** Grabau. (Fig. 130.) Lower Carbonic.

Free growing, or encrusting crinoid stems, sometimes forming a confused agglomeration. Epitheca smooth except for growth lines, tissue very dense, the lacunæ small and scattered.

Common in the Keokuk beds of the Mississippi valley.

XXXIV. SYRINGOPORA Goldfuss.

Coral consisting of numerous irregular cylindrical tubes which grow parallel but generally separated, and have at intervals transverse hollow, tubular connecting processes. Interior filled with funnel shaped tabulæ. Young as in *Aulopora*. Septa represented by spines. Sil.–Carb.

FIG. 131. *Syringopora retiformis* (after Lambe).

75. **S. verticillata** Goldfuss. Siluric.

Tubes separated by from one to two or more times their diameter (2 to 3 mm.) connected at distant intervals by transverse tubes of which 2 or 3 are given off at the same plane.

Niagara group of Canada, Michigan, etc.

76. **S. retiformis** Billings. (Fig. 131.) Siluric.

Tubes a millimeter or somewhat less in diameter, irregularly bending or geniculate, joining where in contact but not by tubes.

In the Niagara beds of New York, Canada, Kentucky, etc.

77. **S. tubiporoides** Y. & S. Devonic.

Tubes not parallel, about 3 mm. in diameter and separated by greater distances.

Onondaga limestone of Kentucky, etc.

78. **S. maclurei** Billings. (Fig. 132.) Devonic.

Tubes about 25 mm. in diameter, more regular than preceding, but coming closer together at more or less regular intervals..

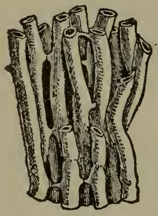


FIG. 132. *Syringopora maclurei.*

FIG. 133. *Syringopora hisingeri.* (After Billings.)

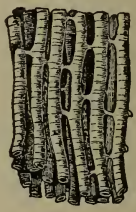


FIG. 134. *Syringopora perelegans.*

In the Onondaga limestone of New York, Canada, Michigan, etc.

79. **S. hisingeri** Billings. (Fig. 133.) Devonic.

Corallites are slender tubes of less than 1 mm. diameter, separated by their own width or a little less or more. Frequent connecting tubes occur.

In the Onondaga limestone of Canada, Michigan, Ohio, New York, Indiana, Kentucky, etc.

80. **S. tabulata** E. & H. Devonic.

FIG. 135. *Syringopora perelegans* (Ind. Geol. Survey).

Corallites slender as in the preceding, but closer together and parallel. Connecting tubes at uniform levels, giving the appearance of horizontal floors connecting the corallites.

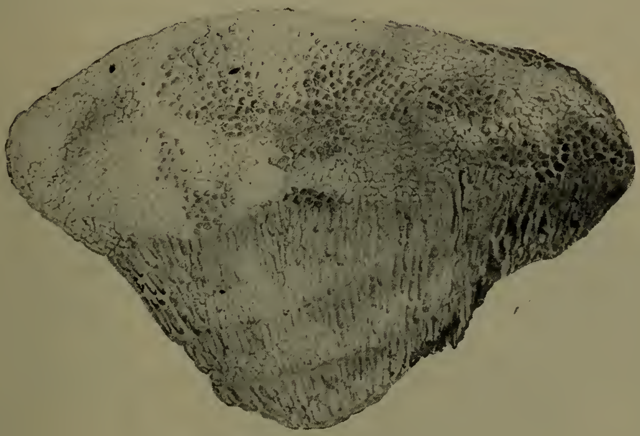


FIG. 136*a*. *Favosites venustus.*

In the Onondaga limestone of the Falls of the Ohio and elsewhere.

81. **S. perelegans** Billings. (Figs. 134–135.) Devonic.

Between *S. maclurei* and *S. hisingeri*. Associated with the preceding species.

Fig. 136*b*. *Favosites venustus* enlarged sections (N. Y. Geol. Survey).

XXXV. Favosites Lamarck.

Corallum massive, more rarely branching, commonly forming heads which may be a foot or more in diameter. Corallites prismatic, thin, in contact but not amalgamated by their walls, which are perforated by equidistant mural pores in one or more rows. Septa rudimentary or obsolete. Numerous more or less regular tabulæ divide the intrathecal space. Peritheca present on the under side of the colony, and usually strongly wrinkled. Ord.–Carb.

82. **F. venustus** (Hall). (= *F. hisingeri* E. & H. ?) (Fig. 136 *a–b*.) Siluric.

Heads hemispheric or spheroidal, up to 2 or 3 feet in diameter, with twelve ascending septal spines, generally visible in section.

In the Niagara group (Lockport beds) of New York, Ontario, Michigan, Cumberland Md., Ohio and Kentucky.

83. **F. favosus** (Goldfuss). (Fig. 137.) Siluric.

Tubes large — up to 6 mm. in diameter with the inside marked

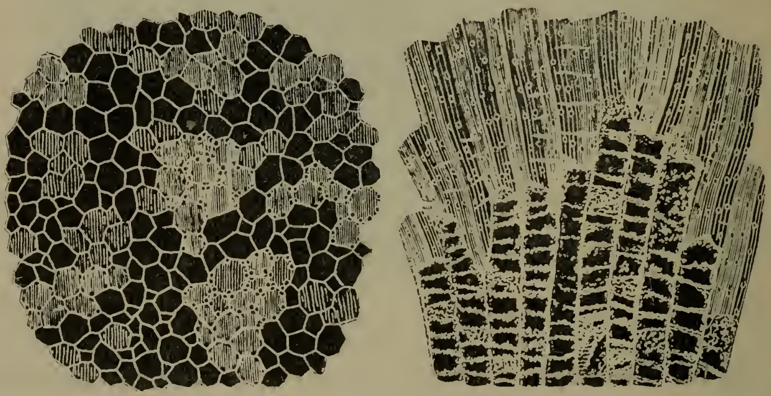


Fig. 137. *Favosites favosus* (Ind. Geol. Survey).

by twelve longitudinal furrows and by granulations. Tabulæ granulose, with their margins deflected into 12 (±) pits or notches corresponding to the longitudinal furrows, marginal pores commonly in more than two rows.

In the Niagara group of New York, Ontario, Michigan, Wis consin, Iowa, and the Falls of the Ohio region.

84. **F. niagarensis** Hall. Siluric.

Tubes much smaller than in the preceding species (about 1.5 mm. in diameter), tabulæ rarely notched at margin; mural pores scattered near the angles of the tubes. Inner surface of tubes delicately spinulose.

In the Niagara group of New York, Ontario, Michigan, Iowa and Kentucky.

85. **F. helderbergiæ** Hall. (Fig. 138.) Lower Devonic.

Heads lenticular or hemispherical, often large, and with the base covered by a strongly wrinkled epitheca. Calices about 1.5 mm. in diameter with strong longitudinal ridges. Mural pores in one or two rows, with elevated rim. Tabulæ close.

In the Lower Helderberg beds of New York and at Cumberland, Md.

86. **F. winchelli** Rom. Devonic.

Tubes much as in *F. favosus*, but with the marginal notching rare. Not infrequently the whole rim of the septum is turned down. Interior of tube with twelve well-marked longitudinal furrows, without squamæ.

FIG. 138. *Favosites helderbergiæ* (reduced) with a group of corallites enlarged (Pal. N. Y.).

In the Onondaga limestone of New York, Canada, Michigan and the Falls of the Ohio. Also in the Hamilton group of Michigan.

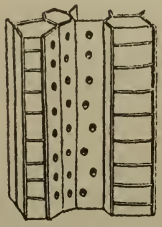


FIG. 139. *Favosites basalticus* (enlarged).

87. **F. basalticus** Goldfuss. (Fig. 139.) Devonic.

Tubes of medium size, sometimes unequal, tabulæ complete, not very close together, the squamæ often not preserved. Generally only a single line of mural pores on each wall.

In the Onondaga limestone of New York, Canada and Northern Ohio.

88. **F. tuberosus** Rominger. Devonic.

Columns of medium size (2–3 mm.), from two to three rows of mural pores on each face, and two rows of stout horizontal squamæ on inside of each face; the squamæ of adjoining rows alternating and often interlocking. Pores surrounded by small pits. Opercula frequent and concave.

In the Onondaga limestones of western New York, Canada, Michigan and the Falls of the Ohio.

89. **F. epidermatus** Rominger. Devonic.

Differs from *F. tuberosus* in irregular arrangement of squamæ and in elevated ring around the small distant pores in rarely more than two rows. Interior of tubes with twelve longitudinal furrows which are commonly visible in reverse on the outside of solid columns. The squamæ are on the spaces between the grooves and the tabulæ are complete.

Common in the Onondaga limestone of Western New York, Canada, Michigan, Indiana and Kentucky.

90. **F. emmonsi** Rominger. Devonic.

Tubes from 1 to 1½ mm. in diameter. Tabulæ for the most part very irregular, closely crowded and compound from union with squamæ; pores large, irregular, in from 1 to 3 rows and often crowded. Differs from *F. epidermatus* in the crowded incomplete tabulæ and in the large crowded pores.

In the Onondaga limestone of New York, Canada, Michigan, Ohio, Kentucky, etc.

91. **F. turbinatus** Billings. Devonic.

Form turban-like, often simulating Cyathophylloid corals, *i. e.*, cup-like; generally curved in the basal portions and not infrequently looking like the mold of large pelecypod shell. Corallites curving outward, with their mouths nearly at right angles to the main axis of the coral, from 1 to 2 mm. or more in diameter, closed in perfect specimens by concentrically striated opercula. Pores generally in single rows; tabulæ complete averaging 1.5 mm. apart, squamæ generally not prominent.

In the Onondaga of western New York, Canada, Michigan, Ohio and at the Falls of the Ohio, and in the Hamilton of Canada and Michigan.

92. **F. hamiltoniæ** Hall. (Syn. *F. billingsi* Rom.) (Fig. 140.) Devonic.

Corals in form of hemispheric heads with the base covered by a wrinkled peritheca. Adult corallites up to 2.5 mm. in diameter, generally surrounded by smaller immature ones. Mural pores in two rows, frequently obscure, tabulæ perfect, sometimes crowded, more generally from 2 to 4 mm. apart, not infrequently with marginal notches. Easily recognized by its distant perfect tabulæ.

Abundant in the Hamilton groups of western New York, Canada, etc.

FIG. 140. *Favosites hamiltoniæ.*

93. **F. alpenensis** Winchell. Devonic.

Differs from *F. hamiltoniæ* in its manner of growth, which results in the formation of rounded or tuberose masses, with generally only a small space for attachment; in the somewhat smaller corallites, which are rounded tubes on the interior owing to the thickening of the walls, and in the more crowded tabulæ.

Very common in the Hamilton (Traverse) group of Michigan. Also in northwestern Canada (Manitoba, etc.). At Alpena a variety forms large heads in the coral reefs.

94. **F. canadensis** (Billings). (Fig. 141.) Devonic.

Generally a more or less flat or undulating expansion, sometimes digitate. Circular tubes, about 1 mm. in diameter, are scattered subregularly between small angular ones, of about one third their size.

Simple tabulæ in the smaller, and tabulæ complicated by squamæ in the larger ones. Opercula often present.

In the Onondaga limestone of New York, Canada, Michigan, Indiana and Kentucky.

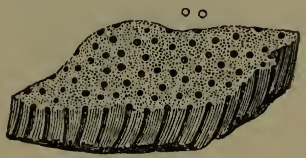


FIG. 141. *Favosites canadensis* (after Billings).

(The ramose or digitate varieties lead to *F. radiciformis* Rom.)

95. **F. placenta** Rominger. Devonic.

Grows in broad, generally thin expansions of an undulating character, the base covered by a wrinkled peritheca. Calices less than a millimeter in diameter with clusters of smaller ones scattered about. In some specimens (especially young ones), the larger tubes are circular and scattered about separately thus forming transition types from *F. canadensis*. Tabulæ of smaller tubes simple, of larger, complicated with squamæ. Pores uniserial.

Abundant in the Hamilton group of Canada and Michigan — also in the same formation in western New York.

96. **F. digitatus** Rominger. Devonic.

Irregular finger-like stems, calices polygonal from one to one and a half millimeters in diameter. Well developed transverse squamæ.

Abundant in the Hamilton beds of Canada, Michigan and other regions.

97. **F. clausus** Rom. Devonic.

Like the preceding, but with large round calices and small angular ones as in *F. canadensis*. The coarse thick branches of this general type are *F. radiciformis* Rom.

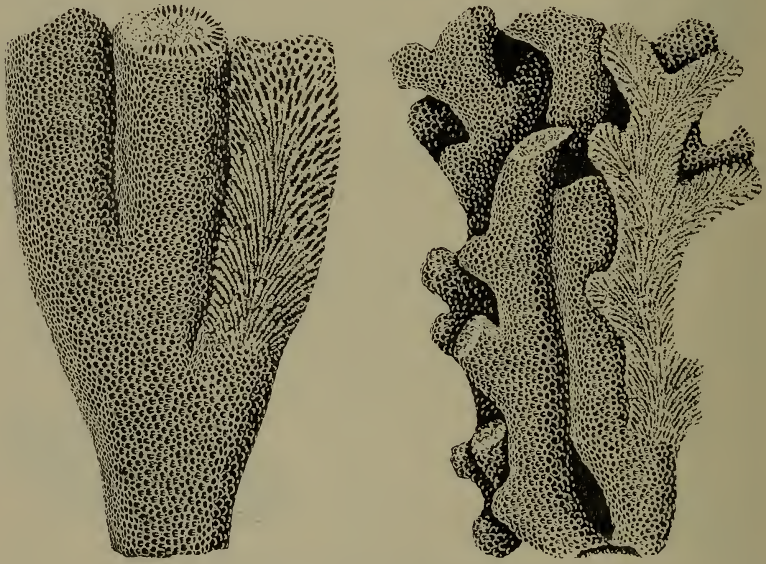


FIG. 142. *Favosites limitaris* (Ind. Geol. Surv.).

Common in the Onondaga and Hamilton beds of New York. Canada, Michigan, and the Falls of the Ohio region.

98. **F. limitaris** Rom. (Fig. 142.) Devonic.

Cylindrical, commonly branching stems 5 to 15 mm. in diameter. Calices circular, opening at nearly right angles to the axis of the branch. Walls thick, the division lines between the corallites shown only in certain states of preservation.

Common in the Onondaga limestones of the Falls of the Ohio. Also in the Onondaga and Hamilton of New York, Canada, Michigan, etc.

XXXVI. PLEURODICTYUM Goldfuss.

Corallum depressed, discoidal, lower surface covered by a concentrically wrinkled peritheca. Corallites small, prismatic, funnel-shaped; septa faint or obsolete, a scanty development of tabulæ occurring; mural pores irregularly distributed. Young cells as in *Aulopora*. Devonic.

99. **P. stylopora** (Eaton). (Fig. 143.) Devonic.

Heads from 1 to 2 inches in diameter, septa faint, forming a crenulation on the calyx margin; tabulæ moderately numerous.

Common in the Hamilton beds of New York and Michigan.

FIG. 143. *Pleurodictyum stylopora.*

XXXVII. MICHELINIA De Koninck.

Convex or hemispheric heads consisting of prismatic corallites and basally covered with a wrinkled peritheca. Septa represented by longitudinal ridges. Tabulæ numerous, crowded and convex upward, often incomplete and uniting. Mural pores numerous, irregularly scattered. Differs from *Favosites* in the greater diameter of the corallites, in the crowded arched tabulæ and in the numerous irregularly scattered mural pores. Dev.–Carb.

100. **M. convexa** (d'Orbigny). (Fig. 144.) Devonic.

Calices 8 to 10 mm. in diameter. Tabulæ thin, very close, strongly arched in the center, vesicular at the base.

In the Onondaga limestone of Canada, Michigan and the Falls of the Ohio region.

101. **M. cylindrica** (Michelin). Devonic.

Corallites subcylindrical; on the interior are regular annulations which occupy the same level in the adjoining tubes. Principal tabulæ numerous, slightly arched, uniting with the incomplete one.

In the Onondaga limestone of Michigan, Ohio and Kentucky, etc.

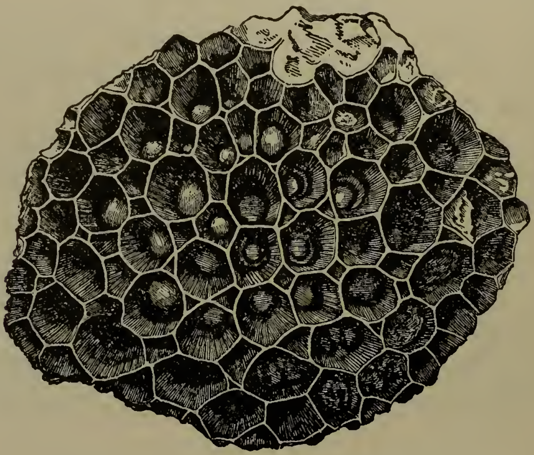


FIG. 144. *Michelinia convexa* (after Billings).

102. **M. favositoidea** Billings. Devonic.

Calices 4–6 mm. in diameter; tabulæ horizontal, pores numerous, crowded. (Forms transition type to *Favosites*.)

In the Onondaga limestone in New York, Canada, and the Falls of the Ohio.

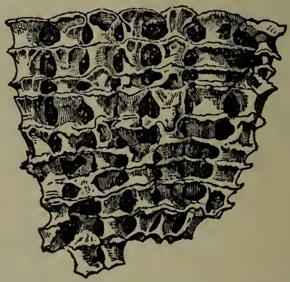


FIG. 145. *Chonostegites ordinatus* (after Billings).

XXXVIII. CHONOSTEGITES E. & H.

Coral heads composed of cylindrical tubes, either closely adjoining or distinct and expanding at regular intervals into connecting horizontal plates, which are pierced by canal-like pores. Tabulæ as in *Michelinia*, septa represented by rows of spinules New buds arise from the connecting plates. Devonic.

103. **C. clappi** E. & H. Devonic.

Tubes 5 mm. or more in diameter, connecting plates crowded, giving the whole a very compact appearance.

In the Onondaga limestone of western New York, Ontario, and Falls of the Ohio.

104. **C. ordinatus** (Billings). (Fig. 145.) Devonic.

Tubes smaller and more distant and plates more widely separated than in preceding. Whole aspect more loosely aggregated.

In the Onondaga beds of western New York and Canada.

XXXIX. Thecia E. & H.

Generally massive corals composed of prismatic thick-walled tubes with funnel-form calices. Base with a wrinkled peritheca. Septa 12, strong, uniting in adjoining calices across the intervening space. Tabulæ and mural pores as in *Favosites*. Sil.–Dev.

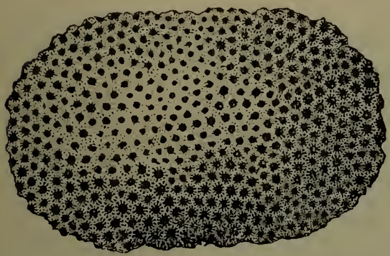


FIG. 146. *Thecia major* (Ind. Geol. Surv.).

105. **T. major** Rom. (Fig. 146.) Siluric.

Corallites 2 mm. in diameter; septa extend half way to center, their edges with two rows of granulose spinules.

In the Niagara beds of Michigan, Tennessee, the Falls of the Ohio and other regions.

106. **T. minor** Rom. (Fig. 147.) (*T. Swinderana ?* (Goldf.).) Siluric.

Tubes about 1 mm. in diameter, otherwise similar to the preceding. Occurs with the preceding.

107. **T. ramosa** Rom. Devonic.

Branching, cylindrical stems from half an inch to two inches in diameter. Calices unequal from 1 to 2 mm. in diameter.

In the Onondaga beds of Michigan and the Falls of the Ohio.

FIG. 147. *Thecia minor* (enlarged).

XL. Alveolites Lamarck.

Massive or arborescent coralla. Tubes thin-walled, closely appressed, the calices oblique, compressed, triangular or crescentic. Septa rudimentary. Tabulæ complete; mural pores large but irregularly disposed. Sil.–Dev.

108. **A. niagarensis** Rominger. Siluric.

Hemispheric masses of concentric laminæ, with epitheca on lower side. The large marginal pores cause a pouch-like dilation of the tube-wall.

In the Niagara group of Michigan and the falls of the Ohio.

109. **A. squamosus** Billings. Devonic.

Differs from the preceding in the greater horizontal expansion (5–6 in.) as compared with the thickness (1 in.) also in the great obliquity of the apertures, and in the absence of the pouch-like protuberances. Septal spines present. Greatest diameter of tubes .5 to 1 mm.

In the Onondaga formation of New York, Canada, Michigan, Ohio, Kentucky, etc.

110. **A. goldfussi** Billings. Devonic.

Flattened or disk-like expansions like the preceding with a basal epitheca. Tubes larger (1.5 to 2 mm.), oblique and in various stages of compressions in the same specimen.

In the Hamilton group of New York, Canada, Michigan, Iowa and in strata of similar age near Louisville, Ky.

XLI. Cladopora.

Coral composed of branching stems or flattened expansions, with thick-walled elongate, conical tubes, opening oblique to the surface, with dilated orifices. Mural pores and occasional tabulae present. Sil.–Dev.

Flattened Expanded Species.

111. **C. laqueata** Rominger. Siluric.

Expansions composed of round or compressed elliptical stems from two to four millimeters in diameter and uniting repeatedly so as to form a coarse network. Orifices of tubes distant with a strong lip, oval, transverse to the branches, width nearly a millimeter.

In the Niagara group of Michigan and at the falls of the Ohio.

112. **C. lichenoides** Rominger. Devonic.

Irregular expansions with peritheca on the under side. Tubes flattened, extending outward, prostrate but bending upward at the ends. Orifices oblique or at times nearly at right angles to the tube, and polygonal.

In the Onondaga beds of New York, Canada, Michigan and the Falls of the Ohio.

113. **C. fisheri** Billings. Devonic.

Flat leaf-like expansions attached at one point to foreign bodies, and with oblique orifices on both sides.

In the Onondaga (?) beds of Kentucky and Indiana and in the Hamilton group of Canada, etc.

ROUND STEMMED SPECIES.

114. **C. seriata** Hall. (Fig. 148.) Siluric.

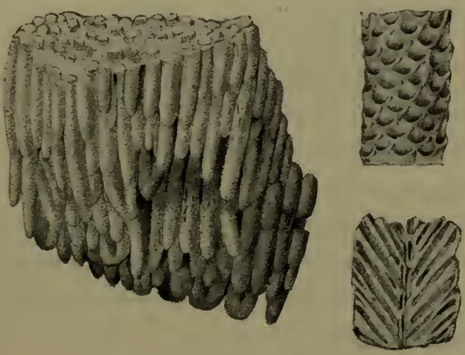


FIG. 148. *Cladopora seriata* (N. Y. St. Geol. Surv.).

Nearly parallel crowded branches, forming a glomerate mass, the branches sometimes bifurcating. Calices in alternating series with projecting circular lip.

In the Niagara group of New York, Canada, etc.

115. **C. cryptodens** (Billings). (Fig. 149.) Devonic.

Cylindrical bifurcating branches from five to ten millimeters in

FIG. 149. *Cladopora cryptodens* (after Billings).

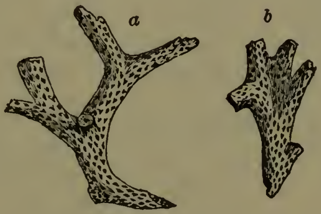


FIG. 150, *a–b*. *Cladopora labiosa* (after Billings).

diameter. Tubes with oblique dilated orifices from 1 to 1½ mm. in diameter.

In the Onondaga beds of New York, Canada, Michigan, and Western States.

116. **C. labiosa** (Billings). (Fig. 150, *a–b*.) Devonic.

Stems smaller and more frequently branching, often reuniting. Oblique (2 to 5 mm. in diameter) subcircular orifices with a prominent convex lip.

Abundant in the Onondaga of New York, Canada, Michigan and the Falls of the Ohio.

117. **C. roemeri** (Billings). Devonic.

Cylindrical or compressed stems, about 5 mm. or less in diameter with large oblique orifices, which merge into an indefinite interstitial surface or into angular pits.

In the Hamilton group of Canada and at the Falls of the Ohio.

118. **C. pulchra** Rominger. Devonic.

Similar to preceding but with circular orifices, more than a tube-diameter apart, and often at the summit of a small elevation.

In the Onondaga of Canada, Michigan and the Falls of the Ohio.

119. **C. robusta** Rominger. Devonic.

Large compressed cylindrical stems from 10 to 20 mm. thick and often forming net-like expansions covering several square feet. Oblique orifices with strong semicircular lips.

In the Onondaga beds of Michigan and the Falls of the Ohio, and in the Hamilton of Michigan.

XLII. Striatopora Hall.

Coral stock of simple dividing cylindrical branches, with thick-walled corallites, opening in rounded apertures, which are surrounded by polygonal depressed calices, the sides of which are striated by rudimentary septa. Occasional septal spines, tabulæ and mural pores present. Sil.–Dev.

120. **S. flexuosa** Hall. (Fig. 151.) Siluric.

Bifurcating branches. Polygonal expansion of cells deep, and bounded by angular ridges, vertically striate, the striæ becoming fainter upward. Calices circular at the base.

In the Niagara beds of New York, etc.

121. **S. linnæana** Billings. Devonic.

Orifices of unequal size through intercalation of smaller ones, moderately oblique, 2 mm. in diameter and narrowing in diameter.

Twelve radial furrows, not always preserved in fossilization, mark the orifices and between them are rows of spinules.

In the Hamilton group of Canada and Michigan and in Devonic beds of somewhat earlier age at the Falls of the Ohio.

FIG. 151. *Striatopora flexuosa* (N. Y. Geol. Surv.).

XLIII. TRACHYPORA E. & H.

Corallum consisting of branching cylindrical stems, which are made up of polygonal corallites with very thick walls, and circular calices, which are superficially far apart. Scattered mural pores, remote tabulæ, and rows of spines representing the septa, are characteristic. Dev.

FIG. 152. *Trachypora ornata* (= *T. limbata* Hall) (Pal., N. Y.).

122. **T. ornata** Rom. (Fig. 152.) Devonic.

Stems 10 to 20 mm. in diameter, orifices circular or oval, generally slightly elevated, irregularly dispersed, the interspaces wider than the diameter of orifice, which is about 1½ mm. Granules and short radial ridges surround the orifices.

Common in the Hamilton group of New York, also more rarely in Canada and Michigan.

123. **T. elegantula** Billings. Devonic.

Stems 2 to 5 mm. in diameter, orifices in four rows, oval and partly edged by an elevated rim.

Hamilton group of Michigan and Canada.

XLIV. Halysites Fisher.

Corallum composed of cylindrical or compressed corallites, which are joined into intersecting and anastomosing laminæ of single layers of tubes united along the whole of their adjoining side.

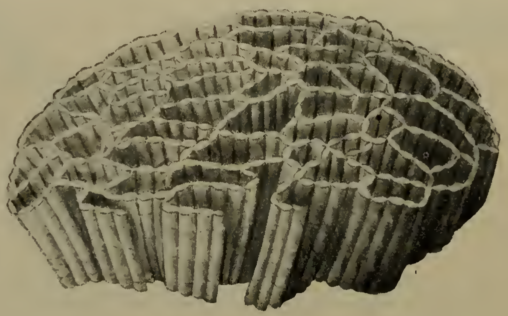


Fig. 153. *Halysites catenulatus* (N. Y. Geol. Surv.).

The tubes are covered by a continuous peritheca on their free sides. No mural pores; tabulæ well developed; septa obsolete or in cycles of 12. Ord.–Sil.

124. **H. catenulatus** (Linn.). (Fig. 153.) (Ord.) to Siluric.

Tubes oval in section united by their narrower sides, or with a minute closely tabulate tube intervening. Epitheca with fine and occasionally coarse lines of growth; meshes formed by tubes, large, irregular and varying in size.

In the Ordovicic beds of Anticosti, Wisconsin, Colorado, but especially in the Middle Siluric of Europe and North America generally.

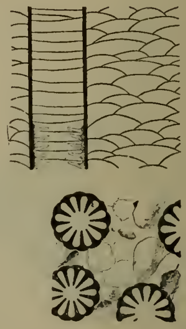


Fig. 154. *Lyellia americana*, vertical and transverse sections enlarged (after Lambe).

Octameral Corals.

XLV. Lyellia E. & H.

Coral head consisting of numerous cylindrical tubes, growing parallel and united by vesicular cœnenchyma, septa 12, short, tabulæ irregular. Siluric.

125. **L. americana** E. & H. (Figs. 154–155.) Siluric.

Tubes 1½ to 2 mm. in diameter, separated by two tube-diameters or something less. Septa comparatively short, cœnenchyma of fine cysts.

In the Niagara group of Michigan, Iowa and the Falls of the Ohio. Also at Anticosti.

XLVI. HELIOLITES Guettard.

Corallum compound, varying from spheroidal to flabellate, with large cylindrical macrocorallites, furnished with twelve infoldings of the wall, or pseudosepta, and numerous angular microcorallites

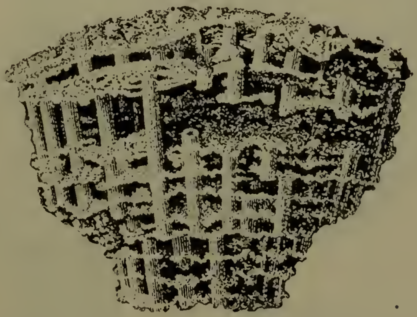


FIG. 155. *Lyellia americana* (Ind. Geol. Surv.).

investing the larger ones. Tabulæ in both corallites, more numerous in the smaller. No mural pores. Basal peritheca present. Ord.?–Dev.

126. **H. megastoma** McCoy. Siluric.

Convex heads with the macrocorallites about 2 mm. in diameter and distant somewhat less. Twelve very short pseudosepta. Form subglobular.

In the Niagara group of New York, Canada, Michigan, Iowa, Wisconsin, etc.

127. **H. interstinctus** Linn. (Figs. 156, 158, *a*, *b*.) Siluric.

Discoid or in leaf-like expansions with a basal peritheca. Macro-

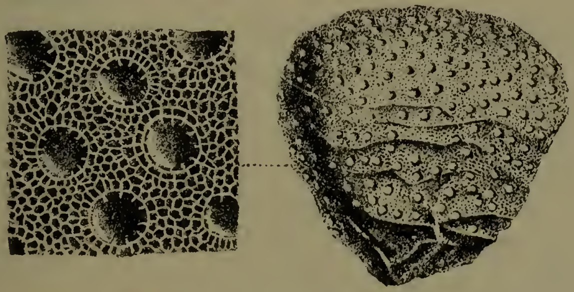


FIG. 156. *Heliolites interstinctus*, with part of surface enlarged (after Roemer.)

corallites slightly larger than in preceding, and somewhat more distant. Pseudosepta nearly reaching the center in well-preserved specimens. Microcorallites polygonal.

Fig. 157. *Heliolites elegans* (N. Y. Geol. Surv.).

In the Niagara group of Michigan, Indiana, Kentucky, Tennessee, etc.

128. **H. elegans** Hall. (Fig. 157.) Siluric.

Hemispheric coralla with macrocorallites a little over .5 mm. in diameter, and pseudosepta in the form of oblique spines and reaching half way to the center. Microcorallites crowded, minute.

In the Niagara group of New York, Michigan, Indiana, Kentucky, etc.

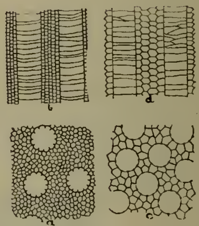


Fig. 158, *a*, *b*. *Heliolites interstinctus*; *c*, *d*, *Plasmopora follis*, vertical and horizontal sections enlarged (after Lambe).

XLVII. Plasmopora E. & H.

Differs from *Heliolites* in having twelve well-developed vertical rows of spinulose pseudosepta and cœnenchyma composed of intersecting plates which however form no true microcorallites, and whose tabulæ become more or less continuous, producing a vesicular tissue. Ord ?–Dev.

129. **P. follis** E. & H. (Fig. 157, *c*, *d*.) Siluric.

Tubes from 1 to 1.5 mm. in diameter with circular crenulated orifices, and separated by an equal width. Growth in pyriform or subcylindrical club-shaped masses, with a rudimentary peritheca at the conical base.

In the Niagara beds of Michigan — more commonly in the same beds of Indiana, Kentucky and Tennessee.

XLVIII. Tetradium Dana.

Massive heads composed of numerous long, slender, prismatic and thin-walled corallites, quadrangular or petaloid in section and with four primary septa and numerous tabulæ. Increases by fission. Ordovicic.

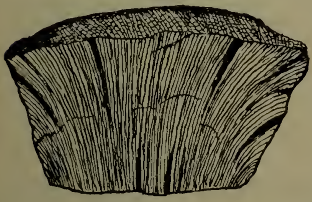


Fig. 159. *Tetradium fibratum.*

T. fibratum Safford. (Figs. 159, 160.) Ordovicic.

Septa nearly reaching center; diameter of corallites 0.04 inch.

In Stones River and Black River of New York, Canada, Tennessee and other localities.

Hexameral Corals.

XLIX. Parasmylia E. & H.

Cylindrical or conical, simple corals with a scar of attachment at the base. Calyx circular, with granular septa and a spongy colu mella. Epitheca absent or rudimentary, and costæ strong. Cretacic.

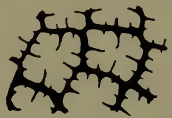


Fig. 160. *Tetradium fibratum*, cross-section much enlarged (after Lambe).

130. **P. austinensis** Roem. Cretacic.

Top-shaped coral attached by a broad base, above which it is contracted, strong equal costæ. Calyx slightly compressed with septa in four cycles.

In the Edwards limestone (Lower Cretacic) of Texas.

131. **P. texana** Vaughan. (Fig. 161.) Cretacic.

Differs from the preceding in having costæ alternating large and small.

In the Buda limestone (Lower Cretacic of Shoal Creek, Texas).

L. Pleurocora E. & H.

Branching cylindrical corals with a thick compact wall without epitheca. Columella of numerous points (papillose); septa granular, projecting above the calyx. Costæ distinctly wavy. Cretacic.

132. **P. coalescens** Roem. Cretacic.

Slender cylindrical, much branching corals with calices 3 mm. in diameter — septa not reaching to center, which is occupied by spongy columella.

In the Edwards limestone (Lower Cretacic) of Texas.

FIG. 161. *Parasmylia texana* (Vaughan, Bull. U. S. G. S.).

LI. CLADOPHYLLIA E. & H.

Branching corals with cylindrical stems multiplying by fission. Calices circular with a rudimentary columella or none; a well-developed epitheca is present. Cret.–Recent.

133. **C. furcifera** Roem. (Fig. 162.) Cretacic.

Calices 4 to 6 mm. in diameter. No columella, septa in 3 cycles. Growth a regular forking, with uniform branches. Epitheca concentrically wrinkled.

In the Edwards limestone (Lower Cretacic) of Texas.

FIG. 162. *Cladophyllia furcifera*, section of calyx, × 2.

LII. SEPTASTRÆA d'Orbigny.

Compound corals, with corallites prismatic from crowding. Calices of moderate depth with simple septa,

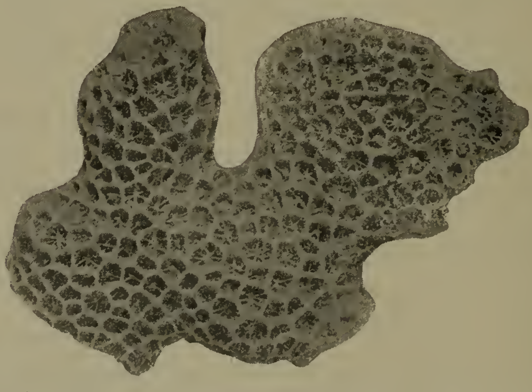


FIG. 163. *Septastræa marylandica* (Md. Geol. Surv.) reduced.

the longer of which unite in the center, where they often form a pseudocolumella. No true columella or pali occur. Tertiary.

134. **S. marylandica** (Conrad). (Fig. 163.) Miocenic.

Compressed stems with short, rounded branches, or large flattened lobate or digitiform expansions. Corallites averaging 5 or 6 mm. in diameter. Twelve large and a similar number of smaller septa occur; sometimes a third series.

Abundant in the St. Mary's Miocene formations of various parts of the Atlantic coast.

FIG. 164. *Flabellum cuneiforme*, two varieties, with calyx of *F. lerchi* (after Vaughan, Mon. U.S.G. S.).

LIII. FLABELLUM Lesson.[1]

Simple wedge-shaped compressed corals free or attached, with numerous septa, and a compressed columella. A wrinkled epitheca sometimes with spinous processes occurs. Tert.–Recent.

135. **F. cuneiforme** Lonsdale. (Fig. 164.) Eocenic to Oligocenic.

Base with a short prolongation of attachment; exterior of compressed wedge-shaped structure marked by strong ridges or costæ which are largest in the middle. First three cycles of septa form the columella by fusion of their inner margins. Claibornian, Jacksonian and Vicksburgian groups of South Carolina, Alabama, Mississippi, Louisiana, Arkansas and Texas. Several distinct varieties are recognized.

LIV. PLATYTROCHUS Milne-Edwards & Haime.

Simple cuneiform corals, with a columella formed of the fused inner edges of the septa. Externally the septa are represented by thick costæ, while within the outer wall their margins are carinated. Tertiary.

136. **P. stokesi** (Lea). (Fig. 165.) Eocenic.

Small, with the base drawn out into a wedge nearly as wide as the coral above. Septa and costæ 24, nine of which on the middle of each broad face, converge and unite downward, while those on either side become broader. Surface rough with granules. Columella papillose.

In the Claibornian group of South Carolina, Alabama, Mississippi and Texas.

LV. Discotrochus Milne-Edwards & Haime.

Free, disk-like corals, with a flat base and slightly arched upper surface. Septa carinate, radial, the longer joining the papillose columella. Costæ simple. Tertiary.

137. **D. orbignianus** E. & H. (Fig. 166.) Eocenic.

Base with the large unequal costæ becoming indistinct near the concave center. Diameter 6 mm., height 1.5 mm.

Fig. 165. *Platytrochus stokesi* (after Vaughan, enlarged).

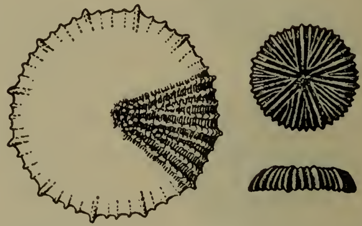


Fig. 166. *Discotrochus orbignianus*, with partial enlargement (after Vaughan).

In the Lower Claibornian of Alabama, Mississippi, Louisiana and Texas.

LVI. Turbinolia Lamarck.

Small, free, conical corals with a circular calyx. Septa prolonged externally into strong costæ. Septa in several cycles. Alternate septa triple from union with smaller ones, columella well developed. Tert.–Recent.

138. **T. pharetra** Lea. (Fig. 167.) Eocenic.

Twenty-four rounded and prominent costæ, with entire margins, twelve of which become larger basally and only six occurring at the base. A double row of pores occurs in the furrows between the costæ. Columella slightly projecting in the form of a star, with six rays, each of which fuses with a principal septum.

Fig. 167. *Turbinolia pharetra* (after Vaughan, enlarged).

In the Claibornian and Jacksonian groups of Alabama, Mississippi, Louisiana and Texas.

LVII. Oculina Lamarck.

Composite corals generally in the form of branching stems with the calices spirally distributed over the stem, generally on crater-

Fig. 168. *Oculina vicksburgensis.*

Fig. 169. *Oculina mississippiensis.*

(After Vaughan, Mon. U. S. G. S.)

like elevations and separated by dense layers of cœnenchyma. Septa in several cycles, the longer reaching the center which is occupied by a papillose columella surrounded by a cycle of vertical rods or pali. Tert.–Recent.

139. **O. vicksburgensis** (Conrad). (Fig. 168.) Oligocenic.

Branches 20 to 30 mm. in thickness. Circular calices separated by once or twice their diameters or more, shallow, but often with a prominent margin. Feeble flexous striæ radiate from the calices on the cœnenchyma. Diameter of adult calyx averaging 4 mm.

In the Vicksburgian and Red Bluff beds of Mississippi.

140. **O. mississippiensis** (Conrad). (Fig. 169.) Oligocenic.

Calices strongly projecting, crowded, with thin septa. Costal striæ faint or obsolete.

In the Vicksburgian group of Mississippi.

LVIII. Astrohelia E. & H.

Similar to *Oculina*, but with the calices merely excavated, rarely raised on crater-like elevations. Columella spongy. Tertiary.

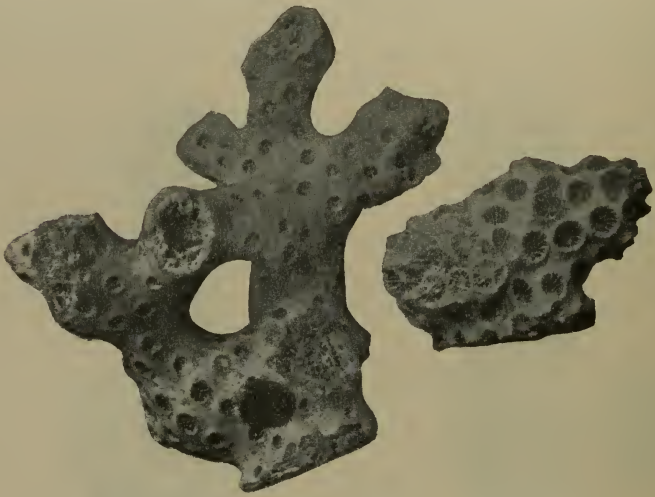


Fig. 170. *Astrohelia palmata* (Md. Geol. Survey) reduced.

141. **A. palmata** (Goldfuss). (Fig. 170.) Miocenic.

Branching, often coalescing, or in palmate expansions. Calices circular, excavated, septa in three cycles, the first and second reaching the columella.

In the Choptank and Calvert formations of the Miocene of the Atlantic coast.

LIX. Balanophyllia Wood.

Simple conical corals with a broad base of fixation. Septa very numerous, closely crowded and partly fused together. Columella spongy. Epitheca often present, structure porous. Eocenic–Recent.

142. **B. desmophyllum** E. & H. (Fig. 172.) Eocenic.

Basal portions cylindrical, becoming conical upwards. Section elongate, elliptical with rather deep calyx. Septa thin, costæ fine. Epitheca rudimentary or absent.

In the Chickasawan and Claibornian beds of Alabama, Mississippi, Texas and in Maryland.

143. **B. irrorata** (Conrad). (Fig. 171.) Eocenic.

Slender cylindro-conical, curved, cross-section elliptical, epitheca on basal portion.

In the Claibornian and Jacksonian beds of Alabama, Louisiana and Mississippi. Varieties also found in Texas.

Fig. 171. *Balanophyllia irrorata* with enlargement of calyx (Vaughan).

144. **B. haleana** (E. & H.). (Fig. 173.) Eocenic.
Conical, slightly curved, broadly elliptical in sections, basally at-

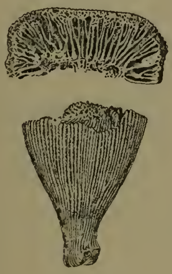


Fig. 172. *Balanophyllia desmophyllum.* Fig. 173. *Balanophyllia haleana.* Fig. 174. *Eupsammia elaborata.*
(After Vaughan.)

tached. Costæ dividing upwards. Septa crowded, extremely thin, with granulated surfaces. Columella large, spongy but dense. Basal epitheca present.

Common in the Chickasawan of Alabama.

LX. Eupsammia E. & H.

Like *Balanophyllia*, but acutely pointed and free. Septa of the last cycle stouter than the rest. Columella present or absent. Tert.–Recent.

145. E. **elaborata** (Conrad). (Fig. 174.) Eocenic.
Conical with elliptical section; finely perforated, costæ trifurcating upwards. No epitheca. Spongy columella, and thin anastomosing septa; wall spongy.
In the Chickasawan beds of Maryland, Virginia and Alabama.

LXI. ENDOPACHUS Lonsdale.

Corals with the general form of *Flabellum*, but with the porous wall structure and septal arrangement of *Eupsammia*. Lateral wings often developed. A compressed spongy columella occurs. Tertiary.

146. E. **maclurii** (Lea). (Fig. 175.) Eocenic.
Cuneate, with subparallel margins, sides and ends rounded.

FIG. 175. *Endopachus maclurii* (after Vaughan).

Lateral wings well developed. Columella narrow and elongate in long axis of corallum; very vesiculate.
In the Claibornian and Jacksonian beds of Alabama, Mississippi, Louisiana and Texas.

Phylum IV. MOLLUSCOIDEA.

Class **Bryozoa (Polyzoa).***

The Bryozoa or Polyzoa are marine or fresh-water animals almost always occurring in colonies, known as *zoaria*, which increase by gemmation. Each *zooid* of the colony is enclosed in a membranaceous or calcareous double-walled sac, the *zoœcium*, into which it can withdraw (Fig. 176*a*). The animal possesses a mouth, an alimentary canal, and an anal opening, and, in addition to these, a fringe of respiratory tentacles —the lophophore (Fig. 176*b*). The colony is commonly attached to foreign bodies, which it either encrusts or from which it arises as an independent frond. The frond may be *unilaminar*, *i e.* with the cells opening on one side only. It may be encrusting or lined with a basal *epitheca*.

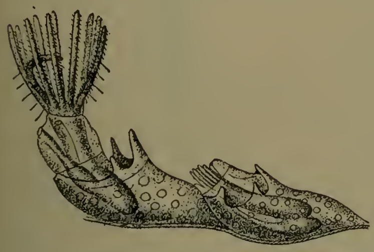


Fig. 176*a*. *Membranipora pilosa* (recent). Two zooids, one expanded and one withdrawn into the transparent zoœcium. Enlarged. (After Farre.)

When the ends of such a unilaminar frond unite, a hollow tube lined with epitheca is produced. Again the frond may be *bilaminar* or *bifoliate*, with the epithecæ of the two parts growing together, forming a *mesotheca*. This often contains *median tubuli*. Other forms are *massy* (hemispheric, globular, or discoidal in shape) with gemmation on all sides; *ramose* or branching and *dendroid*.

A network is often formed, when the branches grow together, leaving *fenestrules* along the border of which are found the apertures of the cells. The branches, instead of anastomosing, may be straight and united at intervals by cross-bars or *dissepiments* which commonly have no apertures (Fenestella, etc.). The branches may be ornamented by nodules, spines or a longitudinal *keel* or *carina*; this latter may be sharp, expand, or even bear a complicated superstructure. In some types (Archimedes) these fronds

* Thin sections are required in the study of this class.

are twisted in a spiral form, of which generally the solid axis alone is fully preserved in fossil form.

In the Palæozoic genera the cell apertures are often surrounded by elevated rims or *peristomes*. Often a portion of the posterior wall is more or less thickened and curved to a shorter radius, forming *lunaria*, the ends of which may project into the tube as *pseudosepta*. At the junction of the apertures small cylindrical tubules projecting above as spines, the *acanthopores*, often occur. When the zoœcial tubes are crowded and thin-walled their apertures generally have an angular outline, but when they are thick-walled or separated by interspaces, they are circular, oval or variously formed. The interspaces may be occupied by smaller tubes, the *mesopores*, or by vesicular tissue. The mesopores may be scattered or gathered into clusters. Elevations or *monticules* and flattened or depressed spots or *maculae* are other characteristic surface features. They may be solid or contain the openings of zoœcia (generally somewhat larger than the ordinary) or of mesopores.

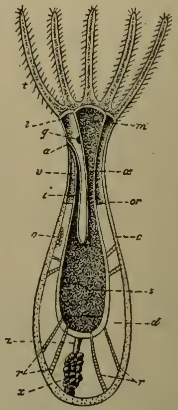


FIG. 176*b*. Diagram showing structure of single bryozoon zooid. (After Busk.) *a*, anus; *c*, ectocyst; *d*, perigastric space; *g*, nerve ganglion; *i*, intestine; *l*, lophophore; *m*, mouth; *o*, ovary; *oc*, œsophagus; *or*, aperture of the zoœcium; *r*, retractor muscles; *s*, stomach; *t*, tentacles; *v*, tentacular sheath; *x*, testis; *z*, funiculus.

In the Cryptostomata the opening of the zoœcium is the cell orifice. Above this occurs a tubular shaft formed by the thickening of the surface of the zoarium for strengthening or protective purposes. This shaft is the vestibule, and its aperture is variously formed.

In most Palæozoic Bryozoa the tubes are variously divided by cross plates or *diaphragms* which in some types are vesicular, forming *cystiphragms* (Trepostomata). The diaphragms may be complete or pierced by a central opening. In the Cryptostomata additional plates the *hemisepta* project from the wall into the cavity. When they project from the posterior wall, they are known as *superior hemisepta*, when they project from the anterior wall they are the *inferior hemisepta.* In the Chilostomata the wall is frequently only partly calcified and hence in fossil forms the cell opening is very large. Additional pores the *avicularia* are commonly found.

Literature.

General Reference.

1900. **Nickles, John M., and Bassler, Ray S.** A synopsis of American Fossil Bryozoa including Bibliography and Synonymy. Bull. 173, U. S. Geol. Survey. This work is indispensable to the student of Bryozoa. It contains complete references to literature, to date of publication, generic descriptions and a bibliography of all described American Palæozoic species.

Palæozoic.

1847, 1852. **Hall, James.** Palæontology of New York, Vols. I. and II. Contains Bryozoa of the Ordovicic and Siluric of New York.

1876–79. **Hall, James.** Fauna of the Niagara Group in central Indiana. 28th Ann. Rep. N. Y. State Museum of Natural History; Trans. Albany Inst., X., 1883.

1879. **Nicholson, H. Alleyne.** On the structure and affinities of the Tabulate Corals of the Palæozoic period. Edinburgh.

1881. **Nicholson, H. A.** On the structure and affinities of the genus Monticulipora, etc. Edinburgh.

1882–1884. **Ulrich, E. O.** American Palæozoic Bryozoa. Journ. Cincin. Soc. Nat. Hist., V., VI., VII.

1887. **Hall, James.** Fenestellidæ of the Hamilton group of N. Y. 6th Ann. Rep. State Geologist of N. Y., pp. 43–70, pls. i.–vii.

1887. **Hall, James, and Simpson, Geo. B.** Palæont. of N. Y. VI., Corals and Bryozoa. (Lower and Upper Helderberg, and Hamilton.)

1888. **Hall, James.** Fenestellidæ of the Lower Helderberg. Rep. State Geol. of N. Y. for 1887. 41st Ann. Rep. N. Y. State Mus. Nat. Hist.

1890. **Ulrich, E. O.** Palæozoic Bryozoa. Geol. Surv. of Ill., VIII., pp. 285–688, pls. XXIX.–LXXVIII.

1891. **Hall, James.** Continuation of descriptions of Bryozoa not printed in Vol. VI. Pal. of N. Y. 44th Ann. Rep. N. Y. State Mus. Nat. Hist., pp 67–87.

1893. **Ulrich, E. O.** Lower Silurian Bryozoa of Minnesota. Geol. Minn., III., Pt. I., pp. 96–332, pls. i.–xxviii.

1897. **Simpson, George B.** Handbook of genera of North American Palæozoic Bryozoa. 14th Ann. Rep. State Geologist N. Y. for 1894, pp. 407–608, pls. A–E, i.–xxv.

1904 to date. **Ulrich, E. O., and Bassler, R. S.** A revision of the Palæozoic Bryozoa. Pt. I., Ctenostomata; Smithsonian Miscell. Coll. Vol. 45; 256–294, pls. 65–68, 1904; Pt. II. Trepostomata, *ibid.*, vol. 47, pp. 15–55, pls. 6–14, 1904.

1905. **Nickles, John M.** The Upper Ordovician Rocks of Kentucky and their Bryozoa. Kentucky Geological Survey Bulletin 5.

1906. **Bassler, Ray S.** The Bryozoan Fauna of the Rochester Shale, Bull. 292, U. S. Geol. Survey.

Mesozoic and Cenozoic.

1845. **Lonsdale, William.** Polyparia from Timber Creek, N. J. Quar. Jour. Geol. Soc. London, I., pp. 65–75. Corals from Tertiary of North America. *Ibid.*, pp. 495–509. Polyparia from the Eocene Tertiary of N. Amer. *Ibid.*, pp. 509–533.

1860. **Gabb, W. M., and Horn, G. H.** Cretaceous corals from New Jersey. Proc. Acad. Nat. Sci. Phila., XII., pp. 366–367. New species of American Tertiary and Cretaceous fossils. Jour. Acad. Nat. Sci. Phila., ser. 2, IV., pp. 375–404.

1862. **Gabb, W. M. and Horn, G. H.** Monograph of fossil Polyzoa of the Secondary and Tertiary of N. Amer. Jour. Acad. Nat. Sci. Phila., ser. 2, V., pp. 111–178, pls. xix.–xxi.

1890. **Gregorio, Antonio de.** Monographie de la Faune Eocenique de l'Alabama et surtout de celle de Claiborne de l'Etage Parisien. Ann. Géol. et Paléont., Livraisons VII., VIII. Palermo.

Artificial Key to Genera.

I. CTENOSTOMATA. — Zoœcia horny or membranaceous, isolated, budding from internodes of tubular stolon; sometimes appearing as excavation in the host... A.

- A. Thread-like, or very slightly swollen in center........ *.
  - * Arrangement net-like or pinnate........ I. *Rhopalonaria.*
  - * Arrangement more or less radial........ III. *Vinella.*
- A. Swollen, bulb or sausage-like........ **.
  - ** Arrangement in linear series........ IV. *Allonema.*
  - ** Arrangement radial, at intervals along slender stolon..... II. *Ascodictyon.*

II. CYCLOSTOMATA. — Zoœcia simple calcareous tubes, usually without transverse partitions, singly or in association........ B.

- B. Zoœcia free throughout in loosely united branches or strings........ ***.
  - *** Tubes in linear series, budding one from the other uniserially........ 1.
    - 1. Dichotomously branching, apertures subterminal..... V. *Stomatopora.*
    - 1. Irregular branching, apertures terminal........ X. *Hernodia.*
  - *** Tubes budding on two or more sides from a linear median stolon..... 2.
    - 2. Branching; tubes separate and distinct........ IX. *Hederella.*
    - 2. Branching; tubes closely parallel in contact, and of uniform length. XI. *Reptaria.*
- B. Zoœcia united wholly or partly in bundles of two or more; no interstitial cells. ****.

**** Zoœcia few in conical bundles of two or more........ .... 3.
3. Subterminal apertures not elevated .... XIII. *Phacelopora.*
3. Terminal apertures, elevated at right angles to axis of branch, frequently free.. XCVIII. *Filifascigera.*
**** Zoœcia numerous... 4.
4. Zoarium a more or less flattened expansion or attached stem........ *a.*
a. Of flattened attached stems sometimes widening or uniting into sheets, tubes slightly or not at all projecting.. VI. *Proboscina.*
a. Spreading fronds, with ends of tubes projecting.................. *aa.*
aa. Free, bifoliate .... VIII. *Diastoporina.*
aa. Attached, tubes on one side only.......... VII. *Berenicea.*
a. Obconical or cup-shaped, attached by center of sides with epitheca, tubes not projecting .... XCIX. *Discosparsa.*
4. Zoarium a branching cylindrical stem with more or less freely projecting tube ends .... *b.*
b. Tubes regular, distant, generally much exserted.. XII. *Mitoclema.*
b. Tubes crowded slightly exserted, branches hollow, cavity divided by transverse partitions.................................. C. *Cavaria.*

B. Zoœcia in compound zoaria, with interstitial cells or mesopores.. .... 5*.
5* Walls of adjoining zoœcia thoroughly amalgamated and pierced by numerous pores, no lunaria .... 5.
5. Variously formed generally massy with basal epitheca, and uniform zoœcial apertures .... CI. *Ceriopora.*
5. Massy or branching, numerous mesopores or interstitial cells between the zoœcia... CII. *Heteropora.*
5. Of hollow branches the cavity divided by transverse plates; surface with maculæ and mesopores................................ C. *Cavaria.*
5* Walls minutely porous, lunarium present, often very prominent, surface with maculæ or monticules...................................... .... 6.
6. Encrusting .... *c.*
c Lamellose expansions.... .... *bb.*
bb. Mesopores abundant.. *11.*
11. Lunarium forming pronounced hood.
XV. *Ceramoporella.*
11. Lunarium not hooded, interspaces with vesicles.
Fistulipora.
bb. Mesopores few .... *22.*
22. Mesopores scattered................ XVIII. *Anolotichia.*
22. Mesopores mostly in maculæ.......... XVI. *Crepipora.*
c. Disc-shaped, apertures in radiating ridges.. XXV. *Botryllopora.*
6. Lamellate or massy.. *d.*
d. Mesopores few, decreasing toward margin.... XIV. *Ceramopora.*
d. Mesopores numerous... *cc.*
cc. Lunarium well raised... .... XX. *Bythotrypa.*
cc. Lunarium moderate, interspaces with vesicles.
XXI. *Fistulipora.*
cc. Lunarium a strong bidentate process, interspaces with vesicles .... XXIII. *Buskopora.*
6. Branching, more or less cylindrical.. *e.*
e. Branches hollow, lined on inside with epitheca, lunarium hooded.
XVII. *Coeloclema.*

e. Branches hollow, with irregularly expanding and contracting axial tube ; diaphragms few or absent, interspaces with vesicles. XXII. *Chilotrypa.*

e. Branches solid ; diaphragms present.............. XVI. *Crepipora.*

6. Zoarium bifoliate.. *f.*

f. Lunarium prominent, hood like.............. XIX. *Ceramophylla.*

f. Lunarium not prominent, interspaces with vesicles. XXIV. *Meekopora.*

III. TREPOSTOMATA. Zoaria compound, with walls of zoœcia thickened in the outer region with numerous diaphragms or cystiphragms, and monticules or maculæ on surface. Tubes separating upon fracture.. c.

c. Cystiphragms always in outer region, acanthopores mostly abundant.......... 6*.

6* Mesopores few or wanting.. 7.

7. Mesopores scattered or absent, acanthopores small and numerous, cystiphragms throughout, walls granulose.. XXVI. *Monticulipora.*

7. Mesopores few, in clusters, acanthopores generally developed, cystiphragms in outer region only .... XXVIII. *Homotrypa.*

6* Mesopores numerous .... 8.

8. Apertures irregularly petaloid.................... XXVII. *Atactoporella.*

8. Apertures rounded to polygonal .... *g.*

g. Massive conical or discoidal usually free, with wrinkled epitheca on under side.. *dd.*

dd. Zoœcia with cystiphragms................ XXIX. *Prasopora.*

dd. Zoœcia with oblique or funnel-shaped diaphragms (modified cystiphragm)............................ XXXI. *Mesotrypa.*

g. Zoarium a thin expansion with epitheca...... XXX. *Aspidopora.*

c Diaphragms instead of cystiphragms in outer region of zoœcial tubes........... ‡

‡ Mesopores few or absent.. 7*.

7* Acanthopores present.. 9.

9. Acanthopores large.. *h.*

h. Diaphragms of zoœcia few or wanting........................ *ee.*

ee. Erect, ramose, diaphragms few... XXXVI. *Dekayia.*

ee. Ramose, slender diaphragms practically absent, acanthopores sometimes wanting.. XXXVIII. *Bythopora.*

h. Diaphragms often numerous .... *ff.*

ff. Zoœcia with well-marked division line between walls. XXXII. *Amplexopora.*

ff. Zoœcia with periodically thickened walls in mature region.................................... XL. *Stenopora.*

9. Acanthopores small, few, or wanting................................ *i.*

i. Zoœcia with well-marked division line. XXXII. *Amplexopora.*

i. Zoœcia with thick walls................ XXXIX. *Eridotrypa.*

i. Bifoliate with flexuous mesotheca..... XXXIV. *Petalotrypa.*

7* Acanthopores absent.. 10.

10. Zoœcia with well-marked division line.. XXXIII. *Monotrypella.*

10. Zoœcia thick-walled, many diaphragms.. XXXIX. *Eridotrypa.*

‡ Mesopores numerous.. 8*.

8* Zoarium ramose, sometimes with anastomosing branches............ 11.

11. Diaphragms numerous.. *j.*

j. Acanthopores of two sets, large and small. XXXV. *Dekayella.*

j. Acanthopores small, few or wanting.. XXXIX. *Eridotrypa.*
j. Acanthopores large, abundant............ XLIII. *Batostoma.*
j. Acanthopores absent .... XLVII. *Callopora.*
11. Diaphragms few .... *k.*
k. Mesopores small with subcircular openings.
XXXVII. *Batostomella.*
k. Mesopores irregularly angular, often obscurely moniliform.
XLVI. *Trematopora.*
8* Zoarium erect, flattened fronds or laminar expansions............... 12.
12. Mesopores gathered into maculæ, apertures on elevated stellate rays .... XLI. *Constellaria.*
12. Mesopores numerous, in interzoœcial space, filled and obscured by calcareous tissue in older individuals.. XLII. *Nicholsonella.*
8* Zoarium encrusting foreign bodies, apertures oval, mesopores abundant .... XLIV. *Stromatotrypa.*
8* Zoarium massive, hemispheric, subglobose or discoidal; neither mesopores nor acanthopores: zoœcial walls often crinkled.
XLV. *Monotrypa.*

IV. CRYPTOSTOMATA. Zoaria compound often highly complex; zoœcia with a short tubular primitive portion, above which, in the "mature" part, is a tubular shaft or vestibule, often with hemisepta, and surrounded by vesicular or solid calcareous tissue; external orifice round... D.

D. Zoarium a reticulated network or expansion pierced by holes or fenestrules and celluliferous on one side only.. ‡‡.
‡‡ Branches and connecting bars or dissepiments distinct, the latter non-poriferous.. 9*.
9* Apertures on branches in two rows separated by a median keel ... 13.
13. Keel moderate, plain, or tuberculated.............................. *l.*
l. Funnel-shaped structure (fragments flat)...... L. *Fenestella.*
l. Spirally wound axis......................... LVII. *Archimedes.*
13. Keel high, expanded at the summit .... *m.*
m. Expanded portion of keel with large or scattered pores or pits.. LII. *Fenestrapora.*
m. Expanded portion of keel without pores or pits.
LI. *Semicoscinium.*
13. Keel supporting a superstructure.................................. *n.*
n. Superstructure of thin oblique subimbricating plates (scalæ).
LIII. *Unitrypa.*
n. Superstructure a reticulated network ...... LV. *Hemitrypa.*
9* Apertures in more than two rows (rarely two)........................ 14.
14. No median keel (or row of tubercles).............................. *o.*
o. Apertures in 2 to 8 rows in a branch, frond as in Fenestella.
LVIII. *Polypora.*
o. Apertures in 2 to 5 ranges; frond supported by non-poriferous U- or V-shaped base .... LX. *Lyropora.*
14. A prominent median keel present, with two rows of apertures at each side .... LXI. *Fenestralia.*
‡‡ Connecting bars absent or indistinguishable, branches anastomosing. 10*.
10* Branches irregularly anastomosing .... 15.
15. Two to eight rows of apertures; reverse side longitudinally striated .... XLVIII. *Phylloporina.*

15. Apertures in 3 to 7 rows; reverse side not striated. LVI. *Reteporidra.*

10* Regularly anastomosing, or connected by scarcely recognizable dissepiments.......... 16.

16. Apertures in two rows, carinæ expanded sometimes to width of branch.......... LIV. *Loculipora.*

16. Apertures in 3 to 7 rows, no median carina. LVI. *Reteporidra.*

D. Zoarium a repeatedly branching frond, the branches rarely united by dissepiments (sometimes wanting).......... ‡‡‡.

‡‡‡ Branches flexuous and irregular.......... 11*.

11* Apertures angular.......... XLIX. *Drymotrypa.*

11* Apertures rounded.......... LIX. *Thamniscus.*

‡‡‡ Branches rigid, parallel and regular, sometimes absent.......... 12*.

12* Branches short, free, apertures in two rows with median keel. LXII. *Pinnatopora.*

12* Branches long, oblique, smaller than stipe, occasionally united by thin dissepiments.......... LXIII. *Ptilopora.*

12* Branches wanting.......... LXIV. *Diploporaria.*

D. Zoarium of more or less cylindrical branches, preserved generally as fragments. ‡‡‡‡.

‡‡‡‡ Branches in articulating segments or articulated basally.......... 13*.

13* Segments with one of several faces longitudinally striated and without apertures.......... LXV. *Arthrostylus.*

13* Segments celluliferous on all sides.......... 17.

17. Segments uniting by terminal articulation, ends often swollen. LXVI. *Helopora.*

17. Segments with terminal and lateral (pinnate) articulation, the segments commonly showing the articulating facet on the side. LXVII. *Arthroclema.*

17. Slender, articulating only at the pointed base, branching above. LXVIII. *Nematopora.*

‡‡‡‡ Branches not articulating.......... 14*.

14* Branch with one side striated and non-celluliferous, the other with two rows of pores.......... LXIV. *Diploporaria.*

14* Branches celluliferous on all sides.......... 18.

18. Branches solid.......... *p.*

p. Apertures in diagonally intersecting series.......... *gg.*

gg Without peristomes.......... *33.*

33. Frequently branching...... LXIX. *Rhombopora.*

33. Simple or rarely branching, pointed at base. LXXI. *Bactropora.*

gg. With peristomes.......... *44.*

44. Compressed, dichotomously dividing. XCVI. *Stictotrypa*

p. Apertures in longitudinal series.......... *hh*

hh. Cylindrical with pits between apertures. LXXII. *Streblotrypa.*

hh. Cylindrical without pits.......... *Orthopora.*

18. Branches hollow.......... *q.*

q. Apertures with depressed vestibules, interspace narrow. LXX. *Coeloconus.*

q. Apertures small, with elevated generally oblique peristomes. XCV. *Diamesopora*.

D. Zoarium bifoliate, an explanate frond.. 5‡.

5‡ Mesopores present, frond not articulated.................................. 15*.

15* Mesopores tabulated........... .... LXXIX. *Coscinella*.

15* Mesopores not tabulated........................ LXXVII. *Stictoporella*.

5‡ Mesopores absent.......... .... 16*.

16* Articulated basally, vestibules separated by thick walls. LXXV. *Clathropora*.

16* Not articulated, interzoœcial spaces with vesicular tissue. LXXXVI. *Coscinium*.

D. Zoarium bifoliate; not explanate... 6‡.

6‡ Zoarium jointed or articulated at least at the base .... 17*.

17* Apertures arranged in longitudinal series................................ 19.

19. Simple unbranched, lanceolate or falciform frond with basal articulation..... .... LXXIII. *Ptilodictya*.

19. Bushy, of numerous articulating equal segments spread in a plane.. LXXVI. *Arthropora*.

19. Segments from cylindrical root, two buds from truncated end of preceding .... LXXXVII. *Acrogenia*.

17* Apertures in decussating series surrounded by sloping hexagona. areas... LXXIV. *Escharopora*.

6‡ Zoarium not articulated.. 18*.

18* Mesopores present.. 20.

20. Mesopores tabulated.. *r*.

r. Zoarium ramose, compressed, divided dichotomously. LXXVIII. *Intrapora*.

20. Mesopores untabulated .... LXXVII. *Stictoporella*.

18* Mesopores absent .... 21.

21. Branches bifurcating, straight edged with parallel or sub-parallel margins................. .... *s*.

s. With well marked lunarium, nearest to the margin. LXXXIII. *Cystodictya*.

s. Without lunarium...........................LXXX. *Rhinidictya*.

s. Without lunarium, with maculæ.... LXXXII. *Pachydictya*.

s. With strong central ridge making section somewhat rhombic. LXXXV. *Taeniopora*.

21. Branches an irregular explanate frond.............................. *t*.

t. Apertures subelliptical; thin bifoliate expansions, surface with solid maculæ.................. LXXXIV. *Dichotrypa*.

t. Apertures semi-elliptical, with broad triangular space beneath each aperture.................. XCIII. *Worthenopora*.

t. Apertures with eight to ten vertical septa-like ridges. XCII. *Actinotrypa*.

t. Apertures oblique, with posterior edge lip-like. LXXXI. *Phyllodictya*.

D. Zoarium of prismatic branches triangular in cross-section............... .... 7‡.

7‡ Branches triangular, with faces crossed by transverse ridges. LXXXIX. *Scalaripora*.

7‡ Faccs of triangular branches without transverse ridges. LXXXVIII. *Prismopora*.

D. Zoarium not belonging to the foregoing .... 8‡.

8‡ Zoarium a thin expansion, traversed on both sides by salient ridges or crests united into cups .... XC. *Glyptopora.*

8‡ Zoarium free, of four or more vertical leaves radially arranged. XCI. *Evactinopora.*

8‡ Zoarium a subcircular unilaminar expansion with basal epitheca. XCIV. *Lichenalia.*

8‡ Zoarium a thin incrustation, with hexagonal or polygonal apertures. XCVII. *Paleschara.*

V. CHILOSTOMATA. Zoœcia of various forms arranged side by side with more or less anterior orifice of smaller diameter than zoœcium and closed by a movable cover, appearing often to occupy the whole surface of zoarium owing to non-calcification of the front wall and its removal in fossilization ....E.

E. Bifoliate, mostly free .... 9‡.

9‡ Apertures in longitudinal series, oval, and occupying most of the cell surface .... CIII. *Biflustra.*

9‡ Apertures semilunar or crescentic in a large hexagonal area. CIV. *Onychocella.*

E. Cells on one side only .... 10‡.

10‡ Cells with openings occupying the whole or nearly the whole of the exposed surface; encrusting.............................. CV. *Membranipora.*

10‡ Cells with opening only in anterior part; form bulbous or urn-shaped. 19*.

19* Aperture entire, with one or more supplementary pores. CVI. *Adeonellopsis.*

19* Apertures notched below, supplemental pores not present. CVII. *Schizoporella.*

PALÆOZOIC SPECIES.

Order CTENOSTOMATA Busk.

I. Rhopalonaria Ulrich.

Zoarium sunken for about half its mass into the object on which it grows (generally a coral, crinoid stem, or shell) and usually preserved only as threadlike excavations in the surface of this object, often filled with clay. Zoœcia unknown. Ordovicic–Mississippian.

1. **R. venosa** Ulrich. (Fig. 177, *a*.) Ordovicic.

Consists of delicate fusiform cells connected by slender stolons of the average length of the cells; branching irregular, pinnate or sometimes netlike. Fusiform cells average 0.3 mm. in length by 0.1 mm. or less in diameter. Excavated in corals, shells, etc.

Richmond beds of Ohio and Indiana.

2. **R. attenuata** U. and B. Siluric.

Fusiform cells shorter and farther apart than in preceding.

Niagaran beds of New York and Pennsylvania.

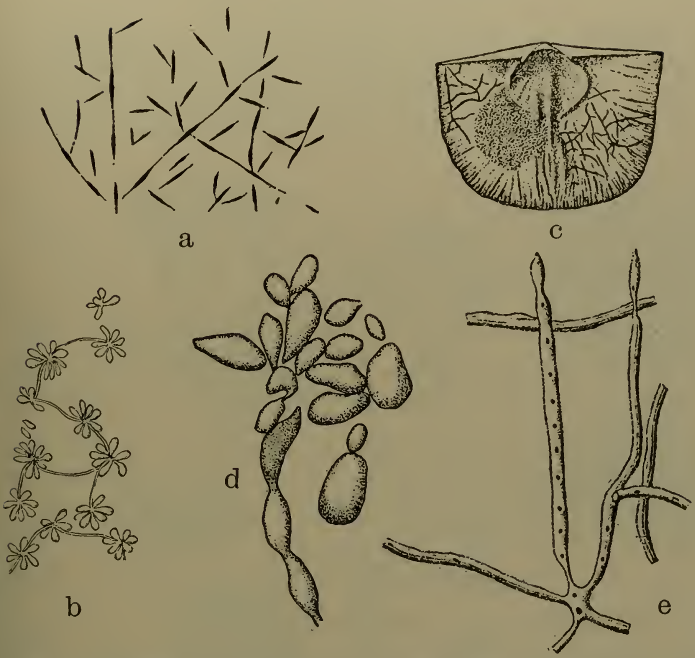


FIG. 177. *a*, *Rhopalonaria venosa* × 9; *b*, *Ascodictyon floreale* × 9; *c*, *Vinella repens* × 1; *d*, *Allonema fusiforme* × 9; *e*, *Vinella repens* × 18. (After Ulrich, and Ulrich and Bassler.)

3. **R. tenuis** U. and B. Devonic.

Like *R. venosus*, but fusiform cells narrower and longer, and connecting stolons shorter.

Hamilton beds of Western New York, Canada and Michigan.

II. ASCODICTYON Nicholson and Etheridge.

Attached to shells, etc., and consisting of ovate or pear-shaped vesicles in clusters or single, arranged along delicate hollow threads or stolons. Zoœcia unknown. Sil.–Miss.

4. **A. stellatum** N. and E. Mid-Devonic.

Ovoid or pear-shaped calcareous vesicles, generally in clusters of six or more (sometimes fewer) cells, averaging nearly 1 mm. in diameter, and connected by filamentous tubes.

Hamilton beds of Western New York and Ontario.

5. **A. floreale** U. and B. (Fig. 177, *b*.) Mid-Devonic.

About half the size of the preceding.

Hamilton of Michigan.

III. Vinella Ulrich.

Attached to shells, crinoid stems, etc., and consisting of very slender tubular stolons arranged in more or less distinct radial manner, each marked in perfect specimens by a single row of pores. Zooecia unknown.

6. **V. repens** Ulrich. (Fig. 177, *c*, *e*.) Ordovicic.
Radial arrangement imperfect. Stolons often bifurcating.
Black River formation of Minnesota.

IV. Allonema U. and B.

Attached, in form sausage-like strings of vesicles with minute punctate surfaces and a large pore toward one end. Sil.–Penn.?

7 **A. fusiforme** (Nich. and Eth.). (Fig. 177, *d*.) Mid-Devonic.
Fusiform, sometimes ovate cells, isolated or joining one another.
Hamilton of Ontario, Michigan and the Falls of the Ohio.

Order CYCLOSTOMATA Busk.

V. Stomatopora Brown.

Dichotomously branching colonies of attached subtubular or subpyriform zooecia, arranged typically in a linear series; apertures subterminal. Ord.–Dev.; Jur.–Recent.

8. **S. inflata** Hall. (Fig. 178, *a*.) Ordovicic.
Pear-shaped cells often forming crowded clusters.
Trenton and Cincinnati beds of New York, Canada, Minnesota, etc., and in the Cincinnati dome region.

9. **S. delicatula** (James). (Fig. 178, *b*.) Ordovicic.
Cells longer and more slender than preceding.
Stones River to Richmond beds of Ohio, Indiana, Kentucky, Tennessee, Illinois, Iowa and Minnesota.

VI. Proboscina Audouin.

Adhering, of several fused rows of cells, sometimes a sheet-like expansion. Zooecia tubular with subterminal apertures. Ord.–Dev.?; Jur.–Recent.

10. **P. frondosa** Nicholson. (Fig. 178, *c*.) Ordovicic.
Branches reuniting, with distant zooecial apertures slightly elevated.
Lorraine and Richmond beds of Ohio, Indiana, Kentucky, Illinois and Manitoba.

11. **P. tumulosa** Ulrich. (Fig. 178, *d.*) Ordovicic.

Narrow bifurcating branches, with a double (rarely triple) row of bulbous zoœcial swellings with apertures.

Black River of Minnesota.

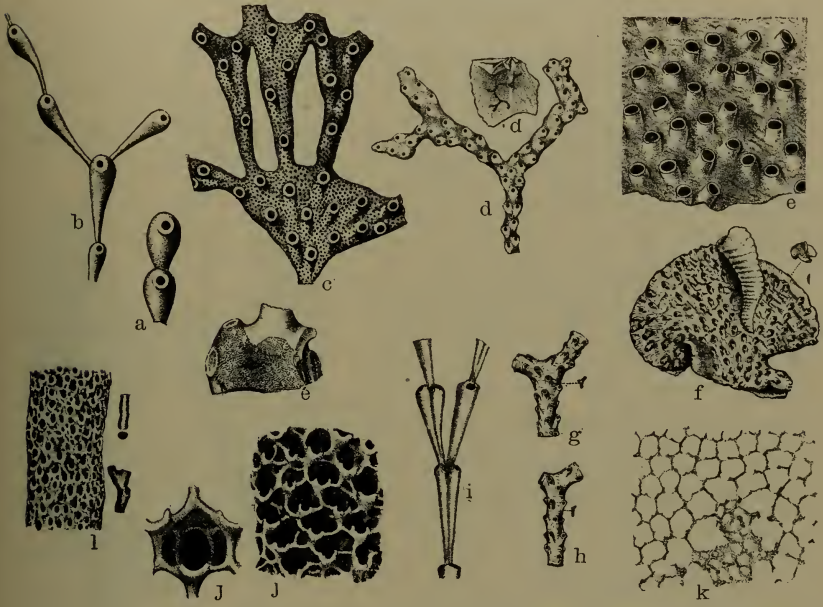


FIG. 178. *a, Stomatopora inflata* × 9; *b, S. delicatula* × 12½; *c, Proboscina frondosa* × 9; *d, P. tumulosa* × ½, and × 4½; *e, Berenicea minnesotensis* × ½ and × 9; *f, Diastoporina flabellata* × ½ and × 3½, with annelid tube attached; *g, h, Mitoclema mundulum* × ½ and × 4½; *i, Phacelopora pertenuis,* × 12½; *j, Ceramoporella inclusa* × 9, and × 20; *k, Crepipora simulans,* tangential section showing a macula and lunaria × 9; *l, Coeloclema trentonense* × ½ and × 4½. (All after Ulrich.)

VII. Berenicea Lamouroux.

Thin, discoid, flabellate or irregular incrustations with tubular zoœcia arranged in irregular, attenuating lines. Ord.–Silur.; Jur.–Recent.

12. **B. minnesotensis** Ulrich. (Fig. 178, *e.*) Ordovicic.

Zoœcia similar to *P. tumulosa,* arranged in irregular rows on a flabellate surface.

Stones River and Black River of Minnesota.

VIII. Diastoporina Ulrich.

Bifoliate zoaria with tubular zoœcia prostrate and partly sunken into the connecting mass. Ordovicic.

13. **D. flabellata** Ulrich. (Fig. 178, *f.*) Ordovicic.
Flabellate or fan-shaped expansion, minute with distant, tubular cells projecting obliquely.
Trenton of Minnesota.

IX. Hederella Hall.

Adhering zoaria with the tubular cells given off on alternate sides from central tubular axis. Devonic.

14. **H. canadensis** (Nicholson). (Fig. 179, *a*, *b.*) Devonic.
Profusely branching, with long, slender zoœcial tubes with oval apertures.
Hamilton group of New York, Ontario, Falls of the Ohio and Upper Canada; Onondaga of Ontario.

FIG. 179. *Hederella canadense*, *a* × 1, *b* × 12. (After Hall and Simpson.)

X. Hernodia Hall.

Similar to preceding, but later zoœcia budding from preceding ones. Devonic.

15. **H. humifusa** Hall. Devonic.
Cells 5 mm. long, gradually enlarging to aperture, which is about 1 mm. in diameter, budding about one third the distance below the aperture.
Hamilton of New York and Falls of the Ohio.

XI. Reptaria Rolle.

Like *Hederella*, but zoœcial tubes parallel and closely placed. Devonic.

16. **R. stolonifera** Rolle. (Fig. 180, *a*, *b.*) Devonic.
Tubes of equal length, slightly annulated, with the last cell terminal.
Hamilton of Western New York.

XII. Mitoclema Ulrich.

Minute, cylindrical, branching stems with zoœcia bending abruptly outwards and often projecting free. Ordovicic.

17. **M. mundulum** Ulrich. (Fig. 178, *g*, *h*.) Ordovicic.
Branches about half a millimeter in diameter, faintly striated transversely, and with the tube-like zoœcia projecting upward and outward in a spiral series.
Trenton of Minnesota.

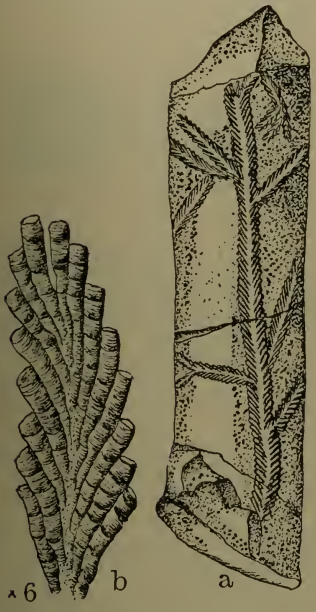


FIG. 180. *Reptaria stolonifera*: *a*, frond on Orthoceras × 1; *b*, portion enlarged × 6. (After Hall and Simpson.)

XIII. PHACELOPORA Ulrich.

Zoarium articulated; two or more conical zoœcia form cone-shaped bundles, with circular slightly contracted subterminal aperture. Ord.–Sil.

18. **P. pertenuis** Ulrich. (Fig. 178, *i*.) Ordovicic.
Minute, thread-like, the segments in linear series, frequently double, producing a dichotomous branching, and each comprising a pair of zoœcia, 0.6 to 0.8 mm. in length.
Richmond of Illinois.

XIV. CERAMOPORA Hall.

Discoidal zoaria free or attached by center of base; under surface with one or more layers of small irregular cells; zoœcia radiating from depressed center on upper surface, with oblique apertures imbricating, and short, irregular mesopores decreasing in number outward. Siluric.

19. **C. imbricata** Hall. (Fig. 181.) Siluric.
Depressed hemispheric, flattened or convex on lower side; apertures arched or triangular, opening on all sides toward outer margin, in alternate imbricating series.
Niagara of New York, Indiana, etc.

XV. CERAMOPORELLA Ulrich.

Zoarium of incrusting layers, often on other Bryozoa, with short, tubular, thin-walled zoœcia with oval oblique apertures, the lunarium forming a hood; abundant mesopores. Ordovicic.

20. **C. inclusa** Ulrich. (Fig. 178, *j*.) Ordovicic.

Thin incrustations with the oval zoœcial apertures occupying, each with three mesopores, the bottoms of subtriangular or rhomboidal obliquely depressed spaces; lunarium strongly elevated.

Stones River, Black River, and Trenton, of Minnesota.

21. **C. distincta** Ulrich. Ordovicic.

Apertures oblique, with overhanging hood, radially arranged about small maculæ and separated by a linear series of mesopores.

Utica and Lorraine of Cincinnati region.

FIG. 181. *Ceramopora imbricata* with enlargement of surface.

22. **C. ohioensis** (Nicholson). Ordovicic.

Cells in intersecting diagonal lines disposed around elevated clusters of larger zoœcia; few mesopores.

Common in the Utica, Lorraine, and Richmond groups of Ohio, Indiana, Kentucky, Tennessee, Illinois and Wisconsin.

XVI. CREPIPORA Ulrich.

Incrusting, lamellate massive, or hollow branches with long, tubular, thin-walled zoœcia, bearing diaphragms, and having angular or subpyriform apertures, the lunarium not overarching, its ends usually projecting; mesopores on elevated or depressed maculæ. Ordovicic.

23. **C. simulans** Ulrich. (Fig. 178, *k*.) Ordovicic.

Clusters of mesopores at intervals of three or four millimeters, with the zoœcial apertures surrounding concentrically and larger near the clusters; lunarium not prominent.

Trenton of Kentucky and Tennessee; Lorraine of Ohio, Indiana, Kentucky and Tennessee; Richmond, of Ohio, Indiana, Illinois, Wisconsin and Kentucky.

XVII. COELOCLEMA Ulrich.

Hollow branches lined internally with striated epithecæ; zoœcia as in *Ceramoporella*, but with thicker walls. Ordovicic.

24. **C. trentonense** (Ulrich). (Fig. 178, *l*.) Ordovicic.

Small apertures in depressed areas, with lunarium not prominent, and two or three mesopores to each zoœcium, regularly or irregularly arranged.

Trenton of New York, Canada and Minnesota.

XVIII. Anoloтichia Ulrich.

Ramose or digitate zoaria of subpolygonal tubes with remote diaphragms, lunarium elevated at surface, traversed by fine vertical tabulated tubes. Mesopores few. Ordovicic.

25. **A. impolita** (Ulrich). (Fig. 182, *a.*) Ordovicic.

Large, bushy, of frequently and irregularly divided solid branches; large, moderately thin-walled zoœcia, with hexagonal, subrhomboidal apertures, practically of uniform size and with well-developed lunarium.

Stones River of Minnesota; abundant and characteristic.

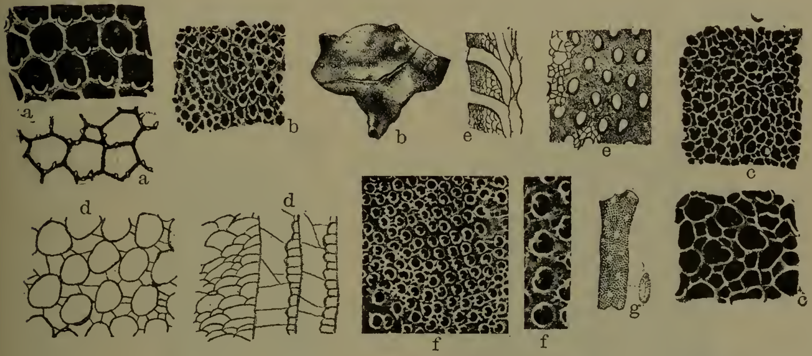


Fig. 182. *a, Anolotichia impolita*, surface and section, × 9; *b, Ceramophylla frondosa*, × ½ and surface, × 4½; *c, Bythotrypa laxata*, surface, ×4½ and × 9; *d, Fistulipora carbonaria*, tangential and longitudinal sections, × 9; *e, Chilotrypa hispida*, half of a vertical section with axial tube on right, and tangential section showing interstitial vesicles, × 9; *f, Buskopora dentata*, surface × 4½ and × 9; *g, Meekopora clausa* and section, × ½. (All after Ulrich.)

XIX. Ceramophylla Ulrich.

Like *Ceramoporella*, but erect and bifoliate, the two layers grown back to back. Ordovicic.

26. **C. frondosa** Ulrich. (Fig. 182, *b.*) Ordovicic.

Fronds 0.5 to 2.0 mm. in thickness; substellate maculæ of mesopores at intervals of about 3 mm.; oblique apertures with posterior margin well elevated, and 2 to 3 mesopores to each zoœcium.

Black River of Minnesota.

XX. Bythotrypa Ulrich.

Massy or lamellate, with long zoœcial tubes with thin diaphragms, subovate apertures and large lunaria. Numerous mesopores open to the surface and form internally a loose vesicular tissue. Ordovicic.

27. **B. laxata** Ulrich. (Fig. 182, *c.*) Ordovicic.

Massy, originally attached, with basal epitheca; subovate apertures with broad, sharply elevated lunarium; numerous mesopores which at intervals form clusters (in weathered specimens) from which zoœcia radiate. Interior irregularly and loosely arranged; walls of granular structure.

Stones River to Trenton of Minnesota, Iowa and Illinois.

XXI. Fistulipora McCoy.

Form various, the under surface with wrinkled epitheca; cylindrical or somewhat compressed zoœcial tubes with few diaphragms,

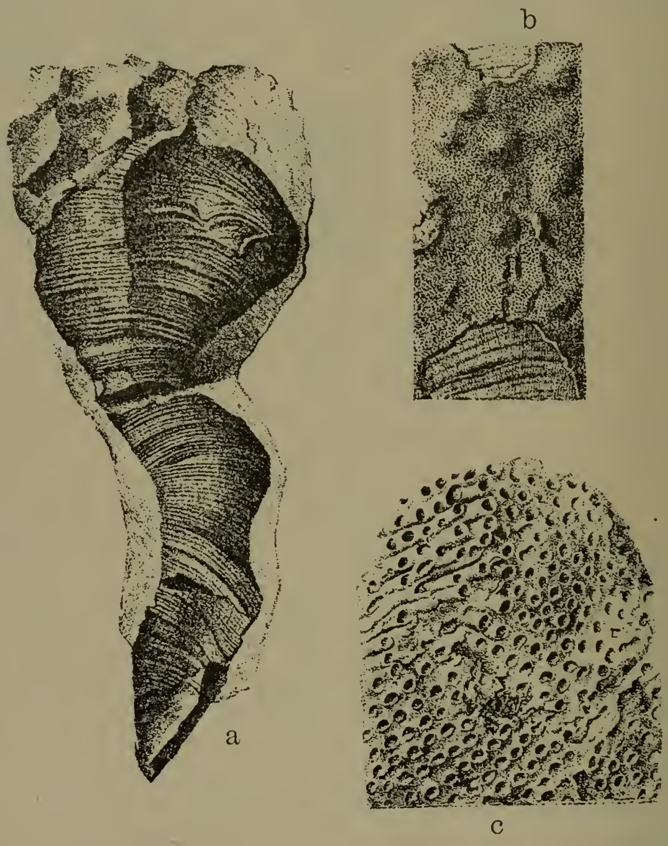


Fig. 183. *Fistulipora torta; a*, epithecal side, × 1; *b*, celluliferous side, × 1; *c*, enlargement of part of *b*. (After Hall.)

surrounded by vesicles; apertures subradially arranged about the maculæ, with more or less strongly developed lunarium, and separated by smooth or granular interspaces. Siluric to Carbonic.

28. **F. neglecta** Rominger. Siluric.

Irregular expansion; base with concentrically wrinkled epitheca; surface with irregularly scattered, smooth maculæ, from which the circular to oval oblique apertures radiate irregularly. Generally adheres by celluliferous face. (Generally identified as *Lichenalia concentrica.*)

Niagara of Indiana, Kentucky, etc.

29. **F. torta** (Hall). (*Lichenalia torta* Hall). (Fig. 183, *a–c.*) Lower Devonic.

Lamellate expansions, flat or involved and contorted, epitheca finely striated radially on under side, and sharply on upper (when cells are removed), nodose at junction, with concentric striæ; apertures circular or oval to trilobate, posterior margin strongly elevated and separated by interspaces of equal size with the apertures.

Helderbergian (Coeymans) of New York, etc.

30. **F. carbonaria** Ulrich. (Fig. 182, *d.*) Carbonic.

Irregularly lamellate or submassy, diameter several inches, thickness half an inch or a little more. Apertures oval or circular, with thin, inconspicuous peristome, with a single row of angular mesopores which at intervals form substellate maculæ.

Upper Coal Measures of Missouri, Kansas, etc.

XXII. Chilotrypa Ulrich.

Small, ramose, with narrow, irregularly contracting and expanding axial tube; oblique elliptical apertures, the lower margin thick and elevated; diaphragms few or none. Sil.–Miss.

31. **C. hispida** Ulrich. (Fig. 182, *e.*) Mississippian.

Zoœcia in regular obliquely intersecting series, 8 or 9 in the space of an inch; small maculæ, surrounded by somewhat larger cells; lip decreasing from posterior end forward; interspaces dense above, vesicular lower down.

Chester of Illinois and Kentucky.

32. **C. ostiolata** (Hall). (Fig. 184, *a*, 184, *b.*) Siluric.

Irregularly branching cylindric stems, gradually tapering toward the extremities, which are obtuse; apertures about their extremity apart, arranged in spirally ascending lines or irregularly; strong peristomes; interapertural spaces smooth; stems solid or encrusting crinoids.

Rochester shales of New York and Ontario.

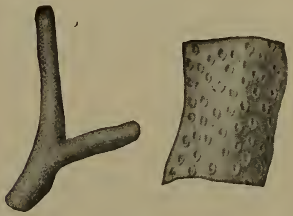


FIG. 184, *a*. *Chilotrypa ostiolata*, branch natural size and enlargement.

FIG. 184, *b*. *Chilotrypa ostiolata;* enlarged.

XXIII. BUSKOPORA Ulrich.

Like Fistulipora, but with pronounced lunarium projecting as bidenticulate process nearly half across aperture. Devonic.

33. **B. dentata** Ulrich. (Fig. 182, *f*.) Devonic.

Incrusting or free expansions, with concentrically wrinkled epitheca on lower side; apertures in regular diagonally intersecting lines; slightly elevated maculæ with smooth centers, at intervals of 5 mm.

Hamilton of Falls of the Ohio.

XXIV. MEEKOPORA Ulrich.

Bifoliate (two layers growing back to back), zoœcial tubes gently curving outward, opening obliquely, distally pointed, and with numerous diaphragms. Convex elevations or ovicells with small apical opening occur at intervals. Silur.–Carb.

34. **M. clausa** (Ulrich). (Fig. 182, *g*.) Carbonic.

Compressed branches, surface with substellate maculæ, between which the zoœcia are uniformly distributed in very regular oblique series; interapertural space flat or slightly concave, usually smooth or minutely pitted or granular, vesiculose in lower part.

Chester of Illinois and Kentucky.

XXV. Botryllopora Nicholson.

Disk-shaped, often coalescing, attached bodies, the apertures in two rows on elevated radiating ridges, increasing by bifurcation or implantation towards margin. No lunaria. Devonic.

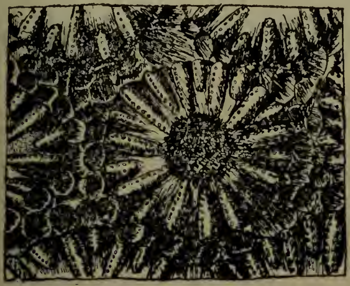


Fig. 185. *Botryllopora socialis*, portion of a colony much enlarged. (After Hall and Simpson.)

35. **B. socialis** Nicholson. (Fig. 185.) Devonic.

Alternate ridges extend to the central area, others one-half to two thirds that distance; apertures minute, often in contact or inosculating.

Hamilton of Western New York, Ontario, Michigan, and the Falls of the Ohio.

Order TREPOSTOMATA Ulrich.

XXVI. Monticulipora d'Orbigny.

Form various, of prismatic zoœcia with cystiphragms and polygonal apertures; monticules and acanthopores occur; mesopores few or wanting; zoœcial apertures polygonal; cystiphragms in mature region. Ord.–?Dev.

36. **M. mammulata** d' Orb. Ordovicic.

Irregularly lobate or palmate, with prominent conical or sometimes elongated monticules; cells of monticules of about same size as others.

Lorraine of the Cincinnati region and Kentucky.

37. **M. arborea** Ulrich. (Fig. 186, *a.*) Ordovicic.

Subcylindrical branches, monticules low or absent, apertures with minutely granular walls bearing acanthopores. No mesopores.

Trenton of Minnesota, Iowa, and Kentucky.

XXVII. Atactoporella Ulrich.

Generally encrusting; apertures petaloid, mesopores numerous, frequently isolating the zoœcia; acanthopores very numerous. Ordovicic.

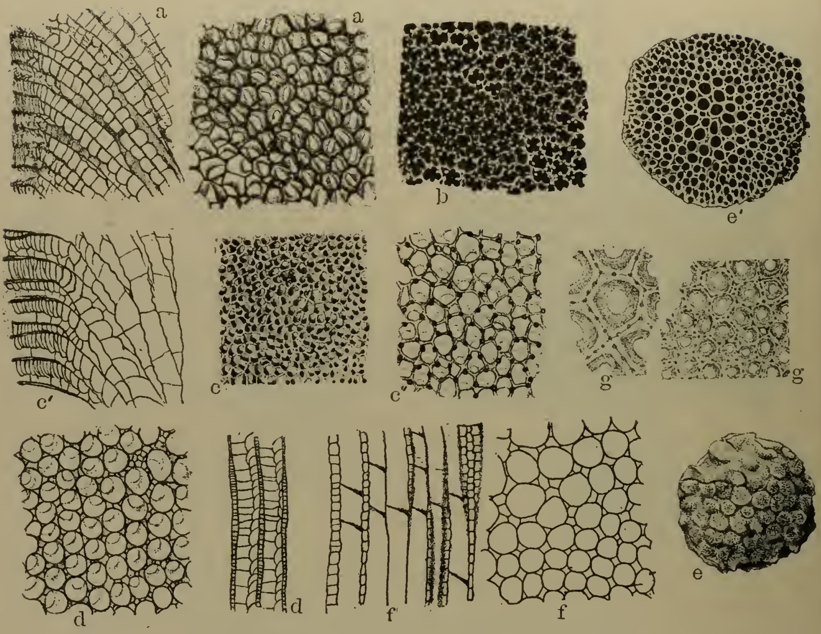


FIG. 186. *a*, *Monticulipora arborea*, peripheral part of vertical sect. and tangential sect. × 9 ; *b*, *Atactoporella typicalis* var. *praecipta*, surface × 9 ; *c*, *Homotrypa subramosa*, surface × 4½, *c''* × 9 and *c'* half of vertical sect. × 9 ; *d*, *Prasopora simulatrix*, tangential and vertical sections × 9 ; *e*, *Aspidopora elegantula*, entire head × ½ ; *e'*, part of surface × 4½ ; *f*, *Mesotrypa quebecensis*, vertical and tangential sections × 9, *g*, *Amplexopora cingulata*, tangential sections × 9 and × 20. (All after Ulrich.)

38. **A. typicalis** Ulrich. (Fig. 186, *b*.) Ordovicic.

Thin crusts on other bryozoans, groups of larger cells at unequal intervals, sometimes on monticules ; cells very regular.

Utica of Kentucky and Ohio. A closely related variety (var. præcipta Ulrich) occurs in the Black River of Minnesota.

XXVIII. HOMOTRYPA Ulrich.

Frondescent or ramose, the surface showing monticules or maculæ of larger cells ; zoœcia with very thin or finely crenulated walls, remote diaphragms in immature and cystiphragms in mature region, and apertures often oblique. Mesopores and acanthopores present, the former few and in clusters. Ord.–Sil.

39. **H. subramosa** Ulrich. (Fig. 186, *c*.) Ordovicic.

Irregularly branching ; monticules low and ill-defined ; axial region tabulated.

Black River of Minnesota.

40. **H. obliqua** Ulrich. Ordovicic.

Flattened branches with well-developed monticules as in *Monticulipora*, from which it is readily distinguished by the larger cells of the monticules.

Lorraine of Cincinnati region.

41. **H. curvata** Ulrich. Ordovicic.

Differs from preceding in absence of monticules, and occurrence of stellar maculæ of minute cells, but appearing smooth, and surrounded by larger cells than average.

Lorraine of the Cincinnati region.

42. **H. flabellaris** Ulrich. Ordovicic.

Growth fan-shaped, surface with obscure maculæ with centers about 4 mm. apart; walls of tubes very thin, appearing flexuous or crenulated in section, with few remote diaphragms in zoœcia, but many in mesopores.

Lorraine and Richmond of Illinois, Ohio, Indiana, Kentucky and Tennessee. Common.

43. **H. minnesotensis** Ulrich. Ordovicic.

Subcylindrical branches from 5 to 15 mm. in diameter, generally dividing dichotomously; clusters of larger cells conspicuous in one variety, raised on monticules, about 25 mm. between centers; true mesopores wanting, acanthopores exceedingly small and few; apertures oblique.

Stones River and Black River of Minnesota, Iowa, Kentucky. and Tennessee.

XXIX. Prasopora Nicholson and Etheridge.

Massy, usually free, with wrinkled epitheca on under side; zoœcia prismatic or cylindrical, thin-walled, with cystiphragms, and generally surrounded by angular mesopores with crowded diaphragms; acanthopores rarely numerous or strong. Ordovicic.

44. **P. simulatrix** Ulrich. (Fig. 186, *d.*) Ordovicic.

Discoidal to hemispheric or subconic, base concave; clusters of larger cells with more numerous mesopores at intervals of about 4 mm., sometimes on monticules; an average of 11 cells in 3 mm.

Black River and Trenton of Kentucky, Tennessee, Wisconsin, and Minnesota.

45. **P. lycoperdon** (Hall). Ordovicic.

Differs from preceding in absence of monticules and in large irregular clusters of closely tabulated mesopores, an average of 9 cells in 3 mm., both cells and mesopores being somewhat larger than in preceding species. (The original description is applicable to so many species, which have gone by this name, that many authors have discarded it altogether.)

Trenton of New York, Canada, etc.

XXX. Aspidopora Ulrich.

Zoarium expanded or of superimposed layers, with a basal epitheca; zooecia decreasing in size outward from center, without diaphragms and few cystiphragms; mesopores numerous, with close diaphragms; acanthopores small or absent. Differs from the preceding mainly in small size and thinness of expansion.

46. **A. elegantula** (Ulrich). (Fig. 186, *e*.) Ordovicic.

Surface with large clusters of large cells at intervals of 3 or 4 mm., generally elevated; mesopores between all zooecia; cystiphragms practically or quite wanting.

Trenton of Minnesota.

47. **A. newberryi** (Nicholson). Ordovicic.

Differs from preceding in absence of elevations and in greater abundance of cystiphragms, which occur in each zooecium.

Utica beds of the Cincinnati region.

XXXI. Mesotrypa Ulrich.

Like *Prasopora*, but flatter, and with oblique or funnel-shaped diaphragms, and zooecia separated by angular mesopores with numerous diaphragms; acanthopores sometimes large. Ord.-Sil.

48. **M. quebecensis** (Ami). (Fig. 186, *f*.) Ordovicic.

Varying in height from 4 to 20 mm., and in diameter from 12 to 45 mm. Normal zooecia 11 or 12 in 3 mm., those of the clusters 0.4 to 0.45 mm. in diameter; oblique diaphragms in zones; acanthopores wanting.

Trenton of Quebec, Vermont, New York, Kentucky and Iowa.

XXXII. Amplexopora Ulrich.

Ramose, discoidal or massy, with prismatic zooecia with diaphragms; acanthopores variable. Ordovicic.

49. **A. cingulata** Ulrich. (Fig. 186, *g*.) Ordovicic.
Ramose, of cylindrical or subcylindrical branches dividing dichotomously; no monticules; apertures subpolygonal, a moderately thin wall studded with granules between them; groups of cells of larger size; no mesopores.
Lorraine of Kentucky and the Cincinnati, O., region.

XXXIII. Monotrypella Ulrich.

Like *Amplexopora*, but distinguished by the absence of acanthopores. Ord.–Dev.

50. **M. (Rhombotrypa) quadrata** (Rominger). Ordovicic.
Irregularly cylindrical branches, from 4.5 to 10.5 mm. thick, the tubes rhombic in section, arranged in curved diagonal lines. No mesopores or monticules.
Richmond beds of Ohio, Indiana, Illinois, Wisconsin and Manitoba. Common and characteristic.

51. **M.? arbuscula** (Hall). (Fig. 187.) Siluric.
Fruticose, several slender (2–3 mm.) stems from a single base; bifurcation frequent; cell tubes very gradually diverging to surface.
A characteristic fossil of the Manlius limestone of New York.

Fig. 187. *Monotrypella ? arbuscula.*

XXXIV. Petalotrypa Ulrich.

Irregular, compressed, bifoliate branches or fronds, with prismatic zoœcia arising from strongly flexuous mesotheca, with polygonal apertures. Devonic.

52. **P. compressa** Ulrich. (Fig. 190, *a*.) Devonic.
Smooth, with scarcely appreciable clusters of slightly larger and somewhat more separated cells; zoœcia subpolygonal to hexa-

gonal; mesopores irregular, scattered, sometimes in clusters; height 2 mm. or more; width 1 cm. or less; thickness 1 to 4 mm.
Hamilton of Iowa and Illinois.

XXXV. Dekayella Ulrich.

Ramose, zoœcia with numerous diaphragms, large and small acanthopores, and a variable number of mesopores. Ordovicic.

53. **D. praenuntia** Ulrich. (Figs. 188, *b*, 190, *b*.) Ordovicic.

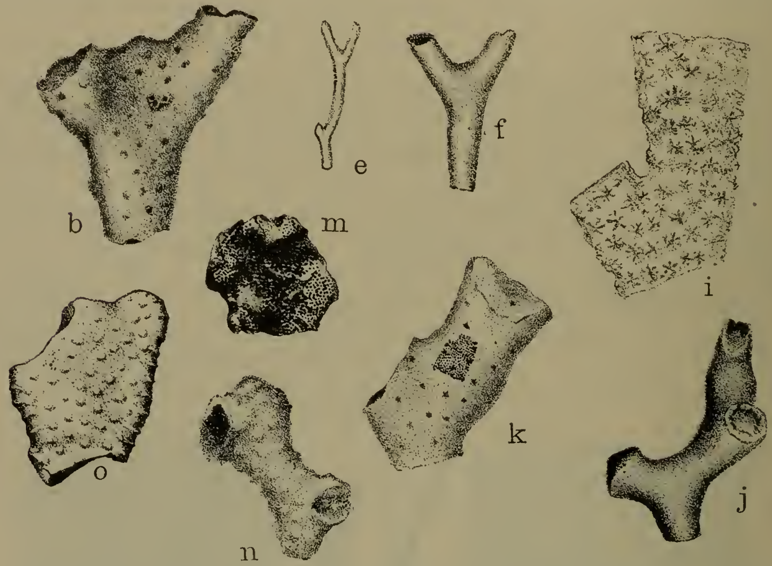


FIG. 188. *b*, *Dekayella praenuntia* var. *echinata*; *e*, *Bythopora herricki*; *f*, *Eridotrypa mutabilis*; *i*, *Constellaria florida*; *j*, *Batostoma winchelli*; *k*, *B. fertile*; *m*, *Stromatotrypa ovata*; *n*, *Callopora multitabulata*; *o*, *Nicholsonella pulchra*, broad form. All natural size. For further illustrations see Fig. 190, corresponding letters. (All after Ulrich.)

Compressed cylindrical, from 4 to 12 mm. in diameter; no monticules, but inconspicuous clusters of large cells; few, irregularly disposed mesopores and acanthopores.
Black River of Minnesota.

54. **D. obscura** Ulrich. Ordovicic.
Small, slender stems, variously branching; monticules obscure.
Utica of the Cincinnati region.

55. **D. ulrichi** (Nicholson). Ordovicic.
Coarse, subcylindrical branching stems, three or more times the diameter of preceding; low monticules of smaller cells (meso-

pores) regularly disposed, and surrounded by cells somewhat above the average in size.

Utica beds of the Cincinnati region. A common fossil.

XXXVI. Dekayia E. and H.

Subcylindrical or flattened stems growing from large base; one set of acanthopores and few or no mesopores and diaphragms. Otherwise like preceding. Ord.–?Dev.

56. **D. aspera** E. and H. (Fig. 190, *c.*) Ordovicic.

General form and aspect like *Dekayella ulrichi*, from which it differs in generic characters.

Lorraine of the Cincinnati region.

XXXVII. Batostomella Ulrich.

Slender branches, with thick-walled zœcia, few diaphragms, and small circular or oval apertures with rounded or canaliculate interspaces; numerous small acanthopores, and mesopores, the latter with subcircular openings. Sil.–Perm.

57. **B. granulifera** (Hall). Siluric.

Oval to elongate apertures margined by wavy, raised, granulose lines, double between cells.

Rochester shale of New York, etc.; common. Waldron, Ind.

58. **B. spinulosa** (Ulrich). (Fig. 190, *d.*) Mississippian.

Subcircular or oval apertures, surface hirsute in well preserved specimens, from abundance of acanthopores.

Chester of Kentucky and Illinois.

XXXVIII. Bythopora Miller and Dyer.

Usually slender branches, zoœcia practically without diaphragms, and with oblique apertures, canaliculate interspaces, few mesopores and comparatively strong acanthopores, rarely more than one to each zoœcium. Ord.–Dev.

59. **B. delicatula** (Nicholson). Ordovicic.

Like *Bythopora spinulosa*, but without the spines.

Richmond beds of Ohio, Indiana, Ontario and Manitoba.

60. **B. herricki** Ulrich. (Figs. 188, *e*, 190, *e.*) Ordovicic.

Similar to preceding, but with apertures long drawn out anteriorly and narrower.

Black River of Minnesota.

61. **B. spinulosa** (Hall). (Fig. 189.) Siluric.

Oval apertures on cylindrical branches with strong spines at regular intervals.

Rochester shales of New York, etc.

XXXIX. Eridotrypa Ulrich.

Of slender branches with more or less oblique thick-walled zoœcia with diaphragms which may be absent in the axial and apertural regions. Mesopores with close-set diaphragms, acanthopores small and scarce, or wanting. Ord.–Dev.

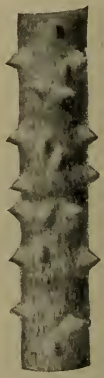


Fig. 189. *Bythopora spinulosa*, enlarged.

62. **E. mutabilis** Ulrich. (Fig. 188, *f*, 190, *f*.) Ordovicic.

Slender, branching, cylindrical stems averaging 3.5 to 4.5 mm. in diameter. Apertures very oblique, especially in young specimens. Small maculæ commonly present in older stems. Axial portion of tubes with diaphragms distant about twice their diameter.

Trenton of Minnesota, Iowa, Wisconsin, Kentucky, Tennessee, Ohio and Canada.

63. **E. similis** Bassler. Siluric.

Zoarium apparently free, consisting of a pointed basal portion growing upward into branching stems.

Niagara (Rochester) of Western New York and Ontario.

XL. Stenopora Lonsdale.

Form varying from ramose to laminar or encrusting, with or without monticules, and with wall of the zoœcia periodically thickened in the mature region; diaphragms perforated centrally; few, irregularly distributed mesopores and large acanthopores. Miss.–Mid Carb.

64. **S. carbonaria** (Worthen). (Fig. 190, *g*.) Carbonic.

Subcylindrical branches 10 to 15 mm. in diameter; surface smooth, no cell clusters; apertures angular to subcircular, frequently thick-walled, with numerous acanthopores and few mesopores.

Coal measures of Illinois, Kansas and Ohio.

XLI. Constellaria Dana.

Erect, flattened branches or fronds from an attached basal expansion; surface with depressed stellate maculæ, the spaces between rays elevated and bearing two or three short rows of closely

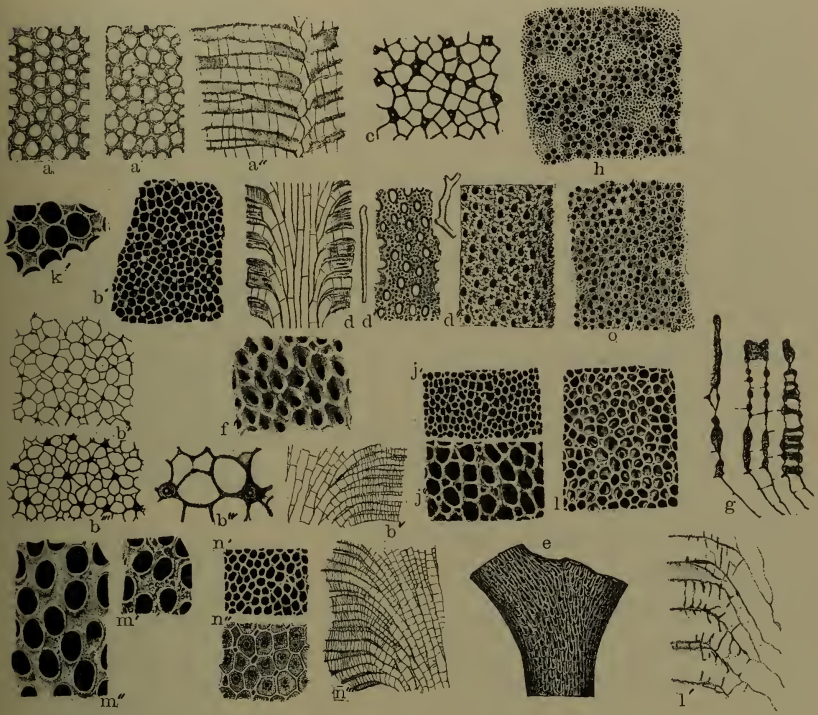


FIG. 190. *a*, *Petalotrypa compressa*, tangential sections with few, and with many mesopores, *a''*, vertical section, × 9; *b*, *Dekayella praenuntia*, *b'*, var. *echinata*, surface × 4½; *b''*, var. *multipora*, thin-walled, small acanthopores, × 9; *b'''*, same, thick-walled, large acanthopores, × 9; *b*^{iv}, same, × 25; *b*^{v}, same, vertical section, × 9; *c*, *Dekayia aspera*, tangential section, × 9; *d*, *Batostomella spinulosa*, × ½, and vertical section, tangential section and surface, × 9; *e*, *Bythopora herricki*, × 4½; *f*; *Eridotrypa mutabilis*, surface, × 4½; *g*, *Stenopora carbonaria*, vertical section, × 9, *h*, *Constellaria varia*, surface, × 4½; *j*, *Batostoma winchelli*, surface, × 4½ and × 9 *k*, *B. fertile*, *var. circulare*, surface, × 9; *l*, *Hemiphragma tenuimurale*, surface with incomplete diaphragms, × 4½; *l'*, part of vertical section, × 9; *m*, *Stromatotrypa ovata*, surfaces of two different layers (*m'* and *m''*), × 9; *n*, *Callopora multitabulata*; *n'*, surface, × 4½; *n''*, surface showing zoœcial covers, × 9; *n'''*, vertical section, × 9; *o*, *Nicholsonella pulchra*, surface × 4½. (All after Ulrich.)

approximated apertures; mesopores aggregated into maculæ with crowded diaphragms. Ordovicic.

65. **C. varia** Ulrich. (Fig. 190, *h.*) Ordovicic.

Flattened branches with large, irregularly stellate maculæ very slightly depressed; zoœcial apertures in clusters of from 4 to 10 each, slightly or not at all elevated; apertures subcircular.

Trenton of Minnesota, Canada and Tennessee.

66. **C. florida** Ulrich. (Fig. 188, *i.*) Ordovicic.

Flattened branches covered with crowded "stars," the rays sharp, petaloid and strongly elevated.

Lorraine of Cincinnati, Ohio, Indiana, Kentucky and Tennessee. Common.

XLII. Nicholsonella Ulrich.

Laminar expansions, sometimes giving off flattened intertwining branches or fronds; interzoœcial spaces wide, with numerous mesopores, having thicker and more numerous diaphragms than zoœcial tubes, but obliterated with age by filling of secondary calcareous deposit. Ord.–Sil.

67. **N. vaupeli** Ulrich. Ordovicic.

Flattened, inosculating expansions with evenly distributed, low monticules of larger pores than ordinary, with center free from pores.

Lorraine of Cincinnati region.

68. **N. pulchra** Ulrich. (Fig. 188, *o*, 190, *o'*.) Ordovicic.

Irregular, flattened branches, monticules faint and often indefinite; interzoœcial space papillose.

Stones River of Tennessee.

XLIII. Batostoma Ulrich.

Irregular branches from large basal expansion; zoœcia thin-walled in immature and thick in mature region, ring-like in section, with diaphragms; mesopores irregular; acanthopores large. Ordovicic.

69. **B. winchelli** Ulrich. (Fig. 188, *j*, 190, *j.*) Ordovicic.

Subcylindrical or slightly compressed branches 4 to 10 mm. in diameter, with rounded or subangular zoœcial apertures with ridge-like walls bearing acanthopores. Mesopores few.

Black River of Minnesota.

70. **B. fertile** Ulrich. (188, *k*, 190, *k.*) Ordovicic.

Large, of coarse, compressed branches, with round or polygonal apertures and often few mesopores. Clusters of larger zoœcia enclose a stellate macula scattered over surface.

Stones River of Minnesota.

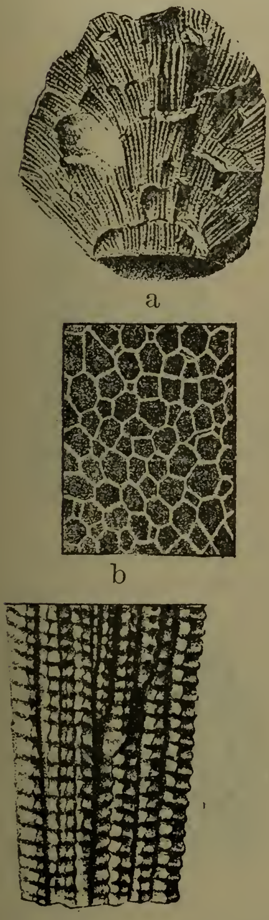


FIG. 191. *Monotrypa tabulata.* *a*, fragment, ×1; *b*, tangential section, ×6, *c*, enlargement of a group of tubes showing corrugations. (After Hall.)

71. **B. (Hemiphragma) tenuimurale** Ulrich. (Fig. 190, *l*.) Ordovicic.

Cylindrical or compressed stems with thin-walled polygonal apertures, without acanthopores and few mesopores; diaphragms in peripheral region incomplete.

Galena of Minnesota.

72. **B. (Hemiphragma) whitfieldi** (James). Ordovicic.

Like preceding, but more robust, and with crinkled walls, readily seen on broken surface

Utica horizon of the region about Cincinnati.

XLIV. STROMATOTRYPA Ulrich.

Encrusting, with short zoœcia, oval in cross section and with few diaphragms. Walls thin, with periodically constricted tubuli, one or more to each zoœcium. Oval apertures with minutely papillose peristomes, separated by depressed interspaces. Closely tabulate mesopores, rarely showing on surface. Ordovicic.

73. **S. ovata** Ulrich. (Fig. 188, *m*, 190, *m'*.) Ordovicic.

Encrusting shells or other Bryozoa, rarely free; without monticules, but with smooth areas of more widely separated apertures.

Stones River and Black River of Minnesota and Wisconsin.

XLV. MONOTRYPA Nicholson.

Massy hemispheric or discoidal, zoœcia comparatively large prismatic, with thin and often crinkled walls throughout; diaphragms remote; no mesopores or acanthopores; mature and immature regions indistinguishable. Ord.–Sil.

74. **M. tabulata** (Hall). (Fig. 191, *a–c.*) Lower Devonic.

Spheroidal or hemispheric; tubes polygonal, with thin and strongly corrugated walls, the corrugations forming nodes at the angles.

Helderberg (Coeymans and Port Ewen) of New York, etc.

75. **M. ? amplectens** Grabau. (Fig. 192 *a–d.*) Devonic.

Encrusting brachiopod shells, generally large Spirifers on which species of Aulopora have grown. The openings of the Aulopora

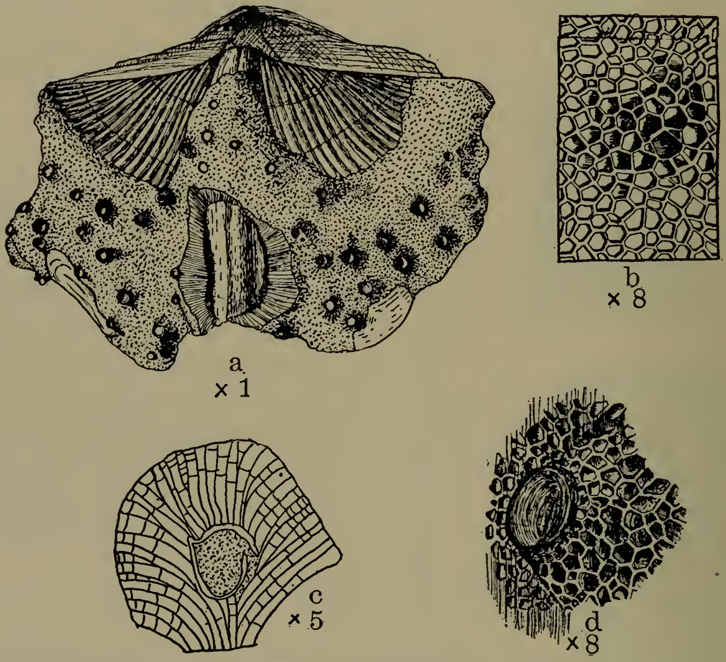


FIG. 192. *Monotrypa amplectens.* *a*, encrusting *Spirifer* shell to which are attached tubes of *Aulopora*, × 1; *b*, surface, × 8; *c*, vertical section enclosing *Aulopora*, × 5; *d*, surface surrounding mouth of *Aulopora*, × 8.

tubes are scattered among the apertures of the bryozoan, similar to the "Caunopora" type of Stromatoporoids. Sometimes on other corals.

Surface with monticules of larger apertures at regular intervals; apertures angular; walls finely striated; diaphragms remote in older, more closely set in outer part of tube.

Hamilton of Western New York and Michigan.

XLVI. Trematopora Hall.

Zoarium ramose; surface smooth or with monticules; zoœcia thin walled, the contact lines of walls of adjoining zoœcia distinct; diaphragms few, in the proximal end of zoœcia; apertures circular or oval with a more or less well-marked peristome; interspaces solid; mesopores irregularly angular, often obscurely moniliform, with diaphragms at the constricted parts; acanthopores of medium or small size usually present.

Fig. 193. *Trematopora tuberculosa* with enlargement of surface.

76. **T. tuberculosa** (Hall). (Fig. 193.) Siluric.

Irregularly ramose and stout branches; tuberculous monticules; tubular cells with oval apertures and thin elevated calicle or margin which is spinulose (bearing acanthopores); interapertural spaces solid, but separate below.

Rochester shales of New York.

XLVII. Callopora Hall.

Branching, and frequently anastomosing into bushy clumps, with prismatic zoœcia which later become, in most cases, cylindrical, and have their apertures operculated; diaphragms closely set except in central part of tube, and crowded in the angular mesopores. Ord.–Sil.

77. **C. multitabulata** (Ulrich). (Fig. 188, *n*, 190, *n*.) Ordovicic.

With strongly elevated monticules, few mesopores and numerous diaphragms.

Black River and Trenton of Kentucky, Tennessee, Minnesota, Canada, etc.

78. **C. ramosa** (d' Orbigny). (Fig. 194, 1.) Ordovicic.

Forming large clusters of stout, irregular, cylindrical stems, with strong, sharp monticules subregularly arranged, rarely uniting into ridges.

Common in the Lorraine of the Cincinnati region.

79. **C. dalei** (E. and H.) (Fig. 194, 3.) Ordovicic.

Branches more slender than preceding and with less prominent monticules, which sometimes unite into ridges, as in the next species.

Lorraine beds of the Cincinnati region.

80. **C. rugosa** (E. and H.) (Fig. 194, 2.) Ordovicic.

Of the type of *C. ramosa*, but the monticules united into prominent transverse ridges with zoœcial apertures.

Lorraine beds of the Cincinnati region.

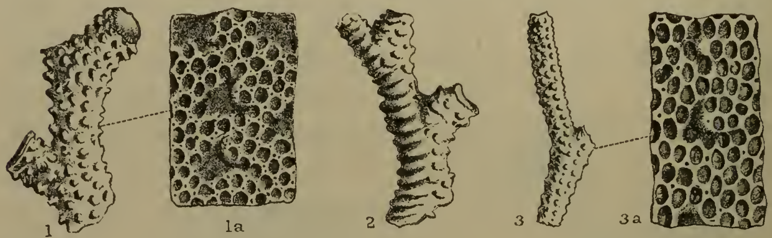


Fig. 194. 1, *Callopora ramosa*, × 1; 1*a*, enlargement of surface; 2, *C. rugosa*, × 1; 3, *C. dalei*, × 1; 3*a*, surface enlarged. (After Nicholson.)

81. **C. elegantula** Hall. (Fig. 195, *a–b*.) Siluric.

Branches solid, extremities often hollow or cup-like, apertures circular, the opercula with central perforation and radiating ridges.

Niagara of New York, Ontario, Indiana, Illinois, etc.

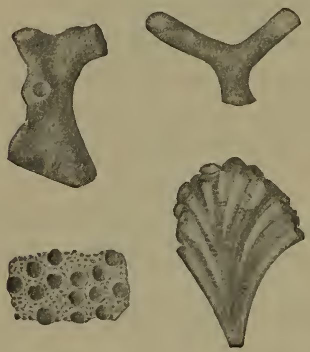


Fig. 195, *a*. *Callopora elegantula* with enlargements of surface and individual tubes.

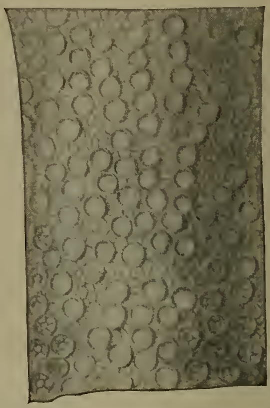


Fig. 195, *b*. *Callopora elegantula*, a fragment much enlarged.

Order CRYPTOSTOMATA Vine.

XLVIII. Phylloporina Ulrich.

Irregularly anastomosing branches, with two to eight rows of apertures on one side, the other longitudinally striated; tabulated interspaces, closed at the surface, generally present; acanthopores often present. Ord.–Sil.

82. **P. reticulata** (Hall). (Fig. 201, *a*.) Ordovicic.

Generally as fragments of depressed, funnel-shaped zoarium with rounded branches 0.2 to 0.3 mm. in diameter, frequently and regularly inosculating; fenestrules about as wide as branches; three

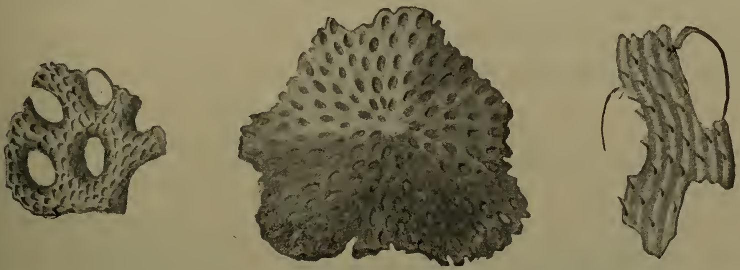


Fig. 196. *Phylloporina asperato-striata* with enlargement of celluliferous and non-celluliferous faces, the latter showing the asperate-striate character.

irregular rows of zoœcia with subcircular apertures and numerous acanthopores; reverse side finely striated.

Black River and Trenton of New York, Vermont, Minnesota and Canada.

83. **P. asperato-striata** (Hall). (Fig. 196.) Siluric.

Oval, somewhat unequal fenestrules; outer face roughly striated, inner with three, four or more rows of subangular cells in obliquely parallel lines.

Rochester shale of New York, Canada, etc.

Fig. 197. *Drymotrypa diffusa* with celluliferous sides enlarged.

XLIX. Drymotrypa Ulrich.

Dichotomously and frequently branching, longitudinally striate on one side, and on the other with several ranges of tubular zoœcia springing from a thin double plate; vestibules expanding from orifices to angular apertures. Ord.–Sil.

84. **D. diffusa** (Hall). (Fig. 197.) Siluric.

Several stems originate from a common base, forming a shrubby frond; stems frequently bifurcate and spread laterally; apertures quadrangular or subrhomboidal.

Rochester shale of New York.

L. Fenestella Lonsdale.

Fan or funnel-shaped reticulated expansion of straight or flexuous rigid branches, apertures united by non-celluliferous cross-bars or dissepiments at regular intervals; two rows of apertures on the inside of branches, separated by a plain or tuberculated median keel. Ord.–Carb.

85. **F. elegans** Hall. (Fig. 198.) Siluric.

Carina subdued, apertures with longer diameter oblique to direction of branches, which are slender and frequently bifurcating, and are united by thin dissepiments; fenestrules on non-celluliferous side oblong-quadrangular, rarely oval.

Niagara of New York, Canada, etc.

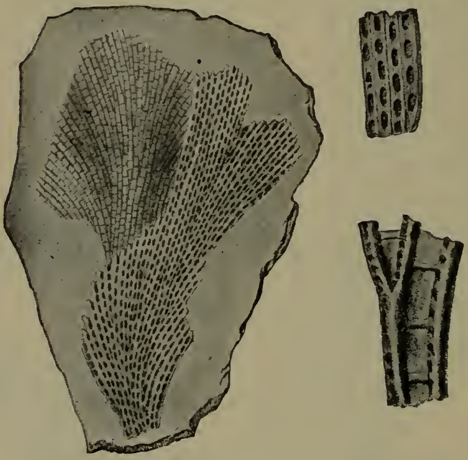


Fig. 198. *Fenestella elegans* with enlargements.

86. **F. crebripora** Hall. Lower Devonic.

Fenestrules wider than branches which are connected by dissepiments, slightly enlarging at contact; keel faint; non-celluliferous side finely striated.

Helderbergian of Eastern New York, etc.

87. **F. emaciata** Hall. (FIG. 199.) Mid-Devonic.
Large funnel-shaped; dissepiments thin and oblique; keel prominent; apertures closely and regularly disposed.
Hamilton of New York.

88. **F. cestriensis** Ulrich. (FIG. 201, *c.*) Mississippian.
Branches irregularly dividing, slightly flexuose; carina angular; apertures circular, with peristomes; reverse side rounded, smooth exept for scattered nodes.
Chester of Mississippi Valley, Kentucky, etc.

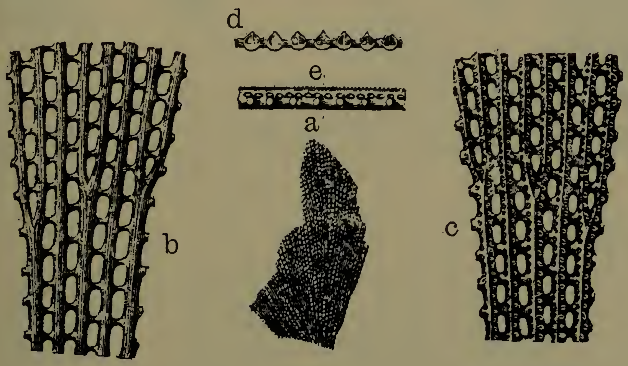


FIG. 199. *Fenestella emaciata.* *a*, fragment of frond (reduced); *b*, non-celluliferous face showing striated branches and oblique dissepiments, $\times 4$; *c*, celluliferous face, $\times 4$; *d*, transverse section of branches, $\times 4$; *e*, lateral view of branches, showing position of apertures, $\times 4$. (After Hall.)

89. **F. tenax** Ulrich. (FIG. 201, *b.*) Mississippian.
Fenestrules narrower than branches; dissepiments moderately thick; no nodes, but faint striations on reverse side; apertures circular, with peristomes.
Chester of Mississippi Valley and Kentucky; Waverly of Ohio.

LI. SEMICOSCINIUM Prout.

Funnel-shaped, all openings on outer side, wide, short dissepiments, the branches appearing to anastomose on non-poriferous face, whose fenestrules are subrhomboidal or rounded; apertures in two rows; median keel very high, expanded at the summit. Sil.–Dev.

90. **S. tenuiceps** (Hall). (FIG. 200.) Siluric.
Carina sharp and thin; transverse dissepiments do not extend as high as the branches, sometimes scarcely visible; apertures

large, round, opening laterally; fenestrules oval on non celluliferous side, which is striated, but appears granular when worn.

Rochester shale of New York, Canada, etc.

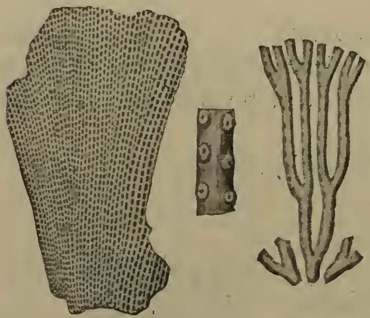


FIG. 200, *a*. *Semicoscinium tenuiceps*. Clinton; with enlargements.

FIG. 200, *b*. *Semicoscinium tenuiceps*. Niagara; enlargements of celluliferous and non-celluliferous faces.

91. **S. planodorsatum** Ulrich. (FIG. 201, *d*.) Devonic.

Fenestrules very small; carina prominent, with circular apertures; reverse side flat, with irregularly oval to circular fenestrules, showing no evidence of branching.

Hamilton of Falls of the Ohio.

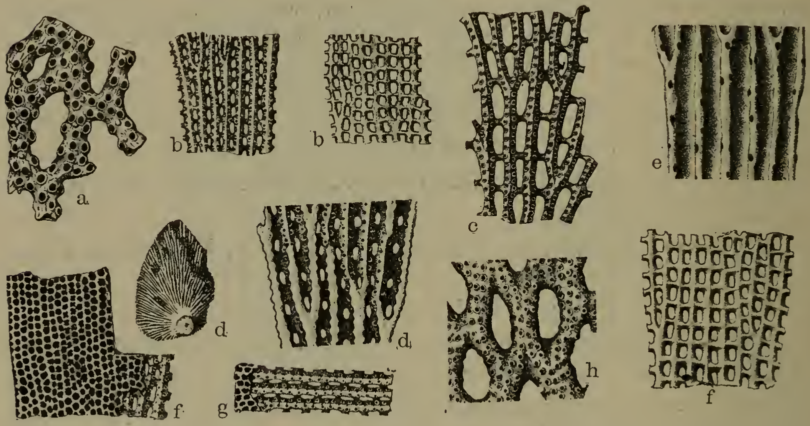


FIG. 201. *a*, *Phylloporina reticulata*, × 9; *b*, *Fenestella tenax*, obverse and reverse faces, × 4½; *c*, *F. cestriensis*, obverse face, × 4½; *d*, *Semicoscinium planodorsatum*, obverse side, × ½ and × 4½; *e*, *Fenestrapora occidentalis* obverse, × 4½; *f*, *Hemitrypa proutana*, non celluliferous and celluliferous faces, the latter with part of superficial network, × 4½; *g*, var. *nodulosa*, × 4½; *h*, *Reteporidra perundata*, obverse face, × 4½. (After Ulrich.)

LII. Fenestrapora Hall.

Differs from *Semicoscinium* in the reverse of the zoarium and the expanded summits of the carinæ being furnished with large scattered pores or pits. Devonic.

92. **F. occidentalis** Ulrich. (Fig. 201, *e*.) Devonic.

Fenestrules oval; carina angular and expanded; the irregularly disposed pits on the side, rather few in number; frond rather coarse.

Hamilton of Iowa.

LIII. Unitrypa Hall.

Differs from *Fenestella* in having the prominent carinæ thickened above and connected by thin, oblique, subimbricating plates (scalæ) varying from two to each fenestrule to the number of zoœcia. Sil.–Dev.

93. **U. scalaris** Hall. (Fig. 202, *a–g*.) Devonic.

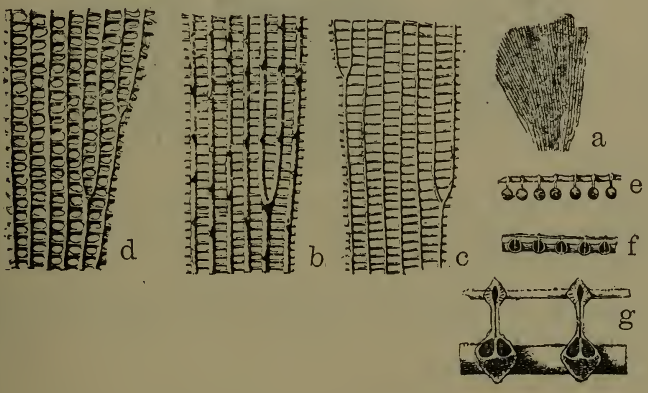


Fig. 202. *Unitrypa scalaris*. *a*, fragment of carinæ and scalæ; *b*, summits of carinæ and scalæ, showing nodes on former, × 4; *c*, fragment showing thin carinæ and scalæ, × 4; *d*, fragment showing under side of carinæ and scalæ, × 4; *e*, *f*, transverse sections of different fronds, × 4; *g*, transverse section much enlarged to show rhomboidal sections of branches, with dissepiment connecting them, the thin expanding carinæ connected by scalæ. (After Hall.)

Branches straight, parallel and rigid, the carinæ and scalæ making a ladder-like structure, the carinæ projecting above the very oblique scalæ.

Hamilton of New York and Ontario.

94. **U. acaulis** Hall. Devonic.

Scalæ very slender and closely disposed; summit of carina very prominent, sometimes noded. Length and width of fenestrules on celluliferous face as 3 to 1; on non-celluliferous, as 2 to 1.

Hamilton of Falls of the Ohio.

LIV. Loculipora Hall.

Funnel-shaped, dissepiments non-poriferous, reduced to a minimum, carinated like the branches; the carinæ coalesce and expand at the summits, their width usually equalling that of branches and dissepiments. Sil.–Dev.

95. **L. perforata** (Hall). (Fig. 203.) Devonic.

Frond regularly reticulated, the fenestrules oval in a depressed hexagonal surface, and each surrounded by nine or ten apertures.

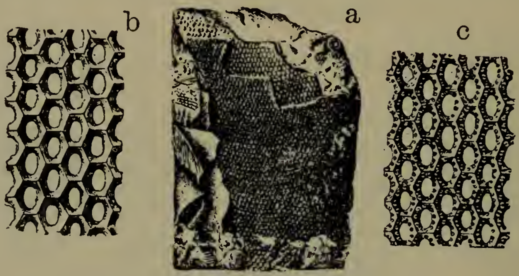


Fig. 203. *Loculipora perforata.* *a*, fragment showing manner of growth; *b*, non-celluliferous face, showing angular slightly carinated branches and dissepiments, $\times 4$; *c*, celluliferous face, $\times 4$. (After Hall.)

The expansion of the carina may make this face appear like the non-poriferous face.

Hamilton of New York.

LV. Hemitrypa Phillips.

Differs from *Fenestella* in a reticulated superstructure, whose meshes correspond in position and numbers to the zoœcial apertures, and rest on pillars which rise at regular intervals from the moderate median keel of the branches. Sil.–Carb.

96. **H. proutana** Ulrich. (Fig. 201, *f*, *g*.) Mississippian.

Superficial network of longitudinal bars, united by short transverse bars, the former strong over the branches and weaker over the interspaces of the underlying frond, the latter alternating in position on opposite sides of each weaker longitudinal bar. The underlying branches have each a low carina with circular pores with peristomes, on either side, and are connected by depressed dissepiments half as wide as the branches.

Keokuk of Illinois and Iowa ; Warsaw of Illinois and Missouri ; St. Louis of Kentucky.

LVI. Reteporidra Nickles and Bassler.

Flabellate or undulating expansion with thickened margins, the sinuous or zigzag non-carinate branches anastomosing at short and regular intervals, producing a regular series of oval fenestrules ; apertures in three to seven rows, non-celluliferous side not striated.

97. **R. perundata** (Hall). (Fig. 201, *h*.) Mid-Devonic.

Fenestrules oval, irregular, non-celluliferous face angular or carinated, celluliferous rounded ; cell apertures in from three to five ranges.

Hamilton of Western New York, etc.

LVII. Archimedes Owen.

Like *Fenestella*, but spirally wound and supported by a solid calcareous central axis, which is often the only part remaining intact.

98. **A. communis** Ulrich. (Fig. 205, *b'*.) Mississippian.

Central axis or "screw" long, slender (1 to 2 mm. in diameter) and uniformly coiled, 7 or 8 volutions in 20 mm., the fenestrated portion forming an angle of from 85 to 90 degrees with axis. (*A. intermedius* Ulrich makes an angle of 72 degrees and has somewhat fewer whorls. *A. swallowanus* varies from 2.8 to 6.7 mm. in diameter, and has an average of 5 volutions to 20 mm., the angle of divergence of the fenestrated portion being 85 degrees. *A. proutanus* Ulrich has from 5 to 7 volutions in 20 mm., and an angle of 65 degrees for the fenestrated part. It is somewhat thinner than *A. communis*.)

Chester of Kentucky and Illinois.

99. **A. wortheni** (Hall). (Fig. 205, *a*.) Mississippian.

Screw large and coarse (5 to 10 mm. in diameter), volutions either right- or left-handed, from 5 to 6 in 50 mm., fenestrated portion diverging at an angle of about 65 degrees. Zoœcia separated by strong spinose carina.

Warsaw of Illinois.

100. **A. laxus** Hall. Mississippian.

Very loosely coiled, axis formed of thickened edge of frond, one volution in 25 mm. or more; angle of fenestrated portion acute.

Chester of Illinois and Kentucky.

101. **A. sublaxus.** (Fig. 205, *b*.) Mississippian.

About half the size of the preceding.

Chester of Illinois.

102. **A. terebriformis** Ulrich. Mississippian.

Differs from *A. communis* in being more slender, with from 3 to 4 volutions in 20 mm. In coiling resembles *A. laxus*. Angle of divergence 60 to 65 degrees.

Chester of Illinois and Kentucky.

LVIII. Polypora McCoy.

Differs from *Fenestella* in having from two to eight rows of zoœcia on a branch, and the median keel reduced to a row of strong nodes or tubercles, or absent altogether. Sil.–Carb.

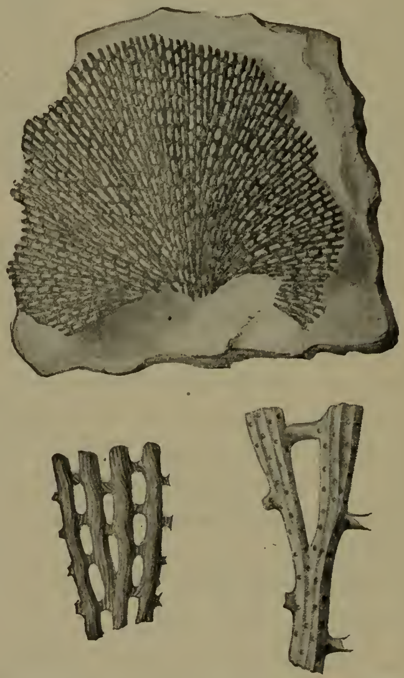


Fig. 204. *Polypora incepta* with non-celluliferous and celluliferous faces enlarged.

103. **P. incepta** Hall. (Fig. 204.) Siluric.

Branches regularly dividing with flexuous striæ on the non-celluliferous side, and several strong ridges separating the three or four rows of oval and alternating apertures, on the celluliferous side; dissepiments thin, scarcely thickened at junction with branches.

Rochester shale of New York and Canada.

104. **P. fistulata** (Hall). Mid-Devonic.

Two to three rows of apertures with strong peristomes; fenestrules oval, dissepiments expanding at the ends.

Hamilton of New York and Ontario.

105. **P. shumardi** Prout. (*P. cultellata* Hall). Mid-Devonic.

Strong branches united by their dissepiments, forming narrow fenestrules on celluliferous side, where branches are marked by sharp nodes, and have from three to seven ranges of apertures; reversed side with broad oval fenestrules, and a faint keel or nodes, or smooth.

Hamilton of Falls of the Ohio.

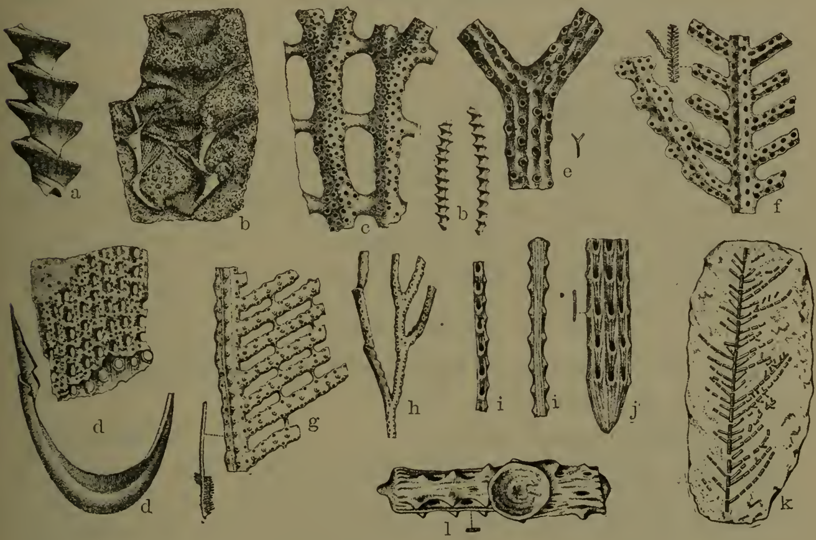


FIG. 205. *a, Archimedes wortheni*, ×½; *b, A. sublaxus*, showing fenestrated portions, × ½; *b′, A communis*, two specimens, × ½; *c, Polypora submarginata*, obverse face, ×4½; *d, Lyropora quinconcialis*, poriferous face, ×4½, *d′*, obverse side of basal support, × ½; *e, Thamniscus furcillatus*, obverse face, × ½ and × 9; *f, Pinnatopora conferta*, × ½ and × 4½; *g, Ptilopora cylindracea*, obverse face, × ½ and × 4½; *h, Diploporaria bifurcata*, × 4½; *i, Arthrostylus obliquus*, lateral and non-celluliferous aspect, × 9; *j, Helopora spiniformis*, × ½ and × 9; *k, Arthroclema billingsi*, frond, × ½; l, *A. armatum*, segment of primary series with articulating socket, × ½ and × 9. (After Ulrich.)

106. **P. submarginata** Meek. (Fig. 205, *c*.) Carbonic.
Branches convex with a row of spines or tubercles, and five ranges of apertures; five or six apertures to a fenestrule, the latter irregular, elongate oval; dissepiments thin.
Upper Coal Measures of Nebraska, Iowa and Illinois.

LIX. Thamniscus King.

Branches like those of Polypora, but bifurcating more freely and rarely or not at all connected by dissepiments. Sil.–Carb.

107. **T. furcillatus** Ulrich. (Fig. 205, *e*.) Mississippian.
Branches small, with three to four ranges of apertures, with continuous or discontinuous low ridges between.
A characteristic species of the Chester group of Illinois and Kentucky.

LX. Lyropora Hall.

Flabellate, the fenestrated portion spread between the arms of a non-poriferons U- or V-shaped calcareous support, which is free or pedunculate at the base; zoœcia in from two to five ranges; no median keel. Miss.

108. **L. quincuncialis** (Hall). (Fig. 205, *d*.) Mississippian.
U-shaped support narrow oval in cross section; fenestrules irregularly oval; two or three ranges of apertures; stout dissepiments, which, on the non-celluliferous side, are often stronger than the branches, forming transverse ridges.
Chester of Illinois and Kentucky.

LXI. Fenestralia Prout.

Differs from Fenestella in having four rows of apertures, two on each side of prominent keel. Miss.

109. **F. sancti-ludovici** Prout. Mississippian.
Branches with strong central carinæ dilated into tubercles at intervals; fenestrules oblong, subquadrangular; two ranges of apertures on each side of carina; dissepiments about two-thirds the width of the branches.
Warsaw and St. Louis of Missouri and Illinois.

LXII. Pinnatopora Vine.

Small, delicate stipe, and short, free lateral branches given off at regular, intervals; apertures in two rows on one face only, separated by a moderate median keel. (Glauconome of authors.) Dev.–Carb.

110. **P. carinata** (Hall.) (*Glauconome carinata* Hall.) (Fig. 206.)
Devonic.

Small, with broad central rachis, and alternating thin, short lateral branches; non-celluliferous face with three prominent carinæ; apertures circular, with comparatively strong peristomes and prominent carinæ between the ranges.

Hamilton of Western New York, etc.

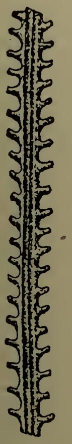


FIG. 206. *Pinnatopora carinata* × 6. (After Hall and Simpson.)

111. **P. conferta** Ulrich. (Fig. 205, *f*.)
Mississippian.

Central rachis, and branches more nearly of the same width; branches nearly opposite close-set; two ranges of close-set pores on rachis and branches, separated by low ridges.

Keokuk of Iowa and Illinois.

LXIII. PTILOPORA McCoy.

Differs from the preceding in having the stipe much stronger than the oblique lateral branches, which are occasionally and irregularly united by dissepiments. Dev.–Miss.

112. **P. striata** Hall. Devonic.

Branches rigid, diverging at angles of 45 degrees, and separated by a space twice their width; dissepiments thin, irregular; apertures in two ranges.

Hamilton of Western New York and Ontario.

113. **P. cylindracea** Ulrich. (Fig. 205, *g*.) Mississippian.

Differs from the preceding in having a row of hollow nodes and a median ridge on the rachis, and a similar row without the ridge on the branches, and very thin, depressed, regular dissepiments.

Keokuk of Iowa and Kentucky.

LXIV. DIPLOPORARIA Nickles and Bassler.

Like *Pinnatopora*, but without the lateral branchlets. Miss.–Coal Meas.

114. **D. bifurcata** (Ulrich.) (Fig. 205, *h*.) Mississippian.

Small, cylindrical stipes (0.3 mm. in diameter) bifurcating at regular intervals; apertures in two ranges on sides of stipe; reverse of branches finely striated.

Chester of Illinois, etc.

LXV. Arthrostylus Ulrich.

Bushy, dichotomously divided branches which consist of numerous, exceedingly slender, equal subquadrate segments, united by terminal articulations; one face longitudinally striated, the other three (sometimes less) with a linear series of apertures generally between longitudinal ridges. Ord.

115. **A. obliquus** Ulrich. (Fig. 205, *i*.) Ordovicic.

Segments needle-shaped, about 4 mm. long; subquadrangular in section (0.2 × 0.15 mm.) slightly expanding to extremity; apertures oblique, lower border prominent; no ridges between ranges.

Stones River of Minnesota.

LXVI. Helopora Hall.

Differs from preceding in its larger segments, which have zoœcial apertures on all sides. Ord.–Sil.

116. **H. spiniformis** (Ulrich). (Fig. 205, *j*.) Ordovicic.

Segments 5 to 10 mm. in length, obtusely pointed at the ends; apertures oblique on all sides, in from 8 to 16 longitudinal ranges, and separated by slightly elevated lines.

Stones River of Tennessee and Illinois.

117. **H. fragilis** Hall. (Fig. 207.) Siluric.

Swollen at one end, apertures oval or subangular, having a spiral direction around the stipe; length 5–6 mm.

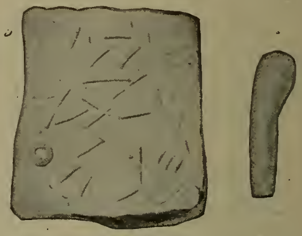


Fig. 207. *Helopora fragilis*, natural size and enlarged.

Clinton and Niagara of New York and Ontario.

LXVII. Arthroclema Billings.

Segments celluliferous on all sides, articulated laterally and terminally in a pinnate manner; apertures oval in series between longitudinal ridges. Ord.

118. **A. armatum** Ulrich. (Fig. 205, *l*.) . Ordovicic.

Of three sets of joints, secondary and tertiary more slender than primary which have sharply-defined articulating sockets, and small apertures in six ranges with strong spines near each; secondary segments with apertures in five or six ranges between strong ridges, and with lower lip spiniform.

Trenton of Minnesota, etc.

119. **A. billingsi** Ulrich. (Fig. 205, *k*.) Ordovicic.

Primary segments 3.5 to 4 mm. long, each with two secondary segments (4 mm. long) upon each side (4 in all), the succeeding ones 2 mm. long; apertures subquadrate, 6 in 2 mm.

Trenton of Canada.

LXVIII. Nematopora Ulrich.

Slender, ramose, with pointed basal extremity, not jointed; subtubular zoœcia arranged radially around one or two minute axial tubes, with oval or subcircular apertures, and peristomes generally in linear series between longitudinal ridges. Ord.–Dev.

120. **N. ovalis** Ulrich. (Fig. 208, *a*.) Ordovicic.

Bifurcating at intervals of 2 mm., diameter 0.3 to 0.4 mm.; large oval apertures, peristomes connected by short ridges, in four or five ranges.

Trenton of New York, Canada, and Minnesota.

LXIX. Rhombopora Meek.

Slender, non-articulate, and solid branches; apertures in longitudinally or diagonally intersecting series; rhombic or diagonal vestibules, in the region of which the zoœcia are thick walled; acanthopores sometimes of two types, large and small. Sil.–Carb.

121. **R. tenuirama** Ulrich. (Fig. 208, *b*.) Mississippian.

Branches 0.4 to 0.5 mm. in diameter; apertures oval, between slightly flexuous longitudinal ridges, carrying both large and small spines.

Chester of Illinois and Kentucky.

122. **R. lepidodendroides** Meek. Carbonic.

Average diameter of branches 1.75 mm., largest 3 mm.; zoœcia in regular quincunx order, oval, with rhombic vestibules, margined by a single or double row of spiniform tubuli, with a large spine at the angle.

Coal Measures of Nebraska, Kansas, Missouri, Iowa, Illinois, and Ohio. Rather common.

LXX. Cœloconus Ulrich.

Simple hollow expansions from an attenuated striated base; zoœcia short, with well developed hemisepta, and apertures in diagonally intersecting series. Miss.

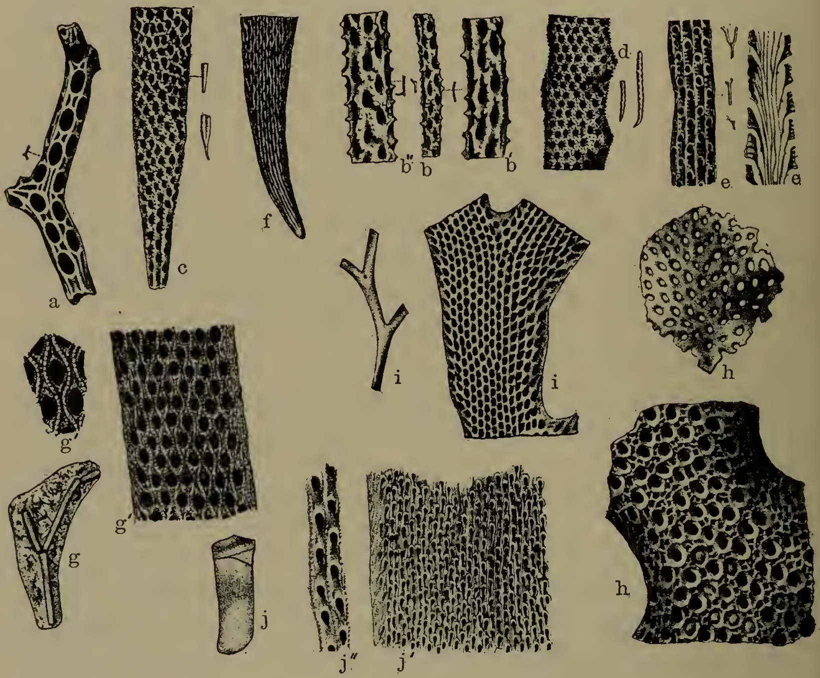


Fig. 208. *a*, *Nematopora ovalis*, × ½ and × 9; *b*, *Rhombopora tenuirama*, × ½ and × 6 and 12 (*b′*, *b″*); *c*, *Coeloconus granosus*, × ½ and × 6; *d*, *Bactropora simplex*, × ½ and × 6; *e*, *Streblotrypa nicklesi*, × ½ and surface and section, × 9; *f*, *Escharopora subrecta*, basal portion, × 4½; *g*, *Arthropora simplex*, × ½, and surface × 9, and × 18; *h*, *Stictoporella cribrosa*, × ½, and portion × 9; *i*, *Rhinidictya mutabilis*, × ½ and × 4½; *j*, *Phyllodictya varia*, × ½ (*j*), surface × 4½ (*j′*), and portion × 9 (*j″*). (All after Ulrich.)

123. **C. granosus** Ulrich. (Fig. 208, *c*.) Mississippian.

Lined on inside with thick epitheca; apertures oval to subcircular, the interspaces with granules; basal portion with vertical granulose ridges between the oval apertures.

Chester of Illinois.

LXXI. BACTROPORA Hall.

Like Rhombopora, but simple or only slightly branched, and with lower extremity pointed. Dev.–Miss.

124. **B. simplex** Ulrich. (Fig. 208, *d*.) Mississippian.
Surface with transversely elongated monticules, appearing often like annulations; apertures oval to subcircular; narrow interspaces with a single or double row of small acanthopores; average size 1.5 mm. in diameter by 18 mm. in length.
Keokuk of Iowa, Illinois, and Missouri.

LXXII. STREBLOTRYPA Ulrich.

Ramose, slender, and solid, frequently bifurcating, with long tubular zoœcia diverging from the center, with hemisepta (inferior one best developed) and regularly elliptical apertures with peristomes usually arranged in longitudinal series; one to fifteen small pits below the apertures, and occasionally very small acanthopores.

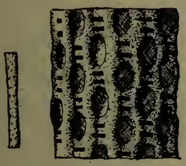


FIG. 209. *Streblotrypa hamiltonensis*, × 1, and × 18. (After Hall and Simpson).

125. **S. hamiltonensis** (Nicholson). (Fig. 209.) Devonic.
Apertures between prominent wavy longitudinal ridges, alternating in position in adjoining ranges, and having two angular pits between the apertures of each row.
Hamilton of Western New York and Ontario.

126. **S. nicklesi** Ulrich. (Fig. 208, *e*.) Mississippian.
Apertures small, between three straight longitudinal ridges, alternating; peristomes strongest anteriorly; interspaces with from nine to fifteen small pores in two or three rows.
Chester of Illinois and Kentucky.

LXXIII. PTILODICTYA Lonsdale.

Simple, unbranched, lanceolate or falciform frond, articulating, with small basal expansion, and having zoœcia on both sides except the margin; zoœcia narrow oblong-quadrate and arranged longitudinally in the young and with additional variously formed zoœcia added in the adult; walls of vestibules thick, solid, and with a double row of minute dots. Ord.–Dev.

127. **P. nebulosa** (Hall). Lower Devonic.

A thin, leaf-like expansion from a thickened, narrow, striated base; rows of cells increase rapidly by intercalation; rounded monticules, separated by about 3 mm. from each other, mark the surface.

Helderbergian of New York, etc.

LXXIV. Escharopora Hall.

Like *Ptilodictya*, but with the apertures in decussating series, and surrounded by sloping hexagonal areas. Ord.

128. **E. falciformis** (Nicholson). Ordovicic.

Falciform, narrow and long, apertures rhombic to oval, in diagonal curved series.

Lorraine of the Cincinnati region and Tennessee.

129. **E. subrecta** (Ulrich). (Fig. 208, *f*.) Ordovicic.

Elongate narrow, straight or curved, flattened and tapering below; apertures oval, between regularly wavy ridges, which regularly approach and diverge; adult portion with a few mesopores, as in *Streblotrypa*.

Black River of Minnesota, Iowa and Wisconsin.

130. **E. pavonia** (d'Orbigny). Ordovicic.

Expanded, more or less irregular; apertures oval to subcircular, with hexagonal vestibules and low, obscure monticules of slightly larger cells; arrangement of cells in curved lines as in *E. falciformis*.

Lorraine beds of the Cincinnati region and Tennessee.

LXXV. Clathropora Hall.

Anastomosing branches forming regular network with round or oval fenestrules and pointed articulating base, apertures on both sides usually subquadrate, arranged longitudinally. Sil.–Dev.

131. **C. frondosa** Hall. (Fig. 210.) Siluric.

Flabellate or funnel-shaped fronds; apertures rhomboidal or oblong quadrangular, opening obliquely upward.

Clinton of Ohio; Niagara of Western New York and Ontario.

LXXVI. Arthropora Ulrich.

Bushy, of numerous articulating equal segments spread in a plane; apertures on both sides, elliptical, surrounded by delicate peristomes, and with interspaces marked by variously disposed thread-like ridges and a row of minute papillæ. Ord.

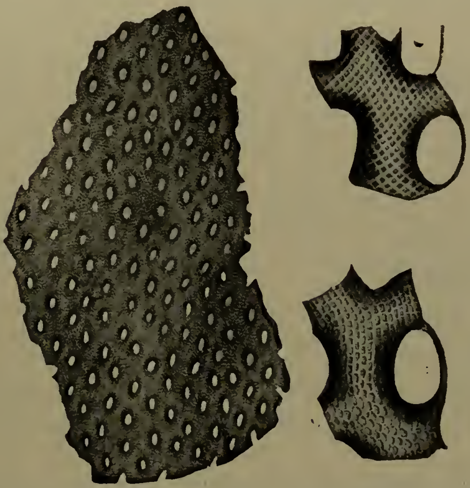


FIG. 210. *Clathropora frondosa*, with portions of celluliferous face enlarged. (Hall.)

132. **A. simplex** Ulrich. (Fig. 208, *g*.) Ordovicic.

Jointed, but generally found in isolated unbranched segments, 12 to 19 mm. long and 1 to 1.8 mm. wide; margins free from apertures; longitudinal wavy and papillose ridges, alternately converging and diverging, surround the apertures.

Stones River and Black River of Minnesota and Iowa.

133. **A. shafferi** Meek. Ordovicic.

Segments flat, branching repeatedly; apertures oval, rather distant; interspaces with from one to four wavy raised lines, visible under high power.

Lorraine of the Cincinnati region.

LXXVII. Stictoporella Ulrich.

Branching and leaf-like, nonarticulate from spreading base; zoœcia on both sides, with primitive portion tubular, usually long, generally without any septa, except occasionally an inferior one; orifices at bottom of wide sloping vestibule; thick walled, untabulated mesopores on margins of frond and between apertures. Ord.

134. **S. cribrosa** Ulrich. (Fig. 208, *h*). Ordovicic.

Fenestrules at irregular intervals and varying greatly in size and form; apertures small, subcircular or elliptical, with sharply defined polygonal or circular vestibules and numerous small mesopores, which often completely surround the zoœcia.

Stones River and Black River of Minnesota.

LXXVIII. Intrapora Hall.

Ramose from a spreading base with compressed and dichotomously divided branches; zoœcia on both sides, tubular, at first parallel to mesotheca, then bending abruptly outward; apertures oval, with peristome; minute angular pits, the openings of tabulated mesopores, in the interspaces, sometimes closed by calcareous tissue. Dev.–Miss.

135. **I. puteolata** Hall. Devonic.

Flattened, dichotomously branching frond, from spreading base; width usually 2 to 4 mm. but sometimes 20 mm. or more; oval apertures closely and irregularly disposed, frequently in contact, with strong peristomes, interspaces and margins with angular pits or mesopores.

Hamilton of Falls of the Ohio.

LXXIX. Coscinella Hall.

Explanate fronds of anastomosing branches from spreading base; zoœcia on both sides of frond, tubular, resting upon the mesotheca, with rather long direct vestibules and irregularly disposed circular apertures; spaces between vestibules and margins of fenestrules occupied by numerous tabulated mesopores which open on the surface as fine pits. Dev.

136. **C. elegantula** Hall and Simpson. Devonic.

Fenestrules irregular in form, size and distribution; apertures circular, with pronounced peristomes, generally separated by a single series of mesopores only.

Hamilton of Ontario.

LXXX. Rhinidictya Ulrich.

Bifoliate ramose, of narrow compressed bifurcating straight-edged branches with parallel margins, attached by continuous expanded base; apertures between longitudinal, slightly elevated or flexuous ridges, carrying a crowded row of small blunt spines; space around apertures sloping to summit of ridges. Ordovicic.

137. **R. mutabilis** Ulrich. (Fig. 208, *i.*) Ordovicic.

Branches commonly from 2.3 to 3.2 mm. wide, dividing at intervals of from 7 to 16 mm.; non-celluliferous margins often almost wanting; zoœcia in 14 or 15 rows, the intervening ridges carrying granules; apertures direct.

Stones River to Trenton, Minnesota and Iowa.

138. **R. trentonensis** (Ulrich). Ordovicic.

Marginal apertures generally somewhat larger; interspaces thin, without granules; superior hemiseptum not developed.

Stones River of Tennessee, Minnesota, Wisconsin and Illinois.

LXXXI. Phyllodictya Ulrich.

Bifoliate, simple or irregularly branched, from an expanded attached base; long tubular zoœcia with diaphragms, but without hemisepta, bending very gradually outward from central axis, forming oblique apertures with posterior edge lip-like; wide subsolid interspaces, traversed vertically by minute tubuli, which appear as papillæ upon the surface. Ord.

139. **P. varia** Ulrich. (Fig. 208, *j*.) Ordovicic.

Leaf-like expansions, surface with smooth or finely granulated striate maculæ at 4 mm. intervals; apertures pyriform, oblique, with peristome strong posteriorly; granulose vertical ridges between the apertures.

Black River of Minnesota.

LXXXII. Pachydictya Ulrich.

Bifoliate, ramose, of narrow, bifurcating stipes with parallel margins; or irregular undulating fronds with acute non-poriferous margins; surface with small maculæ, surrounded by apertures slightly larger than the average; marginal rows of apertures sometimes larger than average; zoœcia thin-walled, elliptical or subquadrate, separated by small vesicles; vestibules direct, thick-walled, ring-like in section; interspaces with minute tubuli; one or more diaphragms present. Ord.–Sil.

140. **P. fimbriata** Ulrich. (Fig. 214, *a*.) Ordovicic

Branches from 2 to 5 mm. wide, with subparallel, wavy or ruffled non-poriferous margins; apertures in rows in central area, between lines of minute pores.

Black River of Minnesota and Stones River of Tennessee.

141. **P. acuta** (Hall). Ordovicic.

Differs from the preceding in its smooth non-poriferous margin and the greater interspaces between the apertures, which are much larger near the margin than at the center.

Trenton of New York, Kentucky, Iowa, Minnesota and Manitoba.

142. **P. crassa** (Hall). Siluric.

Branches 2.5 to 3 mm. wide; cells elliptical, with strong peristomes and separated by slightly wavy ridges; a marginal row of larger apertures, with a non-celluliferous striated margin.

Clinton of New York, Ohio and Ontario; Niagara of New York; Anticosti group of Anticosti.

LXXXIII. Cystodictya Ulrich.

Ramose, of two layers of cells grown back to back, cross sections elliptical; subparallel margins non-poriferous; apertures subelliptical in linear series between longitudinal ridges, with lunarium on marginal side of apertures; interspaces finely striated, granulose or smooth. Worn specimens show pits and cells. Dev.-Carb.

143. **C. gilberti** (Meek). (Fig. 214, *b*.) Devonic.

Repeatedly branching rows of apertures and separating ridges, increasing rapidly by interpolation on the branches.

Onondaga to Hamilton of Ohio and Ontario; Hamilton of Falls of the Ohio and Utica, Indiana.

144. **C. hamiltonensis** Ulrich. Devonic.

Branches bifurcating, 2.5 to 3 mm. wide; apertures nearly circular, alternating in adjoining rows.

Hamilton of Iowa, Illinois, Wisconsin, Western New York and Manitoba.

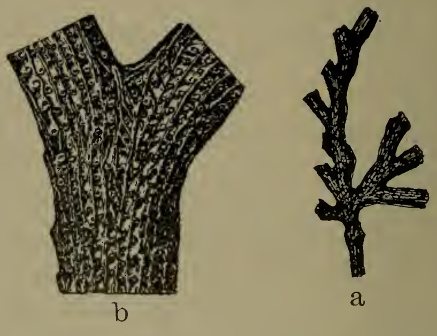


Fig. 211. *Cystodictya incisurata*. *a*, natural size, and *b*, portion enlarged. (After Hall and Simpson.)

145. **C. incisurata** (Hall). (Fig. 211.) Devonic.

Branches bifurcating from 2 to 6 mm. in width, margins parallel or slightly diverging; ridges continuous to the margin, where they often cause denticulations, slowly increasing by intercalation; apertures circular to oval or irregular; lunarium strong.

Hamilton of Central and Western New York and Ontario.

LXXXIV. DICHOTRYPA Ulrich.

Like *Cystodictya*, but in form a large, thin, bifoliate expansion, with solid maculæ on surface. Dev.–Miss.

146. **D. lyroides** Ulrich. (Fig. 214, *c*.) Mississippian.

Frond free, lyre-shaped, with thick, solid, rounded margins; surface with broad monticules, with solid circular or substellate maculæ, bordered by larger cells.

St. Louis of southern Kentucky.

LXXXV. TÆNIOPORA Nicholson.

Differs from *Cystodictya* in having a strongly elevated, longitudinal central ridge on each face, making cross-section somewhat rhomboidal. Dev.

147. **T. exigua** Nicholson. (Fig. 212.) Devonic.

Non-celluliferous margin comparatively narrow, carinæ on main stem and branches strong, rounded; apertures circular, with strong peristomes.

Hamilton of Western New York and Ontario.

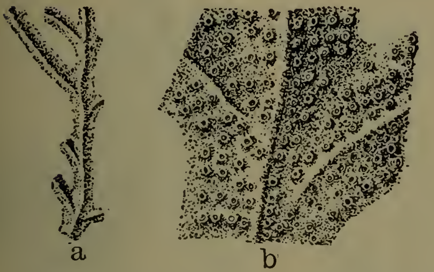


FIG. 212. *Tæniopora exigua.* *a*, fragment × 1; and *b*, small portion × 6. (After Hall and Simpson.)

148. **T. penniformis** Nicholson. Devonic.

Keel broader and more strongly elevated, and non-celluliferous margin wider, than in the preceding; apertures arranged in oblique transverse rows; peristomes pronounced.

Hamilton of Western New York and Ontario.

LXXXVI. COSCINIUM Keyserling.

Differs from *Cystodictya* in having the branches inosculating at short intervals, so as to produce broad fronds, perforated at rhythmic intervals by elliptical or circular fenestrules. Dev.–Carb.

149. **C. cribriforme** Prout. Devonic.

Cells tubular, very oblique, the apertures trilobate, or when worn, arched or subtriangular, closely and irregularly disposed; fenestrules varying greatly in size and distance from each other; lunarium elevated.

Hamilton of Falls of the Ohio and Utica Ind.

150. **C. latum** Ulrich. (Fig. 214, *d.*) Mississippian.
Branches wider than in preceding (4–5 mm.); cell apertures elevated and disposed in diagonal lines.
Burlington of Illinois and Iowa.

LXXXVII. Acrogenia Hall.

Segmented, arising from cylindrical rootlets, two segments from truncated ends of preceding one, each obconical and striated at the base, later becoming flattened and bearing apertures in linear series, separated by ridges, largest in marginal row; lunarium prominent. Dev.

151. **A. prolifera** Hall. (Fig. 213.) Devonic.
Apertures small and circular, with weak peristomes, and in rows, separated by continuous longitudinal ridges.
Hamilton of Central and Western New York.

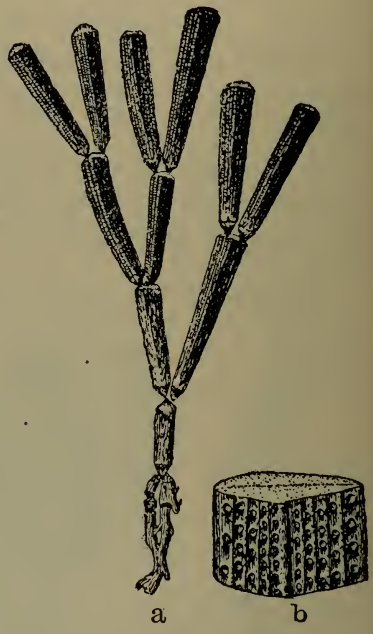


Fig. 213. *Acrogenia prolifera;* (*a*) frond, × 1, and (*b*) small fragment enlarged, × 6. (After Hall and Simpson.)

LXXXVIII. Prismopora Hall.

Ramose, of triangular bifurcating or trifurcating branches, sometimes anastomosing and forming clumps; faces subequal, usually slightly concave, edges sharp, serrated, or wavy; the zoœcia arising from mesothecæ which radiate from center to margins; apertures sometimes on summit of small papillæ; interzoœcial spaces vesiculate, often solid on the surface. Dev.–Carb.

152. **P. triquetra** Hall. Devonic.
Faces of branches from 3 to 6 mm. wide, concave, the apertures in diagonal transverse rows from center of face; peristomes prominent posteriorly; relatively wide non-celluliferous margins; bifurcating branches frequent.
Hamilton of Falls of the Ohio.

LXXXIX. Scalaripora Hall.

Like *Prismopora*, but with faces of triangular branches crossed by salient transverse ridges. Dev.

153. **S. scalariformis** Hall. Devonic.

Faces of branches 3.5 to 4 mm. wide, ray concave, the transverse ridges at intervals of 1.5 mm. and having a height at center of face of 1 mm.; celluliferous; apertures circular, with pronounced peristomes, irregularly disposed.

Hamilton, Falls of the Ohio.

XC. Glyptopora Ulrich.

A thin expansion, with salient ridges or crests on both surfaces, uniting into cup-shaped cavities; ridges sometimes pronounced and leaf-like, composed of two layers of zoœcia arising from a mesotheca; upper surface with solid maculæ or dimples. Miss.

154. **G. sagenella** (Prout). (Fig. 214, *e*.) Mississippian.

Cups elongate, often groove- or channel-like; summit of ridges

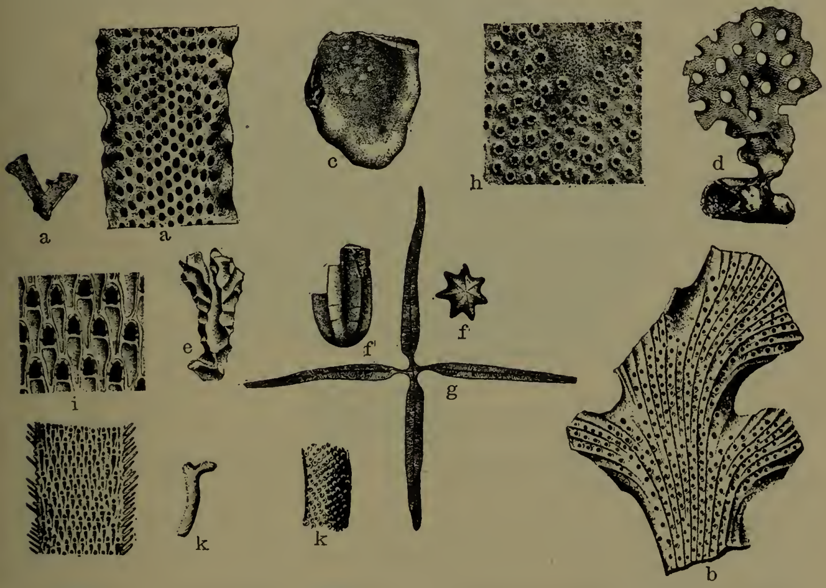


Fig. 214. *a*, *Pachydictya fimbriata*, × ½ and × 4½; *b*, *Cystodictya gilberti*, × 3; *c*, *Dichotrypa lyroides*, fragment showing base, × ½; *d*, *Coscinium latum*, × ½; *e*, *Glyptopora sagenella*, × ½; *f*, *Evactinopora radiata*, basal and lateral views, × ½; *g*, *E. grandis*, × ½; *h*, *Actinotrypa peculiaris*, surface, × 4½; *i*, *Worthenopora spinosa*, fragment showing spines, × 4½, and portion of same enlarged, × 14; *k*, *Stictotrypa punctipora*, × ½, and fragment, × 2. (After Ulrich and Hall.)

sharp, non-poriferous; apertures subcircular, with unequal peristomes.

Keokuk of Iowa; Warsaw of Illinois.

155. **G. (Phractopora) megastoma** (Ulrich). Mississippian.

Cups large; apertures large, subcircular, most pronounced at angles of cups; maculæ conspicuous often on broad elevations; apertures larger near maculæ; generally only fragments of cups found.

Keokuk of Illinois and Iowa; Waverly of Ohio.

XCI. Evactinopora Meek and Worthen.

Free, of four or more vertical leaves of cruciform or stellate arrangement; rays united, thick and nonporiferous in basal portion, free, with subcircular apertures on both sides in upper part; vesicular interspaces, solid at surface. Miss.

156. **E. grandis** Meek and Worthen. (Fig. 214, *g*.) Mississippian.

Large, transverse diameter probably 7 inches; rays 4; apertures small, regularly arranged in quincunx order, separated by about twice their width.

Burlington of Iowa and Illinois.

157. **E. radiata** Meek and Worthen. (Fig. 214, *f*.) Mississippian.

Rounded below, above of eight solid subcarinate rays, with circular pores on thin portions of rays; greatest diameter, from tip to tip of rays, 22.5 mm.

Keokuk of Missouri and Kentucky.

XCII. Actinotrypa Ulrich.

A thin, bifoliate expansion, with 8 to 10 vertical, septa-like ridges in aperture, extending along sides of vestibule. Miss.

158. **A. peculiaris** (Rominger). (Fig. 214, *h*.) Mississippian.

Apertures regularly arranged in diagonal intersecting series, floriform from tooth-like projection of pseudo-septa; peristomes raised; minutely punctured or granular subcircular maculæ characterize the surface at variable intervals.

Keokuk of Missouri, Iowa and Illinois.

XCIII. Worthenopora Ulrich.

Bifoliate, branching or palmate, with regularly arranged elongate rhomboidal zoœcia with semi-elliptical apertures, the truncated posterior margin somewhat raised; line of junction between zoœcia marked by ridge; plain, elongate triangular space below aperture. Miss.

159. **W. spinosa** Ulrich. (Fig. 214, *i.*) Mississippian.

Elongate branches 3 or 4 mm. wide, 0.5 to 0.8 mm. thick; acutely elliptical in section; margins subparallel, with a series of slender spines, pointing obliquely upward.

Keokuk of Illinois and Iowa.

XCIV. Lichenalia Hall.

Subcircular, unilaminar expansion, with prostrate, elongate subrhomboidal zoœcia, having direct subtubular vestibules and rounded apertures with peristome much elevated on posterior side. Sil.

160. **L. concentrica** Hall. (Fig. 215.) Siluric.

Cup-form in young, flattened at maturity, and variously contorted from irregular growth or accident; concentrically striate and rugose

Fig. 215. *Lichenalia concentrica*, with enlargement of fragment. (After Hall.)

surface on non-celluliferous side; apertures in concentric lines, opening on summit of elevated pustules.

Niagara of New York, etc.

XCV. Diamesopora Hall.

Ramose, of hollow stems, lined internally by an epitheca; simple hexagonal or rhomboidal zoœcia with oval orifices in anterior half forming with growth tubular vestibules, separated by compact or horizontally laminated interspaces; peristomes equally elevated, or highest posteriorly. Siluric.

161. **D. dichotoma** Hall. (Figs. 216, *a*, 216, *b*.) Siluric.

Regularly bifurcating, generally filled with rock matrix, or crushed; interior of hollow branches, transversely striated, apertures in regularly ascending spiral lines, strongly elevated posteriorly.

Niagara (Rochester) of New York, etc.

FIG. 216, *a*. *Diamesopora dichotoma* enlarged showing oblique peristomes.

XCVI. STICTOTRYPA Ulrich.

Ramose, not pointed at the base; branches dichotomously dividing, narrow, compressed, with circular or elliptical apertures, evenly elevated peristomes, and flat or concave interspaces of horizontally laminated solid tissue. Sil.

162. **S. punctipora** Hall. (Fig. 214, *k*.) Siluric.

FIG. 216, *b*. *Diamesopora dichotoma*, natural size, showing axial hollow.

Flattened, bifurcating; apertures minute, punctiform with elevated peristomes arranged in diagonal series.

Niagara (Rochester) of New York, etc.

XCVII. PALESCHARA Hall.

Thin incrustations with short, direct, generally thin-walled zoœcia, with long, hexagonal or polygonal apertures. Ord.–Dev.

163. **P. incrustans** Hall. Lower Devonic.

On shells (*Spirifer perlamellosus*) or other bodies; 0.1 to 1.0 mm. thick; cells polygonal in contact; walls thick, sometimes with obtuse spinose processes at the angles.

Helderbergian of New York, etc.

MESOZOIC AND CENOZOIC SPECIES.

ORDER CYCLOSTOMATA.

XCVIII. FILIFASCIGERA d'Orbigny.

Irregularly branching, repent zoaria, with apertures in clusters of from two to five or more. Cret.–Tert.

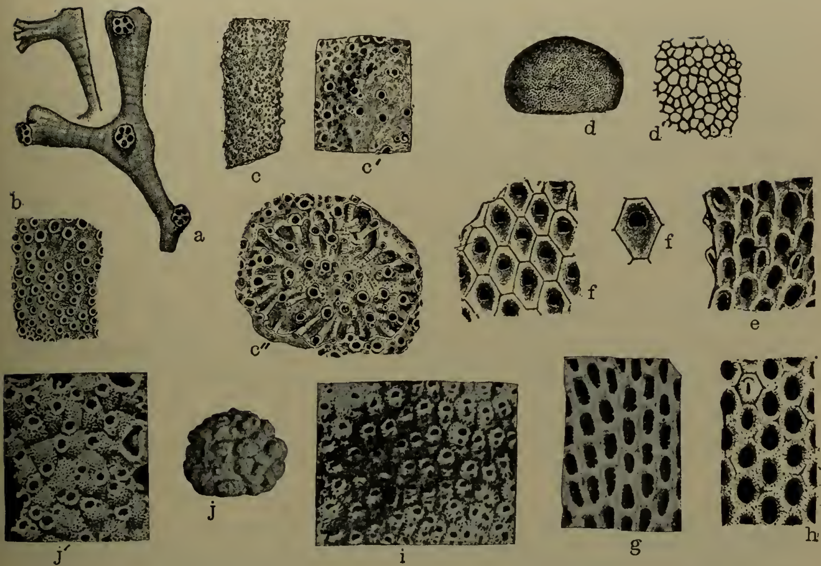


FIG. 217. *a*, *Filifascigera megæra*, × 9, top and side views; *b*, *Discosparsa varians*, surface, × 6; *c*, *Cavaria dumosa*, portion of branch, × 4½; *c′*, fragment showing gonocyst, × 10; *c″*, broken gonocyst to show tubes, × 20; *d*, *Ceriopora micropora*, complete mass, × 3, and surface, × 10; *e*, *Biflustra torta*, surface, × 10; *f*, *Onychocella digitata*, surface, × 10; and single zoœcium showing lunarium-like process, × 15; *g*, *Membranipora oblongula*, surface, × 10; *h*, *M. rimulata*, surface of small-celled variety, × 10; *i*, *Adeonellopsis umbilicata*, surface, × 8; *j*, *Schizoporella informata*, entire mass, × ½; *j′*, surface of same, × 8. (After Ulrich and Md. Geol. Surv.)

164. **F. megæra** Lonsdale. (Fig. 217, *a*.) Cretacic.

Minute, encrusting, with attached portion flattened, clusters of tubes rising at nearly right angles from attached part.

Rancocas formation of New Jersey.

XCIX. DISCOSPARSA d'Orbigny.

Like *Berenicea*, but the obconical or cup-shaped zoœcia attached by center of base only. Cret-Tert.

165. **D. varians** Ulrich. (Fig. 217, *b*.) Cretacic-Eocenic.

Apertures more or less radially arranged about small depressed, smooth maculæ; ringlike peristomes; interspaces solid.

Common in Upper Cretacic (Rancocas) at Vincentown, N. J., and in the Aquia formation of Maryland.

C. CAVARIA Hagenow.

Ramose, with cylindrical branches, the hollow axis divided by a number of plates; apertures all around the stem, immersed and with prominent peristomes. Gonocysts present.

166. **C. dumosa** Urich. (Fig. 217, *c.*) Eocenic.

A bushy mass of frequently and irregularly dividing and coalescing branches 1.5 to 3.0 mm. thick; surface with maculæ slightly depressed, smooth or with mesopores; gonocysts large rounded or irregular inflations; axial hollow 0.2 to 0.4 mm., with partitions incomplete.

Aquia formation of Maryland.

CI. Ceriopora Goldfuss.

Encrusting, massy, lobate, or ramose often in two or more superposed layers of tubes; tubes, of one kind, subequal, in close contact with amalgamated porous walls; apertures round or polygonal over entire upper surface.

Abundant in Alpine Trias, less so in Jura, common in Cretacic; Tert.

167. **C. micropora** Goldfuss. (Fig. 217, *d.*) Eocenic.

Depressed globular, hollow beneath; apertures polygonal variable in size.

Nanjemoy formation of Maryland.

CII. Heteropora Blainville.

Generally ramose, sometimes of several layers of tubes; apertures rounded, with raised peristomes; mesopores numerous, angular, usually completely surrounding the zoœcia or in clusters, their orifices closed in perfect specimens. Structure as in Ceriopora. Jura-Cret., abundant and Tert.-Recent rare.

168. **H. parvicella** Gabb and Horn. Cret.-Miocenic.

Branches round, irregular, often anastomosing, of several layers of cellules; apertures subregularly disposed with numerous round mesopores, and marked peristomes.

Upper Cretacic of New Jersey.

169. **H. tortilis** Lonsdale. Miocenic.

Apertures placed irregularly, with large irregular angular mesopores and thin walls.

Miocenic of Virginia and South Carolina.

Order CHILOSTOMATA Busk.

CIII. Biflustra d'Orbigny.

Colony lamellose or ramose, cellules on sides in longitudinal series, with slightly elevated peristomes, the anterior position partly membranous; the two layers of cells separate readily along the median line. Cret.–Recent.

170. **B. torta** Gabb and Horn. (Fig. 217, *e*.) Cret.–Tert.

Small, of compressed branches, usually twisted; cellules in longitudinal lines, usually in quincunx; close together; aperture oval, about half of the cell surface, without lips or peristomes; colony increases in width by interpolation of new rows of cells.

Rancocas of New Jersey and Aquia of Maryland.

CIV. Onychocella Waters.

Encrusting or erect, branches compressed, zoœcia hexagonal with raised margins (unless worn), oral openings semilunar or crescentic; scattered avicularian openings in pearshaped areas. Cret.–Recent.

171. **O. digitata** Morton. (Fig. 217, *f*.) Cret.–Tert.

Branches compressed, acutely elliptical, bifurcating, somewhat twisted, 2.5–3.0 mm. wide. Zoœcia bounded by a slightly impressed line, apertures in front of center. Small subcircular cells (avicularia) on margins and below bifurcation.

Upper Cretacic (Rancocas) of New Jersey, Aquia of Maryland.

CV. Membranipora Blainville.

Encrusting, irregular calcareous or subcalcareous expansions; zoœcia irregularly arranged or in rows, with variously shaped apertures according to the degree of calcification of the front wall of the zoœcium. Cret.–Recent.

172. **M. plebeia** Gabb and Horn. Cretacic.

Encrusting, sometimes on *O. digitata*, cells generally in radiating lines, elongate to pyriform, separated by depressed lines; apertures large; oral openings occupying the whole cellule.

Rancocas of New Jersey.

173. **M. abortiva** Gabb and Horn. Cretacic.

Cells elongate pyriform to suboval, irregularly arranged; aperture occupying about half the cellule, nearly terminal often acuminate in front and wide behind.

Common in the Upper Cretacic of Timber Creek, and near Mullica Hill, N. J.

174. **M. oblongula** Ulrich. (Fig. 217, *g*.) Miocenic.

Zoœcial apertures in longitudinal series elongate ovate to subquadrate, about twice as long as wide, occupying entire cellule;

walls generally thick, with numerous thin spines projecting inward from them.

Choptank and Calvert formation of Maryland.

175. **M. rimulata** Ulrich. (Fig. 217, *h.*) Eocenic.

Zoœcia hexagonal, arranged quincuncially with longitudinal rows generally regular; apertures occupying entire cell, quite regularly ovate in form; interapertural space narrowed and rounded, sometimes angular, often with depressed central line.

Aquia formation of Maryland.

CVI. Adeonellopsis Macgillivray.

Encrusting with bulbous cells having subcircular to semicircular opening, beneath which is a second circular or crescentic pore. Cret.–Tert.

176. **A. umbilicata** (Lonsdale). (Fig. 217, *i.*) Miocenic.

Irregular nodose masses of numerous layers; zoœcia irregular, central and anterior portion elevated and outline of each marked by a row of pores; upper front wall coarsely punctate; orifice anterior, semielliptical, 2 smaller apertures on the proximal portion of the cell.

Chesapeake Group of Virginia and Choptank formation of Maryland. Common.

CVII. Schizoporella Hincks.

Zoaria variable; zoœcia urn-shaped, the front entirely calcified; orifice varying from semicircular to suborbicular, with a distinct notch or sinus in the lower margin. Cret.–Recent.

177. **S. informata** (Lonsdale). (Fig. 217, *j.*) Miocenic.

Irregular botryoidal or nodulose masses of superposed layers of zoœcia, 20 to 40 mm. in diameter; cells with terminal subcircular orifice with distinct peristome and deep and sharp proximal notch; entire surface punctate; avicularia uncommon.

Chesapeake group of Virginia and Choptank formation of Maryland.

Class **Brachiopoda.**

Brachiopods are marine animals secreting a shell of two pieces or valves which may be calcareous or phosphatic or both. These valves are dorsal and ventral in position and are usually of unequal size, a larger, the *pedicle* or *ventral valve* and a smaller, the *brachial* or *dorsal.* They are usually attached to some foreign object, such as rocks, etc., by a fleshy stalk, the *pedicle* (Fig. 219, 5); this posterior prolongation of the animal's body passes through an opening, the *delthyrium*, or the more restricted *foramen* at the posterior end of the pedicle valve. The shell is sometimes anchored by spines and sometimes it is cemented to its support (*Crania*).

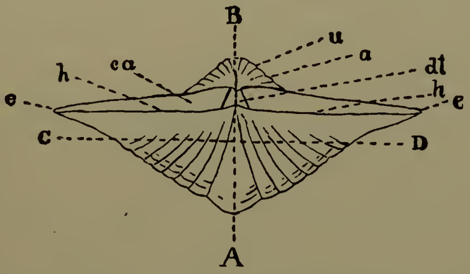


FIG. 218. Diagram of *Spirifer*. (*AB*) longitudinal axis marking the height; (*CD*) transverse axis marking the width; (*A*) anterior (front) end; (*B*) posterior (beak) end; (*h*) hinge line; (*ca*) cardinal area; (*e*) cardinal extremities; (*dt*) delthyrium; (*u*) umbo; (*a*) apex or beak.

The interior of the shell is lined by the mantle, a membranous reduplication of the body wall, which is often studded with minute cæca or blind tubes which enter the perforations (tubules) of the shell, thus giving the shell a punctate structure. The pedicle valve is secreted by the ventral and the brachial valve by the dorsal mantle lobe. In the Protremata the dorsal surface of the pedicle secretes a third shellpiece, the *deltidium*, or pedicle plate, which unites with the posterior margin of the pedicle valve and continues to grow anteriorly (*Schuchertella*, Fig. 276). In the Telotremata, where this deltidium is absent, the extension of the ventral mantle lobe effects the protection of that portion of the pedicle by a secretion of two plates, the deltidial plates or *deltaria* which may unite to form the *pseudodeltidium*. In some of the Neotremata (*Orbiculoidea*, etc.), a single plate, the *listrium*, forms between the apex of the pedicle valve and the opening for the pedicle. In some forms (*Spirifer*) the delthyrium is filled by the deposition within the shell of solid calcareous material. In extreme cases a tubular sheath, the *syrinx*, is formed on this calcareous filling (*Syringothyris*) (Fig. 436).

Externally the shell is marked with concentric lines (*growth lines*) which represent the successive stages of growth; as the shell grows a new layer is added to the inside, projecting beyond the preceding layer, thus forming a "series of outcrops." These growth lines are more or less conspicuous. Besides this ornamentation, shells frequently bear folds or *plications* radiating from the region of the beak to the anterior portion of the valves (*Spirifer*, Fig. 218, *Magellania*, Fig. 219, 4–5). When these are fine they are generally spoken of as *striations*. Frequently the striæ alternate in size. They may increase by intercalation or implantation of new ones between the diverging older ones, or these latter may bifurcate. (See Figs. 251 to 275 for variations). Frequently the median line of the brachial valve bears a much larger fold called the *median fold*, while the corresponding large depression on the pedicle valve is called the *median sinus* (*Spirifer*, Fig. 409). In some forms the sinus and fold are reversed in position (*Anastrophia*, *Gypidula*, *Enteletes*, etc.), while in others they are entirely wanting (*Whitfieldella*).

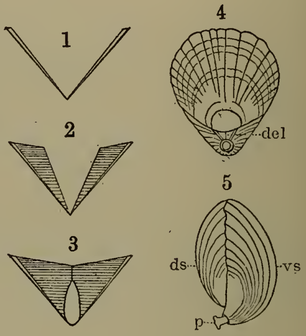


FIG. 219. 1, Delthyrium of young *Rhynchonella* without deltidial plates; 2, the same at a later stage with two triangular deltidial plates; 3, the same after completed growth; showing joining of deltidial plates, and limitation of pedicle opening to ventral beak (foramen); 4, dorsal view of *Magellania flavescens*, showing completed deltidial plates *del*; 5, profile of same; *vs*, ventral (pedicle) valve; *ds*, dorsal (brachial) valve; *p*, pedicle. (After Beecher).

The *length* or *height* of the shell is the distance from the hinge line, or line of junction of the valves, through the middle of the shell to the opposite edge or front (*A–B* in Fig. 218). The *width* is in the direction at right angles to this or on a line extending from side to side of the shell (*C–D* in Fig. 218). The *thickness* is in the direction perpendicular to the plane of length and width through the center of the valves.

There is usually a flattened area at the posterior portion of each valve between the *beak* (*a*) and the *hinge line* (*h*) and extending to the *cardinal angles;* this is the *cardinal area* (*ca* in Fig. 218). The cardinal area of the pedicle valve is the higher.

In the Articulata a pair of *teeth* on the posterior portion of the pedicle valve fit into corresponding *sockets* on the brachial valve. Fitting between the teeth of the pedicle valve is a short prolongation of the brachial valve, the *cardinal process* (Fig. 261). Teeth and sockets are usually absent in the Inarticulata. The dental sockets are bounded on the inside by *hinge plates* which are united above with the cardinal process. Similar plates, the *dental plates*, bound the inner side of the teeth; at times these unite before reaching the bottom of the shell, thus forming a plate or cup upon which are fastened the diductor, adductor and pedicle muscles. This cup is called the *spondylium* (*Gypidula*). In some genera (*Merista*, etc.) a free plate, of different origin, the *shoe-lifter process*, occurs in place of the spondylium. The solid or excavated platforms in some of the Atremata (*Trimerella*, Fig. 226) are homologous to the spondylium. A corresponding structure sometimes occurs in the brachial valve where it is known as the *cruralium*. The muscle areas are more deeply impressed upon the posterior portion of each valve. This area in each valve is frequently divided into halves by a vertical plate or *septum* extending from beneath the beak anteriorly, never reaching the front of the shell (Fig. 233, *s*).

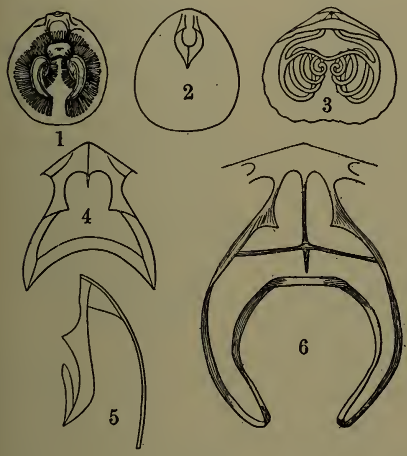


FIG. 220. 1, Dorsal valve of *Terebratulina septentrionalis* with cirrated brachia attached; showing relation of calcareous loop which is darkly shaded; 2, Centronelliform stage of loop of *Dielasma turgidum* $\times$ 6; 3, spirals and loop in *Zygospira modesta* $\times$ 2⅓; 4, loop and crural plates of adult *Dielasma turgidum* $\times$ 4; 5, side view of same $\times$ 4; 6, adult loop of *Terebratalia obsoleta*. (After Beecher, and Beecher and Schuchert).

Curving forward from the posterior portion of the brachial valve or from the cruralium there is a pair of short processes, the *crura*; to these in many shells are united more or less complicated calcareous ribbons, the *brachidia* (Fig. 220, 2–6). When spirally coiled as in *Spirifer* or *Zygospira* they are called *spiralia* (Fig. 220–3).

The valves are opened and closed by muscular action. The pedicle valve is held stationary by means of the pedicle. Through the contraction of two pairs of muscles (*diductors* or *divaricators*) extending from the posterior portion of the pedicle valve to the cardinal process on the opposite valve the shell opens, since the cardinal process by its position posterior to the teeth forms a sort of lever with the teeth and sockets as fulcrum, and the front of the brachial valve as weight. The valves close by the contraction of two muscles (*adductors*) passing from the brachial to the pedicle valve. A pair of muscles extending from the brachial valve and another pair from the pedicle valve with insertion on the pedicle, enable the shell as a whole to move in many different directions. In the Inarticulata the opening and closing of the valves is effected by a more complicated set of muscles. (See *Lingula*, Fig. 221.)

The body of the animal, lying in the posterior portion of the shell, occupies only about one third of the interior. The body wall gives off two folds or mantles, one fitting closely to and building the pedicle valve, the other building the brachial valve. Most of the space between the mantles is filled with the tentacle-bearing *lophophore* (Fig. 220, 1); this is supported by the brachidium. Those portions of the lophophore which diverge arm-like from the two sides of the mouth are called the *brachia*. Through this lophophore and tentacles as well as through the mantle the animal gets its necessary oxygen There is also a cilia-lined groove, which is bounded on the outside by the line of tentacles and on the inner side by a wavy ridge, and which extends from the mouth along each arm of the lophophore. Through this, microscopic food particles (diatoms, infusorians, etc.) are swept into the mouth by the action of the cilia. The *mouth*, a mere slit, is in the middle of the lophophore; it leads into a *stomach* through an *œsophagus*. The stomach leads into an *intestine*, which often ends as a blind sac.

FIG. 221. *Lingula elderi*, outline of interior of dorsal valve showing muscular and vascular markings; *d*, divaricator muscular scars; *ad*, adjustor muscular scars; *pa*, posterior adductor scars; *aa*, anterior adductor scars; *xx*, track of advance of the muscular scars; *s*, great pallial sinuses; *ps*, posterior course of the latter; *o*, inner ramifications of the sinuses. (After Whitfield.)

The body cavity or coelome extends into the lophophore and also sends off four canals (*pallial sinuses*) into each mantle; the outer ones are much branched. Impressions of these pallial sinuses are often found on the inside of the shell and on internal molds (Fig. 221, *s*).

The function of the blood is performed mainly by the fluid filling the coelome and moved by the cilia lining it. A contractile heart and some vessels leading from it have been observed.

The nervous system consists of a ring around the œsophagus with two swellings or ganglia in it; nerves are given off to the rest of the body.

It is apparent that the pedicle valve is so called because the pedicle passes out through it and the brachial valve is so named because the arms or brachia are fastened to it.

Brachiopods are, in the larval stage, free-floating or meroplanktonic, and hence it is during this period of their lives that their distribution takes place.

Brachiopods appear in the Lower Cambric; they reach their maximum in the Siluric and Devonic and continue to the present. There are about 6,000 fossil species known and 140 recent.

These shells often appear very similar to Pelecypods but may be distinguished from them by the following characters, which as a rule hold true:

Brachiopods.	Pelecypods.
Equilateral.	Inequilateral.
Inequivalved.	Equivalved (generally).
Pedicle opening present (except in *Atremata*).	No pedicle opening present.
Teeth in one valve, sockets in the opposite valve (except *Inarticulata*).	Teeth and sockets in each valve (typically).
No ligament present; valves opened by muscles.	Valves opened by ligament or resilium at hinge line.

Brachiopods are divided according to the presence or absence of teeth into two subclasses:

I. *Inarticulata* — Teeth absent. Valves held in apposition by muscles. This is subdivided into two orders:

1. Atremata — Pedicle emerging from between the valves and usually with no pedicle opening present.

2. Neotremata — Pedicle opening confined to pedicle valve and modified by false deltidium or by listrium.

II. *Articulata* — Valves articulated by teeth and sockets. This is subdivided into two orders:

1. Protremata — Pedicle opening restricted to pedicle valve and modified by true deltidium. Brachia have no calcareous supports except very short ones in *Pentamerus*.

2. Telotremata — Pedicle opening shared by both valves in early life and usually confined to one in later stages. Brachia supported by calcareous supports. Deltidial plates usually present.

Literature.

I. *Bibliography and Synonymy.*

1897. **Schuchert, Chas.** Bull. U. S. Geol. Surv. 87. See also Miller, S. A., under general references.

II. *Descriptive Literature. — Selected Works.*

1847–67. **Hall, James.** Pal. of New York, vols. 1–4.

1892–94. **Hall, James, and Clarke, J. M.** Pal. N. Y. vol. 8. Pt. I., II. A discussion of the genera.

1892–94. **Hall, James, and Clarke, John M.** An introduction to the study of the Brachiopods; intended as a Handbook for the use of students. 11th Ann. Rep. N. Y. State Geol., p. 132 and 13th report, pt. II.

These series contain a most complete discussion of Palæozoic genera and species.

1852. **Owen, D.** Geol. Rep. Wis., Ia. and Minn.

1858. **Hall, J.** Geol. Surv. Ia., 1, pt. 2.

1862–74. **Billings, E.** Palæozoic Fossils, 1, 2.

1866–73. **Meek and Worthen.** Geol. Surv. Ill., 2–5.

1872. **Meek, F. B.** Final Rep. U. S. Geol. Surv. Neb.

1873–75. **Meek, Hall, Whitfield.** Pal. Ohio, 1, 2.

1875. **White, C. A.** U. S. Geol. and Geogr. Surv. west of 100th Meridian, 4.

1877. **Meek, F. B.** King's U. S. Geol. Expl. 40th Parallel, 4.

1881–84. **Hall and White.** Rep. State Geol. Ind., 10, 11, 12, 13.

1884. **Walcott, C. D.** Mon. U. S. Geol. Surv. 8 (Eureka, Nevada).

1885. **Whitfield, R. P.** Mon. U. S. Geol. Surv. 9 (New Jersey Cretacic and Tertiary).

1886. **Walcott, C. D.** Bull. U. S. Geol. Surv. 10, 30 (Cambric).

1889. **Nettelroth, Henry.** Kentucky Fossil Shells. Kentucky Geol. Surv. Monographs.

1893. **Winchell and Schuchert.** Minn. Geol. Surv., pt. 3, 1.

1894. **Keyes, C. R.** Mo. Geol. Surv., 4, 5.

1897 to date. **Walcott, C. D.** Proc. U. S. Nat. Mus., 19, 21, 25.

1900. **Beede, J. W.** Univ. Geol. Surv. Kan., 6 pt. 2 (Carbonic of Kansas).

1903. **Weller, S.** Geol. Surv. of N. J., Pal. 3 (Palæozoic of N. J.)

1903. **Girty, G. H.** Prof. paper, U. S. Geol. Surv., 16 (Carbonic of Colorado).

1907 ? **Walcott, C. D.** Cambrian Brachiopoda. Mon. LI. U. S. Geol. Survey. In preparation.

ARTIFICIAL KEY TO THE GENERA.

A. Beak not marginal .... I.

I. Shell cemented, calcareous, with no pedicle opening or notch (rarely free).. 1.

1. Interior of each valve with a large, elevated muscular impression.
XXV. *Pholidops*.

1. Interior of each valve with three or four muscular impressions............ *a*.

a. An S-shaped vascular sinus present................ XXIV. *Craniella*.

a. No S-shaped vascular sinus present..................... XXIII. *Crania*.

I. Shell attached by pedicle, phosphatic; pedicle opening or notch present..... 2.

2. Pedicle opening a narrow groove, not extending to the margin of the shell. *b*.

b. Pedicle groove very narrow, extending almost to the margin of the shell... XIX. *Orbiculoidea*.

b. Pedicle groove suboval, extending about half way from the beak to the margin of the valve.. 11.

11. Both valves convex, the pedicle the more so.. XXI. *Schizotreta*.

11. Brachial valve very convex; pedicle valve concave.......... *aa*.

aa. Pedicle opening surrounded by a depressed area.
XX. *Discinisca*.

aa. Pedicle opening not surrounded by a depressed area.
XXII. *Rœmerella*.

2. Pedicle opening round, abruptly truncating the apex .... *c*.

c. Shell depressed-convex; beak elevated................ XII. *Acrothele*.

c. Shell sub-conical .... 22.

22. Pedicle valve with an apparent cardinal area .... *bb*.

bb. Two wart-like protuberances on the umbo.. XI. *Acrotreta*.

bb. No wart-like protuberances on the umbo... XIV. *Iphidea*.

22. Pedicle valve without apparent cardinal area.
XIII. *Linnarssonia*.

2. Pedicle opening a triangular notch..*d*.

d. Surface with prominent radiating pits...................... XV. *Trematis*.

d. Surface without radiating pits .... 33.

33. Brachial valve extending beyond the pedicle valve on all sides. *cc*.

cc. Surface with radiating striæ .... XVI. *Schizocrania*.

cc. Surface without radiating striæ..... XVII. *Lingulodiscina*.

33. Brachial valve not extending beyond the pedicle valve.
XVIII. *Schizobolus*.

B. Beak marginal .... II.

II. Cardinal area absent or if present rarely straight and generally confined to pedicle valve; hinged line curved or if straight very short 3

3. Shell obolelloid — Small, thick-shelled, ovate in outline. Cardinal areas very short.. *e*.

e. Shell calcareo-corneous...................................... II. *Dicellomus*.

e. Shell calcareous.. 44.

44. Umbo very conspicuous......................... XXVI. *Kutorgina*

44. Umbo not conspicuous..I. *Obolella*.

3. Shell trimerelloid — Large, thick-shelled. Cardinal area of pedicle valve very high; beak straight and very prominent. Beak of brachial valve inconspicuous. Interior of each valve has a conspicuous platform extending from the beaks forward... *f*.

f. Platforms very prominent with conical cavities beneath .... 55.

55. Conical cavities very long, extending from one third to one half the length of the shell as shown by the internal molds.
V. *Trimerella.*

55. Conical cavities short, extending about one tenth the length of the shell .... III. *Dinobolus.*

f. Platforms not very prominent, solid (*i. e.*, with no cavities beneath them) .... IV. *Monomorella.*

3. Shell linguloid — Elongate, corneous, thin (except *Lingulasma*)........ *g.*

g. Inequivalved (pedicle valve the larger, projecting posteriorly), spatulate .... 66.

66. Cardinal area distinct .... *dd.*

dd. Shell minute (about $\frac{1}{12}$ inch long).* VIII. *Leptobolus.*

dd. Shell larger (¼ to ¾ inch long) with high cardinal area.
VI. *Lingulella.*

66. Cardinal area not distinct; pedicle valve often much produced at beak .... VII. *Lingulepis.*

g. Equivalved. Surface glistening .... 77.

77. Platform present in the posterior portion of each valve.
X. *Lingulasma.*

77. No platform present .... IX. *Lingula.*

3. Shell pentameroid — Usually longer than wide and expanding in width from beak to front. Beak generally incurved, not truncated by foramen, rarely with area. Sinus and fold variable. A spondylium in pedicle valve .... *h.*

h. No radiating striæ or plications .... 88.

88. Sinus or fold present .... *ee.*

ee. Small (average length $\frac{3}{8}$ inch) .... LXII. *Camarella.*

ee. Not so small .... †.

† Umbo of pedicle valve very prominent and overarching *.

* Sinus in pedicle valve and fold in brachial.
LXVIII. *Clorinda.*

* Sinus, when present, in brachial valve and fold in pedicle .... LXX. *Gypidula.*

† Umbo of pedicle valve small .... LXVII. *Pentamerus.*

88. Sinus or fold absent .... *ff.*

ff. Umbo of pedicle valve prominent .... LXX. *Gypidula.*

ff. Umbo small .... LXVII. *Pentamerus.*

h. With radiating striæ or plications, without area .... 99.

99. Sinus or fold present .... *gg.*

gg. Striæ or plications absent from umbo .... ††.

†† Small (average length ⅜ inch)..... LXII. *Camarella.*

†† Large .... **.

** Umbo of pedicle valve large..... LXX. *Gypidula.*

** Umbo comparatively small .... 1″.

1″ Shell outline subcircular.
LXIII. *Parastrophia.*

1″ Shell outline subtriangular.
LXXII. *Camarophoria.*

---

* All measurements refer to adults.

gg. Striæ or plications extending from umbo to front of shell. †††.
††† Pedicle valve the larger with more prominent umbo. ***.
*** Radiating plications very few and broad...... 2″.
2″ Umbo of pedicle valve strongly overarching. LXVIII. *Clorinda*.
2″ Umbo not overarching. LXVII. *Pentamerus*.
*** Radiating plications numerous and prominent. 3″.
3″ Spondylium only in pedicle valve. LXXII. *Camarophoria*.
3″ Spondylium in pedicle and brachial valve (cruralium)................................ *a*″.
a″ Umbo of pedicle valve closely incurved against the brachial. LXVIII. *Clorinda*.
a″ Umbo of pedicle valve projecting above the brachial.......................... 1‴.
1‴ Sinus, when present, on brachial valve and fold on pedicle. LXX. *Gypidula*.
1‴ Sinus on pedicle valve and fold on brachial.. LXIX. *Pentamerella*.
††† Brachial valve the larger. Both umbos very closely incurved, that of the brachial valve the more prominent............................... LXIV. *Anastrophia*.
99. Sinus or fold absent... *hh*.
hh. Shell with radiating plications .... ††††.
†††† Plications few and broad...... LXVII. *Pentamerus*.
†††† Plications numerous.................................. ****
**** Plications angular ...... LXXII. *Camarophoria*.
**** Plications round................................... 4″.
4″ Spondylium in pedicle valve. LXV. *Conchidium*.
4″ Spondylium in both pedicle and brachial valves................ .... LXX. *Gypidula*.
hh. Shell with radiating striæ, very fine plications or smooth. 5†.
5† Pedicle valve with a spondylium. LXXI. *Amphigenia*.
5† Pedicle valve without a spondylium. LXXXVIII. *Rensselæria*.
h. Shell with small area and with radiating striae or plications....... ooo.
ooo. Area on both valves, nearly equivalve. LXVI. *Stricklandinia*.
ooo. Area on pedicle valve, which is the larger and has overarching umbo. .... *ii*.
ii. Sinus on brachial and fold on pedicle..... LXX. *Gypidula*.
ii. Sinus on pedicle and fold on brachial valve. LXIX. *Pentamerella*.

3. Shell rhynchonelloid — Length and breadth sub-equal. Cardinal areas rarely present. Umbo not prominent, becoming abruptly pointed (*i. e.*, forming a concave line from beak to greatest width of shell). Beak usually closely incurved, generally not truncated by foramen.

Sinus and fold prominent, in typical forms surface with plicæ generally coarse.. *i.*

i. Fold and sinus absent.. III.

III. Large, with false area, no spondylium. LXXXV *Peregrinella.*

III. Small, with spondylium.......... ....LXXII *Camarophoria.*

i. Fold and sinus present.. 222.

222. Plications moderately developed on the lateral slopes or wanting, prominent centrally and anteriorly, no spondylium........... *jj.*

jj. Sinus exceedingly prominent............ LXXXII. *Pugnax.*

jj. Sinus moderately prominent...... LXXVIII. *Leiorhynchus.*

222. Plications absent from the umbo, sponydium well developed. *kk.*

kk. Plications roughened by strong concentric growth lines. LXXII. *Camarophoria.*

kk. Plications smooth.. .... 6†.

6† Shell very small (about ¼ inch long). LXII. *Camarella.*

6† Shell moderately large........... LXIII. *Parastrophia.*

222. Entire shell covered with plications or striations.............. *ll.*

ll. Both umbos very prominent, that of the brachial valve the more conspicuous, well marked spondylium in pedicle valve.......................................LXIV. *Anastrophia.*

ll. Umbo of pedicle valve the more prominent................. 7†.

7† Pedicle umbo very closely incurved over the brachial. 5*.

5* Plications marked anteriorly by a faint median line. Shells ventricose, no spondylium............ 5″.

5″ Median septum and cardinal process in brachial valve well developed. LXXIX. *Uncinulus.*

5″ Cardinal process absent... LXXX *Wilsonia.*

5″ Median septum in brachial valve very faint. LXXXI. *Hypothyris.*

5* Plications not marked anteriorly by a median line. 6″.

6″ Pedicle valve with obscure muscular scars and well-marked spondylium. LXXII. *Camarophoria.*

6″ Pedicle valve with prominent muscular scars without spondylium.......................... *b″.*

b″ Brachial valve with median septum. 2‴.

2‴. Septum excavated posteriorly; teeth supported by lamellæ; no cardinal process. LXXVI. *Camarotœchia.*

2‴. Septum not excavated; strong recurved teeth without lamella; slender cardinal process. LXXIV. *Rhynchotrema.*

b″. Brachial valve without median septum. LXXVII. *Stenochisma.*

7† Pedicle umbo projecting, not very closely incurved over the brachial, commonly showing deltidial plates and foramen.. 6*.

6* Hinge line straight with flattened margins ......7″.
7″ Pedicle valve prolonged posteriorly and acutely triangular, flattening from large deltarium............ LXXV. *Rhynchotreta.*
7″ Pedicle valve not prolonged posteriorly ; flattening a cardinal area in each valve.
LXXIII. *Orthorhynchula.*
6* Hinge line curved, no flattening................. 8″.
8″ Pedicle valve with deeply excavated muscular scars, sinus forming nasute anterior prolongation...............LXXXIII. *Eatonia.*
8″ Pedicle valve with muscular scars not deeply excavated.................................... c″.
c″ Shell structure punctate.
LXXXIV. *Rhynchopora.*
c″ Shell structure not punctate.......... 3‴.
3‴ Pedicle valve with pseudo area and strong teeth supported by lamellæ ; brachial valve with septum entire.
LXXXV. *Rhynchonella.*
3‴ Small teeth with slender lamellæ, septum of brachial valve excavated posteriorly............. a‴.
a‴ Plications low and rounded.
LXXVIII. *Leiorhynchus.*
a‴ Plications sharp and angular.
LXXVI. *Camarotœchia.*

3 Shell terebratuloid or athyroid — Typically no flat cardinal area. Hinge line curved. Beak incurved, often truncated by foramen. Median sinus and fold often absent ; when present usually broad and ill-defined. Radiating plications or striæ usually absent ; when present they are never angular; arms generally supported by calcareous brachidium. *j.*
j. Shell smooth, calcareous brachidium present.......................... 333.
333. Median sinus and usually fold present........................ *mm.*
mm. Beak of pedicle valve truncated by a round foramen.. 8†.
8† Length and breadth subequal, brachidium a spiralium. 7*.
7* Shell usually small (about ¾ inch long or less).
CXXIII. *Seminula.*
7* Shell of medium size, margins of sinus rounded.
CXXIV. *Meristella.*
7* Shell of medium size, margin of pronounced and broad sinus angulated, fold with median groove.
CXXV. *Pentagonia.*
8† Length greater than breadth, brachidium a simple loop. 8*.
8* Beak of pedicle valve prolonged and greatly incurved over opposite valve. Pedicle opening large................................ XC. *Dielasma.*

8* Beak of pedicle valve much less prominent... 9″.
9″ Shell usually plano-convex (pedicle valve convex)........... LXXXVII. *Centronella.*
9″ Shell biconvex; length but slightly greater than breadth.................. XC. *Cranæna.*
8† Length greater than breadth, brachidium a spiral. CXV. *Whitfieldella.*
mm. Beak of pedicle valve not truncated by a round foramen; brachidium a spiralium or complex loop................. 9†.
9† Median sinus a mere groove...... CXVII. *Nucleospira.*
9† Median sinus very broad and ill-defined; no fold present.............................. { CXX.* *Meristina.* CXXIV.* *Meristella.* }
9† Median sinus very broad and pronounced, sides angulated, fold pronounced and with median groove. CXXV. *Pentagonia.*
9† Median sinus and fold both present and of normal width... 9*
9* Sinus and fold only upon the anterior portion of the shell, spire very short...... XCVIII. *Cyclospira.*
9* Sinus and fold extending from umbo .... 10″
10″ A broad plication present on each side of median sinus and fold... CXVI *Hyatella.*
10″ No plications present........ CV. *Martinia.*
333. Median sinus and fold absent................................... *mm.*
nn. Beak of pedicle valve truncated by a round foramen... 10†.
10† Length and breadth subequal; brachidium a spire.. 10*.
10* Concentric growth lines lamellose............ 11″.
11″ Edges of the lamellæ spinose. CXXII. *Cleiothyris.*
11″ Edges of the lamellæ not spinose. CXXI. *Athyris.*
10* Concentric growth lines few and not lamellose. CXV. *Whitfieldella.*
10† Length greater than breadth or subequal; brachidium a loop... 11*
11* Umbo comparatively narrow; shell elongate.. 12″.
12″ Concentric growth lines usually well marked. LXXXIX. *Cryptonella.*
12″ Concentric growth lines usually not prominent.......................... XCI. *Eunella.*
11* Umbo broad; shell elongate.. XCII. *Terebratula.*
11* Umbo broad; shell subcircular.. XCV. *Kingena.*
nn. Beak of pedicle valve not truncated by a foramen..... 11†.
11† Prominent cardinal area present. 380. *Reticularia perplexa.*
11† No cardinal area present........ CXVII. *Nucleospira.*
j. Shell radially plicate or striate; brachidium wanting in some forms... 444.

---

* These two genera are separated by the character of the loop.

444. Median sinus and fold present; brachidium when present, a spiralium .... *oo.*

oo. Beak of pedicle valve truncated by a foramen. Shell transversely elongate; spires extraverted .... 12†.

12† Plications covered with minute spines.
CXIII. *Parazyga.*

12† Plications without spines...........CXII. *Trematospira.*

oo. Beak of pedicle valve not truncated by a foramen...... 13†.

13† Shell with faint radiating striæ; spirals extraverted.
CXXIV. *Meristella.*

13† Shell radially plicate; spirals absent, or when present not extraverted .... 12*.

12* Plications confined to anterior portion of shell; spiralium absent...............LXII. *Camarella.*

12* Plications covering whole shell................. 13″.

13″ Sinus on pedicle valve and fold on brachial; spirals pointing into pedicle valve.
CXVIII. *Anoplotheca.*

13″ Sinus on brachial valve and fold on pedicle; spirals pointing inward (introverted).
XCVII. *Zygospira.*

444. Median sinus and fold not present .... *pp.*

pp. Beak of pedicle valve truncated by a foramen; deltidial plates visible .... 14†.

14† Shell with faint radiating striæ; brachidium a loop, deltidial plates minute...... XCIII. *Terebratulina.*

14† Shell with coarse plications; brachidium a loop, deltidial plates moderate............ XCVI. *Terebratella.*

14† Shell radially plicate; brachidium of extraverted spires, deltidial plates pronounced, commonly coalesced.. 13*.

13* Plications rather coarse............ CXI. *Hustedia.*

13* Plications fine or striate........................... 14″.

14″ Deltidial plates uncoalesced.
CX. *Homœospira.*

14″ Deltidial plates coalesced..................... *d″.*

d″. Surface plicate..... CIX. *Rhynchospira.*

d″. Surface striate........ CXIV. *Eumetria.*

pp. Beak of pedicle valve not truncated by a round foramen. 15†.

15† Brachidium a spire turned into the extremely convex brachial valve; plications rounded, low.
XCIX. *Atrypa.*

15† Brachidium a loop.................................... 14*.

14* Length greater than breadth; plications fine.
LXXXVIII. *Renssellaeria.*

14* Subcircular; plications angular, prominent; small well defined cardinal area and deltidial plates on pedicle valve........... XCVI. *Terebratella.*

II. Cardinal area present, straight. Hinge line straight and long, usually more than one third the greatest width of shell.. 4.

4. Shell strophomenoid—Length and breadth subequal. Hinge line forming usually the greatest width of the shell. Shell usually concavo-convex, never strongly biconvex. Cardinal areas well developed; delthyrium triangular and usually closed (open in *Vitulina*, *Tropidoleptus*, *Syntrophia*, *Scenidium*). Median sinus and fold usually absent; when present very broad and ill-defined. Surface radially striate, seldom plicate or smooth .... *k*.

k. Surface radially striate.......... 555.

555. Margins of hinge line finely grooved transversely.......... *qq*.

qq. Shell normally concavo-convex (brachial valve concave, pedicle valve convex).......... XXXII. *Stropheodonta*.

qq. Shell resupinate (brachial valve convex, pedicle valve concave).......... XXXIV. *Strophonella*.

555. Margins of hinge line not transversely grooved.......... *rr*.

rr. Cardinal margin of pedicle valve with a simple row of spines.......... 16†.

16† Shell normally concavo-convex.......... 15*.

15* Surface simply striate radially... XLII. *Chonetes*.

15* Surface with a double oblique series of striæ extending from umbo.......... XLIV. *Chonopectus*.

16† Shell resupinate.......... XLIII. *Chonostrophia*.

rr. Cardinal margins without spines.......... 17†.

17† Radiating striæ alternating in height.......... 16*.

16* Shell normally concavo-convex.......... 15″.

15″ Shell large.......... XXXI. *Rafinesquina*.

15″ Shell small...... XXXVII. *Plectambonites*.

16* Shell resupinate.......... XXXV. *Strophomena*.

17† Radiating striæ subequal in height.......... 17*.

17* Front of shell geniculate (abruptly bent almost at right angles); concentric wrinkles on older portion.......... XXXVI. *Leptæna*.

17* Front of shell not geniculate.......... 16″.

16″ Radiating striæ prominent, sharp, crowded; umbo apt to be distorted.......... *e″*.

e″ Pedicle valve with spondylium. LIX. *Clitambonites*.

e″ Pedicle valve without spondylium... 4‴.

4‴ Muscular area of pedicle valve surrounded by a strong ridge. XLI. *Hipparionyx*.

4‴ Muscular area of pedicle valve not surrounded by a strong ridge. *b‴*.

b‴ High median septum present, running through center of muscular area. XXXIX. *Orthothetes*.

b‴ High median septum not present.. XXXVIII. *Schuchertella*.

16″ Radiating striæ faint.......... *f″*.

f″ Shell concavo-convex, resupinate. XXXV. *Strophomena*.

f'' Shell plano- or bi-convex.
XXVIII. *Billingsella.*

k. Surface radially plicate.. 666.
666. Plications coarse, radially striate.................. XL. *Meekella.*
666. Plications not radially striate .... *ss.*
ss. Entire surface pustulose. Shell small..... CXIX. *Vitulina.*
ss. Spines irregularly distributed on the crests of the plications.
XXIX. *Nisusia.*
ss. No spines or pustules present.................................. 18†.
18† Shell distinctly punctate .... 18*.
18* Plications sharp .... XXX. *Protorthis.*
18* Plications rounded......... XCIV. *Tropidoleptus.*
18† Shell not distinctly punctate........................... 19*
19* Shell very small, cyrtiniform (cardinal area of pedicle valve very high)..... LX. *Scenidium.*
19* Shell comparatively large.
XXVIII. *Billingsella.*

k. Surface spinose (productoid).. 777
777. Pedicle umbo prominent and strongly incurved............... *tt.*
tt. Shell small.................................... XLVI. *Productella.*
tt. Shell large.................................... XLVII. *Productus.*
777. Pedicle valve not strongly incurved, often truncate.
XLV. *Strophalosia.*

k. Surface smooth except for concentric growth lines.................. 888.
888. Margins of hinge area vertically grooved.
XXXIII. *Pholidostrophia.*
888. Margins of hinge area not grooved............................... *uu.*
uu. Hinge line short. Umbo usually conspicuous. No spondylium, large delthyrium..............XXVI. *Kutorgina.*
uu. Hinge line long. Umbo inconspicuous; spondylium present.
LXI. *Syntrophia.*

4. Shell orthoid — Shell usually plano- or bi-convex, never definitely concavo-convex. Hinge line usually much less than the greatest width of the shell. Cardinal areas well and almost equally developed in each valve; triangular delthyrium usually well developed in each valve and open. Median sinus when present generally very broad and ill defined. Surface marked with radiating striæ or plications.............................. *l.*

l. Surface radially plicate (*i. e.*, radiating lines coarse).................. 999
999. Hinge line short, forming about one third the greatest width of the shell. Shell globular................. LVIII. *Enteletes.*
999. Hinge line long.. *vv.*
vv. Pedicle valve flat or partly concave; brachial convex.
L. *Dinorthis.*
vv. Pedicle valve convex... 19†.
19† Brachial valve flat... 20*.
20* Deltidium present in pedicle valve............ 17''.
17'' Spines present.............. XXIX. *Nisusia.*
17'' Spines absent .... *g''.*
g'' Shell punctate... XXVIII. *Billingsella.*
g'' Shell impunctate..... XXX. *Protorthis.*

20* No deltidium present .... 18″.

18″ Shell cyrtiniform with erect cardinal area. LX. *Scenidium.*

18″ Shell not cyrtiniform...... XLVIII. *Orthis.*

19† Brachial valve convex.................................. 21*

21* Strong mesial fold on brachial valve and corresponding sinus on pedicle valve, both with sharp plications........... LIII. *Platystrophia.*

21* No mesial fold present. Shallow sinus present or absent........................ XLIX. *Plectorthis.*

l. Surface radially striate (*i. e.*, radiating lines fine; except *Hebertella borealis* 174).. 1111

1111. Strongly two-lobed. Very small............... LIV. *Bilobites.*

1111. Not strongly two-lobed.. *ww.*

ww. Hinge line short (about ⅓ the greatest width of shell). 20†.

20† Valves subequal and gently biconvex. LVI. *Rhipidomella.*

20† Brachial valve very convex. Pedicle valve much less convex............................ LVII. *Schizophoria.*

ww. Hinge line long, pedicle valve deep, brachial valve flat or shallow.. 21†

21† Shell substance punctate.............. LV. *Dalmanella.*

21† Shell substance impunctate............................ 22*

22* Pedicle valve subpyramidal. Deltidium and spondylium present........ LIX. *Clitambonites.*

22* Pedicle valve depressed convex............... 19″.

19″ Muscular impression of pedicle valve small, almost confined between the dental lamellæ .... LII. *Orthostrophia.*

19″ Muscular impression of pedicle valve moderately large, extending about one half the distance from beak to front. LI. *Hebertella.*

4. Shell spiriferoid — Usually transversely elongate with hinge line forming greatest width of shell. Bi-convex, very seldom plano-convex. Cardinal area with the open triangular delthyrium most conspicuous on the pedicle valve, rarely with pseudodeltidium. Median sinus on pedicle valve and fold on brachial (reversed in *Metaplasia*, *Vitulina*, *Scenidium*). Shell usually radially plicate, rarely smooth or striate. Brachidium typically an extraverted spire.............................. *m.*

m. Conspicuous spines present. CIV. *Reticularia* (except *R. nevadaensis*, *R. lævis* and *R. perplexa*).

m. Minute spines present......................... 324. *Spiriferina spinosa.*

m. Spines absent or microscopic .... 2222.

2222. Surface lacking plications.. *xx.*

xx. Mesial fold and sinus normal in position (*i. e.*, fold on brachial valve and sinus on pedicle)............... 22†.

22† Surface smooth. CVII. *Ambocœlia* (except *A. planoconvexa*).

22† Surface with concentric striæ....................... 23*.

23* Sinus and fold undefined and shallow.
376. *Reticularia lævis.*
23* Sinus and fold defined and angular.
CV. *Martinia.*
22† Surface radially striate........... 326. *Spirifer radiatus.*
22† Surface minutely granular (seen under lens).
388. *Ambocœlia planoconvexa.*
xx. Mesial fold and sinus reversed in position.
CVIII. *Metaplasia.*
xx. Mesial fold and sinus lacking or faint..................... 23†.
23† Beak of pedicle valve high and incurved; that of brachial not incurved. Shell nearly plano-convex.
XXVI. *Kutorgina.*
23† Both beaks incurved. Shell bi-convex.
380. *Reticularia perplexa.*
2222. Surface plicated .... *yy.*
yy. Shell structure punctate.. 24†.
24† Small .... 24*.
24* Cardinal area present............................. 20′′.
20′′ Cardinal area very high, giving the shell a semipyramidal form............ C. *Cyrtina.*
20′′ Width much exceeding length, the shell thus lacking a semipyramidal aspect.
CII. *Spiriferina.*
24* Cardinal area absent. Umbo of pedicle valve truncated by a round foramen.
CXII. *Trematospira.*
24† Large, spiriferoid, with pedicle tube or syrinx in rostral cavity of pedicle valve.......... CVI. *Syringothyris.*
yy. Shell structure not punctate.................................. 25†.
25† Low fold on pedicle valve and sinus on brachial. 25*.
25* Shell pustulose, brachidium a spire.
CXIX. *Vitulina.*
25* Shell not pustulose, brachidium absent.
LX. *Scenidium.*
25† Well marked sinus on pedicle valve and fold on brachial. 26*.
26* Cardinal areas of the two valves subequal in height; plications angular, including fold and sinus; no brachidium..... LIII. *Platystrophia.*
26* Cardinal area of pedicle valve greatly exceeding that of the brachial; brachidium spiral... 21′′.
21′′ Cardinal area very high, form of shell subpyramidal, deltidium perforated.
CI. *Cyrtia.*
21′′ Cardinal area variable, form not subpyramidal, deltidium absent or without perforations... .... CIII. *Spirifer*

ATREMATA.

I. Obolella Billings.

Small, thick-valved, oval or round shells. Narrow cardinal area on each valve; that on the pedicle valve is crossed by a pedicle groove, not a slit. A long narrow muscular impression is present on each side in the interior of both valves. Shell structure calcareous. Cambric–?Ordovicic.

1. **O. atlantica** Walcott. (Fig. 222, *a–d.*) Lower Cambric.

Resembles *O. crassa* but differs in its average smaller size (1/8–1/4 inch long), in its more circular form due to the lesser prominence of the umbo and in its stronger concentric growth lines.

Etcheminian of Massachusetts, Newfoundland.

Fig. 222. *a–d*, *Obolella atlantica;* *a*, exterior of ventral valve; *b*, mold of interior of same; *c*, exterior of dorsal valve; *d*, mold of interior of same (greatly enlarged); *e–g*, *Obolella crassa;* *e*, ventral valve, × 2; *f*, mold of interior of same; *g*, mold of interior of dorsal valve (*a*, cardinal; *c*, central, and *d*, lateral or internal muscular scars; *p*, pedicle groove; *x*, area); *h*, *Obolella gemma*, interior of a dorsal valve, much enlarged. (All after Walcott.)

2. **O. crassa** (Hall). (Fig. 222, *e–g.*) Lower Cambric.

Sub-orbicular with beaks extending slightly beyond the margin. The two valves are almost indistinguishable from each other; the beaks of both are curved down, that of the brachial valve nearly touching the short, indistinct hinge line. Surface of both valves radially and concentrically striated. Shell thick and solid. Average shell is 1/3 inch in length.

Etcheminian of Massachusetts, and Georgian of New York, Quebec.

3. **O. gemma** Billings. (Fig. 222, *h*, 223, *a*, *b*.) Lower Cambric.

Ovate. Pedicle valve with an acute beak. Brachial valve nearly circular and obscurely triangular at beak. Surface of both valves usually nearly smooth or feebly striate. Average length $\frac{1}{6}$ inch.

Georgian of New York, Quebec.

4. **O. nitida** Ford. (Fig. 223, *c*.) Lower Cambric.

Brachial valve gently convex. Hinge line slightly curved and equalling about one third the width of the shell. Surface marked by a well defined median depression extending from the most elevated portion of the valve forward for about one half the length of the shell. Valve covered with very fine radiating and concentric striæ. Diameter about ⅛ inch.

Georgian of New York, and Etcheminian of New Brunswick.

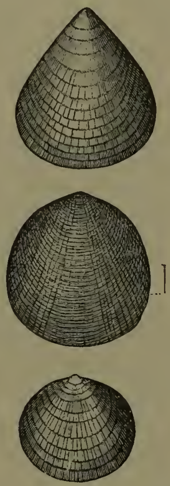


Fig. 223. *a*, *Obolella gemma*, ventral valve, × 6; *b*, dorsal valve, × 6; *c*, *O. nitida*, dorsal valve, × 5. (After Walcott.)

II. Dicellomus Hall.

Small, thick-valved, ovate, biconvex with apices marginal. Outer surface of shell finely punctate. Shell substance calcareo-corneous. Differs from *Obolella* in the partially corneous character of the shell substance, in the absence of a foraminal opening and in some internal characters. In *Dicellomus* the interior of the pedicle valve shows a short cardinal area with a median pedicle groove, composite muscle scars and a short shelf, like a spondylium extending into the valve from each side of the pedicle groove. The interior of the brachial valve has a narrow cardinal area in one species, *D. politus*. Middle–Upper Cambric.

5. **D. politus** Hall. (Fig. 224.) Middle-UpperCambric.

Valves moderately convex with greatest width near the front which is broadly rounded. Pedicle valve acuminate. Umbos prominent. Cardinal areas in both valves. Surface smooth except for concentric lamellæ.

Upper Cambric of Wisconsin, Minnesota, South Dakota, Middle Cambric of Montana, Arizona, Oklahoma.

Fig. 224. *Dicellomus politus* exterior natural size, and interior of ventral and dorsel valves much enlarged. (After Hall.)

III. Dinobolus Hall.

Subcircular; valves convex and thick. Pedicle valve with an acute, prolonged beak; cardinal area triangular, deltidium present. Brachial valve with inconspicuous beak. A V-shaped platform, with the apex of the V anterior, extends in each valve from the beak half way to the front; the vaults beneath are more conical than in *Trimerella*. Ordovicic–Siluric.

6. **D. conradi** Hall. (Fig. 225, *a.*) Siluric.

Oval, slightly wider than long and very symmetrical in outline. About 1½ inches wide by 1⅜ inches long.

Niagaran of Ohio, Iowa, Illinois, Wisconsin.

IV. Monomerella Billings.

Gibbous. Umbo of pedicle valve more or less elevated with high cardinal area; umbo of brachial valve inconspicuous. Internal platforms of both valves much less prominent than in *Trimerella* and *Dinobolus* and with no empty space beneath; platform of pedicle valve usually continued forward as a strong septum. Siluric.

7. **M. prisca** Billings. (Fig. 225, *b–c.*) Siluric.

Pedicle valve ovate with greatest width at about the anterior third of shell; beak narrowly rounded, front broadly rounded; septum for about one third the length of shell. Brachial valve about one fourth shorter than the pedicle and more convex, with a more broadly rounded anterior portion. Pedicle valve one and a half inches long by a little over an inch wide.

Guelph of Ohio, Illinois, Ontario.

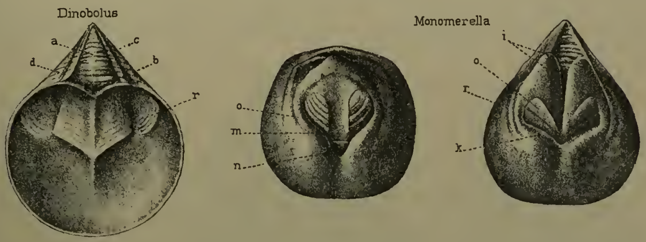


Fig. 225. *a*, *Dinobolus conradi*, interior of pedicle valve, × ⅔ (*a*, deltidium; *b*, deltidial slope; *c*, deltidial ridges; *d*, areal borders; *r*, side of crescent muscular area) *b*, *Monomerella prisca*, internal mold of brachial valve; *c*, internal mold of pedicle valve, × ⅔. (*i*, umbonal chambers; *k*, platform-vaults; *m*, median scars; *n*, anterior scars; *o*, lateral scars; *r*, side of crescent.) (After Hall and Clarke.)

V. Trimerella Billings.

Thick, elongate-ovate. Cardinal area of pedicle valve very prominent; pedicle opening closed by a broad deltidium which is concave owing to the bounding ridges. Brachial valve with no cardinal area but incurved against the deltidium. Long and narrow platforms are present in both valves extending from the apex over half way to the anterior margin; that of the brachial valve is the higher. The area beneath the platforms is occupied by two long, tubular cavities. Most American specimens are internal molds in dolomitic limestone. Siluric.

8. **T. acuminata** Billings. Siluric.

Pedicle valve ovate, widest a little in advance of the middle, tapering from there with nearly straight sides to the beak which is almost acute; the platform bears a deep median furrow. Brachial valve much shorter than the pedicle, more convex and with beak more strongly incurved. Surface marked by coarse concentric growth lines. A very large specimen measures 3½ inches in length by 3 inches in width.

Guelph of Ohio, Illinois, Ontario.

9. **T. ohioensis** Meek. (Fig. 226, *a*, *b*.) Siluric.

Differs from *T. acuminata* in its broader form, and less produced and blunter beak, with thicker septa as indicated by the mold.

In the Niagaran beds of Ohio, Illinois and Ontario.

10. **T. grandis** Billings. (Fig. 226, *c d.*) Siluric.

Ovate, with the greatest width a little in advance of the middle. Both valves moderately and uniformly convex. Surface marked with obscure concentric growth lines. Length of a large shell is 3 inches; width, 2½ inches. This species differs from *T. acumi-*

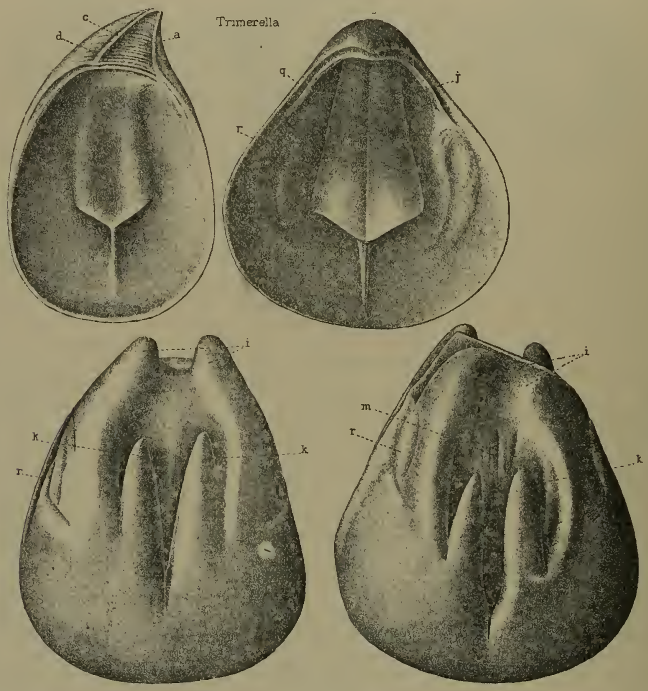


Fig. 226. *a, Trimerella ohioensis*, pedicle valve with distorted umbo, × ⅔; *b.* brachial valve, × ⅔; *c, Trimerella grandis*, internal mold viewed from brachial side, × ⅔; *d*, the reverse of the same specimen, × ⅔. (*a*, deltidium; *c*, deltidial ridges; *d*, areal borders; *i*, umbonal chambers; *j*, platform; *k*, platform vaults; *m*, median scars; *q*, crown of crescent; *r*, side of crescent.) (After Hall and Clarke.)

nata in that the tubular cavities of the interior do not extend to the beak, the pedicle valve is broader and the concentric lines are obscure.

Guelph of Ohio, Wisconsin, Ontario.

VI. Lingulella Salter.

Valves *Lingula*-like but pedicle valve pointed, with a cardinal area, and elevated beyond the brachial valve; a distinct pedicle groove present. Cambric-Ordovicic.

11. **L. aurora** Hall. Upper Cambric.

Broadly ovate; breadth about ½ inch, length somewhat greater. Pedicle valve with beak slightly attenuate, cardinal area high. Brachial valve with very obtuse beak. Surface marked by concentric striæ crossed in partially exfoliated specimens by radiating striæ.

St. Croix of Wisconsin, Minnesota.

12. **L. (Westonia) ella** (Hall and Whitf.) (Fig. 229. *a*, *b*.
Lower-Middle Cambric.

Brachial valve subcircular or ovate; pedicle valve longer than wide, cardinal slopes about 65 degrees (greater when compressed); area flattened, rather broad and with narrow median groove. Growth lines lamellose towards the front; radiating lines indistinct.

Wasatch and Oquirrh Mountains, Utah; near Pioche, Nevada.

VII. Lingulepis Hall.

Lingula-like but strongly inequivalved. Pedicle valve generally much produced at the beak. Differs from *Lingulella* in the absence of a distinct cardinal area and in the often much attenuated beak of the pedicle valve. Upper Cambric-Ordovicic.

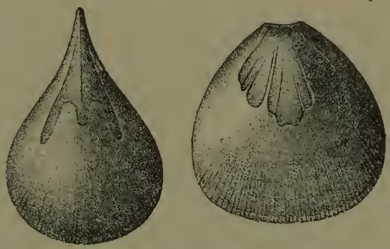


Fig. 227. *Lingulepis pinniformis* internal molds of pedicle and brachial valves, × 2. (After Hall.)

13. **L. pinniformis** (Owen). (Fig. 227.) Upper Cambric.

Pedicle valve spatulate; posterior portion attenuate, acute, convex in the middle. Anterior portion semicircular. Brachial valve without the attenuate portion. Surface of both valves marked with concentric striæ and where exfoliated, with faint radiating ones.

St. Croix of Wisconsin, South Dakota. Potsdam of New York and Canada (*L. acuminata*).

14. **L. prima** (Hall.) Upper Cambric.

Valves moderately convex with rounded front. Umbo very low. Surface marked by a few concentric wrinkles and by many fine longitudinal lines. An average shell measures ¼ inch by $\frac{1}{5}$ inch in length and breadth respectively.

Potsdam of New York, South Dakota.

VIII. Leptobolus Hall.

Minute, with convex valves. Pedicle valve with cardinal area cut by a pedicle groove. Brachial valve slightly thickened on cardinal margin. Interior of both valves with two or three diverging septa. Ordovicic.

15. **L. insignis** Hall. Ordovicic.

Orbicular with a scarcely pointed beak. Valves regularly convex when not compressed. Specimens usually found flattened. Surface marked by concentric growth lines. Differs from *L. occidentalis* in being more nearly circular, with a shorter beak and more regularly convex valves.

Utica of New York, Ohio, Ontario.

16. **L. occidentalis** Hall. Ordovicic.

Widest below the middle. Valves moderately convex and most prominent near the beak. Surface marked by concentric growth lines. About $\frac{8}{100}$ inch in length.

Maquoketa of Iowa and Wisconsin; Lorraine of Ontario.

IX. Lingula Bruguière.

Shell thin, glistening, generally smooth or with fine concentric or rarely radiating striæ; generally equivalved; broad anteriorly, parallel sided or tapering posteriorly. Ordovicic–Recent.

A. Rectangular (sides straight and nearly parallel); hinge extremities abruptly rounded or truncate .... I.
- I. Surface nearly smooth and glossy .... 22. *L. elderi.*
- I. Surface marked by concentric striæ .... 1.
  - 1. Striæ strong, sharp. Shell large .... *a.*
    - *a*. Radiating striæ absent .... 24. *L. iowaensis.*
    - *a*. Radiating striæ present .... 20. *L. rectilateralis.*
  - 1. Striæ fine .... *b.*
    - *b*. Striæ crossed by radiating lines .... 26. *L. clintoni.*
    - *b*. Striæ not crossed by radiating lines .... 29. *L. cuyahoga.*

B. Oval or elliptical (sides curving) .... II.
- II. Small, not exceeding one-half inch in length .... 2.
  - 2. Length exceeding breadth .... *c.*
    - *c*. Front subtruncate .... 32. *L. subspatulata.*
    - *c*. Front broadly rounded .... †.
      - † Beaks attenuate .... 23. *L. modesta.*
      - † Beaks obtuse .... 27. *L. ligea.*
    - *c*. Front regularly rounded .... ††.
      - †† With flattening and faint radiating striæ .... 30. *L. melie.*
      - †† Convex, without flattening or radiating striæ.. 31. *L. umbonata.*
  - 2. Length and breadth nearly equal .... 18. *L. curta.*
- II. Large, 1 inch long .... 17. *L. cobourgensis.*

C. Wedge-shaped, with very acute beaks .... III.
  III. Valves convex. .... 3.
    3. Large .... 25. *L. cuneata.*
    3. Minute .... 28. *L. spatulata.*
  III. Valves depressed .... 19. *L. trentonensis.*
D. With converging but straight sides .... IV.
  IV. Beak obtuse, large .... 21. *L. eva.*

17. **L. cobourgensis** Billings (Fig. 228, *a–b.*) Ordovicic.

Large, oval. Both valves moderately convex. Length about one fourth greater than width. Concentric growth lines fine, becoming

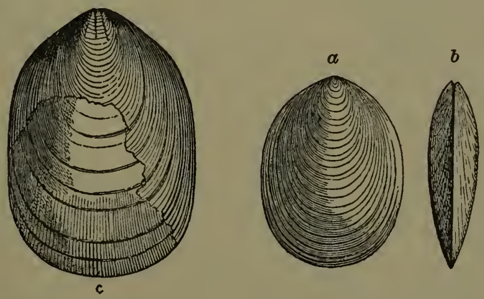


FIG. 228. *a–b*, *Lingula cobourgensis*; *c*, *L. rectilateralis*. All natural size. (After Billings Can. Geol.)

sharp. Elevated and closely crowded striæ on the lateral slopes.

Trenton of Minnesota, southeastern Canada.

18. **L. curta** Conrad. Ordovicic.

Small, obtusely ovate, depressed convex. Length and breadth nearly equal. Beaks scarcely projecting beyond the margin of the shell. Front broadly rounded. Surface covered by elevated concentric lines.

Trenton–Utica of New York, Pennsylvania, Quebec, Frobischer Bay.

19. **L. (Glossina) trentonensis** Conrad. Ordovicic.

Of moderate size, ovate-acute, attenuate toward the apex; sides nearly straight, front rounded. Surface depressed. Smooth or marked by concentric lines which are crossed by obscure radiating striæ.

Trenton and Utica of New York, Wisconsin, Ontario.

20. **L. rectilateralis** Emmons. (Fig. 228, *c.*) Ordovicic.

Large, with nearly parallel sides, form elliptical; front regularly rounded; surface marked by radiating striæ. This species is readily recognized by its large size.

Trenton–Lorraine of New York, Ottawa and Anticosti.

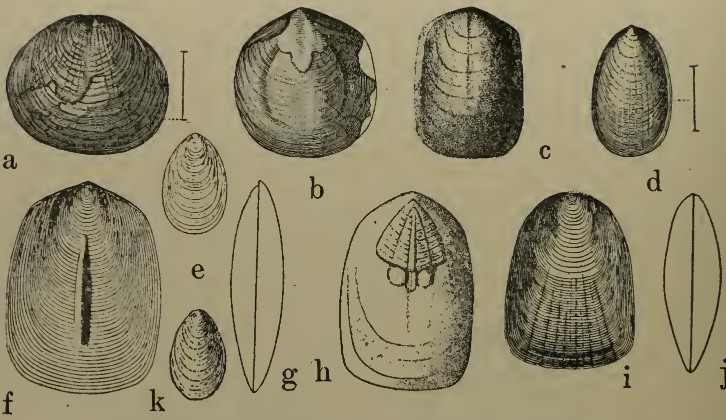


FIG. 229. *a*, *Westonia ella*, × 2; *b*, mold of interior of dorsal valve, × 2; *c*, *Lingula elderi*, dorsal view, × 1; *d*, *L. ligea*, × 2; *e*, *L. modesta*, × 4; *f g h*, *L. iowaensis;* dorsal and profile views, and mold of interior of ventral valve, × 1; *i j*, *L. eva*, dorsal and profile views, × 1; *k*, *L. umbonata*, × 1. (After Walcott (*a*, *b*), Winchell and Schuchert, and Ind. Surv. (*k*).)

21. **L. eva** Billings. (Fig. 229, *i–j*.) Ordovicic.
Widest near the front, with nearly straight gradually converging sides; valves convex, flattened near front; surface with a few prominent radiating striæ on anterior half.

Black River of Canada, Minnesota, etc.

22. **L. elderi** Whitfield. (Figs. 221, 229, *c*.) Ordovicic.
Subquadrangular with nearly parallel margins and subequal extremities, the beak being somewhat angular and the front broadly rounded. Valves quite convex. The dorsal or shorter and more convex valve marked by a flattening along the middle. Surface nearly smooth.

Trenton and Lorraine of Ohio, Wisconsin, Minnesota.

23. **L. modesta** E. O. Ulrich (Fig. 229, *e*.) Ordovicic.
Minute, subovate; widest anteriorly. Valves nearly flat. Anterior third uniformly rounded. Surface marked with very faint concentric undulations.

Trenton-Lorraine of Iowa, Kentucky, Minnesota.

24. **L. iowaensis** Owen. (Fig. 229, *f*, *g*, *h*.) Ordovicic.
Large, broadly subquadrate, generally a little narrower above the middle than below. Beak obscurely angular, front rounded. Sides gently rounded. Valves convex. Beak of pedicle valve projecting a little beyond that of the brachial and more pointed. Surface marked by strong and irregular growth lines.

Galena of Iowa, Illinois, Wisconsin, Minnesota, Manitoba.

25. **L. cuneata** Conrad. (Fig. 230.) Siluric.

Wedge-shaped, very acute at beaks. Margins nearly straight, converging uniformly from beak to front which is but slightly curved (almost truncate). Valves convex on the posterior half but flattened anteriorly. Surface longitudinally striated.

Medina of New York.

FIG. 230. *Lingula cuneata* enlarged, × 2. (After Hall & Clarke.)

26. **L. clintoni** Vanuxem. Siluric.

Sides of shell straight and nearly parallel; abruptly rounded at beak, abruptly truncate at front. Shell flat anteriorly but elevated into a ridge at beak and hence here very convex. Surface marked by concentric growth lines and radiating striæ.

Clinton of New York, Pennsylvania, Ontario, Nova Scotia.

FIG. 231. *Lingula spatulata*, × 2.

27. **L. ligea** Hall (Fig. 229, *d.*) Devonic.

Narrow elliptical with length twice the width. Sides slightly curving. Extremities subequal, with obtuse beak and broadly rounded front. Surface marked by fine concentric striæ.

Hamilton-Portage of New York, Ohio, Nevada, Ontario.

28. **L. spatulata** Vanuxem. (Fig. 231.) Devonic.

Minute, spatulate, moderately convex; attenuate toward the beak; widest across the middle. Length (scarcely three tenths of an inch) about twice the width. Surface marked by fine concentric striæ.

Genesee and Portage of New York, Ohio, Canada and elsewhere.

FIG. 232. *a*, *Lingula cuyahoga*, × 1; (after Hall) *b*, *Lingula melie* large specimen, × 2; (Meek.—Ohio Pal.)

29. **L. cuyahoga** Hall. (Fig. 232, *a.*)

Devonic–Lower Carbonic.

Length and breadth about as five to three. Sides nearly parallel, converging slightly toward the cardinal margins. Beak obtuse; front subtruncate. Surface covered by fine concentric striæ.

Chemung–Waverly of New York, Ohio.

30. **L. melie** Hall. (Fig. 232, *b*.) Lower Carbonic.
Generally smaller than preceding, with curving sides and acute beak, below which is a narrow flattened space gradually widening to base. Growth lines crowded at intervals; radiating striæ obscure.

Waverly of Ohio.

31. **L. umbonata** Cox. (Fig. 229, *k*.) Upper Carbonic.
Of medium size, thin, elliptical with regularly rounding margins and prominent umbonal portion. Surface smooth except for lines of growth.

Coal Measures of Kentucky, Ohio, Iowa, and Missouri.

32. **L. subspatulata** Hall and Meek. Upper Cretacic.
Of moderate size, oblong. Lateral margins only slightly curved, narrowing the shell toward the front. Anterior margin subtruncate. Surface marked by fine concentric striæ.

Nebraska, New Mexico, Manitoba.

X. LINGULASMA E. O. Ulrich.

Large, thick-shelled Lingulæ. Brachial valve much the deeper. Muscles of both valves situated upon a platform which extends over one-half the length of the shell; that of the pedicle valve is low; that of the brachial is high and is continued anteriorly as a strong septum. No pedicle opening present. Deltidium present and probably entirely internal, thus forming a sheath resting upon the posterior portion of the pedicle platform. Ordovicic.

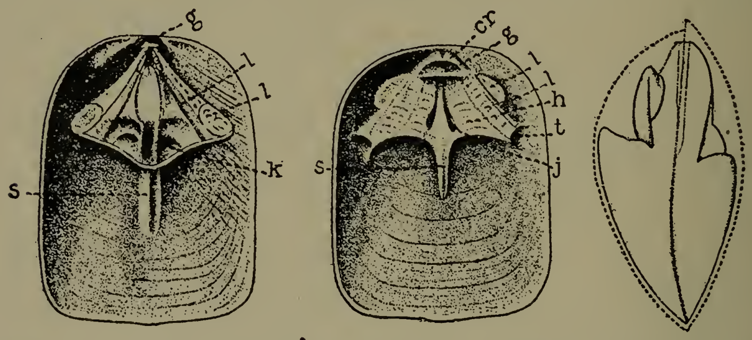


FIG. 233. *Lingulasma galenaense*; interior view of ventral and dorsal valves, and profile of inner mold with outline of shell dotted in (*cr*, crescent; *g*, umbonal scar; *h*, central scars; *j*, anterior scars; *k*, middle scars; *l*, lateral scars; *s*, septum; *t*, transverse scars. × 1. (After Winchell & Schuchert, Min. Pal.)

33. **L. galenaense** Winchell and Schuchert. (Fig. 233.) Ordovicic.

Large, oblong, with nearly straight lateral and anterior margins. Both valves strongly convex. Surface marked with concentric striæ which at irregular intervals rise into small pustules.

Galena of Iowa, Wisconsin, Minnesota.

NEOTREMATA.

XI. Acrotreta Kutorga.

Pedicle valve subconical with apex truncated by pedicle opening. Posterior margin flattened, triangular and resembling a true cardinal area; this slope is divided medially by a shallow groove widening downward. Brachial valve usually flat. Surface concentrically striated. Differs from *Acrothele* in having the slope from the apex to the posterior margin vertical. Cambric.

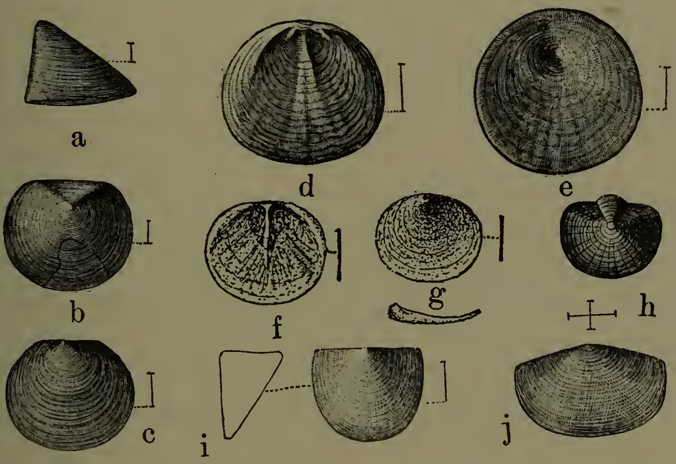


FIG. 234. *a–c*, *Acrotretra gemma*, side and summit view of ventral valve, and dorsal valve, all $\times 3$; *d*, *e*, *Acrothele subsidua*, interior of dorsal and exterior of ventral valves, $\times 3$; *f*, *g*, *Acrothele matthewi*, interior, exterior and profile views, $\times 2$; *h*, *Iphidea bella*; *i*, *j*, *Iphidea swantonensis*, ventral valve and profile, dorsal valve. (*f* and *g* after Matthew, the others after Walcott.)

34. **A. gemma** Billings. (Fig. 234, *a–c*.) Lower to Upper Cambric.

Minute. Brachial valve circular and nearly flat with beak not projecting beyond the hinge line and with wide, shallow mesial sinus. Pedicle valve acutely conical with flat triangular area whose base forms half the width of the shell.

Montana, Utah, Nevada, Newfoundland.

XII. Acrothele Linnarsson.

Corneous, subcircular. Pedicle valve subconical with excentric beak truncated by the pedicle opening, anterior to which are often two wart-like protuberances. Two such protuberances also form the umbo of the brachial valve which is marginal. Differs from *Acrotreta* in having the slope from the apex to the posterior margin quite gentle, and in the absence of a cardinal area. Cambric.

35. **A. matthewi** (Hartt). (Fig. 234, *f–g*.) Middle Cambric.
Round, extremely flat and thin. The two small wart-like protuberances are present in front of the foramen of the pedicle valve.
St. John beds of Newfoundland, New Brunswick.

36. **A. subsidua** (White). (Fig. 234, *d–e*.) Lower to Middle Cambric.
Thin, with transverse diameter slightly exceeding the longitudinal. Sides regularly and front broadly rounded. Posterior margin forms a short and nearly straight hinge line. Brachial valve flat; pedicle valve somewhat convex near the umbo, with rather prominent beak.
Utah, Nevada.

37. **A. gamagei** (Hobbs). Middle Cambric.
Differs from *A. matthewi* in its more nearly circular form, longer hinge-line and in having the surface marked by radiating striæ. Surface flat or slightly convex instead of concave in anterior portion.
Middle Cambric Paradoxides beds of eastern Massachusetts.

XIII. Linnarssonia Walcott.

Calcareous, subcircular, convex. Beak of pedicle valve excentric, perforated by a minute pedicle opening. No cardinal area on either valve. Differs from *Obolella* in the absence of the great lateral muscular impressions and cardinal areas, and also in the presence of a pedicle opening in the pedicle valve. It is smaller and more conical than *Acrothele*. Cambric.

38. **L. pretiosa** (Billings). Upper Cambric.
Breadth exceeding length with greatest width about the middle. Beaks very obtuse. Surface covered with very fine lamellose concentric striæ. Length about ¼ inch.
Quebec.

XIV. Iphidea Billings.

Pedicle valve subconical, strongly elevated at beak; flattened posteriorly, forming an appearance resembling a true cardinal area; this area is crossed by a broad triangular ridge (deltidium). Hinge line nearly straight. Beak excentric, perforated by the pedicle opening. Brachial valve semicircular, slightly convex. Surface of shell covered with fine concentric striæ. The possession of the large convex deltidium distinguishes it from *Acrotreta*. Cambric.

39. **I. bella** Billings (Fig. 234, *h.*) Lower Cambric.
Small and conical. Pedicle valve about ½ inch wide by slightly less long. Surface covered with fine concentric striæ which are continued across the large flat area. These striæ are crossed by a few obscure radiating ones.

Massachusetts, Quebec, Labrador.

40. **I. pannulus** (White). Lower and Middle Cambric.
Differs from *I. bella* in its smaller size (⅛ inch) and in the character of the surface markings; these consist of a fine network of oblique, raised lines, visible under a lens.

New York, Utah, Nevada, Quebec, British Columbia.

41. **I. swantonensis** Walcott. (Fig. 234, *i–j.*) Lower Cambric.
Hemispheric to semioval outline with high hinge area, marking the greatest width of the shell and surface marked by concentric growth lines. (This is also known under the name *Paterina labradorica.*)

Georgian of Swanton and Highgate Springs, Vermont.

XV. Trematis Sharpe.

Subcircular. Pedicle valve unevenly convex, depressed in posterior portion. The margin of the pedicle valve is interrupted by the pedicle fissure which extends almost to the subcentral apex; internally the sides of this fissure are often thickened. Brachial valve convex; apex marginal or slightly projecting. In interior of pedicle valve radiating sinuses extend from the apex. Surface of both valves covered with punctures which are arranged either in quincunxial order or in radiating rows and penetrate the outer calcareous layers of the shell, but not the inner corneous ones. Ordovicic.

42. **T. ottawaensis** Billings. (Fig. 235, *c*.) Ordovicic.

About one inch in diameter. Surface covered with fine radiating striæ and crossed concentrically by fine discontinuous ridges.

Trenton and Lorraine of New York, Kentucky, Minnesota, Ontario, Anticosti.

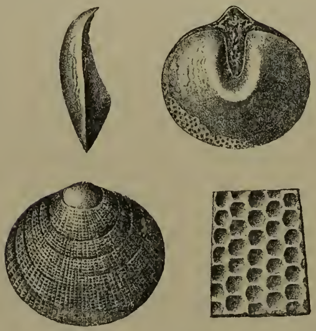


FIG. 235. *a*, *b* and *d*, *Trematis millipunctata*, profile and ventral view, × 4/3 and enlargement of surface, × 16; *c*, *Trematis ottawaensis*, brachial valve, ×2/3. (After Hall and Clarke.)

43. **T. terminalis** Emmons. Ordovicic.

About half as large as the preceding or smaller; foraminal slit flanked by broad depression. Apex of brachial valve marginal, not projecting.

Trenton of New York and Canada.

44. **T. millepunctata** Hall. (Fig. 235, *a–b*, *d*.) Ordovicic.

Intermediate in size between the two preceding; foraminal slit deep, beak of brachial valve projecting. Surface punctate.

From the Utica and Lorraine of Cincinnati, O., and Covington, Ky.

XVI. SCHIZOCRANIA Hall and Whitfield.

Subcircular, strongly inequivalve. Pedicle or lower valve flat or concave; a deep, broad triangular notch extends from near the subcentral beak to the margin where it constitutes about one sixth of the periphery. In the apex of this notch is a triangular transverse plate extending about one third the distance to the margin. Surface covered with concentric lines. Brachial valve convex; larger than the pedicle valve and extending beyond it on all sides. Beak marginal or submarginal. Surface with radiating striæ. Ordovicic and Devonic.

45. **S. filosa** Hall. (Fig. 236, *a*.) Ordovicic.

Slightly ovate. Surface of brachial or upper valve covered with fine, even, radiating striæ. Pedicle valve strongly marked by irregular concentric undulations. This species is usually found attached to brachiopods, particularly to *Rafinesquina alternata*.

Trenton–Lorraine of New York, Ohio, Minnesota, Ontario.

XVII. LINGULODISCINA Whitfield.

Upper (brachial) valve linguloid with nearly terminal beak in typical species; lower (pedicle) valve discinoid with centrally placed beak. Much like *Schizocrania* but the brachial valve has no radiating striæ. Pedicle area much elevated internally and cut by a narrow, open fissure. Devonic–Lower Carbonic.

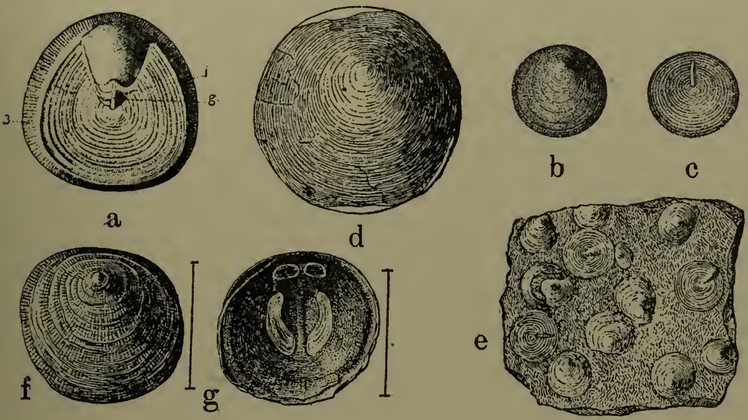


FIG. 236. *a*, *Schizocrania filosa*, ╳ 2, specimen with dorsal or upper valve partly removed, only the margin remaining (*B*) and showing interior of ventral valve (*P*), showing broad notch and pedicle groove *g*; *l*, walls of groove (Winchell & Schuchert); *b*, *c*, *Lingulodiscina newberryi*, dorsal and ventral valves, ╳ 1 (Ohio Pal.); *d*, *Orbiculoidea convexa*, dorsal valve, ╳ 1; *e*, *Orbiculoidea missouriensis*, ╳ 1, (Ind. Survey); *f*, *g*, *Discinisca lugubris*, exterior and interior of dorsal valve, ╳ 1 (Md. Surv).

46. **L. newberryi** (Hall). (Fig. 236, *b*, *c*.) Lower Carbonic.

Brachial valve with prominent apex situated near the posterior margin. Pedicle valve slightly concave with excentric apex and large oval foramen with deeply depressed margins. Shell thick, strong and of a lamellose structure. Surface marked by fine concentric lines.

Waverly of Ohio, Nevada.

XVIII. SCHIZOBOLUS Ulrich.

Oval, depressed convex. Apex of pedicle valve at terminus of a rather deep notch in the posterior margin; apex of brachial valve subterminal and but slightly elevated with no notch present. Each valve with a pair of muscle impressions situated posteriorly and separated by a median ridge extending about one third the distance to the front of the shell. Devonic.

47. **S. concentricus** (Vanuxem). (*S. truncatus* Hall.) (Fig. 237.) Devonic.

Very small, rarely exceeding one fifth inch in length. Broader anteriorly and with posterior margin abruptly rounded or truncate. Surface marked by fine concentric striæ and with faint radiating lines. The brachial valve somewhat resembles a *Lingula*.

Genesee and Naples of New York, Kentucky, Indiana.

FIG. 237. *Schizobolus concentricus*, interior of pedicle and brachial valves and exterior of pedicle valve, × 2.

XIX. ORBICULOIDEA d'Orbigny.

Corneous, subcircular. Apices excentric. Pedicle valve with a narrow pedicle groove beneath the beak extending almost to the margin of the valve; just behind the beak this groove penetrates through a long tube obliquely to the interior of the valve where it opens near the margin; in this it differs from *Discinisca*. Brachial valve larger, depressed conical. Ordovicic–Carbonic.

48. **O. lamellosa** Hall. Ordovicic.

Apex nearly central. Surface covered with rather strong sublamellose concentric growth lines which become more distinct and coarser from the apex outward.

Trenton and Lorraine of New York, Minnesota, Ontario.

49. **O. lodiensis** Vanuxem. (Fig. 238.) Devonic.

FIG. 238. *Orbiculoidea lodiensis*, dorsal valve, × 2.

Small, rarely exceeding one-third inch in diameter. Brachial valve with minute apex. Pedicle valve somewhat abruptly elevated at apex, with linear foramen. Surface covered with fine concentric striæ and on the anterior half of the shell with faint radiating folds or undulations.

Genesee of New York, Nevada.

50. **O. convexa** (Shumard). (Fig. 236, *d*.) Upper Carbonic.

Pedicle valve broadly convex with height nearly equal to one half the diameter; apex moderately prominent, situated at about one third the distance from the posterior margin. Surface marked by distinct concentric growth lines. Diameter about one inch.

Ohio, Indiana, Missouri, Kansas.

51. **O. missouriensis** Shumard. (Fig. 236, *e*.) Upper Carbonic.

Small, averaging about one fourth inch in diameter. Apex prominent. Surfaces of both valves marked by concentric lines and fine lamellations.

Ohio, Indiana, Iowa, Illinois, Missouri.

XX. Discinisca Dall.

Lower or pedicle valve flattened or concave with an elevated interior pedicle disc perforated by an oval pedicle opening which passes directly through the shell; externally this pedicle disc shows as a depressed area. Upper or brachial valve convex. Apices of both valves nearly posterior. Shell structure more or less horny. Miocenic and Pliocenic.

52. **D. lugubris** Conrad. (Fig. 236, *f–g*.) Miocenic and Pliocenic.

Small (about ½ inch in diameter), subcircular. Brachial valve with rather elevated apex which is obtusely pointed and situated at about one fourth the shell's diameter from the posterior margin. Surface strongly lamellose especially over the outer half. Very faint radiating lines are visible.

New Jersey, Maryland, Virginia, South Carolina.

XXI. Schizotreta Kutorga.

Similar to *Orbiculoidea* but with thicker shell and with the relative convexity of the valves reversed, *i. e.*, the pedicle valve very convex and the brachial flattened. Ordovicic–Siluric.

53. **S. pelopea** Billings. (Fig. 241, *a–b*.) Ordovicic.

Nearly circular with strongly elevated pedicle valve and depressed convex brachial valve. Surface marked by numerous strongly elevated concentric lines of growth. Pedicle opening small, oval.

Trenton and Lorraine of Iowa, Wisconsin, Minnesota, Ontario, Quebec.

54. **S. tenuilamellata** (Hall). Siluric.

Shell thin, larger and more circular than preceding, with thin, elevated, prominent, concentric lamellose growth lines; pedicle valve elevated with concave foraminal slope, and elongate external pedicle opening.

Niagaran beds of New York, Ontario, and Nova Scotia.

XXII. Rœmerella Hall and Clarke.

Similar to *Orbiculoidea* but with pedicle valve very concave and brachial very convex. Devonic.

55. **R. grandis** Vanuxem. (Fig. 239.) Devonic.

Large, broadly elliptical. The direction of the foramen in the pedicle valve is in the shorter diameter of the shell.

Hamilton of New York, Ohio, Indiana, Kentucky.

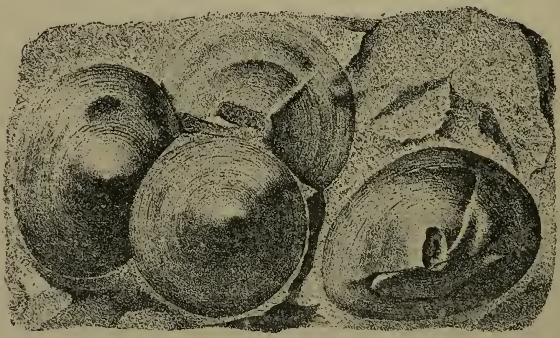


FIG. 239. *Roemerella grandis*, a group of dorsal and ventral valves, × 1. (After Hall.)

XXIII. Crania Retzius.

Nearly circular, inequivalved, with no pedicle opening but attached by apex or by the entire surface of the pedicle (lower) valve which is depressed, conforming to the surface to which it is attached. Brachial (upper) valve conical with subcentral and posteriorly directed beak. In each valve is a pair of widely separated muscle scars near the posterior margin and a pair close together near the center; vascular sinuses digitate. Middle Cambric–Carbonic.

FIG. 240. *Crania scabiosa*, a number of shells attached to a brachial valve of *Rafinesquina alternata*, the ornamentation of which they adopt, × 1. (After Hall and Clarke.)

56. **C. scabiosa** Hall. (Fig. 240.) Ordovicic.

Small, with irregular outline and thickened margins. Brachial valve thin. Surface of both valves usually marked by strongly lamellose growth lines. Found adhering to brachiopods and sometimes unrecognizable because of their assuming the surface features of the body to which they are attached. Differs from *C. modesta* in that the average shell is larger and more rugose.

Utica and Lorraine of Ohio, Indiana, Illinois, Wisconsin.

57. **C. setigera** Hall. (Fig. 241, *e–f.*) Ordovicic.

Small; often with nearly straight cardinal margin. Surface marked with quite coarse pustules or setæ which are most distinct near the margin of the shell.

Trenton and Lorraine of Iowa, Illinois, Wisconsin, Minnesota.

58. **C. trentonensis** Hall. (Fig. 241, *c–d.*) Ordovicic.

Brachial valve thick, thus differing from *C. scabiosa* and not covered as in *C. setigera* with elongate pustules.

Trenton of New York, Illinois, Wisconsin, Minnesota.

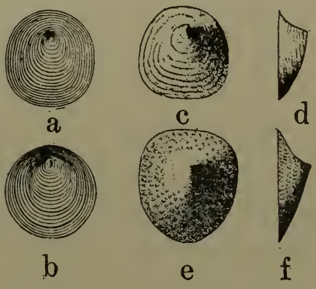


FIG. 241. *a, b, Schizotreta pelopea,* dorsal and ventral valves, the latter showing small oval pedicle opening; *c, d, Crania trentonensis,* dorsal and profile views; *e, f, Crania setigera,* dorsal and profile views. (After Winchell and Schuchert.)

59. **C. lælia** Hall. (Fig. 242.) Ordovicic.

Small, moderately convex, apex of upper valve distant from margin one third diameter of shell; surface with fine sharp striæ, increased sometimes by implantation.

Utica to Lorraine of Ohio and Indiana.

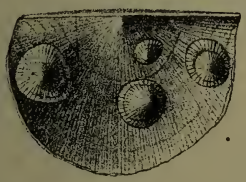


FIG. 242. *Crania lœlia,* four individuals attached to shell of *Strophomena planumbona,* × 1. (After Hall and Clarke.)

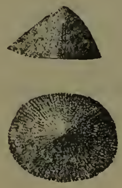


FIG. 243. *Crania crenistriata,* lateral and top views of an elliptical dorsal valve, × 1. (After Hall.)

60. **C. crenistriata** Hall. (Fig. 243.) Devonic.

Brachial valve depressed conical. Surface marked by elevated, crenulate, radiating striæ which reach nearly to the smooth apex.

Onondaga and Hamilton of New York, Ohio, Kentucky, Michigan.

61. **C. modesta** White and St. John. (Fig. 466, *d.*)

Upper Carbonic.

Average diameter ½ inch. Brachial valve moderately convex. Surface concentrically striated.

Ohio, Indiana, Iowa, Kansas.

XXIV. Craniella Œhlert.

Large, subcircular or subquadrangular. Pedicle (lower) valve thin, adhering by its entire surface. Brachial (upper) valve conical with subcentral and posteriorly directed apex. Muscle scars similar to *Crania.* Differs from *Crania* in the vascular sinuses of

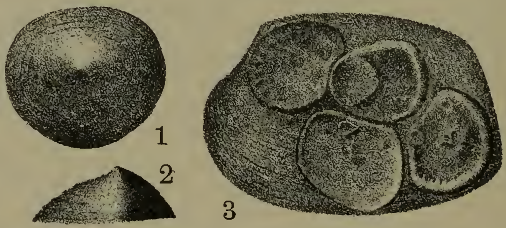


Fig. 244. *1, 2, Craniella hamiltoniæ*, top and lateral view of dorsal valve; *3*, a group of ventral valves attached to shell of *Cypricardella bellistriata*, × 1. (After Hall.)

the brachial valve being S-shaped; they start from near the posterior muscle scars and extend to the anterior portion of the valve, sending to the sides of the valve dichotomizing secondary branches. Ordovicic–Devonic.

62. **C. hamiltoniæ** Hall. (Fig. 244.) Devonic.

Subcircular. Brachial valve nearly conical with subcentral apex, pointed in well preserved specimens. Exterior marked by concentric lamellose striæ. Pedicle valve marked by four strong adductor muscle impressions and by digitate vascular impressions.

Hamilton of New York; Hay and Athabasca rivers, Canada.

XXV. Pholidops Hall.

Small, ovate, unattached, equivalved and equiconvex; without pedicle opening. The edges of the valves are flattened where they join. The interior of each valve is marked by an elevated and sharply defined muscular impression which is subtriangular with the apex of the triangle pointing anteriorly. Ordovicic–Devonic.

63. **P. hamiltoniæ** Hall. (Fig. 245.) Devonic.

Ovate with broader posterior end. Apex excentric and inclined backward. Surface marked by closely arranged lamellose growth lines.

Hamilton of New York.

FIG. 245. *Pholidops hamiltoniæ*, interior, × 8, and exterior, × 4. (After Hall.)

PROTREMATA.

XXVI. KUTORGINA Billings.

Inequivalved; hinge line nearly equal to the greatest width of the shell. Larger or pedicle valve usually much more convex than the brachial; umbo straight or incurved; median sinus present or absent. Between the valves is a relatively large and broad pedicle opening owing to the rudimentary cardinal areas. Surface with concentric growth lines. Interior with muscle scars radiating from the beak. Lower–Middle Cambric.

64. **K. cingulata** Billings. (Fig. 246.) Lower Cambric.

Pedicle valve convex, arching over to the incurved and pointed beak; mesial sinus often present. Brachial valve depressed, with

FIG. 246. *Kutorgina cingulata*, ventral, profile and dorsal views, denuded mostly of outer surface. (After Walcott.)

elevated but not incurved beak. Surface covered with coarse striæ and in older portions with undulations of growth.

Vermont, Quebec, Labrador.

XXVII. DICTYONELLA Hall.

Subtriangular, biconvex. Pedicle valve with a broad median sinus and acute and arched umbo. Delthyrium closed by a depressed plate. Brachial valve with a broad median fold; median septum high. Exterior surface pitted with quincunx, resembling *Trematis*. Siluric.

65. **D. reticulata** Hall. (Fig. 247.) Siluric.

Shell gibbous posteriorly and more attenuate in front. Pedicle valve with small, acute and closely incurved beak which is flattened on the back, forming a " depressed plate."

Niagaran of Ohio, Indiana, Wisconsin.

FIG. 247. *Dictyonella reticulata*, dorsal and cardinal views, × 2. (After Hall.)

FIG. 248. *Billingsella coloradoensis*, dorsal and ventral valves, natural size. (After Hall.)

FIG. 249. *Nisusia festinata*. (After Walcott.)

XXVIII. BILLINGSELLA Hall and Clarke.

Small, subquadrate or semicircular; hinge line straight. Pedicle valve the larger and convex; cardinal area moderately high, vertical or but slightly incurved, with a strong, arching deltidium. Brachial valve flat or concave; cardinal area lower than in pedicle valve but usually also possessing a convex deltidium. Dental plates continued along the bottom of the valve enclosing a small muscular area near the apex. Entire surface covered with radiating plications. Cambric–Siluric.

66. **B. coloradoensis** (Shumard). (Fig. 248.) Upper Cambric.

Differs externally from *Protorthis billingsi* in being less transverse and in that the brachial valve lacks both sinus and cardinal area.

From Texas to Missouri, Minnesota, Wisconsin, Montana, Wyoming and Idaho.

XXIX. NISUSIA Walcott.

Differs from *Billingsella* in that the radiating ribs support irregularly distributed spines on their crests; and in the presence of a mesial sinus on the pedicle valve and a faint mesial fold on the brachial. Lower-Middle Cambric.

67. **N. festinata** Billings. (Fig. 249.) Lower Cambric.

Hinge line straight, usually equalling the greatest width of the shell. Pedicle valve elevated at the umbo with a high cardinal area. Surface covered with narrow radiating ribs, increasing both by bifurcation and intercalation. The spines are located on the ribs more or less irregularly. An average shell measures about one inch in width with length about one third less.

New York, Pennsylvania, Vermont, Quebec.

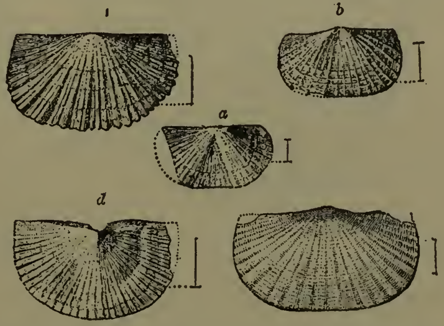


FIG. 250. *Protorthis billingsi*, showing variation of form. (Dawson and Walcott.)

XXX. PROTORTHIS Hall and Clarke.

Like *Billingsella* but differing in the absence of a true cardinal process and in the punctate character of the shell substance. Middle-Upper Cambric.

68. **P. (Billingsella) billingsi** (Hartt). (Fig. 250.) Middle Cambric.

Broader than long, with greatest width at hinge line. Most convex at about the middle and depressed in front. Brachial valve with sinus. Cardinal area very narrow. Surface marked by about thirty radiating striae crossed by distinct lines of growth.

New Brunswick.

XXXI. RAFINESQUINA Hall and Clarke.

Semi-oval; hinge line straight; cardinal area well developed on each valve. Pedicle valve convex; brachial concave. Muscular area of pedicle valve faintly delimited, consisting of two broad, flabellate diductor scars enclosing an elongate adductor; from the margin of the muscular area radiate irregular furrows and nodose ridges. Brachial valve with bilobed cardinal process. Entire surface covered with striae alternating in size and crossed by finer concentric growth lines. Ordovicic-Siluric.

69. **R. alternata** (Emmons). (Fig. 251.) Ordovicic.

Broadly semi-oval. Pedicle valve convex, flattened near the cardinal extremities. Alternation of striæ very pronounced on both valves.

Trenton-Lorraine of New York, Ohio, Indiana, Illinois, Missouri, Wisconsin, Minnesota, Manitoba, Anticosti.

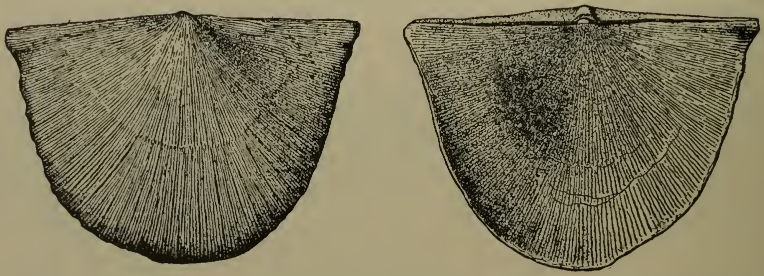


FIG. 251. *Rafinesquina alternata*, ventral and dorsal views, × 1. (Ind. Geol. Survey.)

70. **R. deltoidea** (Conrad.) Ordovicic.

Pedicle valve abruptly deflected at the margin except a small portion in front. Surface of the valve before deflection covered with many irregular concentric wrinkles crossed by radiating striæ which, with the exception of one or two prominent ones in the middle of the shell, are equal. Can be distinguished externally from *Leptæna rhomboidalis* by its usually deltoid outline and by the lesser prominence of its corrugations.

Trenton and Utica of New York, Iowa, Missouri, Wisconsin, Minnesota, Ontario, Manitoba.

71. **R. minnesotaensis** (N. H. Winchell). (Fig. 252.) Ordovicic.

Very similar to *R. alternata* in form and surface features but usually distinguishable by its smaller size and greater convexity.

Trenton of Kentucky, Tennessee, Iowa, Wisconsin, Minnesota.

FIG. 252. *Rafinesquina minnesotaensis* (var. *inquassa*), ventral and profile views of a shell, and interior of brachial valve, × 1. (Min. Geol. Survey.)

XXXII. STROPHEODONTA Hall.

Very similar to *Rafinesquina* but with cardinal margins finely denticulate, *i. e.*, marked by transverse bars which articulate as teeth and pits. Shell structure coarsely punctate.. Siluric–Devonic.

A. Shell with radiating plications .... 83. *S. costata.*
B. Shell with radiating striæ .... *.
* Shell nearly flat .... (1).
(1) Surface with prominent concentric wrinkles .... 75. *S. beckei.*
(1) Surface with only oblique folds at the hinge margin... 72. *S. corrugata.*
(1) Surface with very slight concentric wrinkles or none .... *a.*
a. Shell very thin. Striæ usually wavy .... 85. *S. perplana.*
a. Shell thin. Striæ straight .... 74. *S. varistriata.*
* Shell quite concavo-convex .... (2).
(2) Shell large (about 1½ inches long or longer) .... *b.*
b. Hinge extremities rounded .... 76. *S magnifica.*
b. Hinge line usually extended .... †.
† Strong concentric striæ present, crossing the finer striæ.
78. *S. patersoni.*
† Strong concentric striæ absent .... ‡.
‡ Shell conspicuously concavo-convex .... *x.*
x Pedicle valve with greatest convexity near the front. *aa.*
aa. Striæ alternating .... 81. *S. concava.*
aa. Striæ not alternating .... 80. *S. hemispherica.*
x. Pedicle valve with greatest convexity in the umbonal region .... 77. *S. magniventer.*
x. Pedicle valve regularly convex from beak to front.
73. *S. profunda.*
‡ Shell slightly convex to flat .... 74. *S. varistriata.*
(2) Shell small (about 1 inch long) .... *c.*
c. Radiating striæ strongest near the beak .... 84. *S. demissa.*
c. Radiating striæ not strongest near the beak...... 79. *S. inequiradiata.*
(2) Shell very small (about ½ inch long) .... *d.*
d. Hinge line extended .... 82. *S. inequistriata.*
d. Hinge line less than greatest width of shell .... 86. *S. arcuata.*

72. **S. corrugata** (Conrad.) (Fig. 253.) Siluric.

Small, nearly flat; hinge line extended. Surface covered with fine prominent striæ. Oblique folds present on the hinge margin. Clinton of New York, Tennessee.

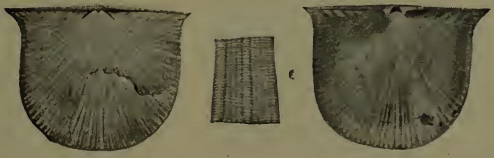


Fig. 253. *Stropheodonta corrugata,* with surface enlarged.

73. **S. profunda** Hall. (Fig. 254.) Siluric.

Large, with width much greater than the length. Brachial valve very concave with abruptly deflected margins. Surface covered with fine unequal striæ.

Clinton and Niagara of New York, Kentucky, Indiana, Illinois, Wisconsin.

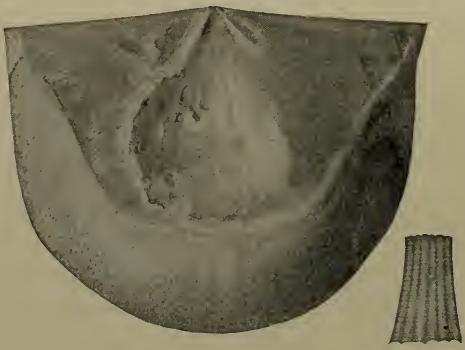


Fig. 254. *Stropheodonta profunda*, with enlargement of striæ.

74. **S. varistriata** (Conrad). (Fig. 255.) Siluric-Devonic.

Pedicle valve varying from slightly convex to gibbous, with slightly elevated beak. Surface usually with alternations of more or less prominent striæ, the sharper ones being separated by several minute ones.

Manlius and Coeymans of New York, Quebec, New Brunswick.

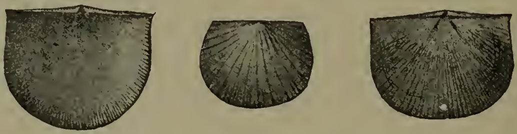


Fig. 255. *Stropheodonta varistriata*.

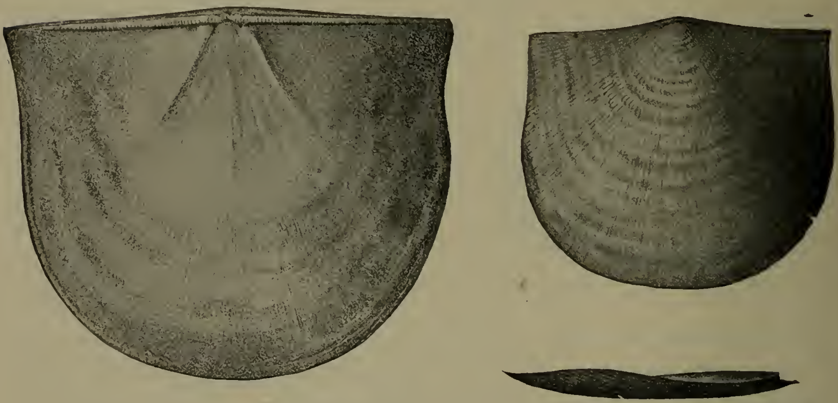


Fig. 256. *Stropheodonta* (*Leptostrophia*) *beckei*, interior and exterior of pedicle valves of different sizes; profile of complete shell.

75. S. **(Leptostrophia) beckei** Hall. (Fig. 256.) Devonic.

Pedicle valve very depressed convex, with small beak. Brachial valve nearly flat. Surface marked with strong, close, bifurcating striæ which are crossed by fine concentric lines and by more or less regular concentric wrinkles. In its surface characters it thus much resembles *Leptæna rhomboidalis* but differs in being almost flat.

Helderbergian of New York, Kennedy Channel of the Arctic region.

76. S. **(Leptostrophia) magnifica** Hall. (Fig. 257.) Devonic.

Very large, with rounded hinge extremities. Pedicle valve depressed convex at the umbo; brachial valve slightly concave.

FIG. 257. *Stropheodonta* (*Leptostrophia*) *magnifica*, pedicle valve partly removed and showing impressions of inner structures; interior of brachial valve.

Radiating striæ rather faint and regularly bifurcating two or three times.

Oriskany of New York, Maryland, Ontario.

77. S. **magniventer** Hall. Devonic.

Length usually ⅔ the breadth. Pedicle valve convex in the umbonal region with slightly incurved beak. Hinge line sometimes extended. Radiating striæ regular and slightly elevated.

Oriskany of New York, Ontario, Quebec.

78. S. **patersoni** Hall. (Fig. 258.) Devonic.

Convex. Distinguished by its form, the pedicle valve being gibbous just in the middle and somewhat deeply deflected at the sides and front. The striæ are distant and elevated with many finer ones between. Strong wrinkles cross concentrically over the fine striæ, being interrupted by the larger ones.

Oriskany–Onondaga of New York, Ohio, Illinois, Nevada, Ontario.

FIG. 258. *Stropheodonta patersoni*, pedicle valve. (After Hall.)

79. **S. inæquiradiata** Hall. (Fig. 259.) Devonic.

Pedicle valve somewhat gibbous, often arching regularly from beak to front and depressed or concave between the umbo and the cardinal extremities which are somewhat prolonged. Beak a little elevated above the hinge line and incurved. Surface covered with striæ, those on the pedicle valve being often coarse, uneven and somewhat fasciculate; those on the brachial valve are more uniform, the stronger ones being distant and sharp with wide interspaces covered with very fine regular striæ.

Onondaga of New York, Ohio, Nevada, Quebec.

80. **S. hemispherica** Hall. (Fig. 260.) Devonic.

Form, size and general characters similar to *S. concava* from which it differs in having the surface striæ fine and nearly uniform, instead of alternating; generally also somewhat more convex than *S. concava*.

Schoharie and Onondaga of New York and equivalent horizons of Ohio, Indiana, Kentucky, and Ontario.

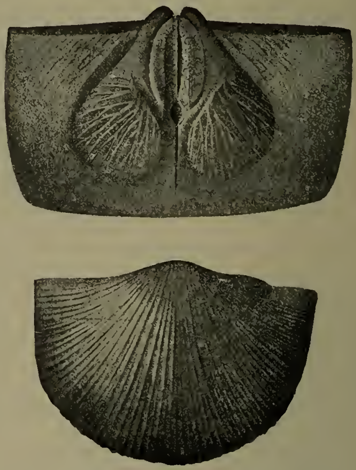


FIG. 259. *Stropheodonta inequiradiata*, with enlargement of interior of brachial valve.

81. **S. concava** Hall. (Fig. 261.) Devonic.

Large, with very convex pedicle valve. Cardinal areas high, almost at right angles to each other. Surface marked by strong sharp striæ with finer ones between, all crenulated by concentric striæ. Profile more concave than that of *S. demissa*.

Onondaga and Hamilton of New York.

82. **S. inæquistriata** (Conrad). (Fig. 262.) Devonic.

Small. Pedicle valve quite convex. Hinge line extended with acute and sometimes auriculate extremities. Surface marked by distant striæ with fine, almost invisible striæ between.

Onondaga–Hamilton of New York, Kentucky, Indiana, Wisconsin, Ontario.

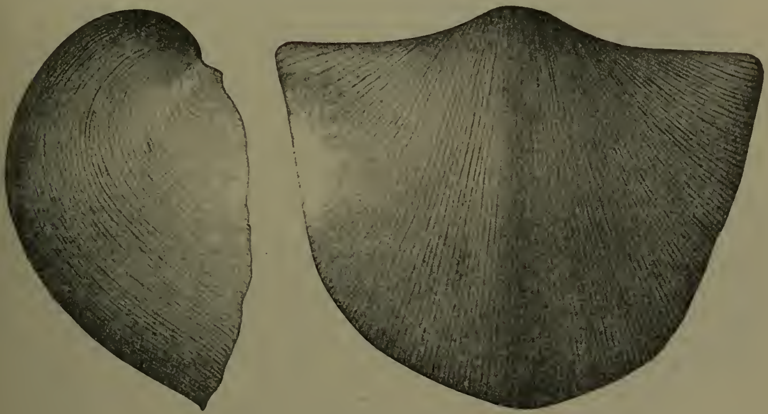


FIG. 260. *Stropheodonta hemispherica.*

83. **S. costata** Owen. Devonic.

Small (hardly 3/8 inch in diameter). Pedicle valve slightly convex; brachial valve nearly flat. Surface covered with about eleven prominent plications.

Hamilton of Iowa, Michigan.

84. **S. demissa** (Conrad). (Fig. 263.) Middle and Upper Devonic.

Length and width nearly equal. Pedicle valve strongly convex. Surface striæ numerous, strongest and most elevated near the beak and increasing by intercalation and bifurcation toward the front.

Widely distributed throughout North America, especially in Hamilton group.

85. **S. (Leptostrophia) perplana** (Conrad). (Fig. 264.) Devonic.

Thin, slightly convex, often almost flat. Extremities of hinge line usually prolonged. Surface covered with fine and nearly equal striæ, crenulated by fine concentric striæ. Differs from *S. corrugata* in its finer and less prominent striæ and in the absence of folds on the hinge margin.

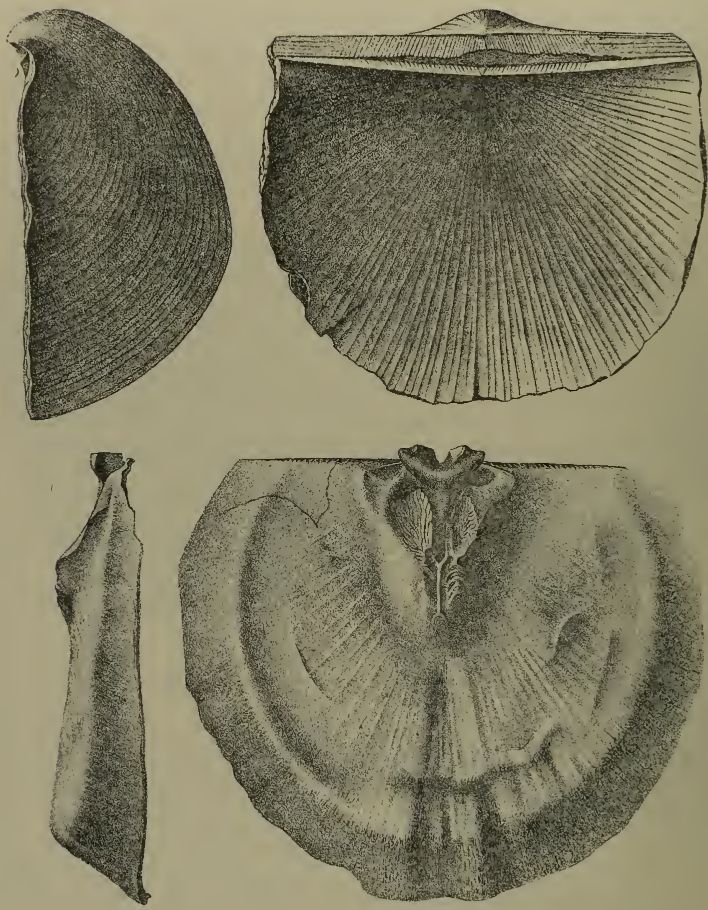


FIG. 261. *Stropheodonta concava*, lateral and dorsal view of exterior of complete shell; and lateral and front view of interior of brachial valve showing bilobed cardinal process, muscular scars; dental sockets, and crenulations of the hinge line, $\times$ 1. (After Hall.)

FIG. 262. *Stropheodonta inæquistriata*, pedicle valve, $\times$ 1. (After Hall.)

Onondaga – Chemung. Widely distributed throughout North America.

86. **S. arcuata** Hall. Devonic.

Hinge line scarcely equalling greatest width of shell below. Pedicle valve very arcuate with sometimes an undefined elevation along the center; cardinal extremities usually a little recurved, delthyrium

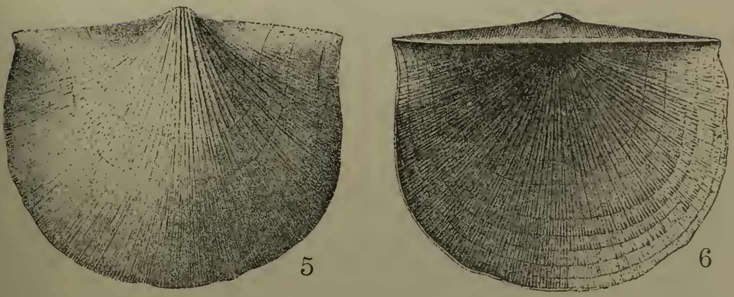


FIG. 263. *Stropheodonta demissa*, ventral and dorsal views, × 1. (After Hall.)

FIG. 264. *Stropheodonta* (*Leptostrophia*) *perplana*, ventral view, and interior of brachial valve.

closed. Brachial valve very concave. Surface covered with strong, sharply elevated radiating striæ, each alternating with three or five smaller ones.

Chemung of New York, Iowa, Nevada, Manitoba.

XXXIII. PHOLIDOSTROPHIA Hall and Clarke.

Differs from *Stropheödonta* in the smooth, often nacreous surface; marked only with a few squamose growth lines. The interior of the brachial valve bears three diverging ridges in front of the muscle area. Devonic.

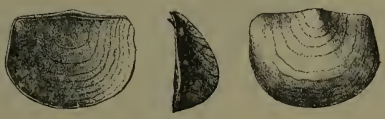


FIG. 265. *Pholidostrophia iowaensis*, dorsal, profile and ventral views, × 1. (After Hall.)

87. **P. iowaensis** (Owen). (Fig. 265.) *S. nacrea* Hall.
Devonic.

Small, semielliptical, having a brilliantly nacreous lustre. Brachial valve concave; pedicle valve convex. Beak small and depressed. Surface apparently smooth, but crossed by microscopic growth lines.

Onondaga and Hamilton of New York, Ohio, Michigan, Indiana, Illinois, Kentucky, Iowa, Ontario.

XXXIV. Strophonella Hall.

Pedicle valve concave; brachial convex. Otherwise like *Strophe-odonta.* Siluric–Devonic.

88. S. **patenta** (Hall). (Fig. 266.) Siluric.

Average shell 1⅜ inches long by 1⅝ inches wide; very convex. Surface covered with fine unequal radiating striæ crossed by

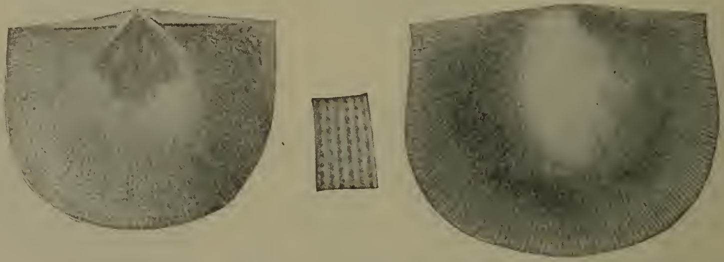


Fig. 266. *Strophonella* (?) *patenta*, with enlargement of surface features. (After Hall.)

fine concentric ones. Inner surface of valves thickly covered with sharp points.

Clinton of New York, Ohio, Indiana, Alabama.

89. S. **striata** Hall. (Fig. 267.) Siluric.

Almost flat, with fine radiating striæ which increase by implantation. Average shell ⅝ inch long and ¾ inch wide.

Niagaran of New York, Kentucky, Indiana.

Fig. 267. *Strophonella striata.* (After Hall.)

90. S. **headleyana** Hall. (Fig. 268.) Devonic.

Length about three fourths the width. Pedicle valve concave, especially near the front and with scarcely elevated beak. Brachial valve depressed at umbo and very convex toward the front. Cardinal area quite wide and marked by transverse striæ. Radiating striæ coarse and sharply elevated, increasing chiefly by implantation.

Helderbergian of New York, Kennedy Channel and Cape Frazier of the Arctic regions.

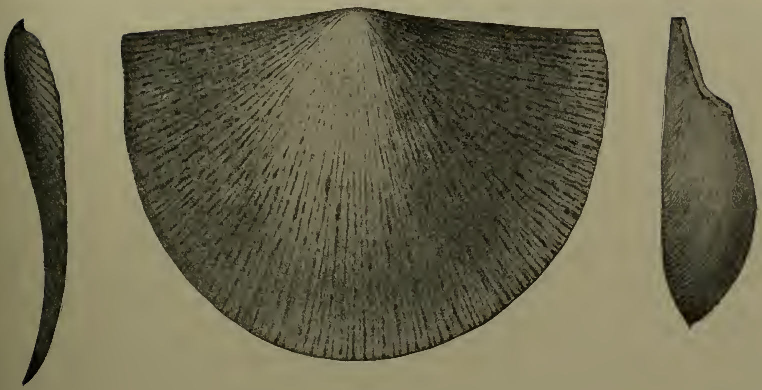


FIG. 268. *Strophonella headleyana*, profile and ventral view (exterior) ; interior profile of pedicle valve. (After Hall.)

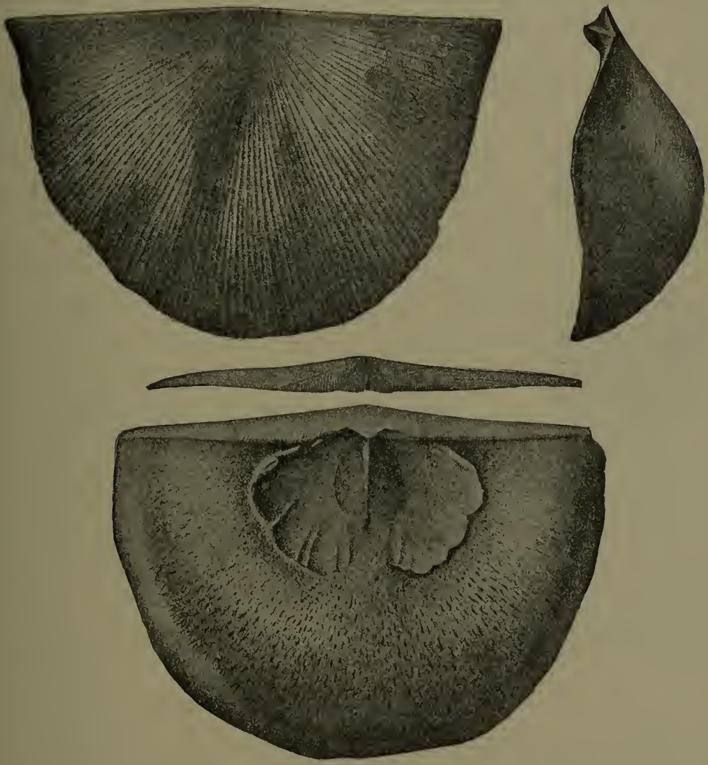


FIG. 269. *Strophonella ampla*, dorsal and profile views of brachial valve; cardinal view and interior of pedicle valve. (After Hall.)

91. S. **leavenworthana** Hall. Devonic.

Distinguished by its strong geniculation toward the front and by its concentric wrinkles, presenting a partial superficial resemblance to *Leptæna rhomboidalis*.

Helderbergian of New York.

92. S. **punctulifera** (Conrad). Devonic.

About four fifths as long as wide. Cardinal area narrow. Striæ strong, increasing both by bifurcation and intercalation and distinctly punctate. The shell outline is much more abruptly curved than that of *S. headleyana*.

Helderbergian of Maine, New York, Pennsylvania, Tennessee, Nevada, Quebec, New Brunswick, Cape Hilgard and Louis Napoleon of the Arctic regions.

93. S. **ampla** Hall. (Fig. 269.) Devonic.

Large, length from two thirds to three fourths as great as width. Pedicle valve very concave. Brachial valve convex in the middle and flat or concave at the umbo. Surface covered with angular, subequal, interrupted or rugose striæ which bifurcate two or three times before reaching the margin. In this species resupination is more marked, and the muscle impressions are stronger than in *S. headleyana*.

Onondaga of New York, Ohio, Ontario.

FIG. 270. *Strophonella reversa*, dorsal and ventral aspects. (After Hall.)

94. S. **reversa** Hall. (Fig. 270.) Devonic.

Semi-circular to semi-elliptical, with hinge line extended; about one third of the shell (young) normal, after which it becomes strongly and abruptly reversed. Striæ simple, strong and angular near the beaks, dichotomizing from one to three times towards the front; also increasing by implantation. Entire surface punctate.

In the Chemung of New York and equivalent beds of Iowa.

XXXV. STROPHOMENA (Rafinesque) Blainville.

Like *Rafinesquina* but with the convexity of the valves reversed. Pedicle valve slightly convex at umbo, becoming concave towards the middle; cardinal area conspicuous with convex deltidium; muscular area subcircular and deeply excavated with an elevated ridge nearly surrounding it. Brachial valve slightly concave at umbo, rapidly becoming convex. Ordovicic–Carbonic.

A. Shell nearly flat... 95. *S. billingsi.*
B. Shell strongly concavo-convex, *i. e.*, pedicle valve concave and brachial convex.. *.
  * Shell triangular in outline. Cardinal extremities marked by oblique wrinkles. 98. *S. trilobata.*
  * Shell transversely extended with acute hinge extremities....................... (1).
    (1) Large, over 1½ inch wide.................................... 96. *S. incurvata.*
    (1) Small, less than 1½ inch wide........................... 97. *S. trentonensis.*
  * Shell subquadrate with more or less rectangular hinge extremities........... (2)
    (2) Of medium size, about 1⅓ inches wide...................... 99. *S. neglecta.*
    (2) Small, less than 1⅓ inches wide.. *a.*
      a. Shell not wrinkled on cardinal margin.................. 100. *S. rugosa.*
      a. Shell obliquely wrinkled on cardinal margin. 100*a.* *S. rugosa subtenta.*

95. **S. billingsi** Winchell and Schuchert. Ordovicic.

Small, usually not exceeding one inch in width. Both valves nearly flat; beaks scarcely distinct from the cardinal area. Brachial valve marked by a very faint mesial depression for about half the way from the beak to the front of the shell. Radiating striæ fine and usually of different sizes.

Trenton of Minnesota, Ontario, Manitoba.

96. **S. incurvata** (Shepard). (Fig. 271, *a–d.*) Ordovicic.

Of medium size, usually about one and three fourths inches wide, with greatest width along the hinge-line and with cardinal extremities acutely angular and deflected. Pedicle valve strongly concave; brachial quite strongly convex. Radiating striæ fine, crowded, alternating in size and crossed by numerous concentric lines and a few stronger growth lines.

Trenton of New York, Kentucky, Tennessee, Missouri, Iowa, Wisconsin, Minnesota, Manitoba.

97. **S. trentonensis** Winchell and Schuchert. (Fig. 272, *a.*) Ordovicic.

Valves thin. Radiating striæ delicate. Cardinal margins marked by oblique wrinkles. Internal markings undefined.

Trenton of New York, Kentucky, Tennessee, Wisconsin, Minnesota.

98. **S. trilobata** (Owen). (Fig. 271, *g–h.*) Ordovicic.

Hinge line extended. Brachial valve broadly trilobate and very gibbous in front. Radiating striæ fine and equal.

Trenton of Iowa, Minnesota, Manitoba.

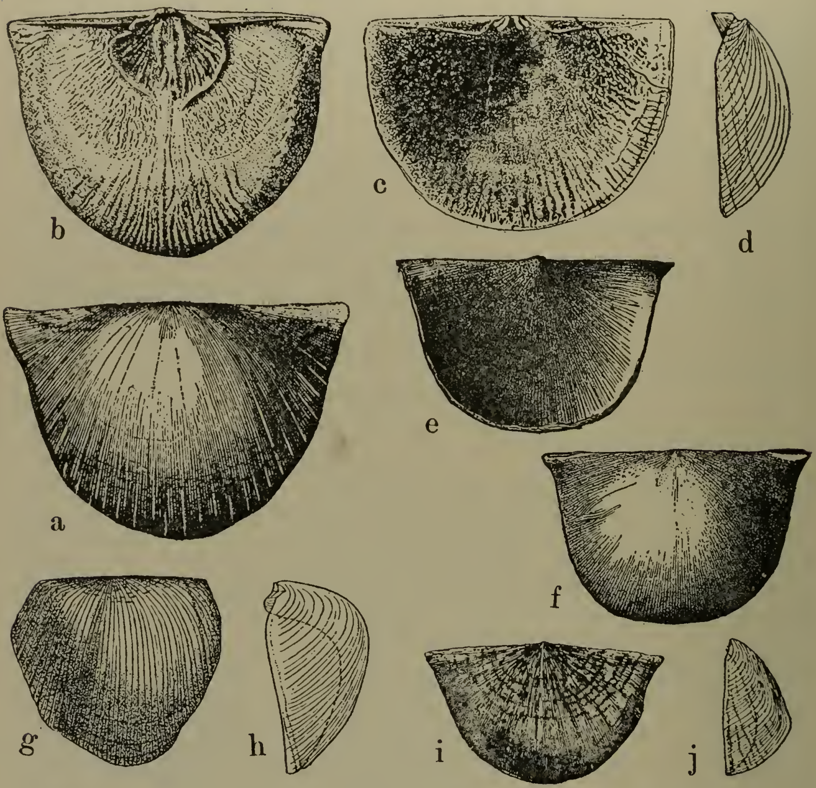


FIG. 271. *a–d*, *Strophomena incurvata*, *a*, exterior of convex brachial valve; *b*, interior of pedicle valve; *c*, interior of brachial valve; *d*, profile; *e–f*, *Strophomena rugosa*, ventral and dorsal views; *g–h*, *Strophomena trilobata*, dorsal and profile views; *i–j*, *Leptæna unicostata*, exterior and profile views of ventral valve. All natural size. (*e–f* after Indiana Geol. Surv., the others after Winchell and Schuchert, Minn. Geol. Surv.)

99. **S. neglecta** (James). (Fig. 272, *b*.) Ordovicic.

Of medium size, about one and one third inches wide by an inch in length with usually the greatest width at the hinge line. Sides meet the hinge line about at a right angle. Surface covered with fine, subequal radiating striæ.

Lorraine of Ohio, Indiana, Illinois, New Mexico.

100. **S. rugosa** (Rafinesque MS.) Blainville. (Fig. 271, *e–f*.) Ordovicic.

Pedicle valve deeply concave, brachial evenly convex. Of medium size with greatest width at the hinge line. Cardinal extremities somewhat acute. Surface covered with numerous fine and close radiating striæ, usually several smaller between two larger, the smaller being always shorter than the larger.

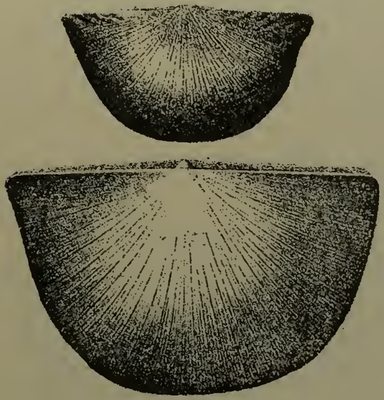


FIG. 272. *a* (upper), *Strophomena trentonensis; b, Strophomena neglecta;* dorsal views. (After Hall.)

Lorraine of Ohio, Indiana, Kentucky, Missouri, Wisconsin, Minnesota, Manitoba, Anticosti.

100, *a.* **S. rugosa** var. **subtenta** (Hall). Ordovicic.

Differs from *S. rugosa* in being obliquely wrinkled along the cardinal margins.

Occurs with the preceding in the Lorraine of Ohio, Indiana, Kentucky, Missouri, Minnesota and Anticosti.

XXXVI. LEPTÆNA Dalman.

Very similar to *Rafinesquina*, but wider in proportion to its length and usually with the flatter portions of the valves marked

FIG. 273, *a.* *Leptæna rhomboidalis* (Niagaran type.)

with conspicuous concentric wrinkles; where these cease the shell is often abruptly and rectangularly deflected. The whole exterior is marked with fine radial striations. Ordovicic–Carbonic.

101. **L. rhomboidalis** (Wilckens). (Fig. 273, *a*; 273, *b*.)
Ordovicic–Lower Carbonic.

Small, usually semicircular; cardinal extremities often much extended. Pedicle valve slightly convex near the hinge, slightly concave just before the deflection.

Trenton–Waverly; generally distributed throughout America and Europe.

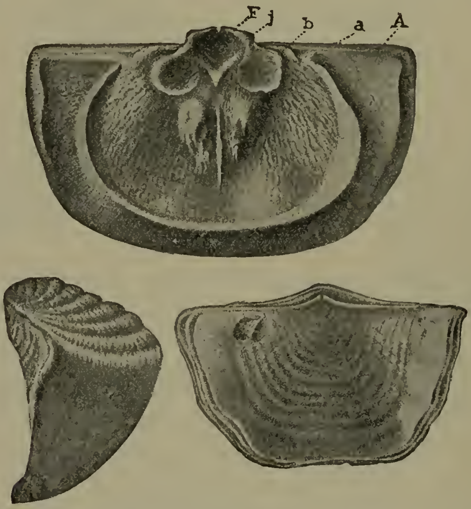


FIG. 273, *b*. *Leptæna rhomboidalis*, interior of brachial valve, profile and dorsal views. Helderbergian type. (After Hall & Clarke.)

102. **L. unicostata** Meek and Worthen. (Fig. 271, *i–j*.)
Ordovicic.

Distinguished from the preceding by the complete absence of concentric wrinkles and the presence of a small mesial ridge on the outside of the pedicle valve.

Lorraine of Illinois, Wisconsin, Minnesota, Iowa, Manitoba.

XXXVII. PLECTAMBONITES Pander.

Small. Pedicle valve convex, brachial concave. Hinge line forming greatest width of shell. Cardinal areas narrow. Cardinal process large and simple, almost filling the delthyrium. Dental plates continued around the long, narrow, muscular areas. Surface striæ very fine, often alternating in size. Ordovicic–Siluric.

103. **P. sericeus** (Sowerby). (Fig. 274, *a–b.*) Ordovicic–Siluric.
Pedicle valve convex in center, deflected at edge. Striæ fine,

FIG. 274, *a*. *Plectambonites sericeus*, pedicel valves showing variation. (After Hall.)

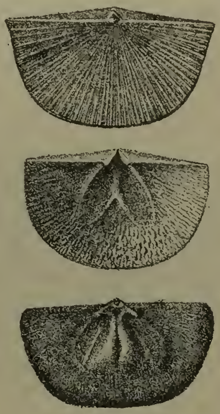


FIG. 274, *b*. *Plectambonites sericeus*, exterior dorsal aspect, and interior of pedicle and brachial valves, × 2. (After Hall.)

alternating with a few slightly elevated ones and crossed by a few weak concentric ones. Surface shining.

Trenton–Clinton of New York, Ohio, Kentucky, Indiana, Missouri, Wisconsin, Minnesota, Manitoba.

104. **P. transversalis** (Wahlenberg). (Fig. 275.) Siluric.
Pedicle valve very convex, brachial very concave. Hinge line, owing to the strongly incurved beak of the pedicle valve, is inflected.

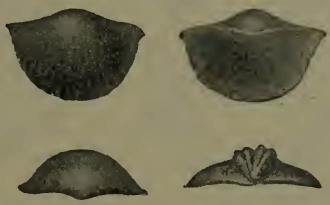


FIG. 275. *Plectambonites transversalis*, ventral, dorsal and cardinal views; and cardinal view of interior of brachial valve. (After Hall.)

Surface marked by distant and strongly elevated striæ with exceedingly fine ones between. The strongly incurved beak of this species is very different from the small beak of *P. sericeus* which is scarcely distinct from the cardinal margin.

Clinton–Niagara of New York, Indiana, Wisconsin, Ontario, New Brunswick, Anticosti.

XXXVIII. Schuchertella Girty.

(*Orthothetes* of authors.)

Shell flat. Much like *Strophomena*. Pedicle valve with well-developed cardinal area, often irregular. Brachial valve with narrow cardinal area. Cardinal process bilobed when viewed from within, quadrilobed when viewed from without; a faint median

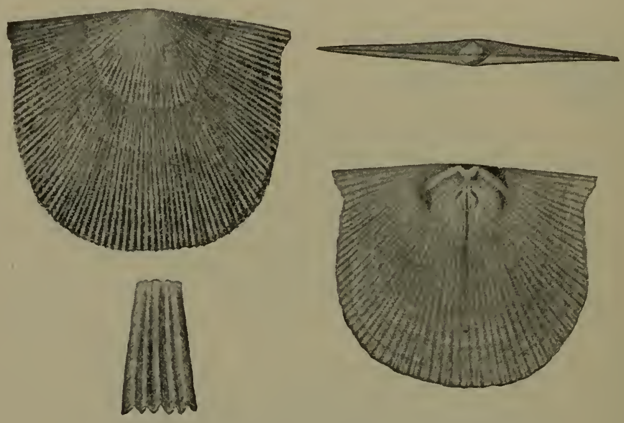


Fig. 276. *Schuchertella subplana*. (After Hall.)

septum present. Surface covered with slender radiating striæ crenulated by sharp concentric growth lines or fine plications. Sil.–Carb.

105. **S. subplana** (Conrad). (Fig. 276.) Siluric and Devonic.

Length and width nearly equal. Hinge line extended. Pedicle valve at first convex, later becoming concave. Striæ coarse, sharp and angular.

Niagaran and Helderbergian of New York, Kentucky, Tennessee, Indiana, Illinois, Missouri, Ontario, Nova Scotia, Anticosti.

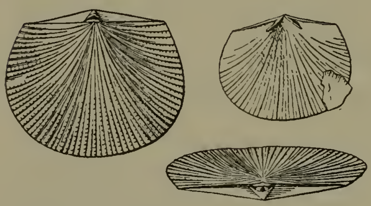


Fig. 277. *Schuchertella interstriata*.

106. **S. interstriata** (Hall). (Fig. 277.) Siluric.

Semioval, subplano - convex. Pedicle valve much elevated at the beak. Radiating striæ strong, not arcuate, with interstitial striæ beginning below the beak. Interior of shell marked with dichotomous, radiating striæ. All radiating striæ crossed by rather strong growth lines.

Cobleskill of New York, Greenfield of Ohio, etc.

107. **S. woolworthana** (Hall). (Fig. 278.) Devonic.

Semielliptical. Both valves depressed convex at beak, concave toward the front. Beaks small. Surface with small, round, crowded,

FIG. 278. *Schuchertella woolworthana.* (After Hall.)

radiating striæ, increasing by interstitial addition, crossed by fine growth striæ and few larger lines of growth. Interior of pedicle valve marked by a large, flabellate muscular area.

Helderbergian of New York.

108. **S. pandora** (Billings). (Fig. 279.) Devonic.

Differs from *S. chemungensis* in the more regularly bilateral position of the umbo and in its lesser prominence; also in the less rectangular form of the shell.

Schoharie and Onondaga of New York, Ohio, Ontario, Nevada.

FIG. 279. *Schuchertella pandora.*

109. **S. arctostriata** Hall. (Fig. 280, *a–b.*) Devonic.

Semielliptical or semicircular, often unsymmetrical. Pedicle valve slightly convex at umbo, flattened anteriorly; beak often distorted; cardinal area usually unequal on the two sides of the foramen. Brachial valve usually depressed convex. Surface covered with sharp, close, crenulated, radiating striæ, increasing mainly by interstitial addition. Length about ¼ to ¾ inch, width slightly greater.

Hamilton of New York, Ohio, Kentucky and Nevada.

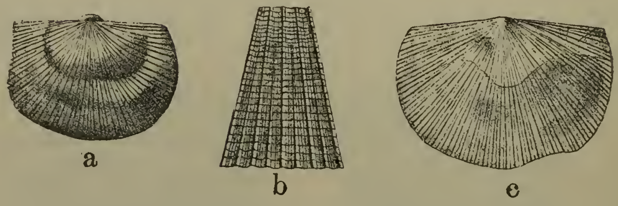


FIG. 280. *a*, *Schuchertella arctostriata*; *b*, enlargement of surface; *c*, *Schuchertella perversa*. (After Hall.)

110. **S. perversa** (Hall). (Fig. 280, *c*.) Devonic.

Subelliptical. Hinge line less than the greatest width of shell. Length and width about as two to three. Front broadly rounded. Pedicle valve very convex at umbo and less so toward the front; beak distorted; deltidium prominent and convex. Brachial valve most convex above the middle, depressed toward the front. Surface marked with distant, elevated striæ, increasing by interstitial additions; interspaces crossed by elevated, undulating striæ.

Onondaga and Hamilton of New York, Nevada and Ontario.

111. **S. chemungensis** (Conrad). (Fig. 281, *a–b*.) Devonic.

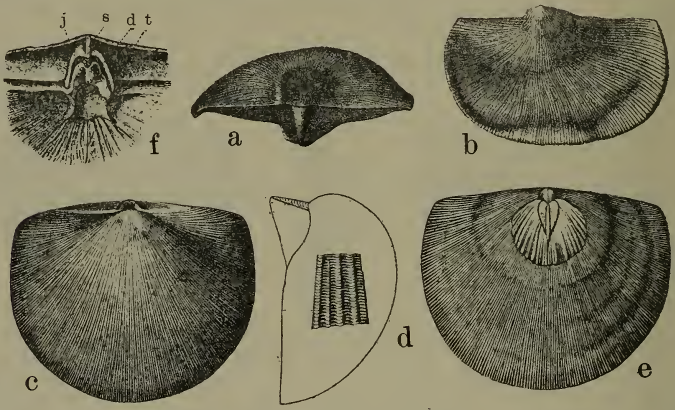


FIG. 281. *a*, *b*, *Schuchertella chemungensis* (× ⅔); *c–e*, *S. crenistria* (× ⅔); *f*, *Orthotetes keokuk*. Cardinal regions of both valves viewed from within; *j*, cardinal process; *s*, median septum in pedicle valve; *d*, dental lamellæ; *t*, teeth (× ⅔). (After Hall.)

Pedicle valve slightly concave, with prominent umbo. Angles of the hinge line with the sides nearly rectangular.

Chemung of New York, Pennsylvania, Ohio, Nevada, Manitoba.

112. **S. inæqualis** Hall. Mississippian.

Hinge line equalling the greatest width of the shell. Brachial valve very gibbous, with the greatest convexity near the center. Pedicle valve nearly flat. Surface marked by alternating larger and smaller radiating striæ.

Kinderhook of Pennsylvania, Ohio, Iowa, Utah.

113. **S. crenistria** (Phillips ?). (Fig. 281, *c–e*.) Mississippian.

Wider than long, with hinge line slightly shorter than width of the shell below. Brachial valve convex medially, pedicle valve flattened. Surface covered with numerous subequal or alternating larger and smaller radiating striæ, crossed by fine and crowded concentric striæ. Length of a rather large specimen 1¾ inches and breadth 2 inches.

Ohio, Michigan, Nevada, Nova Scotia, Feilden Isthmus in lat. 82°, 43′.

XXXIX. Orthotetes Fischer de Waldheim.

(*Derbya* of authors generally.)

In general like *Schuchertella* but the pedicle valve is at times much elevated at the beak and is rarely concave. It differs distinctly from *Schuchertella* in the presence in the pedicle valve of a high median septum extending longitudinally through the center of the muscular area, which is one third to two thirds the length of the valve. Carbonic.

114. **O. (Derbya) keokuk** Hall. (Fig. 281, *f*.) Mississippian.

Differs from *O. crassus* in its broadly semielliptical outline and convexity of brachial valve which is often equal to one third the width of the shell.

Kinderhook-Keokuk of Iowa, Illinois, Indiana, Missouri, Nevada.

115. **O. (Derbya) crassus** (Meek and Hayden). (Fig. 282, *a–d*.) Upper Carbonic.

Subquadrate, owing to the broadly rounded front and somewhat straightened lateral margins. Pedicle valve nearly flat and usually with a somewhat distorted beak. Brachial valve gently convex in the middle. Surface marked by numerous raised radiating striæ crossed by concentric lines and stronger growth lamellæ. Average size about 1 inch in length and breadth.

Widely distributed through central and western North America.

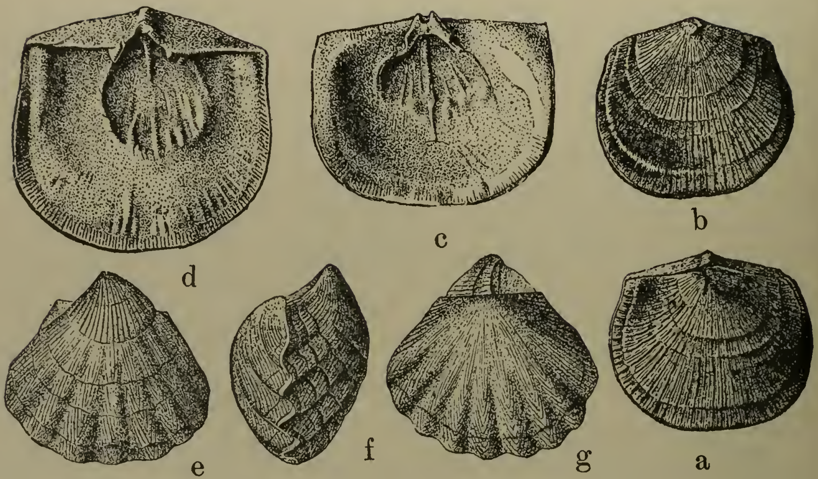


FIG. 282. *a–d, Orthotetes crassus; e–g, Meekella striatocostata.* (Ind. Geol. Surv.)

XL. MEEKELLA White and St. John.

Very biconvex; often subpyramidal; surface plicated. Hinge line straight, shorter than the greatest width of the shell. Cardinal area of pedicle valve high, with deltidium which is convex in the middle and flat along the sides. The prominent dental lamellæ are prolonged forward as septa for half the length of the shell. Cardinal area of brachial valve linear; umbo gibbous; cardinal process thin, erect and high, at times almost reaching the apex of the umbonal cavity of the pedicle valve. Surface of valves, including the coarse radiating plications, covered with fine radiating striæ. Upper Carbonic.

116. **M. striatocostata** (Cox). (Fig. 282, *e–g*.) Upper Carbonic. Beak usually distorted by being flattened. Surface of both valves marked by 10 to 14 angular plications, not extending to the beak and separated by deep angular interspaces. The whole surface covered with fine radiating striæ which in maturity converge upon the crests of the plications and meet one another.

Distributed throughout the western United States.

XLI. HIPPARIONYX Vanuxem.

Large, like *Schuchertella* but with a very convex brachial valve which has no cardinal area; cardinal process high and bifid. Pedicle valve nearly flat, with low cardinal area. Teeth supported by lamellæ which extend as strong ridges entirely around the large muscular area. Oriskany (Devonic).

117. **H. proximus** Vanuxem. (Fig. 283.) Devonic.

Pedicle valve nearly flat; its interior marked by strong muscular imprints which occupy a large cardiform space. The imprint of

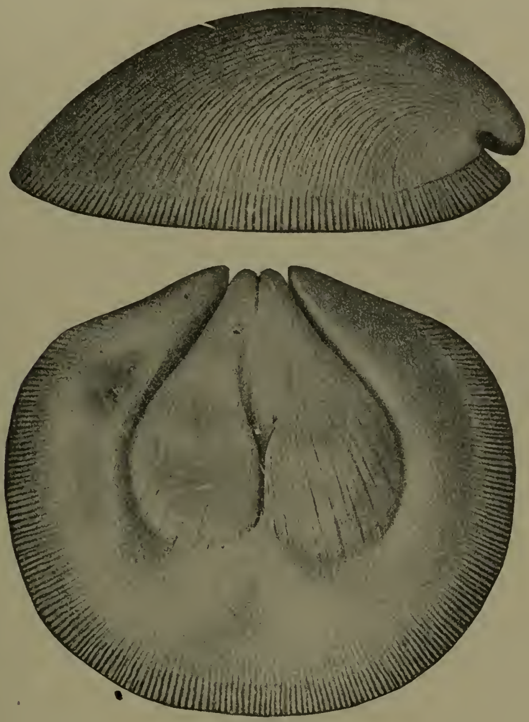


FIG. 283. *Hipparionyx proximus.* (After Hall.)

this on the internal mold suggested the name of "horse's hoof." Brachial valve convex; surface marked by fine subequal striæ.

Oriskany of New York, Pennsylvania, Ontario, etc.

XLII. CHONETES Fischer de Waldheim.

Small. Pedicle valve convex; brachial concave or flat. Hinge line straight, forming greatest diameter of shell. Hinge areas narrow, that of the pedicle valve bearing a single row of hollow spines on its upper margin. Muscular area of both valves divided by a low median ridge. Cardinal process simple. Surface covered with radiating striæ. Siluric–Carbonic.

A. Shell with radiating striæ.......... I.
 I. Pedicle valve with a mesial sinus.......... *.
  * Sinus very deep, giving the shell a bilobed appearance. 134. *C. verneuilianus.*
  * Sinus with a mesial fold in it.......... 132. *C. mesolobus.*
  * Sinus shallow and without mesial fold.......... *a.*
   a. Shell about three fourths inch wide.......... 131. *C. granulifer.*
   a. Shell smaller than above.......... 1.
    1. Hinge line forming greatest width of shell... 133. *C. variolatus.*
    1. Hinge line equal to or greater than greatest width of shell below.......... 126. *C. lepidus.*
 I. Pedicle valve without a mesial sinus.......... **.
  ** Five to seven oblique spines on each side of the beak.......... *b.*
   b. Shell large (about 1 inch wide).......... 2.
    2. Lateral striæ curved anteriorly.......... 118. *C. jerseyensis.*
    2. Lateral striæ straight.......... 122. *C. coronatus.*
   b. Shell small (about ½ inch wide).......... 3.
    3. Shell with 100–120 striæ near front.......... 129. *C. illinoisensis.*
    3. Shell with 50–60 striæ near front.......... 124. *C. scitulus.*
  ** Two to four spines on each side of the beak (except 118 which may have more).......... *c.*
   c. Spines vertical.......... 125. *C. setigerus.*
   c. Spines oblique.......... 4.
    4. Shell large (three fourths inch wide or more).......... †
     † Striæ curving.......... 118. *C. jerseyensis.*
     † Striæ not curving.......... 119. *C. hemisphericus.*
    4. Shell of medium size (½ ± inch in general).......... ††.
     †† Hinge line forming the greatest width of the shell.......... *aa.*
      aa. Umbo of pedicle valve very abruptly incurved at the hinge line.......... 123. *C. pusillus.*
      aa. Umbo of pedicle valve not abruptly incurved. 128. *C. logani.*
     †† Hinge line less than the greatest width of the shell below.......... *bb.*
      bb. Striæ uniform.......... 121. *C. vicinus.*
      bb. Two central striæ stronger than the others. 126. *C. lepidus.*
    4. Shell small (about one fourth inch wide).......... †††.
     ††† Spines bending abruptly until parallel to the hinge line. 120. *C. mucronatus.*
     ††† Spines not bending abruptly.......... 127. *C. aurora.*
B. Shell smooth.......... 130. *C. glaber.*

118. C. jerseyensis Weller. (Fig. 284.) Siluric.

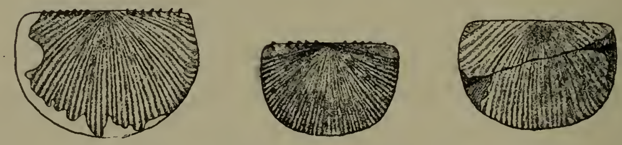


FIG. 284. *Chonetes jerseyensis.* (After Weller.)

Concavo- to plano-convex. Pedicle valve depressed convex. Cardinal spines slightly oblique, about 14. Surface of both valves with rather coarse radiating ribs, 3 or 4 in a space of 2 mm. at the anterior margin; the lateral ribs often curve slightly anteriorly as they approach the margin. Very fine concentric lines also present. Large shell measures 14 mm. in length by 22 mm. in width.

Decker Ferry of New Jersey, Cobleskill, etc., of New York.

119. **C. hemisphericus** Hall. (Fig. 285, *a–b.*) Devonic.

Hinge line often much extended and with 3, 4 or more spines on

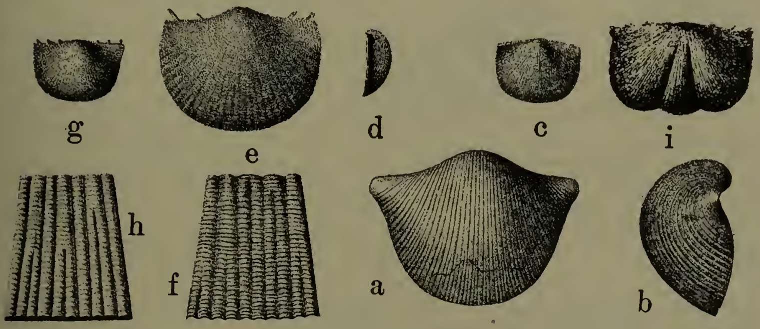


FIG. 285. *a, b, Chonetes hemisphericus; c, d, C. pusillus; e, f, C. aurora*, with enlargement of surface; *g, h, C. logani*, with enlargement of surface; *i, C. mesolobus*. (After Hall.)

each side of the middle. Pedicle valve very ventricose with prominent, incurved umbo. Shell about $\frac{3}{4}$ inch or 1 inch wide.

Onondaga of New York, Nevada, Ontario.

120. **C. mucronatus** Hall. (Fig. 286.) Devonic.

Small (about $\frac{1}{4}$ inch in width), moderately convex with rather distant and strong radial striæ. Cardinal spines, 2–3 on each

FIG. 286. *Chonetes mucronatus*, ×2. (After Hall.)

side of the beak, curving out so abruptly as to become parallel to the hinge line.

Oriskany–Hamilton of New York, Nevada, Ontario, Quebec.

121. **C. vicinus** (Castelnau). (Fig. 287.) Devonic.

Shell ½ ± inch in width, strongly convex. Cardinal margins deflected when seen from the convex side. Striæ finer and more closely crowded than in *C. mucronatus*. Spines short and oblique.

Hamilton of New York, Ohio, Wisconsin, Nevada.

FIG. 287. *Chonetes vicinus*, with enlargement of interior of brachial valve. (After Hall.)

122. **C. coronatus** (Conrad). (Fig. 288.) Devonic.

Large (about ½ inch in width), moderately convex, with numerous surface striæ and 5 or 6 oblique spines on each side of the beak. Interior of pedicle valve strongly pustulose outside the wide spreading adductor impressions.

Hamilton of New York, Pennsylvania, Illinois, Wisconsin, Ontario.

123. **C. pusillus** Hall. (Fig. 285, *c–d.*) Devonic.

Small (about ½ inch wide) with somewhat convex pedicle valve; its umbo abruptly incurved at the hinge extremities which are usually obtuse. Brachial valve nearly as concave as the pedicle is convex. Striæ but little elevated.

Hamilton of Illinois, British America.

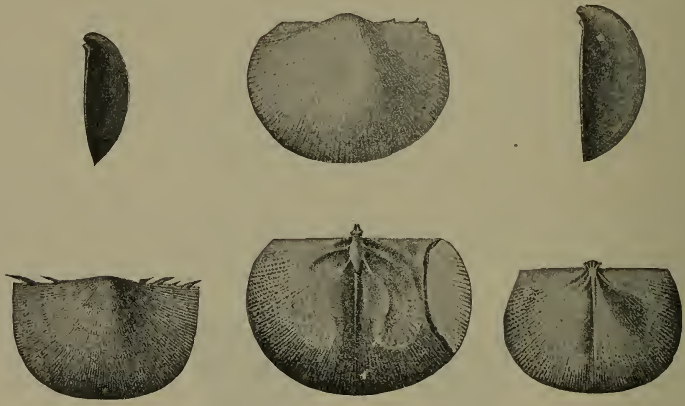


FIG. 288. *Chonetes coronatus.* (After Hall.)

124. **C. scitulus** Hall. (Fig. 289, *a–b.*) Devonic.
Somewhat gibbous, with numerous (50–60) striæ near the front of the shell and many (10–14) oblique cardinal spines. Interior of brachial valve strongly pustulose.
Marcellus–Chemung of New York, Pennsylvania, Ohio.

125. **C. setigerus** (Hall). (Fig. 289, *c.*) Devonic–Lower Carbonic.
Moderately convex with three vertical cardinal spines on each side of the beak.
Marcellus–Waverly of New York, Pennsylvania, Ohio, Michigan, Nevada.

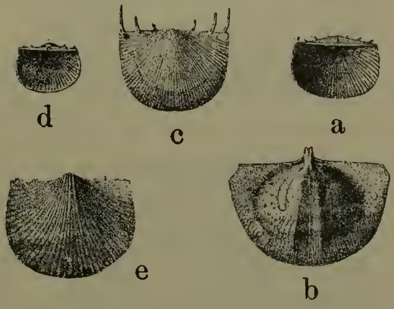


FIG. 289. *a*, *Chonetes scitulus; b*, same, interior of brachial valve, $\times 2$; *d*, *e*, *C. lepidus*, natural size and enlarged; *c*, *C. setigerus*, $\times 2$. (After Hall.)

126. **C. lepidus** Hall. (Fig. 289, *d–e.*) Devonic.
Similar to *C. scitulus* but is smaller, the pedicle valve is more convex, with a mesial sinus and 4 to 10 marginal spines.
Marcellus–Chemung of New York and Pennsylvania.

127. **C. aurora** Hall. (Fig. 285, *e–f.*) Devonic–Lower Carbonic.
Differs from *C. logani* in its smaller size (about ¼ inch wide) and shorter hinge line, the hinge line being usually less than the greatest width of the shell.
Tully–Burlington of New York, Ohio, Iowa, Northwest Territory.

128. **C. logani** Norwood and Pratten. (Fig. 285, *g–h.*) Mississippian.
Pedicle valve quite convex. Greatest width of shell at hinge line (about ½ inch). Surface marked by 20–40 fine, dichotomizing, radiating lines, crossed by fine concentric striæ.
Kinderhook–Burlington of Ohio, Illinois, Iowa.

129. **C. illinoisensis** Worthen. Mississippian.
Small (about ½ inch wide), with five or six oblique spines on each side of the beak. Surface marked by 100–120 very fine dichotomizing striæ near the front of the shell.
Burlington of Ohio, Indiana, Illinois, Iowa.

130. **C. glaber** Geinitz. Upper Carbonic.
Slightly larger than *C. mucronatus*, thin, transversely subsemi-

circular. Length less than one-half breadth. Hinge line slightly longer than greatest width of shell below. Pedicle valve with a broad and shallow mesial sinus which is at times wanting. Cardinal margin with four to seven oblique spines on each side of the beak. Surface smooth except for faint concentric striæ.

Kansas, Iowa, Illinois, Colorado, Nebraska.

131. **C. granulifer** Owen. Upper Carbonic.

Rather large (about ¾ inch wide). Distinguished by the broad shallow sinus in the pedicle valve, the often extended hinge line and the presence of six to ten oblique spines on each side of the beak. Surface marked by very fine radiating striæ.

Alabama, Missouri, Illinois, Iowa, Kansas, Colorado, Arizona.

132. **C. mesolobus** Norwood and Pratten. (Fig. 285, *i*.) Upper Carbonic.

Small. Distinguished by the presence of a lobe or fold in the mesial sinus of the pedicle valve.

Ohio, Missouri, Illinois, Colorado, New Mexico, Arizona.

133. **C. variolatus** (d'Orbigny). Upper Carbonic.

Similar to *C. granulifer* but more convex, very small and with the sinus of the pedicle valve well-marked.

Ohio, Illinois, Missouri, Kansas, Nebraska, Colorado.

134. **C. verneuilianus** Norwood and Pratten. (Fig. 290.) Upper Carbonic.

Small and much wider than long with extended and sometimes mucronate hinge extremities. Pedicle valve bearing a deep, rounded mesial sinus, giving the valve a two-lobed appearance. Hinge line with four oblique spines on each side of the beak. Brachial valve bearing an obtuse median fold. Surface marked by many fine radial striæ. Especially distinguished from other species by its deep sinus and bilobed appearance.

FIG. 290. *Chonetes verneuilianus*; two pedicle valves showing variation. (Ind. Geol. Surv.)

Indiana, Illinois, Missouri, Kansas, Nebraska, Colorado.

XLIII. CHONOSTROPHIA Hall and Clarke.

Differs from *Chonetes* in having the pedicle valve concave and the brachial convex; in the absence of a median septum in the brachial valve and in the bilobed cardinal process.

135. **C. complanata** Hall. (Fig. 291, *a.*) Devonic.

Width 1 inch or more. About two thirds as long as wide. Cardinal spines directed obliquely outwards. Surface with fine, closely arranged, bifurcating striæ.

Oriskany of New York, Ontario and Cumberland, Md.

XLIV. Chonopectus Hall and Clarke.

Chonetes-like in shape, and presence of spines but with the beak of the pedicle valve depressed or distorted, leaving a flattened area which is probably a scar from attachment in early growth. Surface ornamented with a normal series of concentric growth lines and also with a double oblique series of wrinkles looking much like the "engraving on a machine-turned watch case."

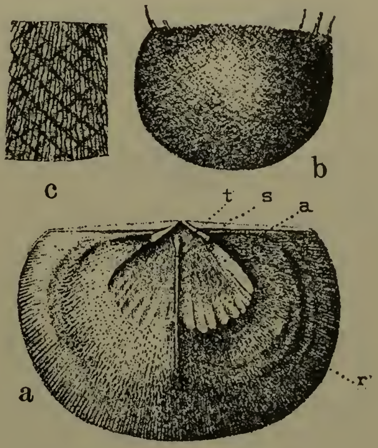


Fig. 291. *a*, *Chonostrophia complanata*; *b*, *Chonopectus fischeri*; *c*, enlargement of surface of same. (After Hall.)

Kinderhook and Burlington (Lower Carbonic).

136. **C. fischeri** (Norwood and Pratten.) (Fig. 291, *b*, *c*.) Lower Carbonic.

Semielliptical. Hinge line with five to seven nearly straight spines on each side of the beak. Surface marked by fine radiating and concentric striæ, beneath which is a "textile" appearance due to a double set of diagonal lines.

Kinderhook and Burlington, of Pennsylvania, Iowa, Missouri, etc.

XLV. Strophalosia King.

Small, semicircular. Hinge line straight. Beak of pedicle valve with scar indicating attachment. Cardinal area of pedicle valve especially conspicuous; delthyrium large, covered; teeth large and cardinal process erect and bifid. Surface of pedicle valve covered with spines; that of brachial valve spinous, lamellose or smooth. Devonic–Carbonic.

137. **S. truncata** (Hall). (Fig. 292.) Devonic.

Small. Pedicle valve gibbous, regularly arched and truncated at the umbo. Cardinal extremities flattened and auriculate. Brachial valve gently concave. Surface of both valves covered with scattered spines.

Hamilton, Portage and Ithaca of New York, Nevada, Ontario.

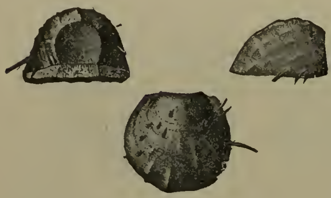


FIG. 292. *Strophalosia truncata.* (After Hall.)

XLVI. PRODUCTELLA Hall.

Productoid. Small, with straight hinge line and narrow cardinal areas. Pedicle valve strongly convex and produced anteriorly, with overarching beak; deltidium present; teeth small. Brachial valve small, concave; cardinal process usually bilobed. Surface marked by radiating ridges which bear spines at intervals. Differs from Strophalosia also in the lack of umbonal attachment. Devonic–Carbonic.

A. Spines numerous .... *.
- * Length much greater than breadth .... 138. *P. navicella.*
- * Length and breadth about equal .... 1.
  - 1. Spines arranged in concentric rows .... 142. *P. speciosa.*
  - 1. Spines irregularly scattered .... *a.*
    - *a.* Brachial valve moderately concave .... 1′.
      - 1′. Lamellose growth lines present .... 144. *P. pyxidata.*
      - 1′. Lamellose growth lines not present .... 145. *P. shumardana.*
    - *a.* Brachial valve very concave .... 2′.
      - 2′. Cardinal margins conspicuously flattened ... 139. *P. spinulicosta.*
      - 2′. Cardinal margins not conspicuously flattened. 146. *P. concentrica.*

B. Spines few and scattered .... **.
- ** Length much greater than breadth, radiating striæ coarse. 143. *P. arcuata.*
- ** Length and breadth about equal, radiating striæ fine .... 141. *P. hallana.*
- ** Length much less than breadth. .... 140. *P. subalata.*

138. **P. navicella** Hall. (Fig. 293, *a–b.*) Devonic.

Small; length much exceeding width. Hinge line less than

FIG. 293. *a, b, Productella navicella; c, d, P. spinulicosta.* (After Hall.)

width of shell below. Pedicle valve projecting about one third its length above the hinge line. Surface marked above by fine spines and below by coarse, spine-bearing ridges.

Onondaga–Hamilton of New York, Nevada.

139. **P. spinulicosta** Hall. (Fig. 293, *c–d.*) Devonic.

Differs from *P. navicella* in the broadly semielliptical or suborbicular outline and in the beak of the pedicle valve which does not extend beyond the hinge line as in *P. navicella.*

Widely distributed in the Onondaga and Hamilton of North America.

140. **P. subalata** Hall. (Fig. 294, *a.*) Middle Devonic.

Semielliptical or semicircular, usually much wider than high. Distinguished by the irregularly scattered spines on the surface.

Illinois, Missouri, Minnesota.

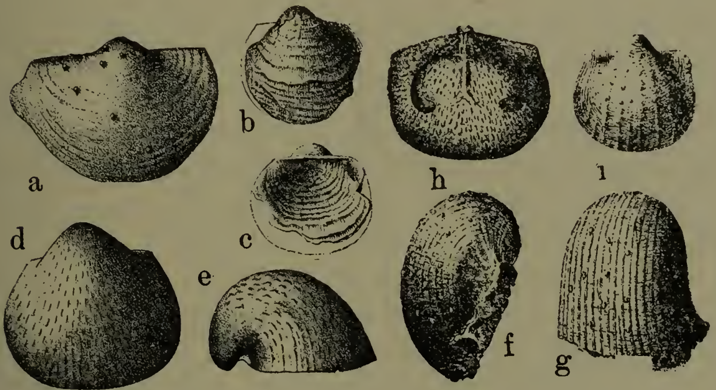


FIG. 294. *a, Productella subalata; b, c, P. hallana; d, e, P. speciosa; f, g, P. arcuata; h, P. pyxidata; i, P. shumardana.* (After Hall, except *b, c,* which are after Walcott.)

141. **P. hallana** Walcott. (Fig. 294, *b–c.*) Upper Devonic.

Semielliptical. Length and breadth nearly equal. Pedicle valve very convex with umbo elevated above the hinge line. Brachial valve deeply concave. Surface of pedicle valve marked by fine radiating striæ, a few strong growth lines and a few scattered spines. Surface of brachial valve marked only by regular concentric lines.

New York, Iowa, Nevada, Northwest Territory.

142. **P. speciosa** Hall. (Fig. 294, *d–e*.)
Devonic–Lower Carbonic.

Broadly ovate with obtusely angular cardinal extremities. Pedicle valve regularly arcuate from beak to front and abruptly depressed between the umbo and the narrow, short ears. Surface marked by fine concentric striæ and on the ears by a few short wrinkles. The whole body of the shell covered with about 25 concentric rows of spine-bearing tubercles.

Portage, Chemung and Kinderhook of New York, Ohio, Iowa, Nevada.

143. **P. arcuata** Hall. (Fig. 294, *f, g*.) Lower Carbonic.

Length exceeding width. Pedicle valve very gibbous with greatly incurved beak. Differs from *P. navicella* in its larger size and in the almost entire absence of spines on the radial costæ, only a few scattered ones occurring.

Kinderhook of Iowa, Ohio and Missouri.

144. **P. pyxidata** Hall. (Fig. 294, *h*.) Lower Carbonic.

Width greater than length. Hinge line shorter than greatest width of shell. Pedicle valve somewhat flattened and slightly recurved at the cardinal extremities; umbo narrow. Surface of both valves marked with lamellose growth lines; spine-bearing radiating ridges at times present on pedicle valve.

Kinderhook of Illinois and Missouri.

145. **P. shumardana** Hall. (Fig. 294, *i*.) Lower Carbonic.

Hinge line about equalling the greatest width of shell. Pedicle valve very convex, gibbous in the middle and towards the umbo; cardinal extremities flattened. Brachial valve moderately concave. Surface of both valves covered with fine concentric striæ and strong spine bases. Differs from *P. pyxidata* in the absence of lamellose growth lines.

Kinderhook of Missouri, Iowa and Ohio.

146. **P. concentrica** Hall. Lower Carbonic.

Small. Hinge line scarcely equalling the greatest width of shell. Brachial valve deeply concave, almost geniculate in front. Surface of older portion of valve covered with strong concentric wrinkles and a few tubercles; the younger portion with elongate spine-bearing ridges.

Kinderhook of Ohio, Indiana, Iowa and Michigan.

XLVII. Productus Sowerby.

Semicircular without functional pedicle but probably anchored by spines of pedicle valve. Pedicle valve large, convex, with inflated and greatly incurved umbo. Brachial valve small, concave or almost flat. Hinge line straight; cardinal areas and teeth absent or rudimentary. Cardinal process large, four-lobed when viewed from within. A median ridge in each valve separates the muscular areas. Surface with radiating ribs crossed by concentric lines or wrinkles, the surface of pedicle valve often studded with spines. Carbonic.

A. Large (over two inches wide) .... *.
  * Surface marked with regular concentric folds from beak to front. 160. *P. punctatus.*
  * Surface marked with very coarse striæ and a few concentric wrinkles. 152. *P. semireticulatus.*
B. Medium (between one and two inches wide) .... **.
  ** Sinus present .... 1.
    1. Beak greatly incurved .... 148. *P. burlingtonensis.*
    1. Beak small, slightly incurved .... *a.*
      a. Radiating striæ coarse .... 154. *P. costatus.*
      a. Radiating striæ very fine .... 155. *P. inflatus.*
  ** Sinus absent .... 2.
    2. Hinge line somewhat shorter than width of shell below .... *b.*
      b. Spines few and scattering .... 153. *P. cora.*
      b. Spines very numerous .... 1′.
        1′. Spines in 2 series; one series of large, the other of small spines. 159. *P. nebraskaensis.*
        1′. Spines in a single series .... 161. *P. symmetricus.*
    2. Hinge line much shorter than width of shell below (equalling only about half the width) .... 147. *P. lævicosta.*
C. Small (less than one inch wide) .... ***.
  *** Hinge line equal to or exceeding the width of the shell below .... 3.
    3. Sides flattened, giving the shell a four-sided appearance from the hinge-margin. No sinus .... 157. *P. mexicoanus.*
    3. Not four-sided .... *c.*
      c. Hinge line extended. Broad mesial sinus .... 156. *P. longispina.*
      c. Hinge line not extended .... 158. *P. muricatus.*
  *** Hinge line less than width of shell below .... 4.
    4. Surface marked by concentric wrinkles .... *d.*
      d. With a marginal fold .... 150. *P. marginicinctus.*
      d. Without a marginal fold .... 149. *P. biseriatus.*
    4. Surface marked by radiating striæ .... 151. *P. fasciculatus.*

147. **P. lævicosta** White. Lower Carbonic.

Subtriangular in general outline, rapidly increasing in width from the small, narrow beak to near the front where it is broadly rounded. No mesial depression present. Hinge line short, forming scarcely more than half the width of the shell. Surface marked with very fine, thread-like striæ. Spine bases scarcely visible.

Kinderhook of Iowa, Missouri, Utah.

148. **P. burlingtonensis** Hall. (Fig. 295, *a–c.*)

Lower Carbonic.

Pedicle valve extremely ventricose with beak incurved to near the middle of the valve; median sinus present, extending from near the beak to the front. Brachial valve moderately concave above and abruptly geniculate in the middle. Surface marked by

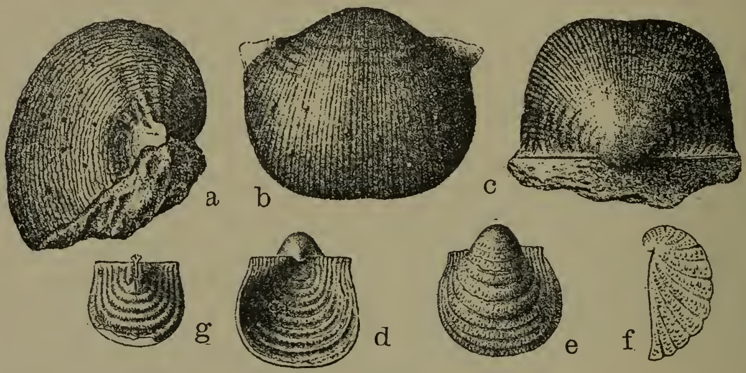


FIG. 295. *a–c, Productus burlingtonensis; d–g, P. biseriatus.* (After Hall and Whitfield.)

radiating, bifurcating ribs crossed by fine concentric striæ. Strong wrinkles present on the upper portion of the shell and scattered spines on the middle and lower parts.

Burlington of Illinois, Iowa, Missouri, Utah.

149. **P. biseriatus** Hall. (Fig. 295, *d–g.*) Lower Carbonic.

Small, longitudinally ovate; hinge line scarcely as long as the width of the shell below. Pedicle valve extremely gibbous, without sinus and marked by five or six elevated, distant, concentric undulations which bear on their upper margins a row of elongate nodes and below this many smaller granulations. Beak attenuate and extremely arcuate. Brachial valve flat near the front and marked by 8 or 9 concentric bands set with granulations.

St. Louis of Kentucky, Indiana, Illinois, Missouri.

150. **P. marginicinctus** Prout. Lower Carbonic.

Brachial valve subquadrate. A conspicuous marginal fold or cincture present on each valve. Surface covered with prominent, rounded, bifurcating costæ, the point of bifurcation marked by a spine base. Fine concentric striæ cover the entire surface; these are accompanied on the older portion of the shell by prominent concentric wrinkles. Width about 1 inch; length somewhat less.

St. Louis of Illinois and Missouri.

151. **P. fasciculatus** McChesney. Lower Carbonic.

Hinge line shorter than width of the shell below. Beak small and appressed. Pedicle valve sharply arcuate above and gently curving, with a slight depression. Surface marked with moderately fine radiating striæ which, when well preserved, have an irregular knotty appearance caused by the thickening of the striæ

FIG. 296. *Productus semireticulatus.* (Ind. Geol. Surv.)

at the spine bases. Very fine concentric growth lines present in front and above, a few obscure transverse wrinkles.

Kaskaskia of West Virginia, Kentucky, Ohio, Indiana, Missouri, Illinois, Utah.

152. P. **semireticulatus** (Martin). (Fig. 296.)
Lower and Upper Carbonic.

Large, much like *P. costatus* in form and character of plications, but larger and with less distinct plications which are crossed by regular concentric wrinkles in younger stages. Shallow mesial sinus present giving the shell a bilobed appearance.

Throughout the Carbonic of North America.

153. P. **cora** d'Orbigny. (Fig. 297, *a–b*.) Upper Carbonic.

Pedicle valve uniformly convex with beak scarcely projecting above the hinge line. Mesial fold and sinus absent. Surface marked with fine radiating striæ and with a few scattered spines.

Throughout the Upper Carbonic of North America.

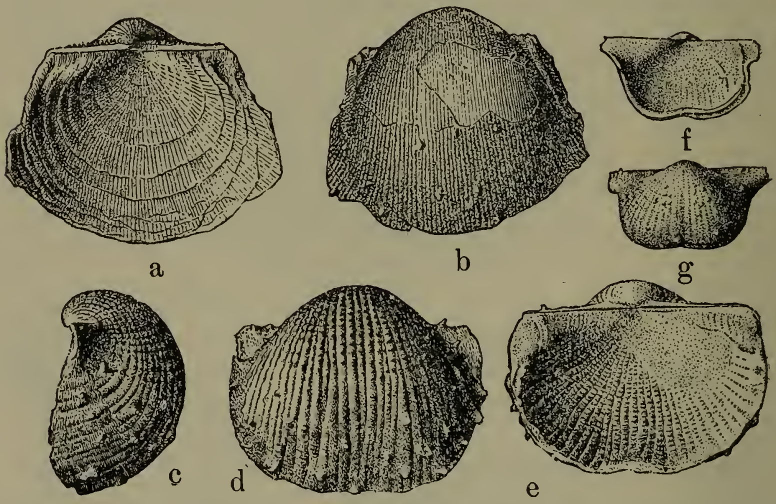


FIG. 297. *a, b, Productus cora; c–e, P. costatus; f–g, P. longispina.* (Ind. Geol. Surv.)

154. P. **costatus** (Sowerby?) de Koninck. (Fig. 297, *c–e*.)
Upper Carbonic.

Of medium size. Pedicle valve gibbous with a broad, shallow sinus producing a slight emargination at the anterior border. Beak prominent but only slightly projecting over the hinge margin. Brachial valve concave with a very slight mesial fold. Surface marked by coarse radiating plications sometimes bifurcating or coalescing and crossed by a few concentric wrinkles. A few strong, scattered spines present on the pedicle valve.

Throughout the Upper Carbonic of North America.

155. **P. inflatus** McChesney. Upper Carbonic.

Very gibbous, subquadrate in outline. Beak small and incurved. Sinus broad, shallow and distinct. Much resembles *P. semireticulatus* but differs in its smaller size and in the fineness of its radial striæ. Concentric wrinkles present in the posterior third. Spines few, distant and large.

Indiana and Colorado.

156. **P. longispina** Sowerby ? (Fig. 297, *f–g*.) Upper Carbonic.

Small, much wider than long with extended hinge line and prominent ears. Pedicle valve gibbous with slightly projecting beak and broad mesial sinus. Brachial valve concave. Surface marked by obscure radiating ribs which are obsolete on the umbo. Spines originally long but usually broken off.

Throughout the Upper Carbonic of the United States.

157. **P. mexicoanus** Shumard. Upper Carbonic.

Small. Sides flattened, giving the shell a somewhat four-sided outline when viewed from the hinge margin. Pedicle valve strongly arched and without mesial sinus. Surface with 16–20 coarse radiating costæ on which are scattered spines.

Nevada, New Mexico.

158. **P. muricatus** Norwood and Pratten. Upper Carbonic.

Small, semicircular with breadth exceeding length. Curvature moderate. Distinguished by its surface markings, consisting of concentric nodose wrinkles and coarse, somewhat nodose striæ. Whole shell covered by small spines.

Ohio, Illinois, Missouri, Iowa, Colorado, New Mexico.

159. **P. nebraskaensis** Owen. (Fig. 298, *a–c*.)

Upper Carbonic.

Of medium size. Distinguished by the absence of a distinct sinus in the pedicle valve and by the large number of spines scattered over the surface of both valves. (See *P. symmetricus*.)

Ohio, Indiana, Illinois, Missouri, Nebraska, Colorado, Nevada, New Mexico, Arizona.

160. **P. punctatus** (Martin). (Fig. 298, *d–e.*)

Upper Carbonic.

Distinguished by its large size, hinge line shorter than the width of the shell below, slight mesial sinus in the pedicle valve, small, incurved beak and numerous regular concentric folds with plain interspaces. Spines numerous, minute and appressed.

Widely distributed throughout North America.

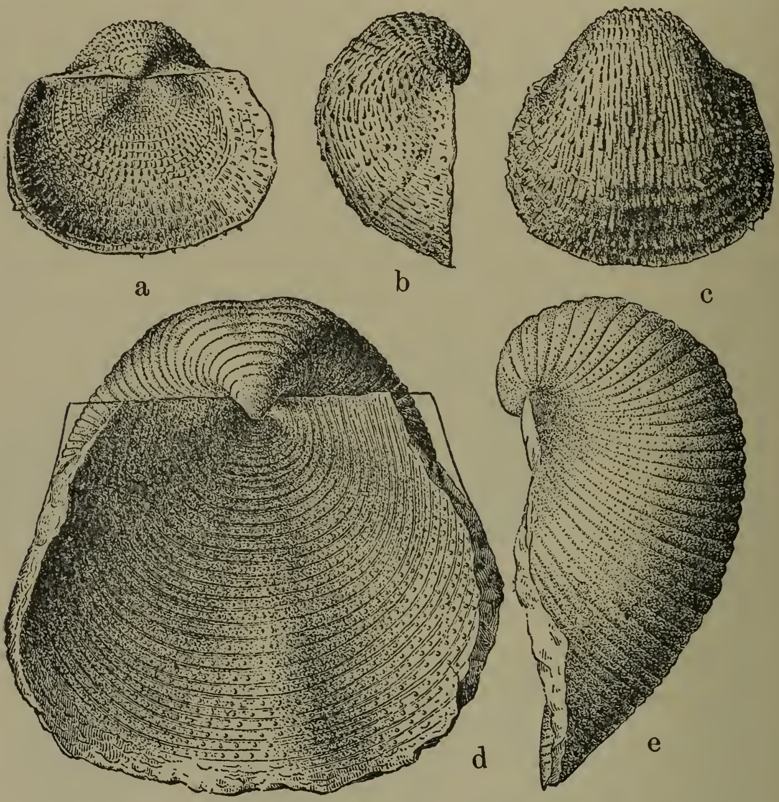


FIG. 298. *a–c, Productus nebraskaensis; d, e, P. punctatus* (Ind. Geol. Surv.)

161. **P. symmetricus** McChesney. (Fig. 299.)

Upper Carbonic.

Cardinal area a little less than greatest width of shell. Front broadly rounded. Pedicle valve without mesial sinus; ears obtusely angular, not well defined from the body of the shell. Brachial valve moderately concave. Surface covered with small concentric wrinkles, covered with many minute spines. Width about two inches, length slightly less. Distinguished from *P. nebraskaensis* by its less convex pedicle valve, its smaller concentric wrinkles, and especially by having a simple series of small, rather compressed spines without the additional stout and erect series of spines.

Upper Carbonic of Indiana, Illinois, Iowa and Nebraska.

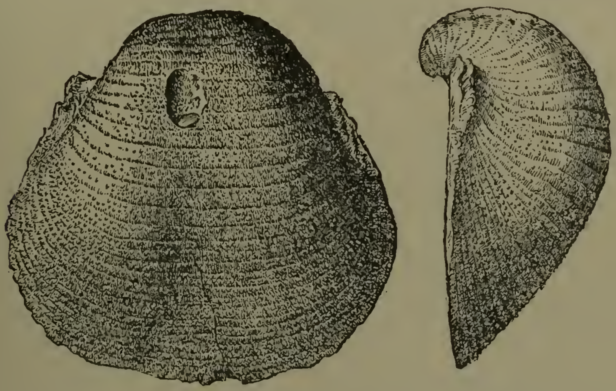


FIG. 299. *Productus symmetricus*. (Ind. Geol. Surv.)

ORTHIDÆ.

ORTHIS Dalman.

Under this name were formerly placed all forms having in general a straight hinge line, cardinal areas well developed in each valve, with usually an open triangular delthyrium in each with deltidium developed only in younger growth stages. Dental lamellæ well developed in the pedicle valve and crural plates in the brachial valve. Surface covered with radiating striæ or plications.

This old genus of *Orthis* has been subdivided into *Orthis* (restricted), *Plectorthis*, *Dinorthis*, *Hebertella*, *Orthostrophia*, *Platystrophia*, *Heterorthis*, *Bilobites*, *Dalmanella*, *Rhipidomella*, *Schizophoria*, *Orthotichia*, *Enteletes*.

A. Shell surface radially plicate (*i. e.*, radiating lines coarse) .... *.
 * Hinge line short (forming about one third the greatest width of shell. Shell globular .... LVIII. *Enteletes*.
 * Hinge line long.. I.
  I. Pedicle valve flat or concave. Brachial convex............... L. *Dinorthis*.
  I. Pedicle valve convex............................... .... *a*.
   a. Brachial valve flat.. XLVIII. *Orthis*.
   a. Brachial valve convex.. I′.

1′. Strong mesial fold on brachial valve and corresponding sinus on pedicle valve .... LIII. *Platystrophia.*
1′. No mesial fold present. Shallow sinus present or absent. XLIX. *Plectorthis.*

B. Shell surface radially striate (*i. e.*, radiating lines fine)................................ **.
** Strongly two-lobed. Very small.................................... LIV. *Bilobites.*
** Not two-lobed.. 2.
2. Hinge line short (forming about one third the greatest width of shell).. *b.*
b. Valves subequally and gently biconvex............ LVI. *Rhipidomella.*
b. Brachial valve very convex ; pedicle valve much less convex. LVII. *Schizophoria.*
2. Hinge line long... *c.*
c. Shell substance punctate.................................. LV. *Dalmanella.*
c. Shell substance impunctate.. 2′.
2′. Muscular impression of pedicle valve small, almost confined between the dental lamellæ .... LII. *Orthostrophia.*
2′. Muscular impression of pedicle valve moderately large, extending about half the distance from the beak to the front of the shell .... LI. *Hebertella.*

XLVIII. Orthis Dalman (emend Hall and Clarke).

Brachial valve flat; pedicle valve convex. Cardinal area of pedicle valve elevated and somewhat incurved. Surface covered with strong, sharp, and comparatively few plications which are usually if not always simple. Dental lamellæ slightly developed. Cardinal process, a vertical plate lying at the bottom of the brachial deltidial cavity, and longitudinally dividing it. Camb.–Carb.

162. **O. costalis** Hall. (Fig. 300, *a–b.*) Ordovicic.

Hinge line slightly less than the greatest width of the shell. Pedicle valve very convex with high cardinal area and beak not

FIG. 300. *a, b, Orthis costalis ; c, d, Plectorthis fissicosta.* (After Hall.)

incurved. Surface covered by about 30 distant, strong and rounded plications.

Chazy of New York.

163. **O. tricenaria** Conrad. (Fig. 301, *a–c.*) Ordovicic.

Distinguished from *O. flabellites* by its smaller size and strongly convex pedicle valve with very high cardinal area.

Trenton ; widely distributed throughout North America.

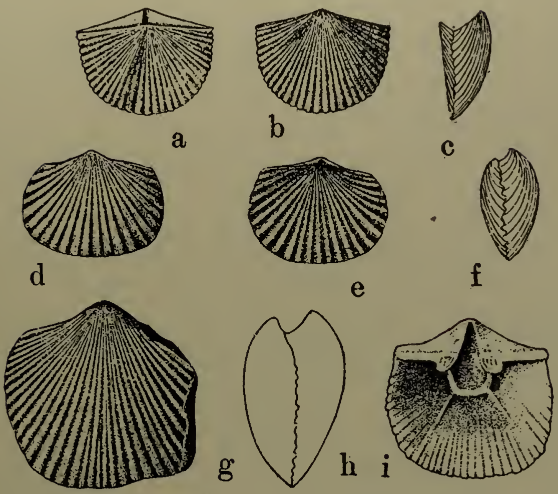


FIG. 301. *a–c*, *Orthis tricenaria* ; *d–f*, *Plectorthis plicatella* ; *g–i*, *P. whitfieldi.* (Minn. Geol. Surv.)

164. **O. flabellites** Foerste. (Fig. 302.) Siluric.

Semioval, with long hinge line. The coarse plications crossed by concentric growth lines.

Clinton and Niagara of New York, Kentucky, Ohio, Indiana, Wisconsin, Ontario.

XLIX. PLECTORTHIS Hall and Clarke.

Differs from *Orthis* (restricted) in the subequal and convex valves, in having less simple plications and in the comparatively low cardinal area of the pedicle valve. Ordovicic – Devonic.

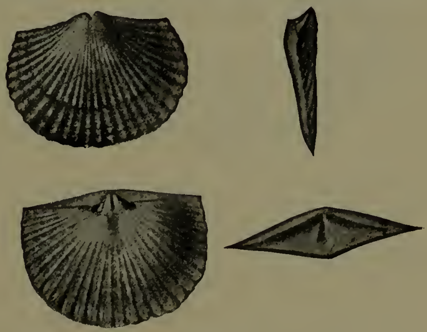


FIG. 302. *Orthis flabellites.* (Pal. N. Y.)

165. **P. indianola** Walcott. Cambric.

Small, transverse. Hinge line varying from slightly less to one fifth greater than the width of the shell below. Pedicle valve about twice as convex as the brachial, with or without a mesial sinus. Brachial valve with a shallow or deep mesial sinus. Cardinal areas low. Surface marked with strong or fine radiating ribs or striæ.

Middle and Upper Cambric of Indian Territory, Oklahoma, Texas.

166. **P. remnicha** Winchell. Cambric.

Of medium size, usually slightly transverse. Hinge line varying in length from nearly the greatest width of the shell to two thirds the greatest width. Cardinal areas narrow. Brachial valve slightly less convex than the pedicle. Surface marked by bifurcating radiating ribs that vary on shells of similar size from sixteen in the space of $\frac{1}{5}$ inch to three in the same space.

Saint Croix of Minnesota and Wisconsin, and equivalent formations of Wyoming, Montana, Indian Territory.

167. **P. plicatella** Hall. (Fig. 301, *d–f.*) Ordovicic.

Broadly semioval. Valves equally convex without depression or elevation. Length and breadth as 3 to 4. Cardinal area narrow. Plications about 20–28.

Trenton–Lorraine of New York, Kentucky, Ohio, Wisconsin, Minnesota.

168. **P. whitfieldi** (N. H. Winchell). (Fig. 301, *g–i.*) Ordovicic.

Larger than *P. plicatella* with an almost square outline. Cardinal area strongly elevated. Plications numerous.

Lorraine of Illinois, Iowa, Wisconsin, Minnesota.

169. **P. fissicosta** Hall. (Fig. 300, *c–d.*) Ordovicic.

Of medium size. Slightly and nearly evenly convex. Distinguished especially by the character of the costæ which are angular and become two or three times divided toward the margin of the shell.

Lorraine of Ohio.

L. Dinorthis Hall and Clarke.

Differs from *Orthis* (restricted) in the convex brachial valve, in the pedicle valve which is elevated at the umbo and becomes gradually depressed and finally flat or concave, in the dental lamellæ being extended around a subquadrate muscular area, and in having an erect cardinal process. Ordovicic.

170. **D. deflecta** (Conrad). (Fig. 303, *a–d.*) Ordovicic.

Brachial valve moderately convex. Hinge line usually forming the greatest diameter of the shell. Cardinal areas at right angles to each other with broadly triangular delthyrium partially covered by a convex deltidium. Surface covered with many fine elevated striæ crossed by finer concentric lines.

Trenton of Kentucky, Tennessee, Illinois, Iowa, Wisconsin, Minnesota.

171. **D. meedsi** Winchell and Schuchert. (Fig. 303, *e–h.*) Ordovicic.

Biconvex owing to the slight convexity of the pedicle valve. Hinge line shorter than the width of the shell below. Pedicle

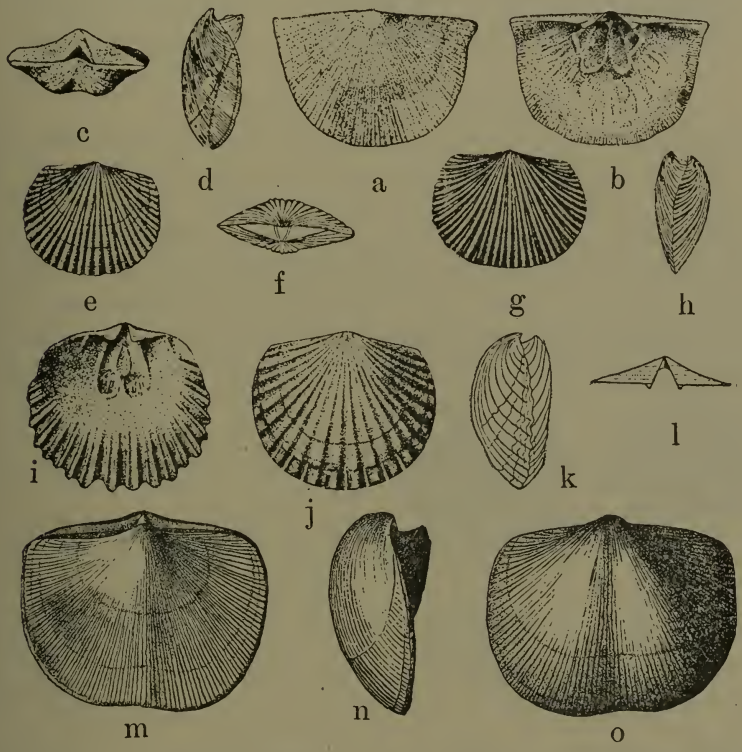


FIG. 303. *a–d, Dinorthis deflecta; e–h, D. meedsi; i–l, D. pectinella* (Minn. Geol. Surv.); *m–o, D. subquadrata* (Ind. Geol. Surv.).

valve marked by a broad, shallow sinus. Surface marked by strong, sharp, fasciculated striæ crossed by growth lines.

Trenton of Iowa, Wisconsin, Minnesota.

172. **D. pectinella** (Emmons). (Fig. 303, *i–l.*) Ordovicic.

Pedicle valve flattened with a broad central depression. Brachial valve regularly convex. Surface marked with 22–30 prominent radii which are as broad as the spaces between and present an appearance much like the radii of *Pecten*.

Trenton of New York, Pennsylvania, Iowa, Minnesota, Ontario, Manitoba.

173. **D. subquadrata** (Hall). (Fig. 303, *m–o*.) Ordovicic.

Larger and more subquadrate than the preceding species, the sides and front being nearly straight. Surface marked by sharp radiating striæ which increase by bifurcation and intercalation.

Lorraine of the Ohio Valley, Missouri, Illinois, Wisconsin, Minnesota, Iowa, Manitoba, Anticosti.

LI. Hebertella Hall and Clarke.

Cardinal area about equalling the greatest width of the shell, that of the pedicle valve being much the higher. Pedicle valve depressed convex, always less convex than the brachial which is frequently much inflated. Both valves covered with fine, rounded and closely crowded striæ or plications which increase by intercalation; these are crossed by concentric growth lines. Dental lamellæ continued as a strong ridge around the obcordate muscular area. Cardinal process simple, elongate. Shell impunctate. Ordovicic–Siluric.

A. Small, less than ½ inch long .... 175. *H. bellirugosa*.
B. More than ½ inch long .... *.
  * Broad sinus present on pedicle valve .... 1.
    1. Surface striate .... *a*.
      a. Striæ irregularly bifurcating. Beak moderately high. 177. *H. occidentalis*
      a. Striæ stronger and regularly bifurcating. Beak very high. 178. *H. sinuata*.
    1. Surface plicate .... 174. *H. borealis*.
  * No sinus present on pedicle valve .... 176. *H. insculpta*.

174. **H. borealis** (Billings). (Fig. 304, *a–c*.) Ordovicic.

Both valves convex. Hinge line somewhat less than the width of the shell below. Brachial valve with a low, undefined mesial prominence; pedicle valve with a broad and very shallow mesial sinus. Surface covered with about 40 radiating ribs. Much like *Plectorthis plicatella*, but differs in the presence of the fold and sinus.

Chazy–Trenton of Kentucky, Tennessee, Wisconsin, Minnesota, Ontario, Quebec

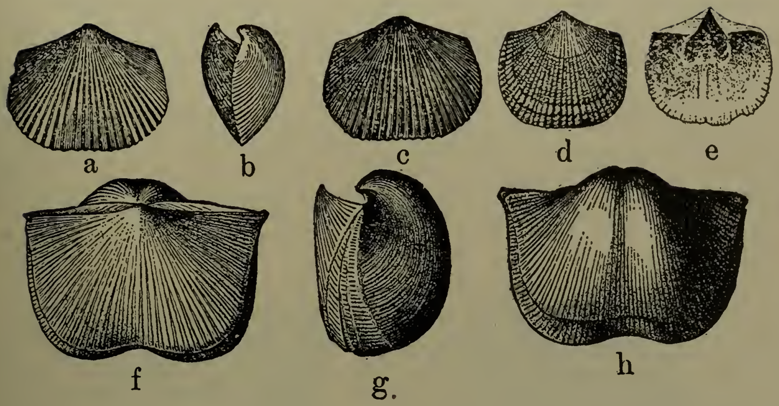


FIG. 304. *a–c*, *Hebertella borealis* (Geol. Surv. Canada); *d*, *e*, *H. bellirugosa* (Minn. Geol. Surv.); *f–h*, *H. occidentalis* (Ind. Geol. Surv.).

175. **H. bellirugosa** (Conrad). (Fig. 304, *d–e*.) Ordovicic.
Small (less than ½ inch long), subquadrate. Valves of nearly equal convexity. Brachial valve with a conspicuous mesial sinus and pedicle valve also at times with a sinus. Surface striæ crossed by imbricating lamellæ which give the shell a rugose appearance.

Trenton of Kentucky, Tennessee, Wisconsin, Minnesota, Iowa.

176. **H. insculpta** Hall. (Fig. 305.) Ordovicic.
Distinguished from *H. bellirugosa* by its larger size (over ½ inch long), more convex brachial valve and less prominent concentric growth lines.

Lorraine of Ohio, Indiana, Illinois, Wisconsin, Iowa.

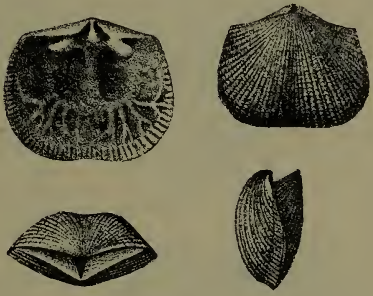


FIG. 305. *Hebertella insculpta*. (After Hall.)

177. **H. occidentalis** Hall. (Fig. 304, *f–h*.) Ordovicic.
Length and breadth about as 5 to 7. Cardinal area of pedicle valve high; delthyrium triangular, large and open. Pedicle valve high at beak, depressed into a broad sinus toward the front. Brachial valve regularly and strongly convex with greatly incurved beak which projects slightly beyond the hinge line. Surface marked by elevated, subangular striæ crossed by fine concentric growth lines.

Lorraine of Ohio, Indiana, Illinois, Missouri, Wisconsin, New Mexico.

178. **H. sinuata** Hall. (Fig. 306.) Ordovicic.

Very similar to *H. occidentalis* from which it differs in the more elevated and acute beak of the pedicle valve and in the stronger and more regularly bifurcating striæ.

Lorraine of Ohio.

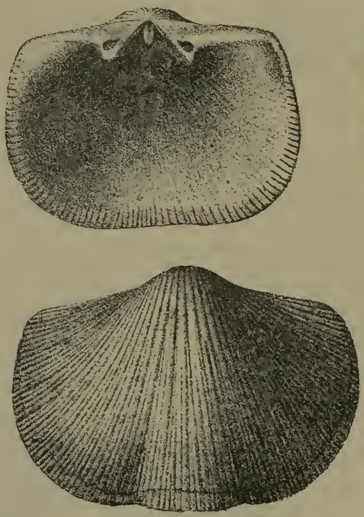


FIG. 306. *Hebertella sinuata.* (Ohio Surv.)

LII. ORTHOSTROPHIA Hall.

Pedicle valve depressed convex; brachial very convex. Surface striated. Cardinal process elongate and simple. Muscular area in pedicle valve deep and narrow, almost confined to the space between the dental lamellæ. The vascular markings are very distinct on both valves. Siluric–Devonic.

FIG. 307. *Orthostrophia (?) fasciata.* (After Hall.)

179. **O.(?) fasciata** Hall. (Fig. 307.) Siluric.

Distinguished by its small size, often extended hinge line and bifurcating and fasciculate striæ.

Niagara of New York.

180. **O. strophomenoides** Hall. Devonic.

Beak of pedicle valve but little elevated above the hinge line; that of brachial valve somewhat the more prominent. Surface marked by a distinct, narrow mesial elevation on the pedicle valve from beak to front and by a corresponding depression on the brachial valve.

Helderbergian of New York, Maine, Tennessee, etc.

LIII. Platystrophia King.

Exterior spiriferoid but interior lacking the calcified brachidia of *Spirifer*. Hinge line long and straight. Cardinal areas almost equally developed on both valves, thus differing from *Spirifer*. Both valves very convex, the brachial the more so, with a strong median fold on the brachial valve and a corresponding deep sinus

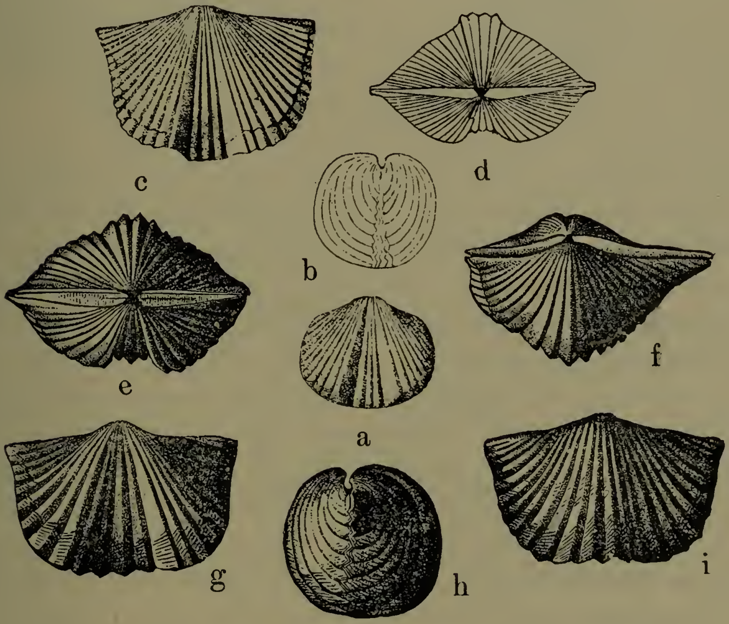


FIG. 308. *a*, *b*, *Platystrophia crassa*; *c*, *d*, *P. lynx*, var. (Minn. Geol. Surv.); *e–i*, *P. acutilirata* (Ind. Geol. Surv.).

on the pedicle valve. Both valves marked by strong sharp plications which extend over sinus and fold. The teeth are thick and very prominent. Ordovicic–Siluric.

A. Height and breadth about equal. Shell very gibbous............... 181. *P. crassa*
B. Breadth exceeding height.. *
 * Hinge line rounded at extremities and less than the greatest width of shell. 183. *P. lynx.*
 * Hinge line extended .... 1.
  1. Two plications in sinus.. 185. *P. biforata.*
  1. Three or more plications in sinus .... *a.*
   a. Hinge line usually with mucronate extremities. Plications many. 1′.
    1′. Fold pronounced.. ....185. *P. biforata.*
    1′. Fold not pronounced ....182. *P. acutilirata.*
   a. Hinge line extremities not mucronate. Plications wide and few. 184. *P. laticosta.*

181. **P. crassa** James. (Fig. 308, *a–b.*) Ordovicic.
Hinge line short with rounded extremities. Shell as wide as long. Both valves very gibbous. (*Cf. P. costata* Pander.)
Lorraine of Ohio, Minnesota, Manitoba.

182. **P. acutilirata** (Conrad). (Fig. 308, *e–i.*) Ordovicic.
Usually much extended on hinge line which is often mucronate. Plications simple, from 10 to 18 on each side of fold and sinus with usually only three in the sinus and four on the fold.
Lorraine of Indiana, Ohio, Missouri and Louisiana.

183. **P. lynx** (Eichwald). (Figs. 308, *c–d;* 309.) Ordovicic.
Large, wider than long. Hinge line usually less than the greatest width of the valves, with obtusely angular extremities. Plications (16–24) angular, with three (1–7) in the mesial sinus.
Trenton of New York, Lorraine of Ohio, Kentucky, Indiana, etc.

184. **P. laticosta** Meek. Ordovicic.
Of medium size, wider than long, with hinge line forming greatest width of shell. Plications large and few, 5 to 7 on the lateral slopes and 1 to 3 on the sinus and 2 to 4 on the fold; those marking fold and sinus are irregular and of different sizes.
Lorraine and Richmond of Ohio valley.

185. **P. biforata** (Schlotheim). Ordovicic and Siluric.
Semielliptical or subquadrate, wider than long. Cardinal extremities varying from submucronate to obtuse. Usually about 2 (2–9) of the sharp plications are in the sinus while about 3 (3–10) mark the fold, rapidly increasing in strength as they approach the front.
Trenton of Hudson and Champlain valleys and Clinton of New York, Ohio, Kentucky and Indiana.

LIV. Bilobites Linnæus.

Small, strongly bilobed. Hinge line short. Teeth and sockets obscure. Cardinal process small and simple. Shell substance punctate. Siluric–Carbonic.

186. **B. bilobus** (Linnæus). Siluric.

Cardinal extremities auriculate. Pedicle valve very convex; brachial valve varying from slightly concave to slightly convex.

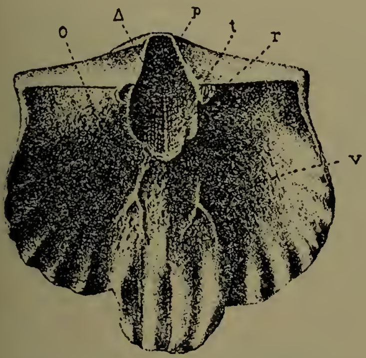


Fig. 309. *Platystrophia lynx.* Interior of pedicle valve × 1. Δ, delthyrium; *o*, ovarian impression; *p*, pedicle muscle scar; *r*, diductor muscle impression; *t*, teeth; *v*, vascular markings. (After Hall.)

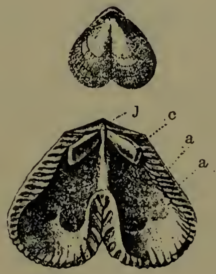


Fig. 310. *Bilobites varicus.* Exterior dorsal view × $\frac{3}{2}$ and interior of brachial valve much enlarged; *j*, cardinal process; *c*, crura; *a*, adductor scars. (After Hall.)

Differs from *B. varicus* in its smaller size, its more extended hinge line, greater inequality of the two valves and in its few radial striæ.

Niagaran of New York, Indiana, Wisconsin.

187. **B. varicus** Conrad. (Fig. 310.) Devonic.

Ventricose. Cardinal area of pedicle valve the higher. Foramen high and narrow. Surface unequally striated, only a few of the striæ being visible to the naked eye. Differs from *B. bilobus* in its larger size, greater gibbosity. and proportionally shorter hinge line.

Helderbergian of New York, Tennessee, New Brunswick.

LV. Dalmanella Hall and Clarke.

Plano-convex or subequally biconvex, subcircular in outline. Pedicle valve elevated and arched over the cardinal area. Surface covered with fine, rounded, bifurcating striæ which curve very conspicuously from the umbo to the sides of the valve. Teeth prominent. Ordovicic–Devonic.

A. Radiating striæ prominent and coarse .... 188. *D. testudinaria*.
B. Radiating striæ very fine .... *.
  * Shell small (less than ¾ inch wide) .... 1.
    1. Pedicle valve wider than long .... *a*.
      a. Shell thin .... 189. *D. emacerata*.
      a. Shell convex .... 190. *D. subæquata*.
    1. Pedicle valve longer than wide .... 191. *D. elegantula*.
  * Shell more than ¾ inch wide .... 2.
    2. Brachial valve slightly convex and with broad mesial depression. 193. *D. subcarinata*.
    2. Brachial valve strongly convex and with slight mesial depression. 192. *D. perelegans*.

188. **D. testudinaria** (Dalman). (Fig. 311, *a–e*.) Ordovicic.

Pedicle valve convex at umbo, rapidly decreasing in height before the edge of the shell is reached; cardinal area high; umbo but slightly incurved. Brachial valve very slightly convex or depressed. Surface marked with very prominent radiating striæ crossed by faint concentric lines.

Chazy–Lorraine throughout America.

189. **D. emacerata** Hall. (Fig. 311, *i–m*.) Ordovicic.

Distinguished by its thinness, the brachial valve being flat and the pedicle valve depressed convex. Cardinal area almost linear. Surface finely striated.

Utica of Ohio, Missouri, Minnesota and Quebec.

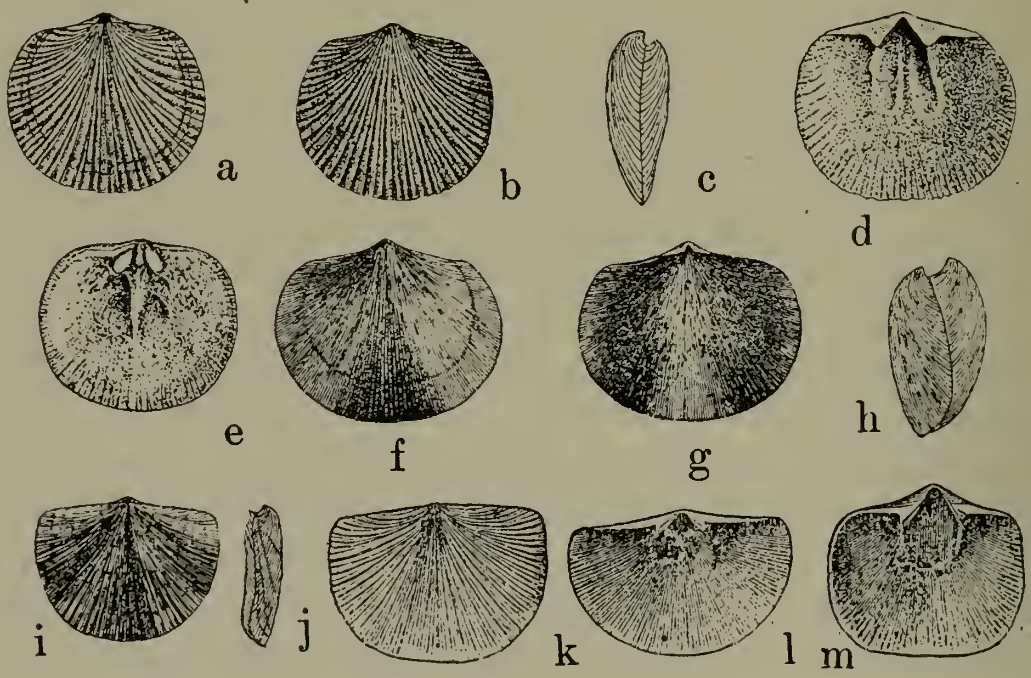


FIG. 311. *a–e*, *Dalmanella testudinaria*; *f–h*, *D. subæquata*; *i–m*, *D. emacerata*. (Minnesota Geol. Surv.)

190. **D. subæquata** (Conrad). (Fig. 311, *f–h.*) Ordovicic.

Both valves convex, the pedicle valve more than the brachial especially at the umbo. Surface marked with fine radiating striæ which are perforate at intervals.

Trenton of Missouri, Wisconsin, Minnesota, Iowa, Quebec.

191. **D. elegantula** (Dalman). (Fig. 312.) Siluric.

Pedicle valve very strongly convex with a high, narrow cardinal area. Brachial valve nearly flat and marked with an undefined median sinus. Striæ fine and close set.

Clinton and Niagara; widely distributed throughout eastern North America.

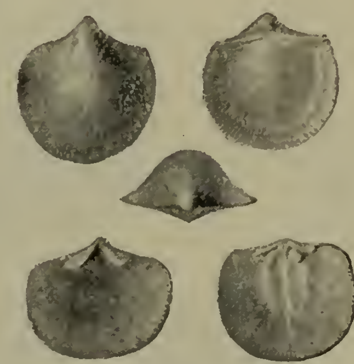


FIG. 312. *Dalmanella elegantula.* (After Hall.)

192. **D. perelegans** Hall. (Fig. 313.) Devonic.

Pedicle valve convex but not subcarinate as in *D. subcarinata.*

FIG. 313. *Dalmanella perelegans.* (After Hall.)

Brachial valve very convex and only slightly depressed medially. In other respects very like *D. subcarinata.*

Helderbergian of New York and Tennessee.

193. **D. subcarinata** Hall. (Fig. 314.) Devonic.

Pedicle valve very convex, subcarinate along median line; umbo strongly incurved over the cardinal area. Brachial valve slightly convex near the hinge with an undefined depression along the median line which broadens rapidly anteriorly. Striæ very fine, numerous and irregularly bifurcating.

FIG. 314. *Dalmanella subcarinata*. (After Hall.)

Helderbergian of New York, Tennessee, Missouri, Wisconsin, Nova Scotia.

LVI. RHIPIDOMELLA Oehlert.

Shell almost circular. Both valves gently convex. Hinge line short. Slight median depression present in each valve. Surface covered with fine, hollow striæ, often opening on the surface. From the base of the two strong teeth on the interior of the pedicle valve a curving ridge extends forward and borders the large flabelliform muscular scars which extend one third or more the length of the valve and are deeply impressed. Shell structure punctate. Siluric–Carbonic.

A. Rounded posteriorly, *i. e.*, beak but slightly elevated above hinge line........... *.
- * Large (average width over ½ inch) .... 1.
  - 1. With broad medial depression in pedicle valve .... *a*.
    - *a*. Outline usually transversely oval.. 1′.
      - 1′. Posterior border curved .... 195. *R. oblata*.
      - 1′. Posterior border straight.............................. 196. *R. alsa*.
    - *a*. Outline circular.. 198. *R. vanuxemi*.
  - 1. Without broad depression in pedicle valve.. *b*.
    - *b*. Beaks prominent... 197. *R. livia*.
    - *b*. Beaks not prominent.. 2′.
      - 2′. Radiating striæ indistinct......................... 202. *R. michelini*.
      - 2′. Radiating striæ strong............................ 200. *R. penelope*.
- * Small (width not exceeding ½ inch).. 2.
  - 2. Sinus present in both valves.................................... 201. *R. thiemei*.
  - 2. Sinus absent in pedicle valve.................................. 205. *R. pecosi*.

B. Pointed posteriorly, *i. e.*, with somewhat elevated beak .... **.
** Small (width not exceeding ⅔ inch) .... 3.
3. With slight mesial depression. Beak not incurved...... 194. *R. hybriaa.*
3. With strong mesial sinus. Beak of pedicle valve somewhat incurved. 204. *R. dubia.*
** Of medium size (not below ⅔ inch in width) .... 4.
4. Curved posteriorly.. 199. *R. leucosia.*
4. Straight posteriorly........................ .... 203. *R. burlingtonensis.*

194. **R. hybrida** (Sowerby). (Fig. 315.) Siluric.

Width exceeding length. Valves very nearly equal. Beaks scarcely incurved. Pedicle valve marked with a broad, undefined depression.

Niagaran of New York, Kentucky, Tennessee, Ohio, Indiana, Missouri, Nova Scotia.

FIG. 315. *Rhipidomella hybrida.* (After Hall.)

195. **R. oblata** Hall. (Fig. 316–317.) Devonic.

Large, transversely oval. Pedicle valve convex at beak and concave toward the front. Brachial valve very convex. Beaks of

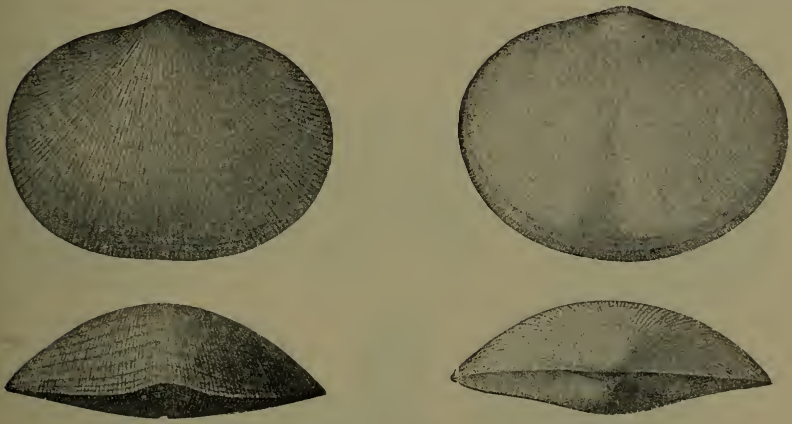


FIG. 316. *Rhipidomella oblata.* (After Hall.)

FIG. 317. *Rhipidomella oblata* internal molds. (After Hall.)

both valves of slight and nearly equal elevation. Surface faintly striated.

Helderbergian of New York, etc.

196. **R. alsa** Hall. (Fig. 318.) Devonic.

Large, nearly transversely oval but hinge line somewhat extended, producing for some distance a straight posterior border.

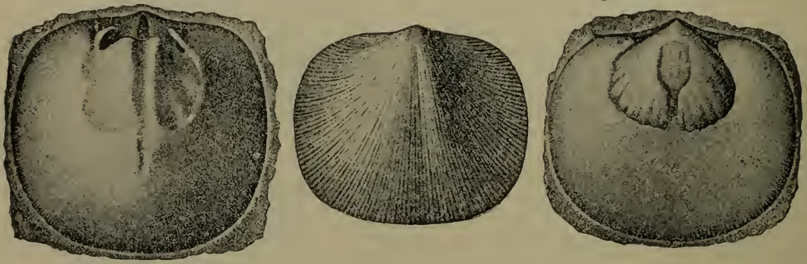


FIG. 318. *Rhipidomella alsa* and internal molds. (After Hall.)

Pedicle valve depressed convex, becoming nearly flat. Brachial valve convex and marked by a mesial sinus. Differs from *R. oblata* in the absence of the depression in the pedicle valve, in the more extended hinge line and in the presence of a sinus in the brachial valve.

Schoharie of New York, Michigan, etc.

197. **R. livia** (Billings). (Fig. 319, *a–b.*) Devonic.

Differs from *R. vanuxemi* in the lesser convexity of the brachial

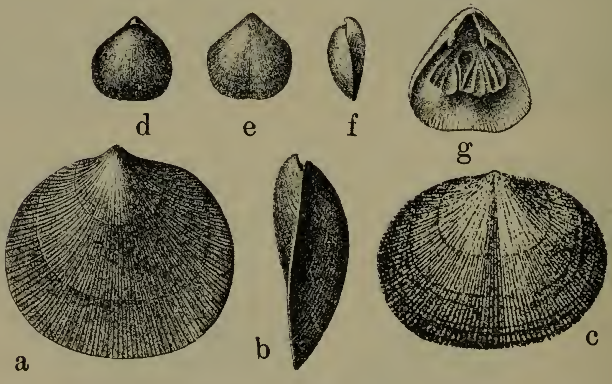


FIG. 319. *a–b*, *Rhipidomella livia*, *c*, *R. michelini* (after Hall); *d–g*, *R. dubia*. (After Whitfield.)

valve and in the absence of a mesial sinus, while the beak is shorter, not rising to nearly the same height as in the pedicle valve. Its suborbicular form distinguishes it from *R. leucosia*.

Onondaga of New York, Ohio, Ontario, Quebec.

198. **R. vanuxemi** Hall. (Fig. 320, *a–c.*) Devonic.

Subcircular. Pedicle valve nearly flat, becoming moderately convex near the beak. Brachial valve convex.

Onondaga–Hamilton of New York, Ohio, Michigan, Illinois, Iowa, Ontario.

199. **R. leucosia** Hall. (Fig. 320, *d–e.*) Devonic.

Broadly ovate with pointed beak. Both pedicle and brachial valves convex.

Hamilton of New York, Maryland.

200. **R. penelope** Hall. (Fig. 320, *f–g.*) Devonic.

Large, subcircular. Brachial valve regularly convex and slightly depressed medially. Pedicle valve depressed convex above, becoming flat or concave toward the margin but lacking a sinuosity in front. Beaks not prominent.

Hamilton of New York.

201. **R. thiemei** (White). Devonic and Mississippic.

Usually a little wider than long. Convex at beak but flattened toward the front owing to a broad, faint sinus in each valve. Beak of pedicle valve short, elevated and slightly incurved beyond the cardinal area. Brachial valve the deeper. Differs from *R. vanux-*

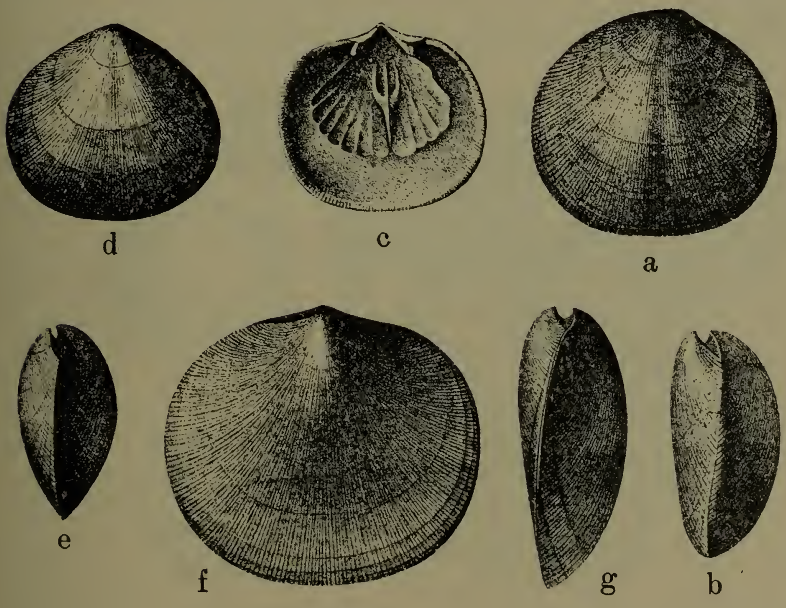


FIG. 320. *a–c, Rhipidomella vanuxemi ; d–e, R. leucosia ; f–g, R. penelope.* (After Hall.)

emi in its smaller size, greater gibbosity and in the more elevated and incurved beak of the pedicle valve.

Chemung of New York and Kinderhook of Iowa.

202. **R. michelini** (L'Eveillé). (Fig. 319, *c.*) Mississippic.

Quite similar to *R. vanuxemi* but differs in the parallel direction of the dental lamellæ and in the character of the radial striæ.

Waverly of Pennsylvania, Ohio, Kentucky, New Mexico.

203. **R. burlingtonensis** Hall. Mississippic.

Of medium size, subcircular. Valves subequally convex. Beak of pedicle valve extended and cardinal area high.

Burlington of Illinois, Iowa, Missouri.

204. **R. dubia** Hall. (Fig. 319, *d–g.*) Mississippic.

Distinguished by its small size, nearly equal convexity of the two valves, thc prominent beak of the pedicle valve and the distinctly defined sinus of the pedicle valve.

St. Louis of Kentucky, Indiana, Illinois, Missouri, Iowa.

205. **R. pecosi** (Marcou). (Fig. 321, *a–c.*) Carbonic.

Small. Length at times exceeding breadth. Pedicle valve often flattened toward the front and lacking a definite mesial sinus. Brachial valve more convex than the pedicle valve. Radiating striæ crossed by fine concentric growth lines and near the front by imbricating lines.

Throughout the Carbonic of North America.

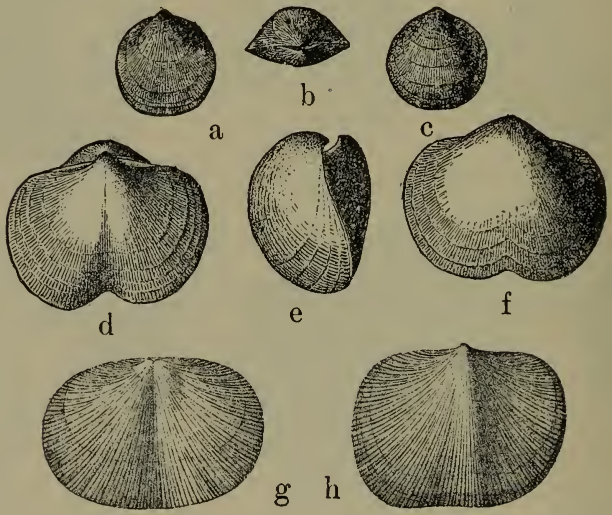


FIG. 321. *a–c, Rhipidomella pecosi; d–f, Schizophoria striatula* (Ind. Geol. Surv.) *g–h, S. tioga.* (After Hall.)

LVII. Schizophoria King.

Pedicle valve depressed convex, becoming slightly concave toward the front. Brachial valve very convex. Hinge line short. Cardinal areas moderately high. Plications rounded, hollow and exceedingly fine. Muscular area of pedicle valve has elevated margins and is deeply sunk in the substance of the shell. Shell substance very punctate. This genus differs from Hebertella principally in its much shorter hinge line and its punctate shell. Siluric–Carbonic.

A. Length exceeding breadth.. 210. *S. macfarlani.*
B. Breadth exceeding length.. *.
  * Striæ fasciculate, *i. e.*, in bundles..211. *S. tioga.*
  * Striæ not fasciculate .... 1.
    1. Hinge line quite long, forming nearly the greatest width of shell. Shell large, often exceeding 1 inch in width.................... 212. *S. swallovi.*
    1. Hinge line equalling only about half the width of the shell............... *a.*
      a. Beak of pedicle valve prominent and pointed.......................... 1′.
        1′. Beak of brachial valve not strongly arched, vascular impressions not bifurcating but diverging.............. 206. *S. multistriata.*
        1′. Beak of brachial valve strongly arched, vascular impressions not bifurcating, but parallel or converging...... 208. *S. tulliensis.*
        1′. Beak of brachial valve arched, vascular impressions bifurcating. 207. *S. propinqua.*
      a. Beaks of both valves about equal and not pointed..................... 2′.
        2′. Cardinal areas narrow.......................... 213. *S. resupinoides.*
        2′. Cardinal areas moderately high ....209. *S. striatula.*

206. **S. multistriata** Hall. (Fig. 322.) Lower Devonic.

Of medium size. Pedicle valve with broad, undefined sinus and prominent, slightly incurved beak. Brachial valve with obtuse beak. Hinge line forming about half the width of the shell. Surface marked by fine, equal, radiating striæ. Concentric growth-lines very faint. Vascular impressions slightly diverging forward but not bifurcating.

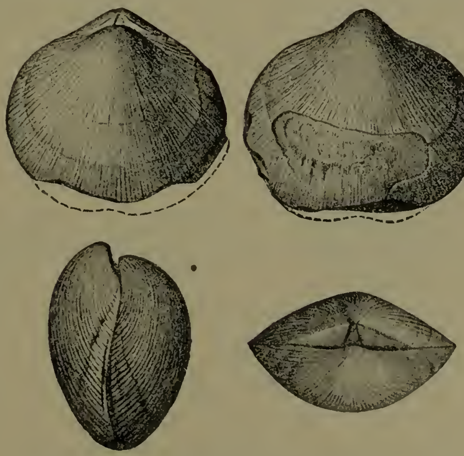


Fig. 322. *Schizophoria multistriata.* (After Hall.)

Helderbergian of New York.

207. **S. propinqua** Hall. Middle Devonic.

Brachial valve somewhat more gibbous than in *S. multistriata*, and pedicle beak and area generally somewhat more arcuate. Vascular impressions on interior of valves bifurcating from one to three times before reaching front of shell.

Onondaga of New York, Ohio, etc.

208. **S. tulliensis** Hall. Upper Devonic.

Differs from *S. propinqua* and *S. multistriata* in being more gibbous, with the beak of the brachial valve more elevated and arching, and in having the divisions of the vascular impressions running nearly parallel to each other or slightly converging, without bifurcation.

Tully of New York, and equivalent horizons of Nevada, etc.

209. **S. striatula** (Schlotheim). (Fig. 321, *d–f*.)

Middle and Upper Devonic.

Brachial valve sinuate in front. Pedicle valve with a broad, undefined sinus, sometimes incurving the margin of the shell. Surface very finely and evenly striated.

Widely distributed throughout North America.

210. **S. macfarlani** (Meek). Middle and Upper Devonic.

Very gibbous. Length in adults slightly greater than the breadth which is about 1 inch. Cardinal and umbonal regions narrow. Hinge line scarcely equalling half the greatest width of the shell. Pedicle valve depressed convex, bearing a broad sinus anteriorly; cardinal area of moderate height. Brachial valve very gibbous with a greatly incurved umbo. About ten fine, bifurcating, radiating striæ may be counted in the space of $\frac{1}{10}$ inch.

New York, Iowa, Nevada, Northwest Territory.

211. **S. tioga** Hall. (Fig. 321, *g–h*.) Devonic.

Differs from *S. striatula* in its smaller size, usually more pronounced elevation of the pedicle valve and in the angular, fasciculate striæ.

Portage and Chemung of New York, Ohio.

212. **S. swallovi** Hall. (Fig. 323.) Mississippic.

Large. Hinge line less than the width of the shell below. Pedicle valve depressed convex near the beak and flat at sides with a broad depression extending from the middle to the front. Brachial valve gibbous. Surface covered with fine and close radiating striæ and sharp concentric growth lines.

Burlington of Illinois, Iowa and Missouri.

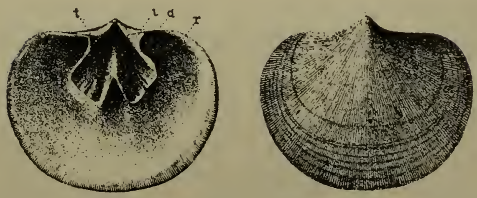


FIG. 323. *Schizophoria swallovi*, $\times \frac{2}{3}$. (After Hall.)

213. **S. resupinoides** (Cox). Carbonic.

Transversely ovate to subquadrate. Hinge line forming about half the greatest width of the shell. Cardinal areas narrow, that of the brachial valve being the higher.

Kentucky, Arkansas, New Mexico.

LVIII. ENTELETES Fischer de Waldheim.

Subglobular, plicate; brachial valve the more convex. Hinge line short. Cardinal area of pedicle valve high; that of brachial valve low, at times linear. Cardinal process small, erect and multi-lobate. Between the much extended and parallel dental

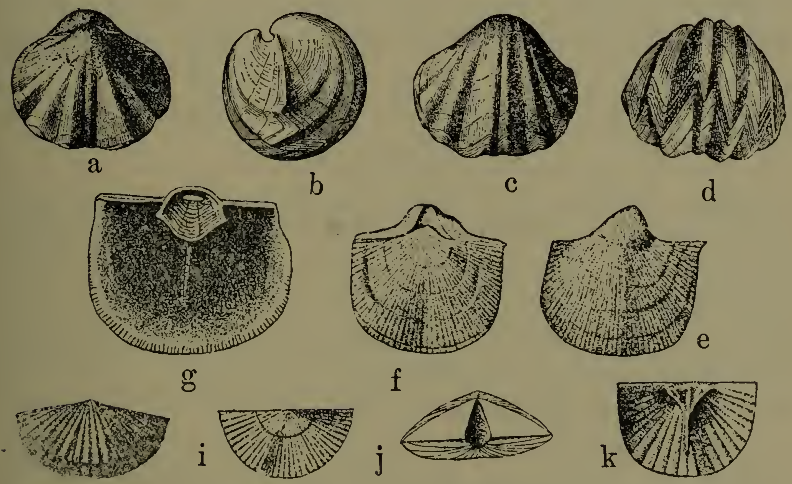


FIG. 324. *a–d*, *Enteletes hemiplicata* (Ind. Surv.); *e–g*, *Clitambonites diversus*, ventral and dorsal views and interior of brachial valve (enlarged); *h–k*, *Scenidium anthonense*, ventral, dorsal and cardinal views and interior of brachial valve(Minn. Surv.).

lamellæ is a blade-like median septum extending from beneath the beak and enlarging to the middle of the valve where it suddenly terminates. Crural plates of brachial valve support long, curved crura. Entire surface of shell, including the few more or less strong plications, covered with fine radiating striæ. Upper Carbonic.

214. **E. hemiplicata** Hall. (Fig. 324, *a–d.*) Upper Carbonic.

Surface covered with fine and crowded radiating striæ and a few large and subangular radial plications which are distinct anteriorly and die out towards the umbo. They are crossed near the front by a few concentric lines of growth.

Missouri, Illinois, Iowa, Nebraska, Colorado.

LIX. Clitambonites Pander.

Semicircular. Hinge line straight, forming greatest diameter of shell. Pedicle valve convex or subpyramidal; cardinal area high and usually vertical with a broad convex deltidium perforate at apex; on the interior the dental plates unite to form a spondylium which is supported on a median septum. Brachial valve depressed convex or flattened. Upper Cambric–Ordovicic.

215. **C. diversus** (Shaler). (Fig. 324, *e–g.*) Ordovicic.

Subquadrangular. Umbo of pedicle valve always laterally inclined toward either extremity of the hinge line. Surface marked by numerous prominent striæ crossed by delicate crowded growth lines.

Trenton–Lorraine of Wisconsin, Minnesota, Ontario, Manitoba, Anticosti.

LX. Scenidium Hall.

Small. Hinge line straight, usually equalling the greatest width of the shell; delthyrium in each valve. Pedicle valve subpyramidal with a high and usually erect cardinal area. Brachial valve depressed, convex to concave, with low cardinal area. The small cardinal process extends forward as a median septum through the length of the valve and is at times so developed anteriorly as to reach into the pedicle valve. Ordovicic–Devonic.

216. **S. anthonense** Sardeson. (Fig. 324, *h–k.*) Ordovicic.

Small with extended hinge line and conspicuous mesial sinus and fold. Surface radiately striated.

Trenton of Tennessee, Illinois, Minnesota.

LXI. Syntrophia Hall and Clarke.

Transversely elongate, biconvex. Hinge line nearly equalling the greatest width of shell. Cardinal area long and straight; an open delthyrium on each valve. Spondylium deep and short, its anterior half unsupported. Upper Cambric–Ordovicic.

217. **S. calcifera** (Billings). (Fig. 325.) Upper Cambric.

Brachial valve triangular posteriorly. Moderate sinus in pedicle valve and fold on brachial. Surface marked by concentric growth lines only. Average length about ⅜ inch.

Saratogan, etc., of Missouri, Utah, Nevada, Quebec, Newfoundland.

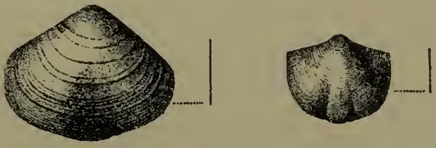


FIG. 325. *Syntrophia calcifera*, pedicle and brachial valves. (After Walcott.)

LXII. CAMARELLA Billings.

Small, smooth in the umbonal region with a few low plications anteriorly; no cardinal areas. Pedicle valve with erect beak and an open delthyrium. Well-defined spondylium present. Brachial valve at maturity the more convex. Median sinus on pedicle valve and fold on brachial. Ordovicic–Siluric.

218. **C. varians** Billings. (Fig. 326.) Ordovicic.

FIG. 326. *Camarella varians* (Canadian Surv.).

Subtriangular. Valves moderately and equally convex. Anterior angles rounded. Plications rounded, 6–8, of which 2–4 occupy the mesial sinus and 3–5 the fold. Length about ⅓ inch, width about the same.

Beekmantown–Chazy of New York, Newfoundland, Mingan Islands.

LXIII. PARASTROPHIA Hall and Clarke.

Subcircular. Hinge line moderately long and straight. No cardinal areas. Brachial valve the larger and more convex, its beak projecting conspicuously beyond that of the pedicle valve. Otherwise much like *Camarella*. Ordovicic–Siluric.

219. **P. hemiplicata** Hall. (Fig. 327.) Ordovicic.

Subglobose, wider than long, with thickness often equal to length. Hinge line short. Pedicle valve depressed convex with an abrupt broad sinus. Brachial valve very convex with a broad median fold. Surface marked by about 6–8 plications, strong toward the front but fading away entirely toward the umbo. 2–3 plications occupy the sinus and 3–4 the fold; all are crossed by concentric lines.

Trenton of New York, Pennsylvania, Wisconsin, Minnesota, Ontario, Manitoba.

LXIV. Anastrophia Hall.

Differs externally from *Parastrophia* in having a more prominent umbo in the brachial valve and in that the valves are covered with many sharp plications extending to the beaks. Siluric–Devonic.

FIG. 327. *Parastrophia hemiplicata* (Canadian Geol. Surv.).

FIG. 328. *Anastrophia interplicata* (N. Y. State Surv.).

220. **A. interplicata** Hall. (Fig. 328.) Siluric.

Subovate. Brachial valve much more convex than the pedicle. Beaks very short and closely incurved. Plications three or four on each side of the beak near the cardinal margins; an additional one is inserted between each pair, except the central ones, about half way toward the front.

Niagaran of New York, Kentucky and Wisconsin.

221. **A. internascens** Hall. (Fig. 329.) Siluric.

Ovoid or subglobose with brachial valve slightly the more gibbous. Pedicle valve with depressed anterior portion marked by

FIG. 329. *Anastrophia internascens.* (After Hall.)

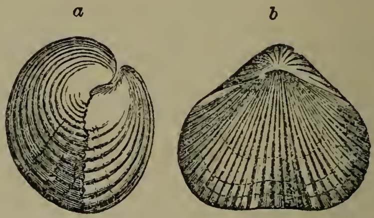


FIG. 330. *Anastrophia verneuili* (Canadian Geol. Surv.).

a broad, undefined sinus and short beak closely incurved over umbo of opposite valve. Brachial valve elevated in center, sometimes forming a broad undefined fold.

Niagaran of Kentucky, Indiana, Wisconsin.

222. **A. verneuili** (Hall). (Fig. 330.) Devonic.

Globose with width generally exceeding length. Pedicle valve with distinct sinus. Brachial valve very elevated with exceedingly gibbous beak, strongly incurved and covering the foramen of the opposite valve.

Helderbergian of New York, Tennessee, Greenland.

LXV. Conchidium Linnæus.

Elongate subpentagonal, strongly inequivalved, biconvex, without well defined median sinus and fold. Pedicle valve highly arched; delthyrium very broad. Spondylium narrow and deep,

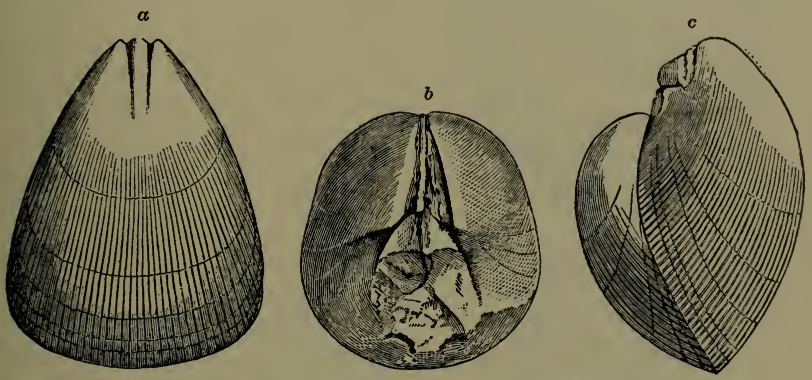


Fig. 331. *Conchidium occidentale* (Canadian Geol. Surv.).

supported by a high septum. Beak of brachial valve closely incurved; cardinal process small; a pair of median septa in posterior portion of valve. Surface with numerous radiating plications. Siluric–Devonic.

223. **C. occidentale** Hall. (Fig. 331.) Siluric.

Ovoid. Plications scarcely equal in width to the spaces between them.

Guelph of Wisconsin, Ontario.

224. **C. nettelrothi** Hall & Clarke. (*C. knighti* Nettelroth.) (Fig. 332.) Siluric.

Differs from the preceding in its proportionately greater convexity of valves, narrower form, higher pedicle valve, with strongly incurved umbo and pronounced flattenings on either side of the delthyrium, and in the coarser close and sparse plications which extend to the beaks.

Niagaran? of Falls of Ohio Region. Upper Siluric of Nova Scotia.

225. **C. laqueatum** Conrad. Siluric.

Large, trigonal or trapezoidal and very ventricose; pedicle valve twice as long as deep, with scarcely incurved but projecting beak; brachial valve shallower. Plications rounded to subangular, more widely spaced towards lateral margins where they disappear.

Niagaran of Indiana, common.

FIG. 332. *Conchidium nettelrothi.* (After Nettelroth.)

LXVI. STRICKLANDINIA Billings.

Usually large. Valves nearly equal. Pedicle valve with a short median septum in the interior supporting a small and short spondylium. Hinge line straight, cardinal area present on each valve and beak of pedicle valve not highly arched; otherwise very similar to *Conchidium.* Siluric.

226. **S. davidsoni** Billings. Siluric.

Longitudinally ovate, $\frac{3}{4}$ inch–3 inches long with width about $\frac{1}{5}$ less. Front of shell narrowed to a linguiform extension. Beaks

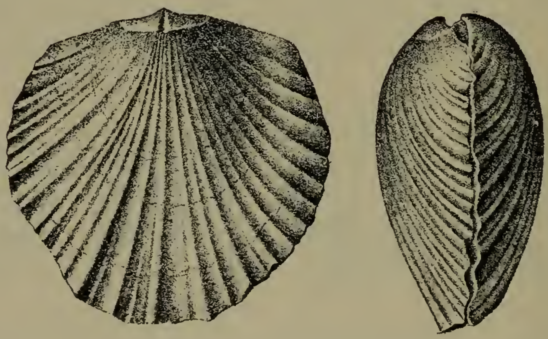


FIG. 333. *Stricklandinia castellana.* (After Hall and Clarke.)

only slightly developed. Pedicle valve often with a faint median sinus in youth, becoming obsolete with age, often developing into a fold. Brachial valve with a fold widening into the linguiform extension. Surface covered with faint radiating ribs, 3–5 occupying the width of $\frac{1}{4}$ inch at the margin.

Anticosti group of Georgia, and of Anticosti and eastern Canada.

227. **S. castellana** White. (Fig. 333.) Siluric.

Valves nearly equiconvex, subcircular; surface of each valve with strong, irregularly fasciculate or duplicate plications.

Niagaran of Iowa.

LXVII. Pentamerus Sowerby.

Strongly inequivalved, biconvex with highly arched pedicle valve. Like *Conchidium*, but with surface smooth or with but a few broad, obscure, radiating undulations. Siluric.

228. **P. oblongus** Sowerby. (Fig. 334.) Siluric.

Very large, varying in outline with age. Wider anteriorly. Valves strongly convex at beaks. Surface marked only by concentric lines of growth which are strongest in old shells. The pair

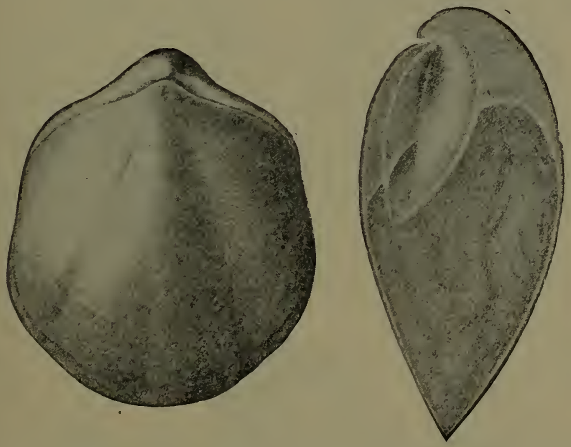


Fig. 334. *Pentamerus oblongus*, dorsal and internal views (Pal. N. Y.).

of septa in the brachial valve are near together and subparallel.

Clinton and Niagaran of New York, Kentucky, Ohio, Indiana, Illinois, Iowa, Wisconsin, Ontario, Anticosti.

228*a*. **P. oblongus** var. **subrectus** Hall. Siluric.

Elongate subquadrate; with high, subrectangular cardinal extremities. Each valve with impressed longitudinal median and two divergent grooves, which divide again. Sometimes indications of a few coarse plications present.

Niagaran beds of Iowa.

228*b*. **P. oblongus** var. **cylindricus** Hall & Whitfield. Siluric.

Elongate, subcircular in cross-section. Valves more or less distinctly trilobed in anterior half, rounded or truncate in front, generally with shallow sinus in each valve in front. Beak of more convex (pedicle) valve overarching.

Niagaran near Louisville, Kentucky, Wisconsin and Indiana.

LXVIII. Clorinda Barrande.

Small, pentameroid. Median sinus in pedicle valve and fold in brachial. Surface smooth or rarely plicate. Spondylium without a supporting septum. Siluric.

Fig. 335. *Clorinda fornicata* (Pal. N. Y.).

229. **C. (Barrandella) fornicata** (Hall). (Fig. 335.) Siluric.

Pedicle valve very convex with overarching beak. Surface obscurely plicate longitudinally. Umbo of pedicle valve much more gibbous than in *C. ventricosa*.

Clinton and Niagara of New York, Indiana, Wisconsin.

230. **C. (Barrandella) ventricosa** (Hall). (Fig. 336, *a–b*). Siluric.

Small, subglobose, usually wider than long. Both valves strongly ventricose with incurved beaks, that of the pedicle valve being

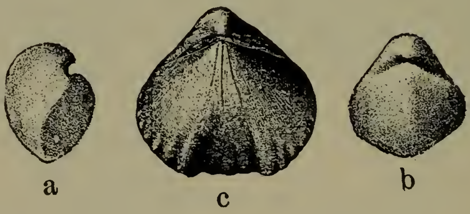


Fig. 336. *a–b*, *Clorinda ventricosa*. (After Nettelroth.) *c*, *Gypidula comis*. (After Walcott.)

much the higher. Surface more or less marked by concentric lines of growth.

Niagaran of Kentucky, Ohio, Illinois, Wisconsin.

LXIX. Pentamerella Hall.

Pentameroid, more or less rotund, with a sinus on pedicle valve and fold on brachial. Much like *Clorinda* but larger and strongly plicate, with a narrow cardinal area. Brachial valve with the crural plates supporting septa conjoined so as to form a broadly sessile spondylium. ? Siluric–Devonic.

231. **P. arata** (Conrad). (Fig. 337.) Devonic.

Ovate, with gibbous pedicle valve which in old age becomes very arcuate with strongly incurved beak. Brachial valve only moder-

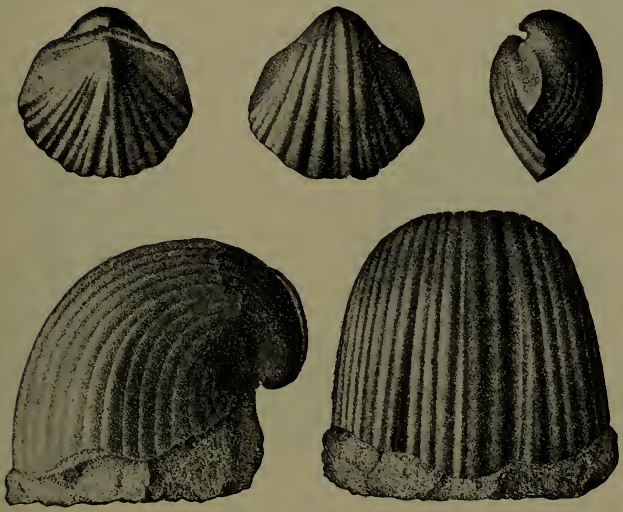


Fig. 337. *Pentamerella arata*, average sized, and extremely old age individuals (Pal. N. Y.).

ately convex. Surface covered with angular plications, often developed only below the first third of the length and usually bifurcating.

Schoharie and Onondaga of New York, Ohio, Kentucky, Indiana, Michigan, Ontario.

232. **P. pavilionensis** Hall. Devonic.

Differs from the preceding, in having the valves more nearly equally convex, and fewer rounded plications which become obsolete toward the beak and often on lateral slopes; and in having a well defined fold and sinus with four and three (or two) plications respectively.

Hamilton beds of New York, Falls of the Ohio, Michigan, etc.

LXX. Gypidula Hall.

Pentameroid, ventricose. Pedicle valve much the larger, with or without a mesial fold; cardinal area generally well defined, cross striated; spondylium unsupported for most of its length. Brachial valve with or without mesial sinus; spondylium large, sessile, acute anteriorly. Siluric–Devonic.

233. **G. (Sieberella) galeata** (Dalman). (Fig. 338.)

Siluric? and Devonic.

Subglobose. Pedicle valve gibbous with a mesial fold toward the front and a strongly incurved beak. Brachial valve gibbous above, with or without a mesial sinus near the margin. Surface in youth smooth but developing longitudinal plications in older forms.

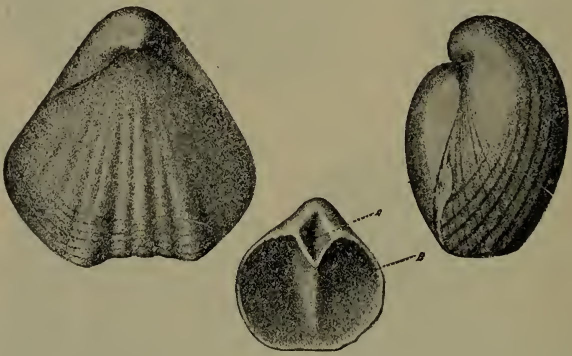


Fig. 338. *Gypidula galeata* (Pal. N. Y.).

Differs from *G. comis* in its greater gibbosity, in the absence of a distinct cardinal area, in the greater prominence of the plications and in the greater incurving of the beak of the brachial valve under that of the pedicle valve, thus concealing the delthyrium.

Helderbergian (Coeymans) of New York, Pennsylvania, Maryland, New Brunswick, Northwest Territory. ? Niagaran of Indiana. Middle Devonic of Europe.

234. **G. (Sieberella) pseudogaleata** (Hall). (Fig. 339.)

Lower Devonic.

Like *G. galeata* but differs in the absence of radiating plications. Becraft of New York, etc.

235. **G. comis** (Owen). (Fig. 336, *c*.) Middle Devonic.

Pedicle valve arcuate, with extended and strongly incurved beak; delthyrium large and bordered by a distinct area. Surface elevated into a more or less distinct mesial fold. Brachial valve depressed anteriorly into a sinus. Surface usually bearing below a few rounded plications which become obsolete above, leaving the upper part of the valve marked only by concentric striæ.

Illinois, Iowa, Nevada, Manitoba.

236. **G. romingeri** Hall and Clarke. (Fig. 340.) Devonic.

FIG. 339. *Gypidula pseudogaleata* (Pal. N. Y.).

Large. Pedicle valve very convex; brachial valve depressed convex. Surface covered with strong plications which frequently bifurcate irregularly toward the front.

Hamilton of Michigan.

FIG. 340. *Gypidula romingeri*, external view and interior of brachial valve. (After Hall and Clarke.)

LXXI. AMPHIGENIA Hall.

Elongate-ovate, high-shouldered, without median fold or sinus. Pedicle valve with a spondylium, brachial valve with a large hinge plate perforated at the apex by a foramen. Surface marked by concentric growth lines and faint radial striæ. Devonic.

237. **A. elongata** (Vanuxem). (Fig. 341.) Devonic.

More or less gibbous, with broadly rounded front. Pedicle valve the more convex; beak closely incurved over the umbo of opposite valve. Both valves often abruptly elevated above the middle. Shell structure punctate.

Oriskany and Onondaga of New York, Michigan, Ontario, etc.

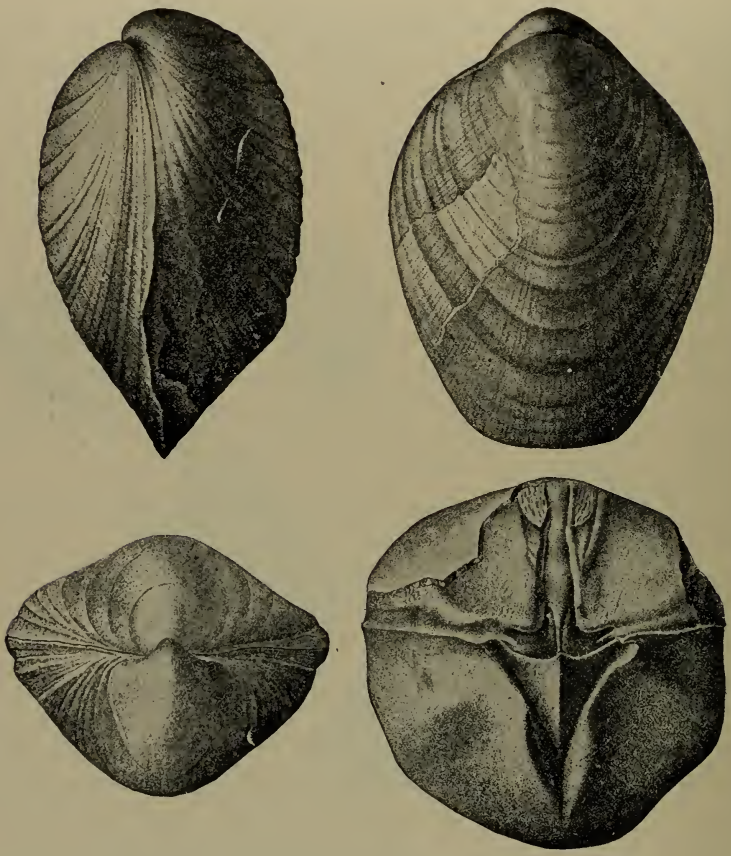


FIG. 341. *Amphigenia elongata* (Pal. N. Y., IV.).

LXXII. CAMAROPHORIA King.

Rhynchonelliform. Surface more or less plicated. Spondylium supported by a long median septum. Devonic–Carbonic.

238. **C. subcuneata** Hall. (Fig. 342, *a–c*.) Mississippic. Wedge-shaped with rounded front, nearly equally biconvex. Beak of pedicle valve very acute and but little incurved, perforated by a triangular foramen. Surface marked by 12–14 angular plications, crossed by concentric striæ.

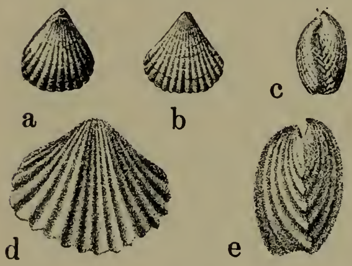


FIG. 342. *a–c*, *Camarophoria subcuneata*. (After Whitfield.) *d–e*, *Orthorhynchula linneyi*. (After Nettelroth.)

St. Louis of Ohio, Indiana.

TELOTREMATA.

LXXIII. Orthorhynchula Hall and Clarke.

Rostrate, with narrowed beaks. Hinge-line straight, extending about one third the transverse diameter of the valves. Cardinal area present on both valves, that of the pedicle valve being the higher; delthyrium open. No dental lamellæ in the pedicle valve. Cardinal process linear. Surface strongly plicate. It thus resembles both *Orthis* and *Rhynchonella*. Ordovicic.

239. **O. linneyi** (James). (Fig. 342, *d*, *e*.) Ordovicic.

Median fold and sinus well developed. Average length $\frac{5}{8}$ inch, width $\frac{6}{8}$ inch, thickness $\frac{1}{2}$ inch.

Lorraine of Kentucky, Tennessee, Ohio.

LXXIV. Rhynchotrema Hall.

Rostrate, thick-shelled. Pedicle valve. with apex closely incurved over that of brachial. Teeth strong. Deltidial plates concave, thick, cemented firmly to the bottom of the valve. Brachial valve with a thickened median septum. Cardinal process slender, linear, with broad and stout crural plate on each side. Ordovicic and Devonic.

240. **R. inequivalve** (Castelnau). (Fig. 343, *a–d*.) Ordovicic.

Small. Pedicle valve strongly convex at umbo and nearly flat on each side of the deep median sinus, sloping laterally. Brachial valve more convex than the pedicle. Surface marked with prominent subangular plications, 15–22 on each valve with 3–5 on the fold and 2–5 in the sinus, crossed by very delicate concentric zigzag lines.

Trenton. Widely distributed throughout North America.

241. **R. dentatum** Hall. (Fig. 343, *e–g*.) Ordovicic.

Pyramidal with breadth somewhat greater than length. Beak of pedicle valve small and acute, closely incurved over that of the brachial valve. Pedicle valve with a broad, deep and angular sinus, strongly elevated toward the front. Surface marked by 8 or 9 strong and deep plications, two of which are very much elvated on the fold of the brachial valve and one of which occupies the sinus of the pedicle valve.

Trenton and Lorraine of New York, Tennessee, Ohio, Indiana.

242. **R. capax** (Conrad). (Fig. 343, *h–k*.) Ordovicic.

Beak of pedicle valve closely incurved over that of brachial. Apex of pedicle valve usually perforated by a small pedic'e opening. Three (rarely 4) angular plications occupy the very promi-

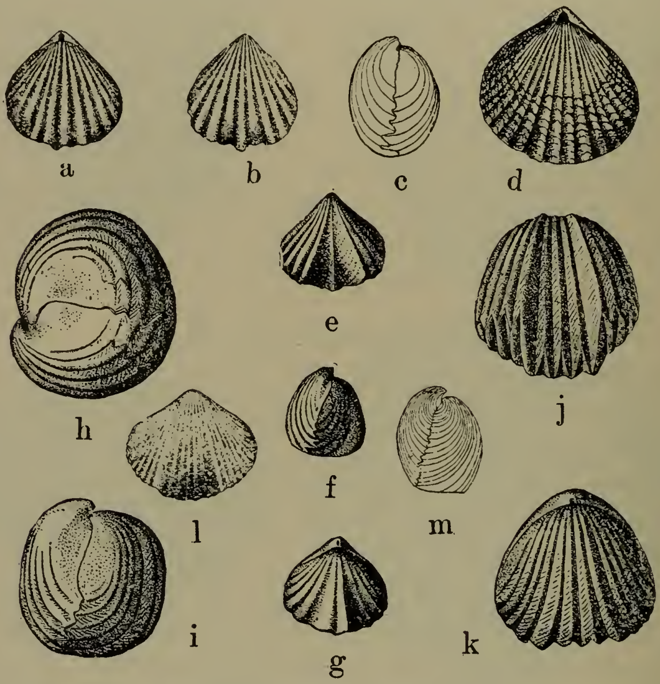


Fig. 343. *a–d*, *Rhynchotrema inequivalve* (Min. Survey); *e–g*, *Rhynchotrema dentatum* (Ind. Survey); *h–k*, *Rhynchotrema capax* (Ind. Survey); *l–m*, *Rhynchotrema ainslii* (Min. Survey).

nent sinus and 4 the corresponding fold on the brachial valve. The angular radiating plications are crossed by many strongly zigzag growth lines.

Lorraine; widely distributed throughout North America.

243. **R. ainslii** N. H. Winchell. (Fig. 343, *l–m*.) Ordovicic.

Differs from *R. inæquivalve* in being usually larger, more transverse, and in having 28 to 34 plications with 6 to 8 on the fold.

Trenton of Iowa and Minnesota.

LXXV. Rhynchotreta Hall.

Elongate triangular, marked with angular plications. Beak of pedicle valve acuminate and produced beyond that of opposite valve. Pedicle valve at first with a median fold which later becomes a sinus; the brachial valve likewise reverses its early median sinus into a fold. Two elevated and longitudinally striated deltidial plates fill the delthyrium. Siluric.

244. **R. cuneata americana** Hall. (Fig. 344.) Siluric.

Wedge-shaped. Beak of pedicle valve angular with compressed sides. Deep frontal emargination extends as a broad sinus two thirds of the distance to the beak. Plications crossed by threadlike concentric striæ.

Niagaran of New York, Kentucky, Indiana, Wisconsin, Ontario.

FIG. 344. *Rhynchotreta cuneata* var. *americana* (Pal. N. Y., II.).

LXXVI. CAMAROTŒCHIA Hall and Clarke.

Rhynchonelloid, rostrate. Brachial valve the deeper. Pedicle valve shallow with beak projecting over that of the brachial. Surface radially plicate. Distinctive internal characters are: a median septum in the brachial valve, dividing posteriorly to form an elongate spondylium, no cardinal process. In the pedicle valve slender vertical lamellæ support the teeth. Ordovicic–Mississippic.

A. Small—less than ½ inch wide .... *.
    * Length and width nearly equal .... 1.
        1. Round posteriorly .... 254. *C. dotis.*
        1. Acute posteriorly .... *a.*
            a. Fold and sinus very conspicuous .... 246. *C. neglecta.*
            a. Fold and sinus inconspicuous .... 252. *C. semiplicata.*
    * Length exceeding width .... 247. *C. acinus.*
    * Width exceeding length. Surface rugose .... 250. *C. lamellata.*
B. Of medium size—½ inch or more wide .... **.
    ** Transversely oval, *i. e.*, width exceeding length .... 2.
        2. Plications angular, numerous (20–24), of which 4–7 mark the mesial sinus and fold .... *b.*
            b. Plications coarse and prominent .... 256. *C. sappho.*
            b. Plications fine .... 255. *C. horsfordi.*
        2. Plications obtuse, few (about 16), of which 2 or 3 mark the sinus and fold .... 258. *C. sageriana.*
    ** Somewhat quadrangular, *i. e.*, with length and breadth nearly equal .... 3.
        3. Both valves noticeably convex .... *c.*
            c. Plications numerous (14–20) .... 1′.
                1′. Shell ventricose, thickness equal to or greater than length. 272. *C.* (*Wilsonia*) *ventricosa.*

1′. Shell not ventricose .... a′.
a′. Pedicle valve with small, closely incurved beak. 245. *C. plena.*
a′. Pedicle valve with large, not closely incurved beak. 251. *C. litchfieldensis.*
c. Plications few (9–14) .... 2′.
2′. Angle at beak between cardinal slopes less than 90°. 248. *C. indianensis.*
2′. Angle at beak greater than 90° .... 249. *C. whitei.*
3. Pedicle valve flattened .... d.
d. Sinus and fold with 2–4 plications .... 257. *C. contracta.*
d. Sinus and fold with 5 or 6 plications .... 253. *C. tethys.*

245. **C. plena** Hall. (Fig. 345.) Ordovicic.

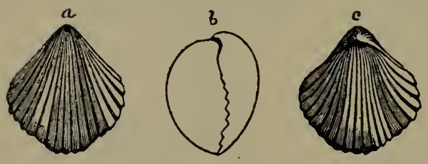


FIG. 345. *Camarotœchia plena* (Canadian Geol. Surv.).

Gibbous. Pedicle valve with small beak closely incurved over that of the brachial valve. Surface of each valve marked with 16–20 strong radial plications, about 4 or 5 of which occupy the sinus and fold.

Chazy of New York, Ontario, Quebec.

246. **C. neglecta** Hall. (Fig. 346.) Siluric.

Small. Brachial valve the more convex. Sides sloping abruptly from beak. Plications 8–13. Strongly defined sinus and fold, the former with 3, the latter with 4 plications. Deep frontal emargination present.

Clinton and Niagaran of New York, Ohio, Indiana, Wisconsin, Ontario, Nova Scotia.

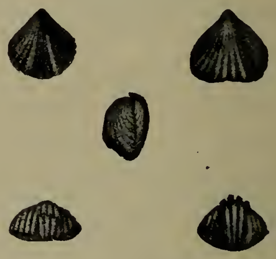


FIG. 346. *Camarotœchia neglecta* (Pal. N. Y. II.).

247. **C. acinus** Hall. (Figs. 347, 348, upper row.) Siluric.

Small, longitudinally ovate, narrowed toward the beak and truncate in front. Valves of nearly equal convexity. Surface marked by few plications of which there is one in the very low sinus of the pedicle valve and two in the inconspicuous fold of the brachial.

Clinton of New York, Niagara of Indiana, Kentucky.

248. **C. indianensis** (Hall). (Fig. 348, middle row.) Siluric.

Subtriangular, moderately biconvex. Length and width nearly equal (about ½ inch). Pedicle valve with pointed and incurved beak. Surface marked by 9–12 strong plications of which 2–3 occupy the sinus and 3–4 the fold. Differs from *C. neglecta* in

FIG. 347. *Camarotœchia acinus.* A specimen in which the fold and sinus are not developed. Enlarged, × 4. Clinton. (After Grabau.)

being larger and more robust with stronger and less angular plications.

Niagaran of Kentucky, Indiana.

249. **C. whitei** Hall. (Fig. 348, lower row.) Siluric.

Somewhat quadrangular. Pedicle valve with beak abruptly attenuate and pointed; sides flattened. Surface marked with five to

FIG. 348. (Upper row) *Camarotœchia acinus*, × 4: (middle row) *Camarotœchia indianensis*; (lower row) *Camarotœchia whitei.* (After Hall.)

six plications on each side of median sinus and fold, with usually but one plication in the sinus and two on the fold. Interspaces wider than plications. Concentric growth lines close.

Niagaran of Indiana.

250. **C. lamellata** Hall. (Fig. 349.) Siluric.

Small, subrhomboidal. Surface with six to seven simple plications on each side of fold and sinus; usually but two plications in sinus and three on fold. Entire shell crossed by strong, imbricating, concentric lamellæ which are conspicuously arched over the plications, giving the surface a rugose appearance.

FIG. 349. *Camarotœchia lamellata* (Pal. N. Y. II.).

Upper Siluric (Cobleskill, etc.) of New York, New Jersey, Pennsylvania, Maryland and West Virginia.

251. **C. litchfieldensis** Schuchert. (Fig. 350.) Siluric.

Large, robust. Length and breadth subequal. Umbo of pedicle valve large and prominent. Surface with 16 to 18 plications,

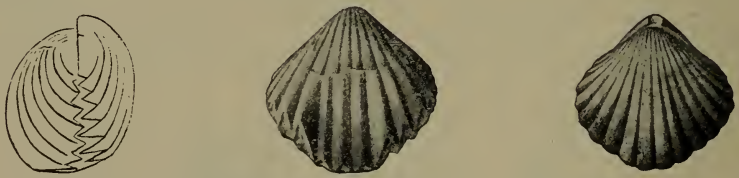


FIG. 350. *Camarotœchia litchfieldensis.* (After Schuchert.)

of which three and four occupy respectively the rather narrow and unpronounced sinus and fold.

Cobleskill and Rondout of New York.

252. **C. semiplicata** (Conrad). (Fig. 351.) Devonic.

Subtriangular. Valves nearly equal. Surface smooth in upper portion with low plications toward the front, one to two of which occupy the shallow sinus and two to three the low fold; a few (one to four) are present on each side of fold and sinus. Very similar to *C. acinus*, but the angle at the beak between the cardinal slopes is larger, the sinus and fold are more pronounced and the shell is larger, averaging about $\frac{5}{16}$ inch in length, while *C. acinus* averages only about $\frac{3}{16}$ inch.

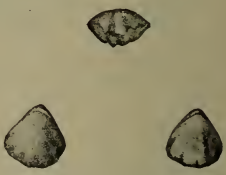


FIG. 351. *Camarotœchia semiplicata* (Pal. N. Y. III.

Helderbergian (Coeymans) of New York.

253. **C. tethys** (Billings). (Fig. 352, *a–c*.) Devonic.

Differs from *C. contracta* in its subtrigonal form and broader sinus and fold which here bear 5 or 6 plications each.

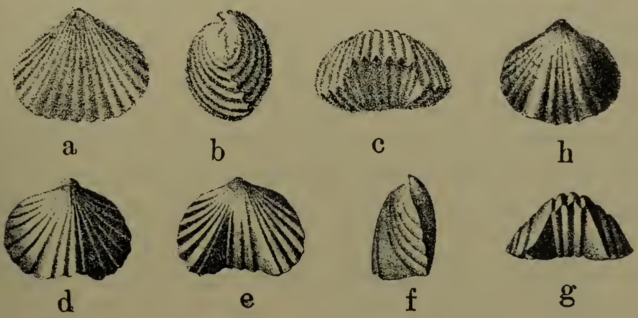


FIG. 352. *a-c*, *Camarotœchia tethys*. (After Nettelroth.) *d-g*, *Camarotœchia contracta* (Pal. N. Y. IV.). *h*, *Leiorhynchus sinuatum*. (After Walcott.)

Onondaga of New York, Ohio, Kentucky, Indiana, Nevada, Ontario.

254. **C. dotis** Hall. (Fig. 353.) Devonic.

Subtriangularly ovate with shallow sinus and moderate fold. Pedicle valve slightly flattened at the sides. Plications about 18 in number of which there are 3 or 4 in the sinus and 4 or 5 on the fold.

Marcellus and Hamilton of New York, Ohio.

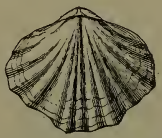


FIG. 353. *Camarotœchia dotis*. (Grabau.)

255. **C. horsfordi** Hall. (Fig. 354, *a, b*.) Devonic.

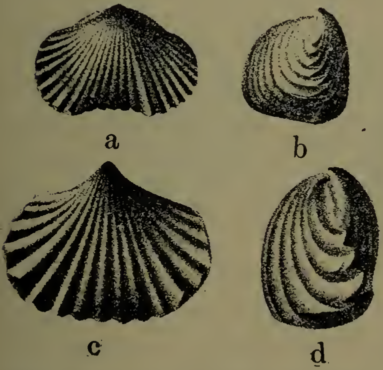


FIG. 354. *a-b*, *Camarotœchia horsfordi*; *c-d*, *Camarotœchia sappho* (Pal. N.Y.IV.).

Length to width as 5 to 6 or 7. Brachial valve very convex. Pedicle valve depressed-convex with sinus appearing first at about the middle of the shell, abruptly curved upward in front. 15-24 angular plications on each valve, of which 4–7 mark the sinus and fold.

Marcellus and Hamilton of New York, Nevada.

256. **C. sappho** Hall. (Fig. 354, *c, d.*) Devonic–Mississippic.
Large and robust, broader than long. Pedicle valve depressed-convex with abruptly acute apex. Brachial valve gibbous, regularly arching transversely. Surface marked with 20–24 strong, angular plications.

Marcellus-Waverly of New York, Ohio.

257. **C. contracta** Hall. (Fig. 352, *d–g.*) Devonic–Mississippic.
Subquadrate, abruptly and deeply sinuate. Pedicle valve very slightly convex, often becoming almost flat near the front and marked by a broad angular sinus. Brachial valve somewhat gibbous in the middle and regularly convex transversely, marked by a mesial fold. Surface with 16–20 angular plications of which there are 4 on fold and 3 in sinus.

Portage-Waverly of New York, Pennsylvania, Ohio.

258. **C. sageriana** (A. Winchell). Mississippic.
Of medium size. Brachial valve quite convex with a prominent and inflected beak and about 16 obtuse radial plications, some of the central ones showing a groove on the summit toward the front. Mesial fold developed only at front of valve where it consists of 2 or 3 slightly elevated plications.

Marshall of Michigan, Waverly of Tennessee, Ohio.

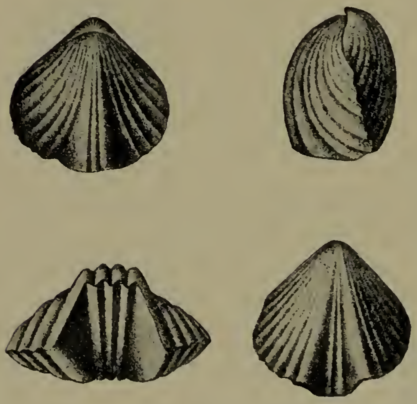


FIG. 355. *Stenochisma formosum* (Pal. N. Y. III.).

LXXVII. STENOCHISMA.

Differs from *Camarotœchia* in wanting the median septum of the brachial valve with its subcardinal cavity; and in having the hinge plate divided by a median fissure which extends to the bottom of the shell and contains a slender cardinal process. Devonic.

259. **S. formosum** (Hall). (Fig. 355.) Devonic.
Subtriangular, the lateral margins forming an angle at the beak of 90° to 110°. Beak of pedicle valve prominent and arched. Brachial valve the more convex. Surface marked with 20 to 24 simple, angular plications on each valve, 2 to 4 of which occupy sinus and fold.

Helderbergian of New York, New Brunswick and Nova Scotia.

LXXVIII. Leiorhynchus Hall.

Similar to *Camarotœchia* but with the plications on the median fold and sinus highly developed while those on the lateral slopes are slightly developed or wanting. Shell substance thin. Dev.–Miss.

260. **L. mysia** Hall. (Fig. 356.) Devonic.

Very small, usually not exceeding 3/8 inch in diameter, with almost circular outline and with proportionally very strong plications of which there is at least one in the sinus with at least three on each side of it.

Marcellus of New York.

Fig. 356. *Leiorhynchus mysia* (Pal. N. Y. IV.).

261. **L. limitare** (Vanuxem). (Fig. 357, *a–b*.) Devonic.

Small, gibbous, with mesial sinus and fold developed toward the front. Plications on fold and sinus bifurcating. Surface plications covered with fine concentric striæ.

Marcellus of New York, Ohio.

262. **L. laura** (Billings). (Fig. 357, *c*.) Devonic.

Length and greatest width nearly equal. Sinus and fold marked with 3 to 7 rounded plications, all bifurcating. Concentric striæ present.

Marcellus-Hamilton of New York, Nevada, Ontario.

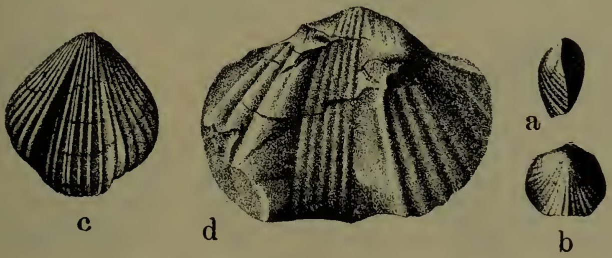


Fig. 357. *a–b*, *Leiorhynchus limitare*; *c*, *L. laura*; *d*, *L. quadricostatum*.

263. **L. quadricostatum** (Vanuxem). (Fig. 357, *d*.) Devonic.

Broadly ovate. Plications of lateral slopes very faint. Sinus and fold marked with 3 to 5 rounded plications.

Genesee of New York, Indiana, Kentucky, Nevada.

264. **L. sinuatum** Hall. (Fig. 352, *h.*) Devonic.

Differs from *L. limitare* in its larger size and more robust development and in its coarser plications which do not extend to the beak.

Chemung of New York, Nevada.

LXXIX. Uncinulus Bayle.

Subcuboidal with an abrupt anterior slope. Fold and sinus sharply developed only at anterior margin. Plications low, marked anteriorly by a faint median line. Muscular scars of pedicle valve very large and deep. Hinge plate of brachial valve undivided. Cardinal process well developed, bifid or simple. Median septum well developed. Siluric–Devonic.

A. Plications numerous, about 25 to 36 .... *.
 * Median fold rather prominent .... 1.
  1. Sides and front abruptly deflected .... *a.*
   a. Sinus comparatively narrow .... 270. *U. vellicatus.*
   a. Sinus comparatively broad .... 269. *U. abruptus.*
  1. Sides and front rounded, not abruptly deflected .... 265. *U. stricklandi.*
 * Median fold rounded, not prominent .... 271. *U. nobilis.*
B. Plications few, about 15 to 25 .... **.
 ** Pedicle valve depressed-convex .... 2.
  2. Brachial valve declining regularly from front to beak ... 267. *U. nucleolatus*
  2. Brachial valve declining more abruptly near the beak.
   266. *U. campbellanus.*
 ** Pedicle valve convex .... 268. *U. mutabilis.*

265. **U. stricklandi** (Sowerby). (Fig. 358.) Siluric.

Large (about 1 inch long), ovate very convex. Length and breadth about equal. Sides and front rounded. Pedicle valve de-

Fig. 358. *Uncinulus stricklandi.* (After Hall.)

pressed-convex; beak small, closely incurved over that of the opposite valve; mesial sinus wide, deep in front. Brachial valve gibbous; mesial fold wide, prominent anteriorly. Surface marked by 25–35 simple angular plications of which 6–8 occupy fold and sinus.

Niagaran of Kentucky, Indiana.

266. **U. campbellanus** (Hall). (Fig. 359.) Devonic.

Laterally compressed. Width $\frac{2}{3}$ length. Brachial valve the larger, elevated near front into a broad undefined mesial fold, curving abruptly at sides. Pedicle valve with a broad shallow

FIG. 359. *Uncinulus campbellanus* (Pal. N. Y., III.).

sinus towards the front; lateral margins of valve abruptly deflected toward opposite valve, thus giving the sides of the shell a flattened appearance. Surface marked by 20–26 simple plications.

Helderbergian (Becraft) of New York.

267. **U. nucleolatus** Hall. (Fig. 360.) Devonic.

Subspherical, declining towards the beak. Pedicle valve depressed convex, abruptly deflected towards margins; brachial valve very convex anteriorly, depressed posteriorly. Surface

FIG. 360. *Uncinulus nucleolatus* (Pal. N. Y., III.).

marked by 15–23 simple plications about 4 or 5 of which, by their slight elevation on the brachial valve and their depression on the pedicle valve form a more or less distinct fold and sinus.

Helderbergian (New Scotland) of Maine, New York, New Brunswick.

268. **U. mutabilis** Hall. (Fig. 361.) Devonic.

Ovate to spherical. Beak of pedicle valve small, pointed and closely incurved over the opposite valve. Beak of brachial valve incurved beyond the hinge line. Cardinal border on each side of the beak concave. Surface bearing numerous (20–26) low, rounded, simple plications of which six and five (sometimes 8 and 7) occupy respectively the fold and sinus.

Helderbergian (Coeymans) of New York.

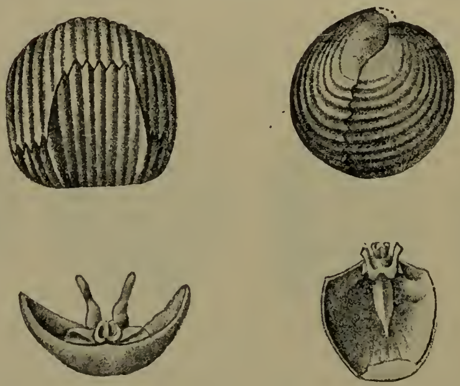


FIG. 361. *Uncinulus mutabilis* (Pal. N. Y., III.).

269. **U. abruptus** Hall. (Fig. 362.) Devonic.

Transversely oval. Pedicle valve depressed-convex and very abruptly deflected (almost at a right angle) toward the opposite valve on the lateral and anterior margins; beak small, closely incurved. Brachial valve very prominent in front; beak depressed.

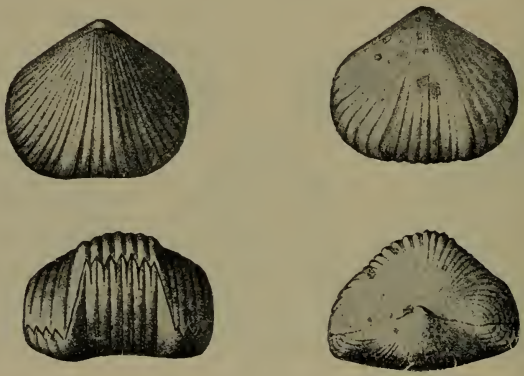


FIG. 362. *Uncinulus abruptus* (Pal. N. Y., III.).

Surface with 25 to 33 simple, subangular plications; the low but distinct fold and sinus occupied by about 7 and 6 respectively.

Helderbergian (New Scotland) of New York.

270. **U. vellicatus** Hall. (Fig. 363.) Devonic.

Pedicle valve depressed-convex. Brachial valve gibbous in front, depressed and rounded toward the beak. Surface with 24 to 36 plications of which 6 to 8 occupy fold and 5 to 7 the sinus. Differs from *U. abruptus* in its smaller size, its smaller and more numerous plications; also in being less ventricose, due to its narrower and more pronounced median sinus and fold and its posteriorly less convex brachial valve.

Helderbergian (New Scotland) of New York and New Brunswick.

FIG. 363. *Uncinulus vellicatus* (Pal. N. Y., III.).

271. **U. nobilis** Hall. (Fig. 364.) Devonic.

Pedicle valve depressed-convex; brachial valve declining laterally with an abrupt curve to meet the inflected margin of the pedicle valve; its umbo rather prominent and incurved. Surface marked with 26 to 32 strong, angular plications, six to eight of which occupy the rounded mesial fold and 5 to 7 the rounded sinus. This species is more elongate than *U. abruptus* and less than *U. campbellanus*.

FIG. 364. *Uncinulus nobilis* (Pal. N. Y., III.).

Helderbergian (Becraft) of New York and Pennsylvania.

LXXX. Wilsonia Kayser.

Hingeplate small, divided by a shallow median incision; no cardinal process; otherwise like *Uncinulus*, from which it is indistinguishable by external characters. Siluric to Devonic.

272. **W. ventricosa** (Hall). (Fig. 365.) Devonic.

Spheroidal, ventricose. Cardinal region on each side of the beak elevated. Beak of pedicle valve rather small and obtuse, closely incurved. Surface with 14 to 20 low, rounded plications. Very inconspicuous sinus and fold at times present, occupied by two to four plications. Front of plications marked by a longitudinal depressed line. Differs from *Uncinulus nucleolatus* externally in having stronger plications.

Helderbergian (Becraft) of New York.

FIG. 365. *Wilsonia ventricosa* (Pal. N. Y., III.).

LXXXI. HYPOTHYRIS King.

Subcuboidal, with plications. Similar to *Uncinulus* but muscular scars of pedicle valve are small and faint and the septum in brachial valve is very faint. Devonic.

273. **H. emmonsi** (Hall and Whitfield). Middle Devonic.

Squarely truncate in front. Pedicle valve depressed-convex; beak small, projecting; median sinus very broad, at front abruptly bent upward in a broad linguiform extension nearly equal to the entire height of the shell and about two thirds as wide as the width of the shell; the sides of this extension are straight and parallel

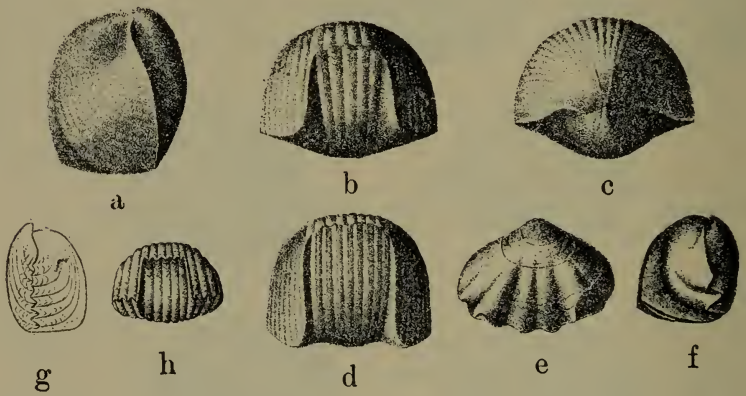


FIG. 366. *a–d*, *Hypothyris cuboides* (Pal. N. Y., IV.); *e–f*, *Pugnax pugnus* (Pal. N. Y., IV.); *g–h*, *Pugnax grosvenori* (Ind. Geol. Survey).

almost to the top. Brachial valve very convex. Surface marked by about 25 low rounded plications on each side of the mesial fold and sinus with about 14 in each of the latter.

Iowa, Nevada, Athabasca.

274. **H. cuboides** (Sowerby). (Fig. 366, *a–d.*) Devonic.
Pedicle valve slightly less convex than the brachial and abruptly depressed in a broad deep sinus. Umbo moderately elevated with minute and closely appressed beak. Brachial valve very gibbous with a defined mesial fold reaching above the middle of the shell and sharply truncate in front, bearing 6 or 7 plications. Whole surface covered with plications which are crossed by fine concentric striæ.

Tully of New York, Manitoba; Europe.

LXXXII. Pugnax Hall and Clarke.

Pedicle valve shallow with a deep median sinus. Brachial valve deep with a much elevated median fold. Plications on lateral slopes often obscure. Otherwise resembling *Hypothyris*. Upper Devonic–Carbonic.

275. **P. pugnus** (Martin). (Fig. 366, *e–f.*) Upper Devonic.
Transversely ovate, *i. e.*, wider than long. Pedicle valve with small, much incurved beak. Each valve has 9–14 plications which become obsolete as they approach the umbo; from 3–6 occupy fold and sinus. Length and breadth about 1 by 1½ inches.

New York, Nevada, Texas, Northwest Territory.

276. **P. striatocostata** (Meek and Worthen). Mississippic.
Subpentagonal, moderately gibbous, with length and breadth about equal. Plications 9 to 11, broad and distinct, all except the outer ones extending nearly to the umbos. Whole surface covered with distinct radiating striæ and fine concentric lines.

Kinderhook of Missouri.

277. **P. grosvenori** Hall. (Fig. 366, *g–h.*) Mississippic.
Subglobose. Beak of pedicle valve small and nearly straight; that of brachial valve obtuse and closely incurved, meeting the opposite valve nearly at a right angle. Surface marked by 14–18 plications about 5 of which mark fold and sinus.

St. Louis of Kentucky, Indiana, Illinois.

Fig. 367. *Pugnax utah* (Ind. Geol. Survey).

278. **P. utah** (Marcou). (Fig. 367.) Carbonic.
Small, emarginate anteriorly. Plications angular, rarely exceeding 9 in number, of which 2–3 are on sinus and fold.

Indiana, Illinois, Iowa, Missouri, Kansas, Arkansas, Nebraska, Utah.

LXXXIII. Eatonia Hall.

Anterior margin deeply sinuate. Pedicle valve nearly flat with a broad deep sinus and small, perforate beak; muscle scars large and deeply excavated. Brachial valve convex and often ventricose; cardinal process very long, resting upon a short median septum and bifid at summit. Differs from *Rhynchonella* in the absence of dental plates, in the presence of a cardinal process and in the stronger muscle impressions of the pedicle valve. Devonic.

279. **E. medialis** (Vanuxem). (Fig. 368.) Devonic.
Hinge line nearly straight. Brachial valve regularly convex from beak to front and elevated into a broad median fold. Pedicle valve somewhat convex at umbo and thence concave to the front

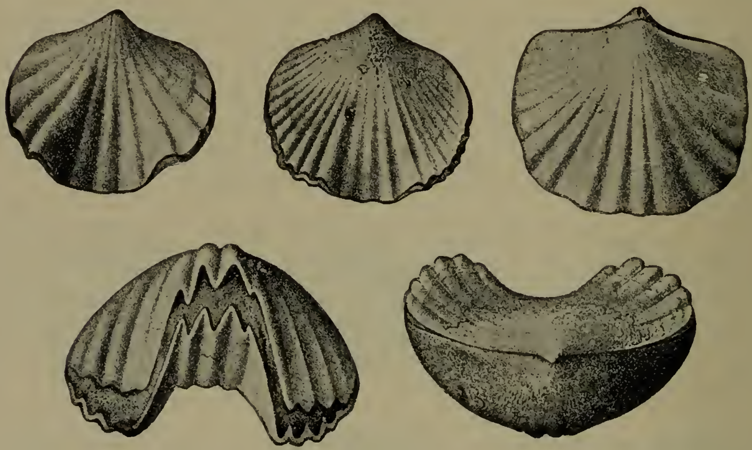


Fig. 368. *Eatonia medialis* (Pal. N. Y., III.).

and depressed into a broad sinus. Surface marked by 12–16 broad plications of which 4 are on the summit of the fold and 3 in the bottom of the sinus.

Helderbergian of Maine, New York.

280. **E. peculiaris** (Conrad). (Fig. 369.) Devonic.
Longitudinally ovate. Hinge line much shorter and more rounded than in *E. medialis;* the mesial fold and sinus are much less pronounced and the margins of the valves are denticulate. Surface marked by fine radiating striæ.

Helderbergian and Oriskanian of New York, Pennsylvania, Maryland, Missouri, Quebec.

LXXXIV. Rhynchopora King.

Resembles *Camarotœchia* but differs externally in its punctate shell structure. Mississippic.

281. **R. pustulosa** (White). Mississippic.

Small, biconvex. Front broadly rounded. Cardinal slopes straightened. Surface marked by 16–22 simple rounded plications five of which are on the sinus and fold each.

Kinderhook of Iowa, Utah, New Mexico.

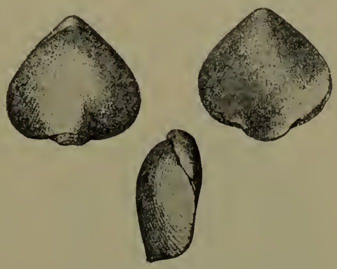


Fig. 369. *Eatonia peculiaris* (Pal. N. Y., III.).

LXXXV. Rhynchonella Fischer de Waldheim.

Rostrate, subpyramidal. Apex of pedicle valve but slightly incurved. Prominent median sinus present on pedicle valve and fold on brachial in typical species. In pedicle valve deltidial plates conspicuous; dental lamellæ present. In brachial valve a median septum present; no cardinal process and no arm supports except crura. Surface radially plicated. Ordovicic (?)–Eocenic.

A. Plications present only upon anterior portion of shell .... 285. *R. æquiplicata.*
B. Plications present upon entire shell .... *.
  * Outline subtrigonal. Shell less than 1 inch wide .... 1.
    1. Median sinus bearing less than 6 plications ....286. *R. gnathophora.*
    1. Median sinus bearing 6 or more plications.... .... *a.*
      a. Surface with 20 to 25 plications..........................283. *R. hubbardi.*
      a. Surface with more than 20 to 25 plications .... 1′.
        1′. Shell small, a half inch or less in width ... 282. *R. eurekaensis.*
        1′. Shell of medium size, more than a half inch in width. 284. *R. myrina.*

282. **R. eurekaensis** Walcott. (Fig. 370.) Mississippic.

Small, subtrigonal in outline. Width and length subequal. Brachial valve slightly deeper than pedicle. Pedicle valve with a prominent, projecting beak and with a rather shallow sinus that forms about half the width of the shell anteriorly. Brachial valve with a slight median fold; umbo strongly incurved. Surface of each valve with 40 to 50 round, simple plications.

Nevada; Arkansas? (Spring creek limestone).

283. **R. hubbardi** A. Winchell. Mississippic.

Small. Cardinal slopes straight. Greatest width about the middle of the shell. The two valves equally convex. Front gently rounded. Pedicle valve with a broad, shallow sinus occupied by 8 or 9 plications. Brachial valve with no fold perceptible but with a shallow sinus extending from the beak for about one third the length of the shell. Surface covered with about 21 narrow plications.

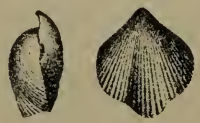


FIG. 370. *Rhynchonella eurekaensis.* (After Walcott.)

Waverly of Ohio, Marshall of Michigan.

284. **R. myrina** Hall and Whitfield. Jurassic.

Of medium size, broadly ovate with greatest diameter below the middle. Brachial valve the deeper, nearly evenly convex from beak to front and with a slightly elevated median fold. Pedicle valve with a prominent projecting beak and a broad, moderately depressed median sinus. Surface marked by 31–34 low, rounded plications, 8–10 of which occupy the fold and sinus.

Dakota, Utah.

285. **R. æquiplicata** Gabb. Triassic.

Subglobose. Valves equally convex. Beak large, prominent and incurved. Sides sloping convexly to extremities of hinge line. Surface with about 14 nearly equal, rounded ribs, beginning on each valve about one third the distance from beak to front; the furrows equalling the ribs in width. Length and width about 1 inch each but length slightly exceeding width. Growth lines faintly developed.

Trias of Humbolt Mt., Nevada.

286. **R. gnathophora** Meek. Jurassic.

Of medium size, subtrigonal, with greatest convexity near the middle. Postero-lateral margins straight, diverging from beak at an angle of 80° to 100°. Brachial valve usually the more convex, especially near the front where it rises into a median fold traceable for about half the way toward the incurved beak. Pedicle valve with a corresponding sinus; beak pointed. Surface with 16 to 20 simple plications of which three or four are in the sinus and four or five on the fold. Length about .8 inch and breadth about .7 inch.

Jurassic of California and Utah.

LXXXVI. Peregrinella Œhlert.

Shell large, pedicle valve generally the more convex. Valves without median fold or sinus; with even margins and plicated surfaces. Beak short, false cardinal area and deltarium present. Cretacic.

287. **P. whitneyi** (Gabb.). (Fig. 371.) Cretacic.

Large, subcircular in outline; the two valves about equally convex. No median fold or sinus present. Surface marked with 40 to 50 narrow, angular plications which are equal in breadth to the deep, angular interspaces. When young the shell is much longer than wide. Length and breadth each about 1¼ inches in maturity.

Knoxville of California.

Fig. 371. *Peregrinella whitneyi.* (After Stanton.)

LXXXVII. Centronella Billings.

Usually small, terebratuloid in outline. Pedicle valve convex, angular in the center; beak acute and incurved with a terminal foramen, which is continuous with a partially closed delthyrium. Brachial valve plane or concave, depressed into a median sinus. Brachidium in two branches uniting medially into a triangular plate bearing a median ridge. Devonic–Mississippic.

288. **C. glansfagea** Hall. (Fig. 372, *a–c*.) Devonic.

Very small, broadly ovate. Pedicle valve much the larger, regularly arcuate from beak to front; beak much extended and strongly incurved. Brachial valve convex above and concave in

Fig. 372. *a–c*, *Centronella glansfagea.* (After Nettelroth.) *d–e*, *C. impressa.* (Pal. N. Y., IV.).

the middle through a broad, undefined sinus; beak not incurved. Surface smooth or with faint concentric growth lines.

Oriskany–Onondaga of New York, Kentucky, Indiana, Michigan, Ontario.

289. **C. impressa** Hall. (Fig. 372, *d–e*.) Devonic.

Pedicle valve angularly convex. Brachial valve small with front produced and curved downward to fill the sinuosity in the front of the pedicle valve. Surface covered with fine concentric and faint radiating striæ.

Hamilton of New York.

LXXXVIII. Rensselæria Hall.

Oval or suborbicular, usually gibbous. Beak of pedicle valve prominent, acute and incurved. Valves without mesial fold or sinus. Brachial valve with large hinge plate; brachidium forming a broad plate anteriorly and giving off two small, rod-like processes posteriorly. Surface radially striated or finely plicated. Shell structure punctate. Devonic.

290. **R. æquiradiata** (Conrad). Devonic.

Elliptical, with nearly equal valves. Pedicle valve often subangular along the center toward the umbo, with beak incurving over that of the opposite valve. Surface marked by simple radiating striæ, which are most conspicuous near the margin.

Helderbergian of New York, Nova Scotia.

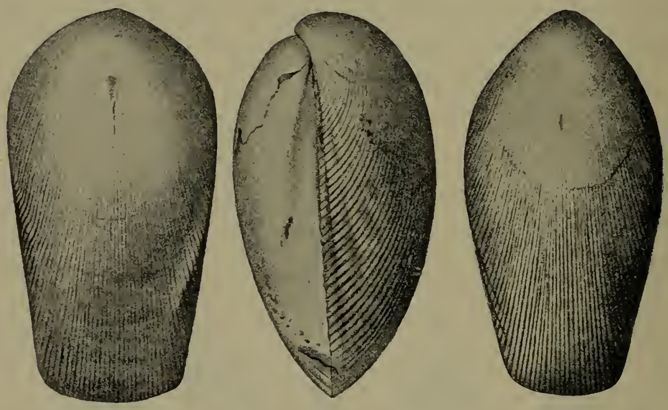


Fig. 373. *Rensselæria ovoides* (Pal. N. Y., III.).

291. **R. ovoides** (Eaton). (Fig. 373.) Devonic.

Length usually much exceeding the breadth, broadest above the middle and abruptly rounded toward the cardinal extremities, narrowing toward the front. Surface marked by simple radiating striæ. Distinguished from *R. æquiradiata* by its different form, larger size and more prominent striæ.

Oriskany of New York, Pennsylvania, Maryland, Virginia, Quebec.

292. **R. cayuga** Hall and Clarke. (Fig. 374.) Devonic.

Lenticular, often large, suboval in marginal outline. Valves subequally biconvex. Very similar to *R. æquiradiata*, from which it differs principally in its suboval marginal outline and in its large size.

Upper Oriskany (Decewville) of Ontario.

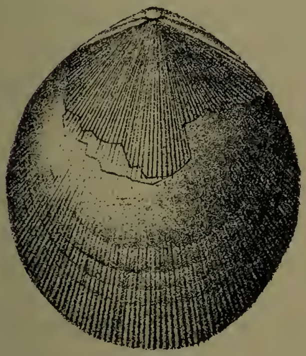


FIG. 374. *Rensselæria cayuga*. (After Hall and Clarke.)

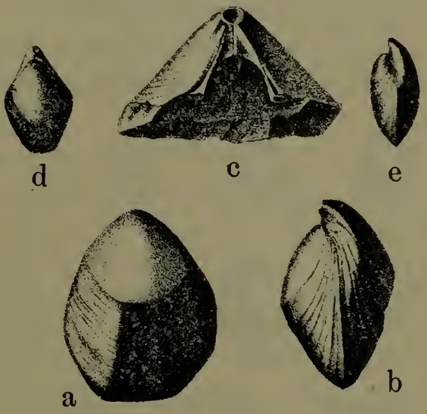


FIG. 375. *a–c*, *Cryptonella planirostris* with beak of pedicle valve enlarged; *d–e*, *C. rectirostris* (Pal. N. Y., IV.).

LXXXIX. Cryptonella Hall.

Elongate-oval, unequally convex, usually without median fold or sinus. Pedicle valve with extended and incurved beak, perforated by a terminal foramen. Surface smooth or marked by concentric striæ. Shell structure finely punctate. Devonic–Mississippic.

293. **C. planirostris** Hall. (Fig. 375, *a–c.*) Devonic.

Often subpentagonal in outline. Pedicle valve with moderately incurved beak. Brachial valve much shorter than the pedicle Surface marked by fine concentric striæ.

Marcellus and Hamilton of New York.

294. **C. rectirostris** Hall. (Fig. 375, *d–e*.) Devonic.

Distinguished from *C. planirostris* by its more elongate form and extended and attenuate beak.

Hamilton of New York, Kentucky, Indiana.

XC. Dielasma King.

Terebratuloid. Pedicle valve with a large foramen. Brachial valve with a large, anteriorly acuminate hinge plate (muscular platform) raised but little above the bottom of the valve and sometimes actually adhering to it. Brachidium a relatively short and simple loop, consisting of descending lamellæ, and a backward arching transverse band. Devonic–Carbonic.

295. **D. (Cranæna) romingeri** Hall. (Fig. 376, *a–c*.) Devonic.

Small, ovate, with rounded cardinal slopes. Concentric striæ often crowded into wrinkles near the front.

Hamilton of New York, Michigan, Indiana, Iowa.

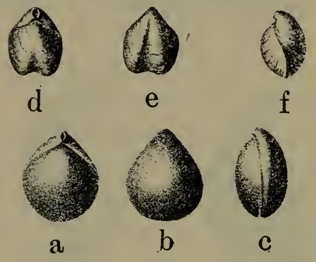


Fig. 376. *a–c*, *Dielasma* (*Cranæna*) *romingeri* (Pal. N. Y., IV.); *d–f*, *D. turgidum*. (After Whitfield.)

296. **D. calvini** (Hall and Whitfield). Devonic.

Shell about $1\frac{1}{2}$ inches long by $1\frac{1}{4}$ inches wide and about $\frac{5}{8}$ inch in greatest thickness. Pedicle valve with umbo curved so that its foramen is at right angles to the plane of separation of the valves. Brachial valve usually with a median fold near the front. Surface smooth except for a few concentric growth lines.

Chemung of Iowa, Northwest Territory.

297. **D. turgidum** (Hall). (Fig. 376, *d–f*.) Mississippic.

Longitudinally ovate, often very gibbous, emarginate in front. Sinus present in pedicle valve and sometimes in brachial. Surface marked by strong concentric growth-lines and occasionally by strong wrinkles in the anterior portion. Differs from *D. romingeri* in its greater gibbosity and in the more strongly marked sinus of the pedicle valve.

Warsaw and St. Louis of Ohio, Kentucky, Indiana, Illinois, Missouri, Iowa.

298. **D. bovidens** (Morton). (Fig. 377.) Carbonic.

Elongate, ovate, averaging about $\frac{3}{4}$ inch in length by $\frac{1}{2}$ inch in breadth. Pedicle valve strongly arcuate with prominent, incurved beak and broad mesial sinus, extending anteriorly from the middle of the valve. Brachial valve almost straight along the median line from the anterior margin to about the middle where it begins to curve gently to the beak; mesial fold usually entirely lacking. Surface nearly smooth. This is larger than *D. romingeri* and lacks its broader ovate character. It differs from *D. turgidum* in its larger size, less gibbous form and less emarginate anterior portion.

FIG. 377. *Dielasma bovidens* (Ind. Geol. Survey).

Widely distributed through the central United States.

XCI. Eunella Hall and Clarke.

Differs from *Dielasma* in the absence of the large hinge plate. Devonic.

299. **E. lincklæni** Hall. (Fig. 378.) Devonic.

Terebratuloid. Pedicle valve at times with a narrow mesial depression; beak more or less abruptly incurved; umbonal slopes concave toward the cardinal margin. Surface of both valves marked by fine concentric growth lines. Shell structure punctate.

Marcellus and Hamilton of New York, Michigan, Indiana.

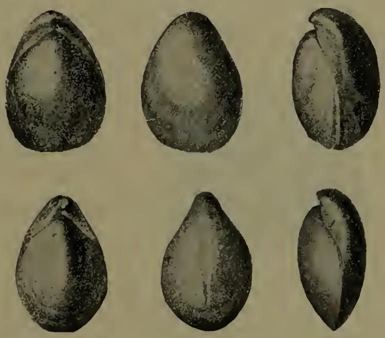


FIG. 378. *Eunella lincklæni.* Views of two individuals showing variation (Pal. N. Y., IV.).

XCII. Terebratula Klein.

Form terebratuloid, elongate biconvex generally with median flattening or depression in each valve. Surface not striate; deltidial plates complete. Loop short, unsupported by a median septum at any stage of growth. (Fig. 380.) Devonic(?)–Recent.

300. **T. ? humboldtensis** Gabb. Triassic.

Of medium size. Front truncate and marked by a simple or double fold and sinus. Pedicle valve slightly flattened across the middle. Beak broad, prominent, but slightly incurved and trun-

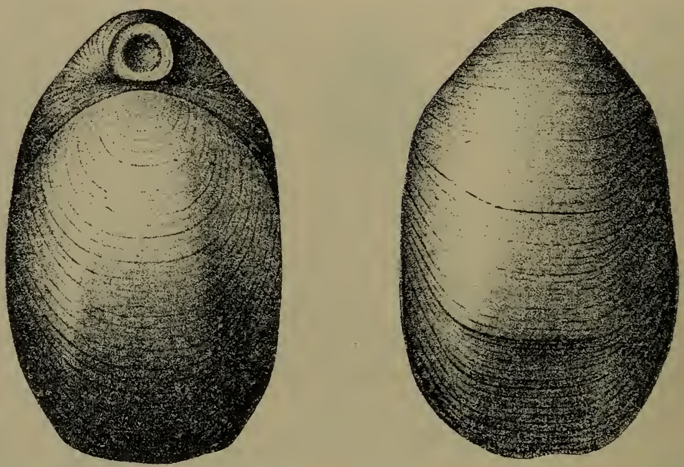


FIG. 379. *Terebratula harlani.* Example of average size. (After Whitfield.)

cated by a large foramen. Cardinal borders strongly inflected and flattened, forming an angularity along the edge of the beak. Surface smooth except for strong and irregular concentric growth lines.

Triassic of Nevada and Nicola Lake, Canada.

301. **T. harlani** Morton. (Figs. 379 and 380.) Cretacic–Eocenic.

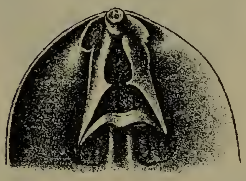


FIG. 380. *Terebratula harlani.* Interior showing loop. (After Whitfield.)

Large (sometimes 2¾ inches long), elongate-oval with subparallel sides. Front more or less truncate, at times slightly bilobate. Valves very ventricose, covered with concentric growth lines. Pedicle valve with large beak, strongly incurved; foramen large. Shell substance finely punctate.

Upper Cretacic (Rancocas) of New Jersey, Delaware, South Carolina. Eocenic of Maryland.

XCIII. TEREBRATULINA d'Orbigny.

Ovate, biconvex. Cardinal extremities faintly auriculate. Pedicle valve with circular foramen; deltidial plates small, generally incomplete; dental plates wanting. Brachial valve with small cardinal process; hinge plate and median septum wanting; socket walls prominent, supporting a short *Dielasma*-like loop with the crural spines typically united into a transverse band or jugum. Surface finely radiate. Jurassic–Recent.

302. **T. atlantica** (Morton). (Fig. 381.) Cretacic.

Ovate. Valves unequally convex. Length about ¾ inch; width ½ inch. Pedicle valve with large foramen; beak not incurved. Both valves covered with numerous bifurcating striæ.

Upper Cretacic (Manasquan) Staten Island and New Jersey.

FIG. 381. *Terebratulina atlantica*. (After Whitfield.)

XCIV. TROPIDOLEPTUS Hall.

Form strophomenoid. Hinge line straight; area well developed. Pedicle valve convex with two broad divergent teeth and open, subcircular delthyrium. Brachial valve concave or flat with large cardinal process bilobed at summit. Teeth and dental sockets corrugated on their outer surfaces. Shell substance highly punctate. Loop of descending lamellæ joined to median septum. Devonic.

303. **T. carinatus** (Conrad). (Fig. 382.) Devonic.

Plications simple, rounded, wider than the interspaces. Central plication of pedicle valve broader and higher than the rest. Concentric striæ fine with occasional coarser imbricating lamellæ.

Marcellus and Hamilton of New York, Pennsylvania, Ohio. Kentucky, Indiana, Illinois. Also foreign.

XCV. KINGENA Davidson.

Subovate, biconvex, inequivalved; terebratuloid in outline, convexity and foramen. In brachial valve a cup-like hollow between the sockets gives rise to a median septum extending about half the length of the valve. Loop more complicated than in *Terebratula*, Shell structure punctate. Comanchic.

304. **K. wacoensis** (Roemer). Comanchic.

Pentagonal, frontal margin straight. Both valves very convex. Pedicle valve with beak greatly incurved and with a distinct car-

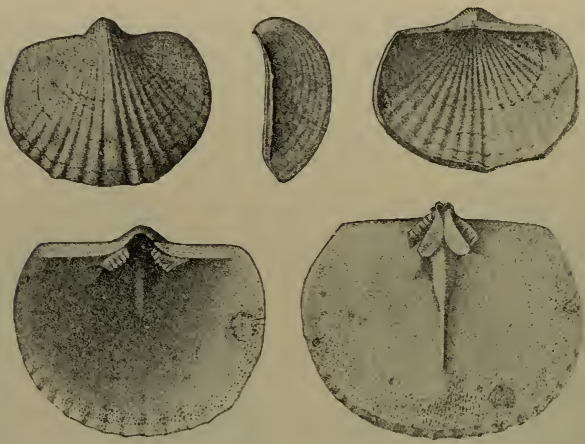


FIG. 382. *Tropidoleptus carinatus.* External and internal views (Pal. N. Y., IV.).

dinal area. Surface marked only with a few concentric growth lines.

Washitan of Texas, Vancouver Island.

XCVI. TEREBRATELLA d'Orbigny.

Plicated Terebratuloids, with straight or slightly curved hinge line. Loop composed of descending and ascending branches, supported by a median dorsal septum throughout life or only in the younger stages. Lias-Recent.

305. **T. plicata** (Say). (Fig. 383.) Cretacic.

Subcircular, somewhat plano-convex, marked by 8–12 or sometimes more, sharply angular plications which extend from beak to

FIG. 383. *Terebratella plicata.* Dorsal and side view; and interior of brachial valve enlarged. (After Whitfield.)

front. Pedicle valve strongly convex with an erect beak of small size; foramen large. Structure strongly punctate.

Upper Cretacic (Matawan and Monmouth) of New Jersey, etc.

306. **T. vanuxemi** Lyell and Forbes. (Fig. 384.) Cretacic.

Valves more convex than preceding, plications more numerous, less angular and less distinct, except occasionally in central portion of valve.

Upper Cretacic (Monmouth) of New Jersey, etc.

FIG. 384. *Terebratella vanuxemi.* Dorsal and side view of average form; dorsal view of more finely plicate form. (After Whitfield.)

XCVII. Zygospira Hall.

Subcircular, biconvex. Like *Atrypa* but small and with a median plicated fold in the pedicle valve. Brachial valve marked by a median sinus; cardinal process stout, bilobed. Spirals composed of fewer coils than in *Atrypa* and turned inwards; primary lamellæ united by transverse jugum (Fig. 385, *e*); surface sharply plicate. Ordovic–Siluric–? Devonic.

307. **Z. recurvirostris** (Hall). (Fig. 385, *a–e*.) Ordovicic.

Length slightly exceeding width. Smaller than *Z. modesta*.

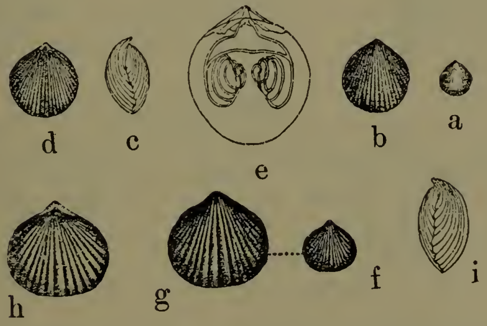


FIG. 385. *a–e*, *Zygospira recurvirostris*; nat. size and three views enlarged × 2 (*e*) brachidium still more enlarged × 4; *f–i*, *Zygospira modesta*, natural size and three enlarged views × 2. (After Winchell and Schuchert.)

Trenton of New York, Kentucky, Wisconsin, Minnesota, Ontario, Manitoba.

308. **Z. modesta** Hall. (Fig. 385, *f–i.*) Ordovicic.

Width slightly exceeding length. Hinge line somewhat extended. Pedicle valve convex with a median ridge occupied by four stronger plications; beak prominent and incurved. Brachial valve depressed-convex and nearly circular with an ill defined mesial sinus. Plications simple, about 18.

Utica to Richmond of New York, Ohio, Missouri, Wisconsin, Iowa, Minnesota, Ontario. Clinton of Ohio.

308*a*. var. **cincinnatiensis** James. Ordovicic.

Differs from the preceding in its larger size, more pronounced median fold and sinus, and coarser, more angular bifurcating plications.

Cincinnatian of Ohio, Tennessee, etc.

309. **Z. nicoletti** Winchell and Schuchert. (Fig. 386, *a–c.*) Ordovicic.

Very small, usually not much exceeding ⅛ inch in width. Length greater than breadth. In these respects it resembles *Z. recurvirostris*; it differs from that species in the faintness of its

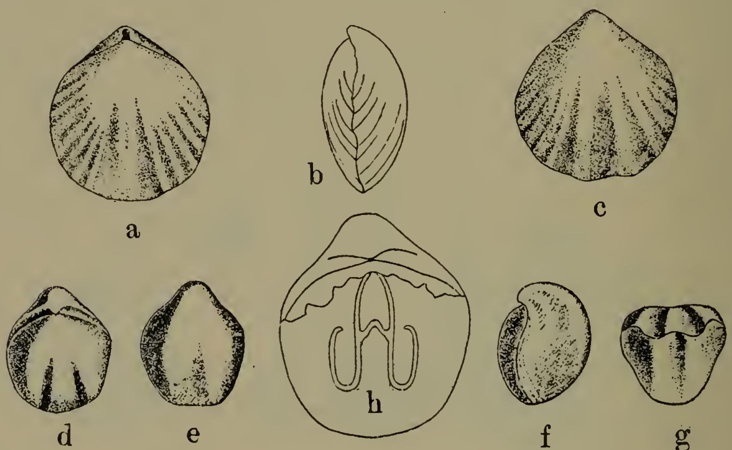


FIG. 386. *a–c*, *Zygospira nicoletti*, three views much enlarged; *d–h*, *Cyclospira bisulcata* four views enlarged × 2; and brachidium still further enlarged × 4. (After Winchell and Schuchert.)

plications and in the presence of a sinus on the pedicle valve and a fold on the brachial, being in these respects exactly opposite.

Trenton of Minnesota, Wisconsin and Missouri.

XCVIII. Cyclospira Hall and Clarke.

Subquadrate. Pedicle valve very convex with a prominent, incurved umbo and keeled posteriorly with a median sinus anteriorly. Brachial valve depressed, bearing a low median fold anteriorly; cardinal process small, supported by a low median septum. Brachidium very simple (Fig. 386, *h*). Surface smooth. Ordovicic–Siluric.

310. **C. bisulcata** (Emmons). (Fig. 386, *d–h.*) Ordovicic.

Small. Beak of pedicle valve defined on each side by two elevated ridges curving to the lateral margins of the valves.

Trenton of New York, Minnesota, Ontario, Manitoba.

XCIX. Atrypa Dalman.

Subcircular, strongly inequivalved. Hinge line short. Brachial valve very gibbous. Pedicle valve much less convex or nearly flat with a small, incurved beak and bearing a median sinus. Teeth large and widely separate. Muscular impressions strong. Spirals directed dorso-medially; jugum in extreme posterior portion. Surface radially plicate. Siluric – Mississippic.

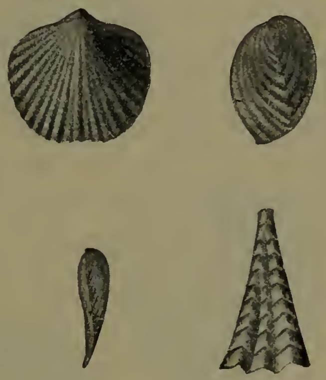


Fig. 387. *Atrypa nodostriata*, with striæ enlarged (Pal. N. Y. II.).

311. **A. nodostriata** Hall. (Fig. 387.) Siluric.

Valves subequal. Surface nodulose because of the lamellose growth lines.

Clinton and Niagaran of New York, Ohio, Kentucky, Wisconsin.

312. **A. marginalis** (Dalman). Siluric.

Length and breadth subequal. Beak of pedicle valve incurving over, but not covering that of the brachial valve. Both valves convex, the pedicle with a well-marked median sinus, bounded on each side by one or two stronger plications, and the brachial with a correspondingly well developed fold. Entire surface marked by radiating plications, which are crossed by concentric striæ; these latter are often obsolete.

Niagaran of Kentucky, Tennessee, Ohio, Indiana, Illinois.

313. **A. rugosa** Hall. (Fig. 388.) Siluric.

Smaller than *A. nodostriata* and with equally convex valves. Surface marked by strong sinus and fold and concentric rugose lamellæ and by plications which are less rounded than in *A. nodostriata*.

FIG. 388. *Atrypa rugosa*, with striæ enlarged (Pal. N. Y. II.).

Niagaran of New York, Kentucky, Indiana, Anticosti.

314. **A. reticularis** (Linnæus). (Figs. 389, *a*; 389, *b*; 392, *a–c*.) Siluric and Devonic.

Pedicle valve often nearly flat. Surface reticulated by the radiating and concentric striæ.

A characteristic Siluric and Devonic fossil throughout the world.

FIG. 389, *a*. *Atrypa reticularis* (Helderbergian) (Pal. N. Y. III.).

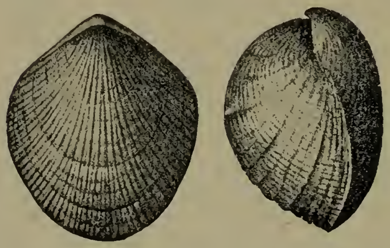


FIG. 389, *b*. *Atrypa reticularis* (Onondaga) (Pal. N. Y. IV.).

315. **A. impressa** Hall. (Fig. 390.) Devonic.

Differs from *A. reticularis* in being more gibbous, in the absence of a sinus in the pedicle valve and in the depression of the brachial valve toward the front. The striæ are finer and less conspicuous.

Schoharie of New York, Michigan.

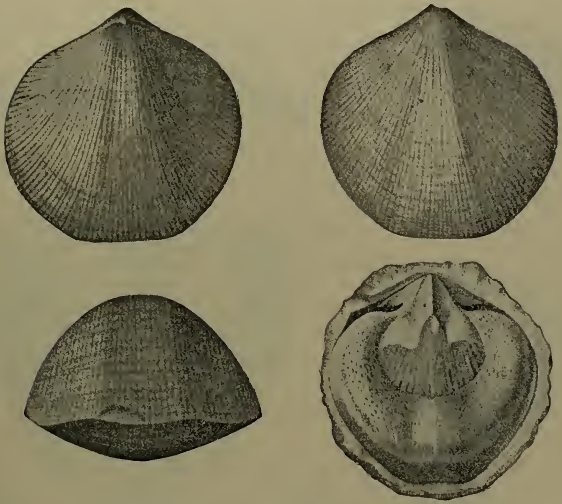


Fig. 390. *Atrypa impressa*, with interior of pedicle valve (Pal. N. Y. IV.).

316. **A. spinosa** Hall. (Figs. 391 and 392, *d.*) Devonic.

Hinge line but little less than the greatest width of the shell. Surface marked by strong, rounded, radiating costæ which bifurcate at unequal intervals and are crossed by strong concentric lamellæ; where these cross the costæ they are often produced into tubular spines. Differs from *A. reticularis* in the smaller number of costæ and in the longer and more nearly straight hinge line.

Onondaga–Chemung. Widely distributed throughout North America.

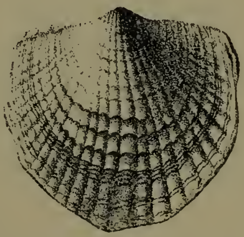


Fig. 391. *Atrypa spinosa*, a spineless individual (Pal. N. Y. IV.).

317. **A. hystrix** Hall. (Fig. 392, *e.*) Devonic.

Differs from *A. spinosa* in its fewer, coarse, rounded plication which are crossed by lamellose lines of growth and occasionally prolonged into few coarse spines.

Chemung of New York, Pennsylvania, Iowa and Wisconsin.

317*a*. **A. hystrix** var. **occidentalis** Hall. (Fig. 392, *f.*) Devonic.

Gibbous, with few coarse plications and strong lamellose growth lines but no spines.

Middle Devonic of Iowa and Rock Island, Ill.

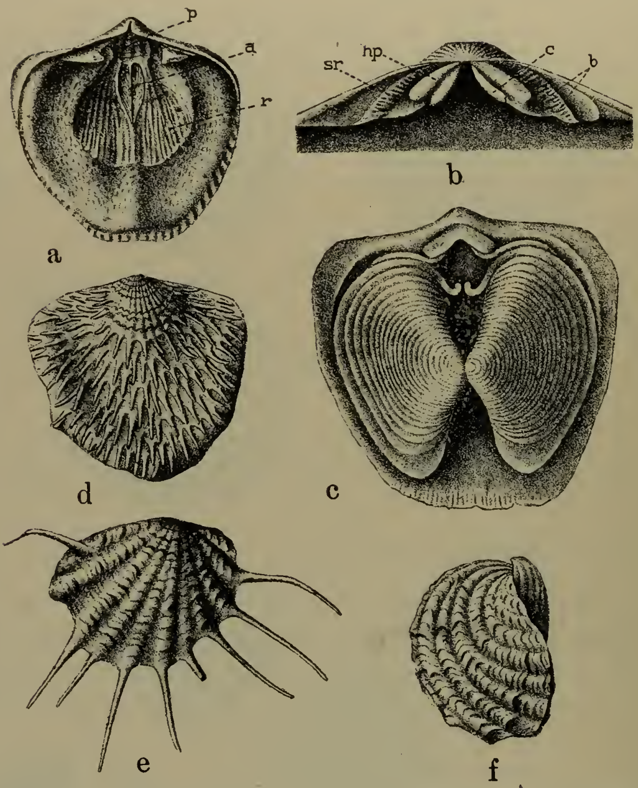


FIG. 392, *a–c*. *Atrypa reticularis*; *a*, interior of pedicle valve; *b*, cardinal portion of brachial valve; *c*, spirals showing after removal of brachial valve; *d*, *Atrypa spinosa*; *e*, *Atrypa hystrix*; *f*, *A. hystrix* var. *occidentalis*. *a*, adductor scars; *b*, dental sockets; *c*, crural bases; *hp*, hinge plate; *p*, pedicle scar; *r*, diductor scars; *sr*, crenulated ridge in sockets. (After Hall and Clarke.)

C. CYRTINA Davidson.

Small, spiriferoid, with very unequal valves. Differs from *Spirifer* in the semipyramidal form of the pedicle valve, the high, flat cardinal area and the narrow delthyrium closed by a convex pseudodeltidium which is usually perforated by a circular foramen. Shell structure punctate. The dental plates converge from the inner margins of the delthyrium and unite with the median septum, which reaches to the front, thus dividing the interior of the valve into two parts. Siluric–Mississippic.

A. Cardinal area of pedicle valve strongly arched. .... *.
- * Shell large, more than ½ inch wide............................ 321. *C. alpenaensis*.
- * Shell small, less than ½ inch wide.............................. 320. *C. umbonata*.

B. Cardinal area of pedicle valve not strongly arched.. **.
** Beak incurved and pronounced.................................. 319. *C. hamiltonensis.*
** Beak inconspicuous. Cardinal area of pedicle valve almost vertical............ 1.
1. 2 to 5 plications on each side of fold and sinus........ 322. *C. acutirostris.*
1. 6 to 9 plications on each side of fold and sinus ....318. *C. dalmani.*

318. **C. dalmani** (Hall). Devonic.
Brachial valve semicircular; mesial fold flat; beak scarcely defined. Concentric lamellæ strong. Surface granulose-punctate.
Helderbergian of New York, Tennessee, Missouri and New Brunswick.

319. **C. hamiltonensis** Hall. (Fig. 393, *a–c.*) Devonic.
Beak slightly incurved and frequently distorted. Surface marked with 6–8 plications on each side of the well marked sinus and fold.

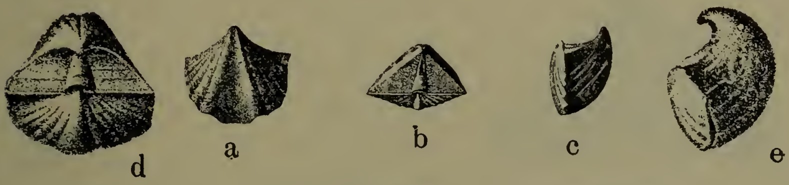


FIG. 393, *a–c.* *Cyrtina hamiltonensis; d–e, Cyrtina alpenensis* (Pal. N. Y. IV. and VIII.)

Onondaga, Hamilton and Portage; distributed throughout North America.

320. **C. umbonata** (Hall). Devonic.
Differs from *C. hamiltonensis* in its broader, arcuate and incurved umbo and beak and in that the 5 or 6 plications on each side of the mesial fold and sinus become obsolete before reaching the umbo, thus leaving that smooth or nearly so.
Hamilton of Illinois, Missouri, Iowa, Michigan.

321. **C. alpenaensis** Hall and Clarke. (Fig. 393, *d–e.*) Devonic.
Very similar to *C. umbonata* but is larger, with broad well defined plications and smooth median fold and sinus.
Hamilton of Michigan.

322. **C. acutirostris** (Shumard). Mississippic.
Small. Pedicle valve with very high and nearly vertical cardinal area. Brachial valve depressed-convex. Surface with two to five simple rounded plications on each side of the median fold and sinus; these are crossed by imbricating growth lines. Differs

from *C. umbonata* in its smaller size, wider hinge line and higher cardinal area.

Chouteau of Missouri.

CI. Cyrtia Dalman.

Semipyramidal shells with cardinal area vertical, that of the pedicle valve high and triangular. Delthyrium narrow, generally open. Otherwise like *Spirifer*. Siluric–Mississippic.

323. **C. alta** Hall. (Fig. 394.) Mississippic.

Semipyramidal with hinge line equaling the greatest width of shell. Pedicle valve very elevated ; height to width about as three to five ; sinus broad and rounded ; cardinal area vertically striated. Brachial valve depressed-convex ; cardinal area comparatively wide ; surface marked with 25 to 30 low, rounded plications on each side of the median fold. Median fold and sinus faintly plicated.

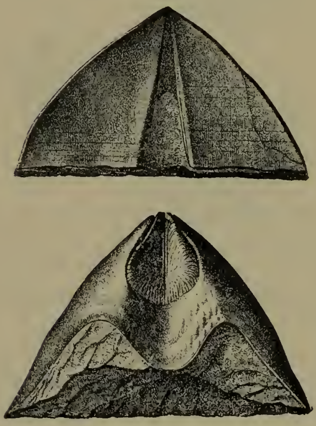


Fig. 394. *Cyrtia alta* $\times \frac{2}{3}$ (Pal. N. Y. VIII.).

Waverly of Pennsylvania and Ohio.

CII. Spiriferina d'Orbigny.

Differs from *Cyrtina* in that the dental plates do not unite with the high median septum and in that the valves are less unequal in size. Shell substance punctate. Devonic? Mississippic–Jurassic.

324. **S. spinosa** (Norwood and Pratten). (Fig. 395.) Mississippic–Carbonic.

Of less than medium size, semioval. Brachial valve with prominent median fold. Pedicle valve slightly more convex than the opposite with strongly defined mesial sinus and slightly arched beak Surface bearing four or five sub-angular or rounded plications on each side the fold and sinus, crossed by imbricating lamellæ of growth. Whole surface

Fig. 395. *Spiriferina spinosa*, a Mississippi Valley and a Nevada specimen. (After Walcott.)

finely punctate. Numerous, irregularly scattered, small spines present.

Kaskaskia of Kentucky, Indiana, Illinois. Upper Devonic? Mississippic and Carbonic of Nevada.

325. **S. kentuckiensis** (Shumard). (Fig. 396.) Upper Carbonic.

Small, varying in outline from subcircular to transversely produced. Differs from *S. spinosa* in its smaller size, pointed hinge extremities and greater number of plications (10-18).

Widely distributed in North America.

FIG. 396. *Spiriferina kentuckiensis* (Ind. Geol. Surv.).

CIII. SPIRIFER Sowerby.

Usually much wider than long, radially plicate or striate, crossed by concentric growth lines. Hinge line generally long and straight. Usually a median sinus present on pedicle valve and corresponding fold on brachial. Pedicle valve with moderately high area and open delthyrium, the margins of which are prolonged into stout, simple teeth supported by dental lamellæ. A calcareous brachidium in the form of a double spire, whose apexes are directed toward the cardinal extremities nearly fills the cavity of the shell. Jugum incomplete. Cardinal process low. A median septum at times present in one or both valves. Siluric–Carbonic.

A. Plications absent. Strong radiating striæ present.................... 326. *S. radiatus*.
B. Plications present.. *.
 * Plications covering entire surface... .. †.
  † Plications arranged in bundles or groups (fasciculate)........................ ‡.
   ‡ Plications of nearly equal size................................. 371. *S. striatus*.
   ‡ Plications of unequal size .... 372. *S. cameratus*.
  † Plications not fasciculate........................ .... ‡‡.
   ‡‡ Plications on fold and sinus nearly or quite like those on rest of shell.......................... .... I.
    I. Shell large, ventricose .... *a*.
     a. Length exceeding breadth, very large...... 366. *S. grimesi*.
     a. Breadth exceeding length... I′.
      I′. Sinus prominent, much produced anteriorly......... *a*′.
       a′. Beaks of both valves very prominent and arching. 346. *S. divaricatus*.
       a′. Beak of pedicle valve much more prominent than that of brachial .... 368. *S. logani*.

1′. Sinus not produced anteriorly.........339. *S. arenosus.*
1. Shell of medium size and convexity.................................. *b.*
b. Cardinal area narrow.. 2′.
2′. Shell granulose.................... 365. *S. marionensis.*
2′. Shell not granulose.. *b′.*
b′. Hinge line extended.......... 364. *S. centronatus.*
b′. Hinge line not extended......... 371. *S. striatus.*
b. Cardinal area moderately high.................................. 3′.
3′. Hinge line shorter than width of shell below.
373. *S. rockymontanus.*
3′. Hinge line forming greatest width of shell (usually recognized by internal mold).... 361. *S. disjunctus.*
‡‡ Plications on fold and sinus extending only part way to the beak and hence differing from the other plications.............................. 2.
2. Plications angular .... 369. *S. leidyi.*
2. Plications rounded .... *c.*
c. Cardinal extremities rounded........................ .... 4′.
4′. Plications of sinus unequal................ 342. *S. grieri.*
4′. Plications of sinus equal.................. 363. *S. keokuk.*
4′. Plications of sinus obscure........... 337. *S. concinnus.*
c. Cardinal extremities angular............. 370. *S. increbescens.*
* Plications covering all the surface but fold and sinus .... ††.
†† Plications crossed by more or less conspicuous concentric lines, often producing a lamellose appearance .... ‡‡‡.
‡‡‡ Shell small, usually less than 1 inch wide .... 3.
3. Hinge line usually shorter than width of shell below........... *d.*
d. Furrow in median fold .... 331. *S. vanuxemi.*
d. No furrow in median fold.. 5′.
5′. Plications obsolescent .... 333. *S. corallinensis.*
5′. Plications well developed............... 330. *S. crispus.*
3. Hinge line extended...................... .... *e.*
e. Plications 4–7 on each side fold and sinus... 329. *S. sulcatus.*
e. Plications many on each side fold and sinus............... 6′.
6′. Front broadly rounded......... ..... 344. *S. varicosus.*
6′. Front narrowly rounded owing to the often mucronate hinge extremities .... 362. *S. subattenuatus.*
‡‡‡ Shell 1 inch or more wide except if young .... 4.
4. Furrow in fold of brachial valve, hinge line extended.. .... *f.*
f. Cardinal areas narrow... .... 7′.
7′. Plications few and absent from the cardinal extremities.
357. *S. sculptilis.*
7′. Plications many...................... 354. *S. mucronatus.*
f. Cardinal areas wide.. .... 8′.
8′. Beak prominent........... .... 356. *S. consobrinus.*
8′. Beak small........................... 360. *S. mesicostalis.*
4. No furrow in fold of brachial valve.................................. *g.*
g. Hinge line shorter than width of shell below............... 9′.
9′. Beak of pedicle valve much elevated.
337. *S. concinnus.*
9′. Beak of pedicle valve not much elevated.
336. *S. cyclopterus.*

g. Hinge line extended .... 10′.
10′. Cardinal area high.. *c′*.
c′. Plications few (2–5) on each side the mesial fold and sinus .... *22*.
22. Plications broad, nearly equalling the mesial sinus in width..............343. *S. raricosta*.
22. Plications much narrower than mesial sinus. 335. *S. perlamellosus*.
c′. Plications many................. 338. *S. murchisoni*.
10′. Cardinal area linear.. .... *d′*.
d′. Plications few (7 or 8 on each side the mesial fold and sinus) .... 340. *S. duodenarius*.
d′. Plications many............... 354. *S. mucronatus*.
†† Plications marked by radiating striæ.................................. ‡‡‡‡.
‡‡‡‡ Cardinal area wide.. 5.
5. Plications few (3–4 on each side the mesial fold and sinus). 327. *S. eudora*.
5. Plications many.. *h*.
h. Shell small (¾ inch wide)....................... 358. *S. tullius*.
h. Shell of medium size or large .... 11′.
11′. Hinge line much extended. Shell often inequilateral. 351. *S. iowaensis*.
11′. Hinge line only slightly longer than width of shell below.. ..... *e′*.
e′. Cardinal area subsemicircular.. 347. *S. euryteines*.
e′. Cardinal area subtriangular...... 348. *S. fornacula*.
‡‡‡‡ Cardinal area narrow... 6.
6. Plications few (2 or 3 on each side mesial fold and sinus). 334. *S. macropleura*.
6. Plications many.. *i*.
i. Fold and sinus rapidly expanding. Shell large. 359. *S. mesistrialis*.
i. Fold and sinus slowly expanding...... 328. *S. niagarensis*.
Plications granulose, sometimes in radiating lines........... .... 5‡.
5‡ Groove usually present in fold. Shell large.......................... 7.
7. Granules scattered, sinus deep, angular...... 350. *S. granulosus*.
7. Granules in lines, sinus rounded...................... 349. *S. oweni*.
5‡ No groove in fold. Shell of medium size................ 355. *S. asper*.
†† Plications apparently smooth... 6‡.
6‡ Shell very convex... .... 8.
8. Large (over 2 inches wide) .... *j*.
j. Hinge line shorter than width of shell below. 367. *S. neglectus*.
j. Hinge line forming greatest width of shell................. 12′.
12′. Shell very ventricose with prominent triangular fold. 345. *S. acuminatus*.
12′. Shell moderately gibbous with low, rounded fold. *f′*.
f′. Plications numerous (30–35)........ 349. *S. oweni*.
f′. Plications few (10–16)........ 338. *S. murchisoni*.
8. Small (about ¾ inch wide), often with conspicuous concentric lines developed toward the front................................ *k*.

k. Plications well developed.................. 341. *S. gregarius*.
k. Plications nearly obsolete...................... 332. *S. eriensis*.
6‡ Shell moderately convex with extended hinge line..................... 9.
9. Proportion of length to breadth as 1–3......... 353. *S. angustus*.
9. Proportion of length to breadth as 1–2........ 352. *S. audaculus*.

326. **S. radiatus** Sowerby. (Figs. 397, 398.) Siluric.

Beak of pedicle valve strongly incurved; cardinal area moderately high. Median sinus broad and shallow; median fold flat-

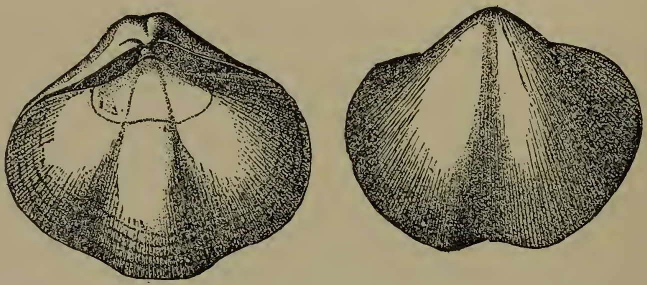


FIG. 397. *Spirifer radiatus* Smith. Western type. (After Hall.)

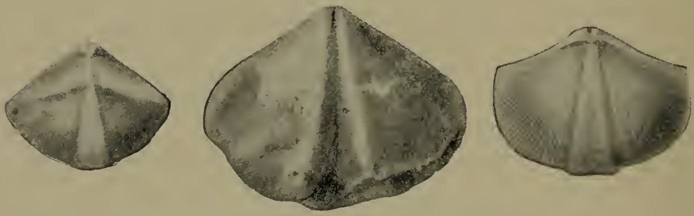


FIG. 398. *Spirifer radiatus*. New York type showing variation (Pal. N. Y., II.).

tened. No plications present but entire surface covered with fine, uniform, radiating striæ.

Clinton and Niagaran of New York, Tennessee, Kentucky, Indiana, Illinois, Wisconsin, Ontario, New Brunswick.

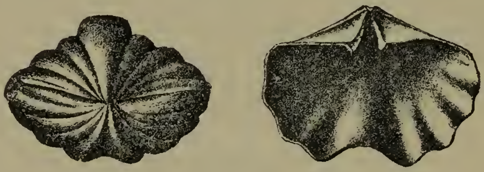


FIG. 399. *Spirifer eudora*. (After Hall.)

327. **S. eudora** Hall. (Fig. 399.) Siluric.

Of moderate size. Valves very gibbous. Hinge line less than width of shell below, with rounded extremities. Surface marked by 3 to 4 strong, subangular plications on each side of the fold and sinus. Mesial sinus broad and deep. Entire surface covered with fine radiating striæ.

Niagaran of Kentucky, Indiana, Wisconsin.

328. **S. niagarensis** (Conrad). (Fig. 400.) Siluric.

Of moderate size, convex with nearly equal valves. Pedicle valve with strongly incurved beak. Surface covered with many fine depressed plications which become obsolete toward the extremities and sometimes appear quite flattened out. Fine, thread-like radiating striæ cover plications and interspaces alike.

FIG. 400. *Spirifer niagarensis* (Pal. N. Y., II.).

Niagaran of New York, Indiana.

329. **S. (Delthyris) sulcatus** Hisinger. (Fig. 401.) Siluric.

Gibbous. Valves unequal. Hinge line more or less extended, often mucronate. Plications 4 to 7 on each side of the mesial fold and sinus, crossed by strong imbricating lamellæ and longitudinally marked by fine striæ.

Niagaran of New York, Ontario.

FIG. 401. *Spirifer* (*Delthyris*) *sulcatus*, with striæ enlarged (Pal. N. Y., II.).

FIG. 402. *Spirifer crispus* (Pal. N. Y., II.).

330. **S. crispus** (Hisinger). (Fig. 402.) Siluric.

Small. Pedicle valve very convex with incurved beak and high cardinal area. Surface marked by broad plications, from 6 to 8 on each valve, strongest near fold and sinus and crossed by fine, thread-like concentric striæ.

Niagaran of New York, Indiana, Ontario, Nova Scotia.

331. **S. vanuxemi** Hall. (Fig. 403.) Siluric.

Small, with rounded extremities. Surface marked by 2 to 4 broad plications on each side the mesial fold and sinus and by imbricating concentric growth lines. Differs from *S. crispus* in its narrower cardinal area, less elevated beak and less gibbous form, and from *S. cyclopterus* in its smaller size and fewer plications, and from both in its scarcely distinguishable fold and sinus.

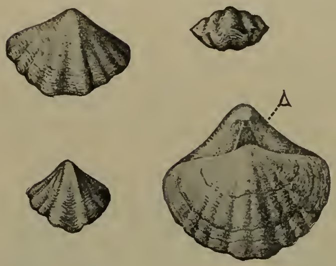


FIG. 403. *Spirifer vanuxemi.* Nat. size and enlarged (Pal. N. Y., VIII.).

Manlius of New York, Ohio, Michigan.

332. **S. eriensis** Grabau. (Fig. 404.) Siluric.

Pedicle valve very gibbous and almost square in outline. Cardinal area high. Sinus and fold sharply defined and angular, bounded by a few broad and nearly obsolete plications.

Cobleskill and Manlius of New York, etc.

FIG. 404. *Spirifer eriensis.* (After Grabau.)

333. **S. corallinensis** Grabau. (Fig. 405.) Siluric.

FIG. 405. *Spirifer corallinensis* (Pal. N. Y., III.).

Very small. Similar to *S. crispus* but differing in the uniformly obsolescent plications and the angular median sinus.

Cobleskill of New York, etc.

334. **S. macropleura** (Conrad). (Fig. 406.) Devonic.

Large, ventricose. Valves nearly equally convex. Pedicle valve with broad, deep sinus and three broad, rounded plications on each side. Brachial valve with broad, rounded fold and two rounded plications on each side. Whole surface covered with fine and close radiating striæ.

Helderbergian (New Scotland) of Maine, New York, Maryland, Tennessee.

335. **S. (Delthyris) perlamellosus** Hall. (Fig. 407.) Devonic.

Hinge line more or less extended. Pedicle valve arcuate with much extended and incurved beak. Sinus deep and profound,

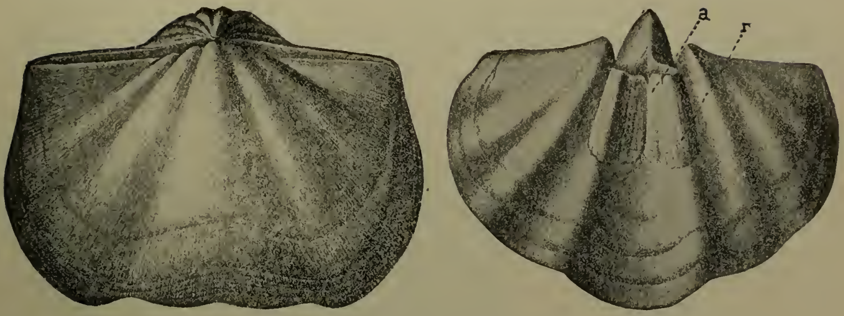


FIG. 406. *Spirifer macropleura* (Pal. N. Y., VIII.).

produced anteriorly into a linguiform extension. Brachial valve convex in the middle with closely incurved beak. Surface marked by 4 to 6 strong plications on each side the median line and concentrically crossed by regular imbricating lamellæ which are strongly arched in passing over the plications, giving the surface a rough appearance.

Helderbergian of Maine, New York, Pennsylvania, Maryland, Tennessee, Missouri.

336. **S. cyclopterus** Hall. Devonic.

Semicircular. Hinge line usually shorter than width of shell below. Convexity of valves nearly equal. Surface marked by 7 or more rounded plications on each side of the mesial fold and sinus, concentrically crossed by fine, close, lamellose striæ.

Helderbergian and Oriskanian of Appalachian region (Maryland to New Brunswick and Gaspé).

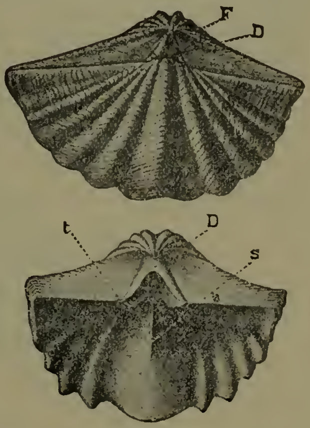


FIG. 407. *Spirifer* (*Delthyris*) *perlamellosus* (Pal. N. Y., VIII.). *D*, deltarium; *F*, foramen; *S*, median septum; *t*, teeth.

337. **S. concinnus** Hall. (Fig. 408.) Devonic.

Semicircular. Hinge line usually shorter than the width of the shell below. Beak of pedicle valve elevated and incurved. Sinus and fold angular and sometimes marked by obscure plications toward the front. Plications rounded, 12–14 on each side of the median line and crossed by concentric striæ. Differs from *S.*

cyclopterus in the more elevated beak of the pedicle valve, the more numerous plications and in the angular character of sinus and fold with occasionally obscure plications.

Helderbergian (Becraft and Port Ewen) of New York.

FIG. 408. *Spirifer concinnus* (Pal. N. Y., VIII.).

338. **S. murchisoni** Castelnau. (Fig. 409.) Devonic.

Pedicle valve with elevated and incurved beak and high, concave cardinal area. Surface marked by 5 to 8 plications on each side of the prominent sinus and fold. Entire shell surface covered with fine, close concentric and radiating striæ. Internal mold of pedicle valve distinguished by a large, prominent striated process, indicating the form and dimensions of the muscular area. The mold is strongly papillose on each side of this area.

Oriskany of New York, Maryland, Ontario.

339. **S. arenosus** (Conrad). (Fig. 410.) Devonic.

Large, with valves of about equal convexity. Pedicle valve with broad and slightly incurved umbo. Mesial sinus very shallow

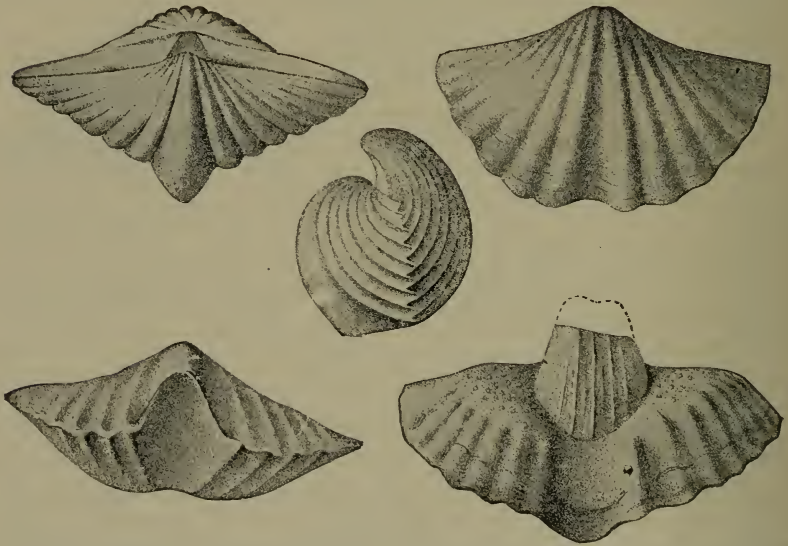


FIG. 409. *Spirifer murchisoni*. External views and internal mold (Pal. N. Y., III.).

and often producing merely a flattening of the surface. Mesial fold moderately elevated. Whole surface covered with 20 to 40

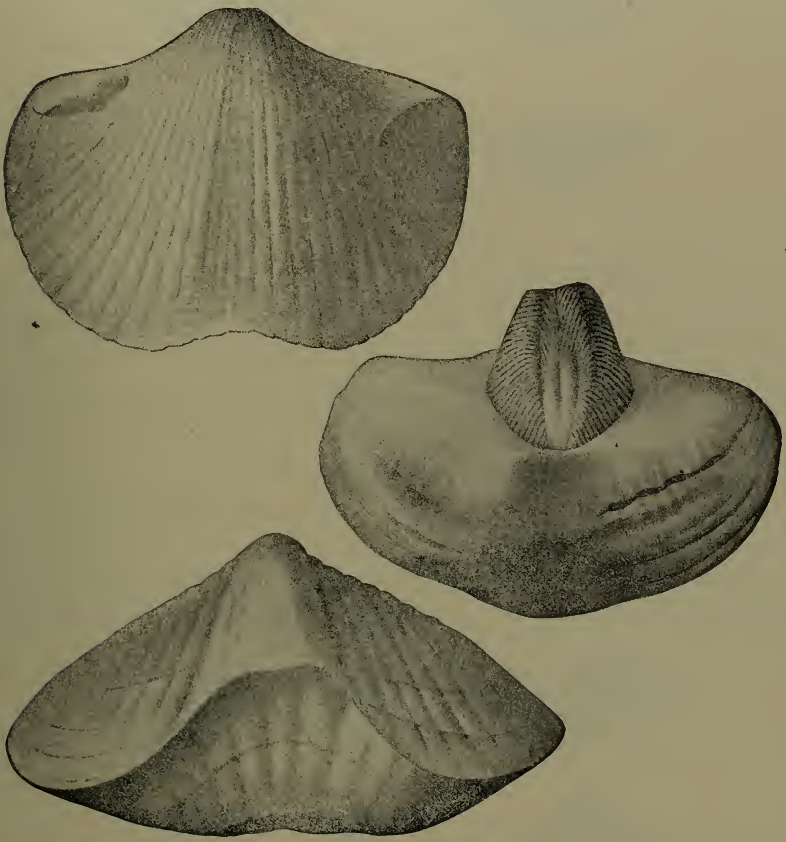


FIG. 410. *Spirifer arenosus.* External views and mold of interior (Pal. N. Y., III.).

low and even plications. Occurs largely as internal molds in the sandstones.

Oriskany and Onondaga (?) of New York, Pennsylvania, Maryland, Virginia, Ontario.

340. **S. duodenarius** (Hall). (Fig. 411.) Devonic.

Somewhat resembles *S. cyclopterus* but differs in its more extended hinge line which here forms the greatest width of the shell, in the narrow cardinal area which is here almost linear and in the less conspicuous striæ. Both valves are flattened at the cardinal extremities.

Onondaga of New York, Ohio, Kentucky, Indiana, Ontario.

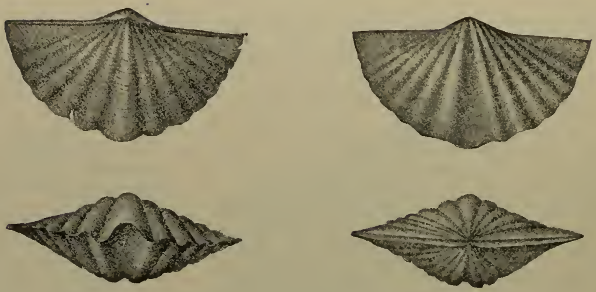


FIG. 411. *Spirifer duodenarius* (Pal. N. Y., IV.).

341. **S. gregarius** Clapp. (Fig. 412, *d–e*.) Devonic.

Small, ventricose. Cardinal extremities truncate or rounded. Pedicle valve regularly arcuate from beak to front with strongly incurved beak and high cardinal area; mesial sinus much produced in front. Surface marked with 6–10 strong ribs on each side of the median line. Entire surface covered with concentric striæ which toward the front become strong zigzag lines.

Onondaga of New York, Ohio, Kentucky, Indiana, Ontario.

342. **S. grieri** Hall. (Fig. 412, *a–c*.) Devonic.

Gibbous. Hinge line usually shorter than the width of the shell below, with rounded extremities. Pedicle valve with promi-

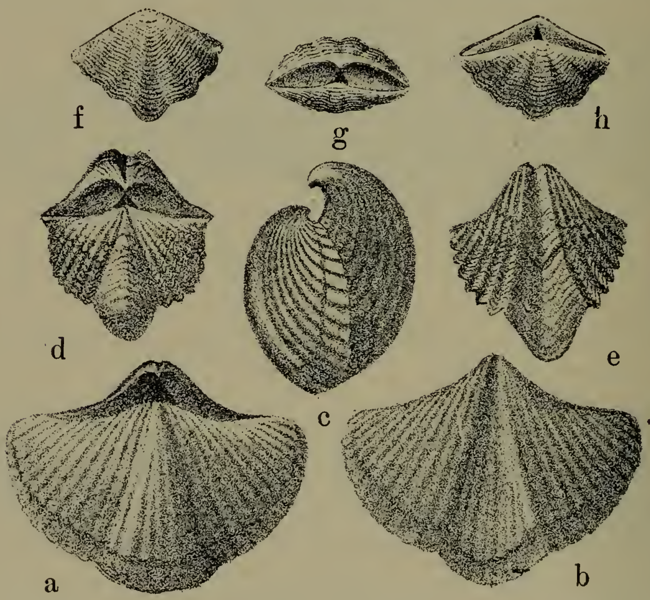


FIG. 412. *a–c*, *Spirifer grieri*; *d–e*, *Spirifer gregarius*; *f–h*, *Spirifer* (*Delthyris*) *raricosta*. (After Nettleroth.)

nent and much elevated beak, incurved over the high arcuate area. Sinus wide and deep. Brachial valve with small beak, slightly incurved over a nearly vertical, narrow cardinal area. Fold prominent and angular. Surface marked by 6 to 10 plications on each side of the fold and sinus, while 3 or 4 smaller bifurcating plications are usually present on fold and sinus. Concentric lines present on well preserved specimens.

Onondaga of New York, Ohio and Kentucky.

343. **S. (Delthyris) raricosta** Conrad. (Fig. 412, *f–h.*) Devonic.

Gibbous, with rounded cardinal extremities. Pedicle valve with greatly elevated beak incurving over the high cardinal area. Brachial valve with small arching beak. Surface marked by 2 to 4 strong rounded ribs on each side the median line, crossed by concentric lamellose striæ and marked by fine and close radiating striæ.

Onondaga of Maine, New York, Ohio, Kentucky, Indiana, Nevada, Ontario, Quebec.

344. **S. varicosus** Hall. (Fig. 413, *a–c.*) Devonic.

Small, with length not exceeding half the width. Hinge extremities angular or mucronate. Pedicle valve much the more

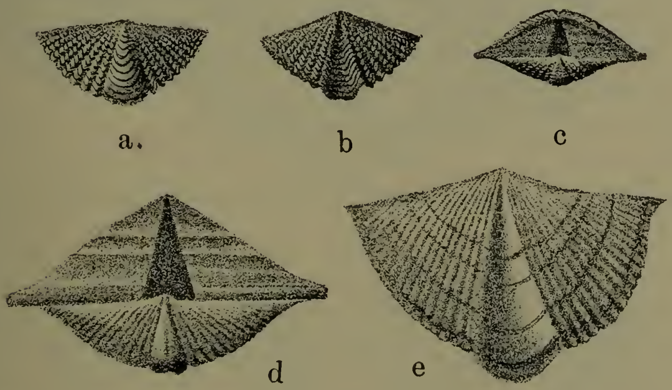


FIG. 413. *a–c*, *Spirifer varicosus ; d–e*, *Spirifer euryteines.* (After Nettleroth.)

convex with high cardinal area. Surface distinguished by the strong lamellose lines of growth which give it a varicose appearance.

Onondaga of New York, Ohio, Kentucky, Nevada, New Brunswick.

345. **S. acuminatus** (Conrad). (Fig. 414.) Devonic.

Large, ventricose. Pedicle valve with umbo incurved over the wide delthyrium. Surface distinguished by the very elevated and angular mesial fold and deep sinus, bounded by 16 to 20 plications.

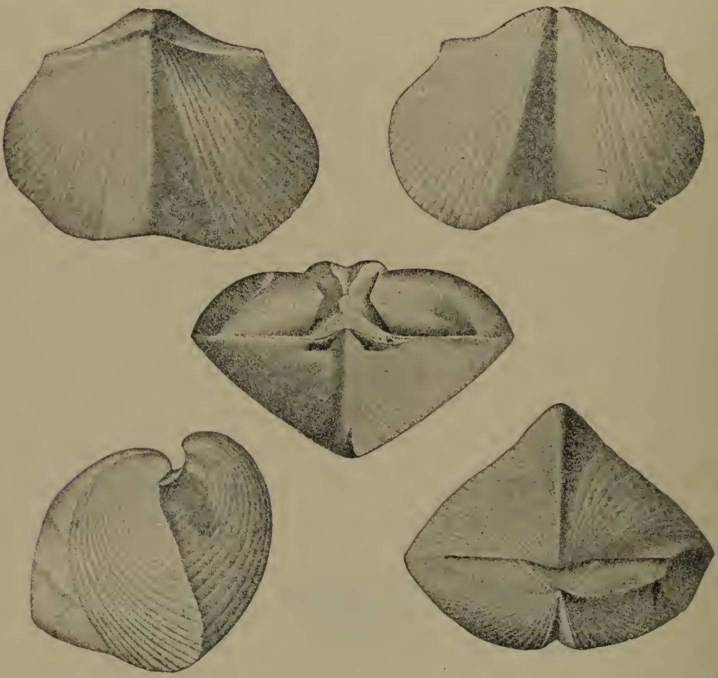


FIG. 414. *Spirifer acuminatus* external views and internal mold (Pal. N. Y., IV.).

Onondaga and Hamilton of New York, Ohio, Kentucky, Indiana.

346. **S. divaricatus** Hall. (Fig. 415.) Devonic.

Ventricose. Hinge line less than width of shell below, with rounded extremities. Cardinal areas wide. Beaks of both valves prominent and arching. Sinus and fold prominent and angular. Whole surface, including sinus and fold, covered with fine, rounded, bifurcating plications which are crossed by fine, zigzag, concentric striæ.

Onondaga and Hamilton of New York, Ohio, Kentucky and Port Colborne, Canada.

347. **S. euryteines** Owen. (Fig. 413, *d–e*.) Devonic.

Semielliptical. Cardinal area wide and slightly concave; beaks sometimes more than ½ inch apart. Fold and sinus bounded on

each side by 18 to 20 plications. Fold marked by a shallow sinus in the median line. Whole surface finely striated longitudinally.
Hamilton of Iowa, Michigan, Nevada, Ontario.

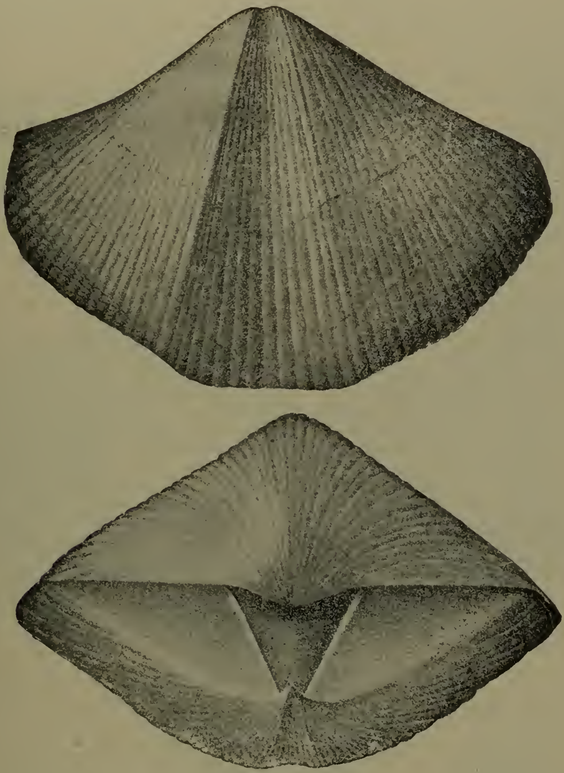


FIG. 415. *Spirifer divaricatus* (Pal. N. Y., IV.).

FIG. 416. *Spirifer fornacula* (Ind. Geol. Survey).

348. **S. fornacula** Hall. (Fig. 416.) Devonic.
Pedicle valve subpyramidal with the elevation equalling nearly half the width, curving abruptly to the front and lateral margins;

cardinal area extremely elevated, nearly flat above, with a large, open delthyrium. Brachial valve moderately convex. Sinus and fold bounded on each side by 16 to 20 plications. Length about ¾ inch.

Hamilton of Ohio, Kentucky, Indiana, Illinois, Wisconsin.

349. **S. oweni** Hall. Devonic.

Very similar to *S. granulosus* but differs in its smaller size, its subangular plications and median sinus, fewer plications (15 to 17 on each side the median fold and sinus), its subauriculate hinge extremities and especially in lacking the granulose surface so characteristic of the latter species.

Hamilton of Falls of Ohio region and Michigan.

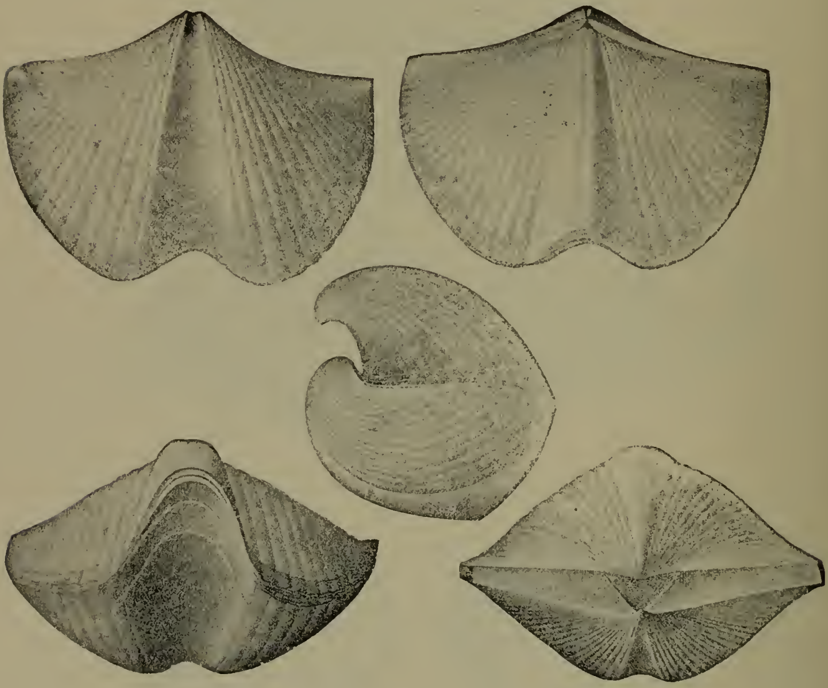


FIG. 417. *Spirifer granulosus* (Pal. N. Y., IV.).

350. **S. granulosus** (Conrad). (Fig. 417.) Devonic.

Large, robust and gibbous with high, curved cardinal area. Brachial valve with a prominent rounded fold, marked by a median depression. Plications low. Surface strongly granulose.

Hamilton. Widely distributed throughout eastern United States.

351. **S. iowaensis** Owen. (Figs. 418, 419.) Middle Devonic.
Often inequilateral. Hinge line much extended. Valves often nearly equally convex. Beak of pedicle valve much elevated and slightly incurved. Whole surface, including fold and sinus and

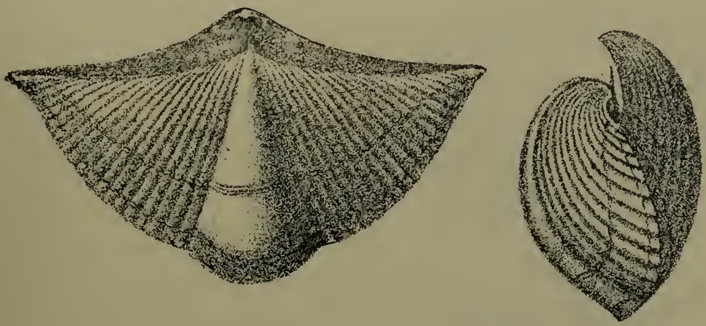


FIG 418. *Spirifer iowaensis.* (After Nettleroth)

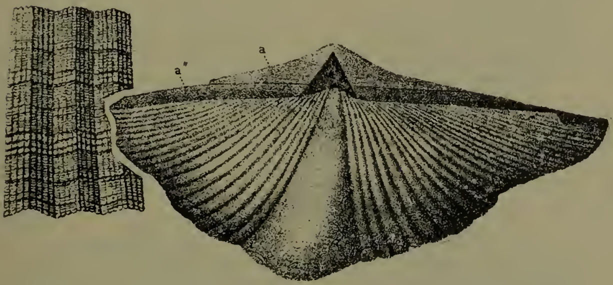


FIG. 419. *Spirifer iowaensis* (*S. pennatus* Owen) × ⅔ with enlargement of surface. (After Hall.)

numerous plications, covered with slender, radiating striæ crossed by concentric growth lines.

Hamilton of Kentucky, Michigan, Indiana, Illinois, Wisconsin, Iowa, Arctic North America lat. 82° 42′.

352. **S. audaculus** (Conrad). (Fig 420, *a.*) Devonic.
Ventricose when old. Pedicle valve with high, concave cardinal area and incurved beak. Cardinal area of brachial valve linear. Mesial fold and sinus well marked. Surface covered with many concentric lines and plications marked with radiating striæ. Differs from *S. granulosus* in being smaller and in that the cardinal area of the brachial valve is linear.

Marcellus and Hamilton of New York, Kentucky, Indiana, Wisconsin.

353. **S. angustus** Hall. (Fig. 420, *b*.) Devonic.

Valves with great lateral extension and pronounced inequality; the pedicle valve forming nearly the entire thickness of the shell. Brachial valve flat with narrow cardinal area and low mesial fold. Plications fine, from 48 to 56 on each valve.

Hamilton and Portage of New York, Wisconsin.

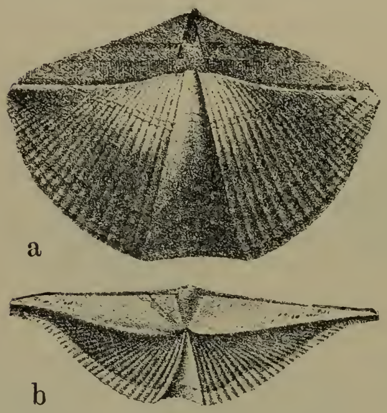


FIG. 420. *a*, *Spirifer audaculus*; *b*, *Spirifer angustus* (Pal. N. Y., IV.).

354. **S. mucronatus** Conrad. (Fig. 421.) Devonic.

Hinge line extended and often mucronate, giving the shell a width of from two to four times the length or greater. Cardinal areas low. Fold in brachial valve often flattened or grooved. Radiating plications numerous, crossed by lamellose lines of growth which are often crowded near the front. Often a plication in sinus.

Marcellus, Hamilton and Chemung of New York, Pennsylvania, Maryland, Virginia, Wisconsin, Ontario.

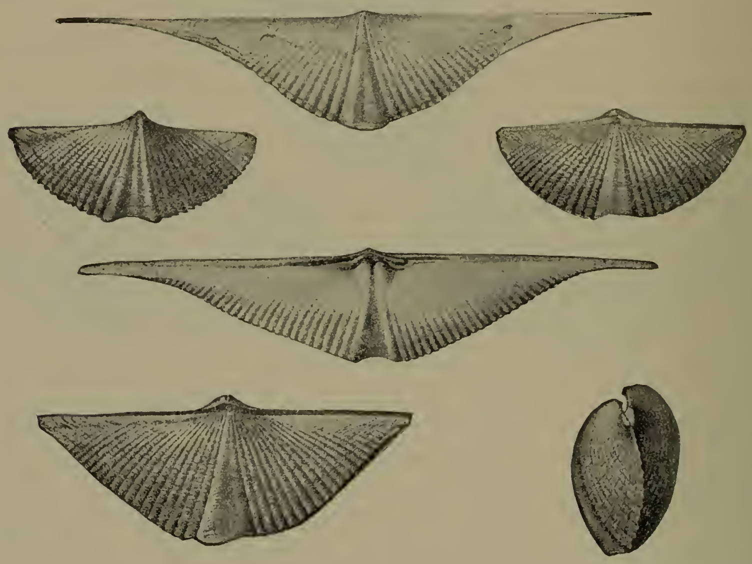


FIG. 421. *Spirifer mucronatus*, showing some of the varieties (Pal. N. Y., IV.).

355. **S. asper** Hall. Devonic.

Small, subpyramidal. Pedicle valve with high, flat cardinal area, narrow delthyrium and broad, shallow sinus, rapidly narrowing toward the beak. Fold low and rounded. Plications fine and low. Whole surface granulose.

Hamilton of New York, Illinois, Wisconsin, Iowa.

356. **S. (Delthyris) consobrinus** d'Orbigny. (Fig. 422, *a–b*.) Devonic.

Gibbous with pedicle valve the more convex and arcuate from beak to front. Cardinal area elevated and concave. Sinus deep and wide. Brachial valve with an abruptly elevated mesial fold usually marked by a depression. Surface marked by 8 to 12 angular radial plications crossed by concentric lamellæ.

Hamilton of New York, Kentucky, Ohio, Wisconsin.

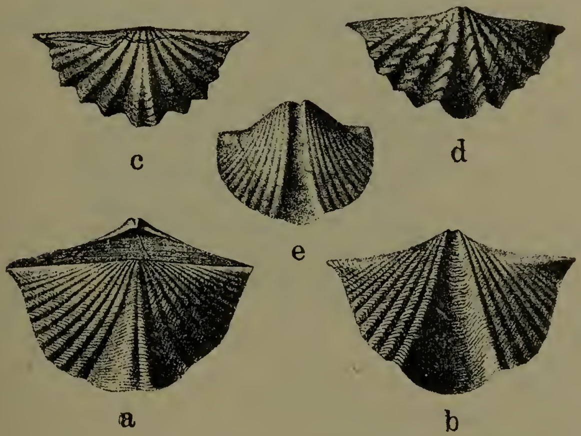


FIG. 422. *a–b*, *Spirifer* (*Delthyris*) *consobrinus*; *c–d*, *S.* (*Delthyris*) *sculptilis*; *e*, *Spirifer tullius* (Pal. N. Y., IV.).

357. **S. (Delthyris) sculptilis** Hall. (Fig. 422, *c–d*.) Devonic.

Gibbous. Hinge line prolonged into mucronate extensions. Length of shell about half the width on the hinge line. Surface strongly marked by 3 to 5 strong plications on each side of the fold and sinus, leaving a somewhat wide space at the cardinal extremities marked only by the concentric striæ which cross the whole shell as strong imbricating lamellæ.

Hamilton of New York, Pennsylvania, Kentucky, Indiana, Ontario.

358. **S. tullius** Hall. (Fig. 422, *e.*) Devonic.

Small, gibbous, subelliptical. Pedicle valve with high cardinal area. Plications rather flattened and low. Whole surface covered with fine, uniform, radiating striæ and faint concentric ones. Sinus and fold well defined, extending quite to the beak.

Upper Hamilton of New York, Northwest Territory.

359. **S. mesistrialis** Hall. (Fig. 423.) Devonic.

Large. Cardinal angles rounded or mucronate. Sinus and fold broad, rapidly becoming expanded toward the front. Plications 16

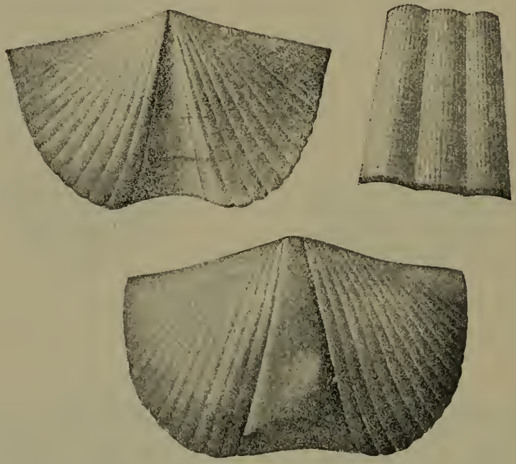


Fig. 423. *Spirifer mesistrialis* with enlargement of striæ (Pal. N. Y. IV.).

to 20. The whole shell, including sinus and fold, conspicuously marked by fine radiating striæ.

Portage and Chemung of New York.

360. **S. (Delthyris) mesicostalis** Hall. (Fig. 424, *a.*) Devonic.

Cardinal extremities usually extended. Pedicle valve with small beak, the upper part only being abruptly curved over the moderately high cardinal area. Sinus angular with a well defined fold in the bottom. Brachial valve with linear cardinal area and mesial fold marked by a deep groove in the middle. Differs from *S. mucronatus* in the duplication of the mesial fold and in the long septum extending from the beak nearly to the front of the muscular impression.

Ithaca and Chemung of New York.

361. **S. disjunctus** Sowerby. (Fig. 424, *b–d.*) Devonic.

Very variable in shape from semicircular to attenuate winged. Pedicle valve but slightly incurved at beak, its internal mold gives a triangular area in part marked by the muscular impression dis-

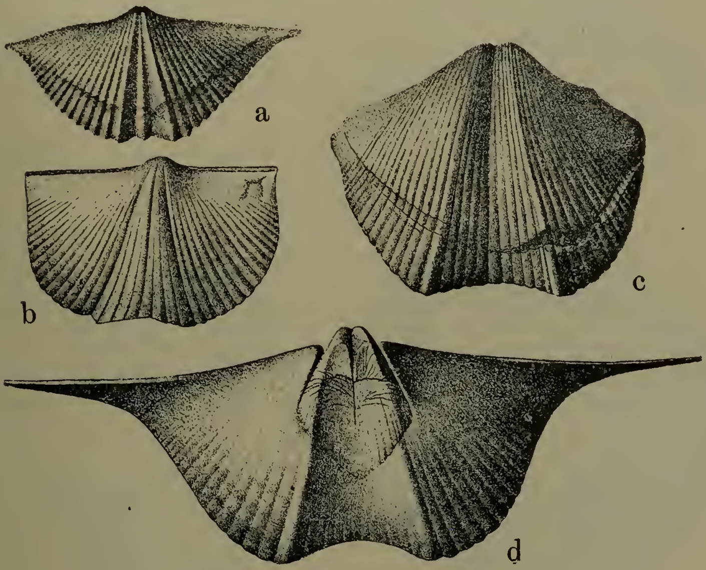


FIG. 424. *a, Spirifer mesicostalis; b-d, Spirifer disjunctus* showing variation of form; *d*, internal mold (Pal. N. Y.).

joined from the sides of the shell by narrow fissures formerly occupied by the dental lamellæ. Surface of both valves, including sinus and fold covered with very low, even plications. Sinus and fold are sharply defined from the rest of the shell.

Chemung; throughout North America. Also Europe, etc.

362. **S. subattenuatus** Hall. Devonic–Mississippic.

Small, with hinge line often extended into mucronate points. Mesial sinus deep and subangular. Surface with 8 to 12 strong plications on each side the median line, crossed by sharp concentric laminæ. Differs from *S. mucronatus* in its smaller size, more elevated plications and stronger imbricating lamellæ.

Chemung of New York and Marshall of Michigan; equivalent horizons of Illinois, Iowa, Northwest Territory.

363. **S. keokuk** Hall. (Fig. 425, *a–b.*) Mississippic.

Gibbous. Valves nearly equal in convexity. Pedicle valve with very prominent and strongly incurved beak. Plicatious many, covering the entire shell and marked by fine radiating and concentric striæ.

Keokuk of Ohio, Illinois, Iowa, Utah.

364. **S. centronatus** A. Winchell. (Fig. 425, *c*.) Mississippic.

Of medium size, broadest at hinge line, often mucronate. Valves moderately convex. Beak of pedicle valve strongly elevated and incurved. Surface with 34 to 42 small plications of which 4 to 6 mark sinus and fold.

Waverly of Ohio, Michigan, South Dakota, Utah, Wyoming, Nevada.

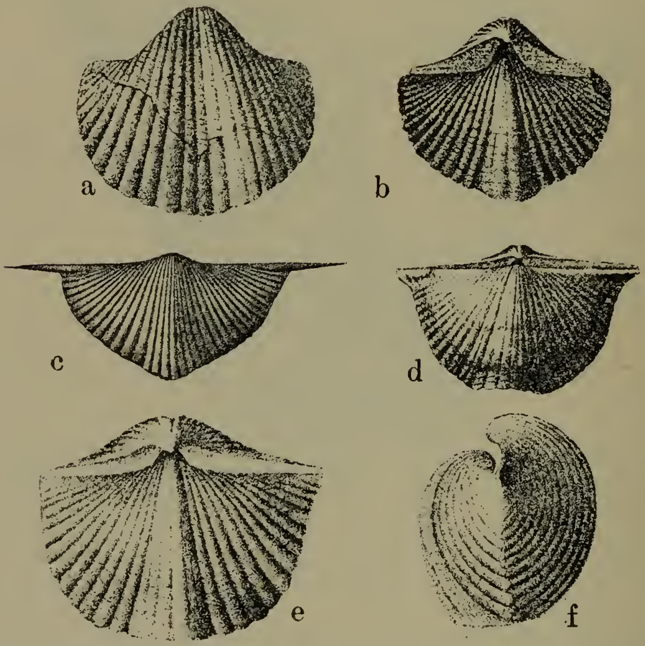


FIG. 425. *a-b*, *Spirifer keokuk*. *c*, *Spirifer centronatus*. *d*, *Spirifer marionensis*. *e-f*, *Spirifer increbescens*. (After Hall, Nettelroth and Pal. Ohio.)

365. **S. marionensis** Shumard. (Fig. 425, *d*.) Mississippic.

Nearly semicircular with hinge line extended in mucronate points. Valves nearly equally convex. Fold and sinus marked by 2 or 3 dichotomizing plications. Cardinal areas narrow. Surface covered with many plications which irregularly bifurcate. Granulose.

Chouteau of Ohio, Missouri.

366. **S. grimesi** Hall. (Fig. 426.) Mississippic.

Very large and gibbous. Mesial fold and sinus broad and ill defined. Entire surface covered with very depressed, irregularly bifurcating plications.

Kinderhook and Burlington of Missouri, Illinois, Iowa, Arctic North America lat. 82° 43′.

367. **S. neglectus** Hall. Mississippic.

Hinge line less than width of shell below and rounded at the extremities. Pedicle valve a little more convex than the brachial with strongly arched beak and cardinal area. Mesial fold and sinus small at beak but increasing very rapidly in width toward the front. Surface marked by about 6 plications on each side the fold and sinus.

Keokuk of Illinois, Iowa, Nevada.

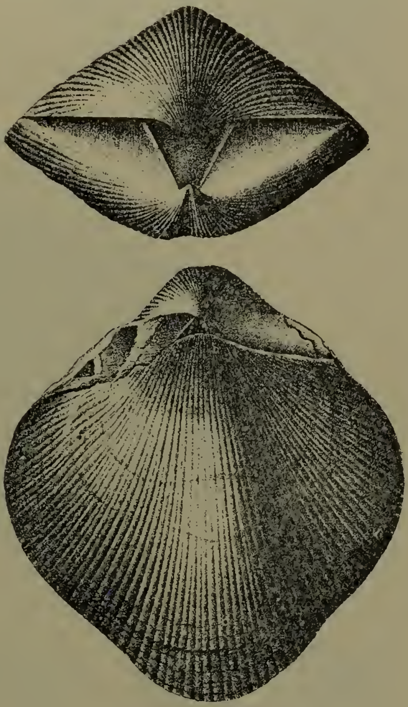


FIG. 426. *Spirifer grimesi*, × ⅔. (After Hall.)

368. **S. logani** Hall. (Fig. 427.) Mississippic.

Very large, gibbous. Length and width as three to four. Fold in brachial valve very prominent and elevated. Sinus in pedicle valve broad and undefined, produced anteriorly. Surface, including fold and sinus, covered with small, nearly equal plications.

Keokuk of Illinois, Tennessee and Missouri.

369. **S. leidyi** Norwood and Pratten. (Fig. 428.) Mississippic.

Small. Pedicle valve gibbous; brachial valve depressed-convex. Mesial fold bearing a well defined depression in the center, reaching half way to the beak. Surface marked by 7 or 8 plications and by longitudinal and concentric striæ.

St. Louis of Kentucky, Indiana, Illinois, Utah, Nevada.

370. **S. increbescens** Hall. (Fig. 425, *c–f*.) Mississippic.

Gibbous. Hinge line always as long as the greatest width of the shell and terminating in more or less extended mucronate tips which are often unequal on the two sides of the shell. Whole surface covered with plications, those on the fold and sinus extending only part way to the umbo and narrower than those on the sides of the shell.

Kaskaskia of Illinois and Kentucky.

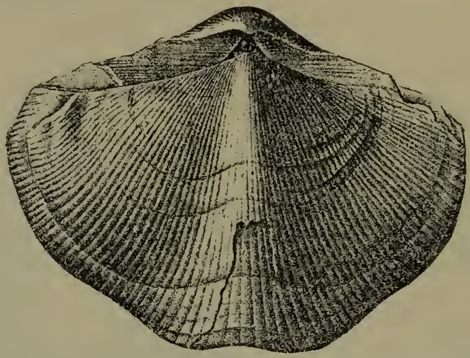


FIG. 427. *Spirifer logani*, × ⅔. (After Hall.)

FIG. 428. *Spirifer leidyi*. (After Whitfield.)

371. **S. striatus** (Martin). Carbonic.

Pedicle valve the more convex and marked by a broad, ill defined mesial depression; beak small, pointed and closely incurved. Entire surface of valves marked by plications which are nearly uniform in size with little tendency to become fasciculate as in *S. cameratus*.

Utah, Nevada, New Mexico, Nova Scotia.

372. **S. cameratus** Morton. (Fig. 429.) Carbonic.

Of medium size or large, broadest at hinge line, with cardinal extremities often pointed. Pedicle valve with concave cardinal area of moderate height. Mesial fold and sinus as well as the rest of the shell covered with many striæ of unequal size, usually arranged in bundles (fasciculate).

Throughout North America.

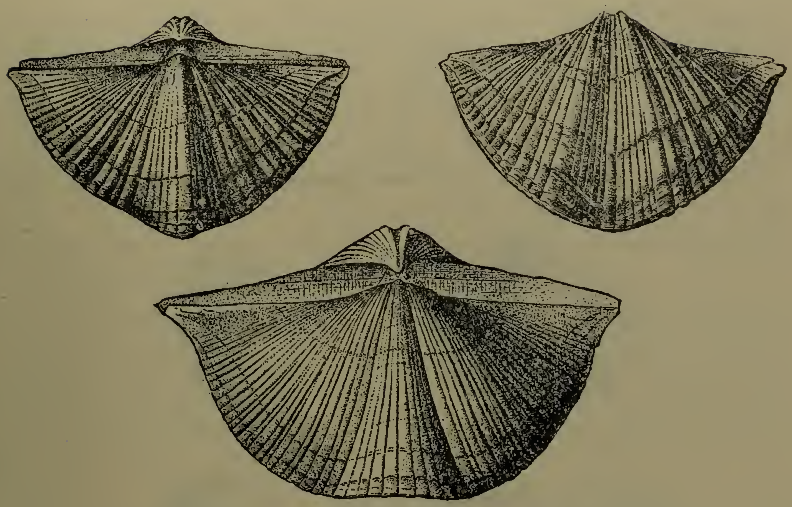


Fig. 429. *Spirifer cameratus.* Two individuals showing variation. (Ind. Geol. Survey).

373. **S. rockymontanus** Marcou. (Fig. 430.) Carbonic.

Hinge line a trifle shorter than the width of the shell below. Pedicle valve with moderately well defined sinus and concave cardinal area with beak strongly incurved over it. Whole surface marked by 24 to34 quite uniform plications.

Widely distributed through North America.

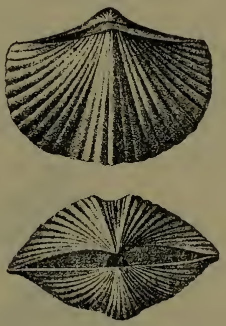


Fig. 430. *Spirifer rockymontanus.* (After Hall.)

CIV. Reticularia McCoy.

Like *Spirifer* but with hinge line less than the greatest diameter of the shell. Radial plications obsolescent or absent. Surface bearing rows of fine spines placed on concentric striations or ridges. Siluric–Carbonic.

A. Conspicuously spine-bearing .... *.

* Small, diameter about $\frac{2}{5}$ inch .... 377. *R. cooperensis.*

* Of medium size, diameter exceeding 1 inch .... 1.

1. Width much exceeding length .... *a.*

a. No plications on surface .... 378. *R. pseudolineata.*

a. Low plications present (3–9 on each side the median line). 374. *R. fimbriata.*

1. Width and length about equal .... 379. *R. setigera.*

B. Apparently spineless .... **.
** Surface usually smooth. Shell large.................................. 376. *R. lævis.*
** Surface smooth ; shell of medium size........................ 375. *R. nevadaensis.*
** Surface marked by crenulate concentric lines. Small....... 380. *R. perplexa.*

374. **R. fimbriata** (Conrad). (Fig. 431, *a–b.*) Devonic.
Gibbous, with rounded cardinal extremities. Pedicle valve with

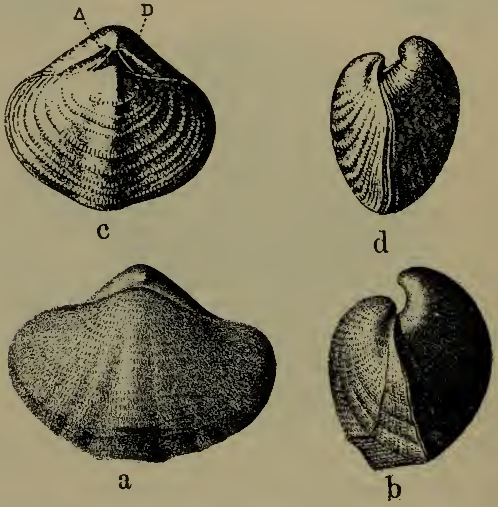


FIG. 431, *a–b. Reticularia fimbriata* ; *c–d, Reticularia setigera.* (After Hall.)

small beak incurved over the high and concave cardinal area which is striated vertically. Brachial valve with small and slightly arching beak. Surface marked by 3 to 9 low plications on each side the mesial fold and sinus, crossed by imbricating lamellose striæ ; these striæ are studded with elongate nodes or tubules.

Oriskany – Ithaca. Widely distributed through North America.

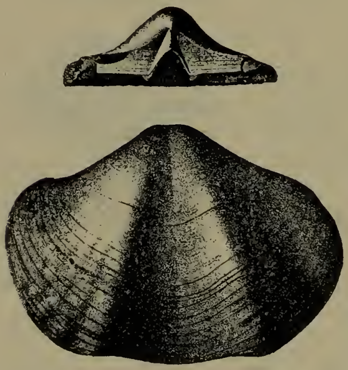


FIG. 432. *Reticularia lævis,* $\times \frac{2}{3}$ (Pal. N. Y. IV.).

375. **R. nevadaensis** (Walcott). (Fig. 435, *c.*) Upper Devonic.
Less transverse than preceding ; fold and sinus often more angular ; no plications, surface appearing smooth.

Devonic limestones of Nevada.

376. **R. lævis** (Hall). (Fig. 432.) Upper Devonic.

Ventricose with rounded cardinal extremities. Length to breadth as 2 to 3 or as 3 to 4. Pedicle valve with abruptly attenuate and arching beak; foramen partially closed by an arching and very convex pseudo-deltidium. Sinus either shallow or deep. Brachial valve only moderately convex with an undefined mesial fold. Surface usually smooth or marked only by concentric growth lines. In old age at times there appear a few obscure radiating folds.

Portage of New York.

377. **R. cooperensis** (Swallow). Mississippic.

Small (length and breadth about $\frac{2}{5}$ inch), gibbous, with greatest breadth a little above the middle. Front subtruncate or slightly sinuous in the middle. Pedicle valve much the more gibbous with a

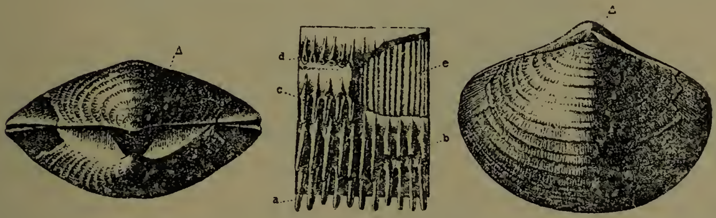


FIG. 433. *Reticularia pseudolineata*, $\times \frac{2}{3}$, with enlargement of part of surface. (After Hall.)

shallow mesial sinus; beak prominent and incurved beyond the hinge line; foramen wide and triangular. Brachial valve depressed-convex with low mesial fold. Surface covered with 2 to 4 very obscure and depressed radial plications on each side the fold and sinus.

Kinderhook of Tennessee, Indiana, Missouri, Iowa.

378. **R. pseudolineata** (Hall). (Fig. 433.) Mississippic.

Width greatly exceeding length. Pedicle valve with shallow mesial sinus and prominent incurved beak. Surface marked by more or less regular concentric lamellose folds or wrinkles and radiating striæ extended into long spines from the edges of the folds.

Burlington–Keokuk of Missouri, Indiana, Illinois?, Iowa.

379. **R. setigera** (Hall). (Fig. 431, *c–d*.) Mississippic.

Much like *R. pseudolineata*, but differs in that here the length and breadth are more nearly equal and the beak is higher and narrower.

Kaskaskia of Kentucky, Illinois, Utah.

380. **R. perplexa** (McChesney). (Fig. 434.) Carbonic.

Small; moderately gibbous. Beaks prominent and incurved. Pedicle valve without pronounced mesial sinus, but slightly flattened or with a shallow though sharp depression anteriorly. Surface marked by numerous very faint radiating lines and somewhat stronger concentric lines, the latter finely crenulate, marking the bases of hair-like spines not preserved.

Widely distributed in North America.

FIG. 434. *Reticularia perplexa* (Ind. Geol. Survey).

CV. MARTINIA McCoy.

Like *Spirifer*, but with hinge line shorter than the greatest width of the shell, and cardinal angles obtusely rounded. Surface smooth except for the concentric striæ. Muscular impressions narrow and faint. Devonic–Carbonic.

381. **M. maia** (Billings). (Fig. 435, *a–b*.) Devonic.

Longitudinally ovate. Cardinal area narrow and sometimes hidden by the beak. Brachial valve with rounded mesial fold.

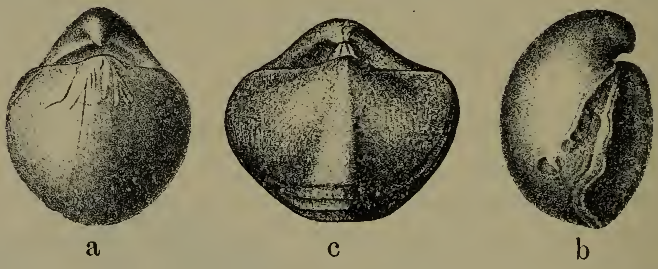


FIG. 435. *a–b*, *Martinia maia*; *c*, *Reticularia nevadaensis*. (After Walcott).

Pedicle valve more convex than the brachial, with a large incurved beak.

Onondaga of Ohio, Nevada, Ontario.

382. **M. glabra** (Martin). Carbonic.

Subcircular to ovate. Pedicle valve with a moderately developed mesial sinus, high cardinal area and incurved beak. In the brachial valve the mesial fold merges into the rest of the surface.

Nova Scotia var. *contracta* in Chester of Illinois, Ohio and Nevada.

CVI. Syringothyris A. Winchell.

Spiriferoid, usually large. Pedicle valve with high, erect, cardinal area; that of brachial valve low. Dental lamellæ strong, surrounding the broad, muscular impressions. A tube (syrinx), open along its inner margin, extends from the apex of the pedicle valve between the dental lamellæ and the deltidium (when present) for

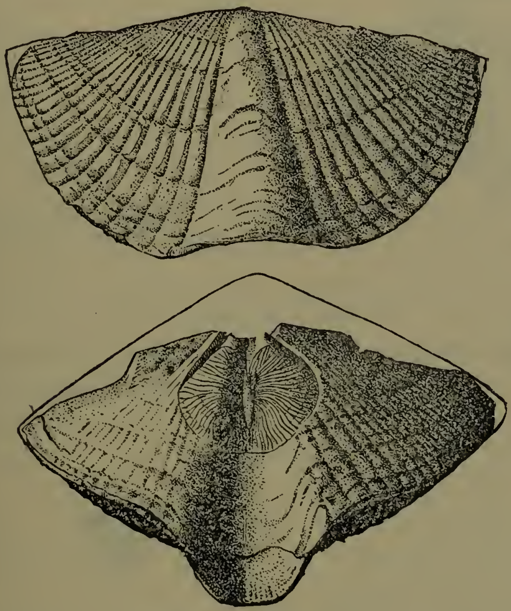


Fig. 436. *Syringothyris texta.* (Ind. Geol. Survey.)

about half the length of the valve. It is formed by the deposition of accretions to the margins of the delthyrium. Shell punctate. Entire surface marked by minute, elongated pits, giving (under a lens) the appearance of twilled cloth. Mississippic.

383. **S. carteri** (Hall). Mississippic.

Length usually more than half the width or subequal. Cardinal extremities nearly rectangular. Pedicle valve the more convex; prominent at the umbo.

Waverly, Burlington and Chouteau of Ohio, Missouri, Iowa, Montana, Nevada.

384. **S. texta** (Hall). (Figs. 436–437.) Mississippic.

Large, 1/3 to 1/2 as long as broad. Height often greater than length. Hinge line forming the greatest width of the shell. Pedicle valve the more convex, very prominent at umbo; mesial sinus deep, rapidly increasing in width from beak to front where it occupies about one fourth of the anterior margin; beak angular; cardinal area high and nearly straight. Brachial valve most convex near the front. Surface marked by about 20 simple plications on each side the median line, crossed by concentric growth lines. Much heavier, wider and more robust than *S. carteri*.

Waverly–Keokuk of Kentucky, Indiana, Ohio, Iowa, Illinois.

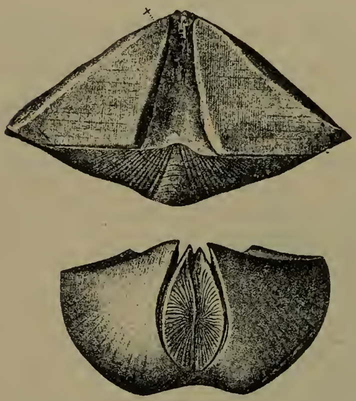


FIG. 437. *Syringothyris texta*, var. × 2/3 (Ohio Pal.).

CVII. AMBOCŒLIA Hall.

Small. *Spirifer*-like. Pedicle valve greatly elevated, with a conspicuous, strongly incurved umbo; cardinal area arched and delthyrium open. Brachial valve with long, narrow cardinal process, crural plates long, parallel, erect; four well defined adductor scars present near the anterior margin. Devonic–Carbonic.

385. **A. præumbona** Hall. (Fig. 438, *a–b*.) Devonic.

Hinge line less than the greatest width of shell, with rounded cardinal extremities. Pedicle valve very ventricose, bearing a shallow impressed median line. Brachial valve slightly convex. Surface marked only by concentric striæ which are sometimes crowded into imbricating folds.

Hamilton of New York.

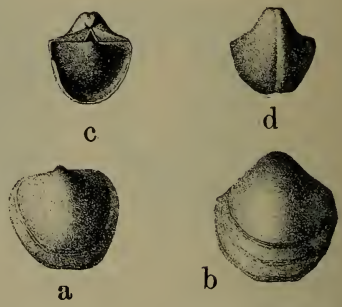


FIG. 438. *a–b*, *Ambocœlia præumbona*; *c–d*, *Ambocœlia umbonata* (Pal N. Y. IV.).

386. **A. umbonata** (Conrad). (Fig 438, *c–d.*) Devonic.

Differs from *A. præumbona* in its smaller size, distinct though narrow mesial sinus and proportionally longer hinge line which here usually forms the greatest width of the shell.

Marcellus–Chemung of New York, Pennsylvania, Kentucky, Indiana.

387. **A. nana** Grabau. (Fig. 439.) Devonic.

Small, transverse. Brachial valve convex, bearing a shallow mesial depression. Surface covered with numerous elongated pits.

Marcellus and Hamilton of New York.

FIG. 439. *Ambocœlia nana.* (After Grabau), enlarged, × 2.

FIG. 440. *Ambocœlia planoconvexa* × 2 (Ind. Geol. Survey.)

388. **A. planoconvexa** (Shumard). (Fig. 440.) Carbonic.

Breadth and length about equal. Brachial valve circular except for its truncation by the hinge line and nearly flat, with minute beak and narrow cardinal area. Pedicle valve convex; mesial sinus represented by a slight flattening in front. Surface seen to be finely granulose under a lens.

Widely distributed throughout North America. Conemaugh of Pennsylvania, Ohio and West Virginia.

CVIII. METAPLASIA Hall and Clarke.

Spiriferoid but differing from *Spirifer* in the reversal of sinus and fold, *i. e.*, the pedicle valve bears the median fold and the brachial the median sinus. The teeth are supported by lamellæ, the muscular impressions of the pedicle valve are separated by a short, thick septum and the cardinal process is strong and bilobed. Devonic.

389. **M. pyxidata** Hall. Devonic.

Small. Pedicle valve with a strong, broad elevation, furrowed by a narrow sinus down the middle. Brachial valve flat and marked by a broad depression in the center of which is a narrow elevation. Surface when perfectly preserved both concentrically and longitudinally striated.

Oriskany of New York, Maryland, Ontario.

CIX. Rhynchospira Hall.

Rostrate, subtriangular. Hinge line short and curved. Umbo of pedicle valve incurved; apex truncated by circular foramen. Deltidial plates coalesced; teeth small, not supported by dental plates. In brachial valve hinge plate produced anteriorly into two flat lobes. Median septum short and sometimes obscure. Surface bearing simple radial plications. Shell punctate. Siluric–Mississippic.

390. **R. formosa** Hall. Devonic.

Pedicle valve tapering toward the beak, which is prominent and arched. Brachial valve gibbous, with closely incurved beak. Surface marked by 18 to 23 simple plications, two or three of which are smaller and slightly depressed on the middle of each valve; these are crossed by fine concentric growth lines which become strongly lamellose anteriorly.

Helderbergian of Maine, New York, Ohio.

Fig. 441. *Homœospira evax* × 2. (After Hall.)

Fig. 442. *Hustedia mormoni* (Ind. Geol. Survey).

CX. Homœospira Hall and Clarke.

Like *Rhynchospira* but in the brachial valve the crural plates are separated by a linear cardinal process, and a high median septum is present, while the deltidial plates frequently remain uncoalesced; shell punctate. Siluric.

391. **H. (Retzia) evax** Hall. (Fig. 441.) Siluric.

Ovate, usually longer than wide, gibbous. Both valves sometimes bearing a shallow sinus anteriorly. Pedicle valve the deeper, with greatly elevated and incurved umbo. Foramen circular. Surface marked by 16 to 28 radiating plications crossed by fine striæ and imbricating, lamellose growth lines.

Niagaran of Tennessee, Indiana.

CXI. Hustedia Hall and Clarke.

Differs externally from *Rhynchospira* only in its much coarser plications. Internally it differs in the structure of the hinge plate and in the presence of a split and weak tube attached by one side to the deltidial plates. Carbonic.

392. **H. mormoni** (Marcou). (Fig. 442.) Carbonic.

Both valves more or less gibbous. Umbo prominent and arched. Surface marked by 14 to 17 simple radiating ribs.

Widely distributed throughout central and western United States.

CXII. Trematospira Hall.

Spiriferoid, transverse with nearly equally convex valves. Hinge line straight with abruptly rounded cardinal extremities. Surface plicate. Pedicle valve with median sinus; beak truncated by a circular foramen; delthyrium covered by two short plates resting upon the umbo of the opposite valve. Teeth prominent. Brachial valve with a median fold and with small and deep dental sockets. Cardinal process very prominent and elevated, divided into four parts by a deep longitudinal and a less prominent transverse groove. Distinguished externally from *Rhynchonella* and *Spirifer* by its punctate structure. Siluric–Devonic.

Fig. 443. *Trematospira camura* (Pal. N. Y., II.).

393. **T. camura** Hall. (Fig. 443.) Siluric.

Small, transversely elliptical to subrhomboidal. Valves almost equally convex. Sinus of pedicle valve marked by one or two small plications which die out toward the beak. Fold of brachial valve with two small plications which likewise become obsolete toward the beak. Surface marked by four to six plications on each side the median line and by concentric growth lines.

Niagaran of New York.

394. **T. multistriata** Hall. Devonic.

Brachial valve the more convex. Surface granulose or punctate, marked by many fine radial striæ and by concentric growth lamellæ.

Helderbergian of New York.

CXIII. Parazyga Hall and Clarke.

Differs from *Trematospira* externally only in the usually smaller and simple plications and in the surface covering of very fine and short spines; these are usually broken off, leaving only their bases. Internally it has a weak deltidial tube similar to that in *Hustedia*. Cardinal process low, bi-lobed; dental sockets broad. Devonic.

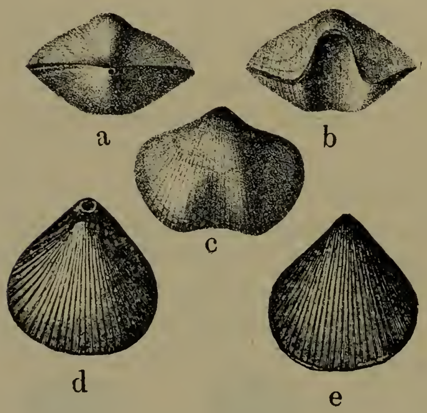


Fig. 444. *a–c*, *Parazyga hirsuta* (Pal. N. Y., II); *d–e*, *Eumetria marcyi* (Ind. Geol. Surv.).

395. **P. hirsuta** Hall. (Fig. 444, *a–c*.) Devonic.

Depressed orbicular. Pedicle valve curving regularly to the apex where it is terminated by a circular foramen. Surface marked with 30 to 40 low striæ which are most conspicuous towards the margin; these are crossed by fine concentric growth lines and more distant lamellæ. Shell punctate.

Onondaga and Hamilton of New York, Kentucky, Indiana, Ontario.

CXIV. Eumetria Hall.

Differs from *Rhynchospira* (No. CIX) merely in the greater complication of the parts of the hinge plate and in the variation in the form of the loop. Punctate. Mississippic to Carbonic.

396. **E. marcyi** (Shumard). (Fig. 444, *d–e*.) Mississippic.

Longitudinally ovate, almost equally biconvex. Beak of pedicle valve elevated and incurved and with a circular foramen. Surface marked by about 50 rounded, punctate striæ.

St. Louis and Kaskaskia of Tennessee, Missouri, Arkansas, Indiana, Iowa, Illinois.

CXV. Whitfieldella Hall and Clarke.

Small, ovate or elongate, subequally biconvex. Beak of pedicle valve not high. Cardinal slopes of both valves broad and not distinctly defined. Anterior margin subtruncate. Median septum present in brachial valve. Surface smooth. Siluric–Devonic.

397. **W. cylindrica** Hall. (Fig. 445.) Siluric.

Elongate-cylindrical. Width and thickness nearly equal. Beak of pedicle valve strongly overarching. Faint mesial depression present in pedicle valve. Surface marked with fine radiating striæ near the front.

Clinton–Niagaran of New York, Ohio, Ontario, Anticosti.

Fig. 445. *Whitfieldella cylindrica* (Pal. N. Y., IV.).

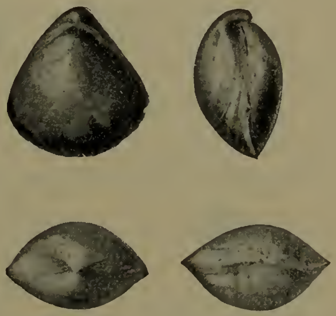


Fig. 446. *Whitfieldella intermedia* (Pal. N. Y., II.).

398. **W. intermedia** Hall. (Fig. 446.) Siluric.

Obovate, rapidly expanding toward the front which is abruptly rounded. Length and width nearly equal. Faint lines of growth on surface.

Clinton and Niagaran of New York, Pennsylvania, Ontario.

Fig. 447. *Whitfieldella nitida* (Pal. N. Y., II.).

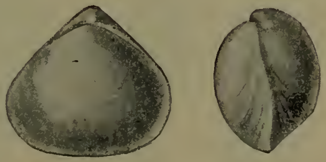


Fig. 448. *Whitfieldella nitida* var. *oblata* (Pal. N. Y., II.).

399. **W. nitida** Hall. (Figs. 447–448.) Siluric.

Varies from broadly to narrowly ovate. Valves strongly and equally convex. Beak of pedicle valve pointed and incurved. Surface smooth except for concentric growth lines which are at times strongly marked. Often a slight sinus occurs near the front in both valves, producing a slight frontal emargination.

Niagaran of New York, Kentucky, Indiana, Ontario, Anticosti.

400. **W. ? nucleolata** (Hall). (Fig. 449.) Siluric.

Beak of pedicle valve pointed and incurved. Front of shell indented. Surface with concentric growth lines. This species is less elongate than *W. nitida* and the frontal indentation is more conspicuous.

Cobleskill of New York, Wisconsin.

401. **W. sulcata** (Vanuxem). (Fig. 450.) Siluric.

Distinguished by its elongate form, strongly ventricose character and well marked mesial sinus in the pedicle valve.

Cobleskill and Manlius of New York.

FIG. 449 *Whitfield-ella nucleolata* (Pal. N. Y., II.).

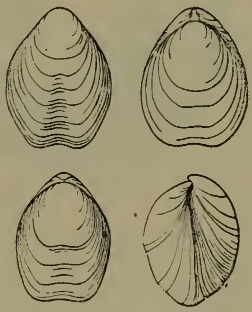


FIG. 450. *Whitfieldella sulcata*. (After Grabau.)

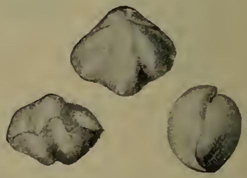


FIG. 451. *Hyattella congesta* (Pal. N. Y., II.).

CXVI. HYATTELLA Hall and Clarke.

Small, nearly five-sided. Valves subequally convex. Differs from *Whitfieldella* in the form and in the absence of a median septum in the brachial valve. Siluric.

FIG. 452. *Hyattella congesta* (Pal. N. Y., II.).

402. **H. congesta** (Conrad). (Figs. 451–452.) Siluric.

Gibbous. Pedicle valve strongly convex with a deep median furrow which deepens and widens toward the front. Strong fold on brachial valve with a more or less prominent lateral fold on each side.

Clinton of New York, Pennsylvania, Ohio, Kentucky, Ontario.

CXVII. Nucleospira Hall.

Small, subcircular, gibbous. Hinge line short. Valves nearly equal. Beak of pedicle valve slightly extended beyond that of opposite valve. Brachial valve with a large, hook-like cardinal process curved sharply posteriorly. Crura long and straight. A

Fig. 453. *Nucleospira pisiformis.* (After Hall.)

conspicuous median septum extends from beak to front in each valve. Surface in perfect specimens covered with numerous slender spines; these are usually worn off.

Siluric–Lower Carbonic.

403. **N. pisiformis** Hall. (Fig. 453.) Siluric.

Small. Each valve bears a slight depression down the center. Surface marked with fine concentric striæ.

Niagaran of New York, Kentucky, Indiana, Missouri.

404. **N. concinna** Hall. (Fig. 454.) Devonic.

Depressed spheroidal. Surface smooth, very finely papillose or when perfect covered with very fine spines.

Onondaga–Hamilton of New York, Pennsylvania, Virginia, Ohio, Kentucky, Indiana, Nevada, Ontario.

Fig. 454. *Nucleospira concinna* (Pal. N. Y., IV.).

CXVIII. Anoplotheca Sandberger (emend. Hall and Clarke).

Pedicle valve convex, with incurved umbo. Brachial valve concave or flat, more rarely convex, with a high median septum. No cardinal area. Plications few, crossed by fine concentric growth lines, making the surface rough. Siluric–Devonic.

A. Shell large, over ½ inch wide......408. *A. flabellites.*
B. Shell small, much less than ½ inch wide...... *.
  * Brachial valve concave......407. *A. concava.*
  * Brachial valve flat or convex...... 1.
    1. Hinge line straight......405. *A. hemispherica.*
    1. Hinge line curved......406. *A. plicatula.*

405. **A. (Cœlospira) hemispherica** (Sowerby). (Fig. 455.) Siluric.

Hemispheric. Brachial valve flat. Hinge line nearly straight. Surface marked by 8 to 12 or more rounded, simple plications which are crossed by strong concentric growth lines.

Clinton of New York, Kentucky, Tennessee, Georgia, Alabama, Nova Scotia, Anticosti.

406. **A. plicatula** (Hall). (Fig. 456.) Siluric.

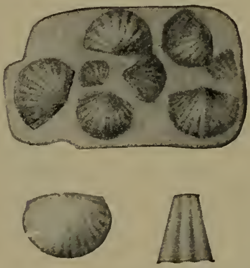


FIG. 455. *Anoplotheca hemispherica* with striæ enlarged (Pal. N. Y., II.).

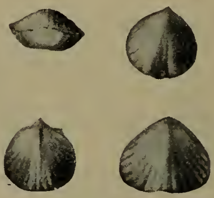


FIG. 456. *Anoplotheca plicatula* (Pal. N. Y., II.).

Small, ovate. Valves subequal. Pedicle valve slightly carinate at umbo, with a slight median sinus anteriorly. Brachial valve almost flat toward the beak and elevated into a median fold anteriorly. Surface with two plications in sinus and three on fold with six to eight on each side. Concentric striæ not conspicuous.

Clinton of New York and Niagara of Wisconsin.

407. **A. concava** (Hall). Devonic.

Pedicle valve convex. Brachial valve flattened near lateral margins and at times depressed in the middle due to the rapidly widening sinus. Surface marked by rounded striæ; the one on the

FIG. 457. *Anoplotheca* (*Leptocœlia*) *flabellites* (Pal. N. Y., IV.).

mesial fold is generally smaller than the others giving the fold a slightly grooved appearance along its center quite to the beak.

Helderbergian of New York, and of Kennedy channel in Arctic region.

408. **A. (Leptocœlia) flabellites** (Conrad). (Fig. 457.) Devonic.

Pedicle valve convex, most prominently along the middle. Brachial valve flat. Sinus of brachial valve and fold of pedicle

Fig. 458. *Vitulina pustulosa* (Pal. N. Y., IV.).

valve quite indistinct. Shell much larger and striæ less numerous than in *A. concava.*

Oriskany and Onondaga of New York, Maryland, Illinois, Ontario, Quebec.

CXIX. Vitulina Hall.

Small. Pedicle valve usually convex and brachial flat. Hinge line forming the greatest diameter of shell. Pedicle opening large and triangular. Cardinal process simple. Devonic.

409. **V. pustulosa** Hall. (Fig. 458.) Devonic.

On pedicle valve an elevated fold present with depression in its center; on brachial valve a sinus with a corresponding fold in the center. Surface marked with a few coarse rounded plications. Interrupted radiating lines give the shell a pustulose appearance.

Hamilton of New York, Pennsylvania.

CXX. Meristina Hall.

Like *Meristella* externally, differing merely in the character of the loop connecting the spirals. Siluric.

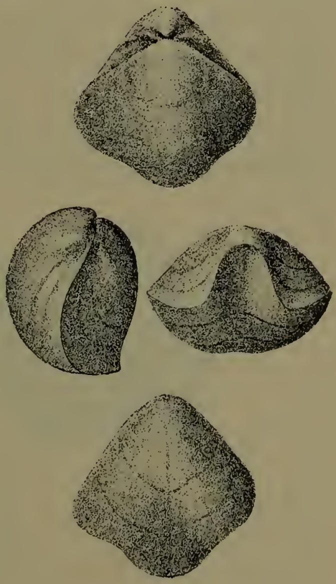


Fig. 459. *Meristina maria.* (After Nettelroth.)

410. **M. maria** Hall. (Fig. 459.) Siluric.

Subquadrangular, gibbous, subequally biconvex. Beaks closely incurved. Pedicle valve with a broad sinus anteriorly and brachial valve with a corresponding fold. Surface marked merely with concentric growth lines. Length equalling or greater than the width.

Niagaran of Ohio, Tennessee, Kentucky, Indiana, Illinois, Wisconsin.

CXXI. Athyris McCoy (emend. Hall and Clarke).

Subequally biconvex, varying in outline from subcircular to transversely elliptical. Beak of pedicle valve incurved, perforated by a round foramen which encroaches upon the umbo. Surface medially sinuate. Teeth prominent and recurved at the tips, supported by stout dental lamellæ. Brachial valve with broad and deep dental sockets and strong hinge plate; the large muscular areas well defined. Spirals laterally directed, with a large saddle shaped jugum, the anterior portion of which divides, each branch uniting again with the primary lamella.

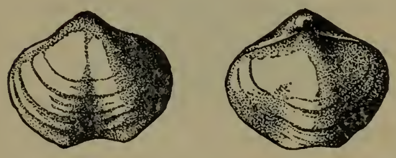


Fig. 460. *Athyris fultonensis* (Ind. Geol. Survey).

Siluric–Mississippic.

411. **A. fultonensis** (Swallow). (Fig. 460.) Devonic.

Differs from *A. angelica* in its subquadrate form and somewhat

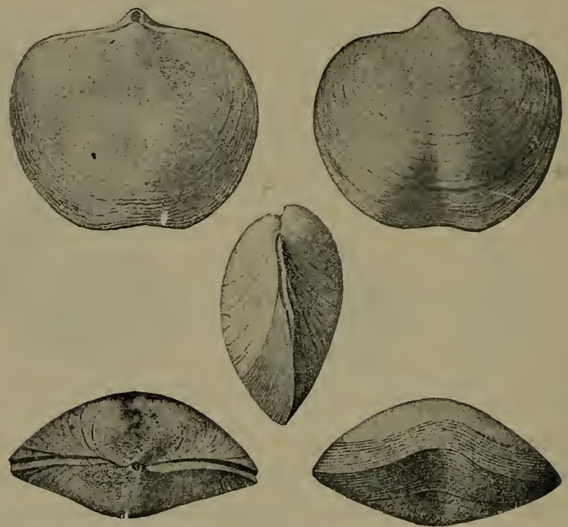


Fig. 461. *Athyris spiriferoides* (Pal. N. Y., IV.).

less prominent beak; from *A. spiriferoides* in its smaller size, the regularity of its lines of growth and the more prominent umbo.

Onondaga and Hamilton of Kentucky, Indiana, Michigan, Missouri, Iowa, Manitoba.

412. **A. spiriferoides** (Eaton). (Fig. 461.) Devonic.

Robust. Front indented by a deep sinus. Surface marked by coarse irregular concentric lamellæ.

Onondaga and Hamilton of New York, Pennsylvania, Maryland, Virginia, Ontario.

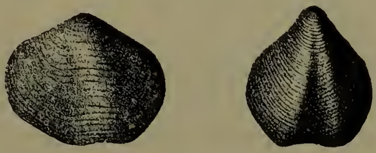


FIG. 462. *Athyris angelica* (Pal. N. Y., IV.).

413. **A. angelica** Hall. (Fig. 462.) Devonic.

Gibbous, deeply sinuate, with short hinge line and very prominent beak. Surface marked by regular, equidistant lamellæ.

Chemung of New York, Pennsylvania, Nevada.

414. **A. lamellosa** (L'Eveillé). (Fig. 463.) Lower Carbonic.

Length about two thirds of width. Hinge line long, nearly straight, and rounded at extremities. Anterior margin usually produced and subangular in the middle at the termination of the mesial fold and sinus. Brachial valve slightly the more convex and

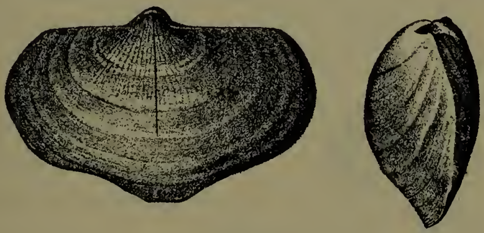


FIG. 463. *Athyris lamellosa* (Pal. Ohio).

rising into a low, rounded mesial fold. Pedicle valve with shallow mesial sinus. Surface of both valves with 8 or 10 strongly projecting lamellæ. Differs from other species in its transversely elliptical form.

Waverly–Keokuk of Ohio, Kentucky, Indiana, New Mexico.

CXXII. Cliothyris King.

Differs from *Athyris* in the surface ornamentation which here consists of concentric rows of flat spinules and also in the spirals and loop. Mississippic–Permic.

415. **C. roissyi** (L'Eveillé). Mississippic.

Differs from *C. hirsuta* in the unequal convexity of the valves, the brachial valve being regularly convex while the pedicle valve is convex above (near beak), but below is depressed and often flattened. It differs also in the scarcely incurved beak of the pedicle valve and in the character of the surface.

Keokuk–Kaskaskia of Mississippi Valley and western United States.

416. **C. hirsuta** Hall. (Fig. 464.) Mississippic.

Nearly equally biconvex. Beak of pedicle valve prominent and incurving over that of brachial valve. Surface marked by concentric imbricating lamellæ on which rise rows of minute spines.

FIG. 464. *Cliothyris hirsuta* (Ind. Geol. Survey).

Sinus and fold absent, being represented merely by a slight depression in the front of the pedicle valve.

St. Louis and Kaskaskia of Kentucky, Indiana, Illinois, Montana.

CXXIII. SEMINULA McCoy (emend. Hall and Clarke).

Small. Differs from *Athyris* in the presence of a median sinus on the pedicle valve and a fold on the brachial with often an obscure fold on each side on both valves. Surface of valves smooth, never lamellose. Mississippic-Carbonic.

FIG. 465. *Seminula trinucleus* (Ind. Geol. Survey).

417. **S. subquadrata** Hall. Mississippic.

Subquadrate with length and breadth nearly equal. Brachial valve slightly the more convex and bearing a broad, mesial fold. Sinus of pedicle valve broad and deep and produced anteriorly. Surface marked concentrically with fine growth lines and toward the margin by strong lamellæ.

Kaskaskia of Ohio, Kentucky, Illinois, Utah.

418. **S. trinucleus** Hall. (Fig. 465.) Mississippic.

Differs from the preceding in having a depression in the center of the fold, and in the pronounced margins of the sinus, which sometimes form distinct ribs near the front.

St. Louis of Indiana, Illinois, Missouri and Kentucky.

419. **S. argentea** (Shepard) (*S. subtilita* Hall). (Fig. 466.) Carbonic.

Subovate, usually longer than wide, moderately gibbous. Pedicle valve slightly more convex than the brachial with prominent beak; mesial sinus becoming obsolete about the middle of the

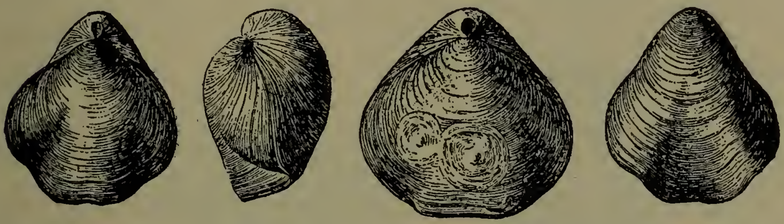


FIG. 466. *Seminula argentea*, one specimen with *Crania modesta* (No. 61) attached (Ind. Geol. Survey).

shell; a more or less distinctly impressed line usually extends along the bottom of this sinus from beak to front. Brachial valve with ill defined mesial fold. Surface marked with concentric striæ and faint traces of radiating lines. Average length about 1 inch.

Throughout the Upper Carbonic of North America.

420. **S. dawsoni** Hall and Clarke. (Fig. 467.) Carbonic.

Smaller and more triangular than preceding, with fold and sinus scarcely defined. Greatest width in anterior third of shell.

Windsor limestone of Nova Scotia — extremely abundant.

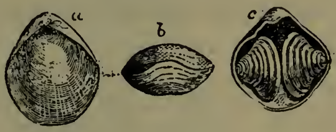


FIG. 467. *Seminula dawsoni.* (After Dawson.)

CXXIV. MERISTELLA Hall.

Oval to suborbicular. Valves unequally convex, with or without a faint median sinus or fold. Umbo of pedicle valve greatly incurved at maturity so as to conceal the open delthyrium. No cardinal area or spondylium present. Surface smooth or with fine concentric lines and very fine radiating striæ. Brachial valve with a strong cardinal process from whose base extends a thin longitudinal septum half way down the valve. Muscular area broadly ovate. Devonic.

A. Width exceeding length ..... *.
  * Median sinus in both valves ..... 421. *M. bella.*
  * Median sinus in pedicle valve only ..... 424. *M. arcuata.*
B. Length exceeding width ..... **.
  ** Anterior margin truncate ..... 1.
    1. Small. Beak of pedicle valve extended ..... 426. *M. barrisi.*
    1. Large. Beak of pedicle valve closely incurved ..... 422. *M. lævis.*
  ** Anterior margin more or less prolonged into a linguiform extension ..... 2.
    2. Greatest width of shell anterior to middle. Sinus in pedicle valve. 423. *M. princeps.*
    2. Greatest width of shell near middle. No sinus in pedicle valve. 425. *M. nasuta.*

421. **M. bella** (Hall). Devonic.

Valves of nearly equal convexity and both marked by a narrow mesial sinus which in meeting give the front an emarginate character.

Helderbergian of New York, Ohio, New Brunswick.

422. **M. lævis** (Vanuxem). (Fig. 468.) Devonic.

Ovate, gibbous. Somewhat resembles *M. bella* but differs in its

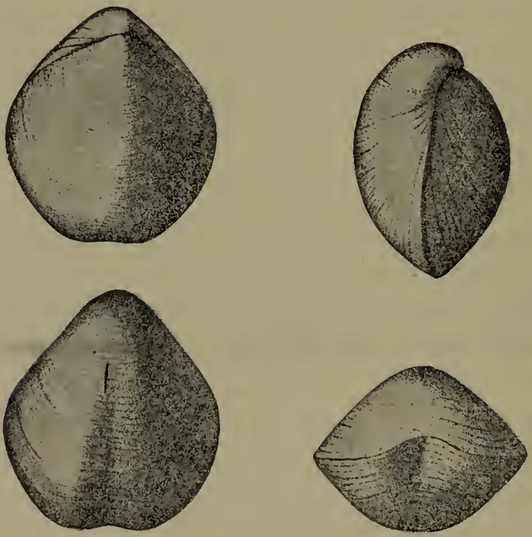


FIG. 468. *Meristella lævis* (Pal. N. Y., III.).

greater length proportionally and in the absence of a sinus on the brachial valve.

Helderbergian of Maine, New York, Pennsylvania, Ohio, Missouri, New Brunswick.

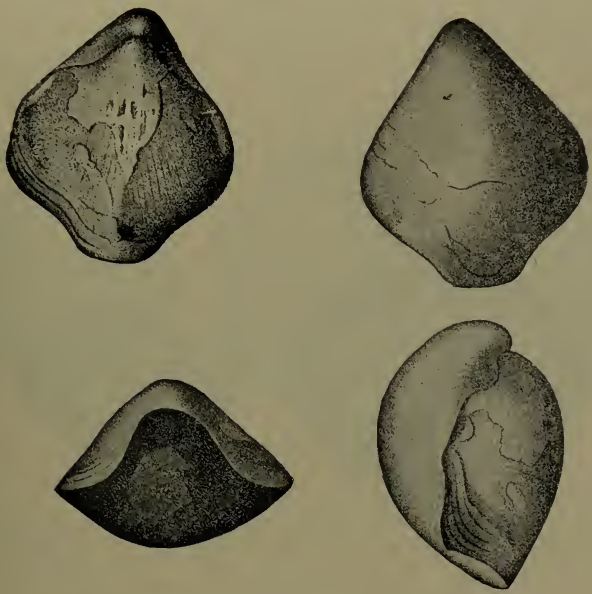


FIG. 469. *Meristella princeps* (Pal. N. Y., III.)

FIG. 470. *Meristella arcuata* (Pal. N. Y., III.).

423. **M. princeps** Hall. (Fig. 469.) Devonic.

Large, ovate, ventricose. Pedicle valve depressed anteriorly into a broad mesial sinus, terminating in old specimens in a linguiform extension. Brachial valve greatly elevated in the middle, producing a strong mesial elevation anteriorly. Distinguished from *M. nasuta* in its greater width being anterior to the middle and in the presence of a sinus in the pedicle valve.

Helderbergian of New York, New Brunswick.

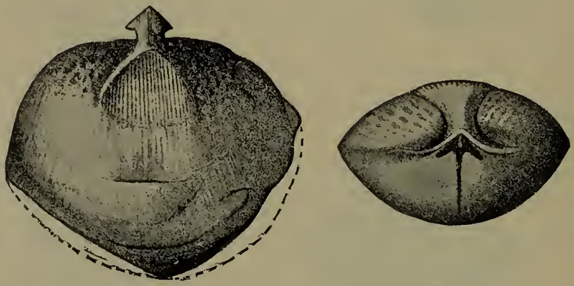


FIG. 471. *Meristella arcuata*, internal mold (Pal. N. Y., III.).

424. **M. arcuata** Hall. (Figs. 470, 471.) Devonic.

Broadly ovate to transversely oval. Pedicle valve bearing anteriorly a shallow depression. Brachial valve gibbous along the middle. Surface smooth except for a few faint radiating and concentric lines.

Helderbergian of New York and New Brunswick.

FIG. 472. *Meristella nasuta*, Schoharie form (Pal. N. Y., IV.).

425. **M. nasuta** (Conrad). (Figs. 472 and 473.) Devonic.
Subrhomboidal with greatest width near the middle. Pedicle valve gibbous with prominent beak. Anterior margin marked by a nasute extension. Brachial valve moderately convex and abruptly elevated toward the front into a short, rounded fold. Beak moderately incurved.

FIG. 473. *Meristella nasuta*, Onondaga form (Pal. N. Y., IV.).

Schoharie and Onondaga of New York, Ohio, Kentucky, Indiana, Nevada, Ontario.

426. **M. barrisi** Hall. (Fig. 474.) Devonic.
Ovoid, more or less elongate, sinuate anteriorly. Pedicle valve depressed toward the front, with beak arching and not closely incurved. Brachial valve abruptly elevated near the anterior margin. Surface smooth or concentrically striated.
Marcellus and Hamilton of New York. Also in Russian Urals.

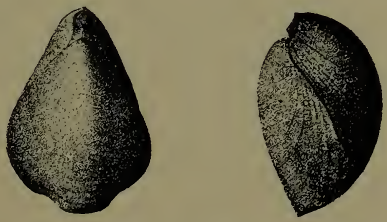


FIG. 474. *Meristella barrisi* (Pal. N. Y., IV.).

CXXV. PENTAGONIA Cozzens.

Pedicle valve with a very broad median sinus outside of which the lateral slopes are very abrupt. Muscular impressions like

Meristella. Hinge plate rises vertically from the bottom of the pedicle valve; its anterior face bears a low, median plication on each side of which posteriorly rise the two short crura. The posterior face of the hinge plate bears a deep concavity. Devonic.

427. **P. unisulcata** (Conrad). (Fig. 475.) Devonic.

Subtrigonal, wider in front. Median sinus of pedicle valve occupying nearly the whole width of the valve and bounded on each side by an angular fold; umbo prominent and incurved over that of brachial valve. Brachial valve gibbous in middle, the prominent mesial fold marked by a sinus extending to the beak. Surface bearing a few concentric growth lines and rarely concentric folds.

Oriskany–Hamilton of New York, Ohio, Kentucky and Ontario.

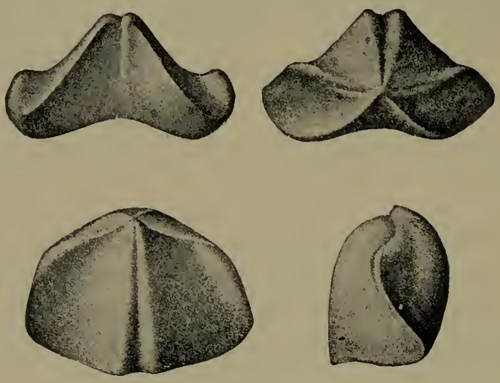


FIG. 475. *Pentagonia unisulcata* (Pal. N. Y., IV.)

Phylum V. MOLLUSCA.

Class **Pelecypoda.** Goldfuss.

(*Lamellibranchiata.* Blainville.)

The Pelecypoda or *Lamellibranchiata* are marine or fresh-water molluscs, with a bivalve shell. The valves are complementary, and are in the majority of species of nearly similar outline and size. In each valve may be distinguished an initial point, or beak, around which the concentric *lines of growth* mark the successive additions of shelly matter.

The orientation of most shells is effected by holding them with the *hinge line* uppermost and the beaks pointing away from the observer. Thus placed, the upper border is the dorsal and the lower the ventral border. The end farthest away from the observer is the anterior end; that nearest, the posterior end. The valves are designated as the right and left valves, respectively. The articulation of the valves is commonly effected by the interlocking of *teeth* which are borne on the hinge or cardinal margin of the valves. They are very various, and not infrequently placed upon a *hinge plate.* In primitive species, and in some specialized types, the teeth may form a continuous row of nearly uniform protuberances and pits (*taxodont dentition*) as in *Arca*, *Ctenodonta*, etc. The specialized type of tooth structure consists of a series (3 or less) of short and stout *cardinal* (starting at the beak) and (2 or less) long, slender, *lateral* (not reaching the beak) teeth placed upon a hinge plate (diogenodont — *Crassatellites*, etc.) and in the most specialized cases with additional structures, such as a roughened area (*Venus*), accessory lamellæ, extra cardinals (*Mactra*), etc. (teleodont type of dentition). Other types of dentition are: coarse, variable, amorphous teeth (schizodont — *Unio*); special curving and interlocking teeth derived from the shell below the beak (isodont — *Spondylus*, and partly developed in *Pecten*); strongly curving teeth from under the beak, without hinge plate (cyclodont — *Cardium*, etc.); variously developed hinge structure from exterior ornamentation (dysodont) and finally, absence of teeth (anodont — *Anodonta*).

The opening of the valve is brought about by an external elastic *ligament* stretched across the hinge line from valve to valve, or by an internal *cartilage* or *resilium*. The ligament may extend on both sides of the beak (*amphidetic* — *Glycimeris*) or be only behind the beak (*opisthodetic* — *Venus*). In the amphidetic type, a flattened area is often developed under the beaks. This may separate into a posterior *escutcheon* carrying the ligament as in the Teleodonta, and into an anterior *lunule*. The ligament may consist of a single elastic strand stretched across from beak to beak (*alivincular* — *Lima*), or there may be many such (*multivincular* — *Perna*, *Arca*, etc.), or it may consist of a split cylinder in the form of a C spring (*parivincular* — *Tellina*, *Venus*). The internal cartilage or resilium may be lodged in *cartilage pits* or *resilifers* (also called chondrophore) (*Mactra*) or supported by variously formed calcareous pieces (*lithodesma*). The closing of the valves is produced by the contraction of closing or *adductor muscles*.

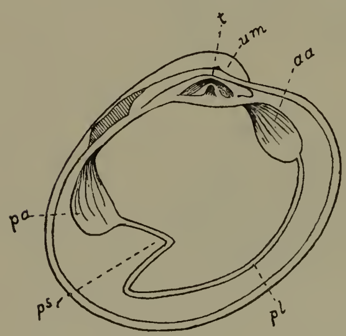


FIG. 476. Diagrammatic view of left valve of *Cytherea*; (*a.a.*) anterior adductor scar; (*p.a.*) posterior adductor scar; (*p.l.*) pallial line; (*p.s.*) pallial sinus; (*l.*) ligament; (*t.*) teeth; (*um.*) umbo or beak. (After Lang, adapted.)

The scars marking the attachment of the adductor or closing muscle, or muscles, vary greatly, and are frequently preserved in the fossil forms. When two are present they are designated respectively as the anterior and posterior adductor scars. The line of attachment of the fleshy mantle which builds the shells, *i. e.*, the *pallial line*, is often visible. Near the posterior end it frequently makes a reëntrant curve — the *pallial sinus* — indicating that the animal had a retractile siphon. The various parts described are indicated in Fig. 476.

The principal soft parts of the animal comprise: the *mantle*, consisting of two fleshy folds, one lining each valve, and building it; the *abdomen*, with the anteriorly placed *mouth*, and the anteroventral *foot*; the *gills* or *branchiæ*, which consist of complicated lamellæ hanging on either side of the abdomen in the mantle cavity; and the *siphons* — present only in certain forms — posteriorly placed, often capable of great extension, and serving, the one for the entrance of the water and food particles, and the other for the exit of the water and waste products.

In the development of the shell a primitive nuclear portion or *prodissoconch* is always present, though not always recognizable. In the majority of forms it has the general characters of a nuculoid pelecypod with a taxodont hinge structure or *provinculum.* This is later replaced by the true dentition, of which the taxodont type retains the primitive character of the provinculum. The inference from this is, that the pelecypod, ancestral to the types with a prodissoconch as described, must have had in general, characters similar in its adult stage to those of the prodissoconch.

In their early stages marine pelecypods like brachiopods are free-swimming meroplanktonic larvæ, which at certain seasons swarm in the pelagic district, and are thus widely distributed. Fresh and brackish waters also abound in pelecypods, but on the whole the number of species is relatively small.

In time, pelecypods are distributed from the Cambric, where they are rare, to the present, where they appear to have reached their acme of development, though many of their most bizarre types were developed in the Comanchic and Cretacic.

Three orders are generally recognized, Prionodesmacea, Anomalodesmacea and Teleodesmacea; under the aberrant division of Palæoconcha, which is probably not a natural group, are united many primitive and perhaps degenerate types.

Literature.

Refer also to General References, p. 7.

Descriptive Literature.—Selected Works.

1847–1885. **Hall, James.** Pal. N. Y., vols. 1–5. (Vol. 5 is exceedingly important for discussion of middle and upper Devonic pelecypods.)

1864–1869. **Gabb, W. M.** Geol. Surv. California, Pal. 1 and 2.

1873–1893. **Hall, Whitfield, Meek, Ulrich.** Pal. Ohio, 1, 2, Geol. vol. 7.

1876. **Meek, F. B.** U. S. Geol. Surv. Terr. 9 (Cretacic). Invaluable for its discussion of Cretacic genera and species.

1884. **White, C. A. and Heilprin, A.** U. S. G. S. Ann. 4 (Fossil Ostreidæ of North America).

1886 and 1907. **Whitfield, R. P. and Weller, S.** Pal. N. J., 1, 3, 4 (Paleozoic to Tertiary). Also Mon. U. S. Geol. Surv., IX. and XXIV.

1889. **Dall, W. H.** Bull. U. S. Nat. Mus. 37 (geologic distribution of recent species of southeastern coast of North America).

1893. **Stanton, T. W.** Bull. U. S. Geol. Surv. 106 (Colorado Formation).

1893. **Cragin, F. W.** Fourth Ann. Rep. Geol. Surv. Tex. (Cretacic).

1895–1903. **Dall, W. H.** Trans. Wagner Free Inst. Sci., vol. 3, parts 3–6 (Tertiary). This exceedingly valuable work revises the classification of the pelecypoda and gives a critical discussion of most of the later genera and many species. It is indispensable to the student of Pelecypoda.

1895 **to date.** Inst. Geol. Mexico Boletin.

1895. **Stanton, T. W.** Bull. U. S. Geol. Surv. 133 (Knoxville of California).

1896–1897. **Harris, G. D.** Bull. Am. Pal. 4, 9 (Eocenic [Midwayan and Lignitic] of Gulf region).

1897. **Ulrich, E. O.** Geol. Surv. Minn. 3, part 2. (A most important discussion of the Ordovicic pelecypods throughout the middle west. Especially good for generic descriptions.)

1898. **Hill and Vaughan.** Bull. U. S. Geol. Surv. 151 (Lower Cretacic Gryphæas of the Texas region).

1900. **Beede, J. W.** Univ. Geol. Surv. Kansas 6, part 2 (Carbonic).

1903. **Clarke, J. M.** Naples Fauna. Mem. 6, N. Y. State Mus.

1901–1906. **Clark, Martin, Glenn.** Md. Geol. Surv. (Eocenic-Pleistocenic).

1906. **Arnold, Ralph.** Prof. paper U. S. Geol. Surv. 47 (Cenozoic Pectens of California).

(See also references under Faunal summary.)

Artificial Key to the Genera.

A. Distinct hinge-plate absent; also hinge margin usually thin and without teeth; when teeth are present they are merely modifications of the hinge margin and not set upon a hinge plate. Two subequal adductor scars .... I.

I. Pallial sinus absent; also pallial line usually obscure. Almost confined to the Palæozoic .... 1.

1. Beaks very anterior .... *a.*

a. Shell transversely elongate; hinge and basal margins subparallel .... 11.

11. Shell moderately elongate; umbonal ridge slight .... *aa.*

aa. Anterior end vertically subtruncate from edge of beak. VII. *Cuneamya.*

aa. Anterior end projecting forward from beak .... †.

†. Beaks very prominent and incurved .... *.

*. Hinge margin thin .... XV. *Cardiomorpha.*

*. Hinge margin thickened .... X. *Grammysia.*

†. Beaks not prominent .... **.

**. A broad sinus present basally anterior to umbonal ridge. *1''.*

1''. Shell higher posteriorly than anteriorly..............*a''*.

a''. Umbonal ridge obsolete..............II. *Clinopistha*.

a''. Umbonal ridge present ....IX. *Orthodesma*.

1''. Shell width subequal posteriorly and anteriorly. XIII. *Palæanatina*.

**. No sinus anterior to umbonal ridge........................2''.

2''. Shell broadly oval......................................*b''*.

b''. Depression posterior to umbonal ridge. XII. *Saffordia*.

b''. No depression posterior to umbonal ridge......1'''.

1'''. A narrow ridge present behind the beaks. XIX. *Edmondia*.

1'''. Ridge absent.......................XX. *Fordilla*.

2''. Shell narrowly oval.....................................*c''*.

c''. Umbonal ridge noticeable only above, near the hinge...................................XI. *Glossites*.

c''. Umbonal ridge as inconspicuous above as below. 2'''.

2'''. Posterior adductor scar three times size of anterior ....XVII. *Psiloconcha*.

2'''. Adductor scars subequal........III. *Phthonia*.

11. Shell very long and narrow..*bb*.

bb. Posterior umbonal slope with different sculpture from rest of shell. VI. *Orthonota*.

bb. Posterior umbonal slope not differently sculptured...............††.

††. Antero-basal end of shell notched.................V. *Prothyris*.

††. Antero-basal end without notch............IV. *Sanguinolites*.

a. Shell subcircular, with radial sculpture and prominent, incurved beaks. XVI. *Cardiopsis*.

1. Beaks subcentral ....*b*.

b. Shell transversely elongate ....22.

22. Surface radially sculptured...*cc*.

cc. Umbonal slope conspicuous ....XIV. *Tellinopsis*.

cc. Umbonal slope very inconspicuous....... ....I. *Solemya*.

22. Surface without radial ribs or striæ......................................*dd*.

dd. Shell abruptly attenuate posteriorly ....CXXX. *Cuspidaria*.

dd. Shell not attenuate posteriorly.................................†††.

†††. Beaks very strongly incurved ....X. *Grammysia*.

†††. Beaks not prominently incurved.............................***.

***. Furrow extending from beak to posterior basal margin. VIII. *Ilionia*.

***. Shell lacking posterior furrow...........XIX. *Edmondia*.

b. Shell sub-circular or vertically elongate......................................33.

33. Surface with radial sculpture strongest....... ....*ee*.

ee. Surface with radiating ribs.......................................††††.

††††. Hinge line straight............. ....****.

****. Umbo high, narrow.................. .....XXI. *Panenka*.

****. Umbo low, broad...... .... XXIV. *Buchiola*.

††††. Hinge line curved ; also ribs numerous, small. XXIII. *Paracardium*.

ee. Surface with fine radiating striæ.....................XXII. *Ontaria*.

33. Surface with concentric sculpture strongest.........XIX. *Edmondia*.

I. Pallial sinus present; also pallial line rather strongly impressed. The following characters also usually hold true: Resilifer present; hinge line straight, moderately long. Hinge and basal margins parallel. Umbos prominent..2.

2. Most prominent surface sculpture concentric..*c*.

c. Concentric sculpture strongest medially....................CXX. *Allorisma*.

c. Concentric sculpture strongest anteriorly..44.

44. Surface sculpture all concentric.......................CXXII. *Rhytimya*.

44. Surface sculpture radial in middle of shell......CXXIV. *Pholadella*.

44. Surface sculpture radial posteriorly.......................................*ff*.

ff. Umbonal ridge angular............................CXXV. *Cimitaria*.

ff. No umbonal ridge present..........................CXXVIII. *Anatimya*.

c. Concentric sculpture uniform over entire shell................................ 55.

55. Middle of each valve with radii....................CXXIX. *Liopistha*.

55. Middle of valves free from radii..*gg*.

gg. Hinge margin with a thin horizontal lamina..CXIX. *Pleuromya*.

gg. Hinge margin with no lamina.....................................5†.

5†. An anterior sinus present, extending from beak to base...5*.

5*. Teeth present...................................CXXI. *Sphenotus*.

5*. Teeth absent..............................CXXIII. *Endodesma*.

5†. No sinus on anterior portion of shell......XVIII. *Chænomya*.

2. Most prominent surface sculpture radial, strongest medially, wanting posteriorly...*d*.

d. Posterior umbonal ridge well marked dorsally.......CXXIV. *Pholadella*.

d. Posterior umbonal slope gently rounded......................................66.

66. Shell attenuate posteriorly.........................CXXVII. *Phenacomya*.

66. Shell broadly rounded posteriorly.......................................*hh*.

hh. Beaks subcentral.....................................CXXIX. *Liopistha*.

hh. Beaks anterior....................................CXXVI. *Pholadomya*.

B. Distinct hinge plate present..II.

II. Shell winged or eared, *i. e.*, the flattened dorsal portion is extended beyond the convex body of the shell and more or less definitely constricted from it. Hinge line straight..3.

3. Hinge line marked with numerous vertical grooves for reception of ligament...*e*.

e. Beaks terminal..77.

77. Concentric sculpture prominent.................LXVII. *Inoceramus*.

77. Concentric sculpture not prominent.......................................*ii*.

ii. Posterior portion of hinge without teeth......LXVI. *Gervilliopsis*.

ii. Posterior portion of hinge with teeth ....6†.

6†. Anterior and posterior lateral teeth parallel to hinge margin. LXIV. *Bakewellia*.

6†. Anterior and posterior lateral teeth ranging obliquely upward. LXV. *Gervillia*.

e. Beaks not terminal..88.

88. Surface with prominent radiating sculpture......XCVI. *Crenipecten*.

88. Surface with prominent concentric sculpture...LXVII. *Inoceramus*.

88. Body of shell with concentric and ears with radial sculpture; beak subcentral ....XCIII. *Euchondria*.

3. Hinge line not marked with numerous vertical grooves for the ligament.....*f*.

f. Shell ostreiform, *i. e.*, strongly inequivalve, distorted by early adherence to other objects. Only one muscle scar present, subcentral. Teeth absent or very obscure. Surface usually crossed by strong, plate-like concentric lamellæ..99.

99. Beaks small, not curved..................................LXXIX. *Ostrea.*

99. Beaks prominent, strongly incurved..*jj.*

jj. Beaks curved in the median plane................LXXX. *Gryphæa.*

jj. Beaks curved to right or left of median plane..LXXXI. *Exogyra.*

f. Shell not ostreiform..ooo.

ooo. Wings or ears two, a small anterior and a large posterior (when small usually called ear; when large, wing)......................*kk.*

kk. Surface radially sculptured...7†.

7†. Hinge area longitudinally grooved on both sides of the beak.6*.

6*. Adductor muscle scars two...*3''.*

3''. Pallial line and umbonal muscles indicated by many small, deep pits......................XLVI. *Limoptera.*

3''. Shell without pits ....XLV. *Pterinea.*

6*. Adductor muscle scar one...*4''.*

4''. Hinge line forming greatest width of shell. XCIV. *Pterinopecten.*

4''. Hinge line not equalling greatest width of shell. XCV. *Lyriopecten.*

7†. Hinge area not grooved longitudinally; also muscle scars practically but one (see LXVIII. *Pteria*) ....7*.

7*. Umbonal ridge very strong...........LXIII. *Conocardium.*

7*. Umbonal ridge weak or wanting...............................*5''.*

5''. Anterior extremity of ear pointed. LXXI. *Ptychopteria.*

5''. Anterior extremity of ear rounded. LXX. *Actinopteria.*

kk. Surface without radial sculpture (where muscle scars are reduced practically to one, see LXVIII. *Pteria*)..........................8†.

8†. Shell strongly oblique...8*.

8*. Anterior ear acute...*6''.*

6''. Hinge longer than body of shell...LXIX. *Pteronites.*

6''. Hinge shorter than body of shell...XLIX. *Leptodesma.*

8*. Anterior ear rounded.. ....XLVIII. *Leiopteria.*

8†. Shell but slightly oblique; wing elongate, narrow. XLVII. *Actinodesma.*

ooo. Ears two, the anterior much the longer; byssal notch edged with a comb-like series of small teeth..................XCVIII. *Chlamys.*

ooo. Ears two, the anterior longer; byssal notch smooth. XCIX. *Camptonectes.*

ooo. Ears subequal...*ll.*

ll. Ears very distinct...9†.

9†. Shell with small internal ribs radiating from beneath the beaks. CII. *Amusium.*

9†. Shell without internal ribs...9*.

9*. Ears diverging at a sharp angle above the beaks. C. *Entolium.*

9*. Ears not diverging at a sharp angle.........................*7''.*

7''. Ligament in shallow grooves roughly paralleling the hinge margin...*d''.*

d''. Shell very strongly lamellose. XCII *Acanthopecten.*
d''. Shell not lamellose............XCI. *Aviculopecten.*
7''. Ligament in numerous grooves vertical to the hinge margin...........................XCVI. *Crenipecten.*
7''. Ligament in a median triangular internal pit........*e''*.
e''. Body of shell equilateral...........XCVII. *Pecten.*
e''. Body of shell inequilateral.............CIV. *Lima.*
ll. Ears moderately distinct, though very small, the anterior one larger ; no byssal notch.........................CI. *Syncyclonema.*
ll. Ears indistinct, merging with the rest of the shell. LXXIII. *Pseudomonotis.*
ooo. Wing or ear one, posterior, or apparently so.......................*mm.*
mm. Surface with radial sculpture, ribs or striæ.................... 10†.
10†. Anterior byssal opening present...........................10*.
10*. Shell slightly oblique.......................................*8''*.
8''. Hinge with teeth...*f''*.
f''. Umbonal ridge exceedingly prominent. LXIII. *Conocardium.*
f''. Umbonal ridge weak ....LVI. *Byssonychia.*
8''. Hinge without teeth..................LVII. *Allonychia.*
10*. Shell quite oblique..*9''*.
9''. Wing very long.......................LV. *Anomalodonta.*
9''. Wing very slightly marked.......LI. *Lunulicardium.*
10*. Shell vertical......................LXXIII. *Pseudomonotis.*
10†. Anterior byssal opening absent; also shell rather strongly oblique......................................LIV. *Ambonychia.*
mm. Surface without radial sculpture...................................11†.
11†. Hinge line long...11*.
11*. Beaks narrowly pointed. Umbonal angle less than 90°. LXXV. *Myalina.*
11*. Beaks rather broadly pointed. Umbonal angle about 90°...*10''*.
10''. Wing separated from body of shell by a deep sinus. LXXII. *Monopteria.*
10''. Wing not separated from body of shell by a deep sinus...*g''*.
g''. Wing very small, narrow, and appressed. L. *Loxopteria.*
g''. Wing very broad.....................LX. *Clionychia.*
11†. Hinge line very short..12*.
12*. Cardinal teeth present; shell long and narrow. LVIII. *Mytilarca.*
12*. Cardinal teeth absent; shell elongate-ovate...... ...*11''*.
11''. Umbo very strongly incurved...LXXVIII. *Aucella.*
11''. Umbo slightly incurved..........LIX. *Plethomytilus.*
ooo. Ear one, anterior...*nn.*
nn. Shell very elongate-triangular.................LXI. *Aviculopinna.*
nn. Shell short-triangular or subcircular ....LII. *Pterochænia.*
II. Shell without wings ....4.
4. Hinge taxodont, *i. e.*, composed of many alternating teeth and sockets which

are mostly similar and form a more or less continuous series................*g.*

g. Shell nuculoid, *i. e.*, hinge line rather sharply arched ; the small shell concentrically striate or smooth ; teeth numerous, similar and transverse..111.

111. Pallial sinus absent ; shell usually subcircular..........................*oo*

oo. Teeth interrupted beneath the beaks by a resiliifer.
XXVI. *Nucula.*

oo. No resiliifer present ....12†.

12†. Shell transversely elongate................XXVIII. *Paleoneilo.*

12†. Shell subcircular or vertically elongate...XXV. *Ctenodonta.*

111. Pallial sinus present ; shell transversely elongate.....................*pp.*

pp. An internal vertical partition beneath the beaks.
XXVII. *Nuculites.*

pp. No internal partition...13†.

13†. Pallial sinus shallow..................................XXIX. *Leda.*

13†. Pallial sinus deep.......................... ....XXX. *Yoldia.*

g. Shell arcoid, *i. e.*, hinge line straight or slightly arched ; teeth more or less vertical or with laterals subparallel to the hinge margin.......222.

222. All teeth vertical..XXIV. *Buchiola.*

222. All teeth vertical to hinge line except the end ones which are more or less oblique...*qq.*

qq. Hinge area with ligament grooves converging from the hinge margin to the beak...14†.

14†. Shell transversely elongate.
XLIII. *Arca* and XLIIIA. *Barbatia.*

14†. Shell subtrigonal..........................XXXIV. *Trigonarca.*

14†. Shell subcircular..............................XLIV. *Glycimeris.*

qq. Hinge area with ligament grooves vertical...XXXV. *Breviarca.*

222. Lateral teeth subparallel to hinge line.................................*rr.*

rr. Only posterior laterals present................XXXI. *Parallelodon.*

rr. Both anterior and posterior laterals present.. ....15†.

15†. Shell transversely elongate.................XXXII. *Nemodon.*

15†. Shell subquadrate or subcircular..........XXXIII. *Cucullæa.*

g. Shell cyrtodontoid, *i. e.*, hinge line straight or only slightly arched ; teeth not forming a continuous series but the posterior laterals widely separated from the cardinals ; no anterior lateral present. All teeth more or less parallel to hinge margin. Strongly convex, subcircular shells with prominent umbos................................. ....333.

333. Cardinal teeth two or more........................... ....*ss.*

ss. Cardinals behind the beaks...................XXXVIII. *Ortonella.*

ss. Cardinals in front of the beaks..16†.

16†. Anterior adductor scar deeply prominent......................13*.

13*. Anterior adductor scar excavated out of hinge-plate.
XXXIX. *Vanuxemia.*

13*. Anterior adductor scar free from hinge-plate.
XXXVII. *Megambonia.*

16†. Adductor scars subequal ....14*.

14*. Area posterior to beaks (escutcheon) striated.
XL. *Whitella.*

14*. Area posterior to beaks not striated..XXXVI. *Cyrtodonta.*

333. Cardinal tooth one (a strong cardinal process)..XLI. *Plethocardia.*

4. Hinge not taxodont ....*h.*

h. Shell distorted usually by adherence to foreign objects, heavy, irregular, usually strongly spiral.............. ....444.
444. Teeth absent or very obscure..........*tt*.
tt. Beaks small, not curved..........LXXIX. *Ostrea*.
tt. Beaks prominent, strongly incurved..........17†.
17†. Beaks curved in the median plane..........LXXX. *Gryphœa*.
17†. Beaks curved to right or left of median plane..........15*.
15*. Valve (the larger) narrowing to beak with great suddenness (looks like *Capulus*, gastropod)...L. *Loxopteria*.
15*. Valve (the larger) narrowing slowly..LXXXI. *Exogyra*.
444. Teeth very prominent, heavy..........*uu*.
uu. Shell with prolonged and irregularly twisted umbo. CXLVII. *Monopleura*.
uu. Shell with regularly spiral umbo in one or both valves..........18†.
18†. Surface strongly lamellose..........CXLV. *Chama*.
18†. Surface not lamellose..........16*.
16*. Attached (left) valve with regularly spiral umbo (right valve operculum-like)..........CXLVI. *Requienia*.
16*. Attached (right) valve coniform.
CXLVII. *Caprina*,
CXLIX. *Ichthyosarcolites*,
CL. *Coralliochama*.
uu. Shell (one or both valves) conical, elongate..........19†.
19†. Attached valve conical, vertically ribbed; free valve flat or conical..........CL. *Radiolites*.
19†. Attached valve coniform; free valve spiral; shell marked with concentric growth lines, though longitudinally fibrous within..........CXLVIII. *Caprina*,
CXLIX. *Ichthyosarcolites*,
CL. *Coralliochama*.
h. Shell more or less distorted through boring habit; a calcareous siphonal tube present..........555.
555. Tubes found in sand. No shell known. Tubes have transverse septa..........CLXXXIII. *Polorthus*.
555. Tubes found in wood..........*vv*.
vv. Valves with a prominent anterior notch..........CLXXXI. *Turnus*.
vv. Valves trilobed..........CLXXXII. *Teredo*.
h. Shell usually entirely free from distortion..........666.
666. Surface marked with radial ribs..........*ww*.
ww. Shell elongate laterally, the greatest length parallel with the long, straight hinge line..........CXXXI. *Pleurophorus*.
ww. Shell subtriangular..........20†.
20†. Shell very elongate-triangular..........LXII. *Pinna*.
20†. Shell of medium length or short..........17*.
17*. Surface with rows of nodes..........XC. *Trigonia*.
17*. Surface spinose..........*12''*.
12''. Byssal opening prominent..........LIII. *Honeoyea*.
12''. Byssal opening absent..........CIII. *Plicatula*.
17*. Surface free from spines and nodes..........*13''*.
13''. Shell exceedingly thin; lower valve flat and perforate near umbo for the byssus..CVII. *Paranomia*.

13''. Shell thicker, not perforate............................*h''*.
h''. Byssal opening prominent.........................*3'''*.
3'''. Beak minute, strongly inflected.
LIII. *Honeoyea*.
3'''. Beak not minute, very slightly inflected.
LI. *Lunulicardium*.
h''. Byssal opening absent.........CLXVII. *Linearia*.
ww. Shell semicircular..................................LXXIV. *Halobia*.
ww. Shell subcircular...21†.
21†. Shell exceedingly thin; lower valve flat and perforate near the umbo for the byssus.................CVII. *Paranomia*.
21†. Shell of medium thickness.....................................18*.
18*. Beaks prominent... ....*14''*.
14''. Both anterior and posterior lateral teeth present...*i''*.
i''. Ribs over entire shell............CLVII. *Cardium*.
i''. Ribs only on posterior part of shell.
CLVIII. *Protocardia*.
14''. No lateral teeth present......CXLIV. *Venericardia*.
18*. Beaks not prominent; cardinal teeth three in each valve.
CXLI. *Ptychomya*.
ww. Shell oval.......................................CLXVII. *Linearia*.
666. Surface not marked with radial ribs, though radiating striæ may be present....................... ....*xx*.
xx. Shell elongate laterally...22†.
22†. Greatest length of shell parallel with the long, straight hinge line...19*.
19*. Beaks terminal or practically so..CXXXI. *Pleurophorus*.
19*. Beaks varying from subcentral to anterior.............*15''*.
15''. An internal rib present, running from beak to base.*j''*.
j''. Left valve with two cardinal teeth.
CLXXI. *Siliqua*.
j''. Left valve with one cardinal tooth.
CLXXII. *Leptosolen*.
15''. No internal rib present.........CLXXIV. *Legumen*.
22†. Greatest length of shell parallel with the long, arcuate hinge line, unioid...20*.
20*. Shell with a small, anterior lobe.......................*16''*.
16''. Umbonal ridge present.....LXXXIV. *Anthracomya*.
16''. No umbonal ridge...............LXXXIII. *Naiadites*.
20*. Shell without a small anterior lobe.....................*17''*.
17''. Cardinal teeth present......................................*k''*.
k''. Cardinals small, several, coalescent.
LXXXV. *Nyassa*.
k''. Cardinals one or two, large, heavy.
LXXXVI. *Unio*.
17''. Cardinal teeth absent....................................*l''*.
l''. Lateral teeth absent.........LXXXVII. *Anodonta*.
l''. Lateral teeth represented by one or two folds.
LXXXII. *Amnigenia*.
22†. Greatest length of shell at about 45° to hinge line........21*.
21*. Beaks prominent, terminal, elongate......................*18''*.

18''. Byssal opening very prominent..LI. *Lunulicardium.*
18''. Byssal opening not prominent........CXVI. *Mytilus.*
21*. Beaks small, appressed, very anterior but not terminal. Shell rounded anteriorly and posteriorly, rather tumid, modioliform..*19''*.
19''. Cardinal area with many longitudinal grooves for ligament..*m''*.
m''. Grooved area on both sides of the beaks.
LXXVI. *Ptychodesma.*
m''. Grooved area only posterior to beaks.
CXIII. *Eurymya.*
19''. Cardinal area not grooved..............................*n''*.
n''. Teeth present..*4'''*.
4'''. Cardinals one to three in each valve......*a'''*.
a'''. Surface with strong concentric ridges.
CXXXIII. *Cypricardinia.*
a'''. Surface with concentric striæ............*1*).
1). Anterior adductor very deeply impressed.
XLII. *Ischyrodonta.*
1). Anterior adductor not very strongly impressed..................CX. *Modiolodon.*
4'''. Cardinals, one strong in left valve and corresponding cavity in right.
CIX. *Modiomorpha.*
4'''. Cardinals, one strong in right valve and corresponding cavity in left...CXI. *Colpomya.*
4'''. Teeth few, microscopic, beneath the beaks.
CXVII. *Modiola.*
n''. Teeth absent ....*5'''*.
5'''. Furrow present, passing from in front of the umbo to the posterior basal margin.....*b'''*.
b'''. Umbonal ridge strong and angular.
CXV. *Goniophora.*
b'''. Umbonal ridge rounded or wanting.....*2*).
2). Umbonal slope sharply limited anteriorly.
a).
a). Umbo long and pointed
CXVII. *Modiola.*
a). Umbo broad and rounded.
LXXVII. *Modiella.*
2). Umbonal slope not sharply limited anteriorly ....CVIII. *Modiolopsis.*
5'''. No furrow present..............................*c'''*.
c'''. Valves equal...........CXII. *Whiteavesia.*
c'''. Valves unequal ; shell minute.
CXIV. *Aristerella.*
xx. Shell broadly oval to quadrate.................................... ....23†.
23†. Beaks prominent..22*.
22*. Umbonal ridge prominent.............CXXXVI. *Veniella.*
22*. Umbonal ridge wanting....... ....*20''*.
20''. Posterior cardinal tooth in right valve bifid at its

summit..........................CXXXIV. *Astartella.*
20''. Cardinal teeth not bifid..........CXXXVII. *Astarte.*
23†. Beaks small, appressed ....23*.
23*. Umbonal ridge present.......................................*21''.*
21''. Length and height subequal.
CXXXII. *Cypricardella.*
21''. Length much greater than height.
CLXXIX. *Saxicava.*
23*. Two weak umbonal ridges present, an anterior and a posterior ....CLXXIII. *Solyma.*
23*. Umbonal ridge absent...................CLXXX. *Panopea.*
xx. Shell subtriangular...24†.
24†. Strong umbonal ridge present, running from beak to posterior basal angle ....24*.
24*. Beaks exceedingly prominent, strongly incurved ; prominent concavity beneath the beaks..CXXXVIII. *Opis.*
24*. Beaks not exceedingly prominent..............................*22''.*
22''. Cardinal teeth (6–8) radiating fan-like from beneath the beaks.......................LXXXVIII. *Lyrodesma.*
22''. Cardinal teeth two in right valve, three in left; teeth more or less transversely striated..........*o''.*
o''. Surface with rows of nodes..........XC. *Trigonia.*
o''. Surface not nodose...........LXXXIX. *Schizodus.*
22''. Cardinal teeth two in each valve.......................*p''.*
p''. Pallial line simple.......................................*6'''.*
6'''. Inner margins of valves dentate.
CXXXIX. *Crassatellites.*
6'''. Inner margins of valves not dentate.
CXL. *Etea.*
p''. Pallial sinus present................................*7'''.*
7'''. Lateral teeth prolonged......................*d'''.*
d'''. Resilifer present............................*3).*
3). Resilifer elongate.....CLXIX. *Semele.*
3). Resilifer spoon-shaped.
CLXX. *Cumingia.*
d'''. No resilifer present......CLXVI. *Tellina.*
7'''. Lateral teeth minute if any.
CLXVII. *Ænona.*
22''. Cardinal teeth two in right valve, one in left.
CLXXVIII. *Corbula.*
24†. Shell without strong umbonal ridge...........................25*.
25*. Surface radially striate ....CXVIII. *Crenella.*
25*. Surface without radial striæ.................................*23''.*
23''. Beaks exceedingly prominent, strongly incurved.
LXXVIII. *Aucella.*
23''. Beaks but moderately prominent ....*q''.*
q''. Cardinal teeth one in each valve; no resilifer present .... CLII. *Tancredia.*
q''. Cardinal teeth two in each valve.
CXXXVII. *Astarte.*
q''. Cardinal teeth, two in right valve, one in left...*8'''.*

8'''. Resilifer and ligament scar separated by a thin septum................CLXXV. *Mactra*.
8'''. Resilifer and ligament scar not separated by a septum..*e'''*.
e'''. Margins of the combined resilifer and ligament pit elevated.
CLXXVI. *Cymbophora*.
e'''. Margins of pit not elevated.
CLXXVII. *Schizodesma*.
q''. Cardinal teeth three in each valve.
CXLII. *Corbicula*.
xx. Shell semicircular and exceedingly thin...... CVI. *Placunopsis*.
xx. Shell subcircular ....25†.
25†. Shell exceedingly thin, fragile, translucent................26*.
26*. Lower valve flat, perforated for the byssus; upper valve convex.......................................CV. *Anomia*.
26*. Lower valve flat, not perforated for the byssus.
CVI. *Placunopsis*.
25†. Shell of median thickness.......................................27*.
27*. Beaks prominent ....*24''*.
24''. Beaks spirally enrolled forward.....CLIX. *Isocardia*.
24''. Beaks merely curved forward.......................*r''*.
r''. Cardinal teeth three in each valve.... ....*9'''*.
9'''. Pallial sinus present..............................*f'''*.
f'''. Pallial sinus long.........CLXI. *Clementia*.
f'''. Pallial sinus short..........................*4*).
4). Lateral teeth present.................... *b*).
b). A posterior lateral tooth in right valve; height and length of shell subequal.....CLXIV. *Dosiniopsis*.
b). No posterior lateral present; length of shell greater than height.
CLXIII. *Meretrix*.
4). Lateral teeth absent.....................*c*).
c). Inner margins of valves crenulate.
CLXII. *Venus*.
c). Inner margins of valves smooth.
CLXV. *Tapes*.
9'''. Pallial line entire...........CXXXV. *Arctica*.
r''. Cardinal teeth two in each valve...............*10'''*.
10'''. Left anterior and right posterior cardinal teeth prolonged and curved..CLVI. *Tenea*.
10'''. Cardinal teeth not prolonged.
CLV. *Diplodonta*.
r''. Cardinal teeth two in right valve and three in left.
CLX. *Cyprimeria*.
24''. Beaks not curved; shell inflated.
CXLIII. *Sphærium*.
27*. Beaks small and subcentral..................... ....*25''*.
25''. Concentric sculpture strong and irregular.
CLIII. *Paracyclas*.

25''. Concentric sculpture delicate..........................*s''*.
s''. Shell inflated..................CXLIII. *Sphærium*.
s''. Shell but slightly convex...........CLIV. *Lucina*.

ORDER I. PRIONODESMACEA.

I. SOLEMYA Lamarck.

Elongate-cylindrical, gaping at each end, with obtuse extremities and very low beaks. Ligament internal, posterior, inserted on an oblique process beneath the beak. No distinct pallial line. Devonic–Recent.

1. **S. (?) vetusta** Meek. (Fig. 477, *a*.) Devonic.

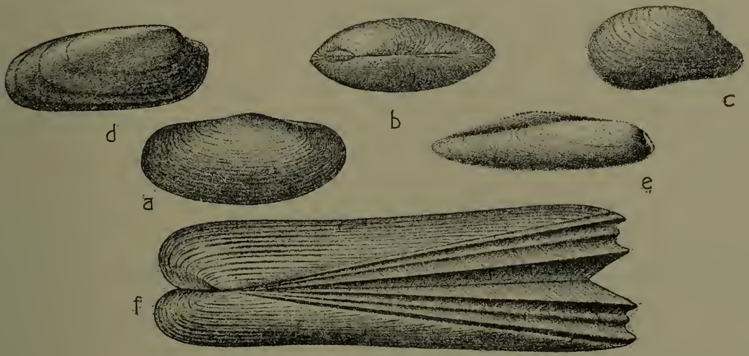


FIG. 477. *a*, *Solemya ? vetusta*, right valve ; *b*, *Clinopistha subnasuta*, cardinal view, showing callosity in front of beaks, Hamilton group ; *c*, same, right valve, Onondaga ; *d*, *Phthonia cylindrica*, right valve ; *e*, *Prothyris lanceolata*, right valve ; *f*, *Orthonota carinata*, both valves in conjunction, × 2. (Pal. N. Y., V.)

Anterior end longer. Surface marked by regular, distinct, and lamellose concentric striæ.

Onondaga: Ohio. Hamilton Group: Falls of Ohio.

2. **S. occidentalis** Stanton. (Fig. 478, *a*.) Comanchic.

Beaks directed backwards. Surface marked with distant, impressed radiating lines, most prominent in the middle of the shell,

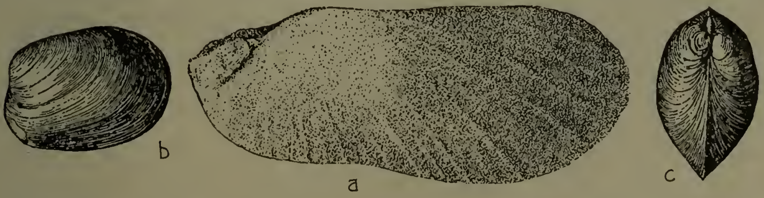


FIG. 478. *a*, *Solemya occidentalis*, internal mold of large right valve, with unusually strong radiating lines (U. S. G. S., Bull. 133) ; *b*, *c*, *Clinopistha radiata*, left and dorsal views. (Ind. Surv.)

and by obscure radiating ridges most prominent anteriorly. These markings are preserved also on molds.

Abundant in Knoxville of California.

II. CLINOPISTHA Meek.

Moderately convex, with nearly straight basal margin, rounded posterior, and short, subnasute anterior end. Callosity present in place of lunule, anterior to beaks. Surface marked by fine growth striæ. Hinge possibly crenulated. Ligament external. Pallial line simple. Devonic and Carbonic.

3. **C. subnasuta** (Hall & Whitfield). (Fig. 477, *b–c.*) Devonic.
Hinge line gently arcuate. Anterior end nasute.
Hamilton: Kentucky.

4. **C. radiata** Hall. (Fig. 478, *b–c.*) Carbonic.
Anterior end scarcely nasute.
Coal Measures: Ohio–Missouri.

III. PHTHONIA Hall.

Elliptical, with short anterior end. Beaks small and appressed. Hinge line straight or slightly arched. Umbonal slope more or less distinctly defined. Surface marked with fine concentric striæ, and at times with radiating striæ. Ligament external. Pallial line simple. Devonic.

5. **P. cylindrica** Hall. (Fig. 477, *d.*) Devonic.
Radiating striæ obscure or absent. Hinge arched.
Hamilton: New York.

IV. SANGUINOLITES McCoy.

Equivalve, elongate, obliquely truncate behind, with beaks low and near the anterior end. Surface concentrically striated and

FIG. 479. *Sanguinolites æolus.* (Pal. Ohio, II.)

bearing a ridge extending from the beak to the basal posterior margin. Teeth absent; anterior adductor scar buttressed by a ridge. Ligament external. Pallial line simple. Miss.–Carbonic.

6. **S. æolus** Hall and Whitfield. (Fig. 479.) Mississippic.

Two or three very obscure longitudinal ridges between the slightly convex umbonal slopes and the cardinal margin.

Ohio (Cuyahoga shale), Nevada.

V. PROTHYRIS Meek.

Thin-shelled, elongate, with very anterior beaks, and often nearly parallel cardinal and basal margins. Lower anterior end generally notched. Surface covered with fine concentric striæ. Hinge without teeth. Ligament external. Pallial line simple. Devonic and Carbonic.

7. **P. lanceolata** Hall. (Fig. 477, *e*.) Devonic.

Length three times the height; oblique, and pointed posteriorly. Anterior end subtruncate, only slightly constricted, and lacking any conspicuous notch.

Hamilton: New York, Pennsylvania. Portage: Pennsylvania.

8. **P. elegans** Meek. Carbonic.

Anterior notch well defined. Surface marked with an obscure fold and furrow parallel to the hinge line. Striæ nearly obsolete on upper portion of shell. Length nearly three and one half times height. Type of genus.

Ohio and Michigan to Nebraska.

VI. ORTHONOTA Conrad.

Extremely elongate, with very anterior beaks. Cardinal and

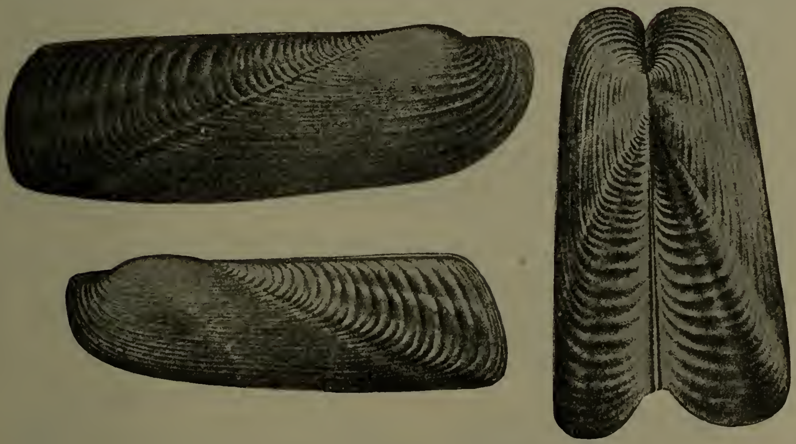


FIG. 480. *Orthonota undulata*. (Pal. N. Y., V.)

basal margins straight and parallel. Umbonal slope defined by one or more distinct folds which extend from the beak to the posterior basal margin. Surface marked with concentric striæ. Hinge without teeth. Pallial line simple. Ordovicic–Devonic.

9. **O. undulata** Conrad. (Fig. 480.) Devonic.

Posterior end nearly vertically truncate. Surface marked by distinct undulations anteriorly and posteriorly.

Hamilton of New York and Pennsylvania; also Ithaca of New York.

10. **O. carinata** Conrad. (Fig. 477, *f*.) Devonic.

Posterior end doubly emarginate. Postero-cardinal slope longitudinally ridged.

Hamilton: New York, Pennsylvania.

VII. Cuneamya Hall and Whitfield.

Differs from Grammysia in that the hinge plate is weak and without teeth. A shallow median furrow usually present. Ordovicic.

11. **C. miamiensis** Hall and Whitfield. (Fig. 481.) Ordovicic.

Fig. 481. *Cuneamya miamiensis.* (Pal. Ohio, II.)

Posterior end acutely rounded.

Cincinnati Group: Ohio, Indiana.

12. **C. truncatula** Ulrich. (Fig. 482, *a*.) Ordovicic.

Anterior end truncate. Median furrow broad.

Middle Galena of Minnesota.

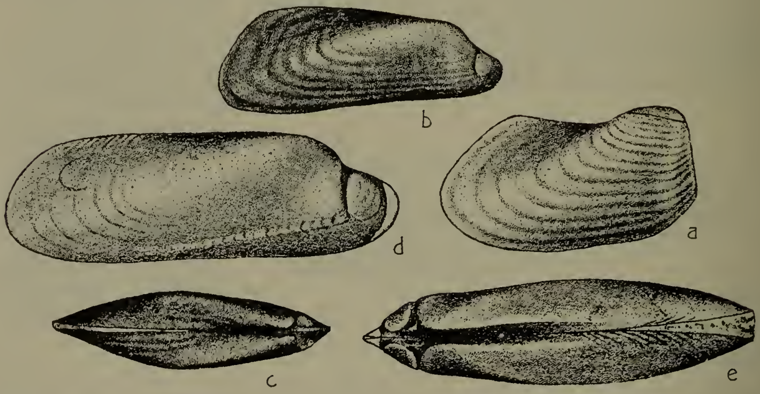


Fig. 482. *a*, *Cuneamya truncatula*, internal mold of right valve; *b*, *c*, *Orthodesma subnasutum*; *d*, *e*, *O. canaliculatum*, right and dorsal views. (Ulrich, Minn. Pal.)

VIII. Ilionia Billings.

Anterior end of shell larger than posterior. A broad furrow extends from the umbos to the posterior basal margin. A large subovate muscular scar in the upper half of the posterior extremity. No teeth. Siluric.

13. **I. galtensis** Whiteaves. (Fig. 483.) Siluric.

Fig. 483. *Ilionia galtensis*, left and right valves. (After Whiteaves.)

Umbos broad, subcentral. Surface concentrically striate.

Guelph: New York, Ontario. Cobleskill: New York.

14. **I. sinuata** Hall. Siluric.

Surface marked by two furrows extending posteriorly from the beak, the one obliquely, the other vertically.

Cobleskill and Manlius of New York.

IX. Orthodesma Hall and Whitfield.

Transversely elongate, somewhat higher posteriorly than anteriorly. Valves thin, gaping at each end, usually marked by an umbonal ridge, anterior to which is a broad depression. Surface marked by more or less distinct concentric striæ. Hinge plate without teeth, thin and long. Ligament mostly external. Pallial line simple. Ordovicic.

15. **O. rectum** Hall and Whitfield. (Fig. 484.) Ordovicic.

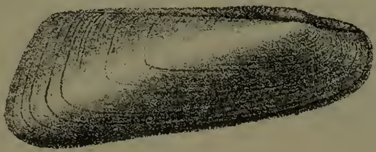


Fig. 484. *Orthodesma rectum*. (Pal. Ohio, II.)

Cardinal and basal lines straight and converging forwards. Posterior end obliquely truncate.

Cincinnati Group: Ohio, Indiana.

16. **O. subnasutum** (Meek and Worthen). (Fig. 482, *b–c.*)
Ordovicic.

Cardinal and basal margins slightly diverging and curving. Concentric undulations irregular.

Galena: Illinois, Minnesota.

17. **O. canaliculatum** Ulrich. (Fig. 482, *d–e.*) Ordovicic.

Differs from other species in the strong, channel-like depression of the hinge line, the nearly parallel cardinal and basal margins, the rounded posterior margin, and in the peculiar pallial line which consists (on the internal molds) of a straight row of obscure pustules extending backward from the base of the anterior adductor scar.

Cincinnati Group: Ohio, Indiana, Minnesota; Trenton of New Jersey.

X. Grammysia de Verneuil.

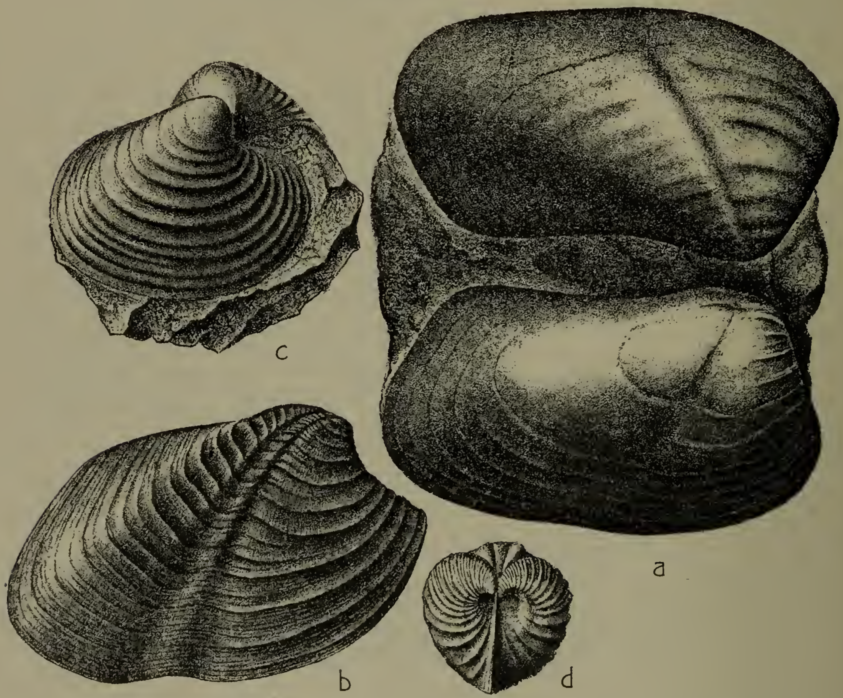


Fig. 485. *a*, *Grammysia ovata*; *b*, *G. bisulcata*; *c*, *d*, *G. globosa*. (Pal. N. Y., V.)

Beaks prominent and incurved, anterior to middle. Escutcheon and lunule well defined. Valves often traversed from beak to base by an oblique sinus or depression and adjacent fold, which may be duplicate and which alternate in the two valves. Surface marked with concentric growth lines and commonly with concentric undulations. Hinge plate short and strong, with one or two cardinal folds in the typical forms. Ligament external. Pallial line simple. Siluric-Carbonic.

18. **G. ovata** Hall. (Fig. 485, *a*.) Devonic.
Length about one third greater than height. Surface marked with subangular, concentric undulations. Sinus shallow and unaccompanied by folds.
Onondaga: Ohio.

19. **G. bisulcata** (Conrad.) (Fig. 485, *b*.) Devonic.
Distinguished by the strong fold with a furrow on each side, extending from beak to base and by the strong and regular concentric ridges.
Hamilton: New York, Pennsylvania.

20. **G. globosa** Hall. (Fig. 485, *c–d*.) Devonic.
Distinguished by its comparatively small size and by its globular form. No fold or sinus.
Hamilton: New York.

21. **G. nodocostata** Hall. (Fig. 486, *a–b*.) Devonic.
Outline oblique; hinge line short and straight. Surface marked with numerous concentric folds and on the umbo with radiating nodose ridges.
Hamilton: New York.

22. **G. obsoleta** Hall. (Fig. 486, *c*.) Devonic.
Large, broadly ovate or elliptical from pressure, constricted at middle of base. Hinge line arcuate and more than half the length of the shell. Sinus and ridge present anteriorly. Differs from *G. circularis* in having the anterior fold and sinus and in not being flattened.
Hamilton: New York.

23. **G. alveata** (Conrad). (Fig. 487.) Devonic.
Hinge line short, almost winged posteriorly. Valves convex below and ventricose above. Surface marked with fine concentric striæ and, anterior to the umbonal slope, by concentric folds which are absent on the posterior slope.

Hamilton : New York, Virginia.

24. **G. lirata** Hall. (Fig. 486, *d.*) Devonic.

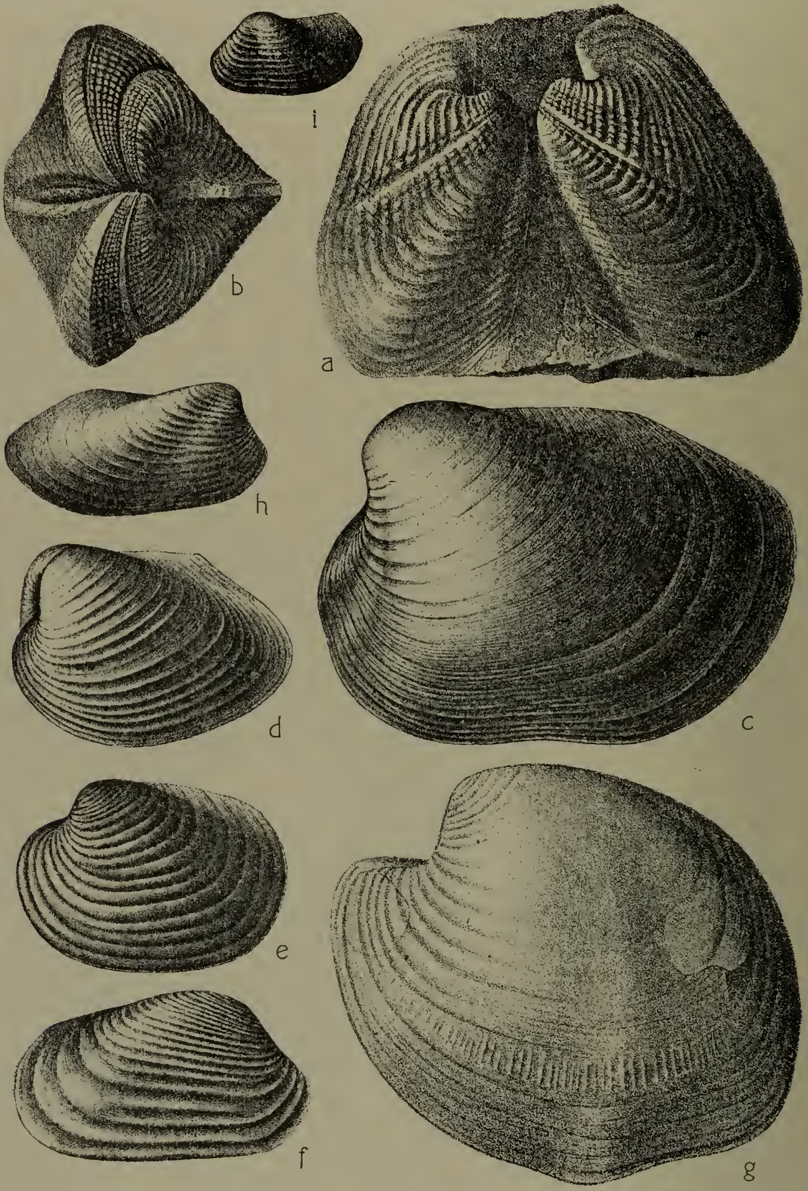


FIG. 486. *a*, *b*, *Grammysia nodocostata ; c*, *G. obsoleta ; d*, *G. lirata ; e*, *f*, *G. arcuata ; g*, *G. circularis*, left valve, partly denuded of shell, showing muscle scars and pallial line ; *h*, *G. communis ; i*, *G. undata*, a small left valve. (Pal. N. Y., V.)

Differs from *G. alveata* in its smaller size and in the presence of concentric folds on the posterior slope.

Hamilton: New York, Pennsylvania, Virginia.

25. **G. arcuata** (Conrad). (Fig. 486, *e–f.*) Devonic.

Distinguished by its somewhat elongate form, rounded posterior extremity, flattened or constricted base, and by the extension of the concentric folds across the whole length of the shell.

Hamilton of New York and the Appalachian region.

26. **G. circularis** Hall. (Fig. 486, *g.*) Devonic.

Subcircular, with lightly impressed fold and furrows extending from beak to base.

Hamilton and Chemung of New York.

27. **G. communis** Hall. (Fig. 486, *h.*) Devonic.

FIG. 487. *Grammysia alveata.* (Pal. N. Y., V.)

Elongate, with subangular umbonal slope, oblique sinus, and strong concentric undulations.

Chemung: New York, Pennsylvania.

28. **G. undata** Hall. (Fig. 486, *i.*) Devonic.

Similar to *G. communis*, but has fewer concentric undulations, a less angular umbonal slope, broader posterior end, and a more nearly vertical sinus.

Chemung: New York, Pennsylvania.

29. **G. hannibalensis** (Shumard). Mississippic.

Similar to *G. communis* but is higher proportionally, and has a more broadly rounded umbonal slope.

Characteristic of the Waverly and equivalent formations from Ohio to Missouri; also in the Mississipic of Nevada.

XI. Glossites Hall.

Elliptical, with short anterior and large, rounded posterior extremity. Beaks small and appressed. Hinge line long and gently arcuate. Umbonal slope prominent only above. Surface marked with fine concentric striæ which often become lamellose. Lunule distinct. Teeth doubtful. Ligament external. Muscular impressions shallow.

Distinguished from *Modiomorpha* by its regular elliptical outline and by the presence of a lunule. Devonic.

30. **G. lingualis** Hall. (Fig. 488, *a*.) Devonic.

Length usually a little more than twice the height.

Chemung Group: New York, Pennsylvania.

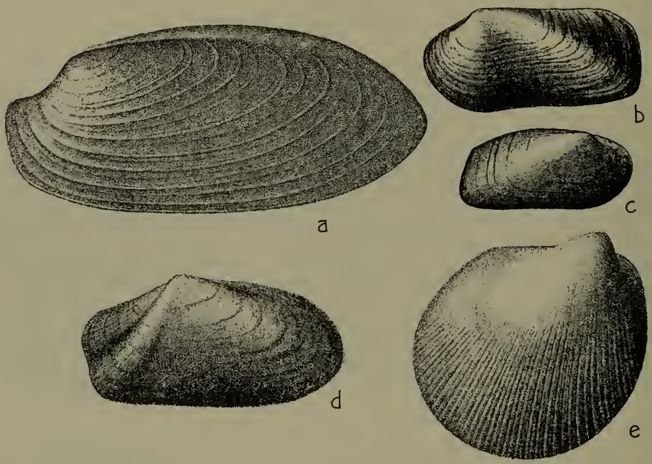


Fig. 488. *a*, *Glossites lingualis*, left valve; *b*, *c*, *Palæanatina typa*, left and right valves; *d*, *Tellinopsis subemarginata*; *e*, *Cardiopsis radiata*. (N. Y. Surv.)

XII. Saffordia Ulrich.

Rather small, transversely ovate, equivalve, and very inequilateral, with beaks near the anterior extremity. Surface bearing a moderate umbonal ridge and a more or less distinct depression dorsally. Lunule and escutcheon present. One wedge-shaped cardinal tooth and a posterior lateral tooth present in left valve and corresponding cavities in the right. Resilifer present. Pallial line simple.

Differs from *Cuneamya* in the thicker shell, more distinct muscular impressions, arcuate posterior cardinal margin, and different hinge characters; from *Grammysia* in the teeth and in the greater depth of the anterior muscle scar. Ordovicic.

31. **S. modesta** Ulrich. (Fig. 489, *c*.) Ordovicic.
Quite small, obliquely ovate.
Lower Galena : Wisconsin, Minnesota.

32. **S. ventralis** Ulrich. (Fig. 489, *a–b*.) Ordovicic.
More nearly circular than *S. modesta*.
Upper Cincinnati Group : Wisconsin, Minnesota.

XIII. Palæanatina Hall.

Left valve larger than right. Elliptical, with short anterior and longer posterior end. Beaks low, that of left valve rising above that of right. Umbonal slope prominent. Valves crossed from beak to base by a shallow depression ; both umbonal ridge and depression less prominent in right valve. Surface covered with

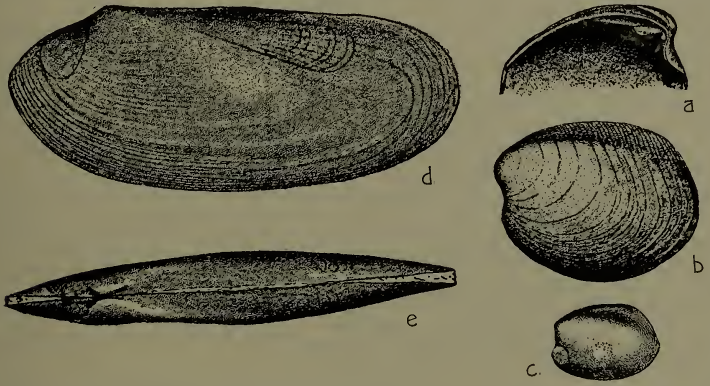


Fig. 489. *a*, *b*, *Saffordia ventralis*, view of left valve ; *c*, *Saffordia modesta*, left view of internal mold ; *d*, *e*, *Psiloconcha grandis*, left and cardinal views. (Minn. Surv.)

fine concentric striæ. Hinge with two slender processes beneath the beak. Pallial line simple. Devonic.

33. **P. typa** Hall. (Fig. 488, *b–c*.) Devonic.
Left valve somewhat gibbous at umbo. Right valve depressed-convex. Beaks anterior to middle.
Chemung Group : New York.

XIV. Tellinopsis Hall.

Elliptical, with rounded anterior and truncate or emarginate posterior end. Beaks small, subcentral. Umbonal slope prominent. Surface marked with concentric striæ and weak radiating striæ. Hinge without teeth. Ligament external. Muscular impressions shallow. Devonic.

34. **T. subemarginata** (Conrad). (Fig. 488, *d.*) Devonic.

From the beak a flattening or depression extends to both the anterior and the posterior margin. Type of genus.

Hamilton : New York, Pennsylvania.

XV. CARDIOMORPHA de Koninck.

Equivalve, inequilateral, oval, gibbous. Beaks almost at the anterior extremity, prominent, spirally enrolled toward the front. Hinge line thin, arched. Hinge margin inflected nearly at right angles to form a hollow lunette extending from the beak nearly to the cardinal angle. Hinge teeth absent. Pallial line simple. Ordovicic to Carbonic.

FIG. 490. *Cardiomorpha missouriensis.* (Kan. Pal., VI/II.)

35. **C. missouriensis** Shumard. (Fig. 490.) Carbonic.

Surface marked with fine and crowded concentric striæ.

Coal measures of Illinois, Kansas, Missouri, Nevada.

XVI. CARDIOPSIS Meek and Worthen.

Valves gibbous, inequilateral, subcircular, with short hinge line and prominent and incurved beak. Surface marked with radiating striæ or costæ and with concentric growth lines. Hinge with one or two cardinal teeth.

Differs from *Cardiomorpha* in the presence of cardinal teeth and radial sculpture. Miss.–Carbonic.

36. **C. radiata** Meek and Worthen. (Fig. 488, *e.*) Mississippic.

Costæ sharp, alternating in part. Type of the genus.

Kinderhook : Indiana, Illinois.

XVII. PSILOCONCHA Ulrich.

Shell very thin, elongate, inequilateral, gaping slightly at both ends. Hinge plate very narrow, without teeth. Ligament internal, linear. Muscular impressions very shallow, the posterior three times the length of the anterior. Pallial line simple. Ordovicic.

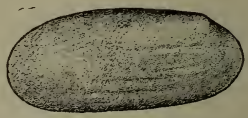


FIG. 491. *Psiloconcha inornata.* (After Ulrich, Pal. O., VII.)

37. **P. grandis** Ulrich. (Fig. 489, *d–e.*) Ordovicic.

Posterior margin regularly rounded ; anterior angular.

Upper beds of Cincinnati Group of Ohio.

38. **P. inornata** Ulrich. (Fig. 491.) Ordovicic.

Both ends regularly rounded. Surface marked only with obscure concentric striæ, usually appearing almost smooth.

Lorraine of Ohio.

XVIII. CHÆNOMYA Meek.

Thin, equivalve, inequilateral, longitudinally oblong or subcylindrical. Anterior side rounded, closed; posterior long, truncated and gaping. Surface marked with radiating granules and with concentric growth lines. Cardinal margin inflected as in *Allorisma*. Teeth absent. Ligament external. Scars of anterior adductors and pedal muscles connected. Pallial line with broad, shallow sinus. Carbonic and Permic.

39. **C. leavenworthensis** Meek and Hayden. (Fig. 492.) Carbonic and Permic.

Surface covered with growth lines and a few concentric undula-

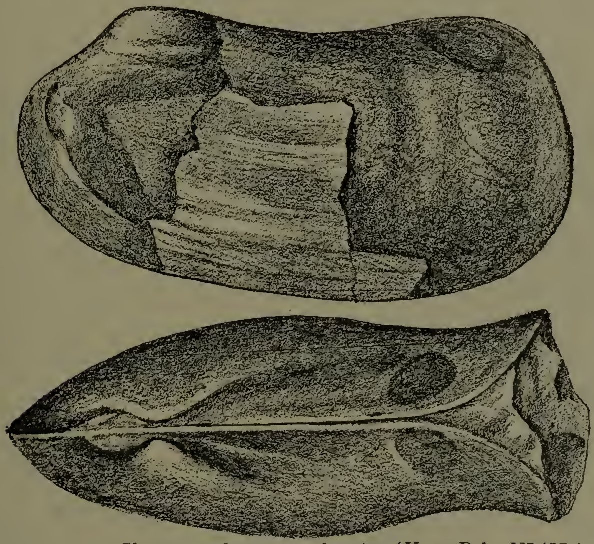


FIG. 492. *Chænomya leavenworthensis* (Kan. Pal., VI/II.)

lations which curve up abruptly behind, parallel to the truncated posterior margin. Type of genus.

Coal Measures of Illinois and Iowa to Colorado; also Permic of Kansas.

40. **C. minnehaha** Swallow. Carbonic and Permic.

Smaller than preceding, with prominent posterior umbonal slope.

Coal Measures of Iowa, Illinois, Missouri, Nebraska; Permic of Kansas.

XIX. Edmondia de Koninck.

Oval or subcircular, gaping anteriorly. A narrow ridge present behind the beaks. Beaks varying from subcentral to nearly anterior. Surface marked by concentric striæ. Hinge line thin, arched, lacking teeth. Ligament external, resting in a groove along the hinge line. Pallial line simple. Devonic–Carbonic.

41. **E. philippi** Hall. (Fig. 493, *a.*) Devonic.

Distinguished by its broadly oval form, at times almost circular,

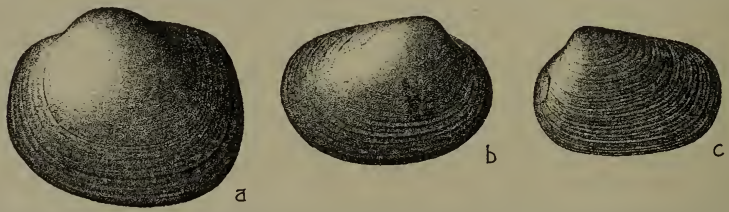


Fig. 493. *a*, *Edmondia philippi*; *b*, *E. subovata*, right valve; *c*, *E. burlingtonensis*. (Pal. N. Y., V.)

by the nearly central beaks, and by the fine concentric striæ which often become lamellose.

Chemung Group: New York, Pennsylvania.

42. **E. subovata** Hall. (Fig. 493, *b.*) Devonic.

Elliptical. Beaks somewhat anterior.

Chemung: New York, Pennsylvania.

43. **E. burlingtonensis** White and Whitfield. (Fig. 493, *c.*) Mississippic.

Differs from *E. subovata* in the more anterior beaks and in the straighter base.

Lower Mississippic of Ohio, Iowa, Missouri.

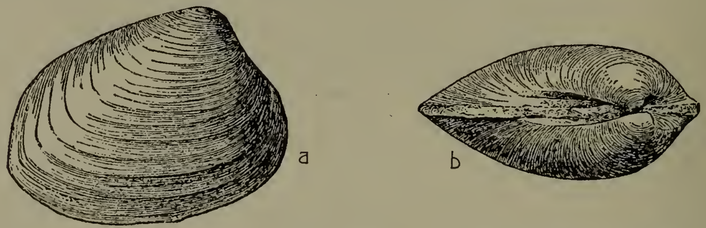


Fig. 494. *Edmondia aspinwallensis*, right and cardinal views. (Ind. Surv.)

44. **E. aspinwallensis** Meek. (Fig 494, *a–b.*) Miss.–Carbonic.

Greatest convexity of valves is in front of middle.

Mississippic of Utah; Coal Measures of West Virginia to Nebraska and Missouri.

XX. Fordilla Barrande.

Minute, thick, oval. Hinge margin nearly straight. Surface concentrically striated.

This may be a bivalve crustacean allied to *Estheria*. Cambric.

45. **F. troyensis** Barrande. (Fig. 495.) Cambric.

Lower Cambric of southeastern New York, eastern Massachusetts

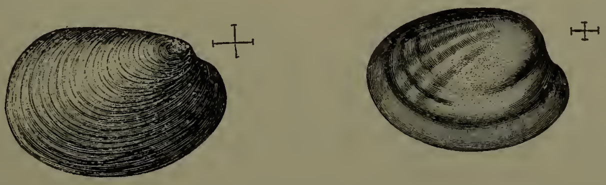


Fig. 495. *Fordilla troyensis*, right valve and right internal mold, enlarged. (U. S. G. S., Ann. 10.)

XXI. Panenka Barrande.

Equivalve. Length and height nearly equal. Beaks prominent and incurved. Hinge line straight or arcuate. Shell thin, marked by growth lines and usually by strong radii. Siluric–Devonic.

46. **P. canadensis** Whiteaves. Siluric.

Subcircular to longitudinally subovate; umbones prominent, surface with numerous ribs.

Upper Monroe of Michigan, Ohio and Canada.

Fig. 496. *Panenka dichotoma*. (Pal. N. Y., V.)

47. **P. dichotoma** Hall. (Fig. 496.) Devonic.

Convex below, gibbous above. Hinge line short and straight. Schoharie: New York.

48. **P. ventricosa** Hall. (Fig. 497, *a–b*.) Devonic.

Distinguished by its subcircular form, straight hinge line, extremely ventricose valves, prominent, subcentral beaks and numerous, fine and close radii.

Agoniatite limestone of Marcellus shale: New York.

49. **P. hero** Hall. (Fig. 497, *d.*) Devonic.

Distinguished by small size, small, subcentral beaks, and strong, distant radii.

Marcellus shale: New York.

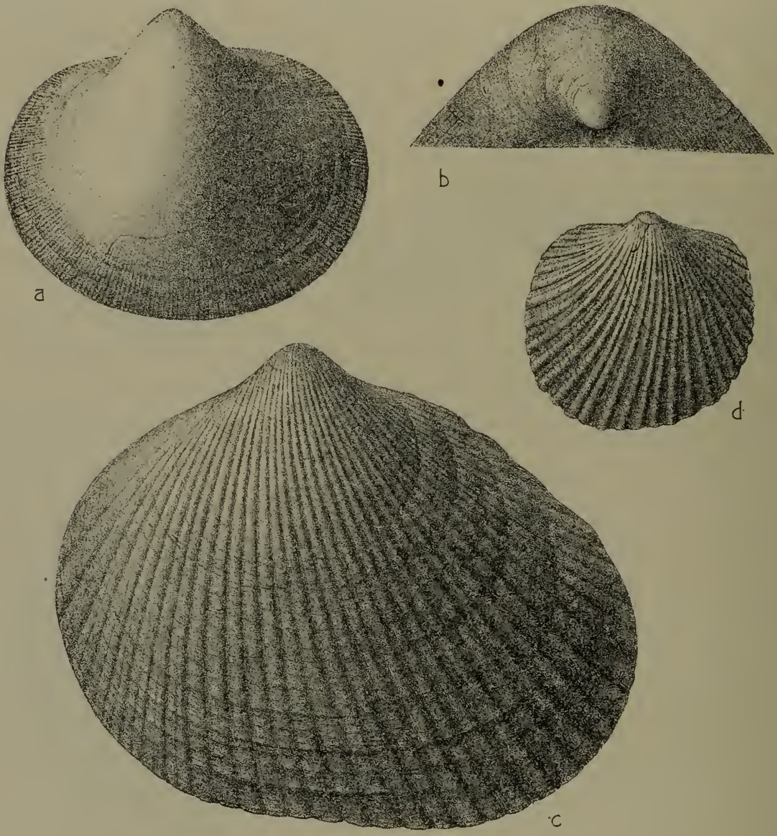


FIG. 497. *a, b, Panenka ventricosa,* left valve and cardinal view showing triangular area under the beak; *c, P. potens,* right valve; *d, P. hero,* left valve. (N. Y. Surv.)

50. **P. costata** Hall. (Fig. 498, *b.*) Devonic.

Differs from *P. hero* in the broader, more rounded radii and in its larger size.

Marcellus shale: New York.

51. **P. potens** Hall. (Fig. 497, *c.*) Devonic.

Large; radii rounded, numbering 35 to 40.

Hamilton: New York.

52. **P. robusta** Hall. (Fig. 498, *a*.) Devonic.

Much like *P. dichotoma* but the plications are more elevated and angular and rarely bifurcate.

Portage Group: New York.

FIG. 498. *a*, *Panenka robusta*, left valve; *b*, *P. costata*, left valve. (N. Y. Surv.)

XXII. ONTARIA Clarke. (*Cardiola* Broderip in part.)

Equivalve, exceedingly thin; beaks not very prominent, turned posteriorly. Cardinal area beneath the beak nearly extinct. Surface covered with fine concentric and radiating striæ. Devonic.

FIG. 499. *Ontaria suborbicularis*, × 2, with enlargements of cardinal region, × 5. (N. Y. Mem., 6.)

53. **O. suborbicularis** (Hall). (Fig. 499.) Devonic.

Suborbicular; beak central to subcentral. Surface marked with sharp, imbricating concentric striæ; very fine radial striæ may be present.

Portage (Naples fauna) of New York.

XXIII. Paracardium Barrande.

Small, circular. Beaks high and slightly projecting. Surface marked with fine, simple radial ribs. Hinge at times with a row of minute tooth-like projections. Siluric and Devonic.

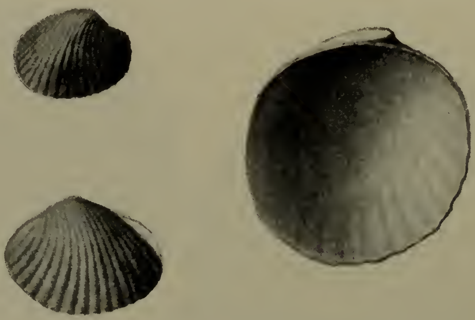


Fig. 500. *Paracardium doris* Hall, a small right valve, × 5 (slightly transverse from compression); a larger left valve, × 3; interior, × 10. (N. Y. Mem., 6.)

54. **P. doris** Hall. (Fig. 500.) Devonic.

Beaks minute, incurved, and directed forward. Surface covered with 20 to 25 fine, rounded ribs, separated by narrower furrows.

Portage: New York, Pennsylvania.

XXIV. Buchiola Barrande.

Cardinal line long and straight. Beaks pointing forward. A row of minute, tooth-like projections often present on the outer edge of the narrow cardinal area. Surface marked with a few

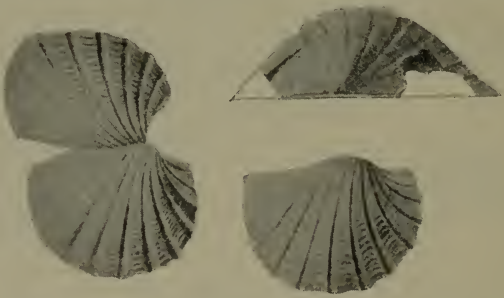


Fig. 501. *Buchiola retrostriata*, conjoined valves, × 3; umbonal view of right valve, showing the thin upturned edge of the hinge line, × 5; a right valve with sharply defined features, × 3. (After Clarke, Mem. 6, N. Y. State Mus.)

broad plications crossed by fine lines curved prominently upward as they cross the ribs. Siluric and Devonic.

55. **B. retrostriata** von Buch. (Fig. 501.) Devonic.

Shell very convex. Umbos large, closely incurved. Surface of ribs flat or concave with backward curving growth lines; grooves narrower than ribs.

Portage: New York (also Genesee), Pennsylvania, Appalachians.

XXV. CTENODONTA Salter.

Equivalve. Surface smooth or with concentric growth lines. Hinge arcuate, with a series of curved, transverse teeth which is at times interrupted beneath the beaks. Cardinal area not striated. Ligament small, immediately behind the beaks. Adductor muscle impressions nearly equal. Pallial line simple.

Differs from *Nucula* in the absence of resilifer beneath the beak, and in the absence of a flattened area (lunule and escutcheon). Ordovicic and Siluric.

56. **C. nasuta** (Hall). (Fig. 502, *o*.) Ordovicic.

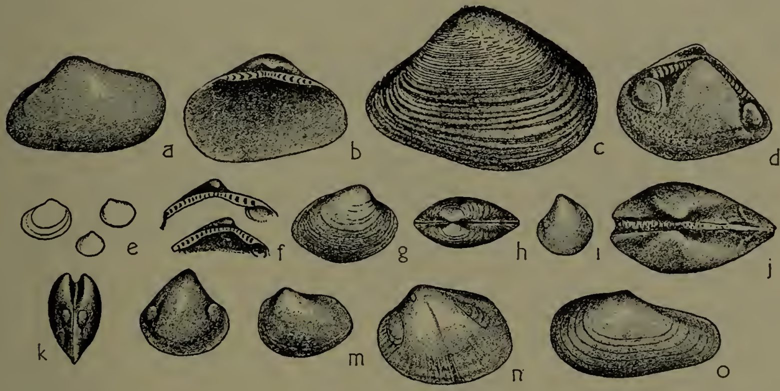


FIG. 502. *a*, *b*, *Ctenodonta logani*; *c*, *d*, *C. gibberula*, exterior of right valve and internal mold of left; *e*, *f*, *C. socialis* (*f* = hinge of right valves enlarged, × 3); *g*, *h*, *C. fecunda*, right and cardinal views; *i*, *j*, *C. obliqua*, internal molds, × 5; *k*, *l*, *C. alta*; *m*, *C. albertina*; *n*, *C. calvini*, internal mold of left valve; *o*, *C. nasuta*, left valve. (Minn. Surv.)

Teeth in a continuous and almost straight series.

Stones River: Tennessee, Illinois, Wisconsin. Black River: New Jersey, Tennessee, Illinois, Minnesota, Wisconsin, Ontario.

57. **C. gibberula** Salter. (Fig. 502, *c–d*.) Ordovicic.

Hinge strongly bent. Muscle scars prominent.

Stones River: Minnesota. Black River: Tennessee, Illinois, Wisconsin, Iowa, Ontario.

58. **C. logani** Salter. (Fig. 502, *a–b.*) Ordovicic.
Beaks large. Muscle scars faint ; hinge nearly straight.
Black River : Wisconsin, Ontario.

59. **C. socialis** Ulrich. (Fig. 502, *e–f.*) Ordovicic.
Shell very small, quite inequilateral. Convexity moderate.
Very abundant in the Black River shale of Minnesota.

60. **C. alta** Hall. (Fig. 502, *k–l.*) Ordovicic.
Erect, subtriangular. Hinge plate as in *C. obliqua.*
Galena : Illinois, Wisconsin, Minnesota.

61. **C. levata** Hall. Ordovicic.
Differs from *C. albertina* in its greater proportional height and convexity, and in the absence of a pit beneath the beak.
Trenton : New York, New Jersey, Wisconsin. Lorraine : Pennsylvania.

62. **C. astartiformis** Salter. Ordovicic.
Differs from *C. obliqua* in its larger size (about twice that of the smaller form), in its smaller and more bent beaks, and in its stronger and more irregular concentric striæ.
Trenton : New York ?, Quebec, Lake Winnipeg, Manitoba.

63. **C. fecunda** Hall. (Fig. 502, *g–h.*) Ordovicic.
Hinge plate arcuate. Muscle scars faint. Form suboval.
Maquoketa : Illinois, Iowa, Wisconsin, Minnesota.

64. **C. calvini** Ulrich. (Fig. 502, *n.*) Ordovicic.
Differs from *C. fecunda* in its larger size and greater posterior height.
Maquoketa : Illinois, Iowa.

65. **C. obliqua** Hall. (Fig. 502, *i–j.*) Ordovicic.
Very small. Concentric lines comparatively strong. Hinge plate bent at nearly a right angle.
Cincinnati group of Ohio, Indiana. Maquoketa of Iowa and the Northwest.

66. **C. albertina** Ulrich. (Fig. 502, *m.*) Ordovicic.
Hinge plate sharply bent ; a small pit present beneath the beak.
Upper beds of Cincinnati group of Ohio and Minnesota.

67. **C. machæriformis** Hall. Siluric.
Shell thin, elongate. Beak subanterior. Surface marked with minute, equal, concentric striæ. Dimensions $1\frac{1}{4} \times \frac{1}{2}$ inches.
Clinton : New York.

68. **C. equilatera** Hall. Siluric.

Elliptical; anterior and posterior ends nearly equal. A groove extends from the beak nearly to the posterior extremity. Dimensions $1\frac{1}{8} \times \frac{5}{8}$ inches.

Cobleskill: New York.

XXVI. Nucula Lamarck.

Pearly, small, equivalve, varying in outline from trigonal to nearly circular or transversely elliptical. Beaks often subcentral, usually posterior to the middle and turned backward. Surface marked by concentric striæ. Hinge with a triangular resilifer beneath the beaks and a series of small transverse teeth on each side. Two subequal adductor muscle impressions in each valve. Pallial line simple. Interior margins often crenulate. (Probably a polyphyletic group.) Ordovicic–Recent.

69. **N. lirata** (Conrad). (Fig. 503, *d*.) Devonic.

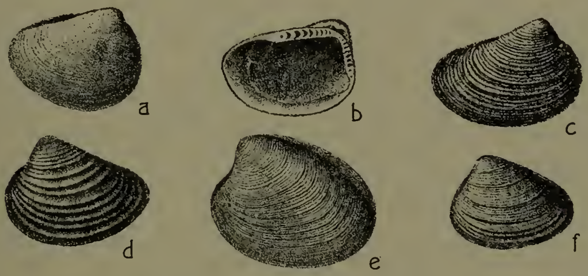


Fig. 503. *a, b, Nucula houghtoni; c, N. randalli; d, N. lirata; e, N. bellistriata; f, N. corbuliformis.* (N. Y. Surv.)

Gibbous. Concentric undulations strong and subangular.

Hamilton: New York, Pennsylvania, Ontario. Onondaga: Indiana.

70. **N. randalli** Hall. (Fig. 503, *c*.) Devonic.

Valves ventricose, their depth conjoined equalling their height. Striæ fine and thread-like but interrupted, especially toward the front, by growth varices.

Hamilton: New York, etc.

71. **N. bellistriata** (Conrad). (Fig. 503, *e*.) Devonic.

Differs from *N. randalli* in its broadly ovate outline, less gibbous valves, and finer striæ, usually without varices of growth

Hamilton: New York, etc.

72. **N. corbuliformis** Hall. (Fig. 503, *f*.) Devonic.
Distinguished by its small size and by its nearly equilateral triangular form.
Hamilton: New York, Pennsylvania.

73. **N. houghtoni** Stevens. (Fig. 503, *a–b*.) Upper Devonic and Mississippic.
Resembles *N. randalli* but is proportionally shorter and the very fine concentric lines are uninterrupted by varices.
Chemung: Iowa. Waverly: Ohio, Michigan.

74. **N. ventricosa** Hall. (Fig. 504.) Carbonic.
Very convex. Concentric striæ fine and regular.
Coal Measures: West Virginia to Colorado and Oklahoma.

75. **N. beyrichi** von Schauroth. (Fig. 505.) Carbonic.

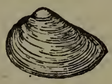


FIG. 504. *Nucula ventricosa.* (Kan. Pal., VI.)

FIG. 505. *Nucula beyrichi.* (Kan. Pal., VI.)

Very small. Hinge line nearly rectangular at beaks.
Coal Measures of Illinois, Kansas, Nebraska, Iowa.

76. **N. cancellata** Meek and Hayden. Cretacic.
Subtrigonal, rather gibbous. Hinge line sloping abruptly anteriorly and posteriorly from the beak. Beaks slightly anterior to the middle, and incurved nearly to touch each other. Surface marked with radiating striæ, crossed by fine concentric lines, so as to form a cancellate sculpture. Length about 1 inch; height about $\frac{2}{3}$ inch.
Pierre: Montana, North Dakota. Fox Hills: South Dakota, Nebraska, Colorado. Montana of Alberta. Also in Mexico.

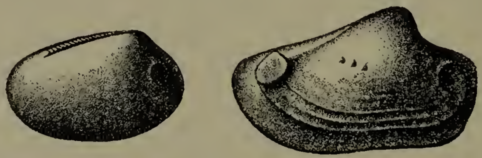


FIG. 506. *Nucula percrassa*, internal molds. (Pal. N. J., I.)

77. **N. percrassa** Conrad. (Fig. 506.) Cretacic.
Large. Surface covered with irregular concentric lines and fine radiating costæ most strongly developed anteriorly. Well preserved internal casts are strongly crenate on the margin.

Ripleyan of New Jersey (Cliffwood–Wenonah), Maryland, North Carolina, Alabama, Mississippi, Texas.

78. **N. whitfieldi** Weller. Cretacic.

Differs from *N. percrassa* in the absence of radiating costæ and marginal crenulations.

Ripleyan of New Jersey (Cliffwood–Red Bank).

79. **N. ovula** Lea. (Fig. 507.) Eocenic.

Margin very minutely crenulated.

Maryland (Aquia), Alabama (Midway and Lignitic).

XXVII. NUCULITES Conrad. (*Cleidophorus* Hall.)

Differs from *Nucula* in the absence of the resilifer beneath the beak, the row of teeth extending without interruption from the anterior muscle scar to the posterior, and in the presence of a nearly or quite vertical partition internally, separating the anterior muscle scar from the cavity of the shell and extending about two thirds the distance from beak to base. This partition leaves a deep furrow on the casts of the interior of the shell in which condition specimens of *Nuculites* are usually found. Ordovicic–Devonic.

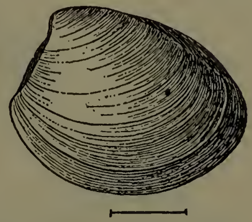


FIG. 507. *Nucula ovula.* (Md. Geol. Surv.)

80. **N. planulatus** (Conrad). Ordovicic.

Differs from *N. neglectus* in its smaller size, more prominent umbonal ridge extending from the beak to the posterior extremity, and in the conspicuous flattening of the shell hingeward from this ridge.

This species is the type of Hall's genus *Cleidophorus* founded upon the fact that no hinge teeth had been observed and also because of the flattening of the shell just noted.

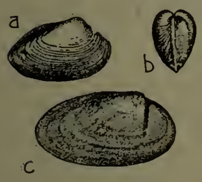


FIG. 508. *Nuculites (Clidophorus) neglectus.* *a*, *b*, external views; *c*, internal mold, enlarged. (Minn. Surv.)

Lorraine: New York, Pennsylvania. Utica: New York.

81. **N. neglectus** Hall. (Fig. 508, *a–c*.) Ordovicic.

Differs from *N. oblongatus* in its smaller size and in its subequal anterior and posterior extremities.

Characteristic of the Maquoketa shale of Illinois, Iowa, Wisconsin, Minnesota.

82. **N. oblongatus** Conrad. (Fig. 509, *a–c.*) Devonic.

Elongate-ovate, widest anteriorly. Beaks appressed and low. Surface marked by very fine concentric striæ.

Very abundant in the Hamilton: New York, Pennsylvania, Virginia. Also present in Marcellus of New York and Portage of Pennsylvania.

83. **N. triqueter** Conrad. (Fig. 509, *d–f.*) Devonic.

Distinguished by its trigonal form, prominent arching beaks and strongly arching umbonal ridge.

Very abundant in the Hamilton: New York, Pennsylvania, Virginia, Ontario. Also present in the Marcellus of New York, and Portage of Pennsylvania.

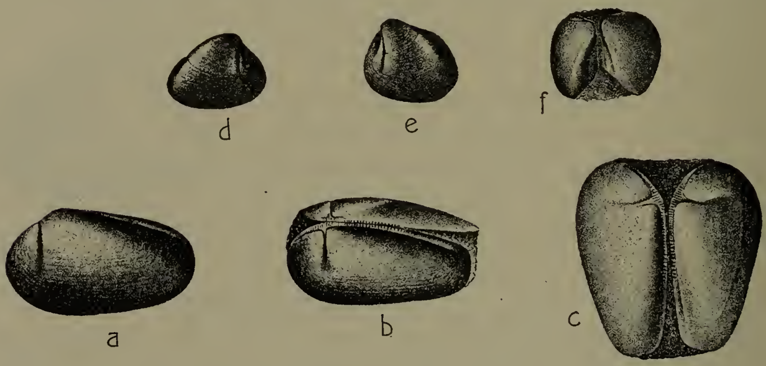


FIG. 509. *a–c, Nuculites oblongatus; d–f, N. triqueter.* (N. Y. Surv., V.)

XXVIII. PALÆONEILO Hall.

Shell *Nucula*-like, with extended anterior and posterior ends, and more or less defined depression along the umbonal slope. Ligament external and contained in narrow groove along the cardinal border. Pallial line simple.

Differs from *Nucula*, *Leda* and *Yoldia* in the absence of a resilifer beneath the beak and in having an external ligament and a post-umbonal depression externally. Differs from *Nuculites* in the absence of the internal anterior ridge. Devonic–Triassic.

84. **P. muta** Hall. (Fig. 510, *g–i.*) Devonic.

Varying in outline from more to less elongate, and thus resembling both *P. tenuistriata* and *P. fecunda.* Differs from both in the strong, lamellose striæ with very fine striæ intermediate.

Hamilton Group: New York, Pennsylvania, Virginia.

85. **P. tenuistriata** Hall. (Fig. 510, *c.*) Devonic.

Large, ovate, doubly truncate posteriorly. Surface marked with fine and often crowded concentric striæ.

Very abundant in the Hamilton of New York, etc.

86. **P. fecunda** Hall. (Fig. 510, *k, l.*) Devonic.

Differs from *P. tenuistriata* in its more elongate outline and coarser striæ, while in *P. muta* the striæ are still stronger, being coarse and lamellose.

Hamilton Group: New York, Virginia, Wisconsin?

87. **P. plana** Hall. (Fig. 510, *f.*) Devonic.

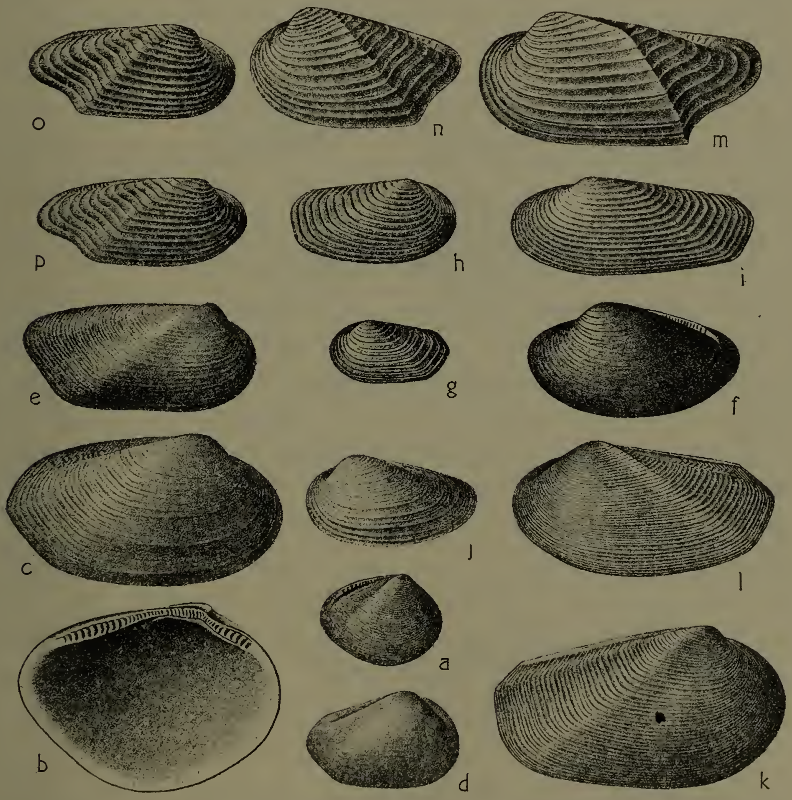


FIG. 510. *a, b, Paleoneilo constricta* (natural size and enlarged); *c, P. tenuistriata*, right valve; *d, P. brevis; e, P. marshallensis*, right valve; *f, P. plana*, enlarged; *g–i, P. muta*, 2 left and 1 right valve; *j, P. sulcatina; k, l, P. fecunda; m–p, P. emarginata.* (Pal. N. Y., V.)

Differs from *P. constricta* in its smaller size and more elongate form.

Common in Hamilton of New York, Pennsylvania and Ontario. Marcellus: New York. Ithaca: New York, Pennsylvania.

88. **P. emarginata** (Conrad). (Fig. 510, *m–p.*) Devonic.

Posterior margin deeply emarginate owing to the strongly marked ridge and depression on the umbonal slope. Concentric striæ strengthened into distant lamellose ridges with finer striæ between.

Hamilton: New York and Appalachian region. Portage: New York.

89. **P. constricta** (Conrad). (Fig. 510, *a, b.*) Devonic.

Basal margin rounded anteriorly and slightly constricted posteriorly. Surface striæ thread-like, often obsolescent.

Hamilton: Appalachian and interior regions. Portage and Chemung of New York and Pennsylvania.

90. **P. brevis** Hall. (Fig. 510, *d.*) Devonic.

Similar to *P. constricta* in general outline but is more gibbous, less curved along the basal margin, and only very slightly constricted posteriorly.

Chemung: New York, Pennsylvania.

91. **P. marshallensis** Winchell. (*P. truncata* Hall.) (Fig. 510, *e.*) Mississippic.

Distinguished by the nearly parallel basal and cardinal margins, the short anterior portion, the truncate posterior margin, and the fine striæ, which though in parts crowded do not rise into varices.

Waverly of Ohio: Marshall group of Michigan.

92. **P. sulcatina** (Conrad). (Fig. 510, *j.*) Upper Devonic and Mississippic.

Valves gibbous, regularly rounded, with no marked truncation or constriction. Concentric elevations sharp and lamellose interspersed with finer concentric striæ.

Chemung: Iowa. Waverly: Ohio, Michigan.

XXIX. Leda Schumacher. (*Nuculana* Link.)

Porcelainous, often somewhat crescent-shaped and produced posteriorly. Rounded anteriorly. Beaks often tumid, turned posteriorly. Surface concentrically striated. Hinge with a line of minute teeth, interrupted at beak by a triangular resilifer. Muscle impressions two and small. Pallial sinus small. Differs from *Nucula* in its more porcelainous structure, the presence of a pallial sinus and in the usually entire margins of the valves; also differs usually in outline. Siluric–Recent.

93. **L. rostellata** (Conrad). (Fig. 511, *d.*) Devonic.

Very small. Differs from *L. diversa* in its more elongate outline, more recurved posterior extremity, and finer striæ.

Hamilton: New York, Pennsylvania, Ontario. Portage: Pennsylvania.

94. **L. diversa** Hall. (Fig. 511, *c.*) Devonic–Mississippic.

Very small. Length about twice the height.

Hamilton and Portage of New York and Pennsylvania. Bedford shale of Ohio.

95. **L. pandoriformis** Stevens. (Fig. 511, *a*, *b.*) Mississippic.

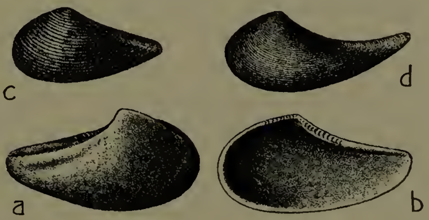


FIG. 511. *a*, *b*, *Leda pandoriformis; c*, *L. diversa; d*, *L. rostellata*, *c* and *d* enlarged, × 2. (Pal. N. Y., V.)

Large, with posterior extremity attenuate but subtruncate at its end.

Waverly: Ohio, Michigan.

96. **L. bellistriata** Stevens. (Fig. 512, *a*, *b.*)

Mississippic–Permic.

Large. Surface covered with fine and regular concentric striæ.

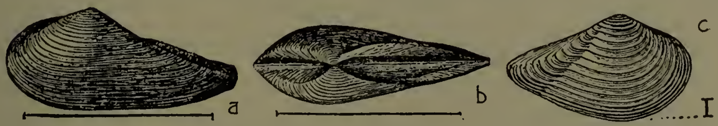


FIG. 512. *a*, *b*, *Leda bellistriata* (Ind. Surv.); *c*, *Leda parva*, right valve (Md. Surv.).

Widely distributed in the Carbonic from Ohio to Colorado. Also in Mississippic of Tennessee (Waverly Group) and Michigan (Marshall Group). Upper and Lower Permic of Kansas.

97. **L. parva** (Rogers). (Fig. 512, *c.*) Eocenic.
Minute (length about $\frac{1}{5}$ inch). Sharp oblique sulcus and sharp concentric lines present.
Atlantic and Gulf regions.

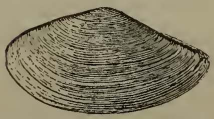


FIG. 513. *Leda eborea.* (After Harris.)

98. **L. eborea** Conrad. (Fig. 513.) Eocenic.
Distinguished by its almost triangular and equilateral form. Surface smooth and polished. Length usually about $\frac{1}{2}$ inch.
Abundant in Midwayan of Gulf region.

XXX. YOLDIA Moller.

Compressed, lanceolate, gaping behind, and more or less prolonged and tapering posteriorly. Beaks turned backward. Surface nearly smooth. Hinge as in *Nucula*. Pallial sinus deep. Differs chiefly from *Leda* in the gaping valves and in the deep pallial sinus. Cretacic–Recent.

99. **Y. septariana** Cragin. Cretacic.
Elongate, subovate, with beaks anterior to middle. Hinge line sloping abruptly on both sides from the beaks. Teeth 16–20 in front of the beaks and 21–29 behind. Surface marked with concentric lines. Length $\frac{3}{5}$ inch; height $\frac{2}{5}$ inch.
Very abundant in septaria of the Benton (Eagle Ford) of Texas.

100. **Y. evansi** Meek and Hayden. (Figs. 514–515.) Cretacic.

FIG. 514. *Yoldia evansi*, internal mold showing pallial sinus and hinge-denticles. (After Meek.)

FIG. 515. *Yoldia evansi* (upper), left valve; *Y. scitula* (lower), left valve. (After Meek.)

Outline similar to that of *Y. longifrons* but the shell is smaller (length not exceeding $\frac{4}{5}$ inch), and the surface is more nearly smooth, the concentric striæ being very obscure.
Fox Hills: South Dakota, Montana, Assiniboia. Pierre: Montana (Claggett), North Dakota (Bearpaw). Also Wyoming.

101. **Y. longifrons** (Conrad). (Fig. 516.) Cretacic.

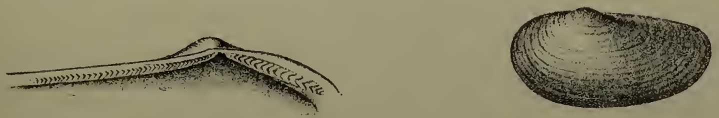


FIG. 516. *Yoldia longifrons;* with enlargement of hinge. (N. J. Pal., I.)

Surface of shell polished, marked only by fine concentric growth lines.

Ripleyan of New Jersey (Woodbury), Mississippi, Arkansas.

102. **Y. scitula** Meek and Hayden. (Fig. 515.) Cretacic.

Smaller than *Y. longifrons* (length about $\frac{2}{5}$ inch) and marked with distinct and regular concentric lines, which are strong on the middle of the valves.

Fox Hills: South Dakota, Montana. Pierre: Montana. Montanan: Assiniboia.

XXXI. PARALLELODON Meek and Hayden.

Elongate to subquadrate. Anterior end angular at cardinal line and rounded below. Posterior end rounded or obliquely subtruncate. Beaks anterior to middle. Hinge line long and straight. Concentric striæ often lamellose. Hinge with several small, diverging teeth beneath the beak and two to four long, lateral teeth near the posterior extremity, Ligament external. Pallial line simple. Devonic–Tertiary.

103. **P. chemungensis** Hall. (Fig. 517, *a.*) Devonic.

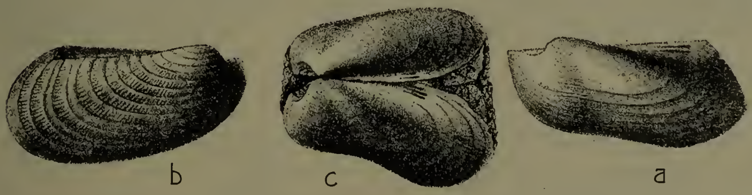


FIG. 517. *a, Parallelodon chemungensis,* left valve; *b, c, P. hamiltoniæ,* right valve and internal mold with valves in conjunction. (Pal. N. Y., V.)

Distinguished by its narrow form, truncated posterior end, and anterior constriction of the base. Concentric lines irregular and lamellose.

Chemung: New York, Pennsylvania.

104. **P. hamiltoniæ** Hall. (Fig. 517, *b, c.*) Devonic–Mississippic.

Differs from *P. chemungensis* in its broadly rounded posterior end, the absence of a sharp constriction in the basal margin, and in the presence of regular concentric varices.

FIG. 518. *Parallelodon obsoletus.* (Kan. Pal., VI.)

Abundant in Hamilton: New York, Pennsylvania, Maryland, Ohio. Mississippic: Ohio, Nevada.

105. **P. tenuistriatus** Meek and Worthen. Mississippic and Carbonic.

Strong radiating lines, scarcely visible anteriorly. Umbo large; anterior end rounded; length $\frac{3}{8}$ inch.

Waverly: Ohio. Coal Measures of Ohio–Nevada.

106. **P. obsoletus** Meek. (Fig. 518.) Mississippic–Carbonic.

Base a little sinuate medially and nearly parallel with the hinge line.

St. Louis of Indiana. Coal Measures of West Virginia–Colorado.

XXXII. Nemodon Conrad.

Equivalve, thin, small, transversely elongate, with sinuous base. Beaks depressed and anterior to middle. Hinge area narrow, long and nearly straight. Teeth consisting of a few minute granular denticles directly under the beak; lateral teeth few, long, linear, parallel to the hinge margin. Laterals longer than in *Cucullæa.*

FIG. 519. *Nemodon brevifrons*, with enlargement of cardinal region. (N. J. Pal., I.)

Surface marked with very obscure, punctate, radiating striæ and concentric lines.

Distinguished from *Arca* and *Parallelodon* by its teeth. Cretacic.

107. **N. vancouverensis** Meek. Cretacic.

Hinge and basal margins nearly parallel. Posterior end rather squarely truncate and the two extremities nearly equal in breadth. Length of small specimen $\frac{3}{4}$ inch; height $\frac{1}{2}$ inch. Surface marked with numerous prominent radiating ribs. Umbo much larger and more elevated than that of *N. brevifrons.*

Horsetown: California, Oregon. Chico: California, Vancouver.

108. **N. brevifrons** Conrad. (Fig. 519.) Cretacic.

Radiating lines nearly obsolete. Umbonal ridge rounded.

Ripleyan of New Jersey (Cliffwood, Wenonah?), North Carolina, Mississippi.

109. **N. eufalensis** (Gabb). (Fig. 520.) Cretacic.

FIG. 520. *Nemodon eufalensis*, with cardinal margin enlarged. (N. J. Pal., I.)

Valves marked with a mesial depression, producing a slight emargination of the base. Radiating striæ fine and numerous.

Ripleyan of New Jersey (Merchantville–Tinton), Georgia, Alabama, Mississippi, Arkansas.

110. **N. sulcatinus** Evans and Shumard. Cretacic.

Similar to *N. eufalensis* in outline but very small (length slightly over $\frac{1}{3}$ inch) and with mesial depression broad and deep.

Coloradoan: Utah, South Dakota. Montanan: Montana.

XXXIII. CUCULLÆA Lamarck.

Similar to *Arca* but hinge with short central transverse or oblique teeth and two to five short lateral teeth nearly parallel to the hinge line. Posterior adductor scar fixed to a thin raised plate.

The subgenus *Idonearca* includes in general the forms with thicker shells and fewer teeth than the typical *Cucullæa*. Jurassic –Recent.

111. **C. vulgaris** Morton. (Fig. 521.) Cretacic.

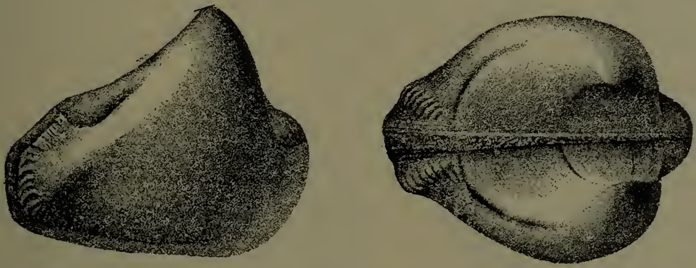


FIG. 521. *Cucullæa vulgaris*, internal molds. (N. J. Pal., I.)

Its internal molds differ from those of *C. tippana* in being more oblique, with longer beaks.

Jerseyan of New Jersey (characteristic of the Hornerstown marl), Maryland (Monmouth).

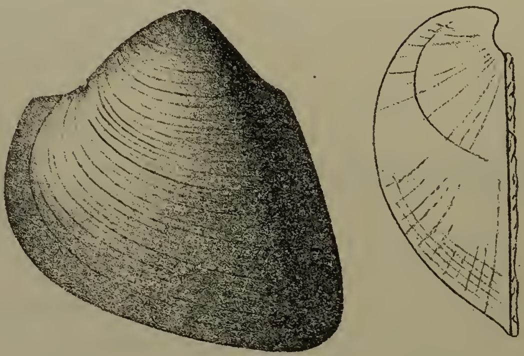


FIG. 522. *Cucullæa tippana.* (N. J. Pal., I.)

112. **C. tippana** Conrad. (Figs. 522–523.) Cretacic.

Basal margin nearly straight; posterior obliquely truncate.

Ripleyan of New Jersey (Marshalltown–Tinton), Texas (Navarro), Mississippi.

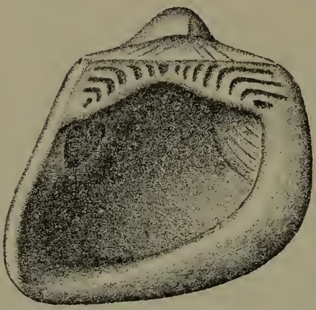


FIG. 523. *Cucullæa tippana*, interior of valve. (N. J. Pal., I.)

113. **C. neglecta** Gabb. Cretacic.

Smaller than *C. tippana* with more rounded outlines.

Ripleyan of New Jersey (Merchantville and Navesink), Alabama.

114. **C. antrosa** Morton. (Fig. 524.) Cretacic.

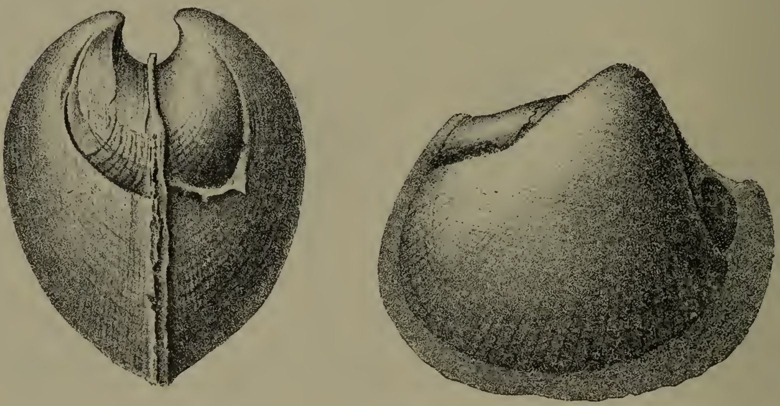


FIG. 524. *Cucullæa antrosa*, internal molds. (N. J. Pal., I.)

Subglobose. Its internal molds differ from those of *C. tippana* in the more rounded outline and usually larger size.

Ripleyan of Arkansas, Texas, New Jersey (characteristic especially of the Merchantville, also occurs in the Navesink).

115. **C. truncata** Gabb. Cretacic.

Differs from *C. gigantea* in the narrower and more pointed and upright, nearly central beaks.

Chico: California, Oregon.

116. **C. gigantea** Conrad. (Fig. 525.) Eocenic.

Varying much in size. Surface covered with numerous radiating striæ and concentric growth lamellæ.

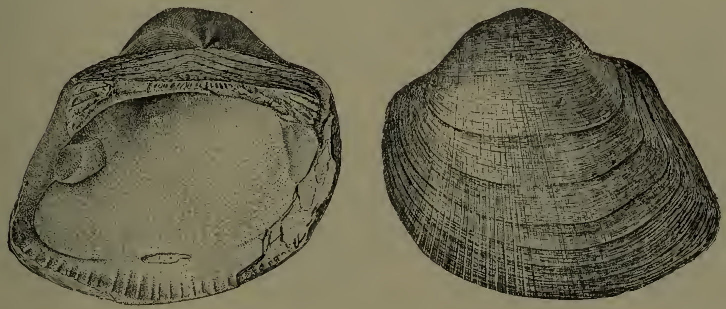


FIG. 525. *Cucullæa gigantea*, left valve from within and without, × ½. (Md. Surv.)

Throughout the Eocenic of Maryland and Virginia; Lignitic of Gulf states.

XXXIV. TRIGONARCA Conrad.

Differs from *Cucullæa* in its somewhat trigonal form, obliquely truncated posterior margin, and somewhat angular posterior basal extremity. Hinge curved. Teeth radially arranged. Hinge area divaricately furrowed. Cretacic and Tertiary.

117. **T. obliqua** Meek. (Fig. 526, *a–e.*) Cretacic.

Beaks small, depressed. Posterior umbonal slope prominent. Both muscle impressions are bordered by elevated ridges.

Coloradoan: Colorado (Pugnellus sandstone), Utah.

XXXV. BREVIARCA Conrad.

Small, suborbicular, with more or less rounded extremities. Surface nearly smooth or marked only with fine radii. Hinge

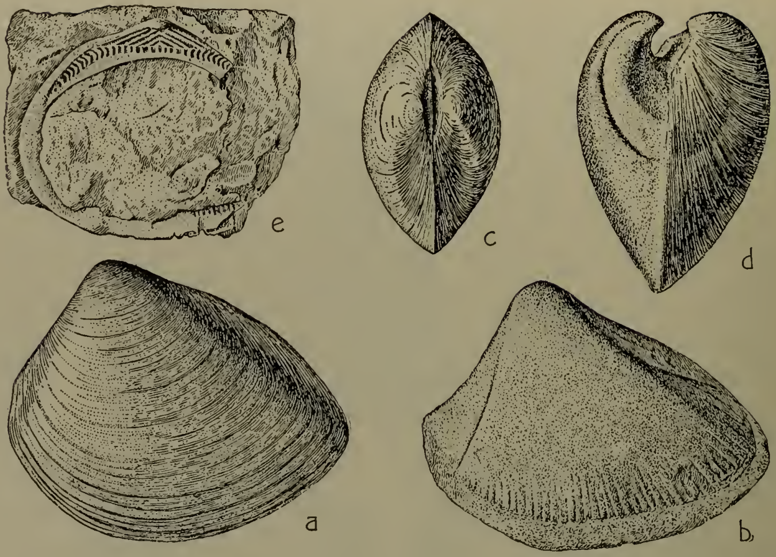


FIG. 526. *Trigonarca obliqua*, *a*, left valve of a large specimen; *b*, internal mold of left valve; *d*, posterior view of same, shell on right valve; *c*, dorsal view of a smaller specimen; *e*, hinge of right valve. (After Stanton.)

area with minute vertical striæ. Denticles very fine and crowded. Cretacic.

118. **B.? siouxensis** (Hall and Meek). Cretacic.

Anterior border vertically subtruncate but convex along the middle and rounding rather abruptly into the base and hinge line. Posterior side abruptly truncate above, narrowly rounded below. Beaks subcentral, nearer the posterior end, slightly or not at all oblique. Distinguished from other species by its large size (length nearly one inch and height slightly less) and by its straight basal margin.

Dakotan: South Dakota, Texas (Woodbine).

FIG. 527. *Breviarca saffordi*, enlargement of hinge and exterior natural size. (After Whitfield, Pal. N. J., I.)

119. **B. saffordi** (Gabb). (Fig. 527.) Cretacic.

Surface covered with fine radiating striæ.

Ripleyan of New Jersey (Woodbury), Tennessee.

120. **B. exigua** (Meek and Hayden). Cretacic.

Is proportionally higher, shorter and more gibbous than *B. saffordi*, but of about same size.

Pierre: Montana, South Dakota.

XXXVI. Cyrtodonta Billings.

Equivalve. Shell convex, usually heavy. Beaks prominent, incurved, situated in the anterior third of the shell. Surface marked with concentric lines. Hinge plate strong. Cardinal teeth two to four, strongly curved, situated mostly in front of the beaks. Posterior lateral teeth two or three, strong, elongate, slightly curved and oblique. Two adductor scars present; the

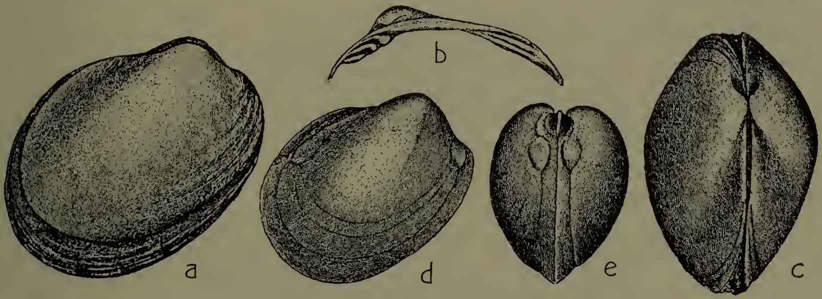


Fig. 528. *a–c*, *Cyrtodonta subovata*; *d*, *e*, *C. billingsi*. (Minn. Surv.)

posterior the larger but less impressed. Pallial line simple. Ordovicic and Siluric.

121. **C. billingsi** Ulrich. (Fig. 528, *d*, *e*.) Ordovicic.

Internal umbonal furrow and ridge present.

Upper Stones River: Illinois, Wisconsin, Minnesota.

122. **C. grandis** Ulrich. (Fig. 529.) Ordovicic.

Large. Surface smooth, marked with fine concentric growth lines.

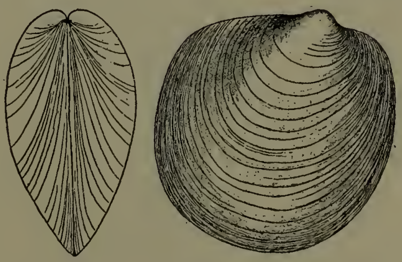


Fig. 529. *Cyrtodonta grandis*, $\times \frac{1}{2}$. (Minn. Surv.)

Trenton and Cincinnati Groups: Pennsylvania, Kentucky, Tennessee, Wisconsin, Minnesota, Iowa.

123. **C. subovata** Ulrich. (Fig. 528, *a–c*.) Ordovicic.
Hinge rather short. Surface nearly smooth, but with age developing strong marginal growth lines.
Upper Stones River of Kentucky. Black River of Wisconsin.

124. **C. undulostriata** Hall. Siluric.
Surface marked with strong concentric folds, covered with fine undulating concentric striæ.
Rochester shale of New York.

125. **C. canadensis** (Hall). (*Megalomus canadensis* Hall). (Fig. 530.) Siluric.
Shell extremely thick, ovoid, its depth equal to its height. Surface concentrically striated. The space within the shell, beneath

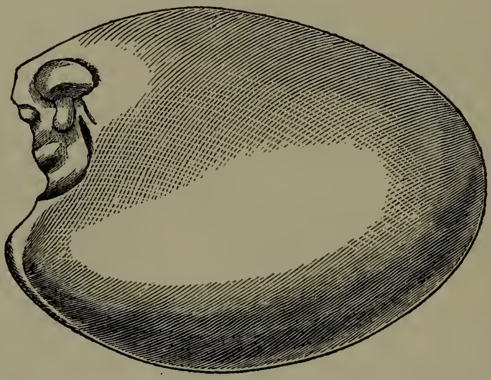


FIG. 530. *Cyrtodonta* (*Megalomus*) *canadensis*, internal mold. (After Logan.)

the beaks and extending over half way to the base of the valves is very much thickened so that an internal mold shows two projections at the hinge line instead of the single one of the beak as usual in *Cyrtodonta*.
Guelph: Ohio, Wisconsin and Ontario.

XXXVII. MEGAMBONIA Hall.

Equivalve or nearly so, gibbous, inequilateral, with shorter anterior end which bears a strong muscular impression. Posterior extremity expanded and compressed, frequently wing-like. Surface marked with concentric growth lines and often with fine radiating striæ. Teeth numerous, in the anterior portion of the hinge.

Differs from *Ambonychia* in the strong anterior muscular impression and the numerous teeth in the anterior portion. Siluric–Carbonic.

126. **M. lata** Hall. Devonic.

Anterior slope oblique; posterior basal margin expanded. Gibbous in the middle and in the umbonal region.

Helderbergian: New York, Oklahoma.

127. **M.? aviculoidea** Hall. (Fig. 531.) Upper Siluric and Lower Devonic.

Surface marked with fine concentric striæ which are unequally lamellose. This may be a Pterinea.

Distinguished from similar species of other genera by the very small anterior ear, the strong anterior muscle scar characteristic of the genus, and the posterior wing, not defined from the rest of the shell by sinus or change of ornamentation.

FIG. 531. *Megambonia ? aviculoidea*, left valve. (Pal. N. Y., III.)

Manlius: New York, New Jersey. Helderbergian: New York.

128. **M. suborbicularis** Hall. (Fig. 532.) Devonic.

Anterior muscular impression prominent on internal molds. Type of the genus.

New Scotland: New York.

FIG. 532. *Megambonia suborbicularis*, *a*, left side of internal mold showing muscular impression; *b*, profile of posterior side of same. (Pal. N. Y., III.)

129. **M. ovata** Hall. Devonic.

Distinguished by its nearly symmetrically ovate form with the anterior side a little more regularly curved than the posterior, and by the subacute beak.

New Scotland: New York.

130. **M.? lamellosa** Hall. (Fig. 533.) Devonic.

Both ears separated from the body of the shell by a depression. Lamellose striæ more or less prominent.

Oriskany: New York–Maryland.

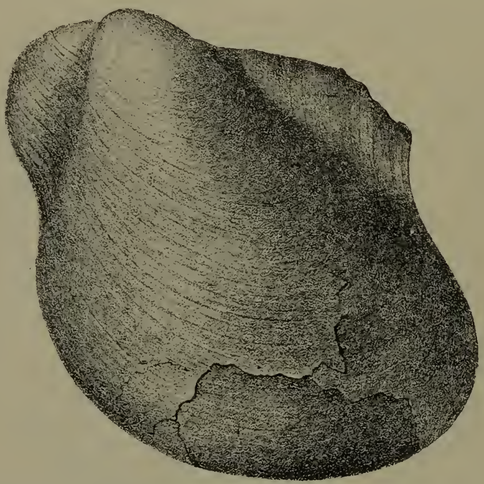


FIG. 533. *Megambonia ? lamellosa.* (Pal. N. Y., III.)

XXXVIII. ORTONELLA Ulrich.

Equivalve, very inequilateral. Beaks and umbonal ridge moderately prominent. Surface marked with concentric striæ. Hinge like that of *Cyrtodonta* but with cardinal teeth stronger and placed immediately behind the beaks. Adductor scars subequal. Ordovicic.

131. **O. hainesi** S. A. Miller. (Fig. 534.) Upper Ordovicic.

Concentric striæ fine. Umbonal ridge rather strong. Type of the genus. Uppermost beds of Cincinnati Group of Indiana.

XXXIX. VANUXEMIA Billings.

Differs from *Cyrtondonta* in the more nearly terminal beaks, and in the anterior adductor muscle scars being excavated out of the hinge plate. An internal umbonal ridge is well developed. Ordovicic.

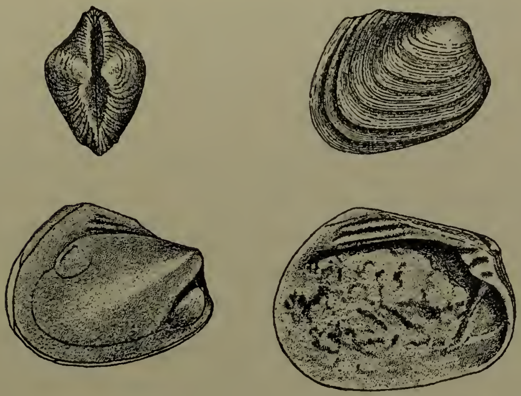


FIG. 534. *Ortonella hainesi.* (Ohio Geol., VII. After Ulrich.)

132. **V. terminalis** Ulrich. (Fig. 535, *g–i.*) Ordovicic.
Beaks terminal. Anterior muscle scars almost hidden.
Upper Stones River of Wisconsin, Minnesota.

FIG. 535. *a–c*, *Vanuxemia dixonensis; d–f*, *V. umbonata*, right and cardinal views; *g–i*, *V. terminalis*, internal molds, left, right and anterior views; *j*, *V. rotundata; k*, *V. hayniana*, right internal mold. (Minn. Surv.)

133. **V. dixonensis** Meek and Worthen. (Fig. 535, *a–c*.) Ordovicic.

More oblique, more convex, and with more rounded hinge extremities than *V. umbonata*.

Upper Stones River of Illinois, Wisconsin, Minnesota.

134. **V. rotundata** Hall. (Fig. 535, *j*.) Ordovicic.

More erect, with more circular outline than *V. dixonensis*.

Upper Stones River of Wisconsin, Minnesota?

135. **V. umbonata** Ulrich. (Fig. 535, *d–f*.) Ordovicic.

Shell substance rather thin. Cardinal teeth long.

Black River: Kentucky, Minnesota.

136. **V. hayniana** Safford. (Fig. 535, *k*.) Ordovicic.

Not so high as *V. umbonata* and with longer hinge line.

Trenton: Pennsylvania, Kentucky, Tennessee, Minnesota.

XL. Whitella Ulrich.

Differs from *Cyrtodonta* in its thinner shell, the presence of a longitudinally striated area extending posteriorly from the beaks, an

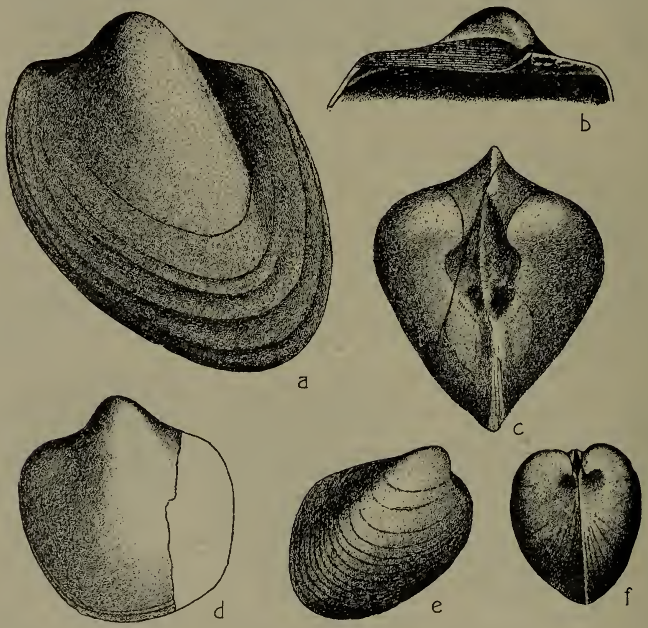


FIG. 536. *a*, *b*, *Whitella scofieldi*, left valve and its hinge; *c*, *d*, *W. quadrangularis*; *e*, *f*, *W. ventricosa*, right and anterior views of internal mold. (Minn. Surv.)

umbonal ridge, anterior teeth merely two to five oblique folds and posterior lateral wanting; internal ligament supported by a ridge in each valve which is at times mistaken for a posterior tooth. Ordovicic-Siluric.

137. **W. megambona** Whitfield. (Fig. 537, *a*, *b*.) Ordovicic.
Hinge line very short. Striated area very short and narrow.
Upper Stones River of Wisconsin, Minnesota.

138. **W. scofieldi** Ulrich. (Fig. 536, *a*, *b*.) Ordovicic.
Outline different and hinge and striated area longer than in *W. megambona*.
Upper Stones River of Minnesota.

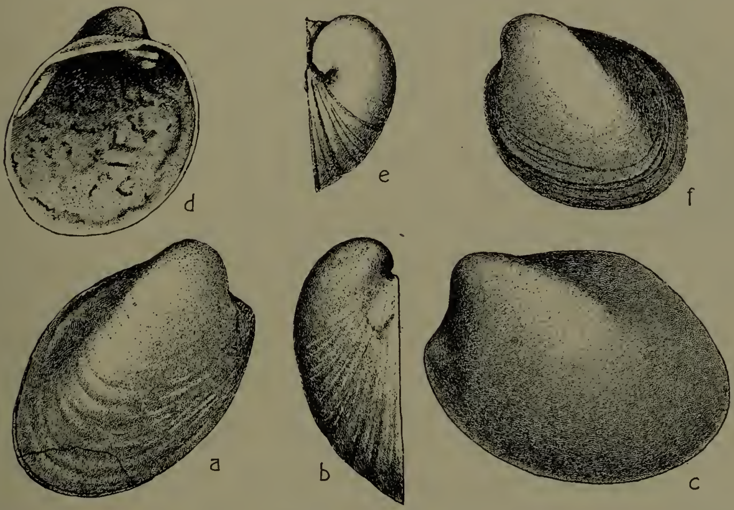


FIG. 537. *a*, *b*, *Whitella megambona*, right valve; *c*, *W. obliquata*, left internal mold; *d–f*, *Plethocardia umbonata*. (Minn. Surv.)

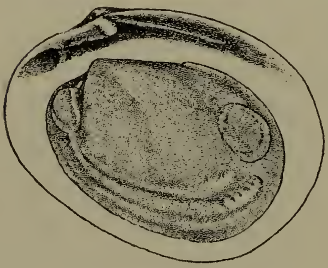
139. **W. ventricosa** Hall. (Fig. 536, *e*, *f*.) Ordovicic.
Very convex.
Black River-Trenton: New York, Minnesota?, Canada.

140. **W. obliquata** Ulrich. (Fig. 537, *c*.) Ordovicic.
Subquadrangular, very oblique.
Cincinnati Group: Ohio, Indiana, Minnesota.

141. **W. quadrangularis** Whitfield. (Fig. 536, *c*, *d*.) Ordovicic.
More convex, less oblique, than *W. obliquata* with larger beaks and wider cardinal area.
Upper beds of Cincinnati Group: Ohio, Illinois, Minnesota.

XLI. Plethocardia Ulrich.

Very similar to *Whitella* but differs from that genus in the large and strong cardinal process which projects forward and downward from just beneath the beak in each valve; also differs in the deeply impressed anterior adductor scar margined on the inner side by a curved ridge extending from the under side of the cardinal process. Ordovicic.



142. **P. umbonata** Ulrich. (Fig. 537, *d–f.*) Ordovicic.
Type of the genus.
Black River: New York, Kentucky, Minnesota.

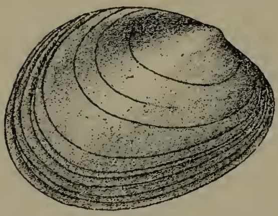


Fig. 538. *Ischyrodonta unionoides*, interior and internal mold; exterior of right valve. (Geol. Ohio, VII.)

XLII. Ischyrodonta Ulrich.

Valves thick. Beaks small, anterior. Hinge plate wide, without posterior lateral teeth but with two strong cardinal teeth in the left valve and one large one in the right. Ligament internal posterior to the beaks. Anterior muscle scar sharply defined on the inner side by a ridge extending from the cardinal teeth to the base of the scar. Ordovicic.

143. **I. unionoides** Meek. (Fig. 538.) Ordovicic.
Surface marked with a few distant growth lines.
Middle beds of Cincinnati Group: Ohio, Kentucky.

144. **I. modioliformis** Ulrich. (Fig. 539.) Ordovicic.
Elongate. Surface marked with subregular concentric furrows and ridges.
Upper beds of Cincinnati Group: Indiana.

Fig. 539. *Ischyrodonta modioliformis*. (After Ulrich, Geol. Ohio, VII.)

145. **I. truncata** Ulrich. (Fig. 540.) Ordovicic.
Subquadrate. Posterior margin truncate rounded. Surface marked with a few sublamellose growth lines.
Near top of Cincinnati Group: Ohio, Indiana.

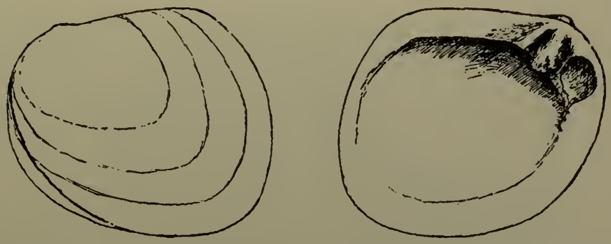


FIG. 540. *Ischyrodonta truncata.* (After Ulrich, Pal. Ohio, VII.)

XLIII. ARCA Lamarck.

Shell thick, ventricose, trapezoidal. Beaks conspicuous, distant, separated by an area which has many ligamental grooves converging from the hinge margins to the beaks. Surface radially sculptured. Hinge line wide, straight, transversely dentate; teeth small and similar (taxodont). Cretacic–Recent.

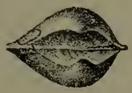


FIG. 541. *Arca quindecemradiata.* Internal mold. (After Whitfield, Pal. N. J., I.)

This has been divided into several subgenera of which *Barbatia* is one.

146. **A. quindecemradiata** Gabb. (Fig. 541.) Cretacic.

Rather small, ventricose and very inequilateral; anterior rounding rapidly into basal margin; beaks slightly incurved, a little in front of the mid-length of the hinge line; obliquely truncate posteriorly; surface with coarse rounded ribs.

Jerseyan (Vincentown) of New Jersey.

XLIIIA. BARBATIA (Gray) Adams.

Central teeth smallest and vertical; lateral teeth becoming gradually larger, more distant, and more oblique. Periostracum hairy. Cretacic–Recent.

147. **B. micronema** (Meek). (Fig. 542.) Cretacic.

Growth and radiating lines faint. Beaks in anterior fourth.

Colorado Group of Wyoming, Utah, Texas. Dakota of Texas.

148. **B. cuculloides** (Conrad). Eocenic–Oligocenic.

Valves marked with strong, subcentral sinus. Posterior side elongated, strongly ribbed, and carinated; anterior end truncate. Surface reticulate by strong growth lines passing over the radiating ribs.

Eocenic: Georgia, Alabama, Mississippi, Arkansas. Lower Oligocenic: Mississippi.

FIG. 542. *Barbatia micronema*, right valves. (U. S. G. S., Bull. 106.)

XLIV. GLYCIMERIS Da Costa. (*Pectunculus* Lamarck.)

Shell thick, equivalve, suborbicular, almost equilateral. Umbos central, slightly curved posteriorly, separated by a small triangular area provided with diverging grooves for the ligament. Hinge with an arched row of strong, transverse teeth, obliterated at the center in older forms by the growth of the area. Margins of valves crenulate inside. Adductor scars subequal. Pallial line with a very small sinus. Cretacic–Recent.

149. **G. (Axinea) subaustralis** (d'Orbigny). (Fig. 543.) Cretacic.
Subcircular, very slightly oblique. Beaks strongly elevated

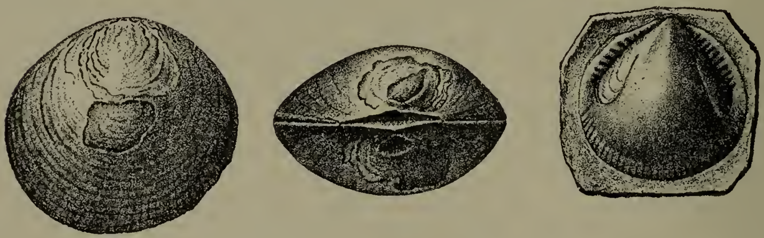


FIG. 543. *Glycimeris* (*Axinea*) *subaustralis*. (N. J. Pal., I.)

and pointed. Surface covered with concentric growth lines and fine radiating costæ.

Ripleyan of New Jersey (Merchantville–Tinton), Gulf states.

150. **G. congesta** (Conrad). Cretacic.

Differs from *G. subaustralis* in its smaller size, more elliptical form, and straighter hinge line.

Ripleyan of New Jersey (Cliffwood–Wenonah), North Carolina.

FIG. 544. *Glycimeris idonea*, × $\frac{2}{3}$. (Md. Surv.)

151. **G. idonea** (Conrad). (Fig. 544.) Eocenic.

Larger. Surface marked with obscure radiating striæ.

Pamunkey of Maryland, Lignitic of Georgia and Alabama.

XLV. PTERINEA Goldfuss.

Inequivalve, very inequilateral. Left valve convex; right valve flat. Hinge margin constricted into ears. Surface radially sculptured or smooth. Ligmental area extending on both sides of the beak and longitudinally grooved. Anterior teeth transverse; posterior elongate, nearly parallel to the hinge line. Anterior muscle scar small. Pallial line simple. Ordovicic–Carbonic.

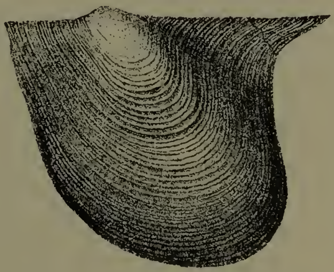


FIG. 545. *Pterinea demissa*. (Geol. Ohio, II.)

152. **P. demissa** (Conrad). (Fig. 545.) Ordovicic.

Distinguished by its strong concentric growth lines and large anterior ear.

Cincinnati Group: New York–Iowa; Wisconsin.

153. **P. emacerata** (Conrad). (Fig. 546.) Siluric.

Right valve flat, smooth, with striated wing. Left valve convex, with strong radii crossed by concentric striæ.

Clinton and Niagara: New York, New Jersey (Decker Ferry), New Hampshire?

154. **P. striæcosta** McChesney. (*P. brisa* Hall.) Siluric.

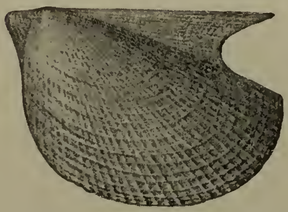


Fig. 546. *Pterinea emacerata.* (Pal. N. Y., II.)

Surface marked with strong, radiating and concentric striæ and broad radiating ribs.

Clinton: Ohio, Indiana, Kentucky. Niagaran: Indiana, Wisconsin.

155. **P. lanii** Grabau. (Fig. 547.) Siluric.

Strongly oblique, surface with concentric striæ only.

Lower Monroe (Raisin River) of Michigan, Ohio and Canada.

156. **P. securiformis** (Hall). (Fig. 548.) Upper Siluric–Lower Devonic.

Shell convex. Anterior ear practically absent; posterior small. Surface covered with concentric striæ and distant strong radiating ones.

Fig. 547. *Pterinea lanii*, left valve of a small individual. (After Whitfield.)

Cobleskill: New York. Helderbergian: New York, Oklahoma.

157. **P. naviformis** (Conrad). (Fig. 549.) Devonic.

Fig. 548. *Pterinea securiformis.* (Pal. N. Y., III.)

Similar to *Actinopteria communis* but differs in its much larger posterior ear and in its obscure radiating and concentric striæ.

Helderbergian: New York, Gaspé.

158. **P. gebhardi** (Conrad). (Fig. 550.) Devonic.

Large, suborbicular. Left valve marked with about 15 slightly impressed radiating grooves, forming faint, wide and convex ribs. Ears equal, not produced. Height about 5 inches.

Oriskany: New York.

159. **P. (Cornellites) flabellum** (Conrad). (Fig. 551.) Devonic.

Left valve with beak curving to or over the hinge margin. Surface marked with 6–12 strong ribs alternating with one to several weaker rays, the latter present also on the ears. Right valve with beak depressed, not rising above the hinge; surface lacking rays except weak ones on the posterior ear. Both valves crossed by concentric growth lines.

FIG. 549. *Pterinea naviformis*, left valve. (Pal. N. Y., III.)

Characteristic of the Onondaga and Hamilton of New York to Indiana, Michigan, Ontario and the Appalachian region; also rarely in the Chemung Group of the same region.

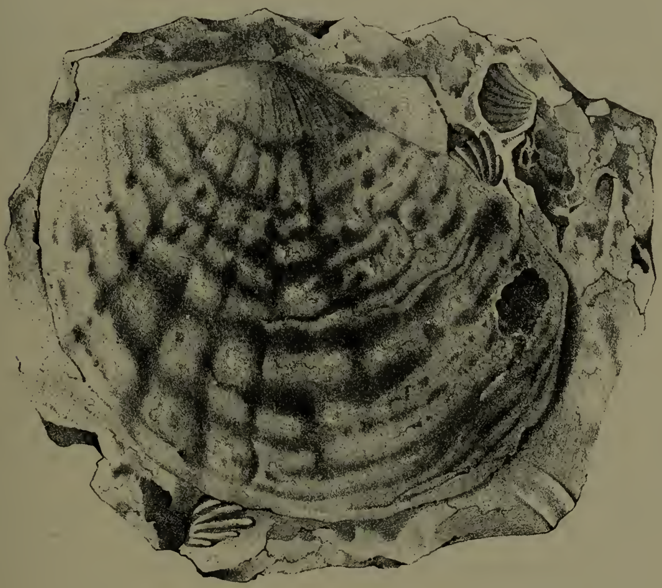


FIG. 550. *Pterinea gebhardi*, × ½. (After Hall, Pal. N. Y., III.)

160. **P. chemungensis** (Conrad). (Fig. 552, *a*, *b*.) Devonic.

Surface of left valve marked with slender, interrupted, irregularly alternating rays which on the right valve are confined to the ears. Surface of both valves crossed by fine concentric striæ. Valves are often less oblique than in figure.

Chemung Group: New York.

161. **P. consimilis** Hall. (Fig. 552, *e.*) Devonic.

Differs from *P. chemungensis* in being shorter, proportionately more extended on the hinge line, with wider ligamental area, more distinct rays, and greatly different proportions of length and breadth.

Chemung Group: New York.

XLVI. Limoptera Hall.

Differs from *Pterinea* in the less conspicuous separation of the posterior wing from the body of the shell, and in the numerous

Fig. 551. *Pterinea* (*Cornellites*) *flabellum*. (Pal. N. Y., V.)

small pits for the attachment of umbonal muscles in the inter-pallial area. Pallial line also formed of a series of small deep pits. Devonic.

162. **L. cancellata** Hall. (Fig. 552, *c, d.*) Devonic.

Body of shell nearly vertical to hinge line. Surface covered with regular sharp concentric striæ and crossed by narrow rays separated by broad flat interspaces.

Hamilton of Falls of the Ohio.

163. **L. macroptera** (Conrad). (Fig. 553, *d.*) Devonic.

Right valve much less convex than left. Anterior ear very small. Surface marked with rays which become obscure below the middle of the shell. Concentric striæ lamellose.

Hamilton: New York, Ontario.

164. **L. obsoleta** Hall. (Fig. 553, *e.*) Devonic.

Differs from *L. macroptera* in its less convexity, less angular posterior ear and in the rays being absent or very obscure.

Hamilton: New York.

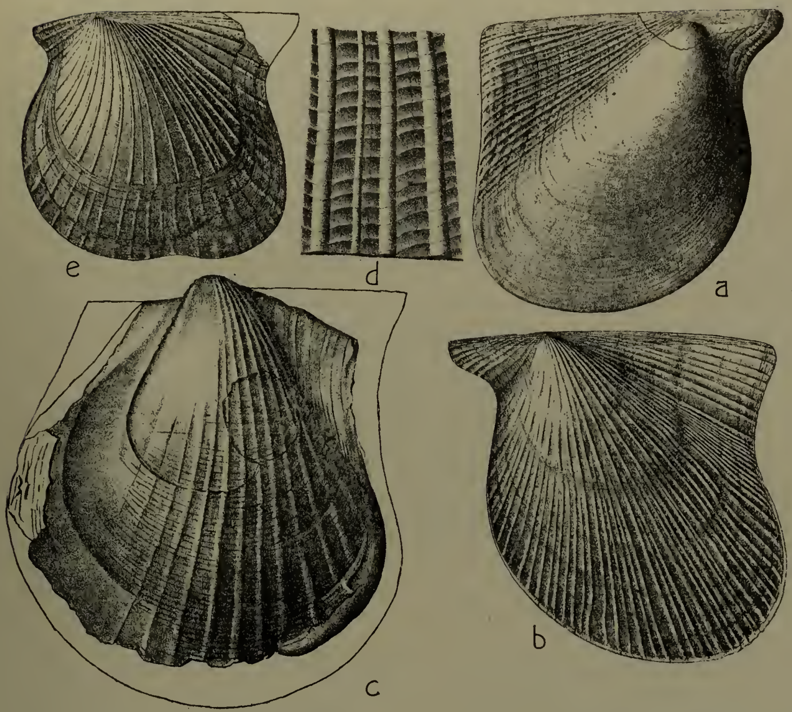


FIG. 552. *a, b, Pterinea chemungensis*, right and left valves; *c, Limoptera cancellata; d*, surface of left valve of *L. cancellata*, enlarged; *e, Pterinea consimilis*, left valve. *a, b, c* and *e*, $\times \frac{2}{3}$. (Pal. N. Y., V.)

XLVII. ACTINODESMA Sandburger. (*Glyptodesma* Hall.)

Like *Pterinea* but with wings elongate and narrow and less strong limitation between body of shell and wing. Surface concentrically striated. Devonic.

165. **A. occidentale** (Hall). (Fig. 553, *c*.) Devonic.

Differs from *A. erectum* in its more orbicular shell, more gibbous umbonal region, more rugose concentric striæ, and less strong limitation between the body of the shell and the much extended posterior wing.

Onondaga: Falls of the Ohio.

166. **A. erectum** (Conrad). (Fig. 553, *a, b*.) Devonic.

Anterior wing limited by a distinct furrow. Surface covered with concentric striæ which are more conspicuous upon the ears. Hinge line often greatly extended.

Hamilton: New York, Ohio, Indiana.

FIG. 553. *a*, *b*, *Actinodesma erectum*, right and left valves; *c*, *A. occidentale; d*, *Limoptera macroptera; e*, *L. obsoleta*. All figures, $\times \frac{1}{2}$. (Pal. N. Y., V.)

XLVIII. LEIOPTERIA Hall.

Outline *Pterinea*-like. Ligament area longitudinally striated. One or two oblique lateral teeth present. Cavity of beak partially separated from the anterior end by a short partition. Surface without rays. Siluric–Mississippic.

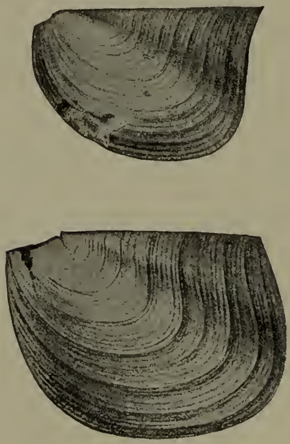


FIG. 554. *Leiopteria? subplana*, left valves. (Pal. N. Y., II.)

167. **L.? subplana** (Hall). (Fig. 554.) Siluric.

Depressed-convex. Right and left valves similar. Ears poorly defined.

Rochester and Cobleskill of New York. Guelph: New York, Canada.

168. **L. lævis** Hall. (Fig. 555, *a*, *b*.) Devonic.

Length and height nearly equal. Anterior ear marked by a strong, angular fold. Surface covered with obscure traces of radiating striæ.

Marcellus and Hamilton: New York, Pennsylvania.

169. **L. rafinesquii** Hall. (Fig. 555, *c.*) Devonic.

Anterior ear broadly arched. Surface covered with concentric striæ which at intervals are raised into strong lamellæ and undulations.

Hamilton: New York, Ontario. Lower Devonic of Nevada.

170. **L. dekayi** Hall. (Fig. 555, *d.*) Devonic.

Differs from *L. lævis* in its larger size and more defined posterior cardinal slope; from *L. rafinesquii* in its finer and not lamellose striæ though concentric undulations are at times present.

Characteristic of the Hamilton of New York.

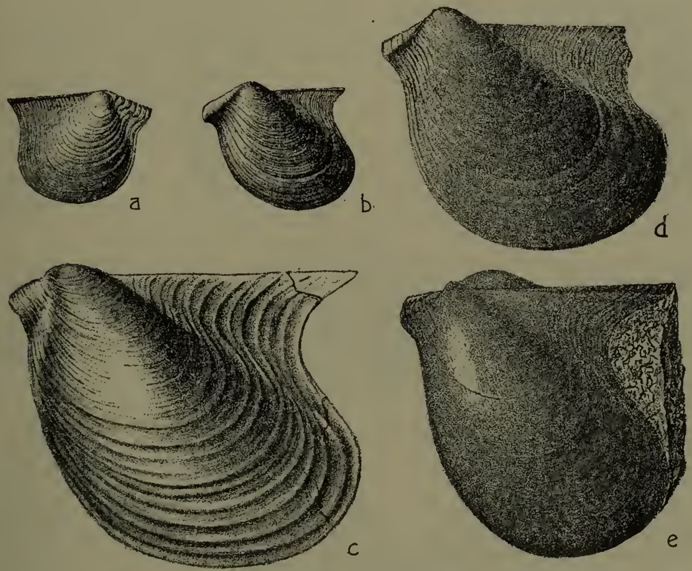


FIG. 555. *a*, *b*, *Leiopteria lævis*, right and left valves, × 2; *c*, *L. rafinesquii*; *d*, *L. dekayi*; *e*, *L. chemungensis*. (Pal. N. Y., V.)

171. **L. chemungensis** Vanuxem. (Fig. 555, *e.*) Devonic.

Differs from *L. dekayi* in its longer hinge line, larger posterior ear, more acute beak, and narrower body of shell.

Chemung of New York, etc.

XLIX. Leptodesma Hall.

Differs from *Leiopteria* in its acute instead of rounded anterior ear; lateral tooth single and nearly parallel to hinge line.

Devonic.

172. **L. rogersi** Hall. (Fig. 556, *b*.) Devonic.

Umbonal region gibbous. Posterior ear with mucronate extremity.

Hamilton: New York, Pennsylvania, Iowa.

173. **L. sociale** Hall. (Fig. 556, *c*.) Devonic.

Distinguished by its form and regular lamellose appearance of the surface.

Chemung: New York.

174. **L. maclurii** Hall. (Fig. 556, *a*.) Devonic.

Body of shell gibbous, oblique. Anterior ear limited by a broad, vertical furrow.

Chemung: New York, Pennsylvania.

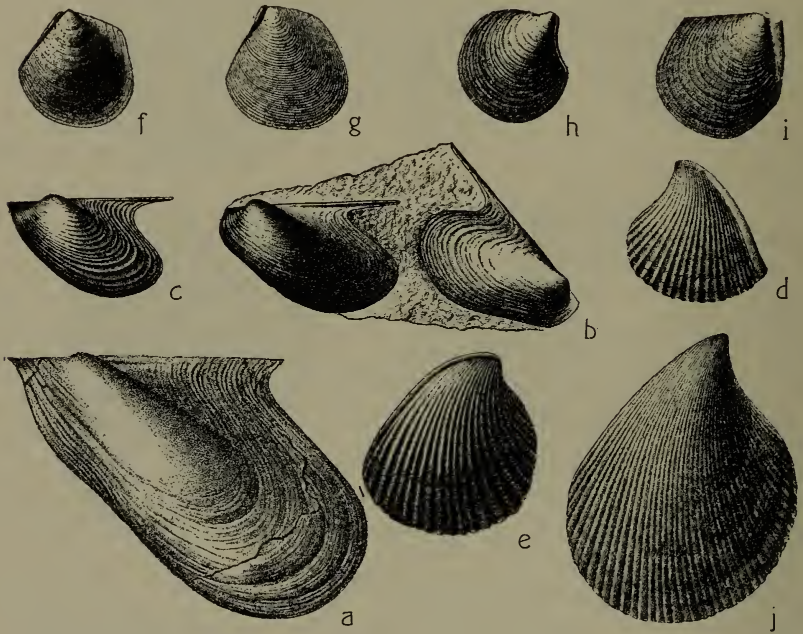


FIG. 556. *a*, *Leptodesma maclurii*, left valve; *b*, *L. rogersi*; *c*, *L. sociale*; *d*, *e*, *Lunulicardium curtum*, right and left valves; *f–i*, *Pterochænia fragilis*; *j*, *Lunulicardium acutirostrum*, left valve. (Pal. N. Y., V.)

L. LOXOPTERIA Frech.

Inequivalve, very inequilateral. Anterior muscle scar small. Ligament external. Teeth obscure.

Appearance like the gastropod *Capulus*. Left valve very convex, with arched and incurved beak twisted backward. Right valve depressed-convex, appearing like the operculum of the larger valve; this valve expands into a small posterior wing. Devonic.

175. **L. lævis** Frech. (Fig. 557.) Devonic.

Surface marked only with concentric striæ.

Portage (Naples fauna) of New York.

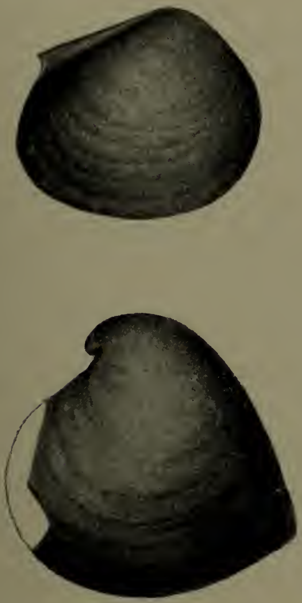


FIG. 557. *Loxopteria lævis*, right valve (upper), $\times 2$; left valve, $\times 1.5$. (After Clarke, Mem. 6, N. Y. State Surv.)

FIG. 558. *Loxopteria dispar*, left valve (upper), $\times 1.5$; right valve, $\times 2$. (After Clarke, Mem. 6, N. Y. State Surv.)

176. **L. dispar** (Sandberger). (Fig. 558.) Devonic.

Surface marked with few radiating ribs but with very numerous and fine radiating and concentric striæ.

Portage (Naples fauna) of New York.

LI. LUNULICARDIUM Munster.

Usually triangular, with acute and abruptly terminal, posteriorly turned beaks. Shell usually obliquely truncate in front, with a deeply impressed area posterior to the beaks; in this area, between the two valves, is a conspicuous opening for the byssus. Posterior and basal margins regularly rounded. Surface crossed by concentric striæ and usually by radii. Teeth absent. Pallial line simple. Siluric and Devonic.

177. **L. curtum** Hall. (Fig. 556, *d, e.*) Devonic.

Length usually less than height. Surface marked by 25–30 regular plications with wider interspaces and by fine lamellose concentric striæ.

Marcellus and Hamilton: New York.

178. **L. ornatum** Hall. Devonic.

Differs from *L. curtum* in its proportionately shorter and straighter anterior margin and the more numerous plications (45–60).

Hamilton–Chemung: New York.

179. **L. acutirostrum** Hall. (Fig. 556, *j.*) Devonic.

Acuminate; lateral margins long. Surface marked with simple radiating plications crossed by coarse concentric growth lines.

Genesee: New York.

LII. PTEROCHÆNIA Clarke.

Differs from *Lunulicardium* in its thin valves, surface marked only with fine concentric growth lines; all radiating lines lie on the inner surface of the valves and may be outwardly visible by translucence. Beaks turned forward. Anterior to the beaks and bounding the conspicuous byssal opening is a wing-like flange which is widest at the beak becoming rapidly narrower towards the base of the shell. Devonic.

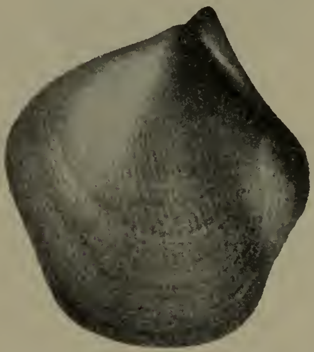


FIG. 559. *Pterochænia sinuosa*, right valve, × 3. (After Clarke, N. Y. Surv. Mem., 6.)

180. **P. fragilis** (Hall). (*Lunulicardium fragile.*) (Fig. 556, *f–i.*) Devonic.

Small, not exceeding $\frac{1}{2}$ inch in diameter, elongate-oval, fragile. Surface marked with concentric striæ. Usually the flat expansion bordering the posterior edge is broken off.

Marcellus–Portage: New York–Indiana.

181. **P. sinuosa** Clarke. (Fig. 559.) Devonic.

Differs from *P. fragilis* in its larger size, sinuous surface and undulated outline.

Genesee : New York.

LIII. Honeoyea Clarke.

Differs from *Lunulicardium* in the minute, inflected beak, and the abrupt slope from the sides of the umbo to the hinge line. Anterior to the beak is a byssal notch and posterior to the beak is a similar concave area which contains no such opening between the valves. Surface covered with radiating ribs. Devonic.

182. **H. erinacea** Clarke. (Fig. 560.) Devonic.

Subtriangular. Surface marked with 12–15 sharply angular ribs alternating with 3 or 4 weak rays. The ridge bounding the posterior hinge area gives off four to six hollow spines.

Portage : New York.

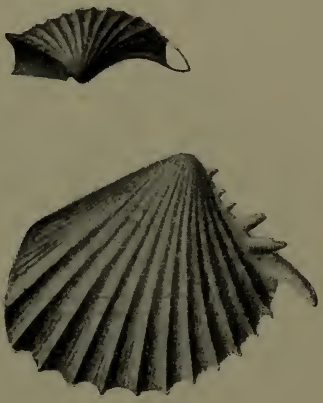


Fig. 560. *Honeoyea erinacea*, left valve, × 5 ; cardinal view of another left valve, × 3. (After Clarke, N. Y. Surv. Mem., 6.)

LIV. Ambonychia Hall (emend Ulrich).

Equivalve and very inequilateral. Beaks nearly or quite terminal. No anterior wing present but a more or less winged posterior extremity. Valves ventricose, thin, and tightly closed all around. Surface marked with fine radiating striæ crossed by concentric growth lines and obscure undulations. Two small, oblique cardinal teeth present ; lateral teeth absent. Ligament external. Posterior adductor scar large and bilobed ; no anterior adductor present. Pallial line simple.

Differs from *Clionychia* in the more convex valves, the more strongly incurved beaks, the radial striations, and in the possession of a small, lobe-like cavity beneath the beaks where in *Clionychia* there is a mere thickening of the margins of the valves.

Differs from *Byssonychia* in the absence of the anterior byssal opening and lateral teeth.

The Ambonychiidæ differ from the Aviculidæ in being equivalved and without anterior wing. Ordovicic.

183. **A. bellistriata** Hall. (Fig. 561, *a, b.*) Ordovicic.

Beaks very prominent and strongly incurved. Surface marked only by radiating striæ.

Middle Trenton: New York. Middle Galena of Minnesota and Cincinnati Group of Indiana.

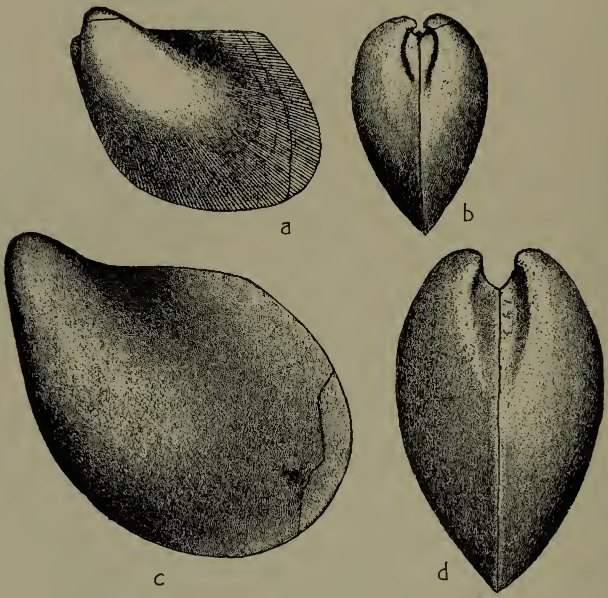


FIG. 561. *a, b, Ambonychia bellistriata*, left valve and anterior view; *c, d, A. amygdalina.* (Minn. Surv.)

184. **A. amygdalina** Hall. (Fig. 561, *c, d.*) Ordovicic.

Differs from *A. bellistriata* in its larger size, less incurved beaks, and less angular post-cardinal margin.

Trenton: New York, Canada. Middle Galena of Minnesota.

LV. ANOMALODONTA Miller.

Closely similar to *Ambonychia* in outline and general appearance but differing in possessing a byssal opening. Distinguished from both *Ambonychia* and *Byssonychia* in the absence of both cardinal and lateral teeth. Ordovicic.

185. **A. alata** (Meek). (*Ambonychia alata.*) Ordovicic.

Outline triangular with hinge line nearly at right angles to the anterior margin. 24–28 strong, radiating ribs present.

Upper part of the Cincinnati Group of Ohio, Indiana.

LVI. Byssonychia Ulrich.

Resembles *Ambonychia* but differs in its more erect form and in the presence of a byssal opening in the upper half of the anterior

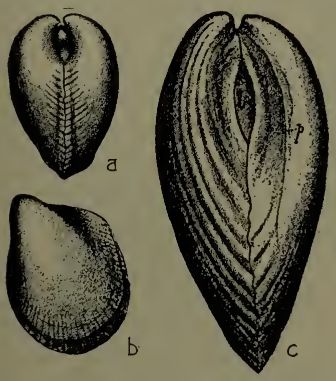


FIG. 562. *a*, *b*, *Byssonychia intermedia; c*, *B. radiata* (*p*=pallial line). (Minn. Surv.)

FIG. 563. *Byssonychia? byrnesi.* (Pal. Ohio, VII.)

side and in the presence of two or three slender lateral teeth situated posteriorly, as well as several cardinal teeth. Radiating lines usually stronger than in *Ambonychia*. Ordovicic.

186. **B. intermedia** (Meek and Worthen). (Fig. 562, *a*, *b*.) Ordovicic.

Small. Beaks strongly incurved, with a slight forward direction.

Galena: Illinois, Wisconsin, Minnesota, Lake Winnipeg, Canada.

FIG. 564. *Byssonychia acutirostris.* (After Ulrich, Pal. Ohio, VII.)

187. **B.? byrnesi** Ulrich. (Fig 563.) Ordovicic.

The hinge is peculiar, having no lateral teeth and only one cardinal. It differs externally from *B. acutirostris* (Fig. 564) in the byssal opening not being impressed; hinge line slightly longer; radii 20 to 22 and slightly curved, instead of 36 to 40 and straight as in *B. acutirostris*.

Utica: Kentucky, Tennessee.

188. **B. præcursa** Ulrich. (Fig. 565.) Ordovicic.

Radii 38–42. Like *B. radiata* but differs in its less obliquity, longer hinge line, and especially in the flattening of its anterior side.

Lorraine of New York, Ohio, Kentucky.

189. **B. radiata** (Hall). (Figs. 562, *c*, 566.) Ordovicic.

Surface marked by strong radiating ribs which are often grooved on the upper portion of the shell, giving them a duplicate character.

Cincinnati Group: New York–Iowa and Wisconsin.

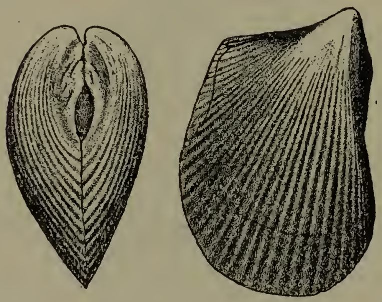


FIG. 565. *Byssonychia præcursa.* (Pal. Ohio, VII.)

FIG. 566. *Byssonychia radiata.* (Pal. Ohio, II.)

LVII. ALLONYCHIA Ulrich.

Like *Byssonychia* in the possession of a byssal opening but with neither cardinal nor lateral teeth. Likewise more erect than other *Ambonychia*-like forms. Ordovicic.

190. **A. jamesi** (Meek). Ordovicic.

Not winged posteriorly but with a lobe-like projection anteriorly. Surface marked with regular radiating ribs. Type of genus.

Cincinnati Group of Ohio.

LVIII. MYTILARCA Hall.

Differs from *Plethomytilus* in the presence of cardinal teeth. Devonic–Miss.

191. **M. chemungensis** Conrad. (Fig. 567, *a*, *b*.) Devonic.

Shell convex, of medium size. Beaks elevated.

Chemung of New York.

192. **M. fibristriata** White and Whitfield. (Fig. 567, *c*.)
Upper Devonic and Mississippic.

Differs from *M. chemungensis* in its straighter form, more erect beaks, and thread-like undulating radii.

Chemung: Iowa. Mississippic: Michigan, Ohio, Iowa.

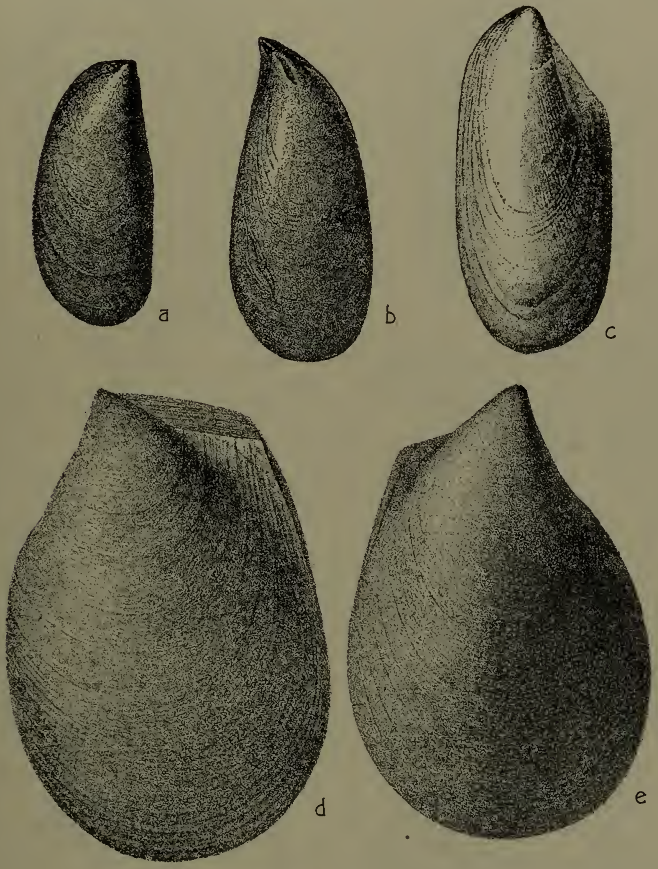


FIG. 567. *a*, *b*, *Mytilarca chemungensis*, right valve showing striated ligament area and left valve showing small cardinal teeth; *c*, *M. fibristriata*, left valve; *d*, *e*, *Plethomytilus oviformis*. (Pal. N. Y., V.)

LIX. PLETHOMYTILUS Hall.

Equivalve, very inequilateral. Hinge line straight. An obscure posterior ear present. Surface covered with concentric striæ. Ligament external, its area striated. Lateral teeth oblique; no cardinal teeth present. Pallial line simple. Devonic.

193. **P. ponderosus** Hall. (Fig. 568.) Devonic.

Shell gibbous, large.

Onondaga: New York, Ohio, Ontario.

Plethomytilus ponderosus × ½. (Pal. N. Y. V.)

194. **P. oviformis** Conrad. (Fig. 567, *d*, *e*.) Devonic.

Differs from *P. ponderosa* in its proportionately longer hinge line, smaller size, and less gibbosity.

Hamilton: New York, Pennsylvania. Lower Devonic of Nevada.

LX. Clionychia Ulrich.

Resembles *Ambonychia* but differs in its smaller and but little incurved beaks, in the possession of concentric striæ alone, and in

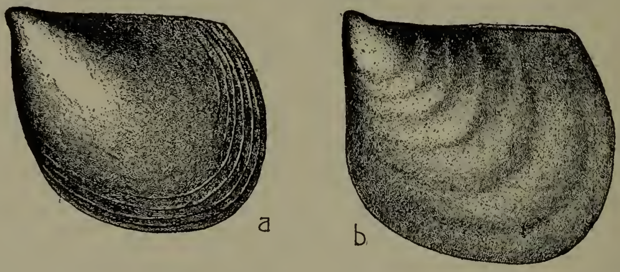


Fig. 569. *a*, *Clionychia lamellosa*, left valve; *b*, *C. undata*, left valve. (After Ulrich, Minn. Surv.)

the thickening of the hinge margins anteriorly, producing in internal molds a well-marked impression in this part.

Differs from *Mytilarca* in its less oblique form and in the absence of teeth. Ordovicic.

195. **C. lamellosa** Hall. (Fig. 569, *a.*) Ordovicic.

Anterior margin almost straight and sloping sharply backward. Beaks attenuate. Concentric growth lines lamellose.

Stones River Group: Illinois, Wisconsin; also Minnesota, Oklahoma.

196. **C. undata** Emmons. (Fig. 569, *b.*) Ordovicic.

Form subquadrate. Surface crossed by broad undulations.

Trenton: New York, Middle Galena of Minnesota.

LXI. Aviculopinna Meek.

This differs from *Pinna* in that its beaks are farther removed from the extreme point of the shell though still nearly terminal; this leaves a small anterior ear, best seen in internal molds. A linear thickening is present along the cardinal border. Surface marked by strong, regular, equally distant, concentric lamellæ. Carbonic and Permic.

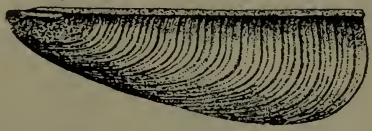


Fig. 570. *Aviculopinna americana.* (Kansas Pal., VI.)

197. **A. americana** Meek. (Fig. 570.) Carbonic.

Beaks nearly obsolete, very oblique, and but slightly behind the obtusely pointed anterior extremity. Surface marked with two or three broad, faint, radiating ridges on the posterior dorsal region.

Coal Measures: Ohio, Iowa, Missouri, Nebraska, Kansas.

198. **A.? peracuta** Shumard. (Fig. 571.) Carbonic–Permic.

Shell almost cylindrical. Cardinal edges of valves suddenly erected so as to give the hinged margin a keeled appearance. Surface covered with very obscure growth lines. Differs from the typical *Aviculopinnas* in its non-lamellose surface.

Throughout the Carbonic from Pennsylvania to Colorado and Arizona. Also in the Permic of Kansas.

LXII. Pinna Linnæus.

Shell equivalve, thin, with a long hinge line. Beaks very nearly or quite terminal. Valves keeled, triangular, wholly open and truncate behind, without teeth. Muscle scars two. Shell structure coarsely prismatic, with a thin, partial, nacreous lining; byssiferous. Jurassic–Recent.

199. **P. petrina** White. (Fig. 572.) Cretacic.

Cardinal margin concave. Surface marked with strong growth lines.

Benton: Colorado, New Mexico?

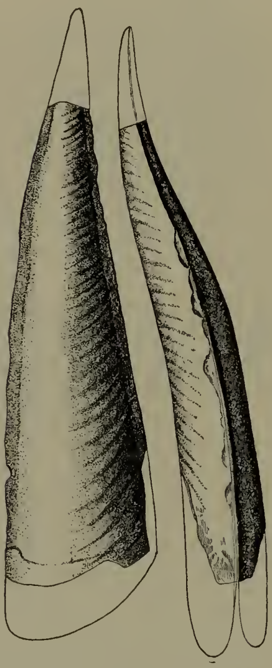


FIG. 571. *Aviculopinna? peracuta*, × ½. (Kansas Pal., VI.)

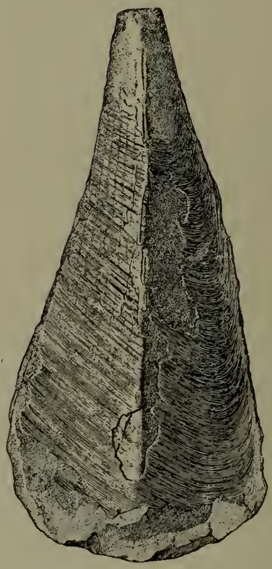


FIG. 572. *Pinna petrina*, left valve, × ½. (After Stanton, Bull. 106, U. S. G. S.)

200. **P. laqueata** Conrad. (Fig. 573.) Cretacic.

Nine to eleven strong, simple radiating ribs on the dorsal portion of valves; lower portion with very strong concentric striæ parallel to the margin.

Ripleyan of New Jersey (Merchantville–Navesink), Gulf region.

LXIII. CONOCARDIUM Bronn.

Very inequilateral. Anterior side short, truncated and flattened laterally but produced along the hinge line into a beak-like appendage; this appendage, however, is usually broken away, leaving a round hole in the flat anterior view. Posterior side extended and gaping in lateral view. Beaks prominent and strongly incurved. Hinge line long. Umbonal ridge prominent, outlining the flat anterior side. Surface marked by concentric striæ and

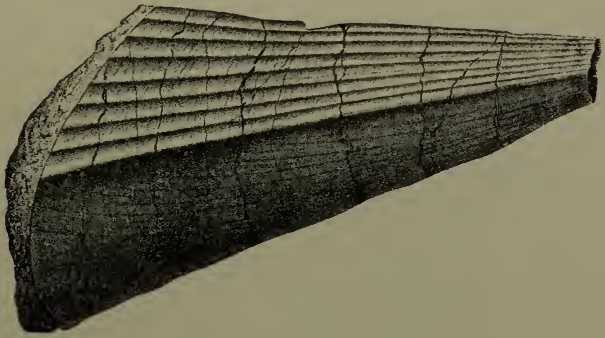


FIG. 573. *Pinna laqueata*, × $\frac{2}{3}$. (Pal. N. J., I.)

usually by radiating plications which crenulate the basal margin. Hinge bearing a single lateral tooth, with occasionally an obscure cardinal tubercle. Ligament external. Pallial line simple.

There is often present an expansion of the shell extending anteriorly from the entire periphery of the umbonal ridge. Ordovicic–Permic.

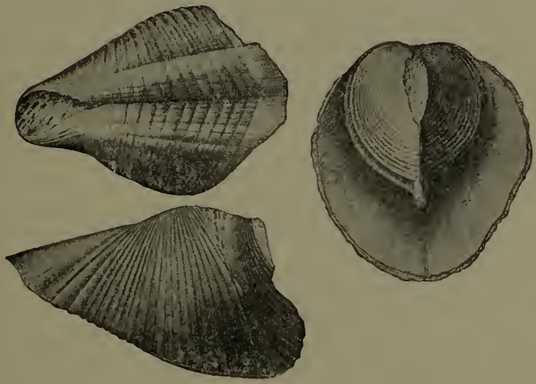


FIG. 574. *Conocardium cuneus*. (Pal. N. Y., V.)

201. **C. cuneus** (Conrad). (Fig. 574.) Devonic.

Valves gibbous. Umbonal slope angular. Radiating plications numerous, crossed by lamellose concentric striæ.

Schoharie Grit and Onondaga of New York. Columbus of Ohio, Falls of Ohio, Ontario. Also Hamilton of Illinois. A closely related form, *C. monroicum* Grabau, occurs in the Upper Siluric (Upper Monroe) of Michigan and Canada.

202. **C. ohioense** Meek. (Fig. 575.) Devonic.

Umbonal slope rounded. The produced posterior extremity is sharply separated from the convex anterior.

Onondaga: Ohio, Falls of Ohio.

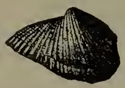


FIG. 575. *Conocardium ohioense*, right valve. (Pal N.. Y., V.)

FIG. 576. *Bakewellia gouldii*, internal mold. (Kan. Univ. Bull.)

LXIV. BAKEWELLIA King.

Small, obliquely elongated, with posterior wing, subequivalve, gaping in front for the passage of the byssus. Umbos depressed, oblique. Surface covered with concentric striæ. Hinge with linear anterior and posterior teeth parallel to the cardinal margin. Muscle scars as in *Pteria*. Two to five cartilage furrows present in each valve. Carbonic–Permic.

203. **B. parva** Meek and Hayden. Carbonic–Permic.

Very small, its axis forming an angle of about 30° with the straight cardinal margin.

Carbonic: Kansas, New Mexico, Arizona. Permic: Kansas, Nevada.

204. **B. gouldii** Beede. (Fig. 576.) Upper Permic.

Beaks low. Umbonal ridge well defined.

Common in Oklahoma (Whitehorse), Texas (Quartermaster).

LXV. GERVILLIA Defrance.

Very inequivalve. Beaks nearly or quite terminal. Posterior wing obscure. Hinge plate thick, marked with a series of transverse ligament pits and by obscure dental ridges subparallel to the long axis of the valve.

Differs from *Bakewellia* in being larger and more elongate, usually with more cartilage pits, and especially differing in that its hinge teeth all range obliquely forward and upward instead of those on the anterior and posterior sides being elongate parallel to the hinge margin. Triassic–Eocenic.

205. **G. propleura** (Meek). (Fig. 577.) Cretacic.

More or less oblique. Right valve flat, smooth, without a byssal notch.

Colorado (Benton), Utah (Coloradoan), Georgia (Ripleyan).

FIG. 577. *Gervillia propleura*, left valve. (After Stanton, Bull. 106, U. S. G. S.)

LXVI. GERVILLIOPSIS Whitfield.

Differs from *Gervillia* in the absence of teeth on the posterior portion of hinge and the oblique dental ridges below the ligament area on the posterior end. It also differs in the truncation of the anterior end, in the continuation of the ligamental (striated) area along the anterior truncation, and in the gaping of the valves anteriorly. Beaks terminal. Comanchic–Cretacic.

206. **G. invaginata** White. Comanchic.

Curved, marked by a central ridge running down its entire length midway between the margins. Hinge line with about 12 ligament pits.

Upper Washita of Texas.

207. **G. ensiformis** (Conrad). (Fig. 578.) Cretacic.
Very oblique, elongate, narrow, and somewhat sickle-shaped. New Jersey (Merchantville–Red Bank), and Gulf region.

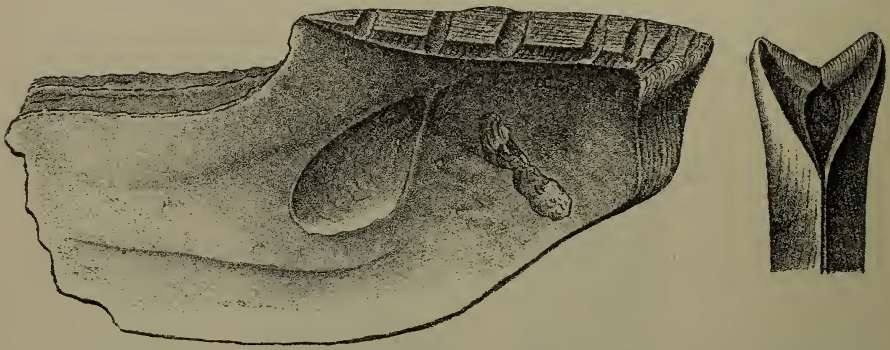


FIG. 578. *Gervilliopsis ensiformis*, interior of left valve and basal view of anterior end. (After Whitfield, Pal. N. J., I.)

LXVII. INOCERAMUS Sowerby.

Rounded, marked with more or less prominent concentric undulations. Umbos prominent, somewhat anterior. Hinge line long, straight, without teeth, but with numerous, small, transverse ligament pits. Jurassic, Comanchic and especially Cretacic.

A. Valves strongly unequal..213. *I. umbonatus.*
B. Valves subequal...I.
  I. A median depression in each valve.................................212. *I. gilberti.*
  I. No median depression...1.
    1. Umbos thick, rather strongly elevated...................................*a.*
      a. Concentric undulations angular ....211. *I. undabundus.*
      a. Concentric undulations rounded...........................215. *I. deformis.*
    1. Umbos low but often prominent...*b.*
      b. Height of shell about 1 inch or less.......................208. *I. dimidius.*
      b. Height of shell 2 inches or more..II.
        II. Beak very acute..*aa.*
          aa. Height about 1.5 inches...............................210. *I. fragilis.*
          aa. Height about 6 inches....................................216. *I. altus.*
        II. Beak rather obtuse...*bb.*
          bb. Beak at anterior edge of shell ....220. *I. barabini.*
          bb. Beak not quite at anterior edge of shell.................................†.
            †. Average length of shell less than 3 inches.
            218. *I. proximus.*
            †. Average length of shell more than 3 inches.............*.
              *. Length and height about equal.
              217. *I. nebrascensis.*
              *. Length greater than height..............................1″.

1''. Greatest length subparallel to hinge line.
209. *I. simpsoni.*
1''. Greatest length at about 45° to hinge line.
214. *I. labiatus.*
bb. Beak but little in advance of middle of shell.
219. *I. vanuxemi.*

208. **I. dimidius** White. (Fig. 579.) Cretacic.

Shell small. Beaks pointed, small, but prominent. Valves subequal.

Coloradoan: Kansas, Colorado, Utah, New Mexico.

FIG. 579. *Inoceramus dimidius*, left and anterior views. (After Stanton, Bull. 106.)

209. **I. simpsoni** Meek. (Fig. 580.) Cretacic.

Large; length nearly twice the height. Anterior end very short. Beaks incurved, projecting but little above the hinge line.

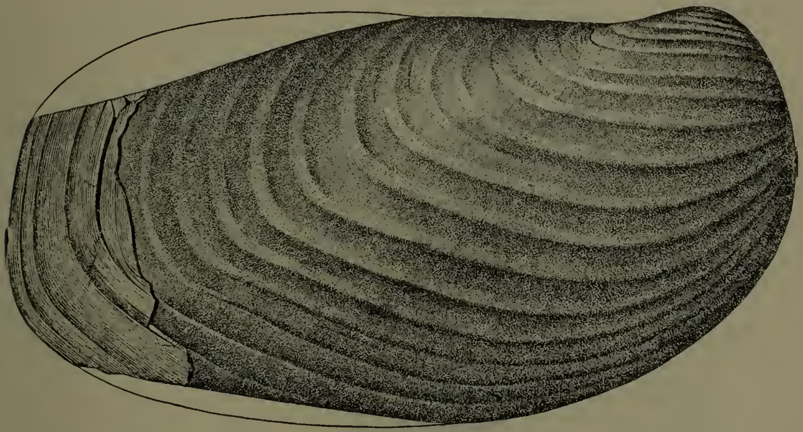


FIG. 580. *Inoceramus simpsoni*, right valve, × ½. (U. S. G. S., Bull. 106.)

Coloradoan: Kansas, South Dakota; also Cretacic of San Luis Potosi.

210. **I. fragilis** Hall and Meek. (Fig. 581, *a.*) Cretacic.

Anterior side vertically truncate. Beaks almost equal, pointed, scarcely rising above the hinge line, curving inward and slightly forward at the points. Surface marked with fine growth lines and a few obscure concentric undulations.

Benton: Texas to Dakota and Montana.

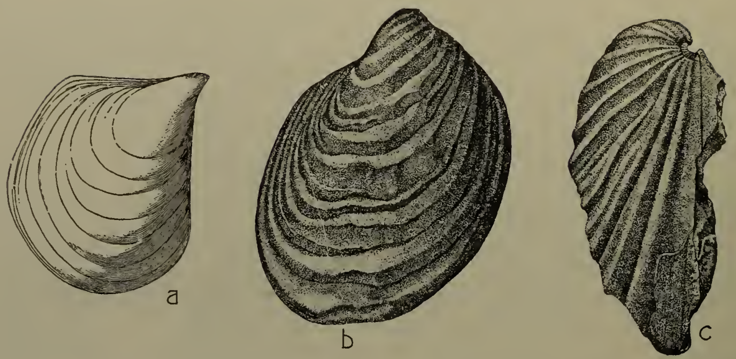


FIG. 581. *a*, *Inoceramus fragilis*, right valve ; *b*, *c*, *I. gilberti*, left valve. All × ½. (U. S. G. S., Bull. 106, after Stanton.)

211. **I. undabundus** Meek and Hayden. (Fig. 582, *c*, *d*.)*

Cretacic.

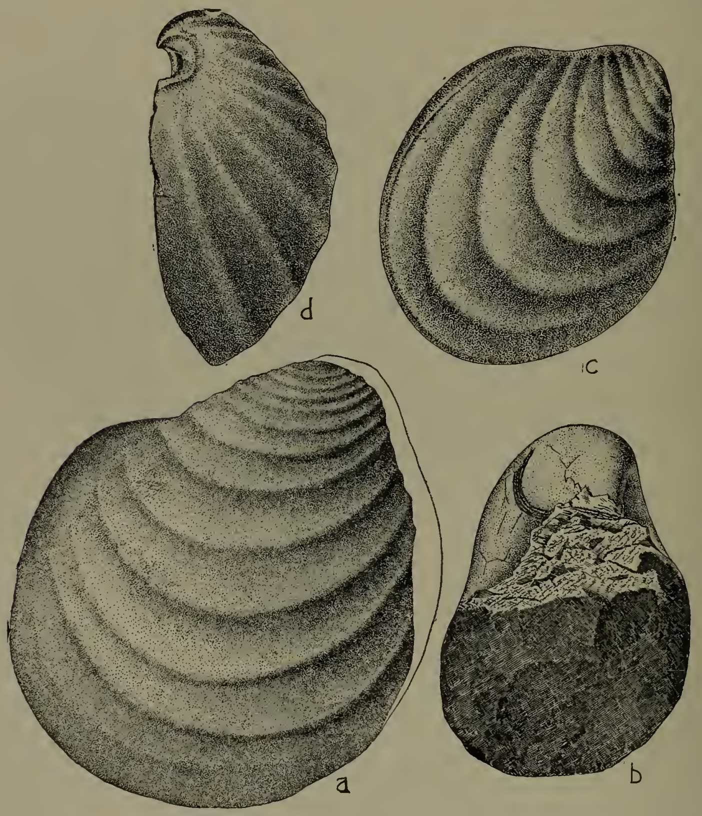


FIG. 582. *a*, *Inoceramus deformis*, right valve ; *b*, *I. umbonatus*, cardinal view of left internal mold ; *c*, *d*, *I. undabundus*, left valve. All × ½. (U. S. G. S., Bull. 106.)

Shell gibbous, obliquely subrhombic in outline. Beaks nearly terminal. Concentric undulations strong, subangular.

Benton: Kansas, Montana.

212. **I. gilberti** White. (Fig. 581, *b*, *c*.) Cretacic.

Surface of each valve marked with a poorly defined median furrow and with extremely prominent concentric wrinkles.

Benton of Kansas and approximately the same horizon in Utah.

213. **I. umbonatus** Meek and Hayden. (Fig. 582, *b*.) Cretacic.

Left valve very convex with strongly incurved beak; height more than one third greater than the antero-posterior diameter. Right valve subcircular, nearly flat; beak rather oblique; surface marked with concentric undulations.

Benton: Kansas, Montana. Niobrara: Texas.

214. **I. labiatus** Schlotheim. (Fig. 583.) Cretacic.

Outline obliquely elongate. Surface marked with concentric undulations. Average length about 4 inches; breadth at right angles to the greatest length 2 inches.

Coloradoan throughout the Plains and Rocky Mountain region.

FIG. 583. *Inoceramus labiatus*, right valve. (After Stanton, U. S. G. S., Bull. 106.)

215. **I. deformis** Meek. (Fig. 582, *a*.) Cretacic.

Beak moderately prominent, situated between the middle and the anterior extremity of the hinge. Surface with strong regular or very irregular concentric undulations becoming abruptly smaller on the umbo where their curves indicate a greater obliquity of the young shell. Shell thick, prismatic structure coarse.

Very abundant in the Niobrara of the Rocky mountains and Plains.

216. **I. altus** Meek. Cretacic.

Differs from *I. fragilis* in its larger size (about 6 inches high, hinge length 2 inches), more concentric undulations, though obscure, and faint traces of radiating markings.

Montanan of Kansas, Wyoming, Alberta; also Coloradoan of South Dakota.

217. **I. nebrascensis** Owen. Cretacic.

Beak about one fifth the length of the shell from the anterior border. Average length and height 5 inches. Anterior side short, making a very broad, oblique curve from beak to base. Posterior and basal margins broadly rounded. Hinge rather short. Differs from *I. proximus* in its larger size and coarser concentric undulations.

Montanan of the Plains and Rocky Mountain regions.

218. **I. proximus** Tuomey. (Fig. 584.) Cretacic.

Hinge line about two thirds the length of the shell. Basal and posterior margins broadly rounded. Average length and height about two inches. Differs from *I. barabini* in being more com-

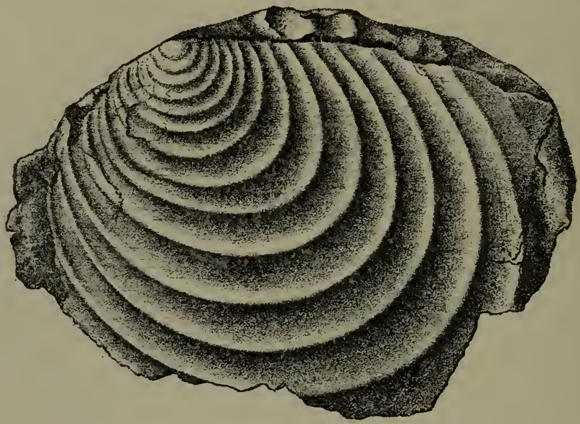


FIG. 584. *Inoceramus proximus*. (After Whitfield, Pal. N. J., I.)

pressed, less oblique, and in having more regular and closely arranged concentric undulations.

Pierre: South Dakota, Colorado. Ripleyan of New Jersey and the Gulf region.

219. **I. vanuxemi** Meek and Hayden. Cretacic.

Subcircular. Hinge short. Beaks located a little in advance of the middle. Valves slightly convex. Surface marked with regular, coarse concentric undulations. Average length 5 inches; height 4.5 inches. Distinguished from *I. nebrascensis* by its much less convex and nearly circular form, its less prominent and more flattened beaks which are also not so oblique and are more distant from the anterior end.

Pierre: Rocky Mountain region.

220. **I. barabini** Morton. Cretacic.

Moderately gibbous anteriorly, cuneate posteriorly.

Abundant in Pierre of Rocky Mountain region; also in Fox Hills formation.

LXVIII. PTERIA Scopoli. (*Avicula* Bruguiere.)

Obliquely oval, inequilateral, inequivalve. Left valve more convex than right. Hinge line long, straight, with one or two small cardinal teeth and a lamellar lateral. Posterior ear wing-like, longer than anterior. A byssal sinus present under right anterior ear. Ligament in a groove, partly internal and partly external. Posterior adductor scar large, subcentral; anterior scar absent in adults. Ordovicic–Recent.

This rather inclusive genus is divided into very many subgenera among which are *Actinopteria*, *Pteronites*, *Ptychopteria* and *Monopteria*. Many species are left here for want of better material to determine their subgeneric relations.

221. **P. sulcata** (Geinitz). (Fig. 585.) Carbonic.

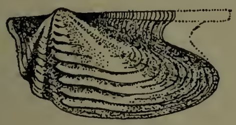


FIG. 585. *Pteria sulcata.* (Kansas Pal., VI/II.)

FIG. 586. *Pteria longa.* (Kansas Pal., VI/II.)

Marked anteriorly with two or three radiating furrows and with several concentric folds.

Kansas, Nebraska.

222. **P. longa** (Geinitz). (Fig. 586.) Carbonic and Permic.

Body of shell obliquely elongated and more or less arcuate.

Coal Measures of Interior. Permic: Oklahoma, Texas.

223. **P. petrosa** (Conrad). (*P. linguiformis* E. and S.) Cretacic.

Surface marked only by concentric growth lines.

Ripleyan of New Jersey (Cliffwood–Wenonah). Montanan of the Plains and of the Rocky Mountain region.

224. **P. gastrodes** Meek. (Fig. 587.) Cretacic.

Shell thick. Surface marked with fine and closely arranged growth lines.

Benton: Kansas, Colorado. Coloradoan of Utah.

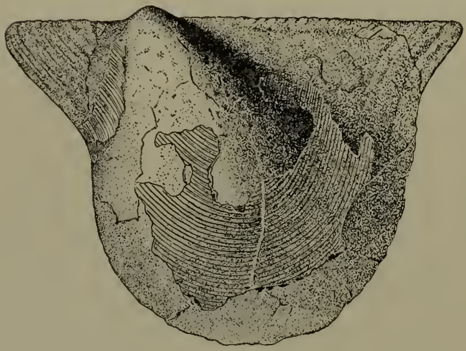


FIG. 587. *Pteria gastrodes*, left valve, × ⅔. (After Stanton.)

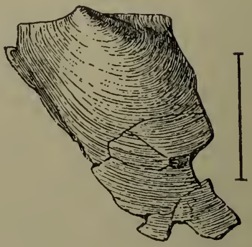


FIG. 588. *Pteria limula*, left valve. (Md. Surv.)

225. **P. nebrascana** Evans and Shumard. Cretacic.

Differs from *P. gastrodes* in having smaller wings, a much shorter hinge line, and a much more oblique axis. Anterior ear very small. Surface under a lens shows traces of small radiating ribs. Average length from end of anterior ear to posterior basal margin .45 inch; length of hinge .32 inch; convexity of the two valves .15 inch.

Montanan: Plains and Rocky Mountain region.

226. **P. limula** (Conrad). (Fig. 588.) Eocenic.

Beak acute. Sinus of posterior ear not deep.

Pamunky: Maryland, Virginia.

FIG. 589. *Pteronites profundus.* (Pal. N. Y., V.)

LXIX. Pteronites McCoy.

Differs from *Actinopteria* in having hinge and rest of the shell much extended posteriorly. Hinge line longer than body of shell;

surface marked by concentric striæ. Upper Devonic to Mississippic.

227. **P. profundus** Hall. (Fig. 589.) Devonic.

Umbonal region gibbous. Anterior ear acute. Posterior ear not defined. Surface covered with concentric striæ which rise at intervals into undulations.

Chemung: New York.

LXX. ACTINOPTERIA Hall. (*Avicula* Bruguiere of American authors in part.)

Inequivalve, oblique, thin. Anterior muscle scar faint or absent. Pallial line simple. Differs from *Pterinea* in the absence of a broad striated ligament area and strong cardinal and lateral teeth. Devonic.

228. **A. communis** Hall. Devonic.

Differs externally from *Pterinea flabellum* in its smaller anterior ear, weaker rays of both sizes which are practically absent from both ears, finer concentric striæ, and in the greater similarity of the surface marking on the two valves.

Helderbergian: Maine, New York (New Scotland), New Jersey, Tennessee.

229. **A. textilis** Hall. (Fig. 590.) Devonic.

Externally very similar to *Pterinea flabellum;* distinguished by the greater strength of its intermediate rays and by its longer posterior wing and greater obliquity.

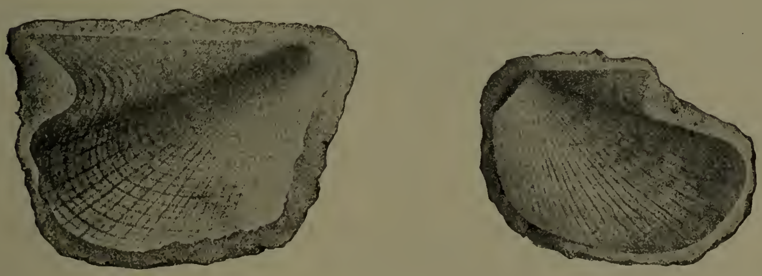


FIG. 590. *Actinopteria textilis.* (Pal. N. Y., III.)

Helderbergian: New York. Oriskany: New York, New Jersey, Tennessee ?, New Brunswick.

230. **A. textilis** var. **arenaria** Hall. Devonic.

Distinguished from *A. textilis* by its greater size and its shorter posterior wing which extends only about one half the distance from beak to base.

Very common in the Oriskany of New York, New Jersey, Pennsylvania, Maryland, Ontario, Quebec.

231. **A. muricata** Hall. (Fig. 591, *a*.) Devonic.

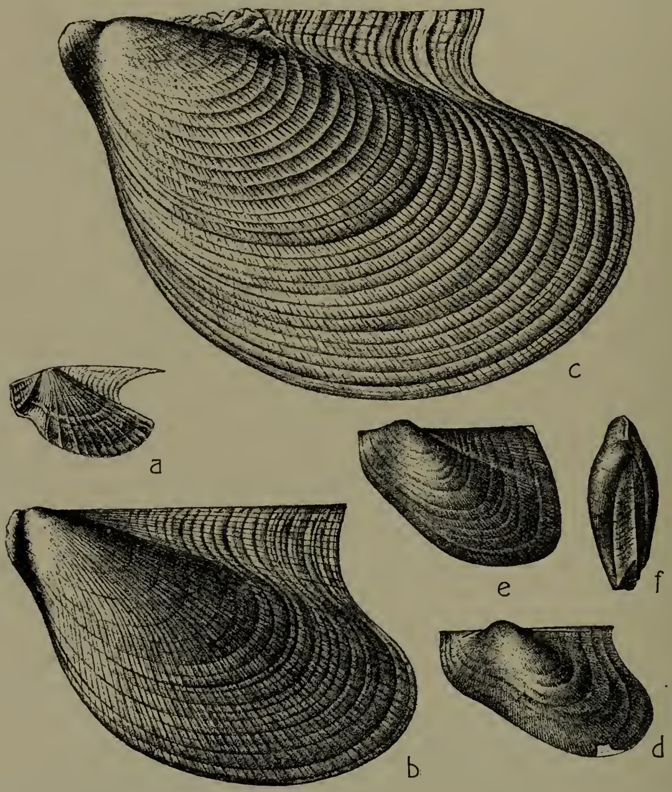


FIG. 591. *a*, *Actinopteria muricata*, $\times 2$; *b*, *A. subdecussata*; *c*, *A. decussata*, left valves; *d*, *Ptychopteria sinuosa*, left valve, showing oblique cardinal and lateral teeth; *e*, *f*, *P. sao*, left and cardinal views. (Pal. N. Y., V.)

Small. Beak acute and arching over the hinge. Anterior ear separated from the body of the shell by a broad undefined furrow which is bounded anteriorly by a strong fold. Surface marked with 8–12 strong rays alternating with finer ones which are continued over the posterior ear. Rays crossed by concentric striæ.

Marcellus: New York, Pennsylvania.

232. **A. subdecussata** Hall. (Fig. 591, *b.*) Devonic.

Beak nearly terminal. Ear very small, limited by a vertical furrow. Surface marked with alternating strong and weak, subangular rays crossed by concentric striæ.

Hamilton: New York, etc.

233. **A. decussata** Hall. (Fig. 591, *c.*) Devonic.

Differs from *A. subdecussata* in the greater and nearly equal convexity of the two valves, in the broader furrow at the anterior

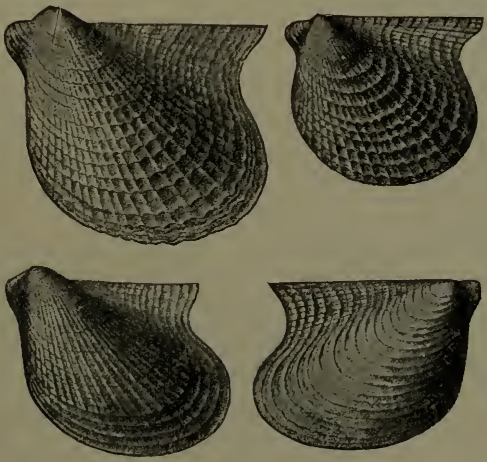


FIG. 592. *Actinopteria boydi.* (Pal. N. Y., V.)

ear, and in the stronger rounded rays and their interruption by the concentric lamellæ.

Hamilton: New York, Pennsylvania.

234. **A. boydi** Conrad. (Fig. 592.) Devonic.

Differs from *A. subdecussata* in the less defined furrow at the anterior ear, the less obliquity and broader body of the shell, and in the rays being practically of one size.

Abundant in the Hamilton: New York, Pennsylvania, Indiana, Ontario. Portage: New York (characteristic). Lower Devonic of Nevada.

LXXI. PTYCHOPTERIA Hall.

Differs from *Actinopteria* in the pointed anterior extremity and large, straight wing marked by a strong longitudinal fold. Hinge line linear, with one or two linear oblique cardinal and lateral teeth. Surface marked with fine rays. Devonic.

235. **P. sinuosa** Hall. (Fig. 591, *d.*) Devonic.

Extremities of hinge angular. Anterior portion of shell with broad sinus. Surface marked by fine undulating rays, crossed by concentric striæ which are at times crowded into lamellæ.

Chemung: Pennsylvania.

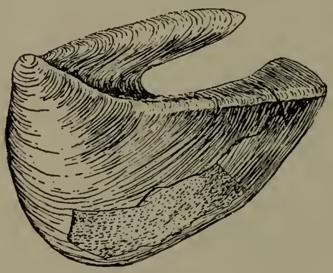
236. **P. sao** Hall. (Fig. 591, *e, f.*) Devonic.

Differs from *P. sinuosa* in the less distance between the anterior end of the shell and the sinus, and in the longer and more truncate posterior wing.

Chemung Group: New York.

LXXII. Monopteria Meek and Worthen.

Differs from *Pterinea* in the absence of teeth, in the very obscure or obsolete anterior muscle impression; anterior ear represented



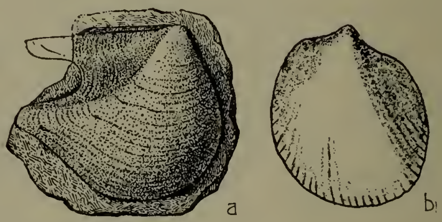


Fig. 593. *Monopteria longispina.* (Kan. Pal., VI/II.)

Fig. 594. *a*, *Monopteria gibbosa*, right valve; *b*, *Pseudomonotis curta*, left valve. (Ind. Surv. and Kan. Univ. Quarterly.)

by a very small appendage drawn back between the beaks in a deep lunule, not seen in side view. Posterior wing slender, produced. Body of shell obliquely produced and angular posteriorly. Devonic to Carbonic.

237. **M. longispina** (Cox). (Fig. 593.) Carbonic.

Surface covered with fine concentric growth lines.

Kentucky–Colorado.

238. **M. gibbosa** Meek and Worthen. (Fig. 594, *a.*) Carbonic.

Semicircular in antero-basal marginal outline, posterior end and wing about equally produced.

Pennsylvania–Kansas.

LXXIII. Pseudomonotis Beyrich.

Suborbicular, inequivalve. Right valve convex, with prominent incurved beak and small or obsolescent ears. Left valve flattened, with slightly prominent beaks; anterior ear minute or wanting. Devonic–Cretacic.

239. **P. hawni** Meek and Hayden. (Fig. 595.) Carbonic and Permic.

Posterior ear narrow, obliquely truncate. Anterior ear larger. Surface marked with irregular undulating ribs of unequal size and concentric lamellæ which at times are very strong over the costæ.

Carbonic: Pennsylvania – Colorado. Permic of Kansas.

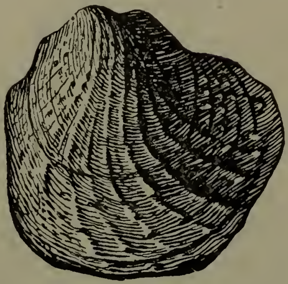


FIG. 595. *Pseudomonotis hawni.* (Kan. Pal., VI/II.)

240. **P. kansasensis** Beede. (Fig. 596.) Carbonic and Permic.

Hinge line nearly straight. Both ears rounded to meet the hinge. Radiating striæ wavy.

FIG. 596. *Pseudomonotis kansasensis.* (Kan. Pal., VI/II.)

Coal Measures: Ohio–Colorado and Arizona. Permic of Kansas.

241. **P. equistriata** Beede. (Fig. 597.) Carbonic and Permic.

Differs from *P. hawni* in being smaller and shorter, slightly more convex, and in having regular striæ.

Pennsylvanic: Kansas, Colorado. Permic: Kansas (Garrison).

242. **P. subcircularis** (Gabb). (Fig. 598.) Triassic.

Ribs alternating in size.

Triassic of Nevada; California–British Columbia

243. **P. curta** Hall. (Fig. 594, *b*.) Jurassic.

Surface marked with fine radiating plications, crossed by con-

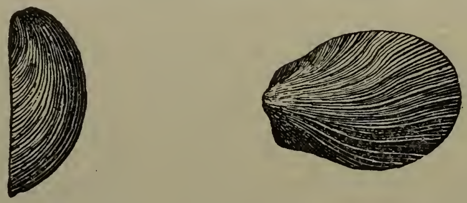


Fig. 597. *Pseudomonotis equistriata.* (Kan. Pal., VI/II.)

centric striæ, producing small nodes at points of intersection.

Sundance: South Dakota, Wyoming.

LXXIV. Halobia Bronn.

Equivalve, semicircular to semioval, with straight hinge, and almost central, scarcely prominent beaks. Teeth absent. Surface radiately ribbed. Wings absent or represented anteriorly merely by a smooth, non-projecting area. Triassic.

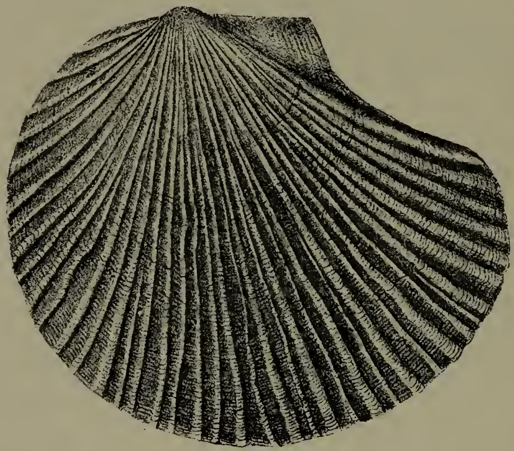


Fig. 598. *Pseudomonotis subcircularis*, left valve. (Pal. Cal.)

244. **H. lommeli** Wissmann. (Fig. 599.) Triassic.

Beaks very small, abruptly pointed, turned slightly forward. Surface marked with more or less wide and irregular flat ribs, separated by linear furrows, and by a few concentric growth lines near the beak.

Nevada, British Columbia.

LXXV. Myalina De Koninck.

Inequilateral, inequivalve, obliquely ovate, slightly sinuous in front for the passage of the byssus. Beaks pointed, terminal or nearly so. Surface smooth or marked with concentric striæ. Hinge without teeth. Ligament area broad, and grooved parallel with hinge line. Deep anterior adductor scar under the beak. Siluric–Permic.

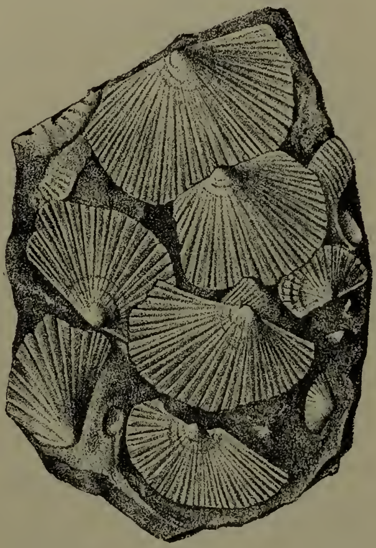


Fig. 599. *Halobia lommeli;* a slab with numerous individuals. (After Hall and Whitfield.)

245. **M. sancti-ludovici** Worthen. (Fig. 600.) Mississippic.

Subquadrate, oblique. Hinge straight and equalling the greatest width of the shell below. Margin of shell regularly though narrowly rounded at base, becoming broadly and shallowly concave towards the hinge line anteriorly and posteriorly. Beak of left valve pointed, curving obliquely forward. Shell crossed by strong and regular concentric laminæ. Average length of hinge line, $\frac{3}{4}$ inch; length of shell at right angles to hinge, 1 inch.

Keokuk: Illinois, Kentucky, Missouri.

246. **M. keokuk** Worthen. Mississippic.

Distinguished from *M. sancti-ludovici* by its larger size (length of hinge, 1.25 inches; length of shell at right angles to hinge, 1.6 inches; greatest length from umbo forward, 2 inches), greater convexity of body of shell and consequent greater prominence of the posterior wing. Umbo stronger and projecting above the hinge line. Anterior side of shell more nearly truncate.

Fig. 600. *Myalina sancti-ludovici.* (Pal. Ill., V.)

Keokuk: Illinois, Indiana, Iowa, Missouri, Arizona (Escabrosa); also Colorado (Ouray).

247. **M. angulata** Meek and Worthen. Mississippic.

Differs from *M. permiana* in its larger size and concave hinge line. Anterior margins of valves abruptly inflected from the umbonal ridge so as to meet on a plane at right angles to that of the valves. Beaks attenuate, compressed in front and behind. Posterior extremity of hinge angular.

Chester of Illinois. Kaskaskia of Missouri.

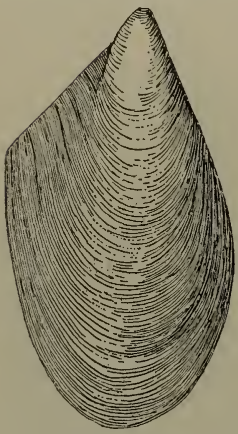


FIG. 601. *Myalina congeneris.* (Kan. Pal. VI/II.)

248. **M. congeneris** Walcott. (Fig. 601.) Mississippic–Carbonic.

Differs from *M. perattenuata* in having the anterior and posterior margins parallel; also the anterior margin is straight while in *M. perattenuata* it is concave.

Mississippic: Nevada. Upper Coal Measures of Kansas.

249. **M. swallovi** McChesney. (Fig. 602, *a*, *b*.) Carbonic.

Small, nearly equivalve. Cardinal area very narrow. [Doctor Hind makes this a synonym of the English shell *Naiadites triangularis* Sowerby.]

Indiana–Wyoming

250. **M. recurvirostris** Meek and Worthen. (Fig. 602, *c*.) Carbonic.

Convex. Beaks pointed; that of left valve twisted. Anterior margin thickened beneath the beaks so as to present a kind of false area. Indiana–Iowa.

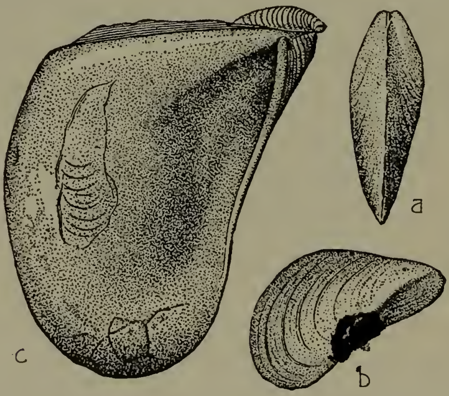


FIG. 602. *a*, *b*, *Myalina swallovi*, dorsal view and right valve; *c*, *M. recurvirostris*, interior of left valve. (Ind. Survey.)

251. **M. subquadrata** Shumard. (Fig. 603.) Carbonic–Permic. Large. Left valve more convex than right which is nearly flat. [Doctor Hind suggests that this is the equivalent of the English *Naiadites quadrula* (Sowerby).]

Carbonic: Colorado, Arizona? Also in Permic (Matfield) of Kansas.

Fig. 603. *Myalina subquadrata*, right valve, × ½. (Ind. Survey.)

252. **M. perattenuata** Meek and Hayden. (Fig. 604.) Carbonic and Permic.

Hinge line very oblique to body of shell.

Carbonic: Illinois–Colorado. Permic: Kansas, Oklahoma, Texas.

253. **M. aviculoides** Meek and Hayden. (Fig. 605, *a*.) Permic.

Beaks slender, greatly prolonged, with a slight upbending at the point. Umbonal ridge placed near anterior border and parallel with it, angular and very convex, giving the shell an almost vertical anterior face.

Kansas, Oklahoma, Texas, Utah?

254. **M. permiana** Swallow. (Fig. 605, *b*.) Permic.

Hinge line shorter than width of shell below. Differs from *M.*

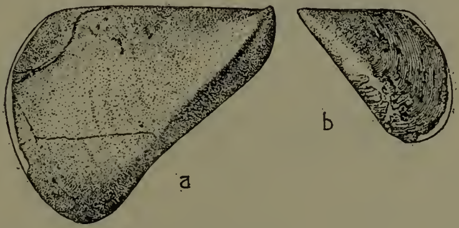


Fig. 604. *Myalina perattenuata.* (Kan. Pal., VI/II.)
Fig. 605. *a, Myalina aviculoides*, right valve; *b, M. permiana*, left valve. (After White.)

aviculoides in its less convex and narrower valves, more rounded umbonal ridge, and in wanting the upturned beaks.

Kansas, Oklahoma, Texas, Utah?

LXXVI. Ptychodesma Hall and Whitfield.

Anterior end short, posterior end broadly rounded. Hinge line short. Surface concentrically striated. Hinge with two or more teeth and a deep ligament area whose sides are marked with parallel grooves. Devonic.

255. **P. knappianum** Hall and Whitfield. (Fig. 606, *a–c.*) Devonic.

Valves convex below and gibbous above. Concentric striæ interrupted by occasional growth varices. Externally resembles some forms of *Modiomorpha* but is distinguished by the deeply grooved ligament area characteristic of the genus. Type of the genus.

Hamilton group: New York, Ohio, Falls of Ohio.

LXXVII. Modiella Hall.

Equivalve, very inequilateral, with short anterior end and very broad and curved posterior end. Hinge line arcuate. Surface covered with fine concentric striæ. Hinge area longitudinally grooved. Pallial line simple. Very similar to recent species of *Modiola* but lacking the pronounced epidermis. Devonic.

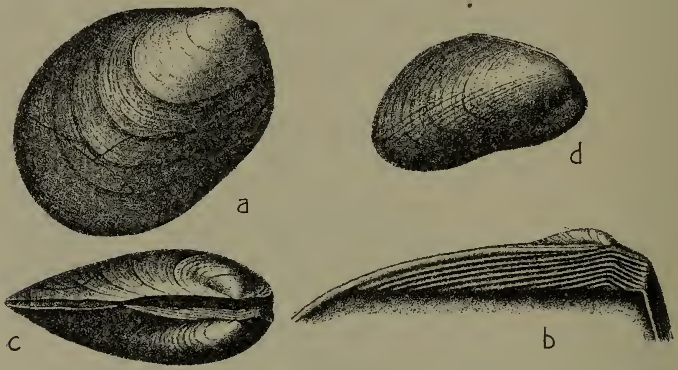


Fig. 606. *a–c*, *Ptychodesma knappianum*, right valve, ligament area enlarged, and cardinal view; *d*, *Modiella pygmæa*, × 2.

256. **M. pygmæa** (Conrad). (Fig. 606, *d.*) Devonic.

Basal margin indented anterior to middle owing to the depression just anterior to the beak and extends to the base. Type of the genus.

Hamilton: New York, Pennsylvania.

LXXVIII. Aucella Keyserling.

Obliquely ovate, with anterior beaks. Left valve larger and arcuate, with a small ear set off from the body of the shell by a deep groove which extends from the margin nearly to the beak. Right valve flatter and smaller. Hinge without teeth but furnished with an interlocking angle in the right valve which fits into a corresponding notch in the left valve. Ligament external, in a long

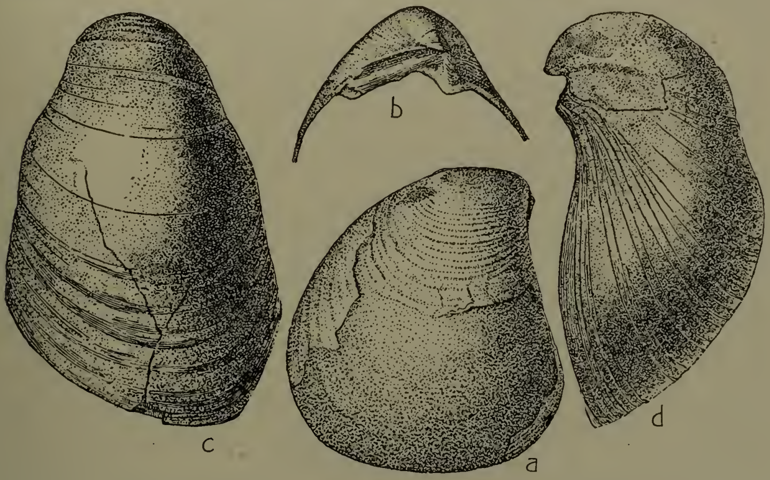


FIG. 607. *Aucella crassicollis.* *a*, a large right valve; *b*, hinge of a left valve; *c*, *d*, var. *gracilis*, two views of a left valve. (After Stanton.)

and shallow groove beneath the overhanging beaks. Differs from *Inoceramus* in the presence of the sinus beneath the beak and in the simple ligament groove as compared with the row of ligament pits in *Inoceramus*. Upper Jurassic to Cretacic.

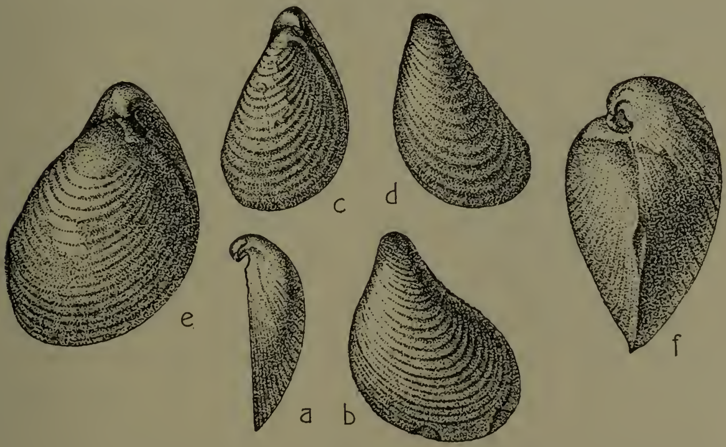


FIG. 608. *Aucella piochii.* *a*, *b*, an average sized left valve; *c*, *d*, two views of a more slender specimen; *e*, *f*, var. *ovata*, two views of an average specimen. (After Stanton.)

257. **A. crassicollis** Keyserling. (Fig. 607.) Comanchic.
Large, inflated. Concentric markings varying from irregular constrictions to strong plications.
British Columbia, Alaska, eastern Greenland. Knoxville of California and Oregon.

258. **A. piochii** Gabb. (Fig. 608, *a*, *b*.) Comanchic.
Small, thin-shelled. Concentric undulations regular.
Knoxville: California, Oregon, Washington.

258*a*. **A. piochii** var. **ovata** Stanton. (Fig. 608, *c*, *d*.) Comanchic.
Larger than *A. piochii*, more broadly triangular, and more convex.
Knoxville: California, Oregon, British Columbia.

LXXIX. Ostrea Linneus.

Shell distorted by adherence to other objects. Structure lamellar. Inequivalve, fixed by the left or larger valve. Beaks terminal. Left valve convex, often marked with radiating ribs. Right valve flat or concave, often smooth. Sculpture usually different on the two valves. Teeth generally absent. Anterior muscle impression absent; posterior nearly central. Ligament cavity conspicuous, triangular or elongate. Pallial line indistinct. Carbonic to Recent.

A. Surface conspicuously plicate radially..I.
I. Outline subcircular..1.
1. Plictions over whole valve ....267. *O. lugubris*..
1. Plications only marginal..265. *O. panda*.
I. Outline sickle-shaped, *i. e.*, curved laterally..2.
2. Entire shell plicate..*a*.
a. Plications 4..262. *O. quadriplicata*.
a. Plications more than 4..271. *O. falcata*.
2. Median area not plicate..*b*.
b. Shell of medium size..273. *O. nasuta*.
b. Shell small..11.
11. Shell auriculate..272. *O. mesenterica*.
11. Shell not auriculate..279. *O. pellucida*.
I. Outline triangular..260. *O. crenulimargo*.
I. Outline oblong-ovate with height much exceeding transverse diameter.
261. *O. subovata*.
B. Surface not conspicuously plicate radially except in some forms when young.....II.
II. Both valves deeply sinuous..281. *O. sellæformis*.
II. Valves not sinuous..3.
3. Lower valve very convex; upper valve flat or only slightly convex........*c*.

c. Lower valve attached by whole lower surface and deep .... 22.
  22. Sides bent up from area of attachment almost at a right angle. 266. *O. congesta.*
  22. Sides curved upward .... 259. *O. strigilecula.*
c. Lower valve not attached by whole lower surface .... 33.
  33. Shell winged posteriorly .... 275. *O. bryani.*
  33. Shell not winged posteriorly .... *aa.*
    aa. Lower valve broadest below middle .... †.
      †. Lower valve very convex in central portion. 270. *O. subspatulata.*
      †. Lower valve very convex towards umbo. 280. *O. vomer.*
    aa. Lower valve broadest at middle .... ††.
      ††. Large .... 282. *O. compressirostra.*
      ††. Small .... 268. *O. cretacea.*
3. Both valves only slightly convex .... *d.*
d. Outline subtriangular .... 44.
  44. Large, 3–4 inches high .... 283. *O. trigonalis.*
  44. Small, not 2 inches high .... 274. *O. plumosa.*
d. Outline elongate-oval .... 55.
  55. Shell attached by whole under side .... 278. *O. inornata.*
  55. Shell not attached by whole under side .... *bb.*
    bb. Shell slightly arcuate laterally .... †††.
      †††. Large (3 inches × 1½ inches) .... 276. *O. glabra.*
      †††. Small (2 inches × 1 inch) .... 277. *O. subtrigonalis.*
    bb. Shell not arcuate laterally .... 4†.
      4†. Margins crenulate .... 269. *O. denticulifera.*
      4†. Margins not crenulate .... 264. *O. haydeni.*
d. Outline round-oval .... 284. *O. percrassa.*
d. Outline very long and narrow with nearly parallel sides. 263. *O. soleniscus.*

259. **O. strigilecula** White. (Fig. 609.) Jurassic.

FIG. 609. *Ostrea strigilecula.* (Kan. Univ. Quarterly.)

Small (up to 1 inch in diameter). Lower valve attached by entire surface.

Throughout the Jurassic of the Interior.

260. **O. crenulimargo** Roemer. (Fig. 610.) Comanchic.

Thin, subtriangular. Beaks short and blunt. Lower valve marked by 5 to 8 strong ribs, 3 of them much the strongest and frequently outlining the shell as a more or less equilateral triangle. Upper valve flat; ribs nearly obsolete. Anterior and posterior margins of both valves minutely crenulated.

Texas (Trinity), northern Mexico (Washita).

261. **O. subovata** Shumard. Comanchic.

Large and massive, oblong-ovate. Both valves only slightly convex. Beak of lower (left) valve elevated and projecting beyond that of right. Surface coarsely imbricate and radially plicate, the ribs

FIG. 610. *Ostrea crenulimargo.* *a*, external, and *b*, internal view of the free valve. (After Roemer.)

usually about 6 or 8, sometimes with tubercles or spines at top. Average height 6 inches.

Common in Fredericksburg and Washita of Oklahoma, Kansas, Texas and New Mexico.

262. **O. quadriplicata** Shumard. (Fig. 611.) Comanchic.

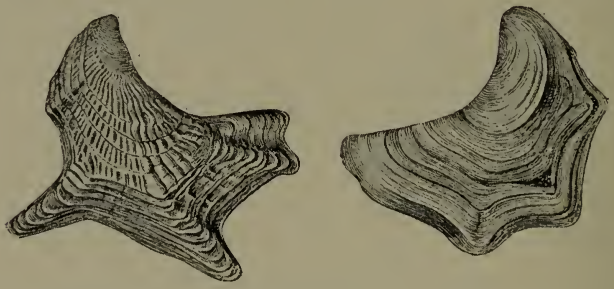


FIG. 611. *Ostrea quadriplicata.* (After Hill.)

Main radiating plications 4, produced at edge of valve.

Washita of Texas (Denison), Oklahoma and Kansas.

263. **O. soleniscus** Meek. (Fig. 612.) Cretacic.

Long and narrow. Often very large and thick.

Through the whole thickness of the Cretacic of Utah, Wyoming and Colorado, and in the Dakota of Texas.

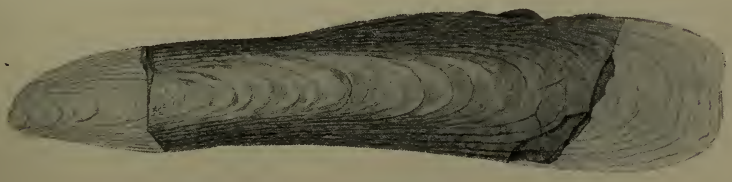


FIG. 612. *Ostrea soleniscus*, × ½. (After White.)

264. **O. haydeni** White. (Fig. 613.) Cretacic.

Small, usually not exceeding 2 inches in height.

Bear River: Wyoming, Idaho.

265. **O. panda** Morton. Cretacic.

Free margins of valves impressed with broad plications which do not extend to the beak.

New Jersey (Marshalltown), Delaware, Texas (Coloradoan).

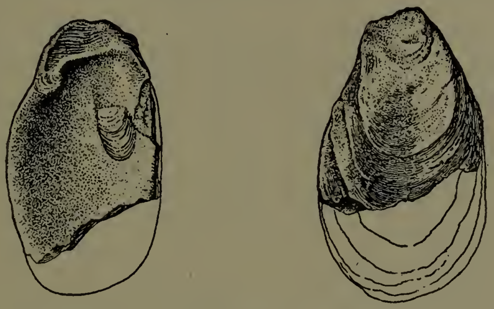


FIG. 613. *Ostrea haydeni*. (After White.)

266. **O. congesta** Conrad. (Fig. 614, *c*, *d*.) Cretacic.

Lower valve cup-shaped, with large area of attachment around which the shell margin abruptly bends up at a right angle. Upper valve flat, with form of attached portion of lower valve.

Very abundant in and characteristic of the Niobrara of North America. Also occurs in the Benton.

267. **O. lugubris** Conrad. (Fig. 614, *a*, *b*.) Cretacic.

Varying from small to medium in size (breadth from $\frac{3}{5}$ inch to $2\frac{1}{2}$ inches). Plications 12 to 18 on each valve but developed only around the margin of the upper valve.

Kansas, Colorado (Niobrara–Pierre), New Mexico (Niobrara), Texas (Eagle Ford–Navarro).

268. **O. cretacea** Morton. Cretacic.

Irregularly ovate, non-plicate. Lower valve moderately convex; upper valve nearly flat. Surface marked with concentric undulations. Height about $\frac{4}{5}$ inch; width slightly greater.

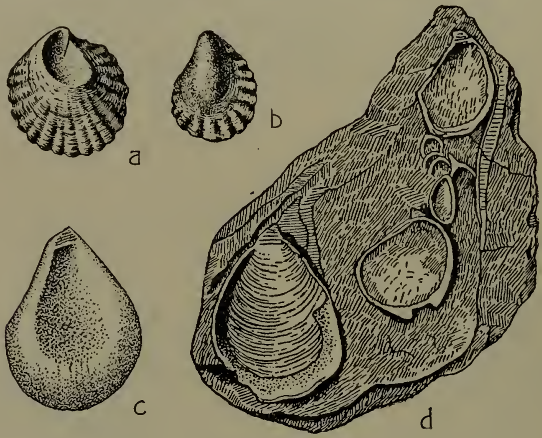


FIG. 614. *a*, *b*, *Ostrea lugubris*, lower and upper valves; *c*, *d*, *O. congesta*, interior of upper valve slightly enlarged and a group of attached lower valves. (After Stanton.)

Ripleyan of New Jersey (Cliffwood), Georgia, Alabama, Arkansas.

269. **O. denticulifera** Conrad. (Fig. 615.) Cretacic.

Flattened, thick. Surface obscurely striate. Margin with tooth-like crenulations.

Ripleyan of New Jersey (Woodbury), Mississippi, Tennessee.

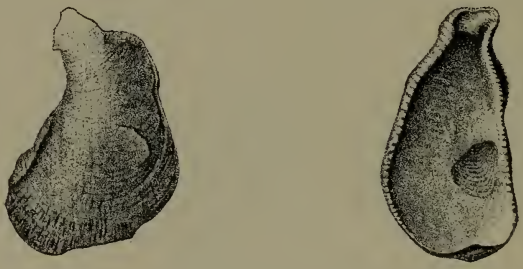


FIG. 615. *Ostrea denticulifera*, Conr. (N. J. Pal., I.)

270. **O. subspatulata** Forbes. Cretacic.

Outline somewhat wedge-shaped with rounded margins. Shell widest below the middle whence it narrows gradually upwards. Lower valve strongly arcuate longitudinally. Surface marked with strong concentric undulations. Internal mold nearly smooth. Height about 2 inches; greatest width about $1\frac{1}{3}$ inches.

Ripleyan of New Jersey (Wenonah), Georgia, Texas.

271. **O. falcata** Morton (*O. larva* of American authors). (Fig. 616.) Cretacic.

Lower valve moderately convex with small scar of attachment. Upper valve flat. Plications alike on both valves.

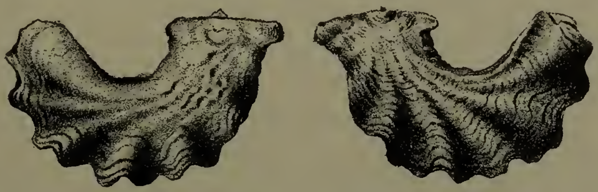


FIG. 616. *Ostrea falcata* Morton. (After Whitfield, Pal. N. J., I.)

New Jersey (very abundant in Marshalltown; also in Navesink), Arkansas.

272. **O. mesenterica** Morton. Cretacic.

Smaller than *O. falcata* and with non-plicate central area. New Jersey (very abundant in Navesink; also in Red Bank and Tinton).

273. **O. nasuta** Morton. Cretacic.

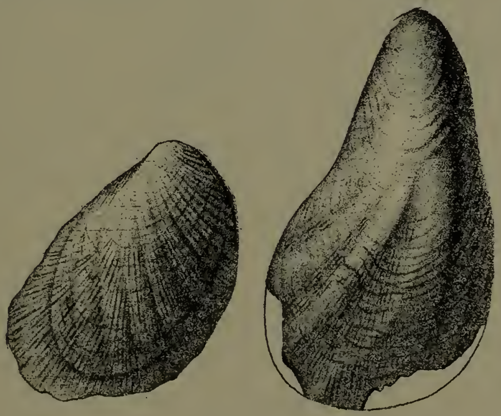


FIG. 617. *Ostrea plumosa* Morton. (N. J. Pal., I.)

Central portion non-plicate as in *O. mesenterica*, from which it differs in large size and broader plications.

New Jersey (Red Bank and Tinton; sparingly in Navesink), Texas.

274. **O. plumosa** Morton. (Fig. 617.) Cretacic.

Thin. Sometimes faintly plicate. Upper valve marked with fine radiating striæ which diverge from a median line.

New Jersey (Marshalltown–Red Bank), Virginia, Gulf region, Wyoming (Montana).

275. **O. bryani** Gabb. Cretacic.

Somewhat like *Gryphæa convexa* but with evidence of attachment of convex valve and with beak not strongly incurved.

New Jersey (Vincentown and Manasquan).

276. **O. glabra** Meek and Hayden. (Fig. 618.) Cretacic.

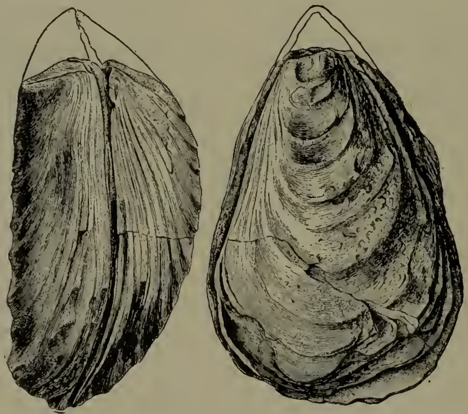


FIG. 618. *Ostrea glabra.* Upper and lateral view of a nearly complete shell, × ½. (After White.)

Subovate, sometimes slightly arcuate laterally. Beak of lower valve curved to the right; cardinal area small and deep. Surface of both valves entirely free from radiating plications or projecting concentric lamellæ, though there are obscure striæ and a few faint growth ridges. Size 3 inches × $1\frac{1}{2}$ inches.

Laramie: Colorado, Montana, Alberta. Fox Hills: Wyoming. Pierre: Montana, Assiniboia. Also San Luis Potosi.

277. **O. subtrigonalis** Evans and Shumard. Cretacic.

Small, depressed, narrowly ovate, slightly arcuate laterally. Lateral margins of lower valve crenate. Upper valve nearly flat. Surface of each valve marked with concentric striæ and furrows. Height not quite 2 inches; width not quite 1 inch.

Pierre: Montana, Alberta, Assiniboia. Livingston: Montana.

278. **O. inornata** Meek and Hayden. Cretacic.

Small, subovate, thin, attached by whole under side of lower valve. Beaks pointed and bent laterally.

Pierre: South Dakota, Colorado; also in Montana of Wyoming, Alberta, etc.

279. **O. pellucida** Meek and Hayden. Cretacic.

Similar to *O. mesenterica* in size, thinness, falcate outline, and marginal plications, but differs in its larger scar of attachment which extends from the umbo to near the middle of the valve; also lacks the straight hinge line with ears characteristic of *O. mesenterica.*

Montana: Wyoming, South Dakota (Fox Hills), North Dakota (Pierre), Montana (Pierre).

280. **O. (Gryphæostrea) vomer** (Morton). (Fig. 619). Cretacic–Eocenic.

Lower valve deep. Upper valve marked with concentric plates.

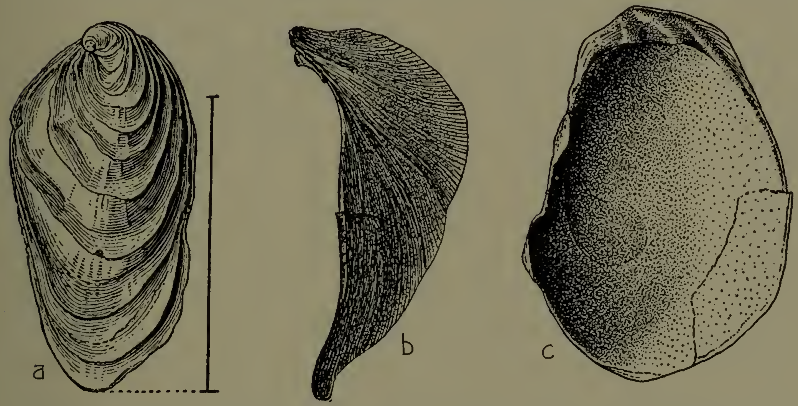


FIG. 619. *Ostrea* (*Gryphæostrea*) *vomer.* *a*, upper valve; *b*, *c*, lower valve. (Md. Surv.)

New Jersey (Marshalltown–Vincentown), Delaware, Texas. Eocenic: Maryland.

281. **O. sellæformis** Conrad. (Fig. 620, *a.*) Eocenic.

Both valves deeply sinuous through vertical folding.

Eocenic: Maryland (Nanjemoy)–Alabama (Lignitic).

282. **O. compressirostra** Say. (Fig. 620, *b.*) Tertiary.

When young much like *O. sellæformis* in form and plicate surface. Differs when adult in lacking the sinuosity of *O. sellæformis.*

Eocenic: Maryland–Alabama. Oligocenic: Florida. Miocenic: New Jersey–Florida.

283. **O. trigonalis** Conrad. (Fig. 621, *a, b.*) Eocenic–Pliocenic.

Lower valve few-ribbed. Upper valve flat.

Upper Eocenic (Jacksonian): Mississippi, Alabama, Louisiana. Lower Oligocenic (Vicksburgian): Florida and Mississippi. Mio-

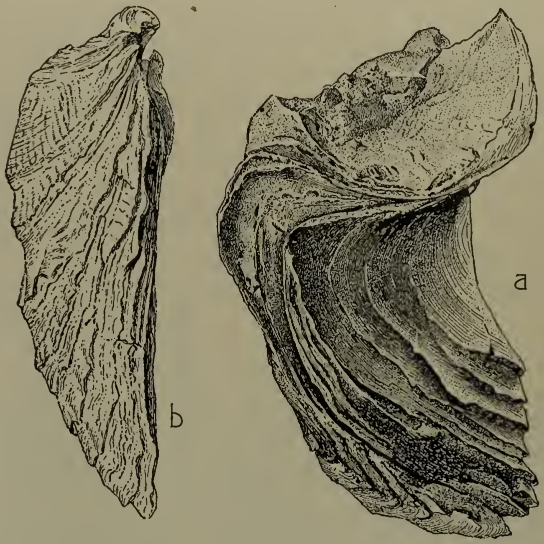


FIG. 620. *a*, *Ostrea sellæformis*, lower valve, × ⅔; *b*, *O. compressirostra*, lateral view. (Md. Surv.)

cenic: Maryland (Choptank) and North Carolina. Pliocenic: Florida.

284. **O. percrassa** Conrad. (Fig. 621, *c*.) Miocenic.

Porous and vesicular, of light weight though very thick. Much

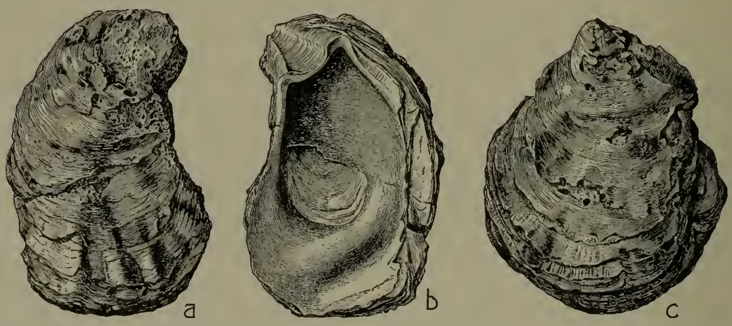


FIG. 621. *a*, *b*, *Ostrea trigonalis*, lower valve, × ⅓; *c*, *O. percrassa*, upper valve, × ¼. (Md. Surv.)

like *O. trigonalis* from which it differs in its somewhat larger size and broader outline.

New Jersey, Maryland (Calvert), Florida.

LXXX. Gryphæa Lamarck.

Sessile when young, free when adult. Left valve strongly arched, with beak incurved usually nearly in plane of median line and usually not much deflected to right or left. Right valve flat and opercular; its beak inconspicuous and not deflected or coiled. Surface usually marked only with concentric growth lines. Muscle impressions as in *Ostrea*. Less irregular than *Ostrea*, with beak of lower valve more produced and recurved. It usually also lacks the strong radial plications often seen in *Ostrea* and *Exogyra*. Also differs from *Exogyra* in that the beak of the lower valve curves upward instead of laterally. Young *Gryphæas* are often much like *Ostreas*. Jurassic–Tertiary.

A. Shell narrow, widening but little from beak.......I.
 I. Dorsal sinus present.......1.
  1. Dorsal sinus beginning near beak.......290. *G. mucronata*.
  1. Dorsal sinus beginning some distance from beak.......286. *G. marcoui*.
 I. Dorsal sinus absent.......285. *G. mexicana*
B. Shell broad, widening rapidly from beak.......II.
 II. Dorsal keel present.......288. *G. navia*.
 II. Dorsal keel absent.......2.
  2. Lower valve winged.......*a*.
   a. Wings on both sides.......11.
    11. Small (less than 2 inches high).......289. *G. washitaensis*.
    11. Large (over 2 inches high); lower valve nearly circular, slightly compressed into wings at cardinal extremities. 292. *G. mutabilis*.
   a. Wing only posterior.......22.
    22. Wing not separated from rest of shell by deep sulcus; surface marked with obscure concentric lines......291. *G. vesicularis*.
    22. Wing separated from rest of shell by deep sulcus; surface marked with rugose concentric lines.......293. *G. convexa*.
  2. Lower valve not winged.......*b*.
   b. Beak usually somewhat twisted.......287. *G. corrugata* and vars.
   b. Beak straight.......294. *G. newberryi*.

285. **G. mexicana** Felix. (Fig. 622.) Upper Jurassic.

Left valve with strongly curved beak which is flattened posteriorly. Growth lines usually thickened into wave-like elevations. Right valve small, flat, and triangular.

Malone of Texas; also Mexico.

286. **G. marcoui** Hill and Vaughan. (Fig. 623.) Comanchic.

Beak narrow and incurved. Dorsal sinus distinct.

Fredericksburg of Texas.

287. **G. corrugata** Say. (Fig. 624.) Comanchic.

Lower valve boat-shaped and thick. Growth lines coarse. Dorsal sinus distinct. Beak usually slightly twisted toward dorsal margin. Upper valve somewhat triangular and thick.

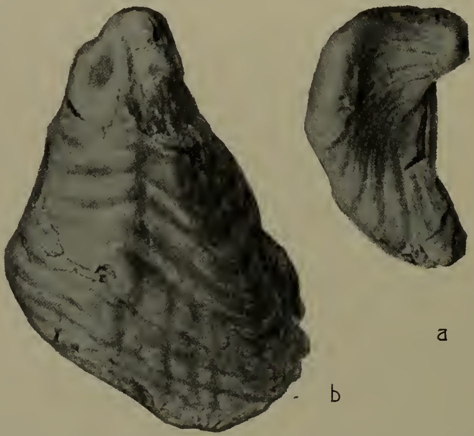


FIG. 622. *Gryphæa mexicana.* *a*, side view of a small lower valve ; *b*, a larger lower valve. (After Cragin.)

Washita of southwestern North America from Kansas to Mexico. Especially common in the Preston of Texas.

Three varieties of *G. corrugata* have been recognized, distinguished mainly by differences in size.

FIG. 623. *Gryphæa marcoui.* (After Hill.)

287*a*. **G. corrugata** var. **hilli** Cragin. Comanchic.

Small, resembling the young of *G. corrugata.*

Very abundant in the Belvidere beds of Kansas.

287*b*. **G. corrugata** var. **tucumcarii** Marcou. Comanchic.

Large.

Kansas, Oklahoma, New Mexico, Texas.

287*c*. **G. corrugata** var. **belviderensis** Hill and Vaughan. Comanchic.

Large but differs from *tucumcarii* in its more triangular and flattened outline.

Comanchic of southern Kansas and Texas.

FIG. 624. *Gryphæa corrugata.* Exterior and interior of lower valve, × ⅔. (After Hill and Vaughan.)

288. **G. navia** Hall. (Fig. 625, *d*, *e*.) Comanchic.

Lower valve distinguished from *G. corrugata* which it resembles in beak and surface characters, by its smaller size, the possession of a dorsal carina separated from the dorsal sinus by a depressed area which at times is marked by slight ridges and by having a dorsal wing, produced by the expansion of the valve at the margin.

Characteristic of the Washita from Kansas to Mexico. Exceedingly abundant in the Kiamitia clays of Texas and Oklahoma.

289. **G. washitaensis** Hill. (Fig. 625, *a–c* .) Comanchic.

Thin. Lower valve with well developed wings on both sides. Growth lines fine.

Characteristic of the middle Washita of Texas, usually associated with *Ostrea carinata* and occurring in great sheets.

290. **G. mucronata** Gabb. (Fig. 626.) Comanchic.

Similar to *G. marcoui* but larger, heavier, and with less abruptly constricted beak. The dorsal sinus begins farther up the umbo than in *G. marcoui* and the growth lines are coarser.

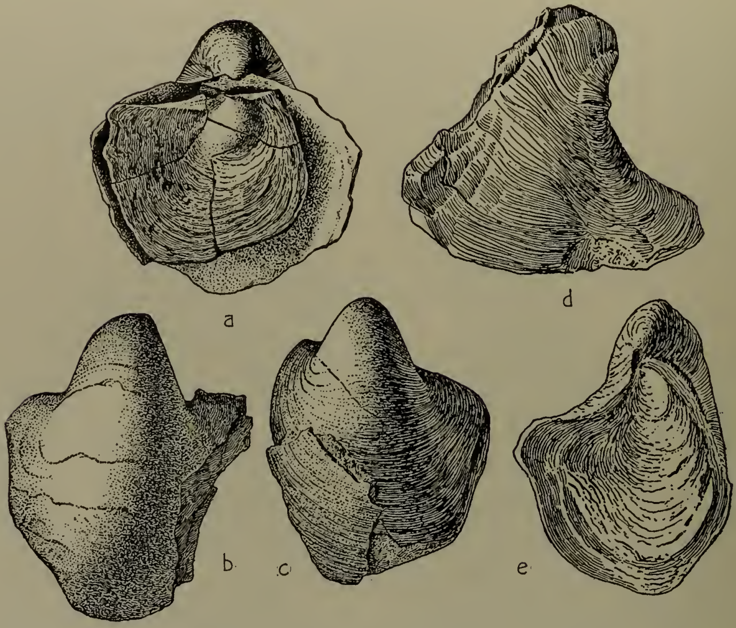


FIG. 625. *a–c, Gryphæa washitaensis; d, e, G. navia.* (After Hill and Vaughan.)

Abundant in the upper Washita (Denison and Buda) of Texas, and in Sonora.

291. **G. vesicularis** Lamarck. (Fig. 627.) Comanchic–Cretacic.

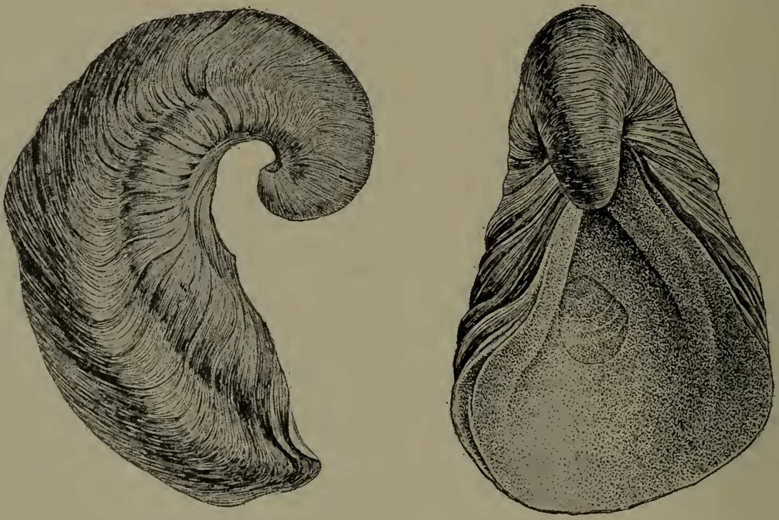


FIG. 626. *Gryphæa mucronata.* (After Hill.)

Differs from *G. convexa* in absence of sulcus and in smooth surface.

Washita of Mexico. Cretacic: Delaware, Texas and Mexico and west to Montana. Also Europe.

292. **G. mutabilis** Morton. (Fig. 628.) Cretacic.

Lower valve depressed-convex and comparatively thin.

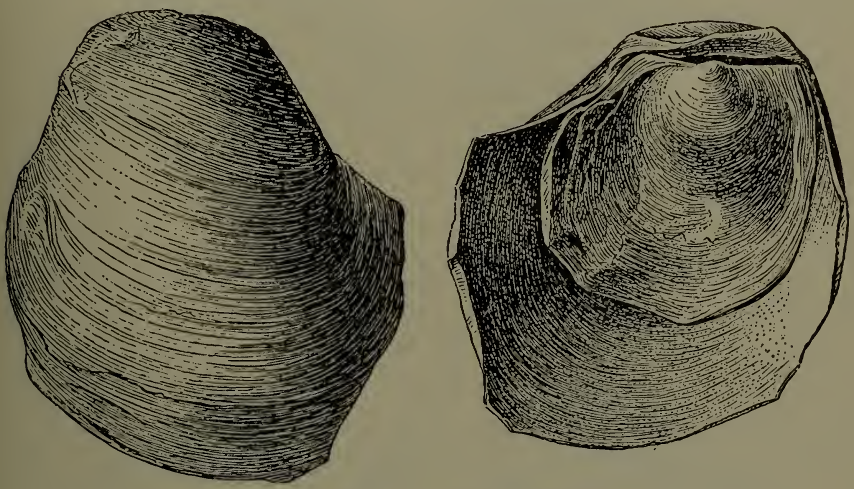


FIG. 627. *Gryphæa vesicularis.* Lower and upper valves. (Md. Surv.)

Especially characteristic of Marshalltown of New Jersey.

293. **G. convexa** (Say). (Fig. 629.) Cretacic.

Lower valve with posterior ear separated from the rest of the

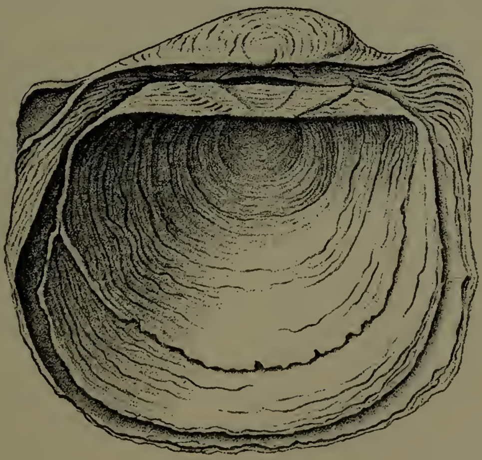


FIG. 628. *Gryphæa mutabilis.* (N. J. Pal., I.)

shell by a conspicuous sinus, extending from the beak obliquely backward. Upper valve flat.

Forms a conspicuous bed in the middle of the Navesink of

FIG. 629. *Gryphæa convexa*, × ⅔. (N. J. Pal., I.)

New Jersey; also in Marshalltown of New Jersey. Also in Ripleyan of Alabama and Mississippi.

294. **G. newberryi** Stanton. (Fig. 630.) Cretacic.

Outline rounded. Beaks broad. Surface marked with con-

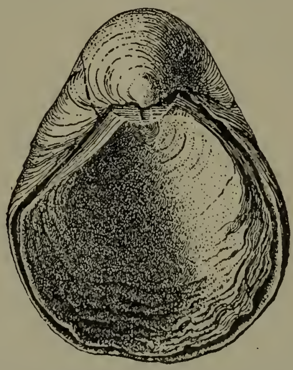


FIG. 630. *Gryphæa newberryi*. (After Stanton.)

centric lines which occasionally become somewhat lamellose.

Coloradoan: Colorado, Utah, New Mexico, Arizona, Texas.

LXXXI. EXOGYRA Say.

Shell massive. Left or under valve always much the deeper. Right or upper valve usually flat. Shell fixed by the left valve. Beak of lower valve always turned strongly backwards and usually more or less spiral. Beak of upper valve inconspicuous but deflected or spiral. Upper Jurassic–Cretacic.

A. Surface smooth or nearly so .... I.
I. Larger valve marked with broad furrow .... 298. *E. suborbiculata.*
I. Larger valve not furrowed .... 300. *E. læviuscula.*
B. Surface marked with prominent concentric lamellæ .... II.
II. Shell large .... 301. *E. ponderosa.*
II. Shell small .... 297. *E. arietina.*
C. Surface marked with distinct radiating ribs or wrinkles .... III.
III. Small .... 1.
1. Nearly flat .... 295*a.* *E texana* var. *weatherfordensis.*
1. Convex .... *a.*
a. Shell with obtusely rounded umbonal ridge .... 299. *E. columbella.*
a. Shell with angular umbonal ridge .... 296. *E. plexa.*
III. Large .... 2.
2. Valves very unequal, the lower very convex, the upper nearly flat. 302. *E. costata.*
2. Valves subequal, flattened .... 295. *E. texana.*

295. **E. texana** Roemer. (Fig. 631–632.) Comanchic.

Valves subequal, thick. Surface marked with unequal radiating ribs.

Widely distributed in the Comanchic of Texas, being especially

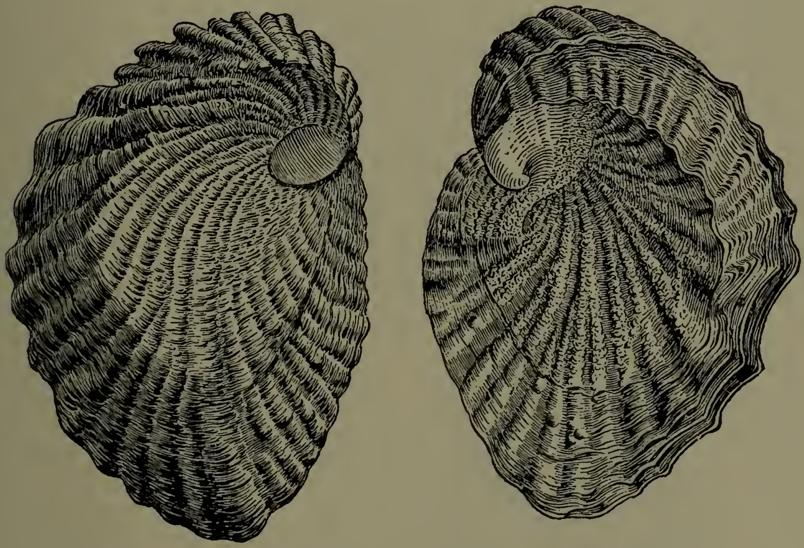


FIG. 631. *Exogyra texana.* Opposite valves. (After Hill.)

abundant in the Fredericksburg. Also in Fredericksburg and Washita of Mexico.

295*a.* **E. texana** var. **weatherfordensis** Cragin. Comanchic.

Small, flattened, with somewhat semicircular outline. Lower valve usually marked with plications which are delicate on the posterior slope and somewhat tuberculate on the anterior.

Trinity of Texas.

FIG. 632. *Exogyra texana.* The two valves in conjunction. (After Hill.)

296. **E. plexa** Cragin. Comanchic.

Lower valve divided into an anterior and a posterior slope by an angular ridge. Both slopes usually marked with radiating lines or wrinkles.

Comanchic: Texas (Fredericksburg and Washita).

297. **E. arietina** Roemer. (Fig. 633.) Comanchic.

Larger valve inflated, tortuous. Smaller valve flat, a plane spiral. Without plications.

Washita: Texas, Mexico.

298. **E. suborbiculata** (Lamarck). (Fig. 635, *c.*) Cretacic.

Lower valve marked with a broad furrow, extending obliquely from the umbo to the postero-basal margin. Surface smooth.

Benton: Colorado (Pugnellus sandstone).

299. **E. columbella** Meek. (Fig. 634, *a–c.*) Cretacic.

Small, left valve marked by radiating ribs. Right valve flat, oval and smooth.

Colorado: New Mexico, Texas (Benton); also Dakota of Texas.

FIG. 633. *Exogyra arietina.* (After Hill.)

300. **E. læviuscula** Roemer. (Fig. 634, *d.*) Cretacic.

Both valves smooth except for concentric growth lines. Smaller valve flat and nearly circular.

Very common in the Austin of Texas; also Benton of Kansas and Utah.

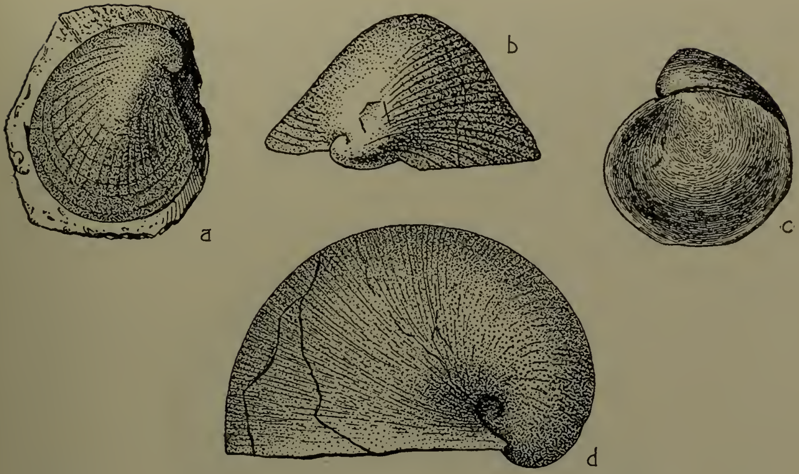


FIG. 634. *a–c*, *Exogyra columbella*, lower umbonal and upper views; *d*, *E. læviuscula*, lower valve. (After Stanton.)

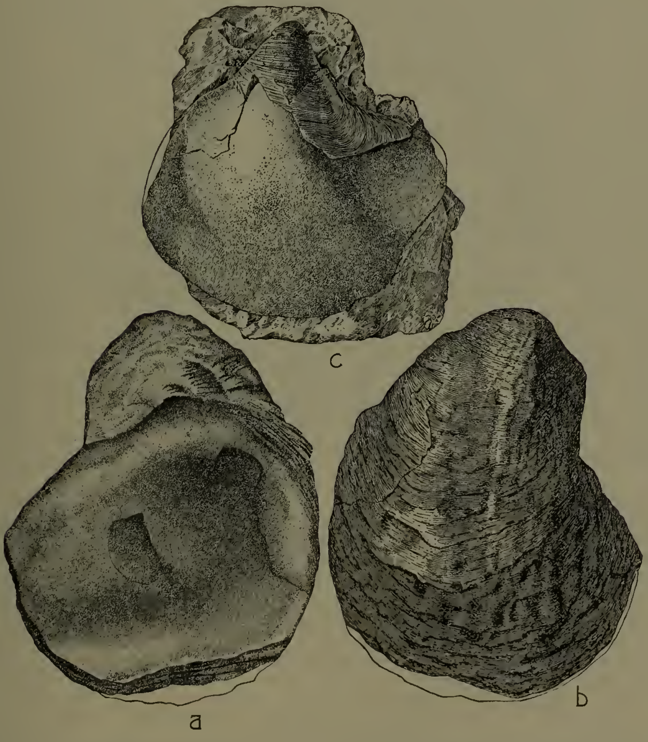


FIG. 635. *a*, *b*, *Exogyra ponderosa*; *c*, *E. suborbiculata*, lower valve. All × ½. (After Stanton.)

301. **E. ponderosa** Roemer. (Fig. 635, *a*, *b*.) Cretacic.

Left valve marked with strong concentric lamellæ, fine concentric striæ and obscure radiating ribs. Right valve with horizontally spiral umbo; concentrically laminated.

Ripleyan of New Jersey (Marshalltown), Alabama, Arkansas. In the Coloradoan of Utah, Texas (Austin) and Mexico.

302. **E. costata** Say. (Fig. 636.) Cretacic.

FIG. 636. *Exogyra costata.* Lower valve, × ½. (After White.)

Differs from *E. ponderosa* in being strongly costate and in lacking the lamellose extensions.

New Jersey (especially characteristic of Navesink; also in Red Bank and Tinton), Delaware, Maryland (Monmouth) and Gulf region to Texas and San Luis Potosi.

LXXXII. AMNIGENIA Hall.

Equivalve, very inequilateral, subelliptical, with very short anterior end and prolonged and wider posterior end; both extremities rounded. Beaks low and appressed. Hinge line long, gently arcuate. Umbonal slope not defined. Surface marked by concentric striæ which become lamellose on the posterior portion of the shell. Teeth obscure. Hinge line marked by one or two longitudinal lateral folds. Ligament external, extending more than half way from the beak to the posterior end. Pallial line simple. Lived in fresh water. Devonic.

303. **A. (Archanodon) catskillensis** (Vanuxem). (Fig. 637.) Devonic.

Shell large, elongate-elliptical.

Oneonta: New York. Catskill: Pennsylvania.

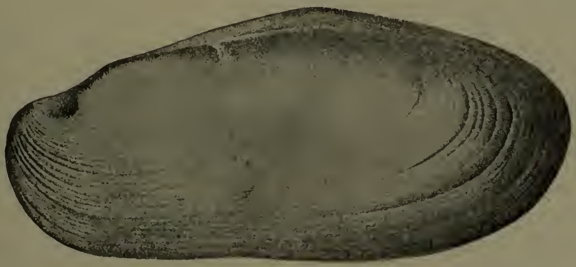


FIG. 637. *Archanodon catskillensis*, × ⅔. (Pal. N. Y., V.)

LXXXIII. NAIADITES DAWSON. (*Anthracoptera*, Salter.)

Inequivalve, obliquely triangular, very inequilateral. Anterior end oblique, forming a small lobe anterior to the umbonal ridge. Hinge line straight. Hinge plate striated, with an obscure cardinal tooth, that in the left valve being anterior, and that in the right posterior. Umbos small, inconspicuous, almost terminal. Byssal notch always present. Shell very strong anteriorly, fragile posteriorly. Surface covered with flat concentric lamellæ. Pallial line entire, represented by a series of small pits. Brackish or fresh water; attached by byssus. Carbonic.

304. **N. carbonarius** Dawson. (Fig. 638, *e*.) Carbonic.

Hinge line more than half the length of the shell. Beak in anterior fourth of hinge line. Anterior margin abruptly rounded; basal margin nearly straight, with a slight sinus; posterior margin broad and regularly rounded. Shell usually much distorted by pressure. Length one inch or more. Type of genus.

Exceedingly abundant in the Coal Measures of Nova Scotia and Cape Breton.

LXXXIV. Anthracomya Salter.

Differs from *Naiadites* in posterior end being produced, expanded, and usually truncate. Hinge with narrow internal ridge parallel with the edge of the valve in its posterior portion. Hinge plate not striated; an oblique diagonal ridge passes from the umbo downwards and backwards. Differs also in being equivalve, with larger and more conspicuous umbos. No byssal notch present. Carbonic.

305. **A. elongata** Dawson. (Fig. 638, *a*, *b*.) Carbonic.
Umbos less anterior than those of *Naiadites carbonarius*.

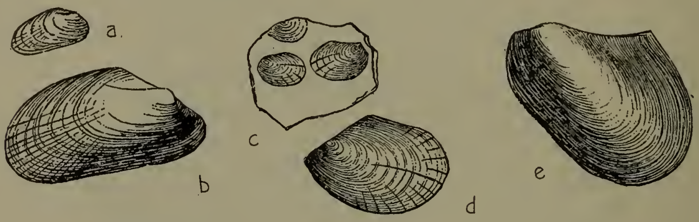


Fig. 638. *a*, *b*, *Anthracomya elongata*, nat. size and enlarged; *c*, *d*, *A. lævis*, nat. size and enlarged; *e*, *Naiadites carbonarius*. (After Dawson.)

Nova Scotia, Cape Breton.

306. **A. lævis** Dawson. (Fig. 638, *c*, *d*.) Carbonic.
Less oblique than preceding; beak more nearly central.
Coal Measures of Nova Scotia.

LXXXV. Nyassa Hall.

Beaks small, anterior. Hinge line long and arcuate. Oblique median depression and umbonal ridge often present. Surface concentrically striated. Hinge with several irregular and coalescent teeth anteriorly and with 1 to 4 elongate lateral teeth pos-

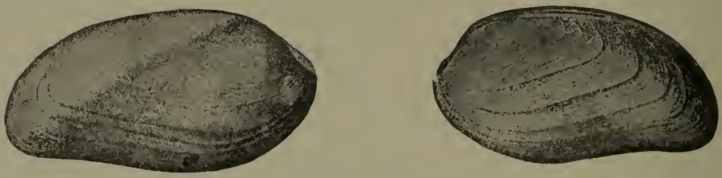


Fig. 639. *Nyassa arguta*.

teriorly. Ligament external and inconspicuous. Pallial line simple. Devonic.

307. **N. arguta** Hall. (Fig. 639.) Devonic.

Distinguished by its arcuate, subelliptical form and sinuate basal margin. Growth lines lamellose.

Hamilton: New York, Ontario.

LXXXVI. Unio Retzius.

Oval or elongated. Epidermis thin. Umbos more or less anterior. Surface smooth, concentrically striated, corrugated, or rarely spiny. Hinge line with heavy, amorphous, radial, pseudo-

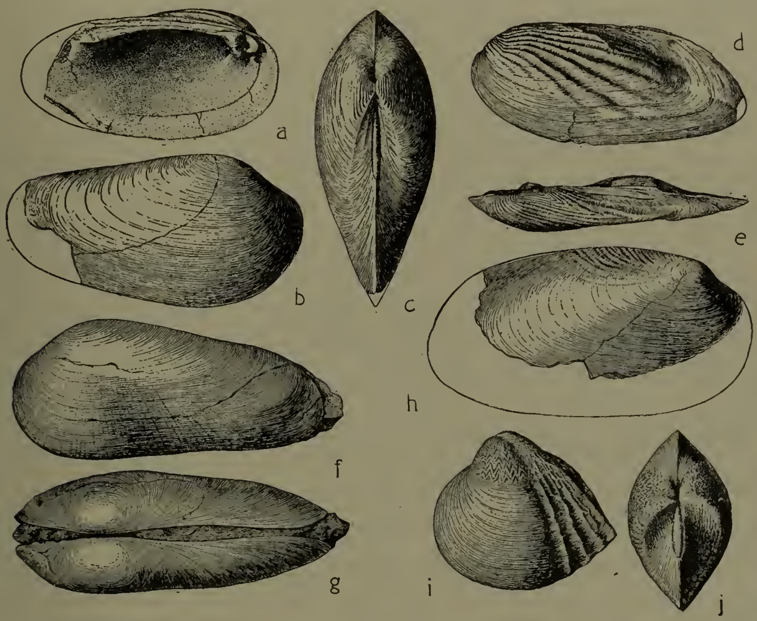


FIG. 640. *a–c*, *Unio vetustus*; *d*, *e*, *U. belliplicatus*; *f*, *g*, *U. danæ*; *h*, *U senectus*; *i*, *j*, *U. holmesianus*. (After White.) All × ½.

cardinal and lateral teeth. Ligament external. Pallial line simple. Fresh water. Jurassic–Recent.

308. **U. vetustus** Meek. (Fig. 640, *a–c*.) Cretacic.

Beaks marked with regular concentric ridges that usually end at the oblique umbonal ridge which extends from the umbo posteriorly: a second ridge present between this and the cardinal margin. Remainder of valve marked merely with growth lines. Length about three inches.

Bear River: Utah, Wyoming, Idaho.

309. **U. belliplicatus** Meek. (Fig. 640, *d*, *e*.) Cretacic.

Umbonal slope with 5 to 8 (or more) coarse, rounded, rather irregular folds or plications, which become obsolete in the last built portion of the shell.

Bear River beds of Wyoming, etc.

310. **U. subspatulatus** Meek and Hayden. Cretacic.

Surface as of *U. vetustus* but differing from that species in more arched hinge line, more anterior beak, straight base and general proportions.

Judith River beds of Montana, Assiniboia.

311. **U. danæ** Meek and Hayden. (Fig. 640, *f, g.*) Cretacic.

Similar to *U. subspatulatus* in size and form but its convexity is greater, the beaks not so anterior, and it is unsculptured.

Alberta (Lower Belly River), Montana and Assiniboia (Judith River); also Lower Laramie of Wyoming and Alberta.

312. **U. senectus** White. (Fig. 640, *h.*) Cretacic.

Thin. Cardinal and lateral teeth separated by a considerable space. Posterior to the line running from the beak to the posterior basal angle the surface has numerous small crenulated undulations. In front of this the surface is marked only with growth lines.

Montana (Judith River), Assiniboia (Lower Belly River); also Laramie of Alberta.

313. **U. holmesianus.** (Fig. 640, *i, j.*) Cretacic.

Basal (latest built) portion of shell marked with only concentric growth lines; the rest of the shell covered with radiating costæ of close-set rhombic papillæ. A strong medial sinus present.

Laramie: Wyoming, Utah.

LXXXVII. Anodonta Cuvier.

Shell like *Unio* externally but usually much thinner and smoother. Hinge without teeth. Fresh water. Cretacic–Recent.

314. **A. propatoris** White. Cretacic.

Elongate, subelliptical, moderately convex. Beaks small, slightly elevated above the hinge line. Hinge line long, straight. Ventral border broadly convex; front regularly rounded from the base to the antero-dorsal border which is more abruptly rounded to the hinge line. Postero-dorsal border oblique and slightly convex. Surface only concentrically striated. Average length 2 inches; height slightly over 1 inch.

Judith River: Montana, Assiniboia. Laramie: Wyoming.

LXXXVIII. LYRODESMA Conrad.

Moderately convex, equivalve, inequilateral. Beaks small, anterior to the middle. Posterior umbonal slope usually prominent. Surface concentrically striated. Hinge with 6 to 8 prominent, subequal, transversely striated teeth radiating regularly from the beak and placed on a thick plate. Posterior adductor

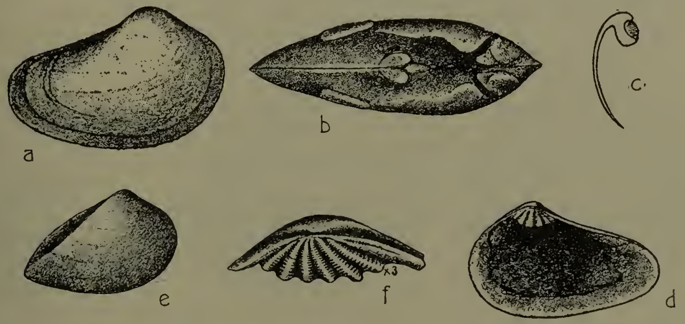


FIG. 641. *a–d*, *Lyrodesma major*. *a*, right valve; *b*, cardinal view, slightly enlarged; *c*, vertical section through valve at beak showing thickness of hinge plate and reason why the beaks in internal molds are widely separated; *d*, interior of right valve; *e*, *f*, *L. acuminatum*, right valve and its hinge, *f* × 3. (After Ulrich.)

scar larger than anterior. Pallial line slightly sinuate posteriorly. No ligament area present. Ordovicic and Siluric.

315. **L. acuminatum** Ulrich. (Fig. 641, *e*, *f*.) Ordovicic.

Posterior cardinal slope with four or five radiating lines. Teeth 6, the central ones curved backward; the anterior ones short.

Stones River: Kentucky. Black River: Minnesota.

316. **L. major** Ulrich. (Fig. 641, *a–d*.) Ordovicic.

Shell much prolonged posteriorly. Posterior umbonal and cardinal slope marked with fine radiating lines. Hinge with 6 teeth.

Cincinnati Group: Ohio, Minnesota.

317. **L. poststriatum** (Emmons). Ordovicic.

Distinguished by its obliquely truncate posterior extremity and strongly striated posterior umbonal slope.

Trenton–Lorraine: New York, Pennsylvania.

LXXXIX. Schizodus King.

Shell thin, ovate, often tending toward quadrate, longest posteriorly. Right valve with two teeth; left with three. Surface marked with concentric striæ or nearly smooth. Muscular impressions two; the anterior with a small radial buttress. Pallial line simple. Devonic–Permic.

318. **S. chemungensis** (Conrad) (*S. appressus* Conrad). (Fig. 642, *b*.) Devonic.

Surface covered with fine concentric striæ which often strengthen into varices near the base.

Hamilton: New York. Chemung: New York, Pennsylvania.

Fig. 642. *a*, *Schizodus qnadrangularis*; *b*, *S. chemungensis*; *c*, *S. gregarius*; *a*, *S. rhombeus*. All left valves. (N. Y. Surv.)

319. **S. gregarius** Hall. (Fig. 642, *c*.) Devonic.

Distinguished by its small size and elongate form.

Chemung Group: Pennsylvania.

320. **S. rhombeus** Hall. (Fig. 642, *d*.) Devonic.

Distinguished by its nearly quadrate form. Below the medium size but larger than *S. gregarius*.

Chemung Group: New York, Pennsylvania.

321. **S. quadrangularis** Hall. (Fig. 642, *a*.) Devonic–Carbonic.

Fig. 643. *Schizodus medinaënsis*. (Ohio Pal., II.)

Differs from *S. chemungensis* in its more quadrate form and more nearly central beaks.

Chemung Group: New York. Waverly: Ohio. Coal Measures: Pennsylvania.

322. **S. medinaënsis** Meek. (Fig. 643.) Mississippic.

Subtrigonal. Surface nearly smooth.

Waverly: Ohio, Indiana.

323. **S. cuneatus** Meek. (Fig. 644.) Mississippic–Carbonic.

Large. Beaks erect, incurved.

Mississippic : Nevada. Carbonic : Pennsylvania–Colorado.

324. **S. curtus** Meek and Worthen. Carbonic and Permic.

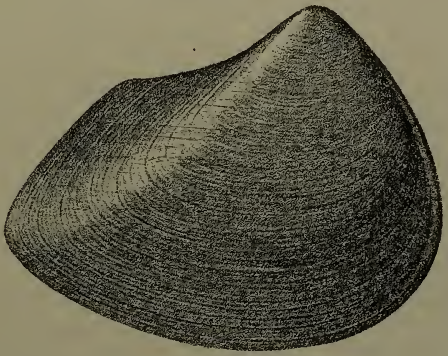


FIG. 644. *Schizodus cuneatus.* (Ohio Pal., II.)

Small, not exceeding $\frac{1}{2}$ inch in length, nearly circular, with very elevated and nearly central beaks.

Coal Measures : Indiana–Missouri. Permic : Kansas (Marion).

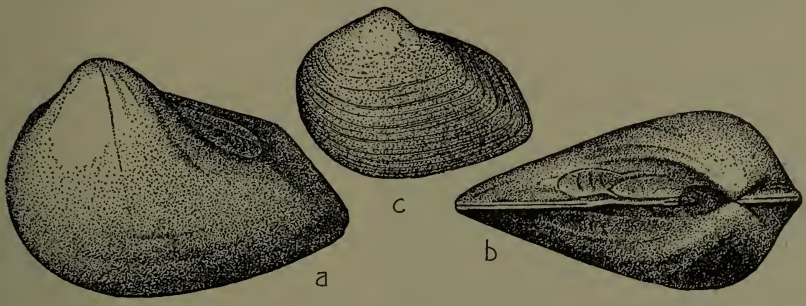


FIG. 645. *Schizodus wheeleri.* *a*, *b*, internal molds ; *c*, exterior of smaller left valve (Ind. Surv.)

325. **S. wheeleri** Swallow. (Fig. 645.) Carbonic–Permic.

Differs from *S. chemungensis* in outline, especially in the obliquely truncated posterior portion.

Coal Measures : Pennsylvania–New Mexico. Permic : Kansas, Wyoming ?

XC. TRIGONIA Bruguiere.

Thick, trigonal, very inequilateral, with rounded anterior and produced and angular posterior margin. Generally marked with a ridge extending from the umbos to the posterior border, cutting off the posterior dorsal area which has a different ornamentation.

Beaks nearly terminal anteriorly, directed posteriorly. Surface bearing rows of tubercles or radiating or concentric ribs. Cardinal teeth two in the right valve; three in the left. Ligament external. Pallial line simple. Jurassic–Recent.

326. **T. quadrangularis** Hall & Whitf. (Fig. 646.) Jurassic.

FIG. 646. *Trigonia quadrangularis.* (After Hall and Whitfield.)

Trigonal to subquadrangular, with two sets of ridges making an acute angle with each other.

Upper Jurassic of Wyoming, Dakota, etc.

327. **T. taffi** Cragin. Comanchic.

Very large (length and height each over 3 inches), rounded-subquadrate. Posterior dorsal area ornamented with numerous, parallel, oblique ridges separated by much broader interspaces; the ridges near the beak become resolved into series of small granules. The rest of the surface covered with close rows of small tubercles.

Trinity of Texas.

328. **T. emoryi** Conrad. (Fig. 647.) Comanchic.

Ribs 30 or more, strong and tubercled, becoming indefinite posteriorly; they change direction in passing over the posterior dorsal area and again over the escutcheon.

FIG. 647. *Trigonia emoryi.* (After Shattuck.)

Fredricksburg and Washita: Texas, Mexico, Oklahoma.

329. **T. equistriata** Gabb. Comanchic–Cretacic.

Small, trigonal, elongate. Beaks prominent. · Cardinal margin nearly straight and sloping posteriorly. Shell truncated posteriorly. Surface crossed by regular broad concentric ribs with flat and equal interspaces. An angular ridge extends from the beak to posterior basal margin.

Horsetown and Chico: California, Oregon.

330. **T. evansana** Meek. Cretacic.

Somewhat similar to *T. eufaulensis* in outline, convexity, and strongly incurved beaks; but its beak is more elevated, its average length is $1\frac{3}{4}$ inches and height $1\frac{3}{8}$ inches, its posterior basal margin is straight or slightly convex, not concave, its ribs are 18 to 23 and proportionally much narrower than the interspaces and less curved than in *T. eufaulensis*.

Chico: California, Oregon.

FIG. 648. *Trigonia thoracica*. (After Weller, N. J. Surv., Pal., IV.)

331. **T. thoracica** Morton. (Fig. 648.) Cretacic.

Ribs nodose, about 15, the anterior ones curving strongly forward. The posterior dorsal area occupied by 12 to 14 subangular ribs.

New Jersey (very abundant in Marshalltown; also in Wenonah and Navesink), Gulf region.

332. **T. eufaulensis** Gabb. (Fig. 649.) Cretacic.

FIG. 649. *Trigonia eufaulensis*. (After Weller, Pal. N. J., IV.)

Drawn out posteriorly. Ribs angular, 12–14.

New Jersey (Merchantville–Wenonah), Gulf region.

XCI. Aviculopecten McCoy.

Pectiniform, inequilateral, inequivalve, with right valve usually less convex than the left. Hinge line straight with both anterior and posterior ears. Surface usually radially sculptured. Ligament internal, extending to both sides of the beak in many shallow grooves roughly parallel to the long hinge line. Resiliifer present. Teeth absent. Pallial line simple. Siluric–Carbonic.

A. Large, — exceeding 1½ inches in diameter........................I.
- I. Striæ fasciculate........................343. *A. providencesis.*
- I. Striæ spiny........................335. *A. scabridus.*
- I. Striæ simple and smooth........................334. *A. princeps.*

B. Of medium size, — about 1 inch in diameter........................II.
- II. Rays in sets of two........................337. *A. duplicatus.*
- II. Rays spiny........................354. *Acanthopecten carboniferus.*
- II. Rays in bundles of irregular size........................333. *A. fasciculatus.*
- II. Rays 4–6, roughened by scales and separated by finer striæ........................1.
  - 1. Ribs prominent only on lower half of shell........................352. *A. vanvleeti.*
  - 1. Ribs prominent from near the beak to the margin........................351. *A. maccoyi.*
- II. Rays of nearly but not quite equal size and crossed by crowded and regular concentric striæ; hinge-line crenulated........................364. *Crenipecten winchelli.*
- II. Rays of equal size but varying lengths........................2.
  - 2. Beak acute and projecting above the hinge line........................353. *A. oklahomaensis.*
  - 2. Beak nearly a right angle and scarcely projecting above the hinge line...*a.*
    - *a.* Ears prominent........................349. *A. occidentalis.*
    - *a.* Ears small........................345. *A. curtocardinalis.*
- II. Rays regularly alternating........................3.
  - 3. Smaller rays only near front........................348. *A. weberensis.*
  - 3. Smaller rays extending nearly to beak........................*b.*
    - *b.* Small rays several........................346. *A. occidaneus.*
    - *b.* Small rays one in broad space........................347. *A. parvulus.*
- II. Without rays, marked only by concentric lines........................344. *A. interlineatus.*

. Small, less than 1 inch in greatest diameter........................III.
- III. Radiating striæ fine and numerous........................4.
  - 4. Radii crossed by fine concentric lines, producing a cancellated appearance..*c.*
    - *c.* Length and height nearly equal (about ⅓ inch)....342. *A. pellucidus.*
    - *c.* Height slightly exceeding length (about ⅕ inch wide). 338. *A. cancellatus.*
  - 4. Concentric striæ absent or not prominent........................*d.*
    - *d.* Length and height nearly equal........................339. *A. caroli.*
    - *d.* Height exceeding length........................336. *A. striatus.*
- III. Radiating striæ rib-like and alternating in length........................5.
  - 5. Length and height about equal........................*e.*
    - *e.* Posterior margin nearly straight........................341. *A. rectilaterarius.*
    - *e.* Posterior margin angular........................340. *A. coxanus.*
  - 5. Height exceeding length........................350. *A. germanus.*

333. **A. fasciculatus** Hall. (Fig. 650, *g*.) Devonic.
Axis of shell quite oblique to the hinge line. Surface including

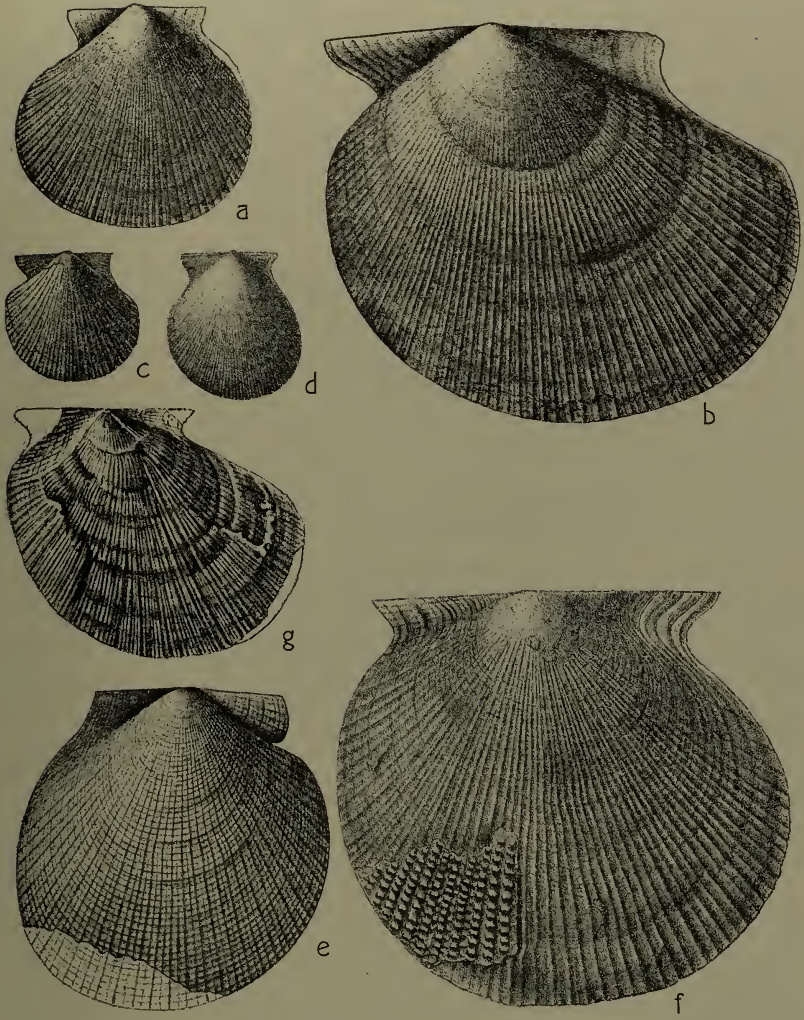


FIG. 650. *a*, *Aviculopecten duplicatus*, left valve ; *b*, *A. princeps*, left valve ; *c*, *A. caroli*, left valve ; *d*, *A. striatus*, left valve ; *e*, *A. cancellatus*, right valve, $\times 2$; *f*, *A. scabridus*, left valve ; *g*, *A. fasciculatus*, left valve. (Pal. N. Y., V.)

ears covered with numerous, fine and irregular rays which are often fasciculate or in diverging bundles. Distinguished from other species by its irregular surface markings.

Hamilton : New York, Indiana.

334. **A. princeps** (Conrad). (Fig. 650, *b*.) Devonic.

Large ; rays nearly obsolete on the large ears. Whole shell covered with fine concentric striæ.

Hamilton: New York, Ohio, Kentucky, Indiana, Michigan.

335. **A. scabridus** Hall. (Fig. 650, *f*.) Devonic.

Differs from *A. princeps* in its very obtuse angle at the hinge line, and especially in the imbricating growth lines which usually form short, almost tubular spines when passing over the rounded rays.

Hamilton: New York.

336. **A. striatus** Hall. (Fig. 650, *d*.) Devonic.

Small; surface including ears covered with fine regular and closely arranged rays.

Chemung: New York, Pennsylvania.

337. **A. duplicatus** Hall. (Fig. 650, *a*.) Devonic.

Beaks obtuse, prominent. Ears small. Surface including ears covered with regular duplicating rays crossed by fine concentric striæ; umbo nearly smooth.

Chemung: New York, Pennsylvania.

338. **A. cancellatus** Hall. (Fig. 650, *e*.) Devonic.

Height slightly greater than length. Lateral margin of anterior ear rounded. Surface including ears marked with fine rays crossed by fine striæ, giving the shell a cancellated appearance.

Chemung: New York.

339. **A. caroli** Winchell. (Fig. 650, *c*.) Mississippic.

Differs from *A. striatus* in its more circular form, obtuse beak, and stronger radii.

Waverly: Ohio, Iowa.

340. **A. coxanus** Meek and Worthen. (Fig. 651.) Carbonic.

FIG. 651. *Aviculopecten coxanus*. (Kan. Pal., VI/II.)

Radiating ribs alternating in size, the smaller ones dying out before reaching the hinge. Concentric striæ fine and close.

Coal Measures: Pennsylvania–Oklahoma and Nebraska.

341. **A. rectilaterarius** (Cox). Carbonic.

Height and length about equal (about $\frac{3}{4}$ inch). Anterior ear separated by an indistinct furrow from body of shell. Posterior ear not defined, large. Posterior margin nearly straight. Radiating striæ somewhat rib-like, crossed by concentric lines. Differs from *A. coxanus* in its slightly larger size; larger posterior ear and straight posterior border.

Kentucky, Indiana, Illinois, Kansas, Colorado (Hermosa), Oklahoma (Poteau Group).

342. **A. pellucidus** Meek and Worthen. Carbonic.

Very small, somewhat oblique, extremely thin and fragile. Ears subequal; the anterior acutely angular. Surface cancellated by the concentric and radiating striæ (12 radii in $\frac{1}{10}$ inch at

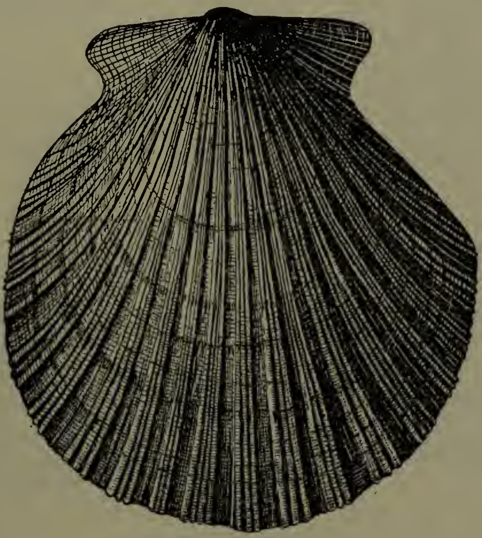


FIG. 652. *Aviculopecten providencesis.* (Kan. Pal., VI/II.)

anterior margin). Length and height about equal ($\frac{1}{3}$ inch). Hinge line shorter than length of shell below.

Illinois, Colorado.

343. **A. providencesis** (Cox). (Fig. 652.) Carbonic.

Large. Striæ in bundles of 3 to 5 which are separated by broad grooves.

Kentucky, Indiana, Missouri, Kansas.

344. **A. interlineatus** Meek and Worthen. (Fig. 653.) Carbonic.

Surface marked only with strong concentric ridges and with fine concentric striæ between.

Ohio–Missouri, Arizona.

345. **A. curtocardinalis** Hall and Whitf. (Fig. 654, *a.*) Carbonic.

Smaller than *A. occidentalis*, with smaller ears and bifurcating simple striæ.

Upper Carbonic of Utah, Wyoming and elsewhere in west.

346. **A. occidaneus** Meek. (Fig. 654, *b*.) Carbonic.

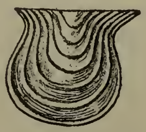


FIG. 653. *Aviculopecten interlineatus.* (Kan. Pal., VI/II.)
FIG. 654. *Aviculopecten curtocardinalis,* × 2 (left); *A. occidaneus.* (After Hall and Whitfield, and after Meek.)

Slightly more oblique than preceding; striæ alternating, 2 to 4 smaller between larger.

Occurs with preceding.

347. **A. parvulus** Hall and Whitf. (Fig. 655, *a*.) Carbonic.

FIG. 655. *Aviculopecten parvulus,* × 3 (left); *A. weberensis.* (After Hall and Whitfield.)

More elongate and with larger ears than preceding, large ribs sharp and strong, smaller generally only one.

Occurs with the preceding.

348. **A. weberensis** Hall and Whitf. (Fig. 655, *b*.) Carbonic.

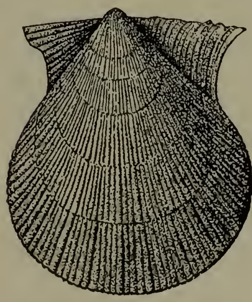


FIG. 656. *Aviculopecten occidentalis,* left valve. (Ind. Surv.)

Ears more pronounced than in preceding, plications smaller, several near front only.

Occurs with preceding generally.

349. **A. occidentalis** (Shumard). (Fig. 656.) Carbonic–Permic.

Both valves crossed by distinct radiating ribs, those of the left valve the more prominent. Whole valve crossed by concentric growth lines. Ears large; umbo rectangular to acute.

Common in Carbonic rocks of the United States from Pennsylvania and Kentucky, westward and southward to Utah and Arizona. Ranges from Lower Coal Measures to the Upper and into Permic in Kansas and Texas.

350. **A. germanus** Miller and Faber. (Fig. 657.) Carb.–Permic.

Radiating ribs about 12, alternating with about the same number of shorter ribs, and all separated by wide, flattened spaces.

FIG. 657. *Aviculopecten germanus.* (Kan. Pal., VI/II.)
FIG. 658. *Aviculopecten maccoyi.* (Kan. Pal., VI/II.)

Coal Measures: Kentucky, Kansas, Oklahoma. Permic: Kansas.

351. **A. maccoyi** Meek and Hayden. (Fig. 658.) Car.–Permic.

Ribs 3 to 6, roughened by scale-like projections and separated by smaller striæ.

Coal Measures: Kansas, Oklahoma. Permic: Kansas. Also Carbonic of New Mexico.

352. **A. vanvleeti** Beede. (Fig. 659, *c*.) Permic.

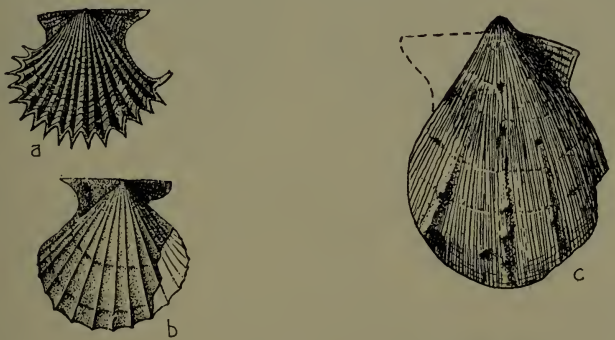


FIG. 659. *a*, *b*, *Acanthopecten carboniferus*; left and right valves. (Ind. Surv.)
c, *Aviculopecten vanvleeti.* (Kan. Sci. Bull.)

Differs from *A. maccoyi* in larger size and in the larger rays which are prominent only when half way down the shell.

Upper Permic: Oklahoma (Whitehorse), Texas (Quartermaster).

353. **A. oklahomaensis** Beede. Permic.

Differs from *A. occidentalis* in its frequently smaller angle at the beak, and in the more pronounced concentric lamellæ.

Upper Permic: Oklahoma (Whitehorse), Texas (Quartermaster).

XCII. Acanthopecten Girty.

In surface characters distinguished from *Aviculopecten* by its large, angular plications, and spinose margin and growth lines. Carbonic.

354. **A. carboniferus** (Stevens). (Fig. 659, *a*, *b*). Carbonic.

Small; right valve less spinose, and less strongly plicate than left. Type of the genus.

Distributed widely in the Coal Measures from West Virginia to Colorado and New Mexico.

XCIII. Euchondria Meek.

Like *Aviculopecten* but with an unsymmetrical resiliifer beneath the beak and with numerous pits on the two sides of it unequal in number and shape. Carbonic.

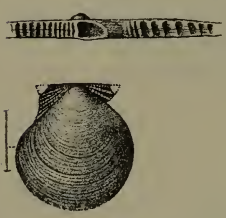


Fig. 660. *Euchondria neglecta*, right valve, ×2; hinge greatly magnified, showing oblique cartilage and smaller lateral pits. (Pal. Ill., V.)

355. **E. neglecta** Geinitz. (Fig. 660.) Carbonic.

Small, with concentric striæ only on body of shell, but ribs on ears. Type of genus.

Illinois, Iowa, Kansas, Nebraska, Missouri.

XCIV. Pterinopecten Hall.

Differs from *Aviculopecten* in the longer hinge line, and ears not well defined; from *Lyriopecten* in its distinctly angular anterior ear. Devonic.

356. **P. exfoliatus** Hall. (Fig. 661, *d*.) Devonic.

Subrhomboidal. Left valve very convex; right less convex. Hinge line longer than shell below. Umbo prominent. Surface of left valve marked with strong rays alternating with one or two finer ones; rays on right valve less strong.

Marcellus: New York.

357. **P. intermedius** Hall. (Fig. 661, *c*.) Devonic.

Differs from *P. exfoliatus* in its greater obliquity, smaller umbo, comparatively smaller posterior and larger anterior ear. Surface rays more thread-like.

Hamilton : New York.

358. **P. vertumnus** Hall. (Fig. 661, *a.*) Devonic.

Depressed-convex. Surface marked with irregular, alternating, flexuous and flattened rays, crossed by sharp concentric striæ.

Hamilton : New York.

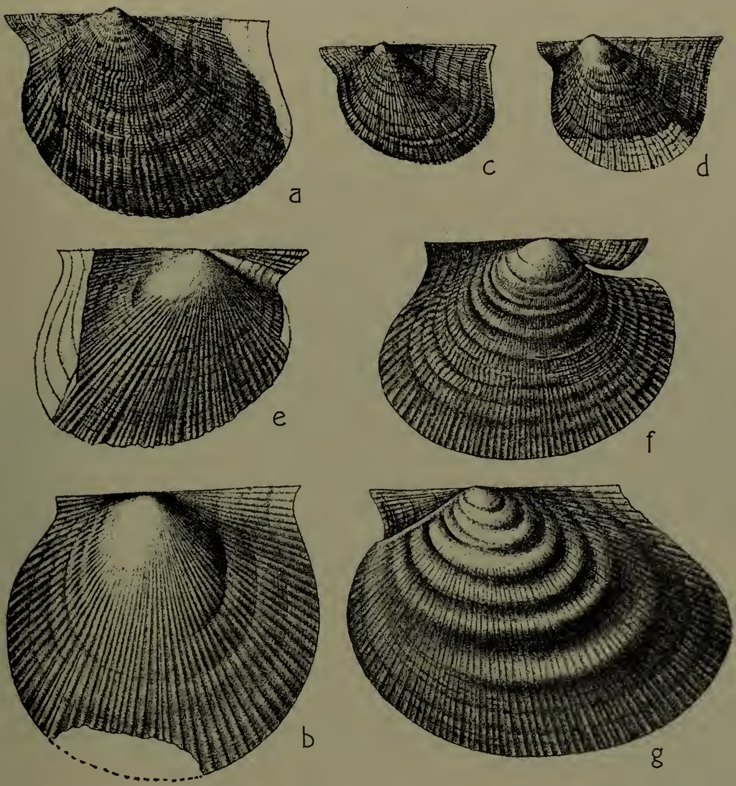


FIG. 661. *a*, *Pterinopecten vertumnus*, left valve ; *b*, *P. suborbicularis ; c*, *P. intermedius ; d*, *P. exfoliatus ; e*, *P. dispandus*, right valve ; *f*, *g*, *P. undosus*, right and left valves. (Pal. N. Y., V.)

359. **P. undosus** Hall. (Fig. 661, *f*, *g.*) Devonic.

Hinge line less than length of shell below. Valves depressed-convex. Surface marked with many rays crossed by lamellose growth lines and by 3–10 strong concentric undulations.

Onondaga and Hamilton of New York.

360. **P. dispandus** Hall. (Fig. 661, *e.*) Devonic.

Rays prominent, alternating with irregular finer ones, those of right valve bifurcate. Rays crossed by strong concentric growth lines. Ear with fold.

Chemung Group: New York, Pennsylvania.

361. **P. suborbicularis** Hall. (Fig. 661, *b*.) Devonic.

Depressed-convex. Extremities of ear angular. Rays regular, about equalling the interspaces, crossed by concentric lamellæ. Differs from *Lyriopecten orbiculatus* in lacking broad ligament area.

Chemung Group: New York, Pennsylvania.

XCV. Lyriopecten Hall.

Differs from *Aviculopecten* in the much less distinct ears and in

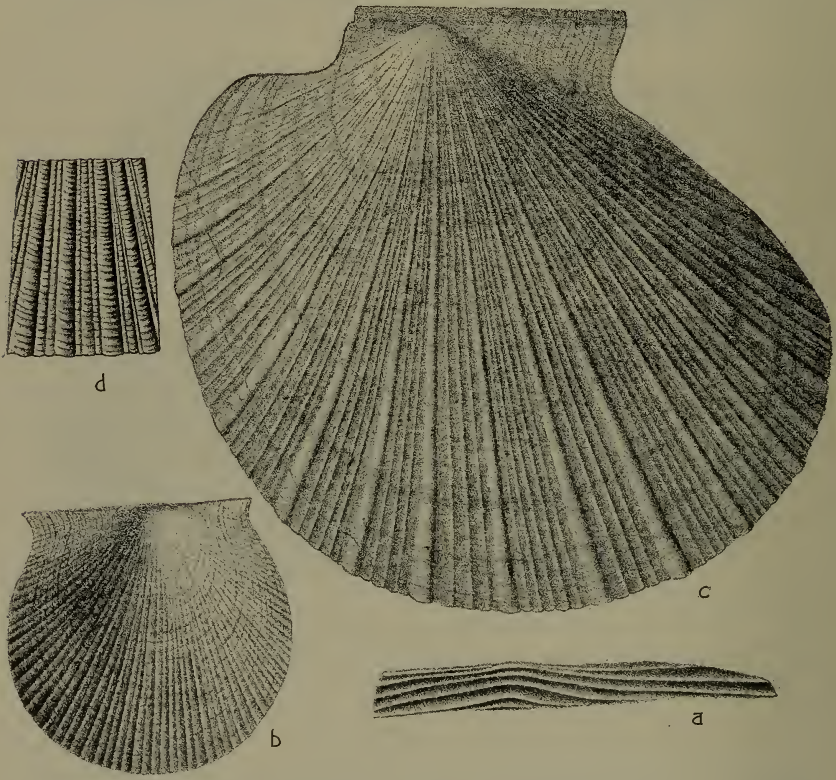


Fig. 662. *Lyriopecten orbiculatus*. *a*, ligament area of right valve, × 3; *b*, interior of left valve; *c*, *d*, *L. tricostatus*, left valve and enlargement of surface. (Pal. N. Y., V.)

the rounded anterior ear, which is much smaller than the posterior ear or absent. Devonic.

362. **L. orbiculatus** Hall. (Fig. 662, *a*, *b*.) Devonic.

Length and height about equal. Beak obtuse. Surface marked with regular rays crossed by sharp concentric lamellæ.

Hamilton: New York.

363. **L. tricostatus** (Vanuxem). (Fig. 662, *c*, *d*.) Devonic.

Large; beak pointed, not extending to margin of hinge. Rays of three sizes, crossed by fine concentric lines.

Lower and Middle Chemung of New York.

XCVI. Crenipecten Hall.

Like *Aviculopecten* but with hinge line composed of a long row of alternating teeth and sockets. Carbonic.

364. **C. winchelli** Hall. (Fig. 663.) Mississippic–Carbonic.

Left valve moderately convex; beak acute, prominent; sur-

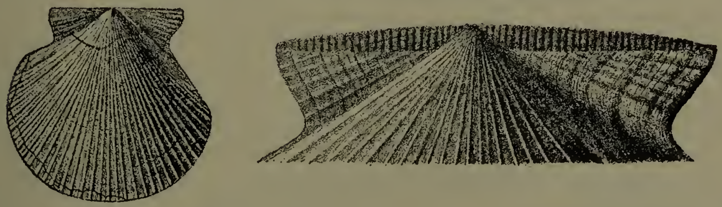


Fig. 663. *Crenipecten winchelli.* Left valve, and its upper portion enlarged to two diameters. (Pal. N. Y., V.)

face with numerous rays. Right valve nearly flat; beak obtuse, depressed; surface marked with obscure rays.

Waverly: Ohio. Upper Coal Measures: Pennsylvania.

XCVII. Pecten Müller.

Nearly equilateral, very inequivalve, with well developed and equal ears. One valve, usually the right, more convex than the other. Surface usually marked with radial sculpture. Hinge line straight, with a strong resiliifer, on each side of which interlocking ridges and grooves radiate in the adult. Byssal notch always present in right valve, not very conspicuous. Single adductor muscle present. Carbonic–Recent.

The genus *Pecten* has been divided into very many subgenera, the most important of which are: *Chlamys*, *Camptonectes*, *Entolium*, *Syncyclonema*, *Amusium*. Under each are here placed those species which are most widely designated by these subgeneric names.

A. Surface of valves without radial ribs..I.

I. Interior of valves marked with small radial ribs....................................1.

1. Interior ribs 8.................................395. *P.* (*Amusium*) *alabamensis*.

1. Interior ribs 18 or more........................396. *P.* (*Amusium*) *mortoni.*
I. Interior without ribs..2.
2. Ears subequal, diverging at a sharp angle above the beaks............ ...*a.*
a. Height greater than breadth....393. *P.* (*Entolium*) *operculiformis.*
a. Height and breadth subequal.........392. *P.* (*Entolium*) *aviculatus.*
2. Ears not diverging at a sharp angle above the beaks.........................*b.*
b. Surface crossed by concentric folds..11.
11. Height greater than length ....394. *P.* (*Syncyclonema*) *rigidus.*
11. Height and length nearly equal............ ....*aa.*
aa. Folds extending across ears ....368. *P. conradi.*
aa. Folds not extending across ears...371. *P. burlingtonensis.*
b. Surface not crossed by concentric folds....................................22.
22. Surface smooth...*bb.*
bb. Ears subequal..................................369. *P. simplicius.*
bb. Ears unequal ....394. *P.* (*Syncyclonema*) *rigidus.*
22. Surface radially striated..*cc.*
cc. Height greater than breadth..†.
†. Anterior ear narrow, separated by a deep byssal sinus from body of shell.
390. *P.* (*Camptonectes*) *pertenuistriatus.*
†. Anterior ear broad. Byssal sinus shallow.
372. *P. argillensis.*
cc. Height and breadth subequal....................................††.
††. Shell oblique to hinge, large.
388. *P.* (*Camptonectes*) *bellistriatus.*
††. Shell nearly erect...389. *P.* (*Camptonectes*) *extenuatus.*
B. Surface of valves with radial ribs...II.
II. Ribs few, about 6............... ....370. *P. quinquenarius.*
II. Ribs many...3.
3. Ribs subequal..*c.*
c. Radially striate... 33.
33. Striæ rough or spiny...*dd.*
dd. Ribs flat-topped...............383. *P.* (*Chlamys*) *magnolia.*
dd. Ribs subangular..............380. *P.* (*Chlamys*) *perplanus.*
dd. Ribs round...†††.
†††. About 6 fine striæ on top of each rib.
382. *P.* (*Chlamys*) *jeffersonius.*
†††. About 3 coarse striæ on top of each rib.
381. *P.* (*Chlamys*) *madisonius.*
33. Striæ not spiny...*ee.*
ee. Ribs about 24...................373. *P.* (*Chlamys*) *stearnsii.*
ee. Ribs about 14...........379. *P.* (*Chlamys*) *wahtubbeanus.*
c. Not radially striate..44.
44. Ribs bifurcating..................376. *P.* (*Chlamys*) *choctavensis.*
44. Ribs simple..*ff.*
ff. Ribs increasing by implantation at front of shell.
378. *P.* (*Chlamys*) *johnsoni.*
ff. Ribs not increasing by implantation........ ....4†.
4†. Ribs 25–30........... ....377. *P.* (*Chlamys*) *greggi.*
4†. Ribs 12–18...*.
*. Shell ½ inch high..375. *P.* (*Chlamys*) *nebrascensis.*

*. Shell 1 inch high....................365. *P. texanus.*
3. Ribs strongly unequal, *i. e.*, major and minor ribs.............................. *d.*
d. Radially striate........................ ....55.
55. Ribs not prominent............374. *P.* (*Chlamys*) *complexicosta.*
55. Ribs very prominent..*gg.*
gg. Major ribs unequal..............386. *P.* (*Chlamys*) *fucanus.*
gg. Major ribs equal............. 385. *P.* (*Chlamys*) *estrellanus.*
d. Not radially striate.. ....66.
66. Ribs not prominent............384. *P.* (*Chlamys*) *marylandicus.*
66. Ribs very prominent..*hh.*
hh. Ribs bifurcating........... ......387. *P.* (*Chlamys*) *healeyi.*
hh. Ribs single...5†.
5†. Anterior margin scalloped between the major ribs....**.
**. Shell very large, about 6 inches high.
366. *P. roemeri.*
**. Shell less than 2 inches high.
367. *P. quinquecostatus.*
5†. Anterior margin not scalloped.
380. *P.* (*Chlamys*) *perplanus.*

365. **P. texanus** Roemer. (Fig. 664.) Comanchic.

Surface of convex valve marked with 6 rounded ribs the spaces between occupied by two lower though equal, rounded ribs.

Very abundant in the Washita, also present in the Fredericksburg of Texas.

FIG. 664. *Pecten texanus.* (After Shattuck.)

366. **P. (Vola) roemeri** Hill. (Fig. 665.) Comanchic.

Large, thick, suboctahedral. Hinge line two thirds length of shell. Both ears and rest of shell marked with radiating costæ, the latter coarse and unequal.

Very abundant in the upper Washita (Buda) of Texas ; also in Mexico.

367. **P. (Neithea) quinquecostatus** (Sowerby). (Fig. 666.) Comanchic–Cretacic.

Right valve very convex, with incurved beak. Surface bearing six strong, rounded, principal radiating ribs and two to four smaller ones between ; ears also ribbed. Left valve flat.

Comanchic : (Washita), Texas, northern Mexico. Cretacic : New Jersey (Merchantville–Navesink).

368. **P. conradi** (Whitfield). (Figs. 667–668.) Cretacic.

Surface of right valve crossed by crowded concentric folds

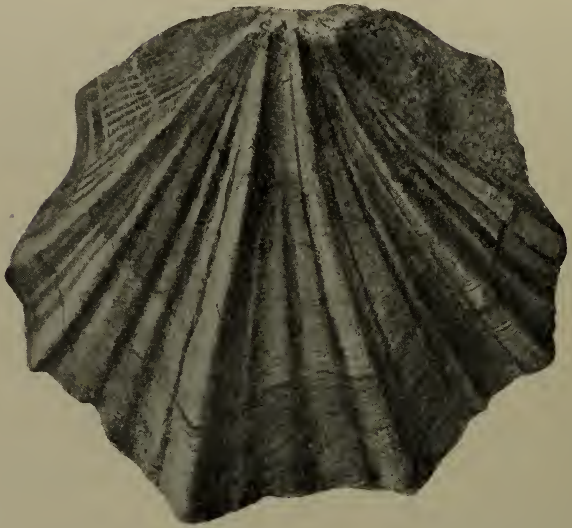


FIG. 665. *Pecten* (*Vola*) *roemeri*, $\times \frac{2}{5}$. (After Shattuck.)

which do not extend across the ears, and are usually marked with five or six radiating lines. Left valve usually smooth.

New Jersey (Merchantville–Navesink).

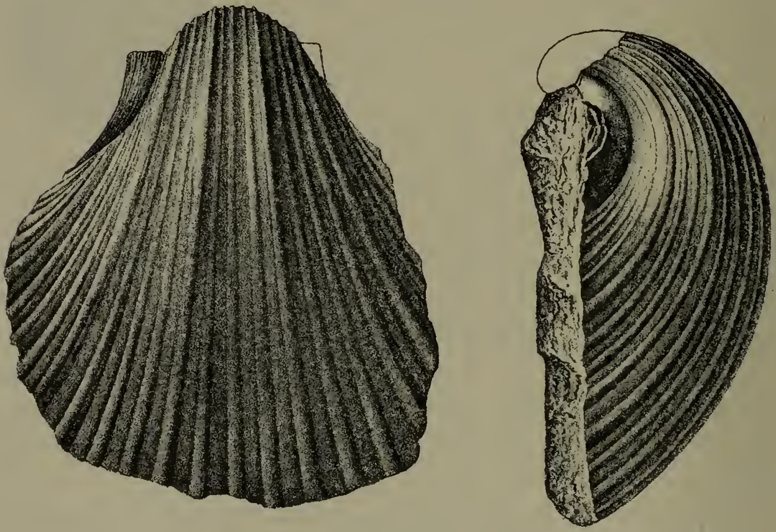


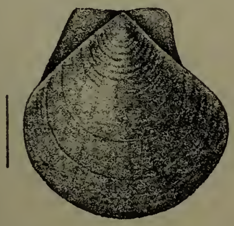
FIG. 666. *Pecten* (*Neithea*) *quinquecostatus*. A large specimen. (After Whitfield, Pal. N. J., I.)

369. **P. simplicius** Conrad. (Fig. 669.) Cretacic.

Differs from *P. conradi* in the smooth surface of its valves.

New Jersey (Red Bank and Tinton); also Alabama, Mississippi, Arkansas, Texas.

370. **P. quinquenarius** Conrad. (Fig. 670.) Cretacic.



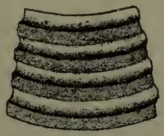


FIG. 667. *Pecten conradi;* enlarged. (N. J. Pal., I.)
FIG. 668. *Pecten conradi,* enlargement of surface. (N. J. Pal., I.)

Right valve flat; left convex. Surface bearing 5 or 6 broad ill-defined radiating ribs.

New Jersey (Wenonah and Navesink), Mississippi.

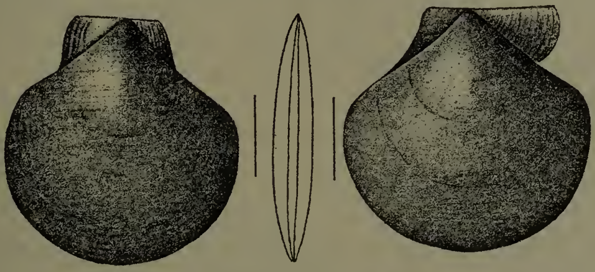


FIG. 669. *Pecten simplicius;* enlarged. (N. J. Pal., I.)

371. **P. burlingtonensis** Gabb. (Fig. 671.) Cretacic.

Right valve nearly flat; left valve depressed-convex. Surface of each valve crossed by concentric bands continuous across the

FIG. 670. *Pecten quinquenarius,* a small right valve. (N. J. Pal., I.)
FIG. 671. *Pecten burlingtonensis.* (N. J. Pal., I.)

nearly equal ears, and marked with very fine radiating striæ. Large shells have a height of over two inches.

New Jersey (Merchantville–Wenonah), more common in former.

372. **P. argillensis** Conrad. (Fig. 672.) Cretacic.

Right valve depressed-convex; left valve more convex. Surface of both valves marked with fine, even, bifurcating, radiating striæ and close concentric lines which project slightly as they cross the radii.

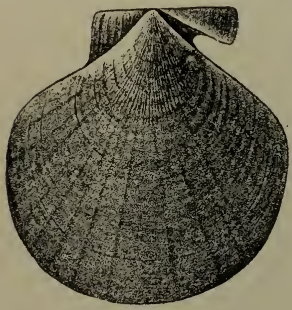


Fig. 672. *Pecten argillensis*, right valve. (After Whitfield, Pal. N. J., I.)

New Jersey (Merchantville–Navesink; especially typical of the Woodbury), Mississippi, Texas.

373. **P. stearnsii** Dall. (Fig. 675, *e.*) Pliocenic.

Right valve with about 26 square ribs separated by narrower interspaces; top of each rib marked by a median shallow groove and by one or two faint riblets on each side of the groove. Surface crossed by concentric lamellæ finer and twice as crowded on the right valve as on the left. On the left valve the interspaces are wider than the rounded ribs. Differs from *P. healeyi* in its radial striation and more numerous ribs.

California.

XCVIII. Chlamys Bolton.

A nearly equivalve *Pecten*, with small, unequal ears (posterior the smaller) and deep byssal notch on whose edge is a well-developed comb-like series of small teeth (ctenolium) in which the byssal threads rested. Surface of shell marked with radial ribs or striæ. Concentric lines often elevated into little tongue-like extensions where they cross the radii. Triassic–Recent.

374. **Pecten (Chlamys) complexicosta** Gabb. (Fig. 673, *g.*) Comanchic.

Surface marked with minute radiating striæ and with 12 to 14 obscure radiating ribs with at times smaller ribs intercalated.

Very abundant in Knoxville of California.

375. **P. (Chlamys) nebrascensis** Meek and Hayden. Cretacic.

Small, suborbicular. Hinge line less than length of valve below. Both ears separated from body of shell by rather angular depressions. Surface of each valve marked with 12 to 15 large, usually simple, angular, radiating ribs, separated by furrows of about the same width as the ribs.

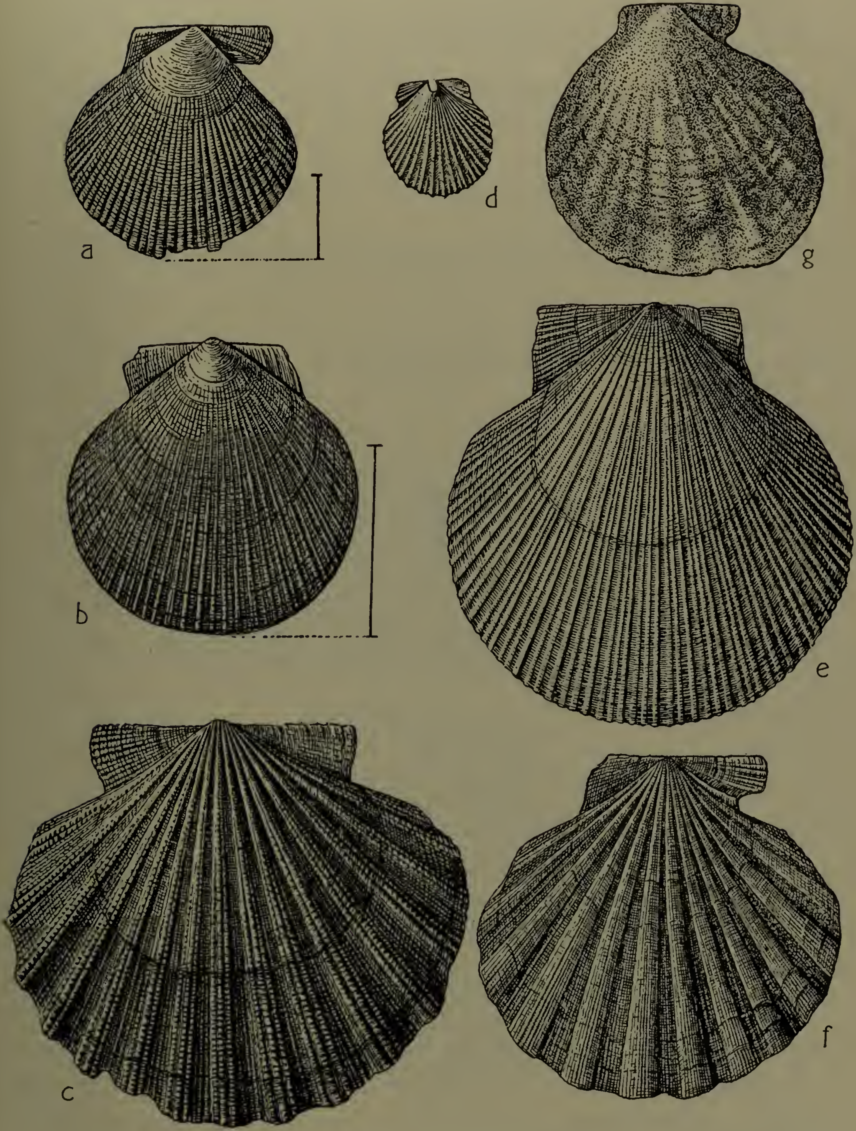


FIG. 673. *a*, *b*, *Chlamys choctavensis*, right and left valves enlarged; *c*, *C. madisonius*, left valve, × ½; *d*, *C. johnsoni*, left valve; *e*, *C. marylandicus*, left valve; *f*, *C. ieffersonius*, right valve, × ½; *g*, *Chlamys complexicosta*, right valve. (*a–f*, Md. Survey; *g*, after Stanton.)

Montanan: North Dakota, Wyoming, Montana, Assiniboia.

376. **P. (Chlamys) choctavensis** Aldrich. (Fig. 673, *a, b.*)

Eocenic.

Surface imbricated when mature.
Maryland (Aquia and Nanjemoy), Alabama (Lignitic).

377. **P. (Chlamys) greggi** Harris. Eocenic.
Differs from *P. choctavensis* in its small number of ribs, and their lack of bifurcation and imbrication.
Lignitic: Alabama, Georgia.

378. **P. (Chlamys) johnsoni** Clark. (Fig. 673, *d*.) Eocenic.
Small. A few ribs implanted at front of shell.
Maryland, Mississippi.

379. **P. (Chlamys) wahtubbeanus** Dall. Eocenic.
Differs from *P. johnsoni* in its fewer ribs (about 14), each with 2 or 3 imbricated radial striæ increasing by bifurcation.
Claibornian and Jacksonian: Alabama, Mississippi, Louisiana.

380. **P. (Chlamys) perplanus** Morton. Eocenic–Oligocenic.
Ribs subangular, about 23, with sloping sides and equally wide interspaces; an obsolescent thread on each side of the median keel of each rib; all crossed by regularly spaced, low lamellæ, slightly produced over each rib. Byssal notch conspicuous but not deep. Height 34 mm.; width 35 mm. (about twice the length of the hinge).
Eocenic: Alabama (Jacksonian), Mississippi. Lower Oligocenic: Florida (Vicksburgian).

381. **P. (Chlamys) madisonius** Say. (Fig. 673, *c*.) Miocenic.
Whole surface covered with scaly striæ; ribs usually about 16, rounded, with about 3 striæ on top of each. Upper part of byssal ear with few and coarse radiating striæ. Byssal notch one third length of ear.
New Jersey, Maryland, Virginia, North Carolina.

382. **P. (Chlamys) jeffersonius** Say. (Fig. 673, *f*.) Miocenic.
Differs from *P. madisonius* in its fewer ribs, with about 6 striæ on top of each, byssal ear covered with fine uniform and numerous radiating striæ, byssal notch barely one eighth the length of the ear. As with many of the *Pectens* these two species grade into each other.
Maryland, Virginia, North Carolina.

383. **P. (Chlamys [Lyropecten]) magnolia** Conrad. (Fig. 674, *a*.) Miocenic.

Differs from *P. jeffersonius* in its flat-topped ribs, with about 10 radiating striæ on each, the flat-bottomed interspaces, and the byssal ear with a few obsolescent rays.

Very characteristic of the lower Miocenic (Vaqueros formation) of California.

384. **P. (Chlamys) marylandicus** Wagner. (Fig. 673, *e.*) Miocenic.

Distinguished from *P. madisonius* by its want of elevated ribs; scales few.

Maryland (Calvert, Choptank), Virginia, North Carolina.

385. **P. (Chlamys [Lyropecten]) estrellanus** Conrad. (Fig. 674, *b.*) Miocenic.

Shell quite convex. Right valve with somewhat square ribs,

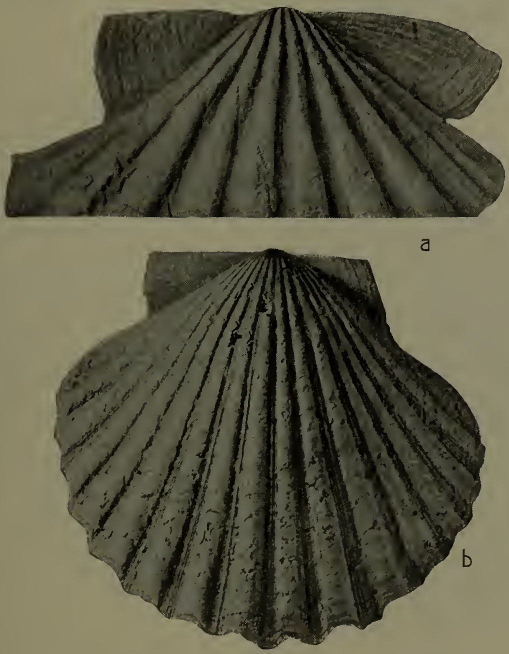


FIG. 674. *a*, *Pecten* (*Lyropecten*) *magnolia*; *b*, *Pecten* (*Lyropecten*) *estrellanus*. Both × ½. (After Arnold.)

separated by interspaces narrower than the ribs and in each of which is a squarish riblet. Left valve with ribs more rounded, narrower, and with wider interspaces whose riblets are inclined to bifurcation. Both valves marked with radiating lines especially on the anterior and posterior portions.

Throughout California.

386. **P. (Chlamys) fucanus** Dall. (Fig. 675, *a*, *b*.) Miocenic.

Surface reticulate. Right valve marked with more or less unequal, squarish, radially striate ribs, with at times smaller riblets

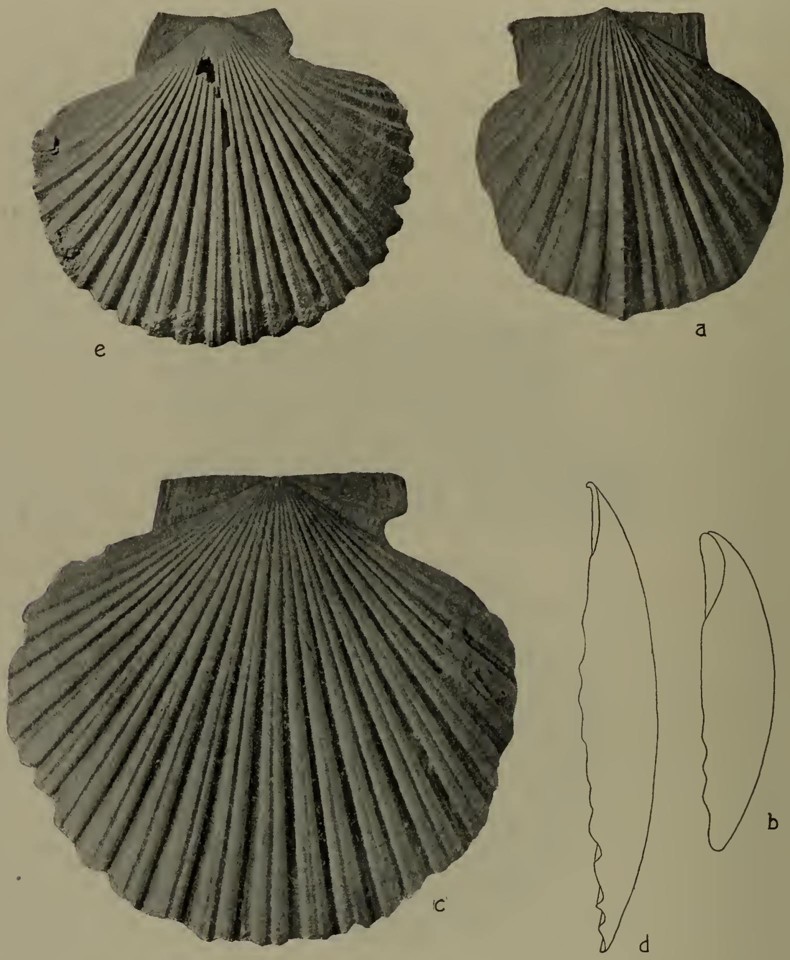


FIG. 675. *a*, *b*, *Pecten* (*Chlamys*) *fucanus*; *c*, *d*, *P*. (*Patinopecten*) *healeyi*; *e*, *Pecten stearnsii*. All × ½. (After Arnold.)

between. Left valve with radially striate ribs, the median one stronger than the rest and usually with imbricating scales.

Washington, Alaska.

387. **P. (Chlamys [Patinopecten]) healeyi** Arnold. (Fig. 675, *c*, *d*.) Pliocenic.

Left valve marked with rounded ribs (slightly keeled at top) and each of the wide interspaces marked with a smaller rib. Right valve marked with squarish ribs, more or less bifurcating; interspaces narrow.

California, Lower California.

XCIX. Camptonectes Agassiz.

A small, thin *Pecten*, nearly smooth, more or less inflated, marked with fine, almost microscopic and more or less vermicular groovings which radiate from the umbo and are deflected laterally from a median line on each valve. (This so-called "*Camptonectes* striation" is common to many recent *Pectens* both ribbed and smooth.) Valves similarly sculptured. Posterior ear small,

Fig. 676. *Camptonectes bellistriatus.* (After Stanton.)

obliquely truncate; anterior much larger, in the right valve cut by a deep byssal sinus. Jurassic–Recent.

388. **Pecten (Camptonectes) bellistriatus** Meek. (Fig. 676.)

Jurassic.

Shell very thin, slightly oblique to the hinge line, compressed. Outline subcircular, slightly wider than high. Posterior ear very short, about one half the size of the anterior. Anterior ear rather large, separated from the body of the shell by an angular sinus about half as deep as the length of the ear. Radiating striæ very fine and regular, increasing by intercalation. Concentric striæ fine and regular, closely arranged. Average height and breadth each $1\frac{1}{4}$ inches. Differs from *P. platessa* in being proportionally broader, with shorter ears and finer radiating striæ.

Upper Jurassic: South Dakota, Wyoming, Utah.

389. **P. (Camptonectes) extenuatus** Meek and Hayden. Jurassic.

Differs from *P. bellistriatus* in its smaller size, more convex valves, more erect form, and height slightly greater than width. Umbonal angle about 105°, height $\frac{5}{8}$ inch; breadth $\frac{9}{16}$ inch.

Upper Jurassic: South Dakota (Sundance), Wyoming (Shirley), Utah.

390. **P. (Camptonectes) pertenuistriatus** Hall and Whitfield. Jurassic.

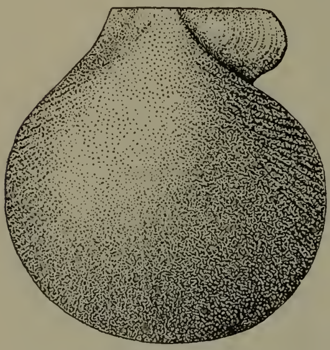


FIG. 677. *Camptonectes platessa*, right valve. (After Stanton.)

Differs from *P. extenuatus* in its more attenuated beak (umbonal angle about 90°), flattened valves, finer striæ, and more elongate form. Average height 1 inch; breadth $\frac{3}{4}$ inch.

Montana, Wyoming.

391. **P. (Camptonectes) platessa** White. (Fig. 677.) Cretacic.

Surface marked with fine radiating striæ which at the sides of the shell recurve.

Coloradoan: Utah, Arizona.

C. ENTOLIUM Meek.

A thin *Pecten*, with nearly equal ears which diverge at a sharp angle above the beaks. Surface nearly smooth. Mississippic Cretacic.

392. **P. (Entolium) aviculatus** (Swallow). (Fig. 678.) Mississippic and Carbonic.

Surface marked with fine, close concentric striæ and occasional faint traces of radiating ones.

A characteristic Coal Measures species: Ohio to Oklahoma and Wyoming; also in Mississippic of Ohio and Arizona.

393. **P. (Entolium) operculiformis** Gabb. (Fig. 679.)
Comanchic–Cretacic.

Height greater than breadth. Sides of umbo straight, forming

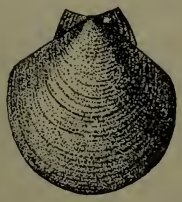


FIG. 678. *Entolium aviculatum*, left valve. (Ind. Surv.)
FIG. 679. *Entolium operculiformis*. (Pal. Cal.)

almost a right angle. Surface smooth, polished.

Chico: California. Horsetown: California, Oregon.

CI. SYNCYCLONEMA Meek.

A small, nearly equivalve, vertically ovate *Pecten*. Hinge line very short. Ears very small, the anterior the larger. Margins closed all around, with no defined byssal sinus in either valve. Surface only concentrically striated. Cretacic.

394. **Pecten (Syncyclonema) rigidus** Hall and Meek. Cretacic.

Hinge line about half the transverse diameter of the valves. Posterior ear obliquely truncate, and hardly half as large as the anterior which is subtrigonal, and slightly pointed. Right valve marked with rather strong and regular concentric ridges and furrows; left valve smooth. Anterior margin with only a shallow, rounded sinuosity under the ears which is nearly as deep in the left valve as in the right. Average length 0.19 inch; height 0.23 inch. Differs from *P. simplicius* in the concentric ridges of the right valve, the more regularly rounded outline of its narrower valves, and in the different form of its ears.

Montanan: South Dakota, Montana, Wyoming.

CII. AMUSIUM Schumacher.

A *Pecten* with raised radial riblets internally. Smooth externally or faintly striated. Valves of about equal convexity, large, rather flat. Ears subequal. Ctenolium absent; byssal notch inconspicuous or absent. Jurassic–Recent.

395. **Pecten (Amusium) alabamensis** Aldrich. Eocenic.

Very small. Surface of right valve nearly smooth; left with a few radial threads crossed by distant concentric lines.

Midwayan: Alabama, Arkansas.

396. **P. (Amusium) mortoni** Ravenel. (Fig. 680.) Miocenic–Recent.

Thin. Inside of valves marked with 18 to 24 radiating double ribs.

Miocenic: Atlantic coast. Also Recent: Gulf of Mexico.

FIG. 680. *Amusium mortoni*, right valve, × ½. (Md. Surv.)

CIII. PLICATULA Lamarck.

Inequivalve, nearly equilateral, compressed. Surface bearing coarse, radial, and often divaricate ribbing. Teeth long, shallow, and crenulate, diverging at a sharp angle. Muscle scar single, excentric. Shell sessile. Triassic–Recent.

397. **P. dentonensis** Cragin. Comanchic.

Rounded, subtriangular. Surface marked with numerous, crenulated, and often spine-bearing ribs with intercalated shorter and finer ones.

Very abundant in Washita of Texas.

CIV. Lima Bruguiere.

Shell inflated, marked with radial sculpture. Valves equal, gaping anteriorly and sometimes posteriorly. Beaks pointed. Hinge line straight, terminating in slightly unequal ears. Hinge area of each valve triangular and with central resiliifer. Teeth absent. Muscle impression single and large. Carbonic–Recent.

398. **L. retifera** Shumard. (Fig. 681.) Carbonic.

Surface marked with about 25 angular ribs about equalling the spaces between, becoming obsolete on the umbo. Entire shell covered with numerous, fine concentric striæ.

Coal Measures: Ohio–Oklahoma.

399. **L. wacoensis** Roemer. Comanchic.

Differs from *L. utahensis* in being slightly larger, more oblique (obliquity about 45°), and more ventricose. Radiating ribs

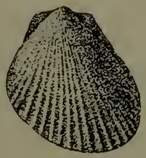


Fig. 681. *Lima retifera.* (Kan. Pal., VI/II.)
Fig. 682. *Lima utahensis*, internal left mold of valve. (After Stanton.)

coarser, more angular, less uniform in size, and less regularly arranged. The ribs frequently increase by implantation and bifurcation.

Washita: Texas, Mexico; also Fredericksburg of Mexico.

400. **L. utahensis** Stanton. (Fig. 682.) Cretacic.

Moderately convex. Small.

Coloradoan: Utah, Mexico.

CV. Anomia Linné.

Thin, translucent, irregular or subcircular, attached by a calcified byssus passing through a rounded sinus near the umbo of the right valve. Right valve flattened, conforming to subjacent surface, bearing a central adductor impression. Left valve larger, convex, with four muscle scars on a central area,—three byssal and one adductor. Teeth absent. Ligament more or less internal and supplemented by a resilium. Jurassic–Recent.

401. **A. argentaria** Morton. Cretacic.

Upper valve with submarginal apex; its surface covered with irregular growth lines and at times with faint radiating striæ.

Ripleyan of New Jersey (Cliffwood–Red Bank), Atlantic and Gulf regions to Mexico.

402. **A. propatoris** White. (Fig. 683.) Cretacic.

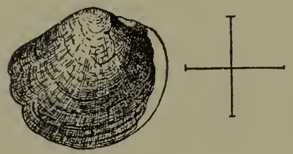


FIG. 683. *Anomia propatoris*, upper valve slightly enlarged. (After Stanton)

Shell a little obliquely subovate. Beak of upper valve depressed. Surface marked with rather coarse growth wrinkles and a few radiating ones and by fine, raised radiating striæ. Differs from *A. gryphorhynchus* in having a less prominent and rounded umbo, in possessing radial and concentric wrinkles and radial striæ.

Coloradoan: Colorado, Utah, New Mexico. Montanan: Utah.

403. **A. gryphorhynchus** Meek. Cretacic.

Elongate, convex. Beak elevated. Growth lines not strong. Brackish water.

Montanan: Montana, Wyoming, Assiniboia, Mexico? Laramie: Colorado, Wyoming.

CVI. PLACUNOPSIS Morris and Lycett.

Free or attached, without foramen for passage of byssus. Rounded, thin, with upper or right valve irregularly convex, and lower or left valve flat or, when sessile, conforming to the surface to which it was attached. Beaks very small, central. Surface marked with irregular radiating lines and broad, faint concentric wrinkles. Carbonic–Cretacic.

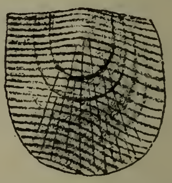


FIG. 684. *Placunopsis carbonaria.* (Kan. Pal., VI/II.)

404. **P. carbonaria** Meek and Worthen.)Fig. 684.) Carbonic.

Concentric and radiating lines nearly obliterated by an oblique series of ridges.

Ohio–Kansas.

CVII. PARANOMIA Conrad.

Irregular, inequivalve. Upper valve depressed-convex. Lower valve flattened, often attached near the umbo to other objects, very thin, probably perforate. Surface of both valves marked with distant, rounded, radiating ribs. Cretacic.

405. **P. scabra** (Morton). (Fig. 685.) Cretacic.

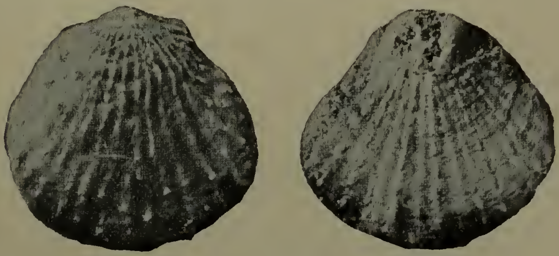


FIG. 685. *Paranomia scabra.* (After Weller, Pal. N. J., IV.)

Ribs produced at irregular intervals into hollow spines.

Ripleyan of New Jersey (Merchantville–Navesink), Tennessee and Gulf region.

CVIII. MODIOLOPSIS Hall.

Shell thin, obliquely elongate, very inequilateral, with small anterior and large posterior end. Beaks nearly at anterior ends. Valves crossed by an oblique depression extending backward from the anterior portion of the umbo. Teeth absent, occasionally represented by an obscure thickening and corresponding depression. Muscle impressions two; anterior deep, and posterior large and faint. Ligament chiefly external, deep seated.

Differs from *Modiomorpha* in the absence of teeth. Ordovicic and Siluric.

406. **M. faba** (Conrad). Ordovicic.

Very small, with prominent umbonal ridge and sinus.

Trenton: New York, New Jersey, Wisconsin.

407. **M. mytiloides** Hall. (Fig. 686, *b*.) Ordovicic.

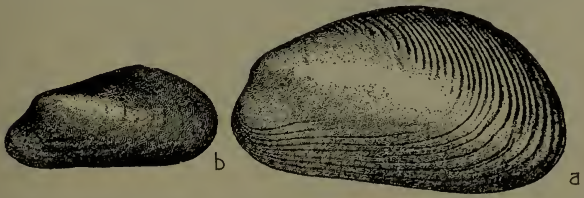


FIG. 686. *a*, *Modiolopsis concentrica*; *b*, *M. mytiloides*. (Minn. Surv.)

Subcylindrical, marked by fine concentric lines interspersed with stronger wrinkles. Junction of posterior margin with hinge line almost angular.

Trenton: New York, Canada. Middle Galena: Wisconsin, Minnesota.

408. **M. concentrica** Hall and Whitfield. (Fig. 686, *a.*) Ordovicic.

Surface marked by regular concentric furrows which become obsolete on the umbonal ridge.

Cincinnati: Ohio, Indiana, Kentucky.

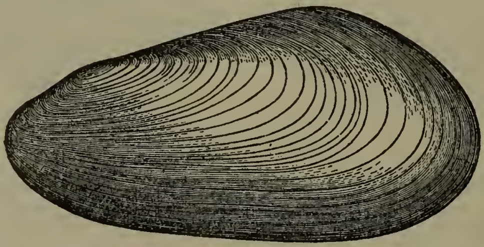


FIG. 687. *Modiolopsis modiolaris.* (After Logan.)

409. **M. modiolaris** (Conrad). (Figs. 687 and 688.) Ordovicic.

Shell narrowed anteriorly, obliquely truncate posteriorly. Beak not prominent. Surface crossed by concentric undulations.

Lorraine: New York, Pennsylvania. Cincinnati region.

FIG. 688. *Modiolopsis modiolaris*, internal mold. (Pal. O., II.)

410. **M. orthonota** (Conrad). (Fig. 689.) Siluric.

Subquadrangular, surface marked with concentric lines only.

Medina: New York.

411. **M. primigenia** (Conrad). (Fig. 690.) Siluric.

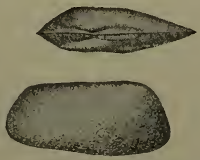
Posterior end with ear. Surface marked with strong concentric striæ and very faint radiating ones.

Medina: New York.

412. **M. dubia** Hall. Siluric.

Differs from *M. orthonota* in that the umbos are nearly at the anterior extremity and the concentric striæ are at times replaced by stronger wrinkles.

Manlius: New York.



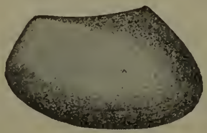


FIG. 689. *Modiolopsis orthonota.* (Pal. N. Y., II.)
FIG. 690. *Modiolopsis primigenia.* (Pal. N. Y., II.)

CIX. MODIOMORPHA Hall.

Subovate, widest posteriorly, crossed obliquely from beak to base by a more or less distinctly defined depression, constricting

FIG. 691. *a, Modiomorpha complanata*, internal mold of left valve; *b, M. mytiloides;* both × ½. (Pal. N. Y., V.)

the basal margin. Beaks small, compressed. Surface marked by rugose or undulating concentric striæ. Hinge with strong wedge-shaped tooth in left valve and corresponding cavity in right. No lateral teeth present. Ligament external, attached to thickened margin of shell which is often longitudinally grooved for its reception. Pallial line simple. Devonic.

413. **M. complanata** Hall. (Fig. 691, *a.*) Devonic.
Large. Margins regularly rounded.
Onondaga : New York, Ohio.

414. **M. mytiloides** Hall. (Fig. 691, *b.*) Devonic.
Above medium size, oblique. Basal margin nearly straight or

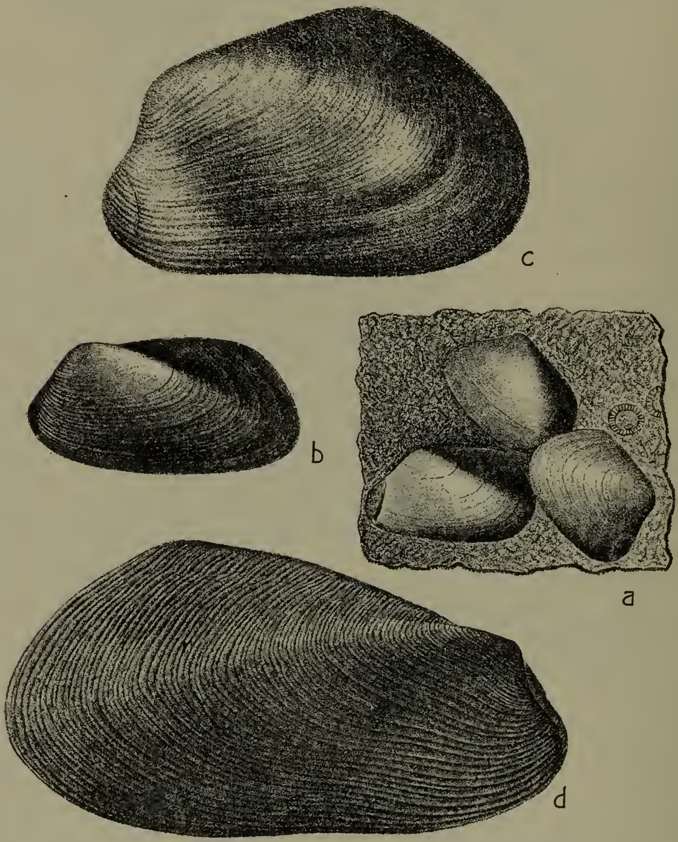


FIG. 692. *a, Modiomorpha quadrula; b, M. subalata; c, M. alta; d, M. concentrica.* (Pal. N. Y., V.)

very slightly concave anterior to middle. Cardinal margin arcuate. Anterior end narrowed and extended.
Hamilton : New York, Pennsylvania, Indiana ?

415. **M. alta** Hall. (Fig. 692, *c.*) Devonic.

Differs from *M. mytiloides* in its greater proportional height and broader and less extended anterior end.

Hamilton : New York, Indiana, Falls of Ohio.

416. **M. concentrica** Hall. (Figs. 692, *d*; 694, *d.*) Devonic.

Of medium size. Distinguished by its strong and regular striæ. Differs also from *M. mytiloides* in its smaller size and more prominent umbos ; from *M. complanata* in its more nearly straight base ; from *M. alta* in its more elongate form.

Hamilton : New York and Maryland–Indiana and Wisconsin.

417. **M. subalata** Hall. (Fig. 692, *b.*) Devonic.

Of medium size or smaller. Distinguished by its more nearly parallel cardinal and basal margins, angular umbonal ridge, and the obsolescence of the striæ on the umbonal region.

Hamilton : New York, Pennsylvania ; also in Marcellus and Ithaca of New York.

417*a*. **M. subalata** var. **chemungensis** Hall. Devonic.

Differs from the species in being longer in proportion to the height, cardinal line less oblique, its posterior extremity usually

FIG. 693. *Modiolodon oviformis.* (Ohio, VII.)

more rounded, umbonal slope more arcuate, and striæ are filiform, sharper and more regular.

Characteristic of Portage of New York, Pennsylvania.

418. **M. quadrula** Hall. (Fig. 692, *a.*) Devonic.

Small, quadrangular, with straight umbonal ridge.

Chemung : New York.

CX. Modiolodon Ulrich.

Modioliform, ovate shells, differing from *Modiolopsis* and *Modiomorpha* in the possession of one to three oblique cardinal teeth in each valve. Hinge much like that of Ischyrodonta. Ordovicic.

419. **M. oviformis** Ulrich. (Figs. 693; 694, *a*.) Ordovicic.

Surface marked with a few faint concentric striæ. Differs from

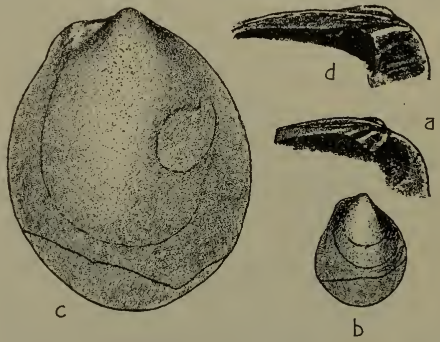


Fig. 694. *a*, *Modiolodon oviformis*, hinge of left valve; *b*, *c*, *M. patulus*, small shell and internal mold of large one; *d*, *Modiomorpha concentrica*, hinge of left valve. (Minn. Surv.)

Modiolopsis modiolaris in its cardinal teeth, more oval shape, and rounded instead of sinuate basal margin. Type of genus.

Basal Trenton of Kentucky and Tennessee.

420. **M. patulus** Ulrich. (Fig. 694, *b*, *c*.) Ordovicic.

Anterior end very short, in the internal mold occupied almost entirely by the elevated anterior muscle scar. Wider, more erect, and more uniformly convex than *M. oviformis*.

Middle Galena: Minnesota, Iowa. Trenton: Kentucky.

CXI. Colpomya Ulrich.

Inequilateral. Hinge and basal margins subparallel. Broad mesial furrow distinct. Beneath beak of right valve is a tooth-like prominence which fits into a corresponding depression in the opposite valve, differing thus from *Modiolodon*; beneath this depression is a strong projecting process. Ordovicic.

421. **C. constricta** Ulrich. (Fig. 695, *a*, *b*.) Ordovicic.

Valves very convex on umbonal ridge. Beaks strongly incurved. Surface marked with strong concentric growth lines. Type of genus.

Upper Trenton of Kentucky.

CXII. Whiteavesia Ulrich.

Very similar to *Modiolopsis* but differs in its thinner hinge plate and shell, in the convex basal outline and absence of a mesial furrow. From *Orthodesma* it also differs in these last two characteristics as well as in its tightly closing instead of gaping valves. Ordovicic.

422. **W. modioliformis** Meek and Worthen. (Fig. 695, *d.*)
Ordovicic.

Shell obliquely oval, marked with rather strong concentric wrinkles especially anterior to the umbo.

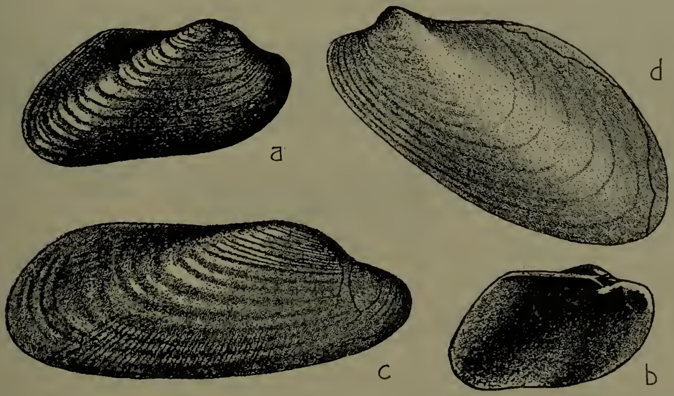


Fig. 695. *a, b, Colpomya constricta*, right and left valves; *c, Whiteavesia cincinnatiensis*, right valve; *d, W. modioliformis*, left internal mold. (Minn. Surv.)

Stones River of Wisconsin, Minnesota?

423. **W. cincinnatiensis** Hall and Whitfield. (Fig. 695, *c.*)
Ordovicic.

Surface marked with numerous, irregular concentric and faint radiating lines. Type of genus.

Eden of Ohio, etc.

CXIII. Eurymya Ulrich.

Somewhat triangular, with broad and wing-like posterior, and greatly narrowed anterior end. Base oblique. Hinge line straight. Beaks small, near anterior extremity. Hinge with obscure cardinal tooth in left valve and corresponding depression in right, and with broad and longitudinally striated ligament area posterior to the beaks. Muscle impressions as in *Modiolopsis.* Differs from *Modiolopsis* and *Modiomorpha* in the wing-like posterior extremity and in the presence of a striated ligament area. It also lacks the mesial depression of *Modiolopsis*. Ordovicic.

424. **E. plana** Hall. (Fig. 696, *a*, *b*.) Ordovicic.

Small, triangular, marked with strong concentric growth lines. Type of genus.

Stones River of Minnesota, and Wisconsin (Lower Blue limestone).

CXIV. Aristerella Ulrich.

Subovate, small, moderately convex, nearly smooth, inequivalve. Left valve the smaller. No mesial furrow present. Hinge apparently very thin and without teeth. Muscle and pallial impressions

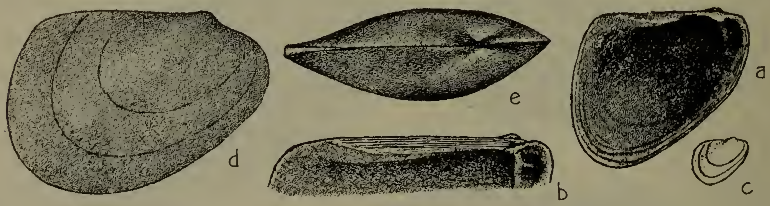


Fig. 696. *a*, *b*, *Eurymya plana*, interior of left valve and its hinge enlarged; *c–e*, *Aristerella nitidula*, natural size and enlarged. (Minn. Survey.)

as in *Whiteavesia*. Differs from *Eurymya* and *Whiteavesia* in its unequal valves. Ordovicic.

425. **A. nitidula** Ulrich. (Fig. 696, *c*, *d*, *e*.) Ordovicic.

Minute; surface nearly smooth. Type of genus.

Black River: Minnesota.

CXV. Goniophora Phillips.

Equivalve, very inequilateral, obliquely truncate posteriorly, rounded anteriorly. Cardinal line straight. Beaks small and closely incurved. Umbo prominent. A strong angular ridge extends from the umbo to the posterior margin and a broad, un-

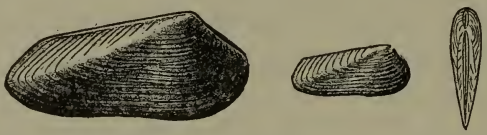


Fig. 697. *Goniophora dubia*, right valve enlarged and natural size. Cardinal view of a complete specimen, natural size. (After Whitfield.)

defined sinus from umbo to base. Surface marked by concentric striæ. Ligament external. Like *Modiomorpha* in internal characters but differing externally in form and in the strong angular umbonal ridge. Siluric–Carbonic.

426. **G. dubia** Hall. (Fig. 697.) Siluric.

Small, elongate; umbonal ridge subangular, a broad shallow sinus below it.

Lower Monroan of Michigan and Ohio. Manlius of New York.

427. **G. perangulata** Phillips. (Fig. 698.) Devonic.

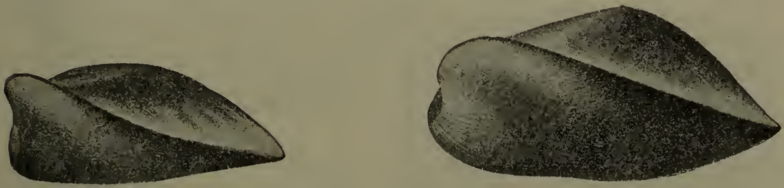


FIG. 698. *Goniophora perangulata.* (Pal. N. Y., V.)

Umbo acutely angular. Umbonal ridge elevated, sharp, curving slightly to the posterior basal extremity. Shell beneath the umbo concave.

New York (Schoharie Grit), Nevada.

428. **G. modiomorphoides** Grabau. Devonic.

Distinguished from other species by its very short anterior end scarcely extending beyond the beaks.

· Middle Hamilton (Encrinal limestone): New York.

429. **G. hamiltonensis** Hall. (Fig. 699, *c.*) Devonic.

Length more than twice the height. Margin but slightly curving. Umbonal ridge strongly angular and prominent.

Hamilton: New York, Pennsylvania.

430. **G. truncata** Hall. (Fig. 699, *b.*) Devonic.

Basal margin rounded anteriorly and slightly sinuate near the middle. Cardinal line short. Concentric striæ on the surface between the umbonal ridge and the sinus crossed by radiating striæ.

Hamilton: New York.

431. **G. ida** Hall. (Fig. 699, *a.*) Devonic.

Distinguished by its narrowly elliptical form, the regularly curving basal margin; the hinge line is comparatively shorter than in any other of the Hamilton species except *G. truncata.*

Hamilton: New York.

432. **G. carinata** Hall. (Fig. 699, *d.*) Devonic.

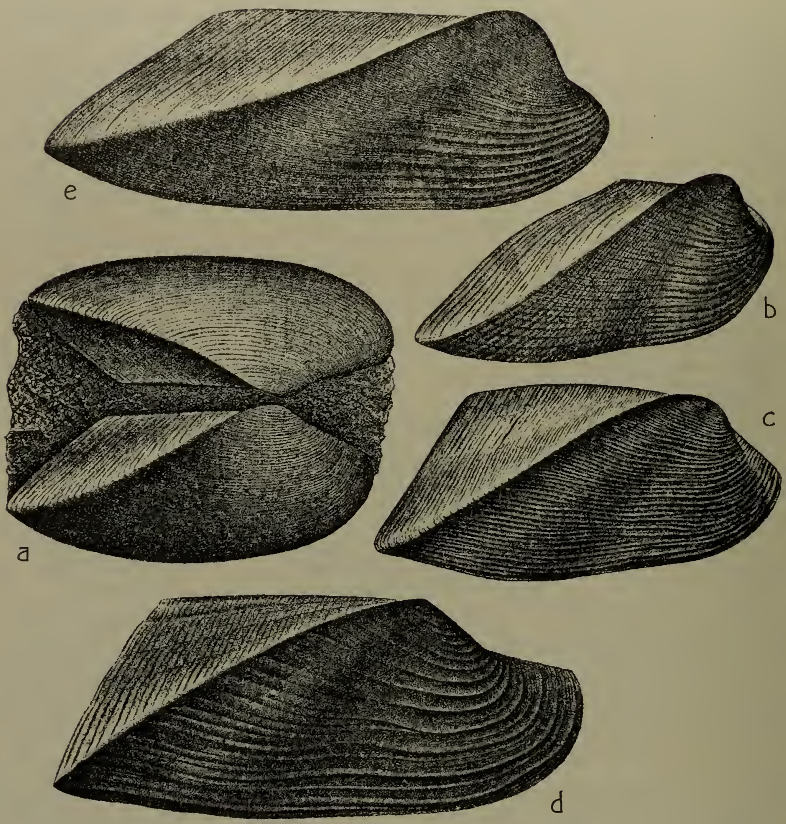


FIG. 699. *a, Goniophora ida; b, G. truncata; c, G. hamiltonensis; d, G. carinata; e, G. chemungensis.* All right valves. (N. Y. Surv.)

Surface marked by fine undulating concentric striæ which are aggregated into folds upon the lower end and anterior portions. Anterior end long.

Hamilton: New York.

433. **G. chemungensis** Hall. (Fig. 699, *e.*) Devonic.

Distinguished by its elongate form, short anterior end and fine concentric striæ which form folds anteriorly.

Chemung: New York.

CXVI. MYTILUS Linné.

Equivalve, very inequilateral, elongated, usually thin, with terminal pointed beaks. Valves wider and rounded below, gaping a little for the byssus, usually smooth. A conspicuous epidermis and a thin nacreous layer present. Hinge with a few small teeth under the beaks or without teeth. Pallial line simple. Triassic–Recent.

434. **M. conradinus** d'Orbigny. (Fig. 700.) Miocenic.

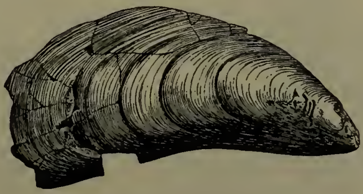


FIG. 700. *Mytilus conradinus*, right valve, × ¼. (Md. Survey.)

Shell very convex. Beak heavy, solid. Hinge with slightly prominent teeth.

New Jersey–Texas.

CXVII. MODIOLA Lamarck.

Like *Mytilus* but umbos obtuse and anterior though not terminal. Valves inflated in front. Epidermis rather hairy. Devonic–Recent.

435. **M. major** Gabb. (Fig. 701.) Comanchic.

FIG. 701. *Modiola major*, × ½. (Pal. Cal., II.)

Shell very large and thick.

Very abundant throughout the Shasta of California.

436. **M. multilinigera** Meek. (Fig. 703, *a*.) Cretacic.

Surface covered with fine radiating and concentric lines.

Coloradoan: Kansas–Utah.

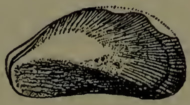


FIG. 702. *Modiola saffordi*, left valve. (After Harris.)

437. **M. julia** Lea. Cretacic.

A rounded umbonal ridge passes backward from the beak to the posterior basal margin. Surface markings are concentric growth lines, which are strongest on the posterior umbonal slope.

Ripleyan of New Jersey (Merchantville, Woodbury), Texas.

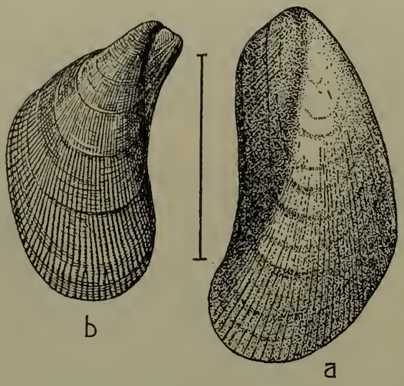


FIG. 703. *a*, *Modiola* (*Brachydontes*) *multilinigera*, left valve. (After Stanton.) *b*, *M. alabamaënsis*, right valve; with indicator of size. (Md. Survey.)

438. **M. saffordi** Gabb. (Fig. 702.) Eocenic.

Umbo and umbonal ridge more prominent than in *M. alabamaënsis*.

Midway: Tennessee, Texas.

439. **M. alabamaensis** Aldrich. (Fig. 703, *b*.) Eocenic.

Hinge margin slightly curved, ascending. Shell strongly arcuate. Umbones prominent, curved.

Pamunkey: Maryland, Virginia.

CXVIII. Crenella Brown.

Shell small, ovoid. Beaks more or less incurved. Surface with a thin epidermis and a fine radial striation. Cretacic–Recent.

440. **C. serica** Conrad. Cretacic.

Radiating striæ seen under a lens; concentric lines large, fine and regular. Anterior slope from umbo abrupt.

New Jersey (Marshalltown and Red Bank), Gulf region.

441. **C. elegantula** Meek and Hayden. Cretacic.

Differs from *C. serica* in its much larger size, its proportionately broader form, and in the absence of conspicuous concentric markings.

Montanan: Nebraska–Montana; Tinton of New Jersey.

Order 2. ANOMALODESMACEA.

CXIX. Pleuromya Agassiz.

Slightly inequivalve. Posterior side the longer, somewhat gaping. Hinge margin with a thin, horizontal lamina in each valve, the left inferior; the margin with a feeble notch behind the lamina. Individuals of the same species quite variable. Triassic–Comanchic.

442. **P. subcompressa** Meek. (Fig. 704.) Jurassic.

Surface crossed by concentric ridges. Posterior end sloping.

Widely distributed in the Jurassic from the plains to the Pacific coast.

FIG. 704. *Pleuromya subcompressa*, right and cardinal views. (After Logan.)

443. **P. inconstans** Castillo and Aguilera. (Fig. 705.) Jurassic.

A broad, shallow sinus usually present in the anterior umbonal region. Posterior end high.

Texas, Mexico. One of the most widely distributed fossils of the Malone formation.

FIG. 705. *Pleuromya inconstans.* (After Cragin.)

CXX. ALLORISMA King.

Equivalve, inequilateral, elongate, thin, arcuate. Anterior side short; posterior long and gaping. Beaks anterior, depressed. Sculpture concentric, strongest medially. Hinge without teeth. Ligament external. Cardinal margin inflected, forming a lanceolate depression along its border behind the beaks. Posterior adductor scar large. Pallial line sinuate. Carbonic and Permic.

444. **A. geinitzi** Meek. Carbonic.

Small. Umbonal slopes carinated from the beaks posteriorly. Surface marked with fine, radiating and concentric lines.

Coal Measures: Illinois, Kansas.

445. **A. costatum** Meek and Worthen. (Fig. 706.) Carbonic.

Radiating costæ present on posterior slope; concentric lamellæ elevated.

Coal Measures: Illinois, Ohio, Kansas, Missouri, Iowa.

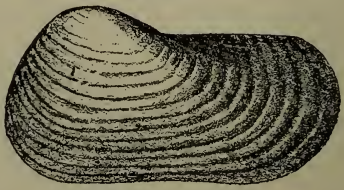


FIG. 706. *Allorisma costatum.* (Kan. Pal., VI/II.)
FIG. 707. *Allorisma granosum.* (Kan. Pal., VI/II.)

446. **A. granosum** Shumard. (Fig. 707.) Carbonic and Permic.

Beaks very prominent, incurved; a slight sinuosity sometimes present in the base.

Upper Coal Measures: Kansas, Missouri. Permic of Kansas.

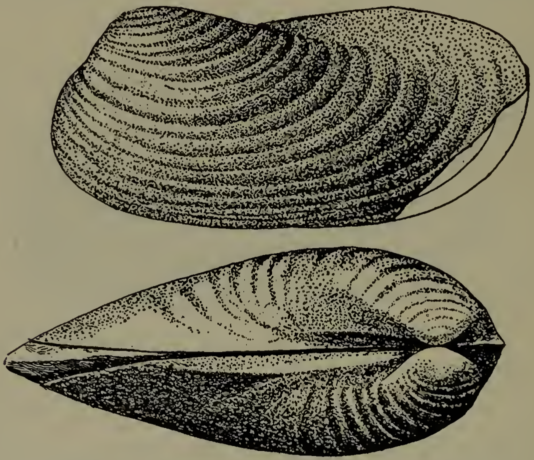


FIG. 708. *Allorisma terminale.* (Kan. Pal., VI/II.)

447. **A. terminale** Hall. (*A. subcuneata* Meek and Hayden.) (Fig. 708.) Carbonic and Permic.

Large. Dorsal and basal margins subparallel.

Coal Measures of United States from Pennsylvania to Utah. Permic of Kansas.

CXXI. SPHENOTUS Hall.

Entire shell almost cylindrical in shape. Posterior end usually obliquely truncate. Beaks very near anterior end, hinge line long and straight. Valves marked with a well-defined umbonal ridge and a broad sinus which often constricts the basal margin. Concentric growth striæ present. Hinge narrow, with two short teeth beneath the beak and with one or two slender lateral teeth. Ligament external and contained in a slender groove, along the hinge line. Muscle impressions two. Pallial line simple. Differs from *Sanguinolites* and *Allorisma* in the umbonal and posterior cardinal ridges, its trapezoidal form, in the cincture crossing the valves, and in the characters of the hinge. Devonic and Mississippic.

FIG. 709. *Sphenotus truncatus.* (Pal. N. Y., V.)
FIG. 710. *Sphenotus cuneatus.* (Pal. N. Y.)

448. **S. truncatus.** (Fig. 709.) Devonic.
Small truncate posterior end, strong angular umbonal ridge.
Ithaca of New York, Pennsylvania, etc.

449. **S. cuneatus.** (Fig. 710.) Devonic.
Larger than preceding, with more pointed anterior and more rounded posterior end; a second pronounced ridge above umbonal ridge.
Ithaca of New York, etc.

450. **S. contractus** Hall. (Fig. 711, *c*.) Devonic.

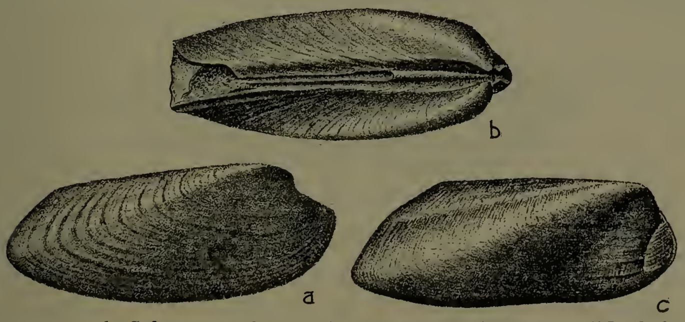


FIG. 711. *a*, *b*, *Sphenotus æolus*; *c*, *S. contractus*, right valve. (N. Y. Surv.)

Posterior extremity oblique, somewhat doubly truncate. Sinus without distinct limitation, merely flattenening the shell above and slightly depressing it below.

Chemung Group: New York, Pennsylvania.

451. **S. æolus** Hall. (Fig. 711, *a*, *b*.) Mississippic.

Distinguished from *S. contractus* by its larger size, more rounded base, simply truncated posterior end, and lamellose growth lines.

Waverly: Ohio.

CXXII. Rhytimya Ulrich.

Shell very thin, elongate, gaping slightly at both ends. Hinge and basal margin subparallel. Beaks prominent. Mesial furrow wide. Ligament external. Hinge apparently without teeth. Muscle scars very faint. Surface covered with concentric folds,

FIG. 712. *Rhytimya radiata.* (Ohio Survey, VII.)
FIG. 713. *Rhytimya producta.* (Ohio, VII.)

strongest on anterior end, crossed on posterior half by radiating rows of small granules. Ordovicic.

452. **R. radiata** Ulrich. (Fig. 712.) Ordovicic.

Mesial furrow very slightly developed.

Lower beds of Cincinnati Group of Ohio, Kentucky.

453. **R. producta** Ulrich. (Fig. 713.) Ordovicic.

Surface crossed by about ten sharp concentric folds anterior to the beaks, becoming less sharp over the rest of the shell. Type of genus.

Middle beds of Cincinnati Group of Ohio, Kentucky.

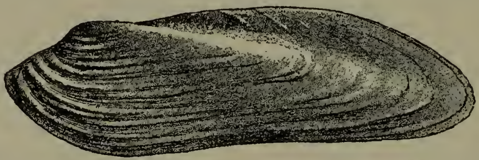


FIG. 714. *Rhytimya mickleboroughi.* (Ohio, VII.)

454. **R. mickleboroughi** Whitfield. (Fig. 714.) Ordovicic.

Shell very elongate, anterior end acute.

Middle beds of Cincinnati Group of Ohio.

CXXIII. Endodesma Ulrich.

Shell very thin, equivalve, convex, elongate. Hinge and basal margins subparallel. Mesial depression deep. Umbones compressed, elevated. Hinge thin, apparently without teeth. A flattened area (lunule) present in front of beaks. Surface covered with concentric lines. Muscle scars very faint. Ordovicic.

455. **E. orthonotum** Meek and Worthen. (Fig. 715, *b*, *c*.) Ordovicic.

Umbonal slope subangular dorsally.

Stones River limestone of Illinois and Minnesota.

456. **E. gesneri** Billings. (Fig. 715, *a*.) Ordovicic.

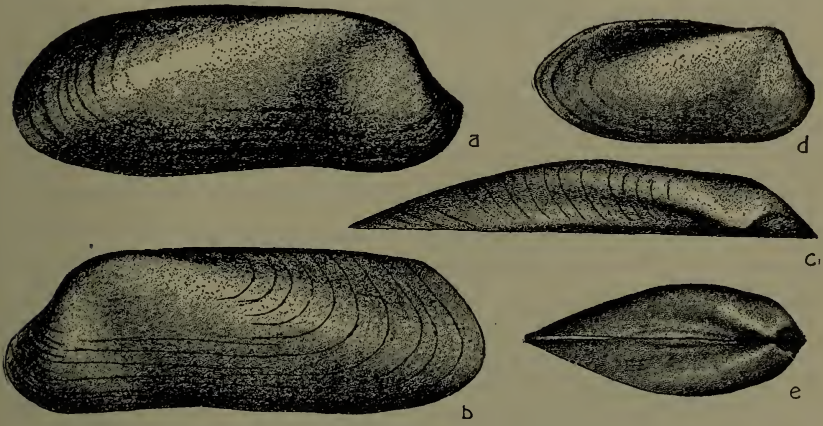


Fig. 715. *a*, *Endodesma gesneri*, right valve; *b*, *c*, *E. orthonotum*; *d*, *e*, *E. cuneatum*, all internal molds. (Minn. Surv.)

Differs from *E. orthonotum* in its subangular anterior extremity, its more rounded upper posterior edge, and its comparatively shorter length.

Black River and Trenton of Ontario.

457. **E. cuneatum** Ulrich. (Fig. 715, *d*, *e*.) Ordovicic.

Surface of internal mold bearing a few obscure concentric folds. Type of genus.

Middle Galena of Minnesota.

CXXIV. Pholadella Hall.

Transversely elongate, with truncate posterior end and rounded or obliquely truncate anterior end. Beaks anterior to middle and prominent. Umbonal slope prominent. Surface marked with fine concentric striæ, often becoming strong undulations, and, on the body of the shell, with distinct radii which are absent from the anterior end and cardinal slope. Ligament external. Devonic.

458. **P. radiata** (Conrad). (Fig. 716.) Devonic.

FIG. 716. *Pholadella radiata*; *a*, *b*, right valves; *c*, *d*, left valves. (Pal. N. Y., V.)

Basal margin slightly sinuous, owing to the depression extending from beak to base.

Hamilton: New York, Pennsylvania, Maryland. Ithaca: Pennsylvania.

CXXV. CIMITARIA Hall.

Very elongate, with anterior and strongly incurved beaks, short and rounded anterior end and long and truncate posterior. Umbonal slope well defined. Surface crossed by strong concentric growth lines and marked by very fine radial striæ and by a depression extending somewhat posteriorly from the beaks to the base. Lunule present. Ligament external. Hinge without teeth. Devonic.

459. **C. corrugata** (Conrad). (Fig. 717, *d*.) Devonic.

Posterior cardinal slope comparatively wide, marked by one or several radial folds. Body of shell marked by concentric undulations.

Hamilton: New York.

460. **C. recurva** (Conrad). (Fig. 717, *a*, *b*.) Devonic.

Differs from *C. corrugata* in its more curving outline and more rounded posterior extremity. Type of genus.

Hamilton: New York, Pennsylvania.

461. **C. angulata** Hall. (Fig. 717, *c*.) Devonic.

Umbonal ridge strong and angular. Concentric striæ regular and covering the whole shell.

Chemung: New York.

CXXVI. PHOLADOMYA Sowerby.

Shell thin, translucent, subovate, ventricose, equivalve, gaping posteriorly and sometimes anteriorly. Anterior side short, rounded.

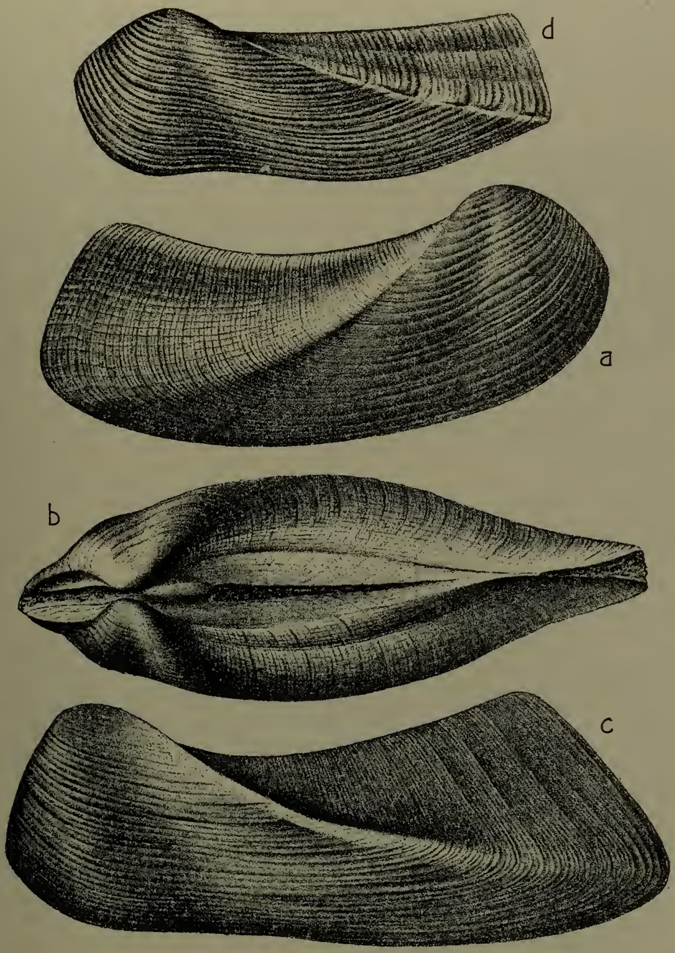


FIG. 717. *a*, *b*, *Cimitaria recurva*, right and cardinal views; *c*, *C. angulata*, left valve; *d*, *C. corrugata*. (N. Y. Surv.)

Surface marked with radiating ribs (feeble in the posterior dorsal region), crossed by concentric striæ. Umbos prominent. Ligament external. Hinge without teeth or with an obscure thickening. Adductor scars feeble. Pallial sinus deep. Jurassic–Recent.

462. **P. sancti-sabæ** Roemer. (Fig. 718.) Comanchic.
Beaks prominent; ribs noded by concentric ridges.
Fredericksburg to Denison: Texas, Oklahoma.

463. **P. papyracea** Meek and Hayden. Cretacic.
Beaks depressed, small, incurved. Surface of each valve marked

with 10 to 12 radiating ribs and with very regular, sharply defined and closely arranged concentric ridges. In form quite similar to *P. marylandica* but it is much smaller (average length 1.2 inches; height 0.8 inch; convexity 0.6 inch), and the surface markings are more prominent.

FIG. 718. *Pholadomya sanctisabæ.* (After Meek, Mex. Bd. Surv.)

Benton: Kansas, Montana.

464. **P. occidentalis** Morton. Cretacic.

Surface marked with 25 to 30 radiating, somewhat irregular, and wavy ribs, closest together on middle of shell.

Ripleyan of New Jersey (Cliffwood–Woodbury); Gulf region, Arkansas.

465. **P. marylandica** Conrad. (Fig. 719.) Eocenic.

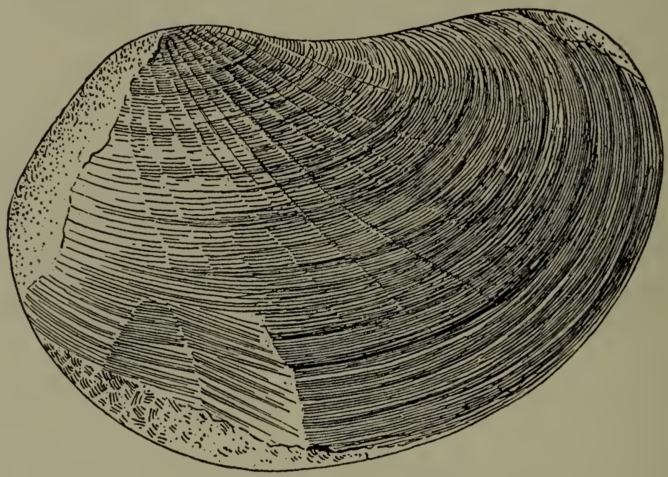


FIG. 719. *Pholadomya marylandica*, left valve. (Md. Surv.)

Length about 3 inches, very fragile.

Aquia: Maryland.

CXXVII. PHENACOMYA Dall.

Equivalve, thin, marked with feeble radii. Anterior end more or less expanded and truncate. Posterior end attenuate and smoother. Eocenic.

466. **P. petrosa** (Conrad). (Fig. 720.) Eocenic.
Ventricose anteriorly. Radii sharp, numerous.
Aquia of Maryland.

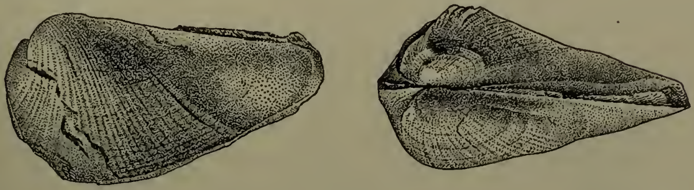


FIG. 720. *Phenacomya petrosa*, left and cardinal views, $\times \frac{2}{3}$. (Md. Surv.)

CXXVIII. Anatimya Conrad.

Oblong. Anterior side with concentric sculpture ; posterior with concentric and radiating ribs. Cretacic.

467. **A. anteradiata** Conrad. (Fig. 721.) Cretacic.

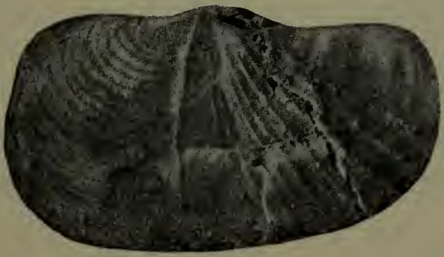


FIG. 721. *Anatimya anteradiata*. (After Weller, Pal. N. J., IV.)

Beaks scarcely elevated above hinge line, pointing posteriorly. Valves depressed-convex. Margins subparallel.
Ripleyan of New Jersey (Woodbury, Wenonah), Mississippi.

CXXIX. Liopistha Meek. (Includes Cymella Meek.)

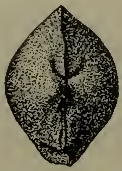
Equivalve, oval, thin, inflated. Valves gaping and compressed posteriorly, concentrically or radially striated. Beaks prominent, incurved. Hinge inflected along its entire length. Cardinal teeth two, projecting directly outward from beneath the beaks. Ligament sunken, partly external. Cretacic.

The typical *Liopistha* has the shell ornamented principally by strong radial ribs, while in the subgenus *Cymella* the chief sculpture is the large, strong, regular concentric undulations which are crossed by only a few radiating markings.

468. **L. meeki** White. (Fig. 722.) Cretacic.

Surface marked with radiating striæ and fine concentric growth lines.

Coloradoan: Utah.



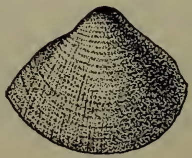


FIG. 722. *Liopistha meeki*, cardinal and right views. (After Stanton.)

469. **L. (Cymella) bella** (Conrad). (Fig. 723.) Cretacic.

Radiating ribs strongest on middle of valve.

Ripleyan of New Jersey (Cliffwood–Wenonah), Virginia and Gulf region.

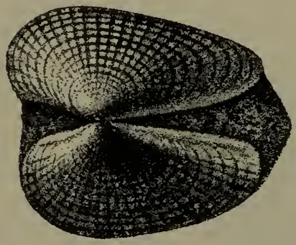


FIG. 723. *Cymella bella*. (N. J. Pal., I.)

470. **L. protexta** (Conrad). Cretacic.

A concave area at posterior extremity nearly or wholly destitute of ribs.

Ripleyan of New Jersey (Wenonah–Tinton), Gulf region.

471. **L. (Cymella) undata** Meek and Hayden. Cretacic.

Radii finer than in *L. bella*. Type of subgenus *Cymella*.

Montanan: throughout the Rocky Mountain region; Wenonah of New Jersey.

CXXX. CUSPIDARIA Meek.

Hinge without teeth, but with a small, internal, posteriorly inclined resilifer in each valve and an elongated ridge behind it. Ligament subinternal, anterior to the beaks or obsolete. Pallial line simple. Surface concentrically sculptured. Jurassic–Recent.

472. **C. ventricosa** Meek and Hayden. Cretacic.

Posterior side of shell the longer, usually abruptly contracted. Surface marked with concentric striæ.

Ripleyan of New Jersey (Wenonah–Tinton), Montanan of South Dakota and Montana.

473. **C. moreauensis** Meek and Hayden. (*Neæra moreauensis*.) Cretacic.

Distinguished from *C. ventricosa* by its regular, concentric ribs, instead of mere striæ.

Montanan : South Dakota, Montana, Assiniboia.

Order 3. TELEODESMACEA.

CXXXI. PLEUROPHORUS King.

Inequilateral, elongated, rectangular, with beaks nearly terminal. Two cardinal and one posterior lateral tooth present in each valve. Anterior muscle scar deep, bounded posteriorly by a ridge. Pallial line simple. Devonic–Triassic.

474. **P. tropidophorus** Meek. (Fig. 724.) Carbonic.

Posterior slope doubly angular with two ridges that pass obliquely backward from the beaks. Surface marked with strong concentric growth lines.

Coal Measures of Ohio, Missouri.

475. **P. oblongus** Meek. Carbonic.

Somewhat similar to *P. tropidophorus* but differs in the small size, with length never exceeding .5 inch, in the wider posterior

FIG. 724. *Pleurophorus tropidophorus*, right valve. (Kan. Pal., VI/ II.)
FIG. 725. *Pleurophorus subcostatus*, left internal mold. (Kans. Pal., VI.)
FIG. 726. *Pleurophorus albequus*, right valve. (After Beede.)

end, producing a slight divergence of the basal and cardinal margins, in lacking the doubly angular slope and in the finer concentric striæ.

Illinois, Missouri, Arkansas, Nebraska.

476. **P. subcostatus** Meek and Worthen. (Fig. 725.) Carbonic.

Surface covered with fine growth lines and with three or four radii extending from the beak to the posterior margin.

Ohio–Colorado.

477. **P. occidentalis** Meek and Hayden. Carbonic and Permic.

Much like *P. oblongus* in size but with narrowing posterior end instead of the vertically truncate end of *P. oblongus* and with radiating ridges extending from the beak to the posterior margin.

Carbonic : Nebraska, Colorado. Permic : Kansas, Nebraska, Texas, New Mexico.

478. **P.? albequus** Beede. (Fig. 726.) Permic.

Surface marked with two to six faint ribs extending from the beak to the posterior margin; growth lines strongest on anterior portion of shell. Differs from *P. occidentalis* in being larger, and in having an arcuate hinge; from *P. oblongus* in being proportionally much longer and in possessing radiating ridges.

Very abundant in the upper Permic of Oklahoma (Whitehorse) and Texas (Quartermaster).

CXXXII. Cypricardella Hall. (*Microdon* Hall.)

Equivalve, inequilateral, subquadrate, with straight or nearly straight hinge line. Anterior end narrow and rounded. Posterior end longer, broad, and truncate. Beaks small, appressed. Umbonal ridge more or less defined, extending backward from the beaks. Surface marked with more or less lamellose concentric striæ. Hinge with a triangular tooth in each valve and corresponding sockets. There is also in the right valve a longer triangular fold or lateral tooth. Ligament external, extending nearly or quite the whole length of the hinge line. Pallial line simple. Devonic and Mississippic.

479. **C. tenuistriata** Hall. (Fig. 727, *a*, *b*.) Devonic.

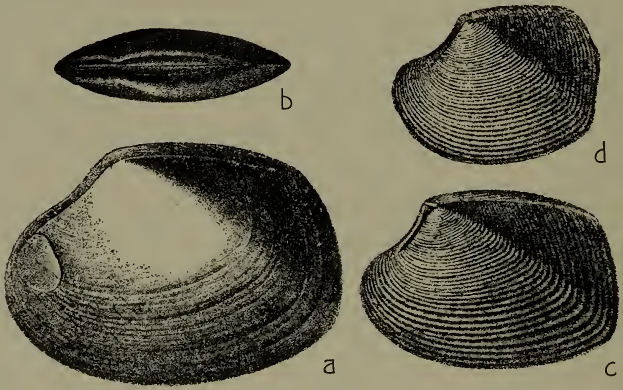


Fig. 727. *a*, *b*, *Cypricardella tenuistriata*, left valve, and cardinal view of small specimen; *c*, *d*, *C. bellistriata*. (Pal. N. Y., V.)

Larger than *C. bellistriata* with less angular umbonal slope and less well-defined striæ.

Hamilton: New York.

480. **C. gregaria** Hall. Devonic.

Smaller than *C. bellistriata*, with more curving posterior end and finer striæ.

Hamilton–Chemung: New York, Pennsylvania.

481. **C. bellistriata** Conrad. (Fig. 727, *c*, *d*.) Devonic–Mississippic.

Distinguished by its strong surface striæ.

Marcellus–Chemung: northern Appalachian region; abundant in Hamilton of New York, Pennsylvania, Maryland, Lower Waverly of Ohio.

482. **C. oblonga** Hall. (Fig. 728.) Mississippic.

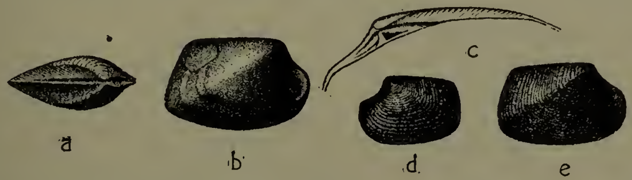


FIG. 728. *Cypricardella oblonga*: *a*, cardinal view; *b*, internal mold of right valve, showing muscular impressions; *c*, hinge of right valve enlarged; *d*, *e*, left and right valves. (After Whitfield.)

Base subparallel to hinge line. Posterior margin obliquely truncate.

Indiana (St. Louis), Kentucky (St. Genevieve).

CXXXIII. Cypricardinia Hall.

Inequivalve, with more convex right valve, somewhat rhomboid or trapezoidal. Anterior end short and rounded; posterior wider and obliquely truncate. Beaks nearly at anterior extremitiy. Umbonal slope prominent. Surface marked by concentric lamellose ridges with intermediate fine growth striæ and in some species radial striæ. Two to three cardinal teeth present. Ligament external. Pallial line simple. Shell thicker than in *Modiolopsis* and concentric striæ stronger. Siluric–Mississippi.

483. **C. arata** Hall. Siluric.

Surface crossed by strong concentric lamellose ridges.

Niagaran: Indiana, Wisconsin, Oklahoma. Also Siluric of Alaska.

484. **C. lamellosa** Hall. Devonic.

Gibbous, with short anterior and long posterior extremities.

Helderbergian : New York.

485. **C. indenta** Conrad. (Fig. 729, *c*.) Devonic.

Length more than one third greater than height. Hinge line straight and oblique.

Onondaga : New York, Falls of the Ohio, Ontario. Abundant

FIG. 729. *a*, *b*, *Cypricardinia consimilis*, right and cardinal views; *c*, *C. indenta*. (N. Y. Surv.)

in Hamilton of New York, Pennsylvania, Virginia. Also in Lower Devonic of Nevada.

486. **C. consimilis** Hall. (Fig. 729, *a*, *b*.) Mississippic.

More elongate than *C. indenta*, with comparatively, narrower posterior end and less sinuate basal margin.

Waverlyan : Pennsylvania, Ohio.

FIG. 730. *Cypricardinia carbonaria*. (Kan. Pal., VI/II.)

487. **C. carbonaria** Meek. (Fig. 730.) Carbonic.

Small. Surface marked with 15 to 20 flattened, subimbricating concentric ridges.

Ohio, Kansas, Missouri, Colorado.

CXXXIV. ASTARTELLA Hall.

Shell thick, smooth or concentrically furrowed. Lunule impressed. Two cardinal teeth present in each valve ; the posterior tooth in the right valve has a longitudinal pit on the summit. Ligament external. Carbonic.

488. **A. vera** Hall. (Fig. 731.) Carbonic.

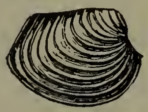


FIG. 731. *Astartella vera*. (Kan. Pal., VI/II.)
FIG. 732. *Astartella newberryi*. (Pal. Ohio, II.)

Surface marked with strong concentric furrows separated by sharp angular ridges.

Coal Measures : Ohio–Oklahoma.

489. **A. newberryi** Meek. (Fig. 732.) Carbonic.

Differs from *A. vera* in the less prominent and more nearly central beaks and the more numerous and regular concentric ridges.

Coal Measures: Ohio, Arkansas, Oklahoma.

CXXXV. ARCTICA Schumacher. (*Cyprina* Lamarck.)

Orbicular or oval, inflated, with thick epidermis. Beaks prominent, incurved. Lunule absent. Three cardinal and one ridge-like posterior lateral in each valve; the middle cardinal of left valve the largest. Surface marked with concentric striæ. Margins of valves smooth. Ligament external and prominent. Pallial line simple. Jurassic–Recent.

490. **A. coteroi** Castillo and Aguilera. (Fig. 733.) Jurassic.

FIG. 733. *Arctica coteroi*, left and front views of internal mold. (After Cragin.)

Surface of shell when preserved marked with concentric growth lines and occasional concentric grooves. Length less than 2 inches.

Upper Jurassic of Texas (Malone) and central Mexico.

491. **A. occidentalis** (Whiteaves). (Fig. 734.) Comanchic.

FIG. 734. *Arctica occidentalis*, right valve. (After Stanton.)

Beaks broad and prominent.

Knoxville of California; Queen Charlotte of Queen Charlotte Islands.

492. **A. ovata** (Meek and Hayden). Cretacic.

Transversely ovate. Beaks rather small and not much elevated. Surface marked with distinct growth lines. Length 2¼ inches; height nearly 2 inches.

Montanan: North Dakota, Montana, Alberta, Assiniboia, Saskatchewan.

CXXXVI. VENIELLA Stoliczka.

Very similar to *Arctica*, but the left valve has the anterior cardinal teeth strong and subtriangular and there is present a more or less pronounced posterior umbonal slope. Cretacic–Tertiary.

493. **V. conradi** (Morton). (Fig. 735.) Cretacic.

FIG. 735. *Veniella conradi.* (N. J. Pal., I.)

Surface marked with several strong projecting growth lamellae which do not extend across the posterior umbonal slope. A low subangular ridge curves from the beak to the posterior extremity of the hinge line.

Ripleyan of New Jersey (Merchantville–Tinton), Gulf region.

494. **V. trigona** (Gabb). (Fig. 736.) Cretacic.

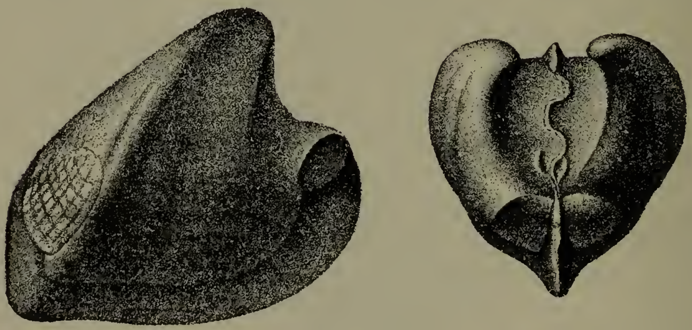


FIG. 736. *Veniella trigona* Gabb. (N. J. Pal., I.)

Differs from *V. conradi* in its thicker and larger shell, and presence of the projecting growth lamellæ only upon the younger portion of the shell; the rest being covered only by strong wrinkle-like ridges.

Ripleyan of New Jersey (Navesink, Tinton), Gulf region.

495. **V. mortoni** Meek and Hayden. Cretacic.

Differs from *V. trigona* in being more oblique, more depressed at the beaks, which are also placed directly over the more truncated anterior margin. Dorsal margin also longer, giving it a greater proportional length, and less sloping.

Benton: Colorado, Montana.

496. **V. humilis** Meek and Hayden. (Fig. 737.) Cretacic.

FIG. 737. *Veniella humilis*, anterior and left views. (After Meek, Surv. Terr., IX.)

Umbonal slope rounded. Surface concentrically striated.

Fox Hills: South Dakota, Wyoming, Colorado.

CXXXVII. ASTARTE Sowerby.

Shell thick, inequilateral, usually rounded triangular or oval, closed, with smooth or concentrically sculptured exterior. Epidermis thick. Lunule impressed; escutcheon elongate. Ligament external. Two cardinal teeth present in each valve; the right anterior strong. Lateral teeth rudimentary. Adductor scars strong, nearly equal; above the anterior is a pedal impression. Pallial line simple. Jurassic–Recent.

497. **A. carlottensis** Whiteaves. Comanchic.

Subcircular to transversely subovate in outline, moderately and regularly convex. Length and height about equal. Margin forming a continuous subelliptical curve from the posterior end of the hinge to the lower end of the lunule. Hinge short and gently convex. Beaks about half way between the middle and anterior margin, prominent, turned forward. Lunule large, deeply and sharply impressed. Surface crossed by numerous, regular, concentric undulations. Average measurements of two types : length and height 20 mm. ; length 26 mm., height 20 mm.

Queen Charlotte Islands, Vancouver.

498. **A. trapezoidalis** Stanton. (Fig. 738.) Comanchic.

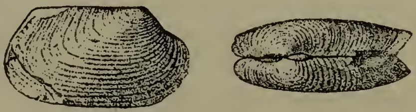


FIG. 738. *Astarte* (?) *trapezoidalis*, right and cardinal views. (After Stanton.)

Shell elongate, marked with a broadly rounded umbonal ridge and crossed by prominent, subangular, concentric ridges.

Knoxville : California.

CXXXVIII. OPIS Defrance.

Trigonal cordate, smooth or concentrically striate, with pronounced epidermis. Beaks prominent, curving strongly so as to be concave forward. Lunule very deep, bordered by a keel. Cardinal teeth very long, narrow ; one in the right valve, two in the left. Triassic–Cretacic.

499. **O. californica** Stanton. (Fig. 739.) Comanchic.

FIG. 739. *Opis californica*, two views of the right and one of the left valve. (After Stanton.)

Surface marked with fine growth lines and more distant, irregular, concentric furrows.

Knoxville : California, Oregon.

CXXXIX. CRASSATELLITES Kruger.

Shell solid, attenuated behind. Umbos small, close together. Lunule distinct. Resilifer present beneath the umbo. Hinge plate heavy, flat, with two cardinal teeth in each valve; lateral teeth present, one (posterior) in each valve, with a small anterior lateral at times in the right valve. Free margins of valves crenate. Adductor impressions deep. Pallial line simple. Cretacic–Recent.

500. **C. alæformis** (Conrad). (Fig. 740, *a*, *b*.) Eocenic.

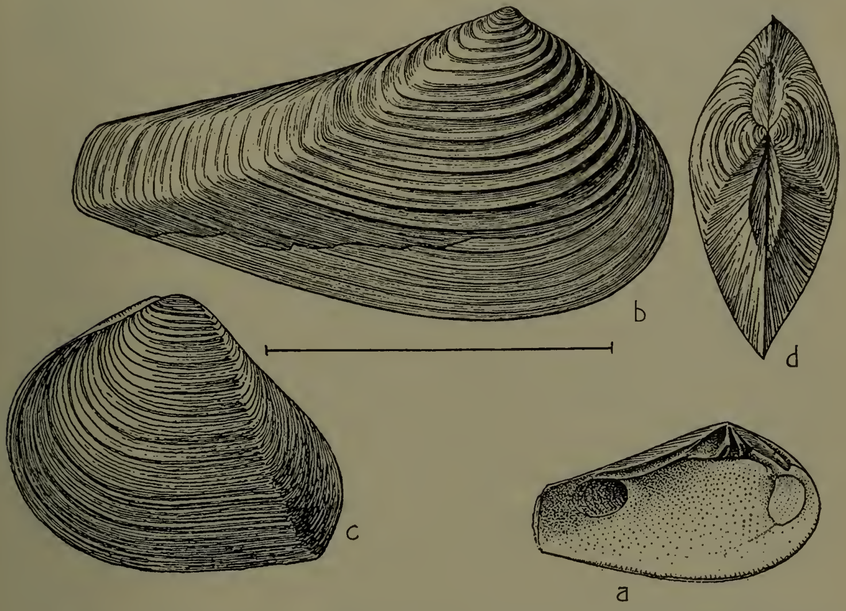


FIG. 740. *a*, *b*, *Crassatellites alæformis*, left and right valves; *c*, *d*, *C. aquiana*, left and cardinal views. (Md. Surv.)

Base of attenuated posterior portion varying from broadly convex to broadly concave; sculpture strong.

Very abundant in the Aquia of Maryland.

501. **C. aquianus** (Clark). (Fig. 740, *c*, *d*.) Eocenic.

Differs from *C. alæformis* in its shorter and broader posterior extremity, its higher umbos, and the absence of deep prominent furrows on the umbos.

Aquia of Maryland.

502. **C. gabbi** Safford. (Fig. 741.) Eocenic.

Surface marked with heavy concentric ribs which become faint at the posterior umbonal slope.

Midway: Gulf region.

503. **C. halei** Harris. Eocenic.

No posterior umbonal slope present.

Lignitic: Georgia, Alabama.

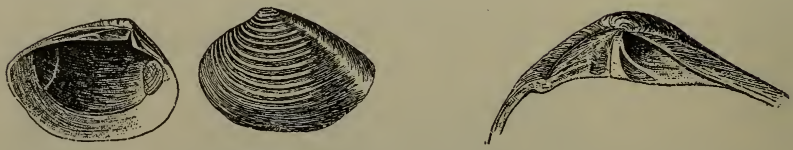


FIG. 741. *Crassatellites gabbi*, interior and exterior of the left valve and hinge, enlarged. (After Harris.)

CXL. ETEA Conrad.

Differs from *Crassatellites* in the absence of crenulations on the inner free margins of the valves and in the hinge characters, possessing beside its two cardinal teeth, an elongate anterior and a posterior lateral tooth in each valve; anterior cardinal of left valve triangular, fitting into a triangular pit of the right valve between the two cardinal teeth of that valve. Cretacic.

504. **E. carolinensis** Conrad. Cretacic.

Umbonal ridge subcarinate. Surface of shell marked with strong, more or less irregular concentric growth lines.

Abundant in Ripleyan (Marshalltown) of New Jersey. Also in North Carolina.

505. **E. trapezoidea** (Conrad). Cretacic.

Less elongate than *E. carolinensis* and its posterior obliquely truncate margin is longer than in that species.

Ripleyan of New Jersey (Merchantville), Alabama, Texas.

CXLI. PTYCHOMYA Agassiz.

Like *Crassatellites* but with radial sculpture and with three cardinal teeth in each valve, the posterior being very long and double in the right valve, with resilifer in front. Comanchic–Cretacic.

506. **P. ragsdalei** (Cragin). (Figs. 742–743.) Comanchic.

Of medium size to large. Radial ribs in three systems which run at angles to one another.

Common in Comanchic of Texas.

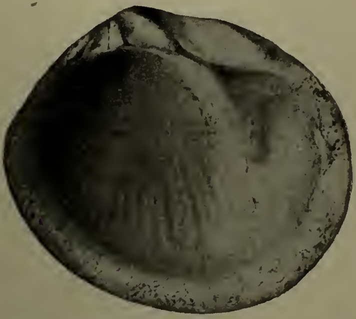


FIG. 742. *Ptychomya ragsdalei*, interior $\times \frac{1}{2}$. (After Shattuck.)
FIG. 743. *Ptychomya ragsdalei;* fragment of exterior. (After Shattuck.)

CXLII. CORBICULA Megerle von Muhlfeld.

Shell porcelaneous, with conspicuous epidermis and marked with concentric growth lines. Pallial line simple or with slight sinus. Ligament prominent, external. Adductor scars nearly equal. Hinge with anterior and posterior laterals distinctly separated from the cardinals and sharply cross striated. Cardinal teeth bifid at summit and usually three in each valve. Fresh and brackish water. Cretacic–Recent.

507. **C. durkei** Meek. (Fig. 744, *a–c.*) Cretacic.
Beaks very strongly incurved.

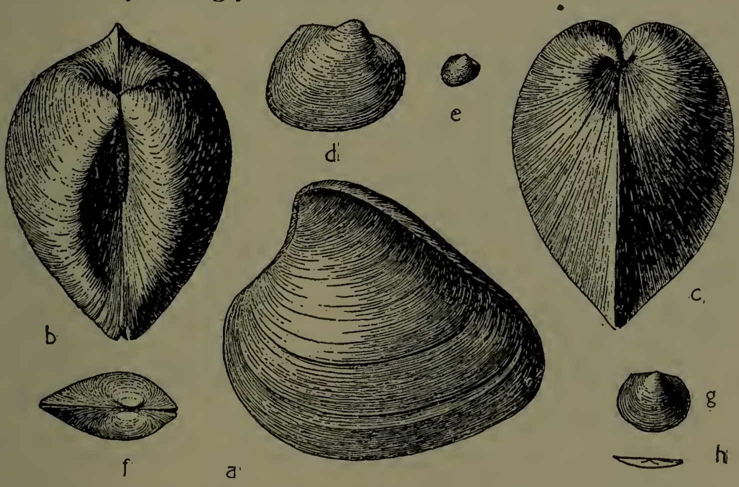


FIG. 744. *a–c, Corbicula durkei; d–f, Sphærium formosum*, natural size and enlargements; *g, h, Sph. planum.* (After White.)

Very abundant in the Bear River of Wyoming, Utah and Idaho.

508. **C. occidentalis** Meek and Hayden. Cretacic.

Shell thick, subtrigonal. Average length and height 1 inch; convexity .75 inch. Slopes from beak subequal; the anterior slightly concave, the posterior somewhat convex. Base broadly curved. Beaks elevated, gibbous.

Especially abundant in the brackish water strata of the Montanan of Wyoming, Montana, Assiniboia, Alberta; also present in the Laramie throughout this region.

CXLIII. Sphærium Scopoli.

Small, thin, inflated, rounded. Sculpture concentric, never strong. Cardinal teeth usually two in each valve, variable, thin, often nearly parallel to the hinge line or in part defective. Lateral teeth compressed, lamelliform, the anterior shortest. Ligament short and feeble, deep-set in a groove. Muscle impressions near margin and scarcely apparent. Pallial line simple. Fresh water. Cretacic–Recent.

509. **S. planum** Meek and Hayden. (Fig. 744, *g*, *h*.) Cretacic.

Much compressed, with very small nearly central beaks that scarcely rise above the hinge line. Surface marked by obscure and irregular concentric striæ.

Judith River (Pierre): Nebraska, Montana, Assiniboia. Laramie: Wyoming.

510. **S. formosum** Meek and Hayden. (Fig. 744, *d–f*.) Cretacic–Lower Eocenic.

Very small (length less than .2 inch). Beaks somewhat tumid and rising a little above the hinge line, a little anterior of the middle. Surface marked by distinct and regular concentric lines.

Pierre (Belly River) of Alberta and Assiniboia. Fort Union of Montana.

CXLIV. Venericardia Lamarck.

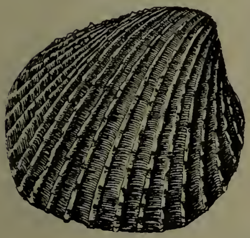
Shell rounded or cordate, inequilateral, with radiating ribs. Umbos prominent. Basal margin crenulated internally. Ligament external. Hinge thick with no lateral teeth but with the posterior cardinal much prolonged. Adductor impressions unequal. Pallial line simple. Cretacic–Recent.

511. **V. smithi** Aldrich. (Fig. 747, *b*.) Eocenic.

Ribs flat on central part of shell, tuberculated on anterior and posterior portions.

Midway: Gulf region.

512. **V. alticosta** Conrad. (Fig. 745.) Eocenic.



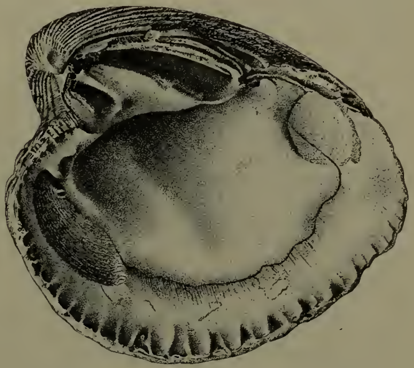


FIG. 745. *Venericardia alticosta*, right valve. (After Harris.)
FIG. 746. *Venericardia planicosta* var. *regia*, × ½.

Ribs about 22, much elevated and nodulose; those on anterior side are laterally keeled.

Claibornian and Jacksonian of Alabama and Louisiana.

513. **V. planicosta** Lamarck. (Figs. 746 and 747, *a.*) Eocenic.

Large, with length at times of 3 or 4 inches.

It has been proposed by some authors to distinguish the Ameri-

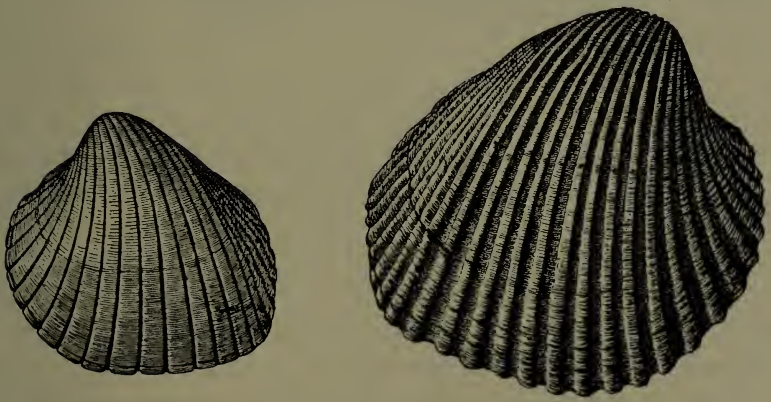


FIG. 747. *Venericardia planicosta*, left valve, and *V. smithi*, right valve. (After Harris.)

can representative of the *V. planicosta* of Europe by the varietal name of *regia*.

Aquia: Maryland. Tejon: California. Eocenic of Alaska.

CXLV. Chama Linné.

Unequal, irregular, attached by umbo of left and larger valve. Beaks more or less spiral, turned forward. Hinge plate heavy. Hinge teeth one in the free valve; two in the attached, the anterior broad and grooved, the posterior long and curved parallel with the hinge line. Sculpture lamellose and more or less spiny. Adductor impressions large, oblong, nearly equal. Ligament and resilium external in a deep groove. Shell structure in three layers, the external colored, laminated with oblique lines of growth and corrugated at right angles to the laminæ, spiny; the middle layer corrugated; the inner translucent and bearing minute processes that give a granular appearance to the internal molds of the shell. Sometimes attached by right valve, in which case the dentition is reversed, the single tooth being always in the free valve. Cretacic–Recent.

514. **C. congregata** Conrad. (Fig. 748.) Miocenic–Recent.

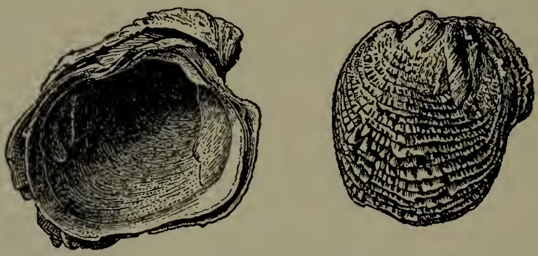


Fig. 748. *Chama congregata*, interior of left and exterior of right valves. (Md. Surv.)

Small, plump, usually attached by beak of left valve which is quite turbinate. Internal margins crenulated. Both valves covered with scales.

Miocenic: Atlantic coast. Also Recent: North Carolina to Yucatan.

CXLVI. Requienia Matheron.

Usually very inequivalve, attached by umbo of left valve. Left valve spiral, with deep cavity. Right valve smaller, somewhat spiral or flat. Teeth feeble. Ligament external. Posterior adductor scar bordered by a prominent, subspiral ridge in each valve. Comanchic.

515. **R. patagiata** White. (Fig. 749, *d–f.*) Comanchic.

Both valves convex below and flat above, the peripheral angle formed by the meeting of the upper and under sides is bordered in the left valve by a thin, somewhat wrinkled carina. Beak of left valve distorted by attachment. Right valve of more regular shape

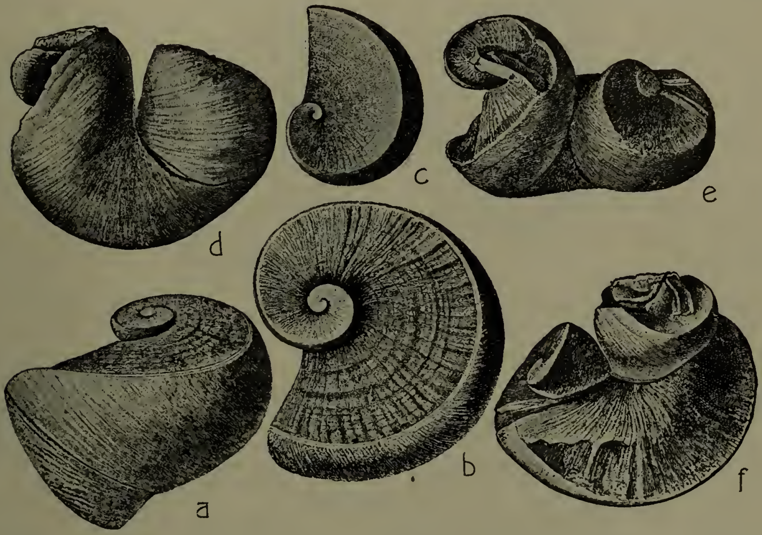


FIG. 749. *a–c*, *Requienia texana*, v ew of both valves and of the left and the right; *d–f*, *R. patagiata*, three views of a specimen with both valves together, $\times \frac{2}{3}$. (After White.)

than the left. Surface of both valves marked by irregular concentric growth lines.

Fredericksburg: Texas, Mexico.

516. **R. texana** Roemer. (Fig. 749, *a–c.*) Comanchic.

Larger, thinner-shelled, than *R. patagiata* with less prominent spires and without a prominent carina on the peripheral angle.

Fredericksburg: Texas, Mexico.

CXLVII. Monopleura Matheron.

Very inequivalve, smooth or ribbed, attached by right valve which may be either twisted or coniform. Left valve conical or flat. Dentition: two cardinals in free valve, and one in the attached. Ligament external in a deep groove. Posterior adductor scar buttressed. Shell substance without canals. Shell often found in groups adhering laterally. Comanchic.

517. **M. texana** Roemer. (Fig. 750.) Comanchic.

Right valve low, conical, with angular umbonal ridge; left valve gently convex.

Fredericksburg : Texas, Mexico.

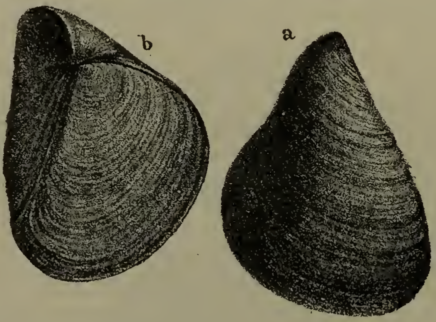


FIG. 750. *Monopleura texana ; a*, large valve from above ; *b*, showing both valves. (After Roemer.)

518. **M. pinguiscula** White. (Fig. 751, *a, b*.) Comanchic.

Right valve elongate. Radiating lines very much fainter than in *M. marcida*. Individuals apparently grew separately.

Upper Fredericksburg of Texas.

519. **M. marcida** White. (Fig. 751, *c, d*.) Comanchic.

FIG. 751. *a, b, Monopleura pinguiscula ; c, d, M. marcida.* (After White.)

Surface of both valves covered with numerous raised radiating lines besides the concentric growth lines. The individuals often grew in clusters.

Upper Fredericksburg of Texas.

CXLVIII. Caprina d'Orbigny.

Very inequivalve, attached by the coniform right valve which is marked only with growth lines and possesses an almost internal ligament groove. Hinge margin, with several deep cartilage pits and with one large posterior tooth. Left valve large, spirally twisted; anterior tooth supported by a plate which divides the umbonal cavity lengthwise; posterior teeth obscure. Inner layer of lower (right) valve made up of concentric lamellæ between which cavities are sometimes left. The middle layer of the free valve traversed by numerous simple, wide, parallel canals, extending from the margin to the apex. A series of depressions present between the posterior adductor scar and the margin. Comanchic.

520. **C. crassifibra** Roemer. (Fig. 752.) Comanchic.

Larger free valve spiral, tortuous or sickle-shaped.

Upper Fredericksburg and lower Washita: Texas.

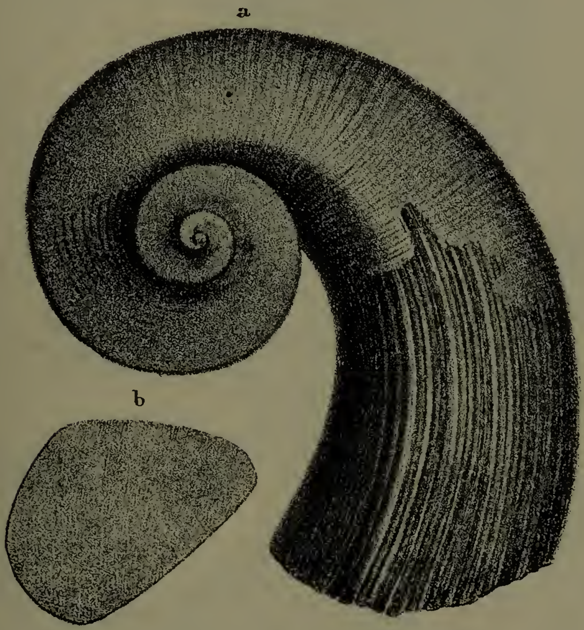


Fig. 752. *Caprina crassifibra*; *a*, complete valve, partly worn towards the end; *b*, section of the same. (After Roemer.)

521. **C. occidentalis** Conrad. (Fig. 753.) Comanchic.

Sickle-shaped, flattened on the side of the outer curve, convex on the opposite side. Outer margins acutely rounded. Surface very obscurely striated transversely. Substance coarsely fibrous. Upper Fredericksburg: Texas.

FIG. 753. *Caprina occidentalis*, views of both sides and cross section of left valve, × ½. (After Meek, Mex. Bd. Surv.)

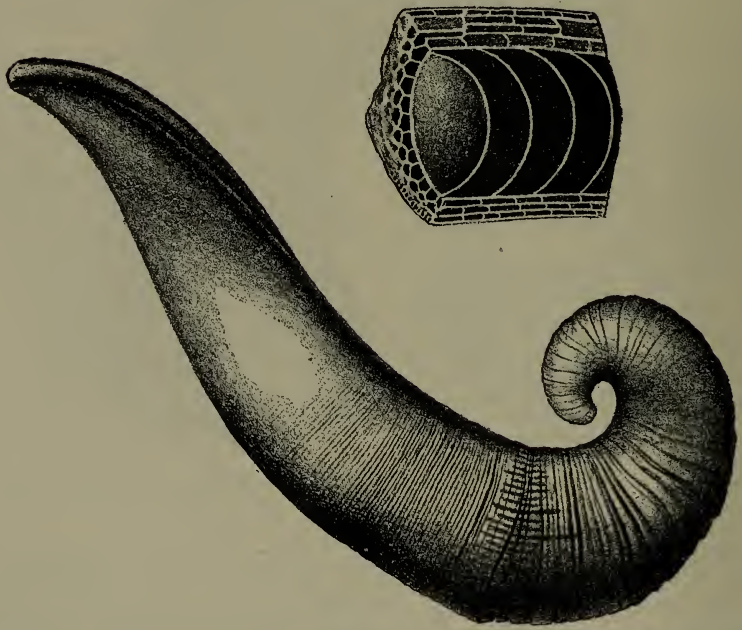


FIG. 754. *Ichthyosarcolites anguis*, complete individual with united valves and longitudinal section of a part of a larger shell. (After Roemer.)

CXLIX. Ichthyosarcolites Desm.

Fixed by right valve or free. Composed of a thick layer of open tubes with a thin superficial lamina. Cartilage internal, contained in several deep pits. Umbos more or less chambered. Right valve conical or elongated, with ligament furrow on the convex side. Hinge with one oblique plate. Left valve oblique or spiral; hinge with two teeth, the anterior supported by a plate which divides the umbonal cavity lengthwise. Comanchic.

522. **I. anguis** Roemer. (Fig. 754.) Comanchic.

Lower valve elongate, snake-like, at times a foot long and over one inch thick. Ligament furrow runs entire length of shell. Transverse section of valve oval or subtrigonal. Upper or free valve spirally once enrolled.

Upper Fredericksburg: Texas.

CL. Coralliochama White.

Shell a large cone fixed by apex of lower (right) valve growing separate or in clusters, thick, of three layers, the outer prismatic, the middle cellular, the inner porcelainous; lower valve irregularly conical, somewhat distorted, upper valve convex with broad incurved beak. Hinge similar to preceding. Cretatic.

523. **C. orcutti** White. (Fig. 755.) Cretacic.

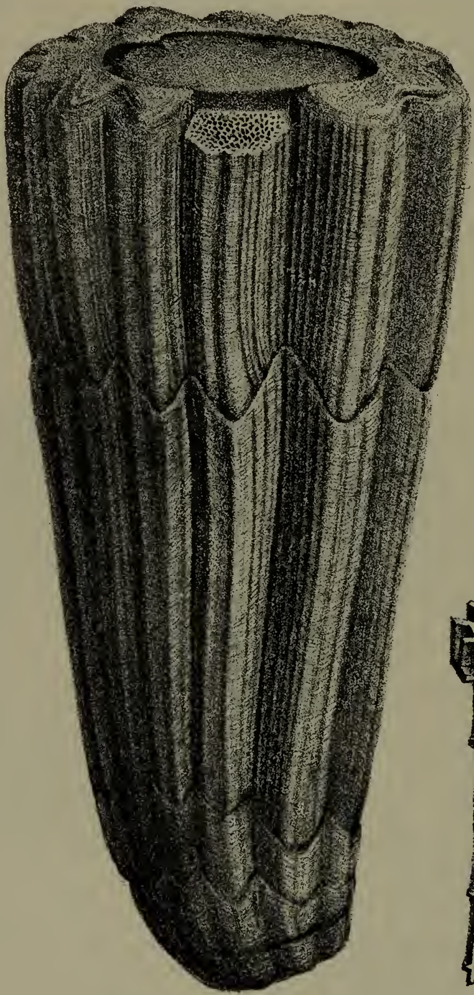
Type of genus. The cellular portion of the shell resembles *Favosites*. (See Bull. U. S. G. S. No. 22.)

Fig. 755. *Coralliochama orcutti*; *a*, complete adult shell; *b*, diagram of transverse section of lower valve, showing outer prismatic, inner porcelainous and middle cellular layers; *c*, section of part of upper valve; *d*, fragment of lower valve showing cellular structure. All, × ½. (After White.)

Lower Chico of California and Lower California.

CLI. Radiolites Lamarck.

Lower valve conical, erect, elongated, vertically ribbed or made up of successive layers; usually with two, somewhat smooth bands extending from the apex to the upper margin, probably marking the position of the siphon openings. Outer layer very thick, composed of large, polygonal cells or hollow prisms. Upper valve



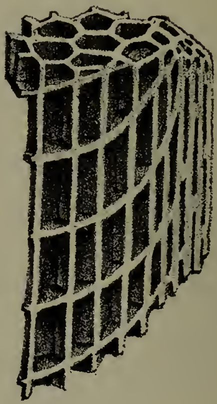


Fig. 756. *Radiolites texanus*, large valve. (After Roemer.)
Fig. 757. *Radiolites texanus*, section enlarged. (After Roemer.)

operculum-like, flat or conical, with central or eccentric umbo. Teeth not forming the hinge but specially modified for the vertical motion of the operculum-like valve; they consist of two vertically striated processes on the smaller valve, fitting into sockets near the outer wall of the fixed (larger) valve; next to and outside of the sockets are two large unequal, slightly excavated muscle scars into which fit the two broad projecting muscle plates from the upper valve. Pallial line simple, enclosing the whole cavity. Comanchic–Cretacic.

524. **R. texanus** Roemer. (Fig. 756–757.) Comanchic.

Larger valve marked with twelve subequal vertically ridged ribs.

Upper Fredericksburg (Edwards): Texas.

525. **R. davidsoni** Hill. (Fig. 758.) Comanchic.

More slender than preceding, with more numerous and finer ribs.

Upper Fredericksburg: Texas.

FIG. 758. *Radiolites davidsoni.* (After Hill.)

526. **R. austinensis** Roemer. Cretacic.

Larger valve made up of successive laminæ which are bound firmly together by some of the polygonal cells composing each lamina, being so arranged as to form furrows upon the inside and ridges on the outside. These laminæ are almost perpendicular to the broad funnel-shaped interior of the shell.

Characteristic of the Austin (Niobrara) of Texas; and at about the same horizon in San Luis Potosi.

527. **R. maximus** Logan. Cretacic.

Shell inversely conical. Outer surface of lower valve marked by parallel longitudinal ridges composed of overlapping plates; inner surface smooth. Valve composed of circular plates placed one upon the other. Upper extremity of lower valve resembling a flange bent upward and outward. Height of lower valve 3 to 4 feet; diameter at top 10 inches; thickness of outer layer of shell 3 inches.

Niobrara: Kansas.

CLII. Tancredia Lycett.

Trigonal, usually with nearly central beaks, but anterior side attenuated and somewhat the longer and posterior wider, shorter, and usually obliquely truncate. Somewhat gaping posteriorly. Margins entire. Surface smooth. One cardinal and one posterior lateral tooth in each valve. Ligament external. Pallial line simple. Triassic–Cretacic.

528. **T. bulbosa** Whitfield. (Fig. 759.) Jurassic.

Anterior portion marked with a broad and shallow depression. Surface smooth except for very fine concentric lines.

Sundance: South Dakota, Wyoming.

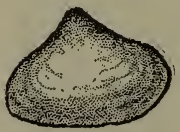


Fig. 759. *Tancredia bulbosa.* (After Logan.)

529. **T. americana** Meek and Hayden. Cretacic.

Thick. Posterior end broader than anterior, obliquely truncate and gaping above. Anterior narrow and somewhat rostrated. Hinge line slightly concave anterior to beaks and convex posteriorly. Beaks small. Length 2.5 inches.

Montanan: Colorado, Alberta, Assiniboia.

CLIII. Paracyclas Hall.

Suborbicular, thin-shelled, with small and low beaks and short hinge line. Posterior portion near the beaks more or less defined by an oblique furrow, sometimes with posterior hinge extremity almost winged. Surface marked with concentric striæ which are often developed into ridges. No lunule present. Ligament set in a deep groove. Pallial line simple. Devonic.

530. **P. ohioensis** (Meek). (Fig. 760, *c.*) Devonic.

Anterior end produced and flattened. Concentric striæ very fine. Rather small.

Onondaga: Ohio, Indiana.

531. **P. elliptica** Hall. (Fig. 760, *d.*) Devonic.

Large. Concentric striæ lamellose at irregular intervals.

Onondaga: New York, Ohio, Michigan, Ontario. Also more rarely in the Hamilton.

532. **P. lirata** (Conrad). (Fig. 760, *b.*) Devonic.

Smaller than *P. elliptica* and more uniformly marked with less angular concentric ridges.

Hamilton: New York–Iowa, Ontario. More rarely in the

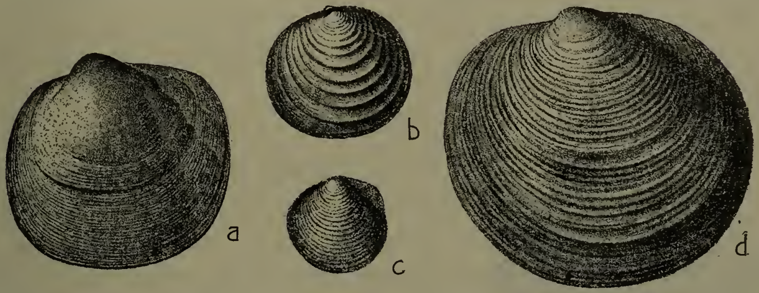


FIG. 760. *a*, *Paracyclas chemungensis; b*, *P. lirata; c*, *P. ohioensis*, right valve; *d*, *P. elliptica*, left valve. (Pal. N. Y., V.)

Onondaga. Abundant in Portage of New York and Pennsylvania.

533. **P. chemungensis** Hall. (Fig. 760, *a.*) Devonic.

Differs from *P. elliptica* in its more prominent beaks and in the finer more regular concentric striæ.

Chemung Group: New York?, Pennsylvania.

CLIV. LUCINA Bruguière.

Shell thin, rounded, convex or lens-shaped, slightly inequilateral, equivalve. Shell substance porcelaneous or chalky. Lunule deep and narrow; no visible escutcheon present. An oblique furrow extends from the umbo to the posterior border. Hinge usually with two cardinal teeth and one or two lateral in each valve; either the lateral or cardinal may be absent. Ligament and resilium deeply inset but visible. Anterior adductor scar elongated and placed mostly within the pallial line. Pallial line entire. Surface concentrically striated. Triassic–Recent.

A. Small — diameter less than .35 inch.......................I.
- I. Posterior fold present.......................538. *L. smithi.*
- I. Posterior fold not present.......................539. *L. curta.*

B. Of medium size — diameter about .5 inch.......................II.
- II. Cardinal margin nearly straight.......................1.
  - 1. Concentric undulations large and distant.......................535. *L. cretacea.*
  - 1. Concentric undulations small and closed.......................534. *L. subundata.*
- II. Hinge line rounded.......................537. *L. aquiana.*

C. Large — diameter over 1 inch.......................536. *L. occidentalis.*

534. **L. subundata** Hall and Meek. Cretacic.

Similar to *L. cretacea* in form but is usually smaller, rarely reaching .5 inch in height, and with finer and closer concentric lines.

Coloradoan : Utah. Pierre : South Dakota, Montana, Assiniboia. Fox Hills of Wyoming.

535. **L. cretacea** Whitfield. Cretacic.

Hinge line nearly straight. Surface marked with a deep constriction passing from the beak to the posterior margin. Concentric lines distant and lamellose.

New Jersey (Cliffwood–Red Bank).

FIG. 761. *Lucina occidentalis*, left valve. (After Gilbert.)

536. **L. occidentalis** Morton. (Fig. 761.) Cretacic.

Broadly oval, rounded anteriorly, somewhat truncated posteriorly. Posterior flattening of shell nearly obsolete. Hinge line nearly straight, slightly declining posteriorly. Surface crossed by distinct concentric lines. Large specimens measure — height 1.5 inches ; length slightly more.

Pierre : Colorado and Kansas–Canada. Fox Hills of South Dakota.

537. **L. aquiana** Clark. (Fig. 762, *c*, *d*.) Eocenic.

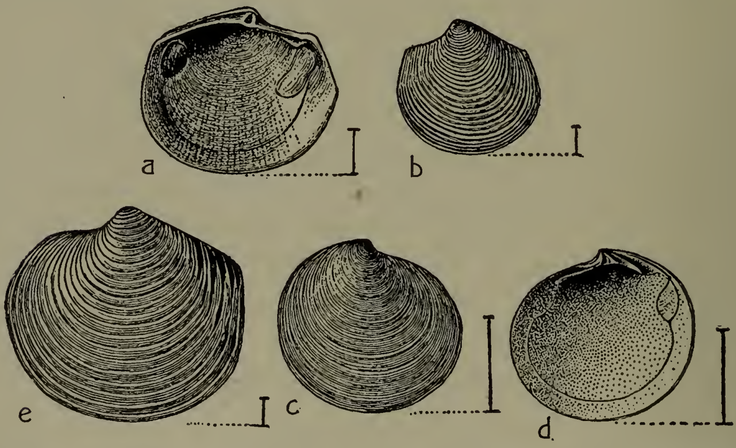


FIG. 762. *a*, *b*, *Lucina curta* (*L. uhleri* Clark), left valve ; *c*, *d*, *L. aquiana*, right valve ; *e*, *L. smithi* (*L. whitei* Clark), left valve. All enlarged. (Md. Surv.)

Nearly circular. Concentric striæ very fine.

Maryland, Virginia.

538. **L. smithi** O. Meyer. (*L. whitei* Clark.) (Fig. 762, *e.*)

Eocenic.

Surface marked with strong concentric lamellæ and posteriorly by a shallow fold extending backward from the umbo. Margin crenulated.

Maryland–Louisiana.

539. **L. curta** Conrad. (*L. uhleri* Clark.) (Fig. 762, *a, b.*)

Eocenic and Oligocenic.

Similar to *L. smithi* in size and shape but differs in the smooth margin and absence of posterior fold.

Chickasawan–Vicksburgian: Maryland and Gulf region.

CLV. Diplodonta Brown.

Thin-shelled, orbicular, convex, concentrically striate or pustulose. Cardinal teeth two in each valve, the left anterior and the right posterior bifid; laterals obscure or absent. Adductor scars continuous peripherally with the pallial line. Tertiary–Recent.

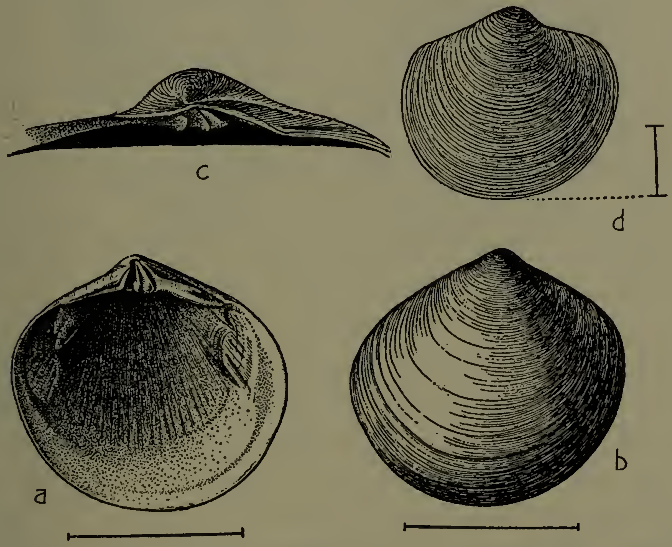


Fig. 763. *a, b, Diplodonta acclinis,* right valve; *c, d, D. hopkinsensis.* (Md. Surv.)

540. **D. hopkinsensis** Clark. (Fig. 763, *c, d.*) Eocenic.

Shell globose. Umbones rather prominent.

Common in the Chickasawan (Lignitic) of Atlantic and Gulf region.

541. **D. acclinis** Conrad. (Fig. 763, *a*, *b*.)

Miocenic and Pliocenic.

More transverse. Growth lines strong.

Characteristic of the Miocenic of New Jersey–North Carolina. Pliocenic: South Carolina and Florida.

CLVI. Tenea Conrad.

Subcircular, thin-shelled, tumid. Left valve with V-shaped cardinal tooth, the anterior lobe of which is continued along the anterior margin of the shell and separated from it by a deep groove. Right valve with two cardinal teeth, the anterior falcate, the posterior curved backwards. No laterals present. Valve margins smooth. Pallial line with a narrow and deep sinus. Cretacic.

542. **T. parilis** Conrad. (Fig. 764.) Cretacic.

Fig. 764. *Tenea parilis*. (N. J. Pal., I.)

Surface nearly smooth, marked only by fine growth lines. At times 1.5 inches in diameter.

Widely distributed through the upper Cretacic of New Jersey, also in North Carolina and Gulf region.

CLVII. Cardium Linné.

Convex, nearly equilateral, rounded-oval. Umbones prominent, incurved, turned slightly forward. Surface marked with radiating, often spiny ribs. Margins of valves crenulated. Two cardinal teeth, one anterior lateral and one posterior in each valve. No lunule nor escutcheon present. Ligament external. Adductor impressions shallow. Triassic–Recent.

543. **C. pauperculum** Meek. (Fig. 765.) Cretacic.

Height slightly exceeding length. Diameter .5 to .75 inch. Specimens are usually flattened or otherwise distorted. When the plications are preserved an angular appearance is given to the posterior umbonal slope by the greater elevation of three or four of the plications there.

Coloradoan : Wyoming, Utah, Colorado, New Mexico.

544. **C. speciosum** Meek and Hayden. Cretacic.

Subcircular, with height slightly exceeding length. Beaks almost central. Surface marked with numerous, very regular, radiating ribs ; in the grooves between these are regularly arranged series of small tubercles. Average diameter slightly over .5 inch.

Montanan : Colorado, Montana.

FIG. 765. *Cardium pauperculum*, right valve enlarged. (After Stanton.)

545. **C. tenuistriatum** (Whitfield). (Figs. 766 ; 767.) Cretacic.

Internal molds strongly gibbous and with abrupt posterior slope.

Ripleyan of New Jersey (Merchantville–Navesink; the most common and widely distributed *Cardium* of the New Jersey Cretacic).

FIG. 766. *Cardium tenuistriatum*. (N. J. Pal., I.)

546. **C. eufaulensis** Conrad. Cretacic.

Height exceeding length; hinge arcuate; shell narrower than preceding with stronger angular costæ (35–40).

Ripleyan of New Jersey (Wenonah)–Mississippi.

547. **C. spillmani** Conrad. Cretacic.

Usually occurs as internal molds which are larger than those of *C. kümmeli*, with more anteriorly curved beaks, and with radiating ribs on posterior portion.

New Jersey (Merchantville and Navesink)–Texas and Oklahoma.

548. **C. kümmeli** Weller. Cretacic.

When found as internal molds it is like the molds of *C. spillmani* in its long and slender form, but it is not usually so large, and lacks the radial ribs which are usually impressed on the posterior slope of those molds.

Ripleyan of New Jersey (Navesink–Tinton), Alabama, Mississippi.

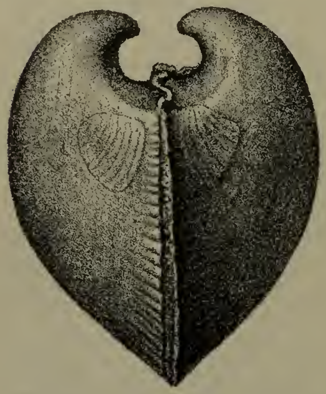


FIG. 767. *Cardium tenuistriatum*, a more robust internal mold. (N. J. Pal., I.)

549. **C. meekianum** Gabb. Pliocenic.

Large (over 2.5 inches in height), oblique, with abruptly truncated posterior end and prominent and rounded anterior. Radiating ribs about 22, absent from the posterior slope, large and flattened on top. Shell crossed by irregular lamellose concentric lines which become tubercles toward the beaks.

Upper and Lower Pliocenic and possibly Miocenic of California.

CLVIII. PROTOCARDIA Beyrich.

Similar to *Cardium* but with radiating ribs only on posterior portion of shell, the remainder covered with concentric ridges. No lunule or escutcheon present. Comanchic–Recent.

550. **P. texana** Conrad. (Fig. 768.) Comanchic.

Small to very large (over three inches long). Posterior fifth of shell covered with about fifteen radiating ribs.

Washita of Colorado, Texas (especially common in the Buda).

FIG. 768. *Protocardia texana*. (After Shattuck).

551. **P. subquadrata** Evans and Shumard. Cretacic.

Small (diameter less than .5 inch), more quadangular than *P. lenis* with posterior margin truncated. Gibbous. Radial ribs of posterior portion somewhat obscure.

Montanan: North Dakota, South Dakota, Wyoming, Assiniboia, Saskatchewan.

552. **P. lenis** Conrad. (Fig. 769.) Eocenic.

FIG. 769. *Protocardia lenis*, right valve. (Md. Surv.)

Posterior margin oblique. Radiating lines about 22.

Pamunkey of Maryland, Virginia, Alabama (Lignitic).

CLIX. ISOCARDIA Lamarck.

Inflated, smooth or concentrically striated. Beaks distant, prominent and much produced and spirally enrolled toward the front. Each valve with two nearly parallel cardinal teeth and one posterior lateral. Jurassic–Recent.

553. **I. cliffwoodensis** Weller. Cretacic.

Ventricose (convexity of valves 6.5 mm.). Beaks small, strongly incurved and directed forward. Anterior umbonal slope abrupt; posterior slope convex. Surface smooth.

Ripleyan of New Jersey (Cliffwood–Wenonah), Texas.

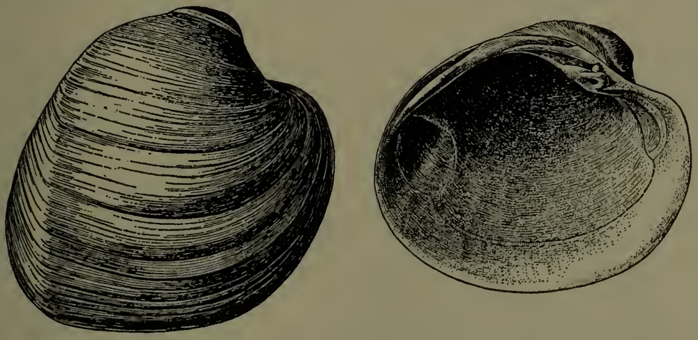


FIG. 770. *Isocardia fraterna*, right and left valves, × ⅔. (Md. Surv.)

554. **I. fraterna** Say. (Fig. 770.) Miocenic.

Surface crossed by rather large concentric wrinkles.

Maryland–North Carolina.

CLX. Cyprimeria Conrad.

Similar to *Venus* but right valve with two cardinal teeth, the posterior bifid; left valve with three cardinals; each valve with a posterior lateral. Pallial sinus very shallow. Resilium usually external, embraced by the ligament. Comanchic–Cretacic.

555. **C. texana** (Roemer). (*Arcopagia texana.*) Comanchic.
Nearly circular, very thin, owing to slight convexity of valves; valves slightly unequal with a somewhat twisted appearance.
Very abundant in the Fredericksburg of Texas.

556. **C. crassa** Meek. Comanchic–Cretacic.
Differs from *C. texana* in its larger size and much greater thickness. Height, 67 mm.; length, 78 mm.; depth, 23 mm.
Fredericksburg and Eagle Ford of Texas. Fredericksburg and Washita of northern Mexico.

557. **C. excavata** (Morton). Cretacic.
Posterior portion of shell obliquely truncate.
Ripleyan of New Jersey (Marshalltown–Navesink), Gulf region.

CLXI. Clementia Gray.

Thin-shelled, inflated. Beaks prominent. Valve margins entire. Surface concentrically sculptured. Anterior left and two posterior right hinge teeth more or less bifid; no lateral teeth present. Pallial sinus long and angular, narrow and ascending. Tertiary–Recent.

558. **C. inoceriformis** (Wagner). (Fig. 771.) Miocenic.
Posterior hinge area marked by an angular ridge, which is wedge-

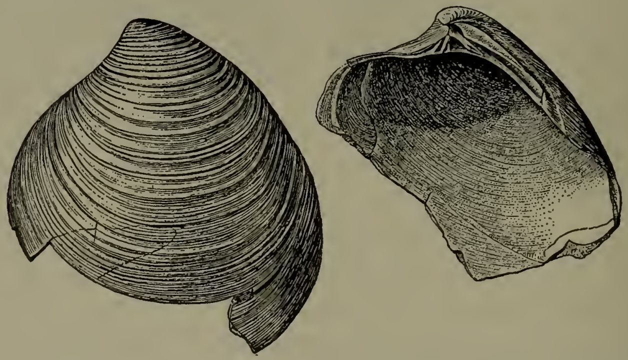


Fig. 771. *Clementia inoceriformis,* left and right valves, × ⅔. (Md. Surv.)

shaped posteriorly and overlaps a groove which runs backward from the beak.

Maryland, Massachusetts?

CLXII. Venus Linné.

Valves equal, inequilateral, oval or rounded, heart-shaped, thick, concentrically or radiately sculptured. Margins crenulate. Hinge plate broad, with three cardinal teeth in each valve and no lateral

Fig. 772. *Venus mercenaria*, right and left valves, × ½. (Md. Surv.)

teeth. Pallial sinus short, angular. The two adductor scars submarginal. Jurassic–Recent.

559. **V. mercenaria** Linné. (Fig. 772.) Miocenic–Recent.

Type of genus.

Atlantic coast region.

CLXIII. Meretrix Lamarck.

Thick, trigonal, smooth or concentrically striated. Lunule well marked. Margin entire. Ligament external. Hinge thick, with three cardinal teeth in each valve, two laterals in the right and one in the left, beneath the lunule; no posterior laterals present. Pallial sinus rather shallow, not acutely angular.

Differs from *Venus* in the possession of lateral teeth, and in lacking the fine crenulations of the valve margin. Jurassic–Recent.

560. **M. tippana** Conrad. (Fig. 773.) Cretacic.

Beaks slightly anterior to center. Length slightly exceeding height. Concentric lines fine and regular.

Ripleyan of New Jersey (Cliffwood–Wenonah), Arkansas, Mississippi, Texas. Also Cretacic of Mexico.

561. **M. eufaulensis** (Conrad). Cretacic.

Nearly rotund. Concentric striæ fine and especially conspicuous and regular for half the distance down from the beak.

Ripleyan of New Jersey (Marshalltown–Navesink), Alabama.

562. **M. veta** (Whitfield). (*Caryatis veta.*) Cretacic.

Length less than 1 inch. Pallial line faint and with a deep and

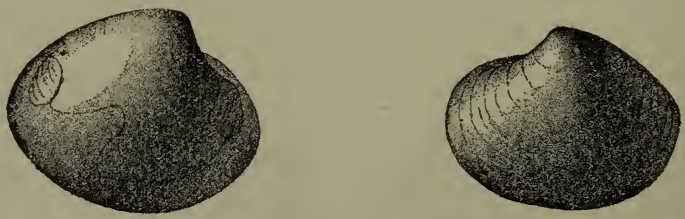


FIG. 773. *Meretrix tippana.* (N. J. Pal., I.)

narrowly rounded sinus. External surface rarely well preserved, marked with fine concentric lines.

Jerseyan of New Jersey (Hornerstown–Manasquan).

563. **M. ripleyana** Gabb. (Fig. 774.)

Cretacic and lower Eocenic.

Shell nearly smooth around the umbo but marked with concentric lines from the middle downwards.

FIG. 774. *Meretrix ripleyana.* (After Harris.)

Eocenic (Midway) of Georgia and Texas. Cretacic (Ripley) of Tennessee.

564. **M. subimpressa** Conrad. (Fig. 775, *d–f.*) Eocenic.

Produced posteriorly so that length considerably exceeds breadth.

Maryland (Nanjemoy), Alabama (Lignitic).

565. **M. uvasana** Conrad. Eocenic.

Over 2 inches long by 1.75 inches high. Beaks nearly anterior. Surface marked with concentric ridges separated by wider spaces which are either plain or striated.

Tejon: California, Oregon.

566*a*. **M. ovata** var. **pyga** Conrad. (Fig. 775, *a, b.*) Eocenic.

Large, thick, ventricose, oval.

Aquia: Maryland.

566*b*. **M. ovata** var. **ovata** (Rogers). (Fig. 775, *c*.) Eocenic.

Smaller, thinner and more elongate than *M. ovata* var. *pyga* and with less rounded basal margin.

Nanjemoy: Maryland.

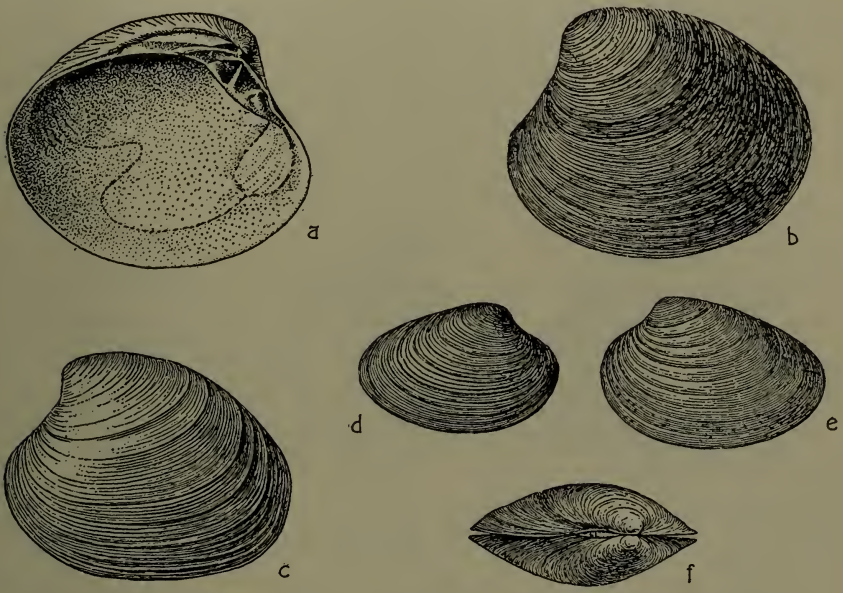


FIG. 775. *a*, *b*, *Meretrix ovata* var. *pyga*, left valve; *c*, *M. ovata* var. *ovata*; *d–f*, *M. subimpressa*. (Md. Surv.)

CLXIV. Dosiniopsis Conrad.

Very similar to *Meretrix* but the pallial sinus is acutely angular and ascending. Beside the anterior lateral teeth there is a single distinct posterior lateral in the right valve with a corresponding socket in the left. Posterior cardinal of right valve broad and deeply channeled above. Shell rotund. Cretacic–Eocenic.

567. **D. deweyi** Meek and Hayden. Cretacic.

Broadly oval, with length slightly exceeding height, rather thin-shelled, moderately convex. Beaks nearly central, somewhat gibbous and incurved to nearly meet each other. Surface marked by fine and regular concentric lines. Diameter slightly less than 1 inch. Pallial sinus narrowly rounded at apex.

Montanan: North Dakota, South Dakota, Montana, Colorado, Wyoming, Assiniboia.

568. **D. owenana** Meek and Hayden. Cretacic.

Like *D. deweyi* in shape, but thick-shelled and larger (diameter about 1.5 inches). Concentric striæ moderately distinct.

Fox Hills: Montana, Colorado.

569. **D. nebrascensis** Meek and Hayden. Cretacic.

Lunule and escutcheon both prominent. Slightly smaller than *D. owenana* but more nearly circular, the height being about seven eighths the length. Pallial sinus narrowly rounded at apex.

Fox Hills: Nebraska–Wyoming, Assiniboia, North Dakota? Pierre: South Dakota.

570. **D. lenticularis** (Rogers). (Fig. 776.) Eocenic.

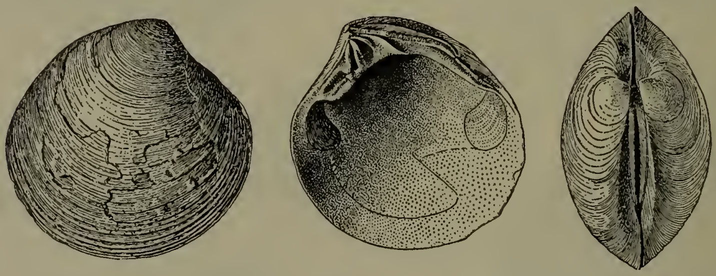


FIG. 776. *Dosiniopsis lenticularis*, right valves and cardinal view, × ⅔. (Md. Surv.)

Shell varying from moderately thin to heavy. Diameter about 2 inches or more. Type of genus.

Aquia: Maryland.

CLXV. Tapes Megerle von Muhlfeld.

More or less elongate-oval, with narrow hinge plate, divergent and often bifid cardinal teeth, no laterals, and a deep pallial sinus. Differs from *Venus* in the absence of lateral teeth; also the inner margins of valves are smooth. Comanchic–Recent.

571. **T. hilgardi** Shumard. Comanchic–Cretacic.

Benton (Eagle Ford) of Texas. Fredericksburg and Washita of Mexico.

CLXVI. Tellina Linné.

Oval, transversely elongate, slightly inequivalve, compressed, rounded anteriorly, angular and gaping posteriorly. Surface marked with an oblique fold extending from the umbo to the lower posterior border. Beaks more or less twisted. Margins of valves smooth. Two cardinal teeth present in each valve and one anterior and one posterior lateral. Laterals often indistinct in left valve. Ligament external, prominent. Pallial sinus very wide and deep, differing slightly in the opposite valves. Jurassic–Recent.

572. **T. equilateralis** Meek and Hayden. Cretacic.

Anterior and posterior sides nearly equal. Posterior end slightly truncated. Umbonal angle about 140°. Posterior slope more convex than anterior and slightly excavated for the reception of the ligament. Umbonal ridge not very distinctly marked. Surface marked with small, irregular concentric wrinkles and obscure growth lines. Length 1.7 inches; height 1 inch.

Montanan: Wyoming, Montana.

573. **T. virginiana** Clark. (Fig. 777, *c*.) Eocenic.

Cardinal teeth small; laterals indistinct. Pallial sinus obscure.

FIG. 777. *Tellina declivis*, left valve; *b*, *d*, *T. williamsi*, right valve; *c*, *T. virginiana*, left valve. (Md. Surv.)

Surface covered with fine concentric growth lines.

Maryland, Virginia.

574. **T. williamsi** Clark. (Fig. 777, *b*, *d*.) Eocenic.

Posterior cardinal tooth bifid. Lateral teeth strongly developed. Surface covered with elevated, close-set concentric ridges or lamellæ.

Aquia and Nanjemoy: Maryland, Virginia.

575. **T. declivis** Conrad. (Fig. 777, *a*.) Miocenic–Pleistocenic.

Posterior end abruptly declining. Lateral teeth distinct.

Miocenic: New Jersey, Maryland, Virginia. Pliocenic and Pleistocenic: Florida.

CLXVII. LINEARIA Conrad.

Differs from *Tellina* in the lengthening of the bifid cardinal teeth, the rounding of the shell posteriorly and anteriorly, the surface partially or wholly radiately ribbed; umbonal ridge obsolete. Cretacic.

576. **L. metastriata** Conrad. (Fig. 778.) Cretacic.

Surface marked with fine concentric and coarser radiating ribs, the latter fainter or obsolete on the central portion of the shell.

Ripleyan of New Jersey (Cliffwood–Red Bank), Gulf region.

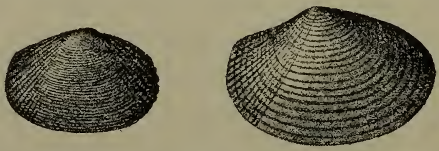


FIG. 778. *Linearia metastriata.* (N. J. Pal., I.)

CLXVIII. ÆNONA Conrad.

Subtriangular, inequilateral. Beaks very small, pointed. Lunule lanceolate, marked by a deeply impressed line. Two very small, widely divergent cardinal teeth in the right valve, one bifid and one rudimentary tooth in the left valve. Cretacic.

FIG. 779. *Ænona eufaulensis.* (N. J. Pal., I.)

577. **A. eufaulensis** Conrad. (Fig. 779.) Cretacic.

Surface smooth and semipolished.

Ripleyan of New Jersey (Woodbury), Alabama, Mississippi, Texas.

CLXIX. SEMELE Schumacher.

Large, rounded, thick. Posterior side slightly folded. Both cardinal and lateral teeth present. Pallial sinus large and rounded. Resilifer elongate. External ligament feeble. Tertiary and Recent.

578. **S. carinata** (Conrad). Oligocenic–Pliocenic.

Concentric lamellæ separated by equal or wider interspaces and crossed by fine concentric and radial striæ.

Uppermost Oligocenic of Florida (possibly as a variety). Miocenic: Maryland–South Carolina. Pliocenic: South Carolina.

579. **S. subovata** (Say). (Fig. 780, *a*.) Miocenic.

More oval, thinner than *S. carinata*, with finer and closer concentric striæ.

Maryland, Virginia, Texas.

CLXX. Cumingia Sowerby.

Small, thin, oval, rounded anteriorly, somewhat wedge-shaped posteriorly. One small cardinal tooth in each valve. Right valve with two strong lateral teeth; left valve with extended dorsal margins to fit in the channels above the laterals of the right valve. These dorsal extensions form a lunule and escutcheon which are thus nearly confined in the left valve. Surface marked with radiating striæ. Concentric lines fine or lamellose. Resilifer spoon-shaped. Pallial sinus deep and wide.

Habit nestling, *i. e.*, though not excavating burrows they occupy those made by true borers. Eocenic–Recent.

Fig. 780. *a*, *Semele subovata*, right valve; *b*, *c*, *Cumingia medialis*, left valve, exterior and interior views. (Md. Survey.)

580. **C. medialis** Conrad. (Fig. 780, *b*, *c*.) Miocenic.

Anterior portion of shell inflated; posterior depressed. Resilifer prominent, projecting.

Maryland (Choptank), Virginia, North Carolina, South Carolina.

CLXXI. Siliqua Megerle von Muhlfeld.

Shell flattened, straight. Hinge line feeble with one right and two left vertical cardinal teeth and in each valve a posterior horizontal tooth. An internal rib runs vertically from the beak. Cretacic–Recent.

581. **S. huerfanensis** Stanton. (Fig. 781.) Cretacic.

Shell thin. Average length 2 inches. Interior rib runs

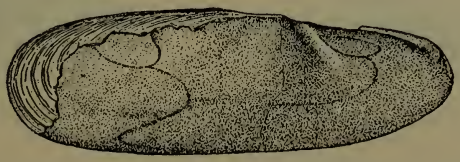


Fig. 781. *Siliqua huerfanensis*, internal mold of right valve retaining portions of shell and showing pallial sinus. (After Stanton.)

obliquely forward just in front of the beak, ending about half way between the dorsal and ventral margins.

Benton: Colorado; probably similar age in Utah.

CLXXII. Leptosolen Conrad.

Thin. Beaks anterior. Epidermis unpolished. A strong internal rib directed vertically extends from beak to basal margin. Pallial sinus very shallow. Hinge with a single cardinal tooth in each valve. Comanchic–Cretacic.

582. **L. conradi** Meek. Comanchic.

Differs from *L. biplicatus* in its smaller size (average length 1 inch; height .35 inch) and in the absence of the two plications.

Upper Comanchic of Kansas and Colorado.

583. **L. biplicatus** Conrad. Cretacic.

Anterior extremity compressed, marked with two obscure plications extending obliquely forward and downward from the beak. Surface covered with inconspicuous growth lines. Average length 1.5 inches; height .5 inch.

Ripleyan of New Jersey (Cliffwood–Red Bank), Gulf region.

CLXXIII. Solyma Conrad.

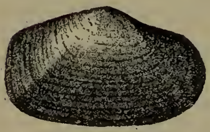


Fig. 782. *Solyma lineolata*. (After Whitfield, Pal. N. J., I.)

Elongate-ovate, thin, equilateral, ventricose. Right valve with two cardinal teeth. Cretacic.

584. **S. lineolata** Conrad. (Figs. 782, 783.) Cretacic.

Posterior margin truncate. Both anterior and posterior umbonal slopes marked by an obscure ridge. Surface of internal molds marked with fine and irregular concentric lines. Type of genus.

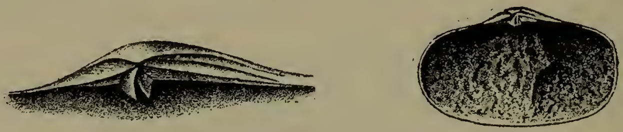


Fig. 783. *Solyma lineolata*, interior of Fig. 782 and enlargement of hinge. (After Whitfield, Pal. N. J., I.)

Ripleyan of New Jersey (Cliffwood–Red Bank), Georgia.

CLXXIV. Legumen Conrad.

Equivalve, very inequilateral. Hinge with two slender teeth in the right valve under the beak, and one posterior, very oblique, and prominently lamelliform lateral tooth. Cretacic.

585. **L. planulatum** (Conrad). (Fig. 794.) Cretacic.

Anterior muscle scar bounded posteriorly by a low ridge which curves forward below. Surface covered with concentric growth lines.

Ripleyan of New Jersey (Merchantville–Red Bank), Gulf region, Montanan of Wyoming.

CLXXV. Mactra Linné.

Nearly equilateral, rounded-triangular. Surface smooth or concentrically sculptured. Margins smooth. Valves equal. Cardinal teeth in right valve two, soldered together dorsally; one cardinal in left valve. Lateral teeth elongate. Hinge plate well developed. Resilifer subtriangular, excavated out of hinge plate and separated from the scar of the external ligament by a thin

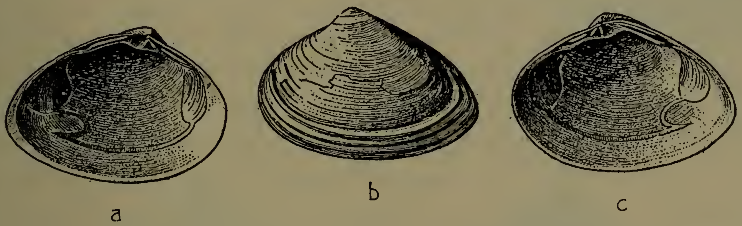


Fig. 784. *Mactra clathrodon*, interior and exterior of left and interior of right valve. (Md. Survey.)

raised plate, just posterior to the beak at the margin of the shell. Tertiary–Recent.

586. **M. clathrodon** Lea. (Fig. 784.) Miocenic.

Shell thin. Lateral teeth crossed by equidistant, minute striæ.

Maryland (St. Marys and Calvert).

CLXXVI. Cymbophora Gabb.

Like *Mactra* but the ligament area and the resilifer are not separated by a plate. Margins of the pit holding ligament and resilium are elevated above the hinge line. Cretacic.

587. **C. ashburneri** Gabb. Cretacic.

Subtrigonal. Average length 1.62 inches; height 1.25 inches. Beaks subcentral. Anterior border slightly concave; posterior straight; basal broadly rounded. Angle between the cardinal margins at umbo 90°. Regularly rounded concentric ribs numerous, few, or absent.

Very abundant in Chico of California and Washington.

FIG. 785. *a*, *Cymbophora utahensis*, right valve; *b*, *c*, *C. emmonsi*, left valve. (After Stanton.)

588. **C.? utahensis** Meek. (Fig. 785, *a*.) Cretacic.

Beaks incurved, with little obliquity. Growth lines fine and obscure.

Coloradoan of Utah.

589. **C. alta** Meek and Hayden. (Fig. 786.) Cretacic.

Thin-shelled. 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 very elevated,

FIG. 786. *Cymbophora alta*, right valves, interior and exterior, × ⅔. (After Meek, Surv. Terr., IX.)

small or pointed, incurved, and very nearly central. Lunule and escutcheon lance-oval, the latter the larger and bounded by a distinctly angular ridge. Surface concentrically striated. Average length 2.6 inches; height 2.2 inches; convexity 1.2 inches.

Montanan: Colorado–Alberta.

590. **C. lintea** (Conrad). Cretacic.

Beaks slightly incurved. Umbonal ridge more or less obscure. Concentric growth lines regular.

Ripleyan of New Jersey (Cliffwood–Tinton), Gulf region.

591. **C. emmonsi** (Meek). (Fig. 785, *b*, *c*.) Cretacic.

Surface marked with fine and obscure concentric growth lines. Pallial sinus short, rounded.

Coloradoan: Kansas, Colorado, Montana ?, Utah.

592. **C. warrenana** Meek and Hayden. Cretacic.

Differs from *C. emmonsi* in its larger size (average length 1.5 inches; height 1 inch), more convex valves, coarser concentric striæ, more gently rounded base and more prominent umbo. Angle between cardinal borders 110°.

Montanan of Colorado–Assiniboia; especially in the Fox Hills.

CLXXVII. Schizodesma Gray.

Very similar to *Cymbophora* but lacking the elevated margins of the "pit." Pallial sinus angular. Ligament scar connected with the upper part of the resilifer. Ligament and resilium only slightly separated by a strong rib which has in one valve developed a small tooth or projection and in the other an obscure socket to receive it. Cretacic–Recent.

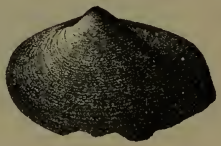


Fig. 787. *Schizodesma appressa.* (N. J. Pal., I.)

593. **S. appressa** Gabb. (Fig. 787.) Cretacic.

Beaks prominent, nearly erect. Surface concentrically striated.

New Jersey (Cliffwood–Wenonah), Georgia, Texas.

CLXXVIII. Corbula Lamarck.

Shell ovate, very inequivalve, closed, rounded in front, contracted behind. Umbones prominent. Right valve convex, the larger with a strong cardinal tooth in front of the resilifer, and also a posterior cardinal tooth. Left valve also with a resilifer and with one posterior cardinal tooth. Pallial line slightly sinuous posteriorly. Triassic–Recent.

594. **C. pyriformis** Meek. (Fig. 788, *a–d*.) Cretacic.

Surface crossed by concentric ridges and furrows most strongly defined on the umbonal region; at times only growth lines present.

Very abundant in Bear River of Wyoming, Idaho and Utah.

595. **C. engelmanni** Meek. (Fig. 788, *e, f.*) Cretacic.

Differs from *C. pyriformis* in its smaller size, different outline, less convexity of valves and less incurving of beaks.

Bear River: Wyoming, Idaho.

596. **C. subtrigonalis** Meek and Hayden. Cretacic.

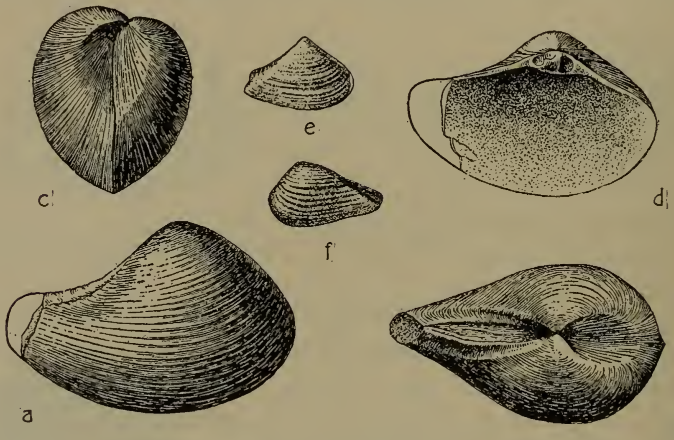


FIG. 788. *a–d, Corbula pyriformis*, right, cardinal, anterior views of complete shell, interior of left valve. *e, f, C. engelmanni.* (After White.)

Outline triangular. Very convex. Average length .75 inch; height .5 inch. Anterior end abruptly rounded; posterior longer and more angular. Umbonal angle about 90°. Beak incurved, gibbous. Posterior umbonal slope subangular. Surface marked with concentric lines and a few growth ridges.

Especially abundant in the Montanan (brackish water beds) of Wyoming, Montana, Assiniboia. Also present in the Coloradoan and Laramie.

597. **C. bisulcata** Conrad. Cretacic.

Beak small, incurved. Surface crossed by fine concentric growth lines.

Ripleyan of New Jersey (Cliffwood–Woodbury), North Carolina, Mississippi, Arkansas.

598. **C. crassiplica** Gabb. Cretacic.

Beaks large, inflated, enrolled, a little anterior of middle. Left valve much the less convex and without the strong concentric ribs of the right valve.

Merchantville–Red Bank of New Jersey; especially characteristic of the Woodbury. Also in Mississippi, Arkansas, Texas.

599. **C. subcompressa** Gabb. (Fig. 789.) Eocenic.

Umbonal ridge angular with slope abrupt.

Midway (basal Eocenic) of Alabama, Tennessee, Arkansas.

FIG. 789. *Corbula subcompressa.* (After Harris.)

600. **C. aldrichi** Meyer. (Fig. 790, *d*, *e*.) Eocenic.

Umbos without concentric lines but marked with radiating striæ.

Maryland, Alabama.

601. **C. oniscus** Conrad. (Fig. 790, *a–c*.) Eocenic.

Solid, with numerous and wrinkled concentric lines.

Maryland, Virginia and the Gulf region.

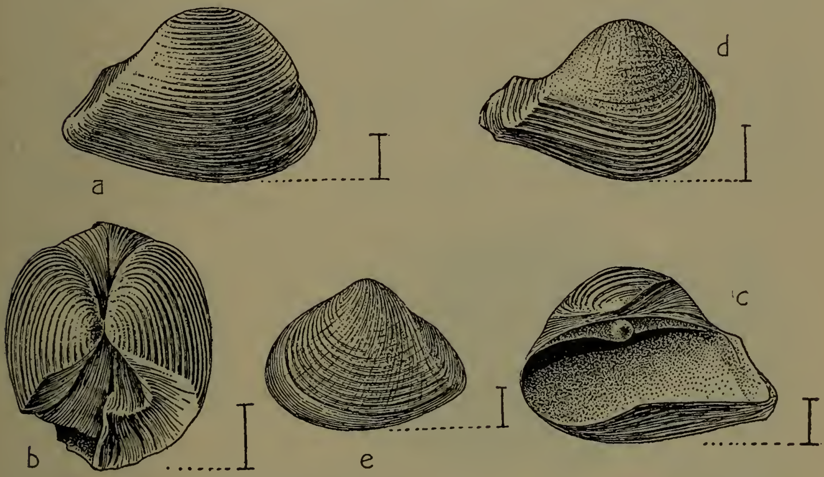


FIG. 790. *a–c*, *Corbula oniscus*, right valve and cardinal view; *d*, *e*, *C. aldrichi*, right and left valves. (Md. Surv.)

CLXXIX. Saxicava Fleuriau.

Small, equivalve, oblong, elongated, gaping and hence not fully covering the animal. Umbones anterior. Ligament external. Teeth absent in adult; consisting of one or two cardinals in the young. No laterals present. Surface rugose. Pallial line sinuated, discontinuous. Bores into soft rocks. Tertiary–Recent.

602. **S. arctica** (Linné). (*C. rugosa.*) (Fig. 791.) Miocenic–Recent.

Surface marked with two ridges extending backward from the beak to the margin.

Miocenic: New Jersey, Maryland, North Carolina, Alaska. Pliocenic: Florida, California. Pleistocenic: northern America. Recent: Almost universal in temperate and cooler seas.

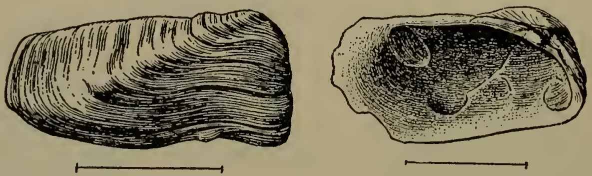


FIG. 791. *Saxicava arctica*, right and left valves. (Md. Surv.)

CLXXX. PANOPEA Menard.

Large, thick, equivalve, inequilateral, oblong, gaping widely behind and slightly in front, thus not fully covering the soft parts of the animal. Shell concentrically striate. Margins smooth. Ligament external on a prominent ridge. An obscure cardinal tooth in each valve. Pallial sinus very deep. Epidermis conspicuous. Cretacic–Recent.

603. **P. elongata** Conrad. (Fig. 792.) Lower Eocenic.

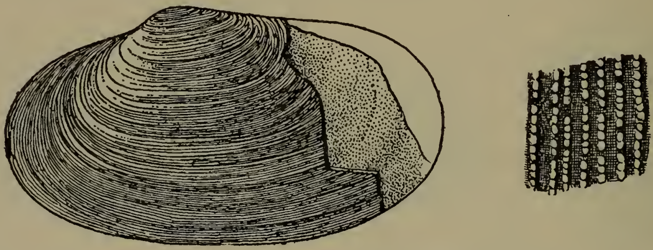


FIG. 792. *Panopea elongata*, left valve and enlargement of surface. (Md. Surv.)

Concentric striæ crossed by close radiating lines of small granules which, when worn, give the surface a "honey-combed appearance."

Aquia: Maryland, Virginia.

604. **P. decisa** Conrad. Upper Cretacic.

Surface marked with strong concentric undulations.

Ripleyan of New Jersey (Merchantville–Red Bank), Gulf region.

CLXXXI. Turnus Gabb.

Thin gaping, furrowed from beak to base by an umbonal groove which appears as a ridge on the interior of the shell. Posterior to this is another internal ridge, passing likewise from beak to base but not evident on the surface. The anterobasal portion of the shell obliquely or angularly truncate, the growth lines curving up around this truncation. Burrows in wood and secretes a shelly tube. Cretacic.

605. **T. kümmeli** Weller. Cretacic.

Tubes exceedingly contorted; maximum diameter about .35 inch. In anterior view the shell is cordate in outline. Beaks in front of middle of shell, pointed and stongly incurved. Umbones very prominent. Anterior basal truncation rectangular.

Ripleyan of New Jersey (Marshalltown–Merchantville), Texas.

CLXXXII. Teredo Linné.

Shell much reduced, equivalve, more or less globular, gaping at both ends. Valves trilobed, with concentric striæ. In interior beneath the umbones is a long, narrow plate for the insertion of the pedal muscles; adductor scars unequal. Pallial line coincident with the valve margins. Posterior portion of animal (elongated siphon) covered by a long calcareous tube, which is cylindrical, straight or curved. The animal bores into wood, the valves occupying the bottom of the burrow and connecting with the exterior by the calcareous tube; the external opening is protected by small accessory simple spatulate valves. Jurassic–Recent.

Fig. 793. *Teredo irregularis*. (After Whitfield.)

606. **T. irregularis** Gabb. (Fig. 793.) Cretacic.

Tubes exceedingly contorted. Shell subglobose, heart-shaped in outline from in front, widely gaping behind, open in front. Beaks a little anterior of middle, prominent, much elevated above the hinge line and strongly incurved. Tubes vary in diameter.

Ripleyan of New Jersey (Magothy and Merchantville), Arkansas.

CLXXXIII. Polorthus Gabb.

Teredo-like, calcareous tubes, with habit of boring into sand of sea bottom instead of wood. Tubes with transverse septa of two kinds. Bivalve shell of any kind unknown. Cretacic.

607. **P. tibialis** (Morton). Cretacic.

Septa convex towards the smaller end of tube, perforated centrally by an elliptical slit. Just below the terminal series of septa is an annular muscle scar. Towards the larger extremity of the tubes there are one to three transverse septa convex toward the larger extremity of the tube.

Jerseyan of New Jersey (Vincentown).

Class **Scaphopoda** Bronn.

The scaphopods are marine mollusks whose bilaterally symmetrical body is protected by a tubular shell, which is generally somewhat curved and open at both ends. The smaller opening permits the expulsion of waste and genital products, while the larger one is the anterior or mouth opening. The concave side of the shell is the dorsal side, and the additions to the shell are made at the larger end. The smaller end suffers by wear and resorption, and in some genera becomes notched or slit. The shell consists of three distinct layers.

The modern species inhabit mostly deeper waters where they are partly embedded in the mud or sand. Their known range is from 2 to over 2,400 fathoms. The fossil species described probably lived in moderate depths.

Literature: Papers on the marine Tertiaries elsewhere cited.

Family *DENTALIIDÆ* Gray.

I. Dentalium Linnæus.

Shell tusk-like, tubular, curved and regularly tapering, with circular cross-section and open ends; surface with strong longitudinal ribs (*sens. strict.*) or with longitudinal striæ or smooth; apex entire or with notch or slit of greater or less length. Ordovicic ?–Recent.

1. **D. (Lævidentalium) martini** Whitfield. (Fig. 794.) Devonic.

Smooth, rather rapidly expanding, moderately curved; section circular, growth lines arching forward on concave side.

Columbus limestone of Ohio.

2. **D. (Lævidentalium) pauperculum** M. & H. (Fig. 795, *a*.) Cretacic.

Minute, smooth, gently curved, gradually tapering, section circular, shell thick, lines of growth oblique.

Pierre and Fox Hills of upper Missouri river region.

3. **D. gracile** Hall and Meek. (Fig. 795, *b–d*.) Cretacic.

Very gently tapering and slightly curved, section nearly or quite circular; apical end smooth; fine round longitudinal lines

FIG. 794. *Dentalium martini.* (After Whitfield.)

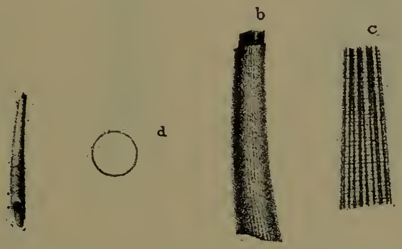


FIG. 795. *a*, *Dentalium pauperculum*, natural size; *b–d*, *Dentalium gracile*; *b*, part of shell; *c*, enlargement of surface; *d*, section of large end. (After Meek.)

FIG. 796. *Dentalium stramineum.* (After Gabb.)

over most of shell, increased by intercalation and becoming obsolete toward larger end.

Pierre formation of Dakota and the Yellowstone river region.

4. **D. stramineum** Gabb. (Fig. 796.) Cretacic.

Rather rapidly tapering, slightly curved, and with numerous longitudinal lines or ridges.

Upper Cretacic of California.

5. **D. (Antalis) cooperi** Gabb. (Fig. 797.) Cretacic.

Very gently curved, moderately tapering, surface with numerous fine parallel striæ separated by depressed lines.

Upper Cretacic of California and Sucia Island.

6. **D. subarcuatum** Conrad. Cretacic.

Slender, very gently arcuate, tapering in 47 mm. from 5 mm.

to 2 mm. Internal molds smooth or with faint lines, and with rounded ridge on cancave side; shell surface with about 12 angular longitudinal costæ and fine annular striæ.

Ripleyan of New Jersey and Alabama.

7. **D. nanaimoense** Meek. Cretacic.

Distinguished from *D. gracile* by its thinner shell and more slender form, and less distinct lines of growth.

Nanaimo of Vancouver and Sucia Islands.

8. **D. (Graptacme) mediaviense** Harris. (Fig. 798.) Eocenic.

Rapidly tapering, curved near small end, smooth near large

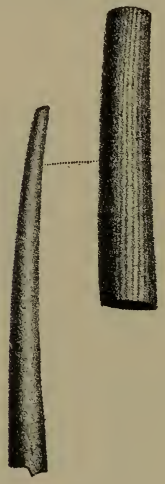


FIG. 797. *Dentalium cooperi*, with enlargement. (After Gabb.)

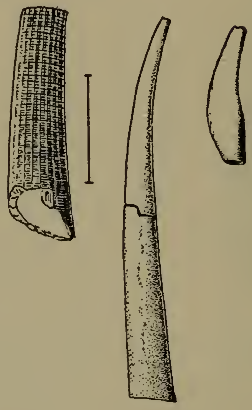


FIG. 798. *a*, *b*, *Dentalium mediaviense; c*, *Cadulus turgidus* (see right). (After Harris.)

end; elsewhere striated with fine sharp alternating longitudinal striæ; faint concentric annulations occur; shell thick except near larger end. Maximum diameter $\frac{1}{3}$ inch.

Midwayan of Alabama and Mississippi.

9. **D. (Graptacme) minutistriatum** Gabb. Eocenic.

Smaller, and less rapidly tapering than preceding; curvature gentle, with minute, regular, non-alternating striæ.

Claibornian of Texas — Nanjemoy of Maryland.

10. **D. thalloides** Conrad. (Fig. 799.) Eocenic.

Curved most strongly near small end, rapidly tapering; costæ strong, alternating, or of three sizes.

Claibornian of Alabama, Louisiana and Mississippi. Abundant.

11. **D. attenuatum** Say. (Fig. 800, *a.*) Miocenic.

Arcuate and rapidly tapering; surface with 12 to 16 rounded

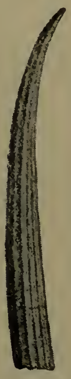


FIG. 799. *Dentalium thalloides.* (After Conrad.)

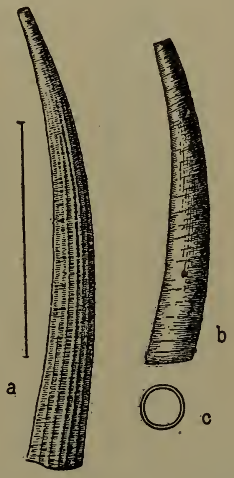


FIG. 800. *a, Dentalium attenuatum; b, c, D. caduloide.* (Md. Surv.)

ridges separated by broader interspaces, and obsolete towards narrow end.

Chesapeakean of Maryland.

12. **D. (Laevidentalium) caduloide** Dall. (Fig. 800, *b, c.*) Miocenic.

Smooth, regularly tapering and more gently curved than the preceding. Section circular.

Chesapeakean of Maryland.

Family *SIPHONODENTALIIDÆ* Simroth.

II. CADULUS Phil.

Differs from *Dentalium* in being swollen near the middle and tapering toward each end. Cretacic–Recent.

13. **C. turgidus** Meyer. (Fig. 798, *c.*) Eocenic.

Rapidly increasing for about two thirds of length and then more rapidly decreasing. Section circular.

Midwayan of Alabama.

14. **C. abruptus** M. & A. (Fig. 801, *a.*) Eocenic.

Rather large, somewhat depressed, inflation less pronounced than in preceding species and nearer to larger end, suddenly decreasing.

Chickasawan of Alabama, Nanjemoy and Aquia of Maryland, etc.

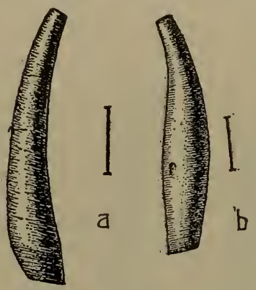


FIG. 801. *a, Cadulus abruptus; b, C. thallus.* (Both after Md. Surv.)

15. **C. thallus** (Conrad). (Fig. 801, *b*.) Miocenic.

Slightly curved, smooth and polished, swelling greatest below middle, regularly tapering in both directions, then more rapidly to small end.

Chesapeakean of Maryland, Virginia, later Miocenic of North and South Carolina and Alum Bluff, Florida.

Class **Gastropoda** (Snails).

The gastropods or snails are marine, fresh-water or terrestrial mollusks, with a well-developed head which usually bears tentacles, eyes, ears and a mouth furnished with a file-like lingual ribbon or radula. Ventrally the animal is provided with a muscular "foot" which is generally a broad expansion and sometimes very large but may be variously modified. The visceral organs are generally protected by a calcareous (rarely horny) shell secreted by a mantle. The shell may be conical or saucer-shaped, but is generally coiled into a spiral, either right-handed or left-handed, the former being the more common type. In all cases the shell may be considered a gradually widening cone, which is generally coiled around an imaginary axis which is often hollow.

The shell begins with the minute embryonic whorls of the *protoconch*, which in many types is quite distinct from the rest of the shell. From this portion, which forms the apex of the *spire*, the coils or *whorls* of the shell gradually increase in size. Normally the whorls are circular or elliptical in section, but from compression and other causes a variety of forms results. The spire may be high or low, broad or slender according to the mode of enrollment, the *apical angle* varying accordingly. The whorls may rest loosely upon one another or embrace to a greater or less extent up to the middle or *ambitus*, or even beyond, so that the earlier whorls may be largely or wholly covered by the later ones. When an angulation occurs, the space between it and the suture above it constitutes the *shoulder*. The shoulder angle may be simple or keeled, or furnished with nodes or spines.

The primitive ornamentation of the shell consists of revolving ridges or *spirals*, and of transverse folds or *ribs*. *Primary spirals* appear in regular succession on either side of the first primary, which generally becomes the shoulder angle if angulation occurs. *Secondary spirals* appear by intercalation between the primary ones, and generally are absent in the young shell, except in some highly accelerated types. *Tertiary spirals* are intercalated between the preceding groups in more specialized species. Ribs are regular transverse foldings of the shell generally extending from suture to suture. They are usually spaced uniformly and crossed by the spirals. In specialized types when a shoulder angle is formed, they become concentrated as *nodes* upon this angle, disappearing from the shoulder above and the body below. Spines may replace the nodes in later stages. They form as notches in the margin of the shell and are subsequently abandoned, often remaining open in front. Irregular spines may also arise on various parts of the surface of the shell (see *Platyceras*). When a row of spines is formed at the edge or *outer lip* of the shell — this sometimes remains behind as a *varix* (*Murex*). Varices may also be formed by simple expansion of the outer lip, and a subsequent resumption of growth from the base of the expansion. These simple varices may project from the shell (*Scala*) or be reflected backwards (*Harpa*). Periodic enlargements of ribs (*Murex*, *Cerithium*) are not to be classed as varices.

The aperture or *peristome* of the shell may be simple or variously modified. An outer and an inner (columellar) *lip* are generally recognized. These may be continuous with each other, or may be divided below by an *anterior notch*. This, in some types (*Fusus*, etc.) is drawn out into an *anterior canal*, of greater or less length. An upper or *posterior notch* is present in certain (chiefly old age) types, and this may result in the formation of a ridge or shelf next to the suture (*Clavilithes*). An outer (lateral) emargination or notch, sometimes prolonged into a *slit* occurs in certain types (Pleurotomidæ, Pleurotomaridæ, Bellerophontidæ, etc.), and the progressive closing of this slit may give rise to a definitely marked *slit band*. In some cases the slit is abandoned and left as a hole

(*Fissuridea*), or by periodic renewal as a succession of holes (*Trematonotus*). The outer emargination is often only indicated by the reflected course of the *lines of growth* on the shell. On the inside of the outer lip various ridges or plications called *liræ* are sometimes found, and these occasionally may be strong and tooth-like (*Nerinea*). Similar ridges or *columellar plicæ* or *folds* are more often found on the inner lip, next to the *columella* or central spiral twist. These may be oblique or normal to the axis of coiling (horizontal), few or numerous, readily seen, or far within the shell so as to be invisible except in broken shells. When the axis of coiling is hollow (*perforate spire*) the opening at the base constitutes the *umbilicus*. This varies greatly in size, and may be wholly or in part covered by an expansion or *callus* of the inner lip (*Natica*).*

Most modern shells are covered by a horny smooth or hairy epidermis or periostracum, which hides the (often brilliant) color markings of the surface. This, as well as the coloration, is rarely preserved in fossil shells.

The apertural end of the gastropod shell is the *anterior* end, the apex of the spire the *posterior*. Most authors figure the shells with the apex of the spire uppermost. French authors generally figure them with the anterior end uppermost. The aperture is often closed by a horny or calcareous *operculum*, of very variable form in the different groups. It is secreted by and attached to the foot of the animal.

Literature.

A. Palæozoic Species.

1847–1879. **Hall, James.** Palæontology of New York. Vols. I., II. and III. and Vol. V., Pt. II.

1861. **Billings, E.** Palæozoic Fossils. Vols. I. and II.

1908. **Raymond, P. E.** The Gastropods of the Chazy Formation. Annals of the Carnegie Museum, Vol. IV., nos. 3 and 4.

1908. **Ulrich, E. O., and Scofield.** The Lower Silurian Gastropoda of Minnesota. Minn. Geol. Surv. Palæontology, Pt. II. (This is in many respects the most important work on American Palæozoic Gastropods.)

For descriptions of American Palæozoic species, see further: The

* For further discussion of these characters see A. W. Grabau, "Studies of Gastropoda, I. and III." (*Am. Nat.*, XXXVI., No. 432, and XLI., No. 490.)

publications of the Canadian Survey, especially "Contributions to Canadian Palæontology" and "Canadian Organic Remains"; various recent publications of the New York State Survey, especially memoirs 5, 6 and 9; Vol. 3 of the Palæontology of New Jersey; the two volumes on the Palæontology of Ohio; and Vol. VII. of the Geology; the Palæontological volumes of the Illinois Survey; the early volumes of the Iowa Survey; certain volumes of the Indiana Survey (especially the 28th); Kentucky Fossil Shells by Nettelroth, 1889; certain publications of the United States Geological Survey (especially Monograph 8); Vol. 10 of the Powell and Vol. 4 of the Wheeler (100th meridian) surveys; and professional papers nos. 16, 58, and numerous papers in periodicals by Beede, Billings, Girty, Hall, Meek and Worthen, Salter, Ulrich, Whiteaves, Whitfield and others.

B. Mesozoic Species.

1886. **Whitfield, R. P.** Gastropoda and Cephalopoda of the Raritan Clays and Green Sands of New Jersey. Pal. N. J., Vol. 1, and Monograph U. S. Geol. Survey, Vol. 9.

Also the following publications: Canadian Geological Survey, Mesozoic Fossils, and Contribution to Canadian Palæontology; New Jersey Geol. Surv. Palæontology, Vol. IV.; Palæontology of California, Vols. 1 and 2; Geology and Palæontology of the Black Hills, and the publications of the several United States Geological and Geographical Surveys, especially the Wheeler Survey of the 100th meridian, Vol. 4, 1877; the Hayden Surveys of the Territory, Vol 9; 3d annual report of the U. S. Geol. Survey under Powell; Bulletins 106, 133; the Boletin de Instituto Geologico de Mexico, especially No. 24, and various papers by Conrad, Cragin, Gabb, Hill, Roemer, Stanton, White and Whitfield.

C. Cenozoic Species.

1832–38. **Conrad.** Fossil Shells of the Tertiary Formation and Fossil Shells of the Medial Tertiary.

1833. **Lea.** Contributions to Geology.

1890. **Gregorio, A. de.** Monographie Eóc. Alabama. Annales de Geologie et de Paléontologie de Gregorio.

1893. **Cossmann, M.** Notes Complémentaires sur la Faune Eocénique de l'Alabama. Ann. de Geol. & de Pal. — Gregorio. No. 12.

1895–1899. **Harris, G. D.** The Midway Stage and the Lignitic Stage, Pt. II. Bull. Amer. Pal., Vols. I. and III.

1890–1892. **Dall, W. H.** Tertiary Fauna of Florida. Pts. I. and II. Transactions of the Wagner Free Institute of Science, Vol, 3, 1890–92.

1900–1906. **Clark, W. B., and Martin, W. G.** Eocene, Miocene and Pliocene Gastropods of Maryland in Geological Survey of Maryland.

1857. **Toumey, M., and Holmes, F. S.** Pliocene Fossils of South Carolina.

1860. **Holmes. F. S.** Post-Pliocene Fossils of South Carolina.

1903. **Arnold, Ralph.** Illustrations of Tertiary Gastropods, etc., of California, in Bulletins U. S. Geological Survey, Nos. 321, 322; and Palæontology and Stratigraphy of the Marine Pliocene and Pleistocene of San Pedro, Cal. Memoirs Cal. Acad. Sci., Vol. III., 1903.

Also the Palæontological volumes of the California Survey, the Surveys of Texas, Alabama and Georgia.

Besides the above, see papers by Aldrich, Arnold, Conrad, Dall, Emmons, Gabb, Harris, Heilprin, Johnson, Lea, Maury, Meyer and others.

Artificial Key to the Genera.

A. Shell patelliform or conical, often curved, but not coiled, or with only a minute. spiral protoconch which is not generally preserved.....I.

I. Shell with a slit or perforation..... 1.

1. Slit marginal.....XCVIII. *Emarginula.*

1. Without slit, but with apical perforation.....XCIX. *Fissuridea.*

I. Without slit or perforation.....2.

2. Aperture ovoid, narrower at one end, sometimes but slightly so..... *.

*. Beak nearest to, and curved toward, narrow end.....a.

a. Surface with growth lines only or with coarse plications. I. *Triblidium.*

a. Surface with fine radiating striæ.....II. *Helcionopsis.*

*. Beak curved to broad end.....b.

b. High and conical; muscle scars in disconnected pairs. III. *Hipseloconus.*

b. Rather low, patelliform; muscle scars a continuous band; aperture sometimes almost oval.....IV. *Archinacella.*

2. Aperture circular or oval, form symmetrical.....**.

**. Surface sculpture of concentric wrinkles, radiating striæ when present very fine.....c.

c. Apex subcentral, wrinkles uniform, continuous around shell. V. *Palæacmæa.*

c. Apex submarginal, wrinkles strongest away from beak. VI. *Helcionella.*

**. Surface sculpture radial or absent.....d.

d. Apex perforated.....XCIX. *Fissuridea.*

d. Apex not perforated.....11.

11. Surface plicate at least in lower part.....aa.

aa. Apex with minute coiled protoconch.....†.

†. Cup-shaped platform on the interior. CX. *Crucibulum.*

†. Without interior platform............CVII. *Capulus.*
aa. Apex pointed..††.
††. Apex straight..................LXXVII. *Igoceras.*
††. Apex curved but not enrolled.
LXXVI. *Orthonychia.*
11. Surface striate or faintly plicate, rarely smooth...........bb.
bb. Beak not incurved............................. ....†††.
†††. Beak subcentral, muscle scars forming a circle at about mid-height.................VII. *Scenella.*
†††. Beak excentric, striæ fine or absent, muscle scars horseshoe-shaped, open in front.
VIII. *Lepetopsis.*
bb. Beaks strongly incurved.................CVII. *Capulus.*
**. Surface smooth or with few coarse and faint plicæ.....................e.
e. Horseshoe-shaped muscle scar open in front.....................22.
22. Beak scarcely incurved......................VIII. *Lepetopsis.*
22. Beak strongly incurved but scarcely enrolled, surface often striate................. ....CVII. *Capulus.*
e. Horseshoe-shaped scar open behind...........CCVII. *Anisomyon.*
e. Muscle scar faint or absent, dorsum often carinate.
LXXV. *Palæocapulus.*
2. Aperture circular or oval, form unsymmetrical..............................***.
***. Low, patelliform, surface often with oblique angulation and posterior truncation........... ....CCVI. *Hercynella.*
***. High, curved, surface smooth or coarsely plicate.
LXXVI. *Orthonychia.*
2. Aperture partly closed...4*.
4*. Closure by a thin platform, beak marginal, curved laterally.
CIX. *Crepidula.*
4*. Closure by the thick, flattened lower portion of the body whorl.
XCVII. *Velatella.*
B. Shell nautiliform, coiled in a single plane throughout, or apparently so...........II.
II. All whorls in same plane, with median notch or reëntrant in outer lip (Bellerophontid)... ....4.
4. Shell with rounded dorsum, often modified by elevated or sunken fold bearing the slit-band...5*.
5*. With large open umbilicus...f.
f. Aperture abruptly expanding, trumpet-like, volutions scarcely embracing.......... ....33.
33. With a long narrow dorsal slit, closed at aperture.
XV. *Salpingostoma.*
33. With slit replaced by a series of elongate openings.
XVI. *Trematonotus.*
f. Aperture not expanded into trumpet mouth.........................44.
44. Lip with sinus but no slit band................................cc.
cc. Dorso-ventrally compressed whorls, sinus shallow and broad..X. *Owenella.*
cc. Rounded whorls, umbilicus mostly small, sinus deep.
XI. *Protowarthia.*
44. Lip with well-marked slit and slit-band......................dd.
dd. Surface with oblique revolving lines...XIV. *Bucania.*

dd. Surface smooth........................XIX. *Bellerophon.*
5*. Umbilicus minute or absent ....g.
g. Aperture abruptly expanding...55.
55. Lip sinuate, no slit-band.......................XXII. *Ptomatis.*
55. With narrow strong slit-band.......XXIII. *Phragmostoma.*
g. Aperture not abruptly, but regularly expanding ....66.
66. Aperture with central emargination and slit-band, often on median keel..ee.
ee. Inner lip expanded as a flat septum.
XXIV. *Carinaropsis.*
ee. Inner lip callous, but not expanded into septum.....4†.
4†. Surface with growth lines only; umbilicus small or absent.......................XIX. *Bellerophon.*
4†. Surface with revolving as well as growth lines....1″.
1″. Revolving striæ uniform over entire shell.
XXI. *Bucanopsis.*
1″. Striæ in form of parallel ridges on inner lip and over part of preceding volution.
XX. *Euphemus.*
66. Aperture without slit-band, but deeply bilobed; surface finely spiraled (or smooth), umbilicus mostly small.
XI. *Protowarthia.*
4. Shell with rounded dorsum, modified by revolving keels or folds or by nodes...6*.
6*. With revolving folds only..h.
h. With median fold, bearing short slit, and one or more lateral folds on each side.......................XIII. *Tetranota.*
h. Dorsum deeply trilobed; aperture sinuate......XII. *Bucaniella.*
6*. With nodes or transverse ribs..i.
i. Umbilicus large..XXV. *Porcellia.*
i. Umbilicus small or absent.........................XIX. *Bellerophon.*
4. Shell with sharp dorsal keel, strongly compressed laterally ....7*.
7*. Whorls more or less triangular..j.
j. Sides angular, generally with ribs, slit short or absent.
IX. *Cyrtolites.*
j. Sides rounded, strong lamellose growth-lines; slit long.
XVIII. *Phragmolites.*
7*. Sides flatly rounded, shell disciform, strongly compressed keel sharp..XVII. *Oxydiscus.*
II. Inner whorls forming low spiral, outer whorl in same plane.....................5.
5. With median notch and slit-band; shell marked by nodes or ribs.
XXV. *Porcellia.*
5. Without median notch or slit, surface smooth............CCXIV. *Planorbis.*
II. All whorls very nearly in same plane..6.
6. Rapidly enlarging; shell minute.......................CCXX. *Pelagiella.*
6. Gradually enlarging.......................................CCXIV. *Planorbis.*
C. Shells naticoid or varying from flat to oval, with round whorls showing rarely a faint angulation and forming a moderate sometimes flat spiral. Final (sometimes all) whorls may be loose-coiled..................................III.
III. Surface without ribs or spirals, but growth-lines may be prominent...........7.
7. Shell umbilicated...8*

8*. Whorls round, resting one against the other without impression; last part often loose-coiled..........k.
k. Small, umbilicus moderate..........XLIX. *Straparollina.*
k. Turbinate to discoid, umbilicus large..........L. *Straparollus.*
k. Minute, umbilicus minute..........LXVII. *Cyclora.*
k. Minute, turbinate or discoidal umbilicus moderate (fresh-water type)..........CCXIV. *Planorbis.*
8*. Whorls rounded, not in contact with each other..........l.
l. Without notch or keel..........LI. *Phanerotinus.*
l. Notch or keel faintly developed..........LIX. *Eccyliomphalus.*
8*. Whorls round except for impressed zone at the point of contact. m.
m. Spire sunken into a flat surface or below it..........77.
77. Whorls flattened dorso-ventrally, umbilical margin notched. CVI. *Solarium.*
77. Whorls not flattened, somewhat angular..........ff.
ff. Many whorled, smooth..........CCXIV. *Planorbis.*
ff. Few-whorled with lamellose growth lines. CCXIII. *Vorticifex.*
m. Spire not sunken..........88.
88. Spire low, umbilicus large..........gg.
gg. Whorls rapidly enlarging, umbilicus open or covered by callus..........XCIII. *Teinostomata.*
gg. Whorls numerous, slowly enlarging, umbilicus open only in internal mold..........LXVI. *Pycnomphalus.*
88. Spire moderately high..........hh.
hh. Whorls strongly embracing; umbilicus large, often covered..........5†.
5†. Lip interrupted at the body-whorl; umbilicus large and deep..........CCXVIII. *Archæozonites.*
5†. Lip continuous, not interrupted at the body whorl. 2″.
2″. Umbilicus large and round..........a″.
a″. Whorls few, round, rapidly enlarging, umbilicus often covered by callus. CXIII. *Natica.*
a″. Whorls less rapidly enlarging, with a depressed sutural band, and generally an angulation around the umbilicus. CXIV. *Gyrodes.*
2″. Umbilicus small, whorls scarcely impressed. b″.
b″. Small, smooth..........CXVIII. *Valvata.* LXVII. *Cyclora.*
b″. Large, with strong growth lamellæ. LXXI. *Holopea.*
hh. Whorls moderately embracing or barely in contact or even free. Internal molds of many naticoid shells which may be non-umbilicate when perfect or may be strongly embracing, or may have spirals or even ribs.
7. Shell without umbilicus..........9*.

9*. Whorls few, rapidly enlarging..n.
n. More or less globular except when uncoiling....................99.
99. Inner lip thickened by callus..................................ii.
ii. Inner lip flattened, callus smooth or transversely striate; aperture oval......................LXVIII. *Naticopsis.*
ii. Inner lip not flattened, callus smooth, aperture semicircular to oval..........................CXIII. *Natica.*
ii. Callus with straight, commonly denticulate border. XCVI. *Nerita.*
99. Inner lip not thickened by callus.............................jj.
jj. Lower lip twisted and grooved, aperture round. LXXII. *Strophostylus.*
jj. Inner lip with columellar fold, aperture elongate. LXXXIX. *Sphærodoma.*
n. More or less conical, with base flat, and last whorl extended so as to form flat periphery.......................CVIII. *Calyptræa.*
n. Elongate, body whorl extended ....ooo.
ooo. Coiling dextral or right-handed..............................kk.
kk. Shell thin, body whorl moderate......CCXI. *Limnæa.*
kk. Shell thick, body whorl very large. CXCIX. *Actæonia.*
ooo. Coiling left-handed or sinistral............. CCXII. *Physa.*
9*. Whorls regularly and gradually enlarging...................................o.
o. Spire low, columella not plicate...111.
111. Close-coiled..ll.
ll. Large...6†.
6†. Whorls few, aperture circular. LXXIII. *Diaphorostoma.*
6†. Whorls many, aperture with umbilical extension. LXVI. *Pycnomphalus.*
ll. Medium sized, aperture interrupted at body whorl; outer lip frequently with varix.......CCXIX. *Helix.*
ll. Minute...7†.
7†. Vertically compressed.........LXV. *Anomphalus.*
7†. Last whorl ventricose ......LXVA. *Protospiralis.*
111. Last portion not coiled; aperture circular or variable. LXXIV. *Platyceras.*
o. Spire low, columella with plications.................................222.
222. Shell broadest in upper part, often with distinct shoulder angle...mm.
mm. Surface smooth ....CCVIII. *Melampus.*
mm. Surface with wrinkles or faint ribs in upper part. CCIX. *Rhytophorus.*
222. Shell broadest in middle or below, no shoulder. CCX. *Alexia.*
o. Spire moderately high................ ....333.
333. Aperture circular or subcircular..............................nn.
nn. Aperture generally more than half the height of shell. LXXI. *Holopea.*
nn. Aperture generally less than half the height of shell. 8†.

8†. Inner lip thickened, shell thick.
CXX. *Campeloma.*
8†. Inner lip not thickened, shell moderate.
CXIX. *Viviparous.*
333. Aperture elongate..oo.
oo. Generally with distinct sutural shelf and smooth columella...............................CXV. *Amauropsis.*
oo. Without sutural shelf and with columellar fold.
LXXXIX. *Sphærodoma.*
III. Surface with transverse striæ or ribs; or with spirals or with both...........8.
8. Shell umbilicated, umbilicus covered by callus of inner lip..............10*.
10*. Spirals or revolving plications most prominent, but not producing distinct shoulder angle..p.
p. Spirals or plications not uniformly distributed, shell partly non-coiling.................... ....LXXIV. *Platyceras.*
p. Spirals more or less uniform, shell mostly or wholly coiled throughout..444.
444. Whorls and aperture round, generally only touching without embracing...pp.
pp. Spirals much stronger than transverse sculpture.
LXII. *Poleumita.*
pp. Spiral sculpture not strong...........XCII. *Margarita.*
444. Whorls more or less embracing, aperture round or irregular...qq.
qq. Strongly embracing.......................................9†.
9†. Whorls somewhat subangular, spirals smooth.
XC. *Gibbula.*
9†. Whorls round, spirals regular, fine.
CXI. *Sigaretus.*
qq. Moderately embracing.. ....10†.
10†. Spirals strongly nodose, spire elevated.
LXIX. *Trachydomia.*
10†. Few spirals, not nodose, spire vertically compressed..........................XCIV. *Adeorbis.*
10*. Spirals faint or absent, transverse striæ prominent.................. q.
q. Shell round-whorled, or more rarely angulated or even compressed...555.
555. Transverse striæ straight and over entire shell.
LXXIX. *Callonema.*
555. Striæ only on upper portion of shell......LXXX. *Isonema.*
8. Shell not umbilicated (rarely with faint umbilical indentation).........11*.
11*. Spirals pronounced, transverse sculpture weak or absent............r.
r. Lip discontinuous, whorls slightly impressed, spire acute to rectangular..666.
666. Spirals numerous, nearly or quite impressed.
LXIII. *Cyclonema.*
666. Spirals few, not of same size, one or more often beaded.
XCI. *Calliostoma.*
r. Lip continuous, outer lip sometimes reflected.....................777.
777. Outer lip reflected and thickened. Columellar plications present... ....rr.

rr. Body whorl inflated, aperture forming more than half the length of the shell....................CC. *Cinulia.*

rr. Body whorl not inflated, aperture less than half the shell length.............................CCI. *Ringicula.*

777. Outer lip neither reflected nor thickened, without columellar plications, sometimes with small teeth or tubercles in peristome........ ....XC. *Gibbula.*

11*. Spirals and transverse sculpture equally developed or nearly so... s.

s. Inner lip thickened with angular emargination in middle. XCV. *Neritopsis.*

s. Inner lip not thickened, smooth......................................888.

888. Vertical sculpture oblique, rib-like folds. CXII. *Vanikoropsis.*

888. Vertical sculpture interrupted transversely so as to produce only rows of tubercles..............LXIX. *Trachydomia.*

11*. Transverse sculpture or ribs alone present; spire low, shell narrowing anterior-wards, ribs only near suture...CCIX. *Rhytophorus.*

11*. Faint spirals alone present..........................CXX. *Campeloma.*

III. Surface with nodes or spines ....9.

9. Shell non-umbilicated................. ....12*.

12*. Whorls few, rapidly and regularly enlarging, surface nodose. LXIX. *Trachydomia.*

12*. Whorls few, forming irregular spiral which is sometimes conical, base flat, formed by extended last whorl; surface irregularly spinose..CVIII. *Calyptræa.*

9. Shell umbilicated when not wholly uncoiled.................................13*.

13*. Spines irregular, tubular, last whorls mostly uncoiling. LXXIV. *Platyceras.*

D. Shell in general form like the preceding group, but with the roundness of the whorls modified by one or several strong angulations, often flattened; no marginal notch or slit...IV.

IV. Shell umbilicated...10.

10. Angulations few (3–5), with all or most of the spaces between them flattened or concave ....LXIV. *Trochonema.*

10. Angulation only on upper surface or around umbilicus or both........14*.

14*. Naticoid, high-spired with flattened shoulder and oblique lip. LXI. *Omphalotrochus.*

14*. Spire low or flat, the upper carina in center of whorl. LVII. *Euomphalus.*

14*. Spire low, embracing to marginal angulation, last whorl free. LVIII. *Calaurops.*

14*. All whorls disconnected, carina on upper surface; well-preserved specimens always show apertural notch.....LIX. *Eccyliomphalus.*

14*. Spire flat, coil left-handed (sinistral), angulations on periphery and umbilicus...LX. *Maclurea.*

IV. Non-umbilicated...11.

11. With strong peripheral keel alone modifying the roundness of whorl in adult, and with strong oblique folds on upper part of whorl. LXX. *Turbonopsis.*

E. Shells trochiform, spire more or less continuously conical, basal portion abruptly deflected and often flattened. No apertural notch..............................V.

V. Peripheral margin more or less strongly angulated but not sharp; surface with regular ornamentation...12.

12. Non-umbilicated...XCI. *Calliostoma.*

12. Umbilicated...15*.

15*. Umbilicus with distinct and notched spiral..........CVI. *Solarium.*

15*. Umbilicus without markedly notched margin or spiral.
XCIA. *Eutrochus.*

V. Periphery sharply angular, often produced, surface frequently modified by cementation of foreign substances...............................CXVII. *Xenophora.*

F. Shell turreted, mostly high-spired, with round or more rarely flattened and angulated whorls, and entire aperture without peripheral notch or slit.. ....VI.

VI. Non-umbilicate...13.

13. Surface smooth, except for lines of growth.................................16*.

16*. Whorls flattened, sutures scarcely or not at all impressed............t.

t. Columellar lip with tooth.............................CIV. *Odostomia.*

t. Columellar lip with several oblique folds.
LXXXVIII. *Soleniscus.*

t. Columellar lip smooth...999.

999. Dextral, aperture elongate ....ss.

ss. Inner lip only visible in lower half.
LXXXVI. *Meekospiria.*

ss. Inner lip complete...11†.

11†. Shell smooth and lustrous, protoconch dextral.
C. *Eulima.*

11†. Shell thick, apex generally wanting, not dextral.
CXXX. *Goniobasis.*

999. Sinistral, aperture ovoid.........................CCXII. *Physa.*

16*. Whorls rounded, sutures more or less deeply impressed..............u.

u. Body whorl long, one half or more of length of shell, aperture elongate, suture sometimes with narrow shelf.
LXXXVII. *Bulimorpha.*

u. Body whorl much longer than the spire, aperture elongate, anteriorly somewhat drawn out...............LXXXV. *Fusispira.*

u. Aperture rounded, body whorl not very large..................1111.

1111. With fine sigmoid striæ...............LXXXI. *Loxonema.*

1111. Without striæ (when perfect showing a faint peripheral band)....................................XLVI. *Hormotoma.*

13. Surface ornamented with ribs or spirals or with both.....................17*.

17*. Spiral sculpture dominant..v.

v. With fine sigmoid transverse lines..............LXXXII. *Aclisina.*

v. With lines of growth not sigmoid..................................2222.

2222. Spirals few (2 or 3) or absent...............................tt.

tt. Whorls rounded, one or more spirals nodose.
LXXVIII. *Acanthonema.*

tt. Whorls angular, spirals not noded......................12†.

12†. Short and tapering, embracing to angulation.
LXXXIII. *Orthonema.*

12†. Very long and slender, generally not embracing to angulation...................CXXI. *Turritella.*

2222. Spirals numerous; spire high and slender, many-whorled ....uu.

uu. Coiled throughout.................... CXXI. *Turritella.*
uu. Last whorls uncoiled.................CXXII. *Vermetus.*
2222. Spirals numerous; spire short, few-whorled.......... vv.
vv. With two columellar plications.
CXCVII. *Tornatellæa.*
vv. With one columellar plication......CXCVIII. *Actæon.*
17*. Vertical sculpture dominant or equal to spiral........................w.
w. With simple vertical ribs...3333.
3333. Form slender, turritelloid, protoconch erect, reversed.
CII. *Turbonilla.*
3333. Form more tapering, whorls more rounding.
LXXXI. *Loxonema.*
3333. Short and rather solid, sutures scarcely impressed.
CXXVI. *Hypsipleura.*
w. With sharp, regular varices instead of ribs..........CV. *Scalaria.*
w. With both ribs and spirals...4444.
4444. Later whorls mostly with shoulder angle bearing spinose nodes ....ww.
ww. Spire high and slender............CXXVII. *Melania.*
CXXX. *Goniobasis.*
ww. Spire short, shell thick-set......CXXIX. *Pyrgulifera.*
4444. All whorls round..xx.
xx. Columella with tooth...................CIII. *Chrysallida.*
xx. Columella without tooth............CXXX. *Goniobasis.*
CXXVII. *Melania.*
VI. Shell umbilicated, surface smooth, whorls flat or gently convex, suture not impressed, aperture oval, protoconch dextral..........................CI. *Niso.*
G. Shells pleurotomarioid and murchisonioid, varying in form from naticoid or trochiform to high-spired, and characterized by a marginal notch or slit, often continued backward into a slit-band.
VII. Shell turritelliform, with slender spire of numerous whorls...................14.
14. Lip with deep notch but no slit..18*.
18*. Band generally formed but rarely very prominent.....................x.
x. Aperture slightly produced anteriorly, no umbilicus.
XLVI. *Hormotoma.*
x. Aperture round, shell umbilicated...............XLVII. *Cœlidium.*
18*. Band strong, between two pronounced ridges..........................y.
y. Very slender, surfaces flat between carina, whorls compressed.
XLVIII. *Solenospira.*
18*. Band on shoulder formed by slight flattening and angulation of whorl...XXX. *Ormospira.*
14. Lip with slit..*Murchisonia.*
VII. Shell relatively low-spired, apical angle varying from moderately acute (rarely less than 45°) to moderately obtuse (rarely more than 120°)........15.
15. Whorls angulated, shoulder flat or gently concave (rarely gently convex).
19*.
19*. Whorls embracing to angulation, forming more or less trochiform spire ....z.
z. Peripheral angulation drawn out into smooth or spinous flange.
XXVIII. *Euomphalopteris.*
z. Peripheral angulation not drawn out..............................5555.

5555. Aperture with notch, but no slit; a peripheral band generally present... ....yy.

yy. Band vertical on angulation................ ....13†.

13†. Band faint, spire obtuse........XXXV. *Liospira.*

13†. Band strong, spire mostly acute.
XXXVIII. *Clathrospira.*

yy. Band on upper side of angulation ....14†.

14†. Base nearly flat ....XXXVI. *Euconia.*

14†. Base rounded...............XXXVII. *Eotomaria.*

5555. Aperture with slit..aa′.

aa′. Base flat or gently convex...........................15†.

15†. Slit short, upper sutural edges of whorls noded.
XLV. *Trepospira.*

15†. Slit long, sutural edges not noded.
XLIV. *Euconospira.*

aa′. Base strongly rounded, suture channeled.
XLIII. *Bembexia.*

aa′. Base ventricose, suture not channeled.
XLI. *Mourlonia.*

19*. Whorls not embracing to angulation, spire scalariform.............a′.

a′. With one or more strong carinæ, the median one carrying the "band"................ ....6666.

6666. Aperture with notch only............XXXI. *Lophospira.*

6666. Aperture with slit...bb′.

bb′. Band simple..........................XXXII. *Schizolopha.*

bb′. Band crenulated....................XXXIV. *Worthenia.*

a′. With carinæ between flat shoulder and large rounded body whorl.
7777.

7777. Aperture more or less drawn out anteriorly..............cc′.

cc′. Shoulder flat, at right angle to axis of coiling.
XXIX. *Scalites.*

cc′. Shoulder sloping, carrying the band.
XXX. *Ormospira.*

7777. Aperture not drawn out, band only on last whorl.
XXXIII. *Phanerotrema.*

15. Whorls rounded, globose, with vertical slit band near middle of whorl.
XXXIX. *Euryzone.*

15. Whorls rounded and vertically compressed, slit band above deep suture.
XL. *Spiroraphe.*

15. Whorls rounded except for strong revolving spirals.......XLII. *Gyroma.*

VII. Shell very obtuse (more than 120°) to flat, or with sunken spire, the last whorl sometimes loosely coiled..16.

16. With strong keel on upper side of whorl..................................20*.

20*. Lines of growth not deflected by keel...........LVII. *Euomphalus.*

20*. Lines of growth turning back over keel, forming distinct notch...b′.

b′. Keel low, within the periphery..................................8888.

8888. Spire flat or sunken...dd′.

dd′. Whorls slowly enlarging, flat on under side.
LII. *Ophileta.*

dd′. Whorls rapidly enlarging, under side concave.
LVI. *Pleuronotus.*

8888. Spire slightly elevated, shoulder deeply concave.
LV. *Helicotoma.*

b′. Keel marginal, often sharp and high, forming a nearly vertical blade, spire deeply depressed...............LIV. *Eccyliopterus.*

20*. Keel with distinct slit band..........................LIII. *Ophiletina.*

16. Notch only on outer margin of upper surface, no keel, with raised line on upper surface, interrupting lines of growth...XXVI. *Raphistoma.*

16. Without notch or band, but with strong peripheral carina; depressed-conical...XXVII. *Raphistomina.*

H. Shell with aperture notched anteriorly or drawn out into a canal of greater or less length.

VIII. Shell turreted, long and slender, aperture less than half the greatest length of shell, rarely its equal...17.

17. Aperture without expanded lip, notch short..............................21*.

21*. Aperture modified by sharp folds...c′.

c′. Aperture more or less oblique.......................................9999.

9999. Folds always on columella, generally on outer lip as well...CXXXI. *Nerinea.*

9999. Fold on outer lip, sometimes also on columella.
CXXXII. *Nerinella.*

c′. Aperture elongate axially; folds on columella; notch faint.
50.

50. Spire elevated, smooth or with ribs....CLXXXIV. *Mitra.*

50. Spire short, shell oval, surface smooth.
CLXXXIII. *Marginella.*

50. Spire short, surface ribbed.......CLXXXIVA. *Conomitra.*

21*. Aperture unmodified by folds........... ....d′.

d′. Aperture oblique, canal oblique...51.

51. Surface ornamented.....................CXXXIV. *Cerithium.*

51. Surface smooth...........................CXXVIII. *Melanopsis.*

d′. Aperture oval to quadrilateral...52.

52. Outer lip entire.................................CXCII. *Terebra.*

52. Outer lip with faint notches...............CXXV. *Glauconia.*

d′. Aperture elongate, ovoid.......................LXXXV. *Fusispira.*

d′. Aperture elongate, narrow..53.

53. Outer lip entire...ee′.

ee′. Surface smooth......................LXXXIV. *Subulites.*

ee′. Surface cancellated by ribs and spirals.
CXXXIII. *Bittium.*

53. Lip with notch or slit...ff′.

ff′. Notch at suture.........................CXCV. *Mangilia.*

ff′. Notch below suture......... ....CXCIV. *Drillia.*

17. Aperture with outer lip expanded (often broken away or not shown in immature individuals)...22*.

22*. Expansions wholly adhering to spire which may be mostly covered.
CXXXVI. *Calyptrophorus.*

22*. Expansion free or only partly adhering to spire, which may nevertheless be concealed by it..... ....e′.

e′. Expansion simple, free, and blade or wing-like, sometimes divided, anterior end drawn out into canal.
CXXXV. *Anchura*

e′. Expansion compound, posterior notch drawn out and adhering to spire, sometimes covering it; outer lip often much divided. CXXXVII. *Aporrhais.*

17. Aperture with outer lip thickened, but not expanded......................23*.

23*. Anterior notch very slight, shell small, surface ribbed, rarely smooth .... CXVI. *Rissoina*

23*. Anterior notch drawn out into short canal, inner lip reflexed. CXL. *Rimella.*

VIII. Shell short and thick... ....18.

18. All whorls smooth and rounded, shell subglobose......CXC. *Ancillopsis.*

18. At least the younger whorls angulated or ornamented or both.........24*.

24*. Outer lip not denticulate..f′.

f′. Surface with few strong fold-like spirals...CLXXXII. *Ecphora.*

f′. Surface smooth or with ribs and fine spirals.........................54.

54. With distinct shoulder, angle strongly nodose, notch faint. CXXIX. *Pyrgulifera.*

54. Without shoulders, whorls rounded, notch strong. CXLVII. *Buccinum.*

24*. Outer lip denticulate or lirate...................... ....g′.

g′. Surface smooth or spiralled...................CXLVI. *Columbella.*

g′. Surface with ribs and spirals..55.

55. With strong columellar folds.............CXCI. *Cancellaria.*

55. Columella without folds, rarely denticulate................gg′.

gg′. Canal short, deflected, often only notch-like. CLI. *Nassa.*

gg′. Canal longer, slightly bent or straight. CLXXVIII. *Urosalpinx.*

24*. Outer lip reflexed, inner lip expanded, anterior canal short, twisted and bent backwards.............................CXLIV. *Cassidaria.*

24*. Outer lip thickened, inner lip smooth. Anterior notch very slight. CXVI. *Rissoina.*

VIII. Shell varying in form, with aperture as long as, or longer than, the length of the spire..19.

19. Aperture without expanded lip..25*.

25*. Shell fusiform and slender, drawn out anteriorly into more or less slender canal..h′.

h′. Spire high, about equal in length to aperture.......................56.

56. Outer lip with notch or slit, often with slit band........hh′.

hh′. Canal long.........................CXCIII. *Pleurotoma.*

hh′. Canal short, less than half the length of shell.....16†.

16†. Slit or notch at suture.........CXCV. *Mangilia.*

16†. Slit or notch below suture......CXCIV. *Drillia.*

56. Outer lip without notch or slit.....................................ii′.

ii′. Columellar lip without folds...............................17†.

17†. Early whorls ribbed, last whorls smooth, often with sutural shelf........CLXXII. *Clavilithes.*

17†. All whorls smooth or only with spirals, body whorl strongly convex. CLXXVII. *Mazzalina.*

17†. All whorls ribbed or spiralled or both...........‡.

‡. Ribs strong, aperture not abruptly contracted

but narrowing gradually....CLXIV *Exilia*
‡. Aperture abruptly contracted to anterior canal. *a.*
a. Spire slender, suture deeply impressed. *1'.*
1'. Whorls mostly round, ribbed and spiralled, an angulation may appear in later whorls, canal straight........................*a'.*
a'. Protoconch erect, last portion ribbed and ending in a strong varix.............CLX. *Fusus.*
a'. Protoconch mostly covered with fine ribs, not ending in varix, outer lip with slender liræ.
CLXIII. *Heilprinia.*
1'. Whorls round, canal twisted.
CLXVI. *Streptolathyrus.*
1'. Whorls mostly angular, protoconch merging into conch........*b'.*
b'. Ribs and spirals characterizing most or all of the whorls, apical portion of protoconch of several whorls, gradually increasing.
CLXI. *Falsifusus.*
b'. Ribs replaced by spires, apical whorl or protoconch swollen, erect.
CLXII. *Fulgurofusus.*
a. Spire short, thick and few-whorled.
CLXXVIII. *Urosalpinx.*
ii'. Columella with folds or plications... ....18†.
18†. Shells with ribs and nodes or smooth in adult, but not spinose.............................‡‡.
‡‡. Protoconch papillose.
CLXXIV. *Turbinella.*
‡‡. Protoconch not papillose.......................*b.*
b. Spire slender, fusiform, sutures deep, ribs and spirals well developed......*2'.*
2'. Plications few, strong...............*c'.*
c'. Canal shorter than spire....*a'a.*
a'a. Inner lip strong, often umbilicated, with several plications; outer lip lirate.
CLXV. *Latirus.*
a'a. Inner lip with a single tooth-like plication.
CLXXI. *Odontofusus.*
c'. Canal as long as spire; inner lip

weak; no umbilicus or liræ.
CLXVII. *Pseudolathyrus.*
2'. Plications in form of slender lines or ridges.
CLXIIIA. *Barbarofusus.*
b. Sutures not so deeply impressed; aperture less rapidly contracting, ribs and spirals fainter; typically a strong, oblique, anterior columellar fold.
CLIX. *Fasciolaria.*
18†. Shell strongly spinose..........CLXXV. *Vasum.*
h'. Spire short and thick, less than apertural length.................57.
57. Whorls moderately embracing..................................jj'.
jj'. Aperture abruptly contracted to anterior canal, ribbed and spiralled...................................19†.
19†. Columellar and outer lip lirate.
CLXIII. *Heilprinia.*
19†. Columella with single tooth.
CLXXI. *Odontofusus.*
19†. Columella smooth, canal short, slightly curved.
CLXXVIII. *Urosalpinx.*
'. Aperture not abruptly contracted.......................20†.
20†. Columella with strong plications................‡‡‡.
‡‡‡. Whorls round or moderately angulated with continuous ribs, spinose or tuberculated on the angle.....CLXXXV. *Volutilithes.*
‡‡‡. Whorls angulated and generally spinose; aperture broad in front, canaliculated posteriorly; plaits numerous.
CLXXXVI. *Voluta.*
‡‡‡. Whorls rounded in adult only, and without ribs or spirals......CLXXXVII. *Aurinia.*
‡‡‡. Whorls round, smooth throughout...........*c*.
c. Aperture sharp behind, widening forward, oblique grooves on columella...*3'*.
3'. Surface smooth.
CLXXXVIII. *Oliva.*
3'. Surface with vertical striations.
CLXXXIX. *Olivula.*
e. Aperture more or less patulous, strong plications on columella.
CLXXVI. *Caricella.*
57. Whorls strongly embracing, rounded.........................kk'.
kk'. Aperture abruptly contracted to long canal.
CLIII. *Pyropsis.*
kk'. Aperture not contracted...................................21†.
21†. Aperture wide and patulous......CXLV. *Pyrula.*
21†. Aperture narrow ....‡‡‡‡.
‡‡‡‡. Inner lip not expanded ....*d*.
d. Aperture sharp behind, widening forward.
5'.

5′. With several oblique folds on the columella.
CLXXXVIII. *Oliva*.

5′. Without folds.......CXCVI. *Conus*.

d. Aperture blunt behind, scarcely widening forward ....*6′*.

6′. Lip and columella smooth, spire conical or flat....CXCVI. *Conus*.

6′. Lip and columella denticulate, spire mostly covered.
CXLIII. *Erato*.

‡‡‡‡. Inner lip expanded, partly covering body whorl and spire..............................*e*.

e. Outer lip smooth.
CXXXIX. *Orthaulax*.

e. Outer lip lobed.
CXXXVIII. *Pugnellus*.

57. Whorls strongly embracing, angulated..........................11′.

11′. Spire very flat, canal strongly contracted below body whorl..22†.

22†. Protoconch papillose, columella plicate, outer lip lirate...........................CLII. *Tudicla*.

22†. Protoconch not papillose, without columellar plicæ or liræ....................CLIII. *Pyropsis*.

11′. Spire of moderate height, often continuously conical, whorls angulated..............................23†.

23†. With canal abruptly contracted below body whorl outer whorl biangular ....CLIV. *Perisolax*.

23†. Canal gradually contracted below body whorl. 5‡.

5‡. Shell with flat or concave sloping shoulders and angle nodose, keeled or spinose, at least in young..............................*f*.

f. Shell small ....*7′*.

7′. Canal straight.
CLVIII. *Levifusus*.

7′. Canal reflexed.
CLVII. *Strepsidura*.

f. Shell large.....................................*8′*.

8′. Suture channeled.
CLVI. *Sycotypus*.

8′. Suture not channeled.
CLV. *Fulgur*.

5‡. Shell with several angulations, and wide patulous canal..............................*g*.

g. Spire low, angulations pronounced on body whorl......CLXIX. *Fulguroficus*.

g. Spire moderately high, angulations less pronounced on body whorl.
CLXX. *Fusoficula*.

25*. Shell fusiform, but thick set, spire of few rapidly enlarging whorls. i′.

i′. Canal strongly deflected..58.

58. Surface with spirals and in some cases with ribs also. CXLIX. *Siphonalia.*

58. Surface with ribs and spirals, the former often thickened and spinose..CLXXIX. *Murex.*

i′. Canal straight or faintly deflected, aperture wide, surface with spirals and ribs rarely smooth ....59.

59. Spirals faint, sometimes obsolete.............CL. *Neptunea.*

59. Spirals moderate, shell small, aperture rather abruptly contracted.............................CLXVIII. *Lirofusus.*

59. Spirals strong, shell large, aperture but slightly contracted. CXLVIII. *Buccinofusus.*

25*. Shell not fusiform, spire small, aperture occupying greatest length of shell or nearly so...j′.

j′. Shells short and thick, more or less globular......................60.

60. All whorls smooth, not umbilicated.......CXC. *Ancillopsis.*

60. Whorls more or less ornamented, at least the earlier ones; shell umbilicated..........................CLXXIII. *Lacinia.*

j′. Shell elongate...61.

61. Columella with plications or oblique grooves, outer lip smooth..mm′.

mm′. Whorls rounded in adult.....................................24†.

24†. With continuous ribs....CLXXXV. *Volutilithes.*

24†. Without ribs ....6‡.

6‡. Round-whorled in adult only. CLXXXVII. *Aurinia.*

6‡. Round-whorled and smooth throughout....*h.*

h. Aperture narrow behind, widening forward ....*g′.*

g′. Surface smooth. CLXXXVIII. *Oliva.*

g′. Surface vertically striate. CLXXXIX. *Olivula.*

h. Aperture more or less patulous. CLXXVI. *Caricella.*

mm′. Whorls angulated...25†.

25†. With continuous ribs, spinous or tuberculated on angle...................CLXXXV. *Volutilithes.*

25†. Generally spinous, aperture broad in front. CLXXXVI. *Voluta.*

61. Columella plicate..nn′.

nn′. Columellar and outer lip with numerous small notches. CXLII. *Cyprea.*

nn′. Columella smooth except for plications; outer lip notched...................................CXLIII. *Erato.*

nn′. Outer lip smooth.............CLXXXIII. *Marginella.*

61. Columella smooth..oo′.

oo′. Form conical, spire flat..................CXCVI. *Conus.*

oo′. Form subconical, spire elevated.........CLV. *Fulgur.*

19. Aperture with expanded outer lip..26*.

26*. Apertural expansion one of three or more similar ones on same whorl forming varices....k′.
k′. Varices broad lamellæ or rows of spines....CLXXIX. *Murex.*
k′. Varices rib-like, ending in hollow shoulder spines....62.
62. Varices of considerable strength, anterior canal covered. CLXXX. *Typhis.*
62. Varices weak, anterior canal open......CLXXXI. *Trophon.*
26*. Apertural expansion alone present....l′.
l′. Expansion a broad and thick lamella, at posterior notch covering spire....63.
63. With anterior and faint marginal notch...CXLI. *Strombus.*
63. Without marginal notch....CXXXVII. *Aporrhais.*
l′. Expansion lobed or digitate....64.
64. Inner lip expanded and partly covering spire and body whorl....CXXXVIII. *Pugnellus.*
64. Inner lip not expanded, but expansion of outer lip often partly covering the spire....CXLIA. *Pterocera.*
VIII. Shell with spire sunken beneath body whorl, which often completely hides the spire....20.
20. Outer lip enrolled in adult, marginal slit lined by denticulations. CXLII. *Cypræa.*
20. Outer lip sharp....27*.
27*. Apex perforated over the sunken spire....m′.
m′. Shell oval, inflated columella smooth....CCIII. *Bulla.*
m′. Cylindrical, columella with small plications.....CCV. *Cylichna.*
27*. Apex not perforated....n′.
n′. Cylindrical, aperture extended posteriorly so as to form sharp point above apex, surface smooth or with few spirals. CCIV. *Volvula.*
n′. Oval without projecting point, surface with fine spirals. CCII. *Haminea.*
I. Not belonging to the preceding divisions....IX.
IX. Shell twisted or loose-coiled, whorls not in contact....21.
21. Irregularly twisted, with or without apical coil....28*.
28*. Tube entire, ornamented by longitudinal striæ or smooth. CXXII. *Vermetus.*
28*. Tube with a slit, or a row of pores....CXXIV. *Siliquaria.*
21. More or less regular, loose spiral....29*.
29*. Twisted into corkscrew spiral....o′.
o′. Spiral broad, open; tube scarcely increasing. CXXIII. *Laxispira.*
o′. Spiral long, slender, tube regularly increasing....65.
65. Tube entire....CXXI (internal mold of) *Turritella.*
65. Tube with slit or row of holes....CXXIV. *Siliquaria.*
29*. Twisted in single plane, from a part of a volution to several volutions not in contact....p′.
p′. Whorls round, unmodified by carina....LI. *Phanerotinus.*
p′. Whorls with carina or keel on upper side....66.
66. Carina blunt; aperture with broad, shallow notch. LIX. *Eccyliomphalus.*

66. Carina sharp, when perfect drawn out into high collar; apertural notch deep....................LIV. *Eccyliopterus*.

IX. Shell coiled..22.

22. Cylindrical or oval, generally narrowing towards aperture..............30*.

30*. Aperture incomplete, oblique or anterior...............................q′.

q′. Columella and outer lip with teeth...................................67.

67. Columella with callus, aperture with rounded posterior notch..............................CCXVI. *Anthracopupa*.

67. Columella without callus, no posterior notch. CCXV. *Pupa*.

q′. Columella and lip without teeth; center of outer lip nearly in axial line of shell.........................CCXVII. *Dendropupa*.

Family PALÆACMÆIDÆ * Grabau and Shimer.

I. TRIBLIDIUM Lindstrom. (Emend. Berkey.)

Patelliform obovate shells, narrowest anteriorly, often acuminate; conical with beak varying from nearly marginal to overarching anteriorly; muscular scars in rings of seven or eight disconnected pairs; anterior pair meeting in front beneath the beak. Lines of growth, and rarely obscure broad radial plications, mark the surface. Cambric–Ordovicic.

1. **T. rectilaterale** Berkey. (Fig. 802, *a*, *b*.) Cambric.

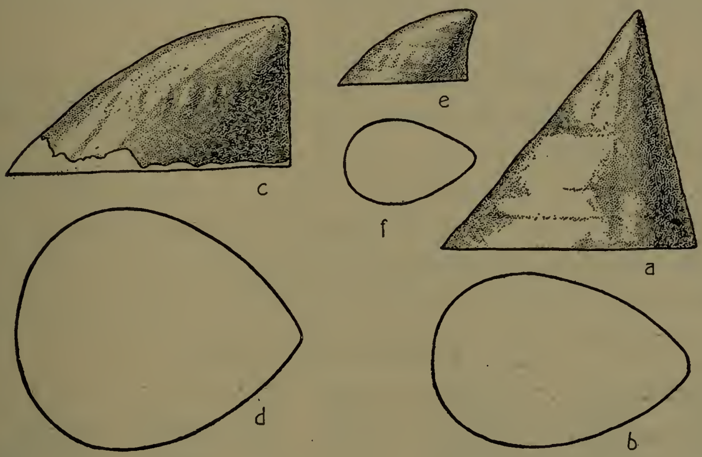


FIG. 802. *a*, *b*, *Triblidium rectilaterale*; *c*, *d*, *T. convexum*; *e*, *f*, *T. barabuensis*. (After Berkey, Am. Geol., 21.)

Large, conical, high, with straight sides and apex somewhat behind the front; aperture ovate-acuminate.

St. Croix (Dresbach) of Minnesota.

* The names starred are new.

2. **T. convexum** Berkey. (Fig. 802, *c*, *d*.) Cambric.

Larger than preceding, lower, and with more broadly ovate-acuminate aperture, and anterior beak.

Associated with the preceding.

3. **T. barabuensis** Whitfield. (Fig. 802, *e*, *f*.) Ordovicic.

More narrowly ovate than preceding; beak slightly overhanging; anterior slope concave.

In the Lower Magnesian series (Jordan sandstone) of Wisconsin.

4. **T. nycteis** (Billings). (Fig. 803.) Ordovicic.

FIG. 803. *Triblidium nycteis.* (After Billings.)

Larger than the preceding, and with the beak curved downwards.

Beekmantown of Mingen Islands.

II. HELCIONOPSIS Ulrich and Scofield.

Like *Triblidium*, but surface marked by fine radiating striæ. Ordovicic–Siluric.

5. **H. striata** Ulrich. (Fig. 805, *a*, *b*.) Ordovicic.

Ovate, rather narrow in front, apex incurved and slightly projecting; radiating lines round, equal.

Upper Cincinnatian: Kentucky and Ohio.

III. HYPSELOCONUS Berkey.

High conical shells, differing from *Triblidium* in being curved towards the broader side of the shell. Cambric–Ordovicic.

6. **H. recurvus** (Whitfield). (Fig. 804, *a*, *b*.) Cambric–Ordovicic.

Curvature very slight, not beyond posterior margin; shell high; angle somewhat variable.

St. Croix (Upper Dresbach) and Lower Magnesian of Minnesota and Wisconsin.

7. **H. cornutiformis** Berkey. (Fig. 804, *c*, *d*.) Cambric.
Slender and high, strongly curved, beak much overhanging.
St. Croix formation (Dresbach shales), Minnesota.

8. **H. franconiensis** Berkey. (Fig. 804, *e*, *f*.) Cambric.

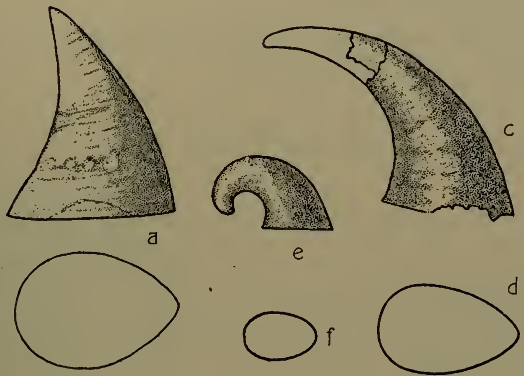


FIG. 804. *a*, *b*, *Hypseloconus recurvus*; *c*, *d*, *H. cornutiformis*; *e*, *f*, *H. franconiensis*. (After Berkey, Am. Geol., 21.)

Curved so as to perform half a volution.
St. Croix formation (Franconia sandstone) of Minnesota.

IV. ARCHINACELLA Ulrich.

Patelliform shells with surface showing only lines of growth, anterior end generally widest; apex in front of center and often submarginal, generally curved, muscular scars forming a continuous band. Ordovicic.

9. **A. deformata** Hall. (Fig. 806.) Ordovicic.
Broader proportionally than *A. deleta*, beak more anterior and overhanging (max. size 11 × 8 mm.).
Common throughout the Chazy of the Lake Champlain region.

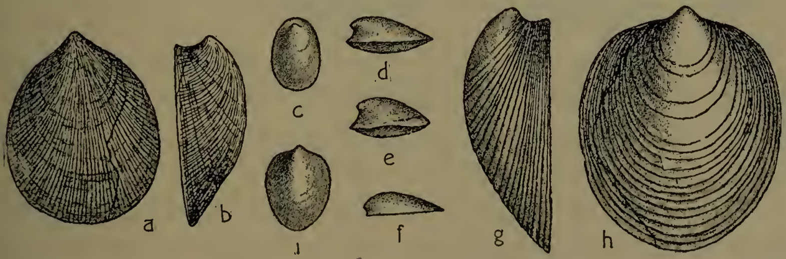


FIG. 805. *a*, *b*, *Helcionopsis striata*; *c–e*, *Archinacella deleta*; *f*, *i*, *A. simulatrix*; *g*, *h*, *A. cingulata*. (After Ulrich, Pal. Minn.)

10. **A. deleta** (Sardeson). (Fig. 805, *c–e.*) Ordovicic.

Small, elliptical, smooth, apex a short distance from front, incurved.

Black River of Minnesota.

11. **A. patelliformis** (Hall). Ordovicic.

Small, slightly narrower anteriorly, beak projecting to margin of shell ; growth lines sublamellose.

Trenton of New York.

12. **A. simulatrix** Ulrich and Scofield. (Fig. 805, *f, i.*) Ordovicic.

Small, widest anteriorly ; beak slightly projecting anteriorly.

Black River of Minnesota. Trenton of Kentucky.

13. **A. cingulata** Ulrich. (Fig. 805, *g, h.*) Ordovicic.

Large ; beak strongly incurved and projecting slightly beyond the somewhat broader anterior end. Growth lines sublamellose.

Trenton of Kentucky.

V. PALÆACMÆA Hall and Whitfield.

Patelliform, circular or elliptical shells with subcentral apex and broad concentric wrinkles marking the surface. Cambric–Ordovicic.

14. **P. (Parmophorella) acadica** (Hartt). (Fig. 809, *c.*) Cambric.

When uncompressed, oval in outline, with beak one third or one fourth distant from the end. Concentric wrinkles weaker on

FIG. 806. *Archinacella deformata.* (After Raymond.)

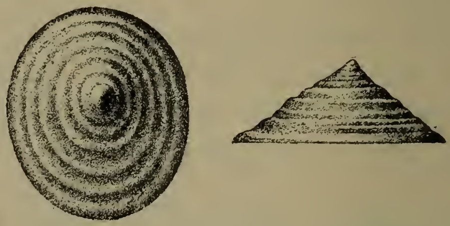


FIG. 807. *Palæacmæa typica.* (After Hall & Whitf., 23d N. Y. Mus. Rep.)

shorter end. When depressed, beak appears subcentral as in the figure.

St. John formation of New Brunswick (Div. 1, *c*) and Hayward argillutytes of Braintree, Mass.

15. **P. typica** Hall and Whitfield. (Fig. 807.) Cambric.

Broadly oval, depressed conical, apex nearly central; undulations strong, subangular. (Type of genus.)

Potsdam sandstone of New York.

16. **P. irvingi** Whitfield. Cambric.

Larger than preceding, but smaller than the next, more nearly circular, with compressed apex, and broad but depressed flat undulations.

St. Croix beds of Wisconsin.

17. **P. quebecensis** (Billings). (Fig. 808.) Ordovicic.

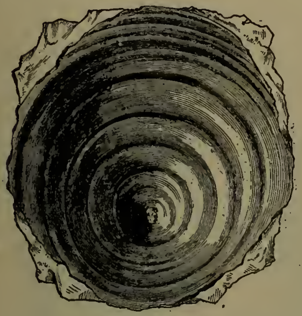


FIG. 808. *Palæacmæa quebecensis*, × ½. (After Billings.)

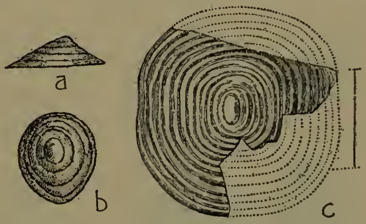


FIG. 809. *a*, *b*, *Palæacmæa humilis*; *c*, *P.* (*Parmophorella*) *acadica*. (*a*, *b*, after U. and S., Pal. Minn.; *c*, after Walcott, Bull. 10, U. S. G. S.)

Large, elliptical, conical, three inches or more in length, with excentric apex, and coarse, shallow concentric undulations.

Quebec (Beekmantown) of Point Levis, Canada.

18. **P. humilis** U. and S. (Fig. 809, *a*, *b*.) Ordovicic.

Small, broadly subovate, anterior outline semicircular, posterior prolonged. Apex slightly bent forward, a short distance in front of center. Concentric wrinkles few, strong, growth lines faint.

Stones River and Black River of Minnesota.

VI. HELCIONELLA * Grabau and Shimer.

Differs from *Palæacmæa* in having the apex submarginal and incurved. Concentric folds broader and most pronounced on the side away from the beak; faint or obsolete under the beak. (Type *Metoptoma rugosa* Hall.) Cambric.

19. **H. rugosa** (Hall). (*Stenotheca rugosa* of authors.) (Fig. 810.) Cambric.

Elliptical to subcircular, moderately high, with beak slightly incurved. Concentric folds strong on the convex side, nearly absent on concave.

Lower Cambric (Georgian) of Troy, N. Y.; Bic Harbor, Quebec; l'Anse au Loup, Labrador, and (?) Etcheminian of Newfoundland.

VII. Scenella Billings.

Conical, often high, shells with subcentral apex and radial plications. Muscular scars forming a circle above the mid-height. Cambric–Devonic.

20. **S. reticulata** Billings. (Fig. 811, *a*, *b*.) Cambric.

Fig. 810. *Helcionella rugosa*, showing variations. (After Walcott.)

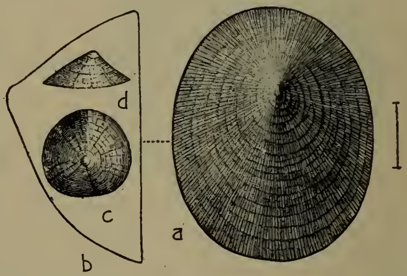


Fig. 811. *a*, *b*, *Scenella reticulata*, enlarged; *c*, *d*, *S. retusa*. (After Walcott, 10th Ann. Rep. U. S. G. S.)

Small, with excentric apex, and an obscure carina extending from apex to one side of margin.

Etcheminian of Newfoundland and Massachusetts.

21. **S. retusa** Ford. (Fig. 811, *c*, *d*.) Cambric.

More nearly circular, smaller, beak subcentral, front slope concave; faint concentric and longitudinal striæ present.

Georgian of Troy, N. Y., Bic Harbor, Canada.

22. **S. superba** Billings. Ordovicic.

Large, ovate to circular, diameter up to 90 mm., height somewhat over half diameter, apex subcentral; radiating plications fine, sharp.

Stones River of Minnesota; Black River of eastern Canada.

23. **S. montrealensis** (Bill.). (Figs. 812, 813.) Ordovicic.

Small, obtusely elliptical, acutely conical, apex slightly excentric and curved forward, radiating striæ fine, concentric growth-lines and occasionally wrinkles occur.

Chazy of Montreal and New York.

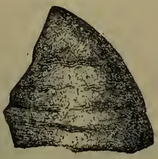


FIG. 812. *Scenella mentrealense*, × 2. (After Raymond.)

FIG. 813. *Scenella montrealense*, × 2. (After Raymond.)

VIII. LEPETOPSIS Whitfield.

Broadly oval, low conical shells with subcentral apex, growth lines, and more rarely radiating lines. Muscular impression horse-shoe-shaped, open in front. Mississippic–Carbonic.

24. **L. levettei** (White). (Fig. 814.) Mississippic.

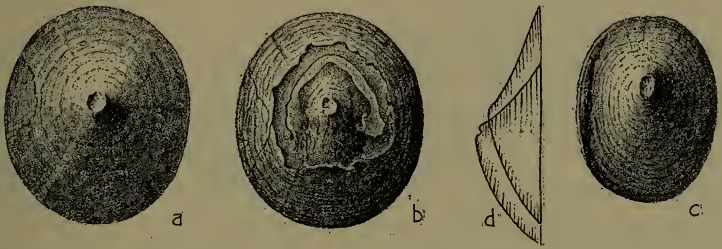


FIG. 814. *Lepetopsis levettei.* *a*, perfect shell; *b*, with apex removed, showing impression of muscular area; *c*, a more elongate form; *d*, side views of the two forms superposed. (After Whitfield.)

Nearly oval, conical, beak slightly excentric, anterior and posterior slopes slightly different; growth lines somewhat lamellose, radiating striæ obscure.

St. Louis group of Indiana.

Family BELLEROPHONTIDÆ M'Coy.

IX. CYRTOLITES Conrad.

Shells coiled in median plane, regularly enlarging, angulated or carinated laterally and on dorsum, aperture with or without median notch. Ordovicic.

25. **C. ornatus** Conrad. (Fig. 815, *a*, *b*.) Ordovicic.

Two to three volutions sharply carinate dorsally, sides subangular; surface pitted. Aperture a little wider than high.

Common in the Lorraine and Richmond of New York, Canada, Pennsylvania, Ohio, Indiana, Kentucky.

26. **C. retrorsus** Ulrich. (Fig. 815, *c, d.*) Ordovicic.

More rapidly enlarging than the preceding; aperture subquadrangular, keel sharper; transverse ribs curving backwards on dorsum.

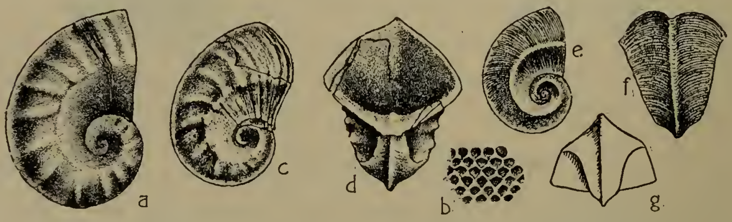


FIG. 815. *a, b, Cyrtolites ornatus* (*b*, enlargement of surface); *c, d, C. retrorsus*; *e–g, C. carinatus.* (After Ulrich, Pal. Minn.)

Black River and Trenton of Kentucky, Tennessee, and Ohio, and Eden of Ohio and Covington, Ky.

27. **C. carinatus** Miller. (Fig. 815, *e–g.*) Ordovicic.

Sharply carinate, with latero-dorsal slopes concave; margin notched medially; sides sharply angulated; surface without undulations, but with lines of growth marked.

Cincinnatian of Cincinnati region, Wisconsin, Iowa, and probably Minnesota.

X. OWENELLA U. and S.

Thin, subglobose, bellerophontid shells with rounded outer surface and gradually enlarging, dorso-ventrally compressed, close-coiled whorls; open umbilicus, and broad insinuation of the lip without slit band. Cambric.

28. **O. antiquatus** (Whitfield). (Fig. 816.) Cambric.

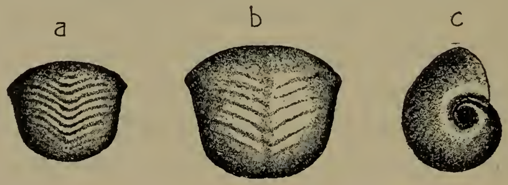


FIG. 816. *Owenella antiquatus.* (After Ulrich and Scof., Pal. Minn.)

Small, generally not more than $\frac{5}{16}$ in. in diameter; whorls strongly involute, surface with growth lines.

St. Croix sandstone of Wisconsin.

XI. Protowarthia U. and S.

Bellerophon shells with aperture large but not abruptly expanded; bilobate or deeply lobed outer lip, but no slit band; and when perfect, fine revolving and transverse striæ. Umbilicus mostly small. Ordovicic–Devonic.

29. **P. rectangularis** U. and S. (Fig. 817, *a–c.*) Ordovicic.

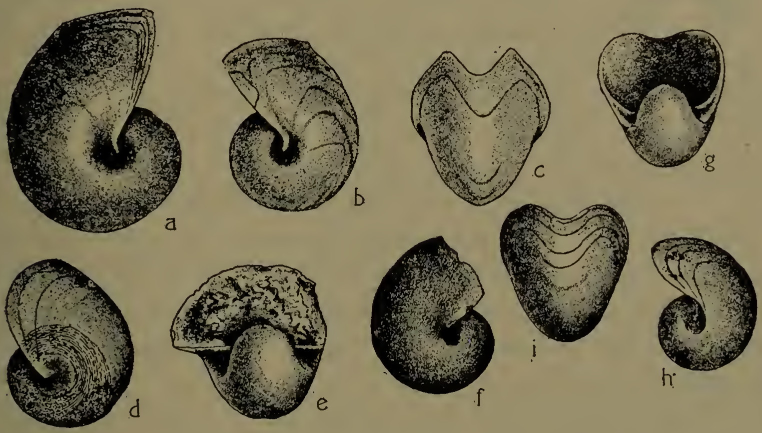


Fig. 817. *a–c, Protowarthia rectangularis; d–f, P. pervoluta; g–i, P. cancellata.* (After Ulrich, Pal. Minn.)

Abruptly rounded dorsally, with small umbilicus and deep marginal sinuation, the lobes of which are rectangular.

Stones River group of Minnesota, Wisconsin, and Illinois.

30. **P. pervoluta** U. and S. (Fig. 817, *d–f.*) Ordovicic.

Dorsum rounded, emargination moderate, lateral lobes of lip rounded.

Black River and lowest Trenton of Kentucky and Black River of Minnesota.

31. **P. cancellata** Hall. (Fig. 817, *g–i.*) Ordovicic.

Regularly rounded dorsum with minute umbilicus and only moderately expanding lip. Sinus deep and more nearly U-shaped. Surface beautifully cancellated by transverse and revolving striæ.

Trenton to Richmond of New York, Canada and throughout the Middle States, chiefly in the Trenton.

32. **P. acutilirata** Hall. Devonic.

Umbilicus rather large and margins subangular; sinus broad and of moderate depth.

Hamilton of New York, Pennsylvania, etc.

XII. Bucaniella Meek.

Bellerophontoid shells with deeply trilobed dorsum, slightly embracing, dorso-ventrally compressed volutions, sinuate aperture without slit band, and faint surface striæ. Siluric.

Fig. 818. *Bucaniella trilobata.* (After Hall.)

33. **B. trilobata** Sowerby. (Fig. 818.) Siluric.

Small, strongly trilobed, the median lobe largest; sinus broad and shallow; surface with fine revolving lines and lines of growth.

Medina and Clinton of New York, Ohio, Pennsylvania. etc. Also Europe.

XIII. Tetranota Ulrich and Scofield.

Bellerophontids with dorso-ventrally compressed shells, laterally expanding aperture, open umbilicus, and sinus ending in a short slit situated on a median revolving fold and flanked on either side by one or more revolving ridges; surface with sharp growth lines. Ordovicic.

34. **T. bidorsata** (Hall). (Fig. 819, *a–d.*) Ordovicic.

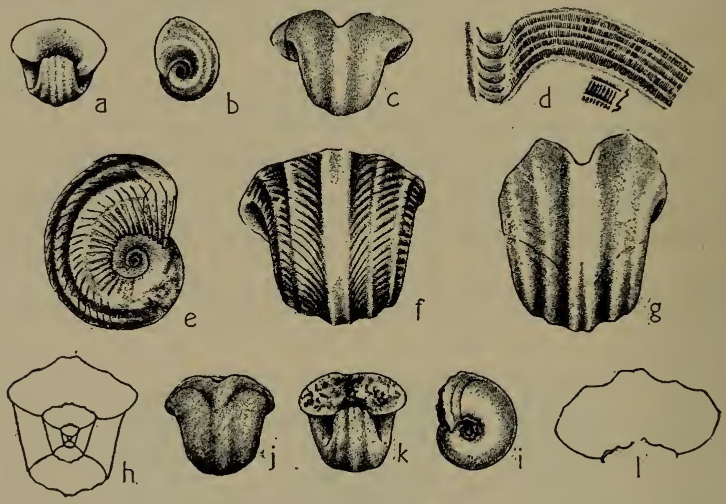


Fig. 819. *a–d*, *Tetranota bidorsata* (*d* = enlargement of surface); *e–h*, *l*, *T. sexcarinata* (*l* = transverse section of whorl); *i–k*, *T. obsoleta*. (After Ulr. and Scof., Pal. Minn.)

With one obtusely angular ridge on each side, half way between umbilicus and ridge flanking the sinus. A median ridge occurs in the slit band, though often not preserved.

Stones River of Tennessee; Black River and Trenton of Minnesota, Canada, New York, and Tennessee.

35. **T. sexcarinata** Ulrich and Scofield. (Fig. 819, *e–h*, *l*.) Ordovicic.

Larger, with stronger and more persistent ridges, with an additional one on either side, making six in all. Surface striæ strong.

Stones River of Minnesota, Illinois, and Tennessee, and Trenton of Minnesota.

36. **T. obsoleta** Ulrich and Scofield. (Fig. 819, *i–k*.) Ordovicic.

Revolving ridges obsolete, umbilicus smaller than in *T. bidorsata*, volutions more rounded.

Stones River of Wisconsin, Black River of Kentucky and Minnesota, Trenton of Minnesota, Utica of Cincinnati region.

XIV. Bucania Hall. (Emend. U. and S.)

Bellerophontid shells with generally large umbilicus and depressed volutions which do not expand rapidly or abruptly; apertural sinus ending in a slit; slit-band distinct, raised or depressed; surface with oblique revolving lines and lines or lamellæ of growth. Ordovicic.

37. **B. sulcatina** Emmons. (Figs. 820, 821). Ordovicic.

Fig. 820. *Bucania sulcatina*, × ⅔. (After Raymond.)

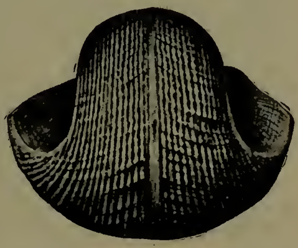


Fig. 821. *Bucania sulcatina*, × 2.

Large; whorls angular at umbilicus, width of aperture about equal to height of shell. Apertural angles acute. Surface with strong revolving and finer transverse striæ.

Chazy of Champlain region.

38. **B. halli** Ulrich and Scofield. (Fig. 822.) Ordovicic.

Aperture twice as wide as high. Lateral angles acute. Smaller than preceding.

Stones River of Minnesota, Black River of Kentucky.

FIG. 822. *Bucania halli.* *a*, *b*, side and dorsal view; *c*, *d*, sections of whorls. (After Ulrich and Scofield, Pal. Minn.)

39. **B. punctifrons** Emmons. Ordovicic.

Rather small with large umbilicus and subpentagonal aperture slightly wider than high; slit band somewhat elevated; surface covered by a meshwork, which gives it a punctate appearance.

Trenton of Canada, New York, Tennessee.

XV. Salpingostoma Roemer.

Bellerophontid shells, with gradually enlarging, scarcely embracing volutions, and abruptly expanding, trumpet-like mature aperture. Inner volutions with a slit band as in *Bucania*, last half of whorl with long, narrow slit, closed behind the peristome; surface with revolving lines often oblique and wavy, and lines of growth. Ordovicic.

40. **S. buelli** Whitfield. (Fig. 823, *a–c*.) Ordovicic.

Of about three and a half volutions, rather large; gradually expanding; lip flaring out abruptly.

Stones River and Black River, Minnesota, Wisconsin, and Illinois.

41. **S. expansa** Hall. Ordovicic.

Subangular, large, of about four volutions, with abruptly expanding aperture, and obtusely carinated dorsum. Section of last volution subtriangular, surface striate.

Trenton limestone of New York, Canada, etc.

42. **S. richmondensis** Ulrich. (Fig. 823, *d*, *e*.) Ordovicic.

About three volutions; the last expanding somewhat more rapidly, and the lips flaring less abruptly than in the preceding species. Richmond group of Indiana.

In the Trenton limestone of New York, Canada, etc.

FIG. 823. *a–c*, *Salpingostoma buelli*, $\times$ ⅔; *d*, *e*, *S. richmondensis*, $\times$ ⅔. (After Ulrich, Pal. Minn.)

XVI. TREMATONOTUS Hall.

Like *Salpingostoma* but with a series of elongate elliptical perforations in the center of the last whorl, instead of a single long slit. Siluric–Devonic.

43. **T. alpheus** Hall. (Figs. 824, 825.) Siluric.

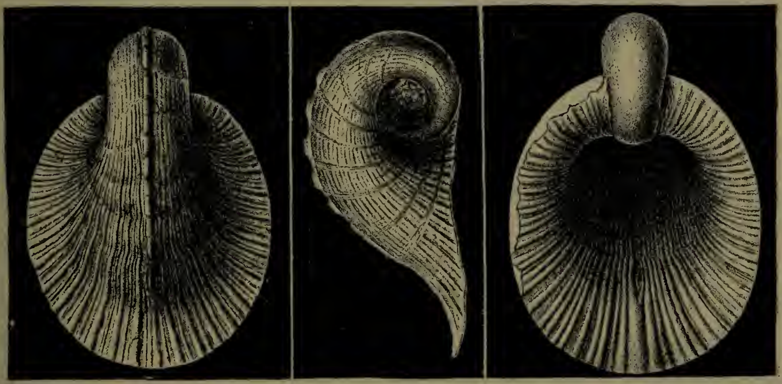


FIG. 824. *Trematonotus alpheus*, $\times$ ⅔. (After Clarke & Ruedemann, Guelph Fauna.)

Whorls 3 to 4, scarcely impressed by preceding ones, aperture with flaring lip, turning out at right angles and finally reflected, frequently long. Surface with coarse flat-topped spirals, increased by intercalation, and concentric wrinkles. Perforations on narrow keel.

Guelph of New York, Canada, Ill., Ohio, and Racine beds of Wisconsin.

44. **T. profundus** Conrad. Devonic.

More strongly embracing, obscurely carinate whorls, with profoundly flaring margin, the latter seldom fully preserved.

Becraft limestone of eastern New York (common).

XVII. Oxydiscus Koken.

Strongly compressed, disciform shells, with mostly slightly embracing, gradually expanding, and sharply-keeled whorls, a lanceolate or subtriangular aperture, without inner callosity, and a deep V-shaped dorsal sinus continued as a long and narrow slit in dorsal keel. Ordovicic–Mississippic.

45. **O. subacutus** Ulrich. (Fig. 826.) Ordovicic.

Fig. 825. *Trematonotus alpheus*, × ⅔, section. (After Clarke & Ruedem.)

Fig. 826. *Oxydiscus subacutus*. (After Ulrich & Scofield, Pal. Minn.)

Volutions embracing one third to one half of the preceding, acutely carinated; section of whorl subtriangular, abruptly inflected at umbilicus.

Trenton of Kentucky, Tennessee (?), and Minnesota (?).

46. **O. curvilineata** (Conrad). (Fig. 827.) Devonic.

Whorls embracing about half the preceding one; sides rounded, rather abruptly inflected at the umbilicus, sinus about one fourth of a volution; striæ of growth often in fascicles; keel sharp.

Oriskany, Schoharie, and Onondaga of New York.

47. **O. cryptolites** (Hall). Mississippic.

Whorls more embracing than in preceding species, so as to leave only a small umbilicus; less compressed; carina less sharply marked; aperture subtriangular.

Rockford limestone of Indiana, Kinderhook of Iowa, Marshall of Michigan, and Waverly group of Ohio.

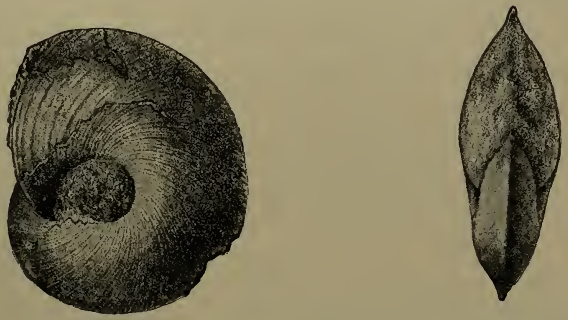


FIG. 827. *Oxydiscus curvilineata.* (After Hall.)

XVIII. PHRAGMOLITHES Conrad. (*Conradella* U. and S.)

Differs from the preceding in the absence of marginal angular sinus and in the coarsely wrinkled lamellose growth lines. Slit generally long, aperture expanded. Ordovicic.

48. **P. triangularis** U. and S. (Fig. 828, *a*, *b*.) Ordovicic.

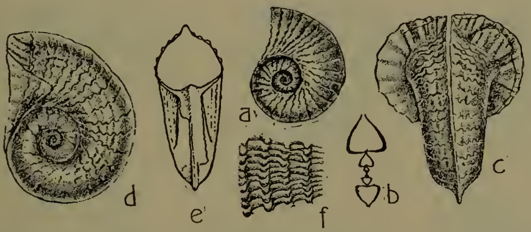


FIG. 828. *a*, *b*, *Phragmolithes triangularis*; *c*, *d*, *P. fimbriatus*; *e*, *f*, *P. dyeri* (*f*, enlargement of surface). (After Ulrich and Scofield, Pal. Minn.)

Readily distinguished by its rather rapidly enlarging volutions of strongly triangular section and abrupt inflection at the umbilicus.

Stones River of Minnesota, Wisconsin, Illinois and Tennessee.

49. **P. fimbriatatus** U. and S. (Fig. 828, *c*, *d*.) Ordovicic.

Rounded whorls sharply carinate and with periodically expanding lip, leaving numerous strong imbricating growth lamellæ.

Stones River group of Minnesota and Illinois.

50. **P. compressus** Conrad. Ordovicic.

Volutions scarcely contiguous, rounded, and sharply and profoundly carinated; narrower and less rapidly enlarging than preceding species; surface striæ strongly zigzag, rather distant, and subimbricating, with finer striæ between.

Trenton of New York and adjoining Canadian regions.

51. **P. dyeri** Hall. (Fig. 828, *e, f.*) Ordovicic.

Small, whorls embracing about one third, rounded laterally and less strongly carinated than in preceding. Surface with spirals due to regular emargination of lamellæ.

Richmond group of Indiana, Ohio, Kentucky, and Minnesota.

XIX. Bellerophon Montfort. (Emend. Waagen.)

Subglobose, umbilicus mostly small or absent, dorsum rounded, aperture generally expanded, usually with a callosity on the inner lip. A central emargination and slit band or elevated blunt (rarely noded) keel present; surface marked only by strong growth lines, rarely by one or more rows of nodes. Ordovicic–Permic.

52. **B. troosti** (d'Orbigny) Safford. (Fig. 829, *a–c.*) Ordovicic.

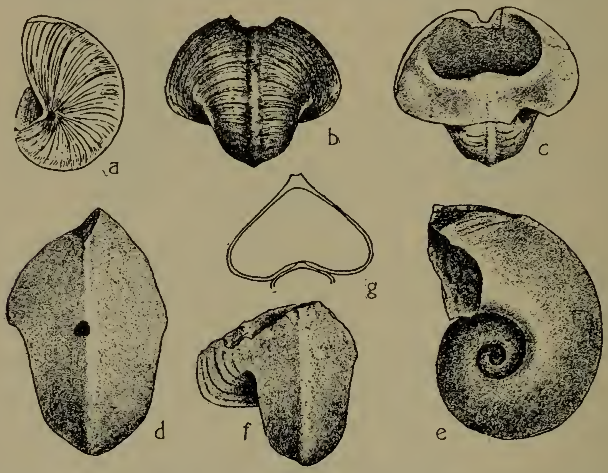


Fig. 829. *a–c, Bellerophon troosti; d–g, B. platystoma* (*g*, cross-section of whorl). (After Ulrich, Pal. Minn.)

Whorls rounded, rapidly enlarging, flaring at lip; umbilicus very small, sharp and deep; dorsum with distinct rounded keel in adult.

Trenton of Tennessee and Kentucky.

53. **B. platystoma** Meek and Worthen. (Fig. 829, *d–g*.)
Ordovicic.

Whorls subtriangular, gradually expanding to aperture, which expands more rapidly; umbilicus rather large.

Trenton (Galena) of Illinois and Minnesota.

54. **B. exiguus** Foerste. Siluric.

Small, umbilicus minute, lip expanding, emarginate aperture subtrigonal, carina rounded; lines of growth strong.

Clinton of Ohio, Indiana.

55. **B. pelops** Hall. (Fig. 830.) Devonic.

FIG. 830. *Bellerophon pelops*, three views. (After Hall.)

Subglobose, non-umbilicate, aperture expanded, with moderate sinus, and broadly rounded lobes on either side. Keel narrow, sharp; lines of growth marked.

Schoharie and Onondaga of New York, Ohio, etc.

56. **B. newberryi** Meek. (Fig. 831, *c*.) Devonic.

FIG. 831. *a*, *b*, *Bellerophon propinquus*; *c*. *B. newberryi*. (After Meek, Pal. Ohio, I.)

Smaller than preceding, less expanding; surface striæ more pronounced and rib-like. In the closely related *B. propinquus* Meek (Fig. 831, *a*, *b*), the striæ are more crowded and the dorsal keel has a median impression. In worn specimens the keel in both may be obsolete.

Columbus (Onondaga) limestone of Ohio.

57. **B. nactus** Hall. Devonic.

More abruptly rounded and with sharper keel; aperture less abruptly expanded.

Chemung of New York and Pennsylvania.

58. **B. sublævis** Hall. (Fig. 832.) Mississippic–Carbonic

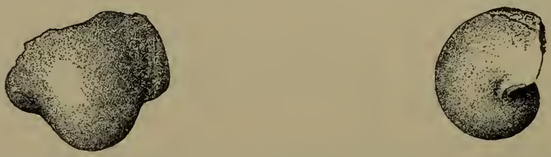


FIG. 832. *Bellerophon sublævis.* (After Whitfield, Bull. Am. Mus. Nat. Hist.)

Medium-sized, subglobose, non-umbilicate, with transverse aperture and an extended thickened lip, with deep emargination and low rounded dorsal carina. Surface smooth except for growth lines, which, together with the carina, are often obsolete.

St. Louis and Chester groups of Indiana, Illinois, Ohio, Missouri, and Arkansas, and Lower Coal Measures of Pennsylvania.

59. **B. crassus** Meek and Worthen. (Fig. 833.) Carbonic–Permic.

Large, subglobose, thick-shelled, slightly umbilicated, with nar-

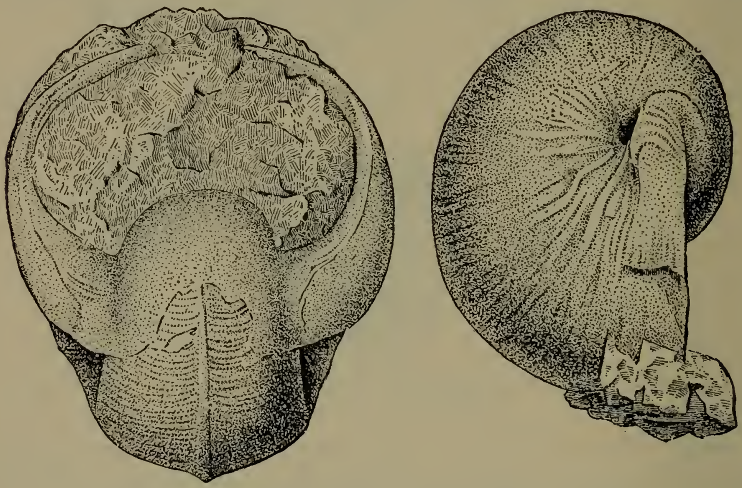


FIG 833. *Bellerophon crassus.* (After White, 13th Ind.)

row, prominent, subangular keel; inner lip strong, spreading over umbilicus; surface with growth lines and fine wrinkles.

Coal measures of Illinois, Indiana, Ohio, Pennsylvania, Arkansas, Missouri, and Nevada ; Permic of Texas.

60. **B. percarinatus** Conrad. (Fig. 834, *a–c, d–f.*) Carbonic.

Medium-sized, rapidly expanding, non-umbilicated ; outer lip laterally thickened ; dorsum with three rows of nodes, the median one most prominent, the lateral ones dying out as ribs. A variety with the lateral nodes obsolete occurs with this (Fig. 834, *a–c*).

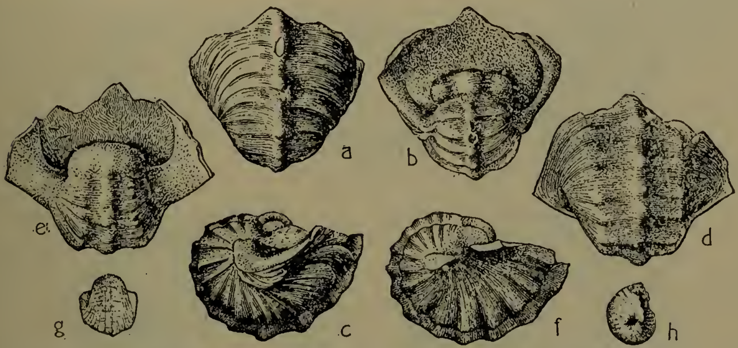


FIG. 834. *a–c, Bellerophon percarinatus* var. β ; *d–f, B. percarinatus ; g, h, Bucanopsis montfortianus.* (After White, 13th Ind. Rep. and Bull. 77, U. S. G. S.)

Coal measures of Nebraska, West Virginia, Pennsylvania, Ohio, Indiana, Illinois, Iowa, Missouri.

XX. EUPHEMUS McCoy. (Emend. Waagen.)

Closely involute, subglobose, Bellerophontid shells, not abruptly expanded, and with wide, but generally obscure band ; inner lip with low parallel columellar folds or ridges, often extending as a thin covering over the greater part of the preceding whorl, giving a part of the shell a strongly striate aspect. Carbonic–Permic.

61. **E. carbonarius** (Cox). (Fig. 835, *a–c.*) Carbonic.

Small, globose, with broadly rounded dorsum, and transversely compressed sublunate aperture, without expanded lip ; band obscure, sometimes concave ; surface, except on final portion of last whorl, with 18–25 strong revolving lines, nodose near the umbilicus.

Coal measures of West Virginia, Ohio, Kentucky, Indiana, Illinois, Iowa, Missouri, Kansas, Nebraska, Arkansas, and Texas.

62. **E. nodocarinatus.** (Fig. 835, *d, e.*) Carbonic.

Large, heavy, subglobose, slightly expanded aperturally, earlier whorls as in preceding, final whorl carinate, with central depressed band and another obscure ridge on each side.

Coal measures of Pennsylvania, Ohio, Indiana, Illinois, Iowa, and Missouri.

63. **E. subpapillosus** White. Carbonic.

Like *E. carbonarius* but larger and with last portion of final

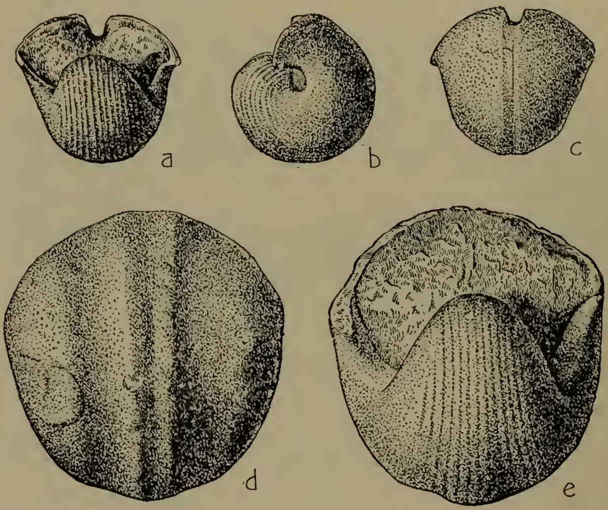


FIG. 835. *a–c*, *Euphemus carbonarius*; *d*, *e*, *E. nodocarinatus*. (After White, 13th Ind.)

whorl studded with slightly raised papillæ in rows continuous with the revolving ridges of preceding portion.

Upper Carbonic of Utah (Upper Aubrey group), of Colorado and Arizona.

XXI. BUCANOPSIS Ulrich.

Like *Bellerophon*, but surface cancellated by regular straight revolving and transverse striæ. Ordovicic–Permic.

(A polyphyletic group, retained for the present.)

64. **B. carinifera** Ulrich. (Fig. 836.) Ordovicic.

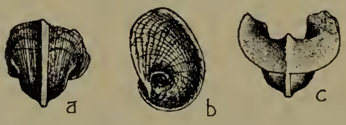


FIG. 836. *Bucanopsis carinifera*. (After Ulrich, Pal. Minn.)

Small, moderately embracing, gradually expanding whorls, with rather abruptly expanding lip; slit band on flat-topped carina; revolving striæ stronger than transverse.

Trenton of Kentucky, Lorraine of Ohio.

65. **B. leda** Hall. (Fig. 837.) Devonic.

Aperture rapidly expanding, carina rounded; slit not deep; revolving striæ alternating in size, sometimes fasciculate, principal ones broad and rounded, transverse striæ fine.

Hamilton of New York, Ontario, etc.

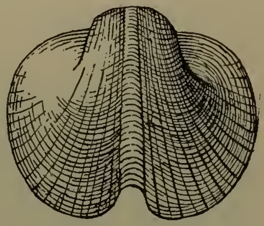


FIG. 837. *Bucanopsis leda.* (Copy from Hall.)

66. **B. lyra** Hall. Devonic.

Less ventricose than preceding and with less abruptly expanded aperture; carina elevated and revolving striæ equal and firm.

Hamilton of New York, Falls of Ohio, etc.

67. **B. kœneni** Clarke. (Fig. 838.) Devonic.

FIG. 838. *Bucanopsis kœneni,* × 2. (After Clarke.)

Like *B. leda,* but smaller, with less rapidly expanding lip and surface strongly tuberculate, through accentuation of ornamentation of *B. leda* type.

Portage (Styliolina limestone) of New York.

68. **B. textilis** Hall. (Fig. 839.) Mississippic.

FIG. 839. *Bucanopsis textilis.* (After Whitfield, Am. Mus. Nat. Hist. Bull.)

Differs from *B. leda* in its narrower band, less rapid expansion, less pronounced umbilicus and finer striæ.

St. Louis of Indiana and equivalent horizon of Nevada (?).

69. **B. marcouana** Geinitz. (Fig. 840.) Carbonic.

Fig. 840. *Bucanopsis marcouanus.* (After Keyes.)

Like *B. leda*, but with fine, regular, simple striæ and rather strong rounded carina, transversely lined. Spirals on band very fine.

Coal measures of West Virginia, Ohio, Illinois, Missouri, Nebraska, and Arkansas.

70. **B. montfortiana** Norwood and Pratten. (Fig. 834, *g*, *h*.) Carbonic.

Shell non-umbilicate, small, but with large expanded lip; band in median depression from each side of which extend large subnodose wrinkles to near the umbilicus, except on the expanded apertural part. Surface with revolving coarser and finer striæ, which are somewhat nodose on the ribs.

Coal measures of West Virginia, Ohio, Indiana, Illinois, Iowa, Missouri, Kansas, Nebraska, Texas, and Utah.

XXII. Ptomatis Clarke.

Like *Bellerophon*, but with very rapid and broadly expanding lip, which is sinuate in front, and without band; granulose callus on inner lip, whorls narrowly umbilicate. Devonic.

71. **P. patulus** (Hall). (Fig. 841.) Devonic.

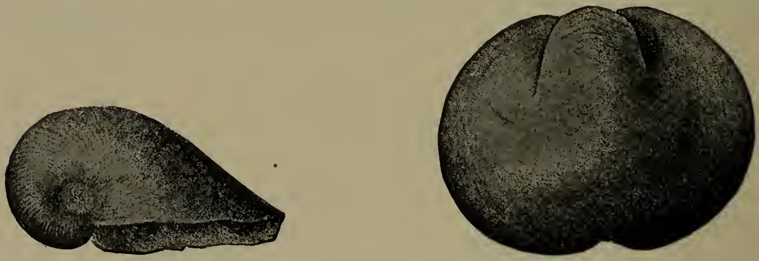


Fig. 841. *Ptomatis patulus.* (After Hall.)

Smooth, except for growth lines, which on earlier whorls are strong and regularly costate; callus granulate; sinus very shallow.

Hamilton of New York, Falls of the Ohio, Maryland, Virginia, and Pennsylvania.

72. **P. rudis** (Hall). (Fig. 842.) Devonic.

Differs in having slight median angulation and strong concen-

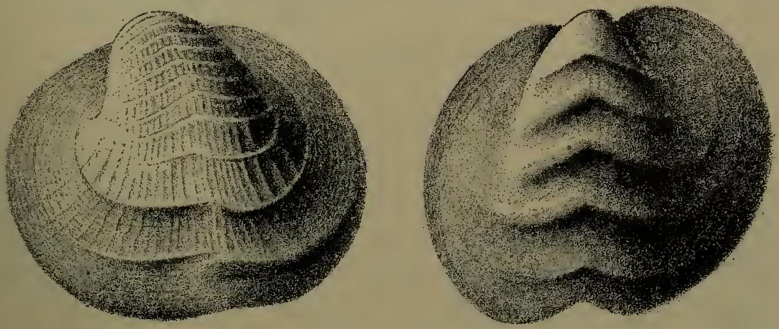


FIG. 842. *Ptomatis rudis*, in different states of preservation, showing striæ and strong undulation, somewhat distorted. (Pal. N. Y., V.)

tric rugæ on last whorl ; radiating striæ often seen between rugæ.

Hamilton group of eastern New York, etc.

XXIII. PHRAGMOSTOMA Hall. (Emend. Clarke.)

Differs from *Ptomatis* in having a narrow, sharply defined slit-band, callus of inner lip thick, flattened, and wedge-shaped, but does not form a true septum as in *Carinaropsis*. Devonic.

FIG. 843. *Phragmostoma natator*. (After Clarke.)

73. **P. natator** Hall. (Fig. 843.) Devonic.

Abruptly expanding lip, narrow deep sinus, surface with growth lines and wrinkles only.

Portage (Naples) beds of New York, etc.

74. **P. chautauquæ** Clarke. (Fig. 844.) Devonic.

With more strongly pronounced narrower young whorls longitudinally striate, smooth in adult, with narrow, sharp slit-band, and abruptly expanding lip.

Portage (Naples) of New York.

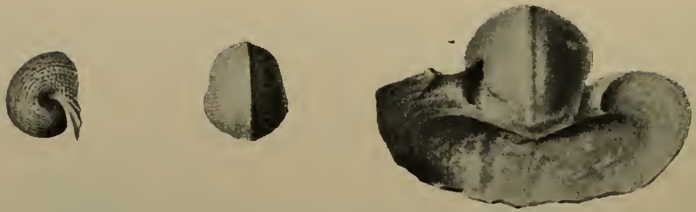


FIG. 844. *Phragmostoma chautauquæ.* (After Clarke.)

XXIV. CARINAROPSIS Hall.

Patelliform shells with apex slightly enrolled in median plane, aperture flaring, emarginate anteriorly; dorsal surface angular medially; a strong concave septum constricting the aperture below the beak; septum carinated on inner side. Operculum generally present. Ordovicic.

75. **C. carinata** Hall. Ordovicic.

Gradually expanding from minutely enrolled apex; faint anterior sinus and strong dorsal carina.

Trenton of New York.

76. **C. cunulæ** Hall. (Fig. 845, *a–c*.) Ordovicic.

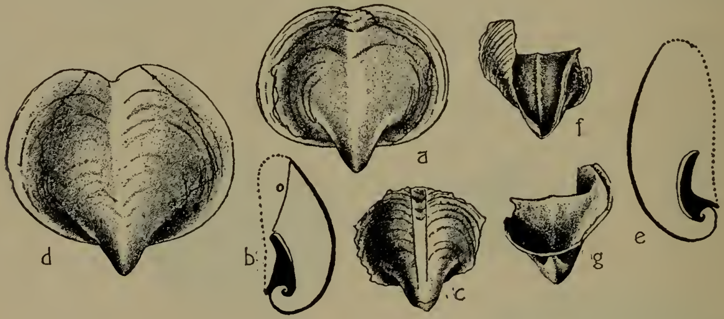


FIG. 845. *a–c*, *Carinaropsis cunulæ*, *c* showing sharp dorsal band; *d–g*, *C. cymbula*. *f*, *g*, a broken specimen showing septum; *b* and *e*, sections (*o* = outline of operculum, arb.). (After Ulrich, Pal. Minn.)

Dorsum faintly subcarinate, the carina often replaced by a slit-band; septum broad, but slighty excavated.

Trenton of Tennessee and Kentucky.

77. **C. cymbula** Hall. (Fig. 845, *d–g*.) Ordovicic.

Like the preceding, but septum deeply excavated on the outer, and strongly carinated on the inner side.

Trenton of Kentucky, etc.

XXV. Porcellia Leveille.

Widely umbilicated, often large shells, the adult whorls coiling in a single plane as in *Bellerophon*, and with a dorsal slit and prominent band. Inner whorls in a flat spire. Surface ornamented by ribs or nodes.

78. **P. crassinoda** (White and Whit.). (Fig. 846.) Mississippic.

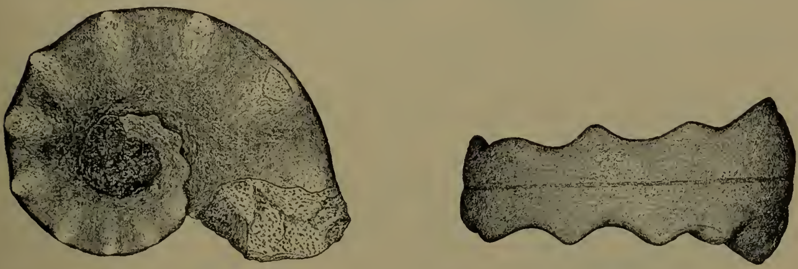


FIG. 846. *Porcellia crassinoda*, two views of type specimen, × ½. (After Weller, St. Louis Acad. Sci. Trans., X.)

Very large, dorsum flatly rounded, very broad, with well-marked narrow median slit band; dorso-lateral angles coarsely nodose, the nodes dying out towards the umbilicus. Cross-section of whorls subtriangular, surface with revolving and transverse lines.

Kinderhook of Iowa.

FIG. 847. *Porcellia nodosa.* (After Keyes.)

79. **P. nodosa** Hall. (Fig. 847.) Mississippic.

Smaller, volutions more nearly rounded, nodes sharper and more pronounced.

Kinderhook of Illinois, Burlington of Illinois and Missouri.

Family Pleurotomariidæ d'Orbigny.

XXVI. Raphistoma Hall.

Flat-spired, umbilicated shells with close sutures and sharply angular volutions of triangular section, without slit or band, but with a shallow notch in the lip at the outer angle, and with the lines of growth interrupted on the flat surface by a raised line and curving forward on the body of the whorl. Ordovicic.

80. **R. striatum** (Emmons). (Fig. 848, *c*, *d*.) Ordovicic.

Large and high with nearly flat spire, sometimes with early volutions elevated; shoulder angle large, often 90°; umbilicus

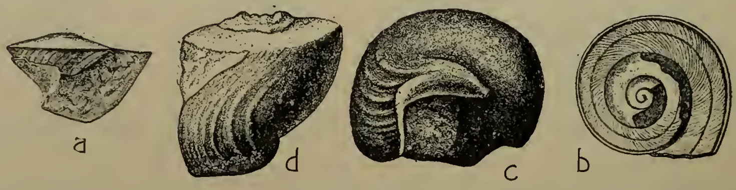


FIG. 848. *a*, *b*, *Raphistoma stamineum; c*, *d*, *R. striatum.* (After Raymond.)

closed except in internal molds; surface with coarse rounded striæ or undulations.

Chazy of New York and Quebec (Aylmer sandstone).

81. **R. stamineum** Hall. (Figs. 848, *a*, *b*; 849.) Ordovicic.

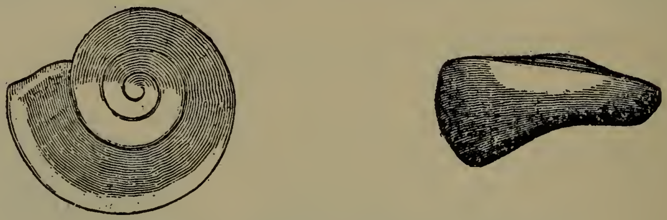


FIG. 849. *Raphistoma stamineum.* (After Hall.)

Large, central portion of spire slightly elevated above outer volution; body of whorl subventricose; shoulder nearly flat; angle sharp; striæ rounded.

Chazy of New York.

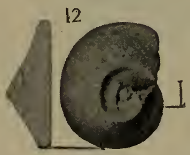


FIG. 850. *Raphistomina attleboroughensis*, enlarged. (After Walcott, 10th Ann. U. S. G. S.)

82. **R. planistrium** Hall. Ordovicic.

Smaller than preceding, of greater proportional height; shoulder slightly concave; striæ flat, imbricating; aperture narrow, trigonal; umbilicus small.

Chazy of New York.

83. **R. peracutum** Ulrich and Scofield. (Fig. 851, *a–d*.) Ordovicic.

Small, spire perfectly flat, shoulder angle very sharp; umbilicus above a fourth of diameter; revolving line a third of the shoulder width from the suture.

Black River of Minnesota.

XXVII. RAPHISTOMINA Ulrich and Scofield.

Depressed conical, umbilicate, with sharply angular and carinate whorls, the carina projecting over the moderately impressed suture; growth lines below carina at first curving backwards; no notch or band. Cambric-Ordovicic.

84. **R. (?) attleboroughensis** Shaler and Foerste. (Fig. 850.) Cambric.

Minute, low-spired; shoulder whorls flat or faintly concave, base of whorls rather flat, shoulder angle not very sharp.

Lower Cambric of Newfoundland? and eastern Massachusetts.

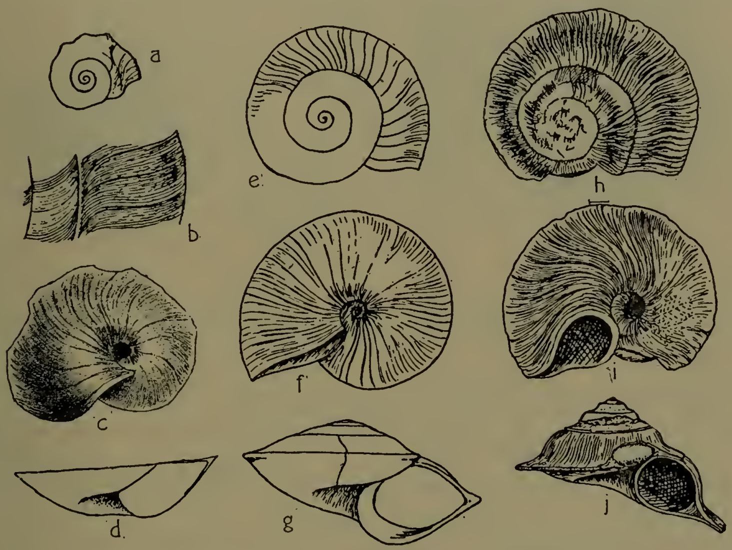


FIG. 851. *a–d*, *Raphistoma peracutum* (*a*, × 1; *b*, enlargement of surface; *c*, *d*, × 2): *e–g*, *Raphistomina lapicida*; *h–j*, *Euomphalopterus valerius* var. *obsoletus* (After Ulrich and Scof., Pal. Minn.)

85. **R. lapicida** Salter. (Fig. 851, *e–g*.) Ordovicic.

Medium-sized, height of spire about equal to height of body of last whorl; whorls embracing to angle except last one, which occasionally falls below; peripheral angulation sharp and carinate.

Black River of Canada and Tennessee.

XXVIII. EUOMPHALOPTERIS Roemer.

Trochoid or subtruncate, broadly umbilicated shells, with the shoulder flat or concave and the body receding, the angle being drawn out into a thin flat carina, which may be very broad and entire or broken up into rude spines. Siluric.

86. **E. valerius** (Billings). (Figs. 851, *h, j*; 852.) Siluric.

Shoulder angle drawn out into a broad hollow flange with comparatively smooth edge, and smooth base without revolving ridge around the umbilicus.

Niagara of Waldron, Indiana, Guelph of Canada, Ohio, and

FIG. 852. *Euomphalopteris valeria*, umbilical view. (After Whiteaves, Pal. Foss., III.)

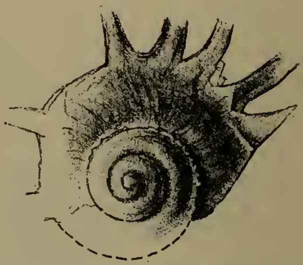


FIG. 853. *Euomphalopteris elora*; apical view. (After Whiteaves, Pal. Foss., III.)

New York, and Upper Monroe of Michigan.

87. **E. elora** (Billings). (Fig. 853.) Siluric.

Similar to preceding, but smaller and with the shoulder angle drawn out into a series of flat spines.

Guelph of Ontario.

XXIX. SCALITES Emmons.

Spirally coiled, with whorls embracing more or less strongly, shoulder flat and horizontal, base of whorl drawn out into a short anterior notch. Ordovicic.

88. **S. angulatus** Conrad. (Fig. 854, *a.*) Ordovicic.

Spire forming about one half of the length of the shell, sutures canaliculated, angle slightly acute, sides of whorl nearly perpendicular; shoulder with obliquely backward bending striæ.

Chazy limestone of New York, etc.

XXX. Ormospira Ulrich.

High-spired, of many rapidly enlarging volutions. Structure as in *Rhaphistoma*, but with very loosely embracing whorls. Ordovicic.

89. **O. laticincta** Ulrich. (Fig. 854, *b*, *c*.) Ordovicic.

Large; angle between shoulder and body of whorl obtuse;

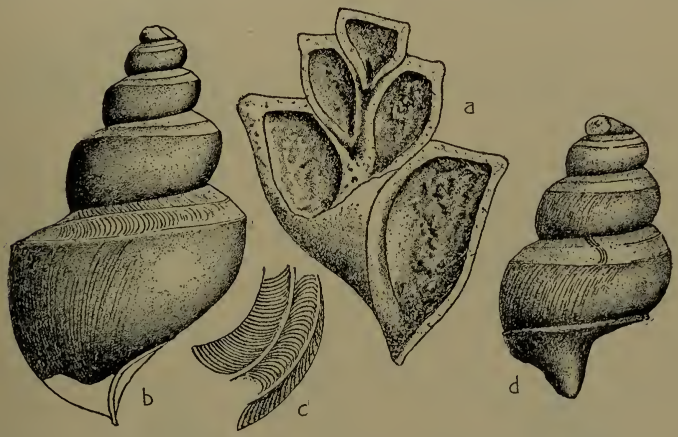


Fig. 854. *a*, *Scalites angulatus*; *b*, *c*, *Ormospira laticincta*, with enlargement of slit band; *d*, *Ormospira alexandra*. (After Ulrich, Pal. Minn.)

shoulder flat; striæ interrupted near middle by revolving spiral, at which they change from convex to concave.

Black River of Tennessee.

90. **O. alexandra** Bill. (Fig. 854, *d*.) Ordovicic.

With smaller apical angle and more rounded whorls than preceding.

Black River of Canada and Kentucky.

XXXI. Lophospira Whitfield.

Shells with more or less elevated spires; close coiled whorls except in senescent (phylogerontic) species. Whorls angular, generally with several carinæ of which the central one forms a strong keel and is marked by an obtusely rounded peripheral "band" which is often marked with spirals of which the central one is heaviest. Umbilicus nearly always present. Outer lip notched but without slit. Ordovicic–Devonic.

A. Lines of growth forming very slight or no peripheral reëntrant.

91. **L. rectistriata** Raymond. (Fig. 855.) Ordovicic.

Distinguished by its small size, nearly straight lines of growth and rather prominent carina beneath the periphery.

FIG. 855. *Lophospira rectistriata*, $\times \frac{4}{3}$. (After Raymond.)

Common throughout lower and middle Chazy of the Lake Champlain region.

92. **L. bicincta** (Hall). (Fig. 856, *a–d.*) Ordovicic.

Shell 15 to 30 mm. high, with apical angle about 60°. Six subangular volutions, the last ventricose-tricarinate, the lower carina hidden in younger whorls. Notch in lip exceedingly shallow. Growth lines sharp.

Stones River and Trenton group of Kentucky, Tennessee, Minnesota, Illinois, Wisconsin, New York, and Canada. Also in the Cincinnati group of Minnesota.

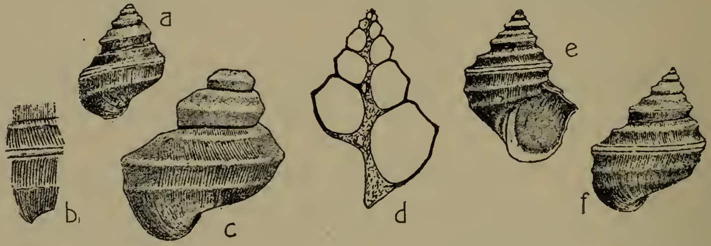


FIG. 856. *a–d, Lophospira bicincta ; e, f, L. quadrisulcata.* (After Ulr. and Scof., Pal. Minn.)

93. **L. quadrisulcata** Ulrich and Scofield. (Fig. 856, *e, f.*) Ordovicic.

Like *L. bicincta*, but with an additional carina and groove on the body whorl, all grooves and carinæ being more pronounced.

Richmond group of Minnesota.

94. **L. helicteres** Salter. (Fig. 857.) Ordovicic.

Whorls bicarinate, intercarinal spaces concave; embracing to lower carina except last whorl, which is free, and which has an additional carina formed by the sutural margin.

Black River of Ontario, Kentucky, and Wisconsin.

95. **L. wisconsinensis** Ulrich and Scofield. (Fig. 858.) Ordovicic.

All except apical whorls loose-coiled and free; carinæ obsolete towards lip.

Stones River of Minnesota, Wisconsin, and Illinois.

B. Lines of growth forming strong peripheral reëntrant, with >-shaped notch.

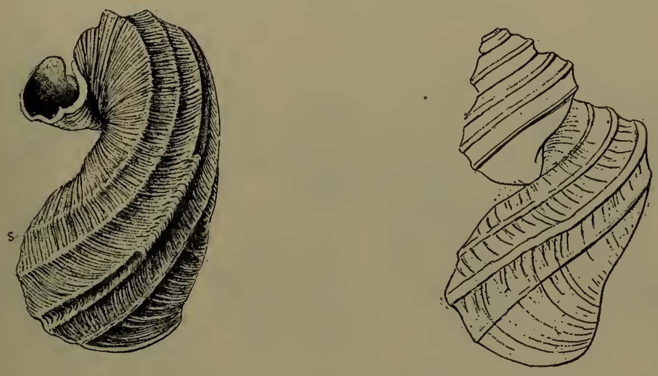


FIG. 857. *Lophospira helicteres*, last, non-coiling portion of large specimen and nearly complete individual; *s*, sutural edge. (After Salter, Can. Organ. Rem. Dec., I.)

96. **L. perangulata** Hall. (Fig. 859, *a–c*.) Ordovicic.

Small, embracing to within one half or two thirds the shoulder width of the periphery, last whorl often free, shoulder slightly concave; apical angle 50° to 70°; band prominent, trilineate; lower carina pronounced; umbilicus small.

Stones River of Kentucky, Tennessee, Minnesota; Lowville of

FIG. 858. *Lophospira wisconsinensis*. (After Ulrich and Scofield, Pal. Minn.)

New York and Ottawa River, Canada ("Black River" group). Chazy of New York.

97. **L. acuminata** Ulrich and Scofield. (Fig. 859, *d*.)

Ordovicic.

With sharper periphery and lower carina than preceding, more numerous whorls and smaller apical angle; no umbilicus.

Richmond group of Indiana, Ohio, and Minnesota.

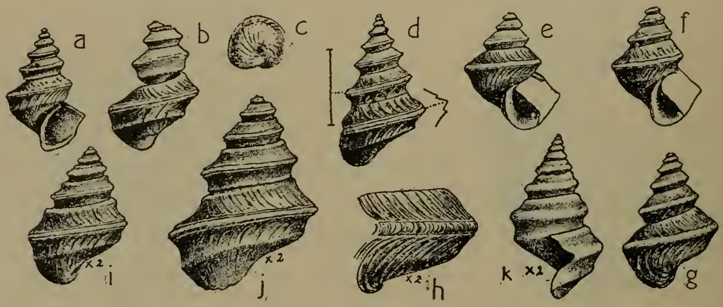


FIG. 859. *a–c*, *Lophospira perangulata*; *d*, *L. acuminata*; *e–h*, *L. medialis*; *i–k*, *L. pulchella*. (After Ulrich, Pal. Minn.)

98. **L. medialis** Ulrich and Scofield. (Fig. 859, *e–h*.)

Ordovicic.

Embracing to near periphery; apical angle 58° to 70°; lower carina faint; umbilicus small.

Trenton of New York, Minnesota, Kentucky, Tennessee, and Missouri.

99. **L. pulchella** Ulrich and Scofield. (Fig. 859, *i–k*.)

Ordovicic.

With well-marked subsutural carina, concave shoulder and lower carina strong and obtuse; angle 50° to 56°; umbilicus minute or closed.

Black River of Minnesota, Trenton of Kentucky. Variety with smaller angle (50° to 46°) in Richmond of Minnesota.

100. **L. oweni** U. and S. (Fig. 860, *a–c*.) Ordovicic.

Subsutural carina broad and obscure; band thick, rounded; shoulder less concave than preceding; lower carina obsolete in adult.

Stones River and Black River groups of Kentucky and Minnesota, and a variety in Eden of Ohio.

101. **L. ampla** Ulrich. (Fig. 860, *d*, *e*.) Ordovicic.

Broader than preceding (apical angle 70° to 80°); shoulder with pronounced carina near suture.

Lorraine of Ohio and Kentucky; Richmond of Indiana and Kentucky.

102. **L. tropidophora** Meek. (Fig. 860, *f–h*.) Ordovicic.

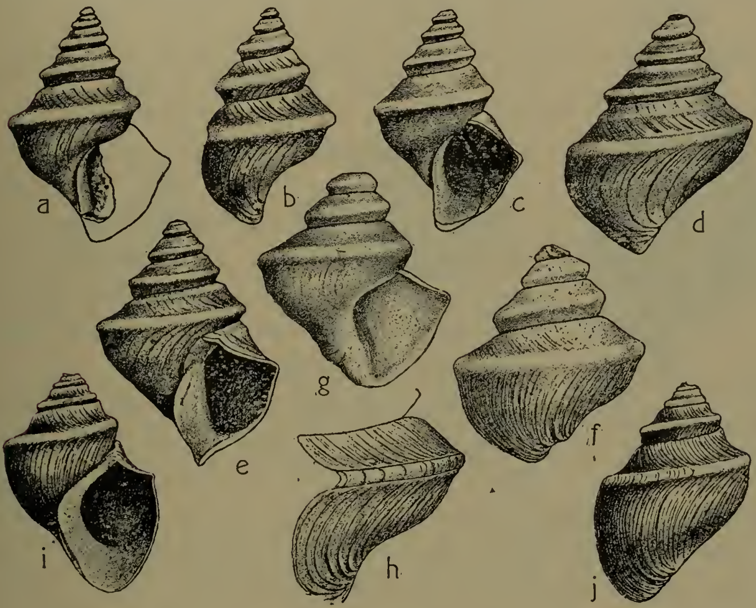


FIG. 860. *a–c*, *Lophospira oweni*; *d*, *e*, *L. ampla*; *f–h*, *L. tropidophora*; *i*, *j*, *L. sumnerensis*. (After Ulrich, Pal. Minn.)

Like the preceding, but without the upper carina.

Cincinnati group (Eden to Richmond) of Ohio, Kentucky, and Indiana.

103. **L. sumnerensis** Safford. (Fig. 860, *i*, *j*.) Ordovicic.

Body whorl large, vertical below periphery; band prominent, rounded; shoulder concave; apical angle 60° to 73°; no accessory carinæ.

Trenton of Tennessee, Kentucky, and Minnesota.

104. **L. bowdeni** Safford. (Fig. 862, *a–c*.) Ordovicic.

High-spired; apical angle 26° to 34°; shoulder concave below, convex near suture from obscure carina; band round, not prominent; lower carina faint or absent; umbilicus covered by reflexed lip.

Upper Nashville of Tennessee; Lorraine and Richmond of Ohio, Indiana, and Kentucky.

105. **L. augustina** Billings. (Fig. 861.) Ordovicic.

Fig. 861. *Lophospira augustina*, × ⅔. (After Billings.)

Large, with 8 to 10 strong volutions, up to 120 mm. in height; apical angle 33° to 40°, embracing to within two thirds shoulder width of periphery (to within one third in var. *minnesotensis* Ulrich and Scofield).

Quebec group of Newfoundland; Trenton of Minnesota and Ottawa, Canada.

106. **L. serrulata** Salter. (Fig. 862, *d, e, f.*) Ordovicic.

Very sharply carinate with intercarinal spaces deeply concave; shoulder carina in upper third, two nearly equidistant carinæ on body whorl; final whorls generally free; some specialized varieties scarcely coiled.

Stones River beds of Minnesota, Wisconsin, Illinois; Black River of Wisconsin, Tennessee, and Ottawa River, Canada.

107. **L. bispiralis** (Hall). Siluric.

Apical angle about 60°, whorls embracing so as to leave body-space equal to one half or two thirds the shoulder width; band,

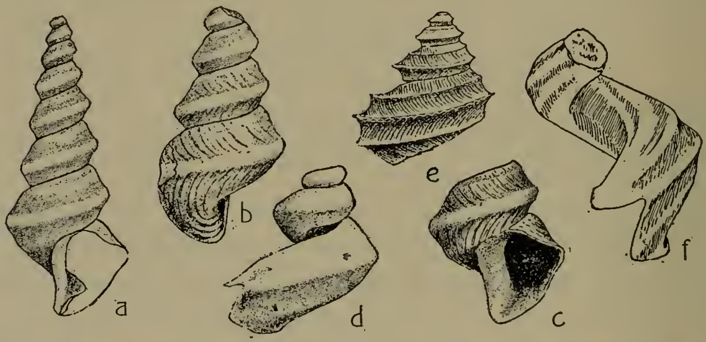


Fig. 862. *a–c, Lophospira bowdeni; d, e, L. serrulata; f, L. serrulata* var. *laxa*. (After Ulrich, Pal. Minn.)

which is concave, bordered by raised line, and at the center of the body whorl; shoulder nearly flat, with median carina, strong in young but faint in adult individuals. Emargination slight.

Guelph of Canada and New York, Upper Monroe of Michigan and Canada.

108. **L. adjutor** (Hall). (Fig. 863.) Devonic.

Whorls of round aspect; periphery depressed; band concave, margined by two spirals; shoulder and body carinæ nearer to peripheral band.

Onondaga of New York and Ohio.

109. **L. trilix** (Hall). (Fig. 864.) Devonic.

FIG. 863. *Lophospira adjutor.* (After Hall, Pal. N. Y., V.)

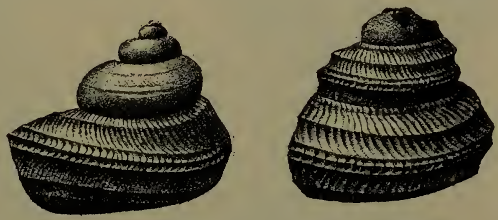


FIG. 864. *Lophospira trilix*, × 2. (Pal. N. Y., V.)

Peripheral band tricarinate; shoulder with strong median or supra-median and sometimes faint sutural carinæ; body with two close set carinæ crossed by later whorls; growth lines strong, lamellose.

Hamilton of eastern New York, Pennsylvania, Maryland, etc.

XXXII. SCHIZOLOPHA Ulrich.

Like *Lophospira*, but with the apertural notch prolonged into a long slit with parallel edges.

110. **S. moorei** Ulrich. (Fig. 865.) Ordovicic.

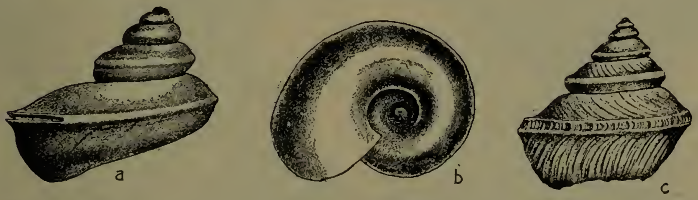


FIG. 865. *Schizolopha moorei*; *a*, lateral, and *b*, umbilical, view of internal mold; *c*, specimens with shell preserved. All × ⅔. (After Ulrich, Pal. Minn.)

Apical angle about 75° (more or less); whorls embracing to within one half or one third shoulder width of the angle; shoulder and body free from spirals, gently concavo-convex; slit occupying about one fifth of length of last whorl.

Lorraine and Richmond of the Cincinnati dome region.

XXXIII. PHANEROTREMA Fischer.

Turbinate shells with few rapidly enlarging whorls, developing a shoulder angle in the later whorls, slit band deep on the angle of the last whorls. Siluric–Carbonic.

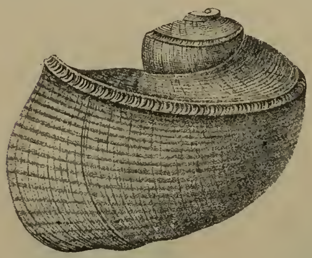


FIG. 866. *Phanerotrema occidens*, × 2/3. (After Hall, 20th Mus. Report.)

111. **P. occidens** (Hall). (Fig. 866.) Siluric.

Angle extending back through most of the whorls, final coil somewhat loose; shoulder flat but sloping, with strong revolving spirals, cancellated by growth lines; body of whorls rounded.

Niagara limestone of Wisconsin.

112. **P. labrosa** (Hall). (Fig. 867.) Devonic.

Large, last whorl very ventricose, angulation chiefly on last portion of outer whorl, spirals strong on all parts of shell, cancellating lamellæ strong.

Helderbergian (Becraft) of New York, etc.

113. **P. grayvillensis** N. and P. Carbonic.

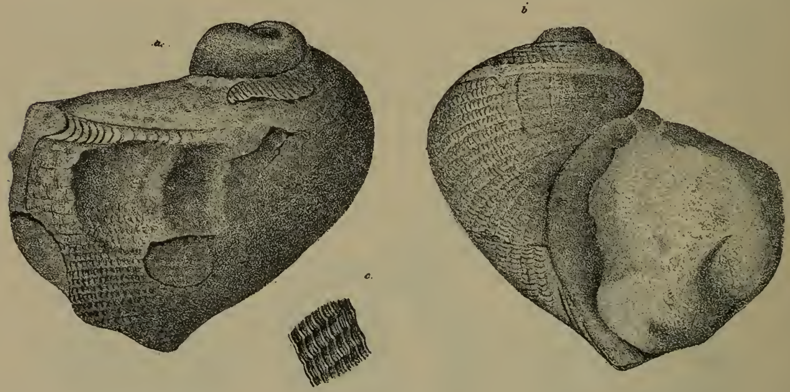


FIG. 867. *Phanerotrema labrosa*; *a*, *b*, opposite views of a specimen partly denuded of the shell, × 5/6; *c*, enlargement of surface markings. (Pal. N. Y., III.)

Small, high-spired; volutions all angular, shoulder slightly concave; spirals strong.

Coal measures of West Virginia, Kentucky, Illinois, Indiana, Iowa, Missouri, Nebraska, and Arizona.

XXXIV. Worthenia DeKoninck.

Conical, with whorls embracing part way to angulation, which is pronounced and carries the slit. This extends back one third or one fourth the length of the whorl; band regularly nodulated or crenulated; spirals well developed. Carbonic.

114. **W. tabulata** (Conr.). (Fig. 868.) Carbonic.

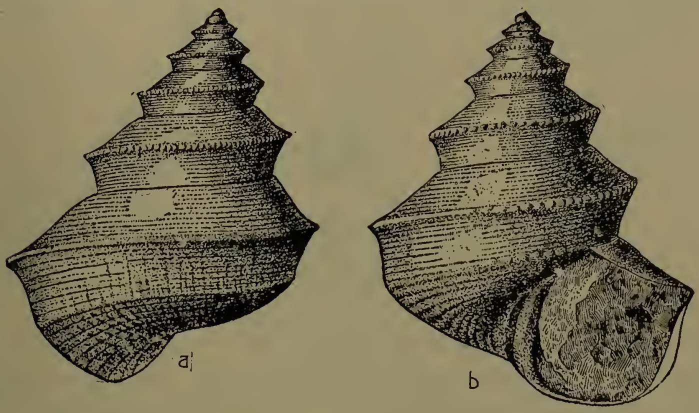


Fig. 868. *Worthenia tabulata.* (After White, 13th Ind. Rep.)

Large, exposed part of whorl below carina equalling width of shoulder, and like it flat or slightly concave. Nodulated band prominent; spirals more subdued. A second carina on body whorl at level of suture.

Coal measures of Pennsylvania, Indiana, Illinois, Missouri, and Texas. Also in Belgium.

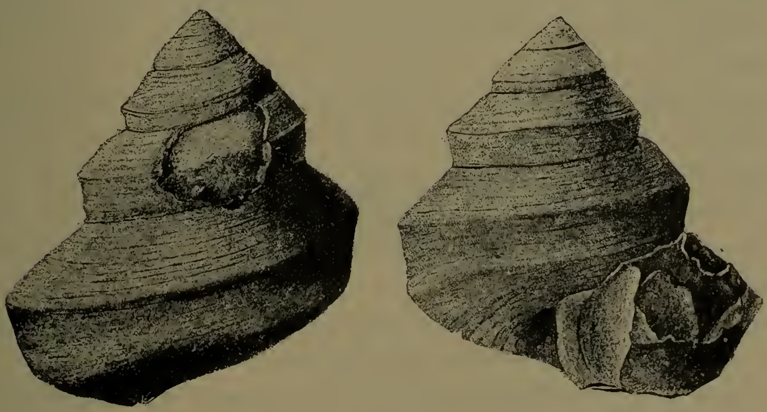


Fig. 869. *Worthenia subscalaris*, opposite views. (After Meek and Worthen, Ill. Pal., II.)

115. **W. subscalaris** (Meek and Worthen). (Fig. 869.) Carbonic.

Large; early whorls embracing to near periphery, later showing space below carina equal to shoulder. Lower carina strong; spirals and nodulations subdued.

Coal measures of Illinois and Missouri.

116. **W. speciosa** (Meek and Worthen). (Fig. 870.) Carbonic.

FIG. 870. *Worthenia speciosa*; *a*, *b*, opposite views, nat. size; *c*, enlargement of part of surface. (After Meek and Worthen, Pal. Ill., II.)

Less than half the size of the preceding, of seven or more volutions, whorls embracing to within half the shoulder width of the carina; slit-bearing angulation and lower carina strong; shoulder slightly concave, with growth lines strengthened at regular intervals; spirals numerous, fine.

Coal measures of Illinois, Missouri, and Oklahoma.

XXXV. LIOSPIRA Ulrich and Scofield.

Pleurotomariod shells with low spire, subrhomboidal volutions, which are flat, gently convex or slightly concave above, and not infrequently angular at the edge of the umbilicus. The aperture is deeply notched and the band is scarcely distinguishable. Ordovicic.

117. **L. micula** (Hall). (Fig. 871, *a–d*.) Ordovicic.

Small; whorls flattened and continuous in the spire, the suture scarcely depressed. Umbilicus filled by reflex callosity of lip.

Trenton group of Kentucky; Eden and Lorraine (?) (Maquoketa) of Minnesota, Wisconsin, Illinois, Iowa, Ohio, and Kentucky.

118. **L. progne** (Bill.). (Fig. 871, *e–g*.) Ordovicic.

Like *L. micula*, but about twice as large or more.

Stones River and Black River beds of Canada, Kentucky, Tennessee, and Minnesota.

119. **L. vitruvia** (Bill.). (Fig. 871, *h–k*.) Ordovicic.

Larger than preceding, with stronger, backward deflected lines of growth and more strongly defined band. Umbilicus open and

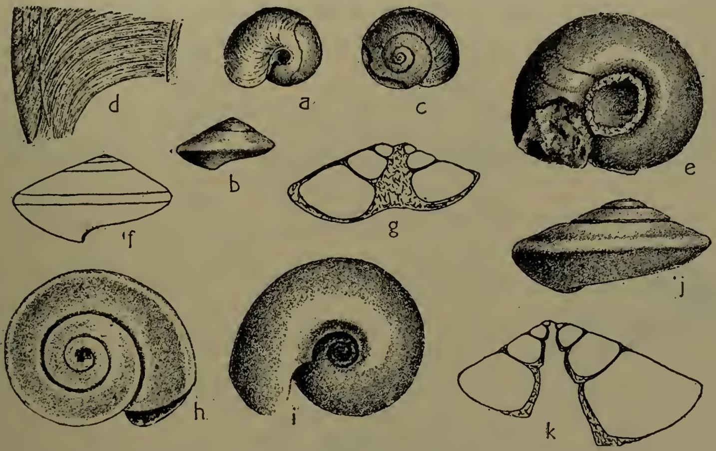


FIG. 871. *a–d*, *Liospira micula* (*d*, surface enlargement); *e–g*, *L. progne*; *h–k*, *L. vitruvia* (*g* and *k* = longitudinal sections showing hollow axis). (After Ulrich and Scof., Pal. Minn.)

often a third of the diameter of the shell. Lower lip with tongue-ike projections.

Stones River to Trenton ; Canada, New York, Tennessee, Kentucky, Ohio, Indiana, Illinois, Iowa, Wisconsin, and Minnesota.

120. **L. americanus** (Bill.). Ordovicic.

Differs from *L. vitruvia* in more rounded lower lip, as shown by lines of growth. Umbilicus wider and less abrupt and without angulation.

In the Trenton limestones of eastern Canada, New York, Minnesota, and Manitoba ; Stones River and Black River of Tennessee.

FIG. 872. *Liospira eugenia*. (After Billings.)

121. **L. eugenia** (Bill.). (Fig. 872.) Ordovicic.

Shoulder convex near suture, concave near periphery ; periphery elevated ; umbilicus closed.

Black River of Canada (Encampment d'Ours, etc.).

122. **L. mundula** Ulrich. (Fig. 875, *a*, *b*.) Ordovicic.

Differs from *L. eugenia* in having shoulder wholly concave, peripheral band high and obtuse, and umbilicus open.

Black River of Paquette's Rapids, Canada; Trenton of Kentucky.

XXXVI. Euconia Ulrich.

Subtrochiform shells with nearly flat base and regular conical spire, the suture scarcely depressed, the base umbilicated; band on upper side of peripheral edge, mouth subquadrate. Ordovicic–Siluric.

Fig. 873. *Euconia etna*. A small specimen.

123. **E. ramsayi** (Bill.). Ordovicic.

Of medium size, regularly conic and with small umbilicus.

Beekmantown of Canada.

124. **E. etna** (Bill.). (Fig. 873.) Ordovicic.

With wide umbilicus; often large (2 in. in basal diameter and nearly same in height).

Beekmantown of Newfoundland.

125. **E.** (?) **pervetusta** (Conrad). (Fig. 874.) Siluric.

Fig. 874. *Euconia pervetusta*.

Small, with gently convex whorls (about four) embracing to ambitus or beyond; umbilicus large and deep, extending to apex.

Medina of New York.

XXXVII. Eotomaria Ulrich and Scofield.

Depressed-conical pleurotomarioids, characterized by a notch but not a slit, and with the band on the upper side of the periphery; surface with simple lines of growth. Ordovicic–Siluric.

126. **E. dryope** Bill. (Fig. 875, *c–e*.) Ordovicic.

Shoulder convex near suture, concave near band; coiling sometimes slightly loose; umbilicus moderate.

Stones River of Minnesota; Black River of Tennessee.

127. **E. vicina** Ulrich and Scofield. (Fig. 875, *f*.) Ordovicic.

FIG. 875. *a*, *b*, *Liospira mundula*; *c–e*, *Eotomaria dryope*; *f*, *E. vicina*.

Like the preceding, but with shoulders flat, forming a cone equal in height to body of last whorl.

Stones River of Minnesota and Wisconsin.

128. **E. supracingulata** (Bill.). (Fig. 876.) Ordovicic.

FIG. 876. *Eotomaria supracingulata*, three views, × ⅔. (After Ulrich, Pal. Minn.)

Large; whorls not embracing to periphery; shoulders gently convex; notch deep; umbilicus large.

Stones River and Black River of Illinois, Wisconsin, Michigan, and Minnesota; Pogonip group of Nevada (?).

129. **E. areyi** Clarke and Ruedeman. Siluric.

Large and robust, with nearly flat shoulders, a prominent band, and the sides of the body whorl nearly vertical.

In the Guelph of Canada and New York; Upper Monroe of Michigan.

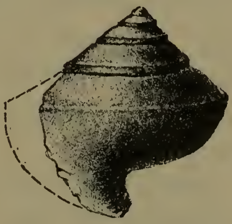


FIG. 877. *Eotomaria galtense*. (After Whiteaves, Pal. Foss., III.)

130. **E. galtensis** (Bill.). (Fig. 877.) Siluric.

Depressed conic, apical angle about 100°, shoulders nearly flat, whorls embracing to ambitus, body portion receding, making ambital angle often less than 90°; growth lines recurving, sometimes strong on upper surface.

Guelph of Canada and New York; Upper Monroe of Michigan.

XXXVIII. CLATHROSPIRA Ulrich and Scofield.

Distinguished from *Eotomaria* by a delicate cancellated surface sculpture, and concave vertical band on the periphery. Ordovicic–Devonic (?).

131. **C. subconica** (Hall). (Fig. 878, *a–c.*) Ordovicic.

Volutions flattened above and embracing nearly to the periphery of the preceding, under side rounded; band sharply defined, covered by succeeding whorls; surface marked by spiral and similar cancellating growth lines.

Stones River and Black River groups of Minnesota, Wisconsin,

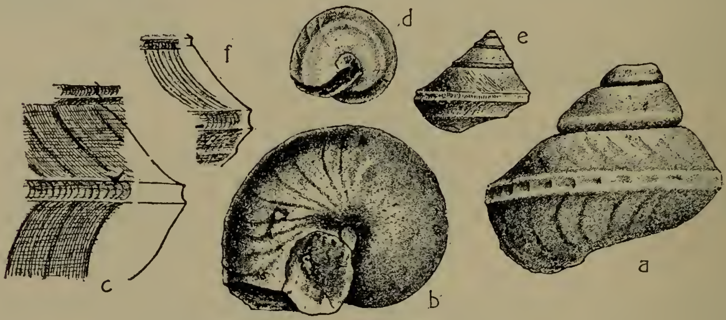


FIG. 878. *a–c*, *Clathrospira subconica*; *d–f*, *C. conica*. (*c*, *f* enlargement of surfaces.) (After Ulrich and Scofield Pal. Minn.)

Illinois, Kentucky, and Tennessee; Black River and Trenton of Canada and New York. Also doubtfully in the Cincinnati group of Ohio, Indiana, and Kentucky.

132. **C. conica** U. and S. (Fig. 878, *d–f.*) Ordovicic.

Smaller; shoulder concave or flat, body concave below periphery, the concavity bounded below by an angulation or faint carina.

Black River and Trenton of Minnesota; Trenton of Kentucky and Lorraine of the Cincinnati region.

XXXIX. EURYZONE Koken.

Round-whorled *Pleurotomarias*, sometimes with slightly flattened shoulder and with a slit band near the middle of the whorl often covered by the margin of the succeeding whorls. Band concave, flat or rarely convex; surface with fine revolving striæ cancellated by lines of growth, rarely smooth. Umbilicus variable. Devonic.

133. **E. rugulata** (Hall). (Fig. 879, *a.*) Devonic.

Last whorl greatly expanding; revolving striæ faint, generally not preserved; band broad, concave, generally showing on all volutions; slit moderate.

In the Agoniatite limestone horizon of the Marcellus of eastern North America; also in the Hamilton group (?) of New York.

134. **E. itys** (Hall). (Fig. 879, *b.*) Devonic.

Higher spire than preceding, volutions regularly expanding, band narrow, partly covered by succeeding whorls; revolving striæ equal to transverse or stronger, often nodose from cancellation.

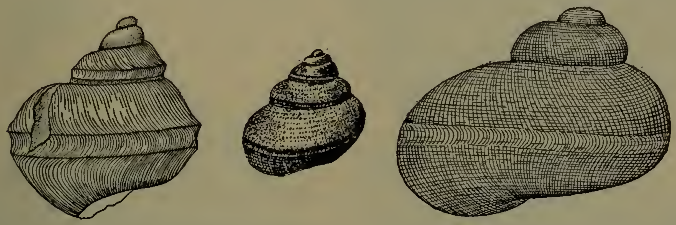


Fig. 879. *Euryzone rugulata*, × 2; *E. itys*, × ⅔; *E. lucina*, × ⅔. (Copies from Hall.)

Hamilton beds of New York, Maryland, and Virginia, and representative form at Falls of the Ohio.

135. **E. (Pleurorima) lucina** (Hall). (Fig. 879, *c.*) Devonic.

Large; whorls rather more compressed vertically than in preceding, and regularly and more rapidly enlarging; band wide, crossed by succeeding whorls except in senile individuals; revolving striæ equal to or fainter than transverse.

Onondaga and Hamilton of western New York and Falls of the Ohio.

XL. Spiroraphe Perner.

Umbilicated pleurotomarioids of depressed-rounded whorls, with profound suture and subquadrangular section. Band above suture throughout, forming strong, convex or flat spiral. Growth lines strong, often elevated, strongly reflected backwards. Spiral sculpture absent. Ordovicic–Devonic.

136. **S. arata** Hall. (Fig. 880.) Devonic.

Whorls depressed; moderate spire and deep sutures; body whorl ventricose toward aperture; umbilicus not large; surface with strong, often elevated transverse striæ ; increasing by intercalation in last whorl.

Schoharie grit and Onondaga of New York, etc.

XLI. Mourlonia DeKoninck.

Umbilicated pleurotomarioids, with body of whorl large, shoulder more or less flattened, forming conical or discoidal spire ; band

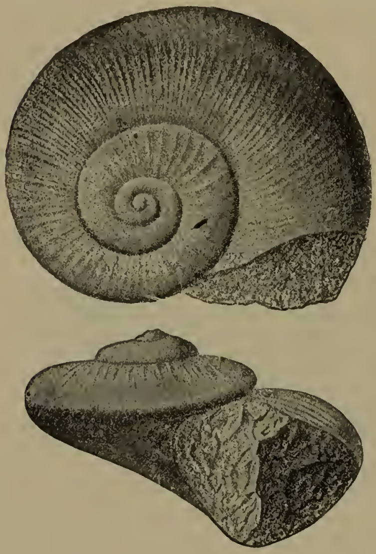


Fig. 880. *Spiroraphe arata*. (After Hall.)

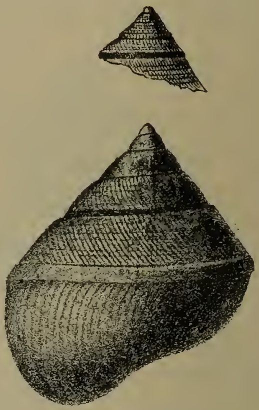


Fig. 881. *Mourlonia mississippiensis*. (After Meek, Pal. Ohio, II.)

heavy just above the ambitus ; surface with spirals cancellating the growth lines. Mississippic–Carbonic.

Fig. 882. *Gyroma capillaria*. (After Hall.)

137. **M. mississippiensis** (Wh. and Whit.). (Fig. 881.) Mississippic.

With nearly flat shoulders ; whorls embracing to ambitus, generally covering band of preceding whorl.

Kinderhook of Iowa ; Waverly of Ohio.

XLII. Gyroma Oehlert.

Round-whorled pleurotomarioids ornamented by revolving spirals and transverse ridges. Band above the middle Devonic.

138. **G. capillaria** (Conrad). (Fig. 882.) Devonic.
Turreted, with deep suture, 2–3 strong spirals above the concave band, which is also bound by spirals; aperture subrhomboidal.
Hamilton of New York.

XLIII. Bembexia Oehlert.

Depressed subconical shells with angular volutions and concave, vertical or oblique band, situated on the periphery, with a slit about one fourth volution in length; surface strongly striate. Devonic–Mississippic.

139. **B. sulcomarginata** (Conrad). (Fig. 883.) Devonic–Mississippic.
Moderately high-spired; volutions embracing to base of band;

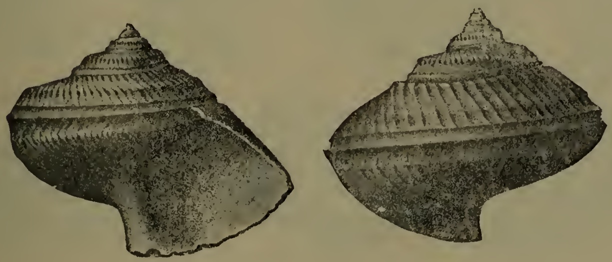


Fig. 883. *Bembexia sulcomarginata.* (After Hall.)

shoulder with two revolving ridges, one below the suture and one near periphery; growth lines strong, regular, even, and lamellose. Suture often canaliculate; body rounded, with a faint carina below the band.

Hamilton of New York, Maryland, Virginia, and Falls of the Ohio; Bedford and Berea of Ohio.

XLIV. Euconospira Ulrich.

Almost regularly conical shell with nearly flat (concave or slightly convex) base, with flat shoulder, except in the young; slit covers from a third to a fourth of the last volution, with concave band between sharply elevated lines; fine spirals on the later whorls. Mississippic-Carbonic.

140. **E. turbiniformis** M. and W. (Fig. 884, *a*, *b*.) Carbonic.
With slightly convex base and small umbilicus bordered by obscure ridge; surface cancellated by fine spirals and oblique growth lines.

Coal measures of Illinois, Indiana, and Missouri.

XLV. Trepospira Ulrich and Scofield.

Early whorls rounded, later with flat shoulder embracing up to the peripheral angulation; no umbilicus, slit short, band wide and concave; sutural edge of later whorls nodose. Devonic–Carbonic.

141. **P. rotalia** Hall. Devonic.
Shoulder of last whorls gently convex, nodes faint.
Hamilton of New York.

142. **P. sphærulata** (Conrad). (Fig. 884, *c*, *d–f*.) Carbonic.
Shoulders flat or slightly concave; nodes prominent.

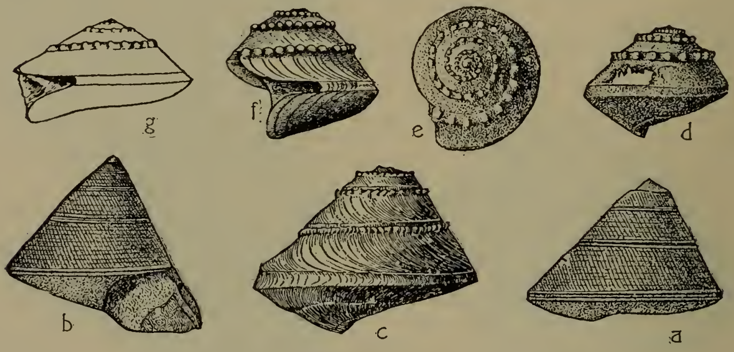


Fig. 884. *a*, *b*, *Euconospira turbiniformis*; *c*, *Trepospira sphærulata*; *d*, *e*, *T. sphærulata* var. *a*; *f*, var. *β*; *g*, *T. illinoisensis*. (*a–e*, after White, 13th Ind.; *f*, *g*, after Ulr. and Sc., Pal. Minn.)

Coal measures of the Alleghanies, Indiana, Illinois, Iowa, Missouri, Kansas, and Texas.

143. **P. illinoisensis** (Worthen). (Fig. 884, *g*.) Carbonic.
Smaller than preceding and more depressed, with greater apical angle; nodes smaller, round, separated by more than their diameter.
Coal measures of Kentucky, Iowa, Illinois, Missouri, and Arkansas.

Family *MURCHISONIDÆ* Koken.

XLVI. Hormotoma Salter.

Shell elongate, consisting of from 8 to 14 rounded or subangular whorls, the outer lip with a broad and deep V-shaped notch, but no slit. Band near the center generally obscure, marginated on each side by a delicate raised line. Ordovicic–Devonic.

144. **H. gracilis** (Hall). (Figs. 885, *a–d*; 886, *a–d*.) Ordovicic.
Slender, small, and rather loosely coiled, the whorls embracing very little, generally rounded or slightly angulated.

A number of varieties have been recognized, one or another of which occurs in most of the Trenton and Lorraine localities in

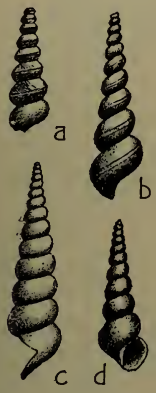


FIG. 885. *a*, *Hormotoma gracilis*, typical form; *b*, var. *sublaxa*; *c*. var. *multivolvis*; *d*, var. *angusta*.

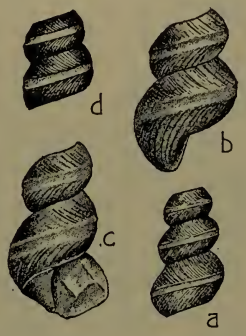


FIG. 886. *a*, *Hormotoma gracilis*, part of fig. *a* enlarged; *b*, var. *sublaxa*, part of *b* enlarged, × 2; *c*, another specimen of same, × 2; *d*, var. *angusta*, × 2.

eastern United States and Canada. It ranges as far down as the Stones River group, and into the Chazy of Lake Champlain.

145. **H. salteri** Ulrich. (Fig. 887, *c*, *d*.) Ordovicic.

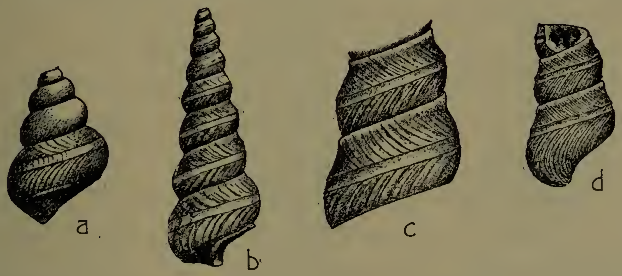


FIG. 887. *a*, *Hormotoma bellicincta*; *b*, *H. trentonensis*; *c*, *d*, *H. salteri*. (After Ulrich, Pal. Minn.)

Large, and with greater apical angle than *H. gracilis*; whorls embracing to two thirds or less shoulder width; faint subsutural band present.

Black River of Paquettes Rapids, Canada (var. *canadensis*) and

Tennessee (var. *tennesseensis*); Trenton of Kentucky (also var. *nitida*).

146. **H. bellicincta** (Hall). (Fig. 887, *a*.) Ordovicic.

Stout, with rapidly enlarging whorls, whose diameter is about twice their height; apical angle 42° to 50°; small umbilicus and flat band.

In the Trenton limestone of New York and Canada; also in Minnesota, etc. A great number of forms have generally been identified with this species, the *Murchisonia bellicincta* of Hall.

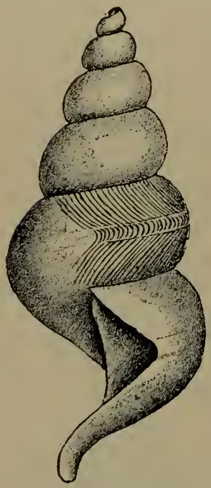


FIG. 888. *Hormotoma trentonensis*. (After Ulrich and Scof., Pal. Minn.)

147. **H. trentonensis** U. and S. (Figs. 887, *b*; 888.) Ordovicic.

Longer and more slender than preceding, apical angle averaging 35°. Commonly confounded with *H. bellicincta* Hall.

Occur generally as internal moulds in the Trenton limestone of New York and Canada. Also in Minnesota and Illinois, Kentucky, and Tennessee, though rarely.

148. **H. major** (Hall). (Fig. 889.) Ordovicic.

Large, apical angle about 25°; generally preserved as internal molds. In these the suture is deep, with an angulation on the upper side of the whorl and a flat space beyond this. In the shell the whorls embrace far up on the preceding one.

Trenton (Galena) of Minnesota, Wisconsin, Iowa, Missouri, Dakota.

149. **H. subcarinata** Grabau. Siluric.

Differs from H. *salteri* in its looser coiling, the exposed body of whorl being often half again as wide as the shoulder and bearing a faint indication of a lower spiral.

In the upper Monroe of Michigan, Ohio, and Ontario.

150. **H. desiderata** Hall. (Fig. 890.) Devonic.

Large, slender, embracing to within one half or two thirds the shoulder width; shoulder flat above, gently convex near band, which is flattened or slightly concave.

Onondaga of Falls of Ohio and New York (?).

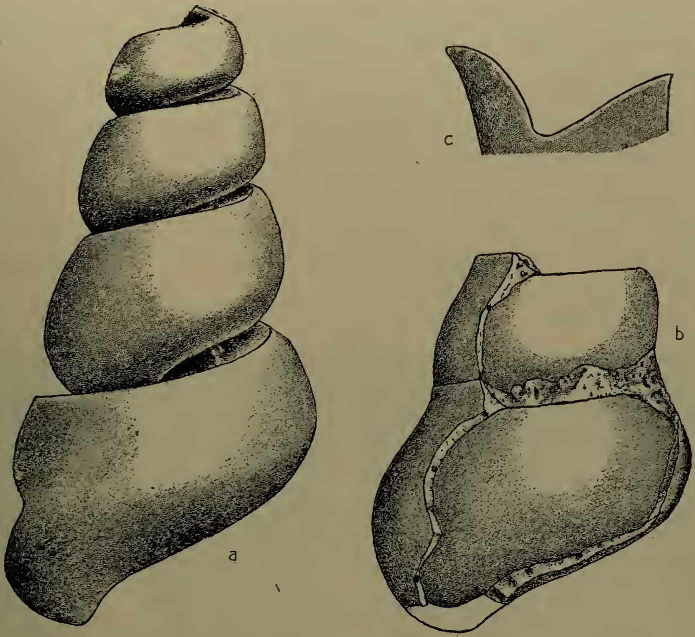


FIG. 889. *Hormotoma major*, × ⅔. (After Ulrich, Pal. Minn.)

151. **H. (Hormotomina*) maia** (Hall). (Fig. 891.) Devonic.
Whorls embracing more strongly, shoulder more convex, lines of growth strong; a faint carina close to the suture and another in the middle of the band. Onondaga limestone of Ohio.

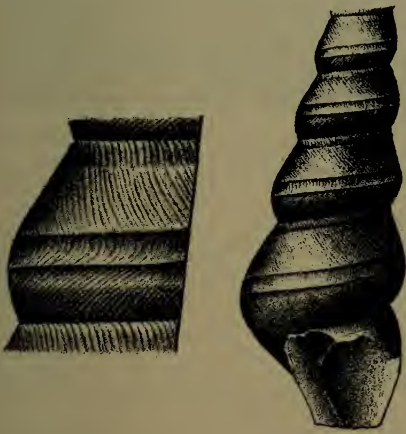


FIG. 890. *Hormotoma desiderata*, natural size and part of a whorl enlarged. (After Hall, Pal. N. Y., V.)

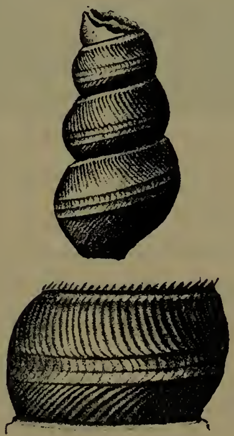


FIG. 891. *Hormotoma* (*Hormotomina*) *maia*, natural size and a single whorl enlarged. (After Pal. N.Y., V.)

XLVII. Cœlidium Clarke and Ruedemann. (*Cœlocaulus*, Oehlert.)

Differs from *Hormotoma* in greater length and more numerous depressed whorls and perforated axis, small umbilicus and rounded, not produced aperture. Ordovicic–Devonic.

152. **C. linearis** (Bill.). Ordovicic.

More strongly embracing than the next, suture almost obliterated.

Beekmantown of Mingen Islands.

153. **C. oehlerti** U. and S. (Fig. 893, *a*, *b*.) Ordovicic.

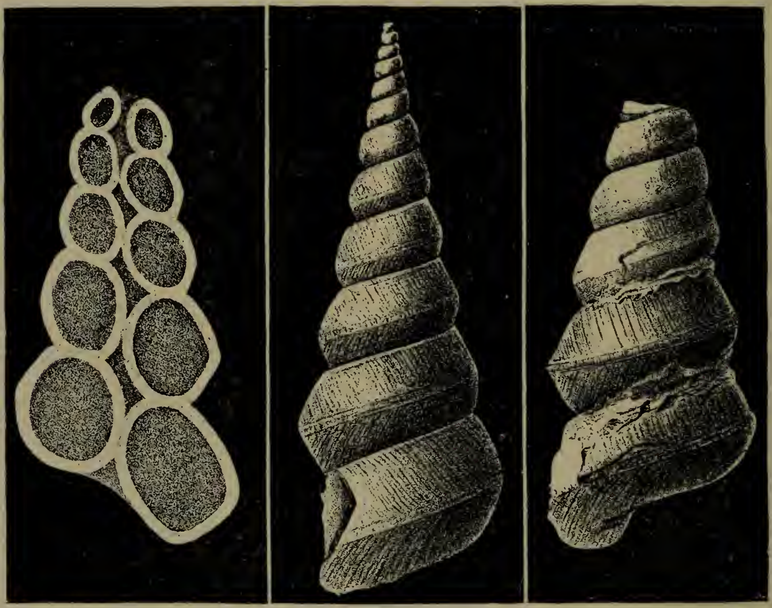


Fig. 892. *Cœlidium macrospira*, longitudinal section, showing perforate axis, and two more or less complete shells, showing form and surface character. (After Clarke and Ruedemann, Mem. N. Y. State Museum, V.)

Of numerous (30 ?) closely embracing compressed whorls, making an apical angle of 12°.

Galena of Illinois.

154. **C. macrospira** (Hall). (Fig. 892.) Siluric.

Large, apical angle 20° to 25°, early whorls embracing to within one half shoulder width or less, later ones to two thirds shoulder width or wider; periphery subangular with faint band; surfaces above and below gently convex.

Guelph of Canada, New York, Wisconsin, etc.

XLVIII. Solenospira Ulrich.

Small shells differing from *Hormotoma* in the small apical angle, the compressed character of the whorls, the surfaces of which are mostly flattened and divided by a prominent median band, depressed between sharp spirals, with or without other ridges ; mouth without slit. Ordovicic–Mississippic (?).

155. **S. prisca** (Bill.). (Fig. 893, *c*.) Ordovicic.

Apical angle about 14° ; shoulder and body flat or gently concave ; band wide, carinæ prominent, a third carina below the periphery, covered by later whorls.

Beekmantown of Mingen Islands ; Stones River of Minnesota, Wisconsin, and Tennessee.

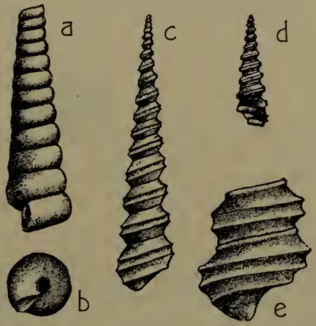


Fig. 893. *a*, *b*, *Cœlidium oehlerti* ; *c*, *Solenospira prisca* ; *d*, *S. pagoda* ; *e*, enlargement of part of same. (After Ulrich and Scofield, Pal. Minn.)

156. **S. pagoda** (Salter). (Fig. 893, *d*, *e*.) Ordovicic.

Differs from the preceding in having an additional carina just below the suture, the lower carina also being commonly visible above the suture.

Black River of Minnesota and Canada.

157. **S. minuta** (Hall). Siluric.

Minute, apical angle about 17°, shoulder and body gently concave ; carinæ only two, sharp and margining the median band.

Manlius limestone of New York ; Lower (and Upper ?) Monroe of Michigan.

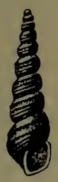


Fig. 894. *Solenospira ? turritella*. (After Whitfield, Am. Mus. Nat. Hist. Bull.)

158. **S. (?) turritella** (Hall). (Fig. 894.) Mississippic.

Small, slender, with narrow shoulder and two or more spirals below the band.

St. Louis (Spergen) of Indiana.

Family Euomphalidæ de Koninck.

XLIX. Straparollina Billings.

Shell small, spirally coiled, spire low, whorls rounded, umbilicus of moderate width. Cambric–Ordovicic.

159. **S. remota** Bill. (Fig. 895, *a*, *b*.) Cambric.

Small, with low spire of three whorls sometimes slightly angular at outer margin; height 4.5 to 6.75 mm., width 6.75 to 9 mm.

Lower Cambric (Etcheminian) of Newfoundland and eastern Massachusetts.

160. **S. primæva** (Bill.). (*Platyceras primævum* Bill.) (Fig. 895, *c*.) Cambric.

Minute; spire depressed; last whorl partly free. (Some spec -

FIG. 895. *a*, *b*, *Straparollina remota*; *c*, *S. primævum*. (After Walcott, 10th Ann. Rep. U. S. G. S.)

mens show deep dorsal sinus, while others appear to be without it (Massachusetts). These may represent distinct groups of phylogerontic shells in which the power to coil becomes obsolete.)

Lower Cambric (Georgian) of Quebec, and Troy, N. Y. Etcheminian of eastern Massachusetts.

L. STRAPAROLLUS Montfort.

Shells varying from broadly turbinate to discoidal, with rounded whorls without sinus, and with broad umbilicus. Siluric(?)–Jurassic.

161. **S. clymenioides** Hall. (Fig. 896.) Devonic.

FIG. 896. *Straparollus clymenioides*. (After Hall, N. Y., V.)

FIG. 897. *Straparollus rudis*, × ⅔. (Copy from Hall.)

Four to five gently enlarging volutions almost in same plane, slightly compressed; diameter 1 to 2 inches.

Schoharie of New York; Decewville of Canada.

162. **S. rudis** Hall. (Fig. 897.) Devonic.

More rapidly enlarging; volutions less rounded below; striæ often fasciculate and irregular.

Hamilton of New York.

163. **S. cyclostomus** Hall. (Fig. 898.) Devonic

FIG. 898. *Straparollus cyclostomus.* (After Hall, Geol. Iowa, I., 2.)

Low-spired, of five or six round, gradually increasing smooth volutions with circular aperture.

Hamilton of Iowa.

164. **S. hecale** Hall. Upper Devonic.

Similar to *S. rudis*, but with the whorls more gently enlarging.

Chemung of New York and Pennsylvania.

165. **S. ammon** Wh. and Whitf. (Fig. 899.) Mississippic.

FIG. 899. *Straparollus ammon.* (After Keyes.)

Small; whorls round, rising but little above plane of volution.

Kinderhook and Burlington of Iowa and Missouri; also western New York.

166. **S. planispira** Hall. (Fig. 900, *a*, *b*.) Mississippic.

FIG. 900. *a*, *b*, *Straparollus planispira*; *c–e*, *S. spergenensis*. (After Whitfield, Am. Mus. Nat. Hist. Bull.)

Small, with flat or scarcely concave spire of 5 or 6 slender, very gradually enlarging, rounded, smooth volutions.

St. Louis beds of Indiana.

167. **S. spergenensis** Hall. (Fig. 900, *c–e*.) Mississippic.

Early whorls flat, later slightly depressed, umbilicus deep.

St. Louis of Indiana and Missouri.

LI. PHANEROTINUS Sowerby.

Like *Straparollus*, but with the whorls disconnected, forming an open spire. Devonic–Carbonic.

FIG. 901. *Phanerotinus laxus.* (After Hall.)

168. **P. laxus** Hall. (Fig. 901.) Devonic.

Whorls round, gently enlarging in very loose spiral almost in same plane.

Onondaga and Hamilton of New York.

169. **P. eboracensis** Hall. (Fig. 902.) Devonic.

Like *Straparollus rudis*, but loose-coiled, often showing scars of attachment of foreign objects.

Hamilton of New York.

170. **P. paradoxus** Winchell. (Fig. 903.) Mississippic.

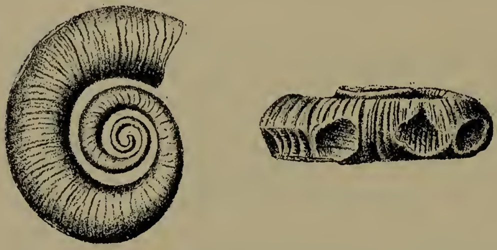


FIG. 902. *Phanerotinus eboracensis.* (After Hall, Pal. N. Y., V.)

FIG. 903. *Phanerotinus paradoxus.* (After Hall, Pal. N.Y., V.)

Like *P. laxus*, but the inner whorls depressed below plane of outer, and less loosely coiled.

Kinderhook–Burlington of Iowa and Missouri.

LII. OPHILETA Vanuxem.

Shells with depressed spire and flat base, consisting of narrow whorls which enlarge very slowly and are in contact throughout. They are flattened or gently convex on the under side, and have a faint lower and stronger upper keel, the latter ending in a deep >-shaped apertural notch. Ordovicic.

171. **O. complanata.** (*O. compacta* Salter.) (Fig. 904.) Ordovicic.

Of numerous whorls, flat on the lower and strongly concave on the upper side, outer face flat and nearly vertical, upper surface sharply keeled. Diameter 1 to 1½ inches.

In the Beekmantown (and Upper Potsdam ?), widely distributed throughout North America. Also European.

FIG. 904. *Ophileta complanata.* Umbilical (*b*) and upper view; *a*, outer keel; *d*, inner angle. (After Salter, Can. Org. Rem., Dec., I.)

172. **O. bella** Bill. (Fig. 905.) Ordovicic.

Whorls more rounded than preceding, basal portion less flat, spire less sunken, fewer whorls, upper keel nearly central; growth lines coarse, subsquamose.

Div. P, Quebec group, Newfoundland.

FIG. 905. *Ophileta bella.* (After Billings.)

LIII. OPHILETINA U. and S.

Like *Ophileta*, but with a distinct slit-band on the upper carina.

173. **O. sublaxa** U. and S. (Fig. 906, *a*, *b*.) Ordovicic.

Small, flat above, concave below (reversed in var. *depressa*), final whorl free; upper surface with two, outer with one median carina, a fourth at the baso-lateral angle.

Stones River of Minnesota, Wisconsin, and Illinois; varieties in Tennessee and Trenton of Minnesota.

LIV. ECCYLIOPTERUS Remele.

Contiguous or disconnected whorls with the structure of *Ophileta* but with the upper carina drawn out into a thin vertical "collar," which is not always preserved. Ordovicic.

174. **E. beloitensis** U. and S. (Fig. 906, *c–e*.) Ordovicic.

Rapidly enlarging, whorls in contact, coiling nearly in same plane, outer surface convex, moderately high collar.

Stones River of Wisconsin and Kentucky.

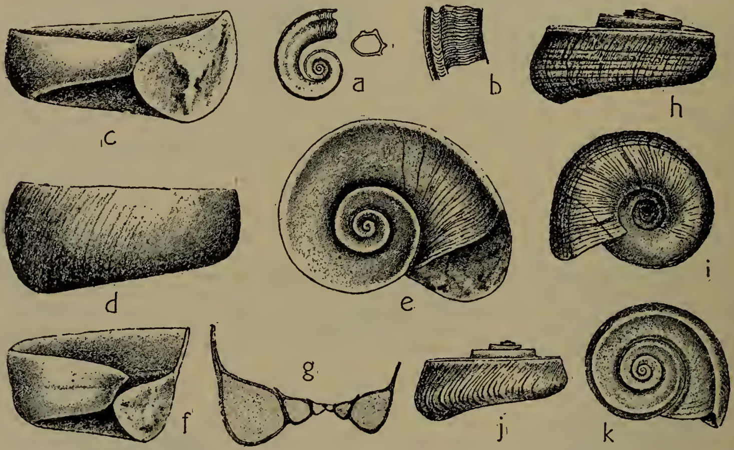


FIG. 906. *a, b, Ophiletina sublaxa* (*b*, enlargement of surface); *c–e, Eccyliopteris beloitensis; f, g, E. owenensis* (*g* = section); *h, i, Helicotoma planulata; j, k, H. tennesseensis.* (After Ulr. & Sc., Pal. Minn.)

175. **E. owenensis** Meek and Worthen. (Fig. 906, *f, g*.) Ordovicic.

Smaller, with the sides flat, and the collar, when preserved, very high and thin.

Galena (Trenton) of Minnesota and Illinois.

LV. HELICOTOMA Salter.

Differs from *Ophileta* in having a low spire rising above the outer volution, a deep umbilicus, and the whorls rounded on the under side. The carina is generally high and sharp. Ordovicic–Devonic (?).

176. **H. planulata** Salter. (Fig. 906, *h, i*.) Ordovicic.

With three to six strong, simple or double spirals on the outer side of the whorls.

Black River of Paquettes Rapids, Canada; Trenton of Missouri; Stones River of Illinois (var. *robusta*). A somewhat lower-spired form, with wider and shallower umbilicus, deeper notch, and fainter spirals (*H. umbilicata* U. and S.) occurs in the Stones River of Minnesota, Wisconsin, and Illinois.

177. **H. tennesseensis** Safford. (Fig. 906, *j*, *k*.) Ordovicic.

Like the preceding, but without the spirals; suture slightly canaliculate.

Very abundant in lower Stones River of Tennessee, also in Black River; Stones River and Black River of Kentucky. (*H. planulatoides* Ulrich.)

LVI. Pleuronotus Hall.

Shells with flat or concave spire and broad, shallow umbilicus; apertural notch deep; a distinct revolving band present. Siluric(?)–Devonic.

178. **P. decewi** Billings. (Fig. 907.) Devonic.

Large, spire flat or gently concave, of three or four volutions, periphery in adult flat and separated from the upper surface by a strong carina.

Onondaga of New York, Canada, Ohio, Michigan, and elsewhere.

Fig. 907. *Pleuronotus decewi.* (After Hall.)

LVII. Euomphalus Sowerby.

Shells with flat or low spires, angulate and carinate above, but without marked notch as in *Pleuronotus*. Young like *Straparollus*. Carbonic.

179. **E. latus** Hall. (Fig. 908.) Mississippic.

Of about four or five volutions, spire very little elevated, upper surface obliquely flattened inside of carina, outer margin angulate and subcarinate; inner abruptly elevated and somewhat carinate at suture line; base broadly umbilicate.

Burlington of Iowa, Illinois, Missouri; Waverly of Ohio.

180. **E. similis** M. and W. (Fig. 909.) Mississippic.

Small, subdiscoidal, spire flat in var. *planus*, otherwise slightly elevated ; angulation nearly median as viewed from above. Diameter one third inch or less.

FIG. 908. *Euomphalus latus.* (After Keyes.)

St. Louis of Illinois ; Maxville of Ohio ; Batesville of Arkansas.

181. **E. planidorsatus** M. and W. (Fig. 910.) Mississippic.

FIG. 909. *Euomphalus similis.* (After Whitfield, N. Y. Acad. Sci. Trans.)

Similar to the preceding but about an inch in diameter ; angulation somewhat nearer to periphery.

Chester of Illinois, Missouri, etc.

FIG. 910. *Euomphalus planidorsatus.* (After Meek and Worthen, Pal. Ill., II.)

182. **E. pernodosus** M. and W. (Fig. 911.) Carbonic.

Large, up to two inches in diameter. Spire flat, shoulder strongly concave, outer margin angulated, lower with row of blunt nodes.

Coal measures of Illinois, Iowa, Missouri, and Arizona.

183. **E. catilloides** Conrad. (*E. subrugosus* M. and W.) (Fig. 912.) Carbonic.

FIG. 911. *Euomphalus pernodosus*, upper side, profile and under side, × ⅔. (After Meek and Worthen, Geol. Ill., V.)

Rather small, strongly carinate both above and below, carinæ subrugose; base rounder, wider than shoulder; outer portion of whorl depressed below carina.

Coal measures of Indiana, Illinois, Iowa, Kansas, Missouri, Nebraska, Eureka district, Nevada.

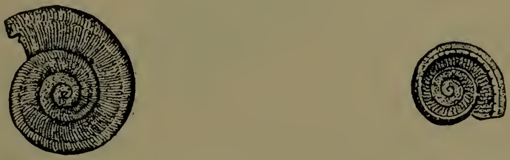


FIG. 912. *Euomphalus catilloides*. (After White, 13th Ind. Rep.)

184. **E. subquadratus** M. and W. (Fig. 913.) Carbonic.

Up to an inch or more in diameter; upper carina strong, nodose;

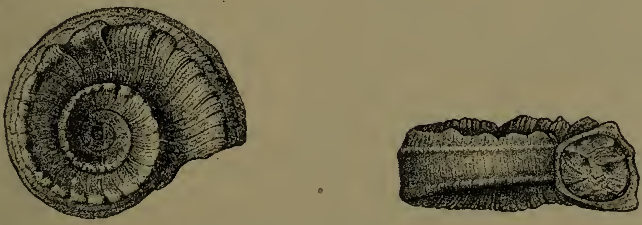


FIG. 913. *Euomphalus subquadratus*. (After Meek and Worthen, Ill. Geol., V.)

lower less strongly marked; a third carina on outer, nearly flat portion of whorl, nearest to upper carina. Otherwise as in the preceding.

Coal measures of Ohio, Illinois, Missouri, Arkansas, Texas.

LVIII. Calaurops Whitfield.

Inner whorls forming a low spire, embracing up to the angulation, which is pronounced; last whorl free and becoming straight. Ordovicic.

185. **C. lituiformis** Whitf. (Fig. 914.) Ordovicic.

Fig. 914. *Calaurops lituiformis*, two views with cross-section, × ⅔. (After Whitfield, Bull. Mus. Comp. Zoöl.)

Inner portion of about two and one half volutions, depressed-convex to flat; angulations less pronounced on free whorls, which curve to a larger radius and then grow straight. Surface with coarse wrinkles alternating with finer growth lines.

In the Upper Beekmantown or Ft. Cassin beds of the Lake Champlain region.

LIX. Eccyliomphalus Portlock.

Shells of loose coiled or disjointed spirals in a plane, like *Phanerotinus*, but with a well developed though shallow apertural notch, and more or less strong upper keel. Ordovicic–Devonic (?).

186. **E. distans** Bill. (Fig. 915.) Ordovicic.

A loose, regularly spiral coil of two or more slender whorls, separated by about once and a half their diameter; upper side carinate, others rounded.

Quebec group (Beekmantown) of Newfoundland.

FIG. 915. *Eccyliomphalus distans*, lower side. (After Billings.)

187. **E. undulatus** Hall. (Fig. 916.) Ordovicic.

Whorls more distant and more rapidly increasing than in the preceding; section subtriangular or ovate-triangular, a broad sinus in the upper lip. Surface often indented from attachment of foreign objects. Inner whorls often cut off by imperforate septa.

Stones River of Minnesota, Wisconsin, Illinois, and Tennessee.

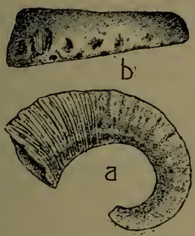


FIG. 916. *Eccyliomphalus undulatus*. (After Ulrich and Scof., Pal. Minn.)

FIG. 917. *Eccyliomphalus triangulus*, internal mold, showing the collar but faintly. (After Ulrich, Pal. Minn.)

188. **E. triangulus** Whitf. (Fig. 917.) Ordovicic.

Very loose coils, one and one half volutions rather rapidly enlarging; keel sharp and prominent, often forming a collar, upper surface concave, lower rounded; notch moderate. (This parallels *Ecciliopterus* in the development of the high collar, and some place it in that genus.)

Beekmantown of New York, Vermont, and Canada.

LX. MACLUREA Leseur. (*Maclurites* Leseur.)

Shell a left-handed or sinistral coil of few rapidly enlarging whorls, the spire flat, and the base somewhat prolonged and umbilicated. Ordovicic.

189. **M. magna** Leseur. (Figs. 918, 918, *A*.) Ordovicic.

FIG. 918. *Maclurea magna*, × ⅔. (After Hall.)

Large, of about six whorls, obtusely angular at outer edge, breadth more than twice the height; upper surface of whorls gently convex; operculum long, parallel-sided with nucleus in center of upper side.

Chazy (middle) of New York, Virginia, Kentucky, Michigan, and other southern and western localities.

190. **M. bigsbyi** Hall. (Fig. 919.) Ordovicic.

Medium-sized, diameter about twice the height. Umbilicus large and abrupt, exposing about half of each of inner whorls. Growth lines cancellated on periphery by revolving lines. Operculum with nucleus at upper inner angle.

Stones River of Wisconsin, Illinois, and Tennessee.

191. **M. logani** Salter. (Fig. 920.) Ordovicic.

Up to 3½ inches in diameter, of few rapidly enlarging whorls, the width of the outer whorl being about three times that of the

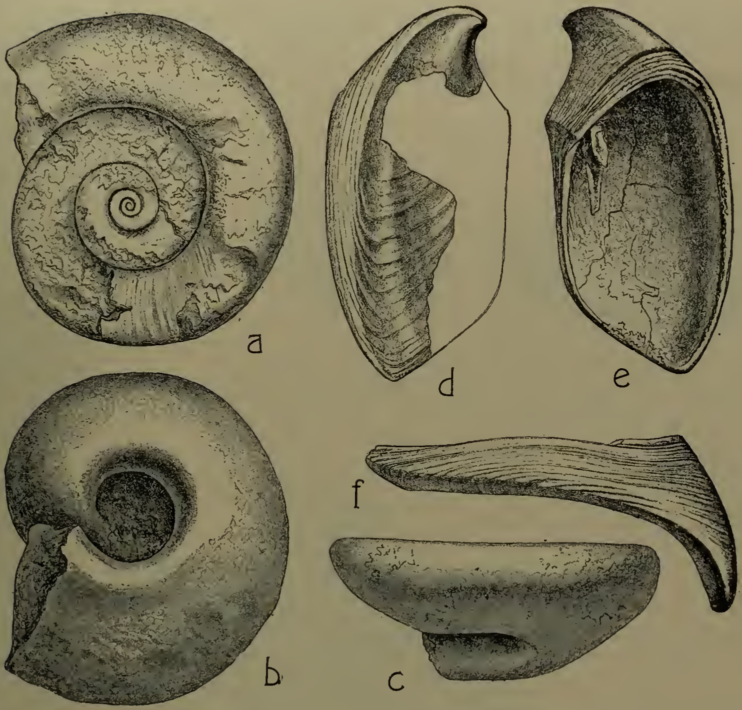


FIG. 918, *A*. *Maclurea magna*, *a*, *b*, *c*, upper, lower and side view of a characteristic shell, × ½ ; *d–f*, 3 views of large operculum, × ½. (After Raymond.)

whorl next adjoining; upper surface almost flat, outer surface of whorls with deep revolving grooves. Operculum with nucleus near rim.

Black River (?) of Ottawa River region in Canada, also European.

FIG. 919. *Maclurea bigsbyi*, × ⅔. Upper, profile and umbilical views. (After Ulrich, Pal. Minn.)

192. **M. (Maclurina*) manitobaënsis** Whiteaves. (Fig. 921.) Ordovicic.

Maximum diameter 8 ½ inches, proportionately low, whorls

FIG. 920. *Maclurea logani*, × ⅔. Young with operculum in place; operculum of adult; umbilical view of first specimen. (After Salter, Can. Org. Rem., I.)

slowly increasing in diameter; umbilicus moderate; upper side with periodic growth constrictions.

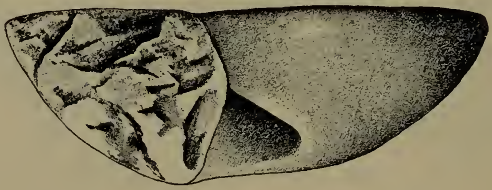


FIG. 921. *Maclurea* (*Maclurina*) *manitobaensis*, × ⅔. (After Ulrich, Pal. Minn.)

Trenton of Minnesota and numerous localities in Manitoba and elsewhere.

193. **M. (Maclurina) cuneata** Whitf. (Fig. 922.) Ordovicic.

FIG. 922. *Maclurea* (*Maclurina*) *cuneata*, × ⅔. (After Ulrich, Pal. Minn.)

* *Maclurina* is separated from *Maclurea* by Ulrich and Scofield on account of the absence of the muscular projections on the inside of the operculum characteristic of the true *Maclurea* (see Fig. 920).

Medium-sized, with small umbilicus and regularly sloping under sides.

Trenton (Galena) of Minnesota, Wisconsin, and Iowa. Similar though larger specimens occur in the limestones of Lower Trenton age in the Big Horn and Black Hill regions.

Family Trochoturbinidæ Koken.

LXI. Omphalotrochus Meek.

Large and ponderous euomphalids, with high spire, whorls touching slightly, aperture oblique, with upper lip projecting. Shoulder, and sometimes also the periphery, flattened or concave. Mississippic–Carbonic.

194. **O. springvalensis** White. (Fig. 923.) Mississippic.

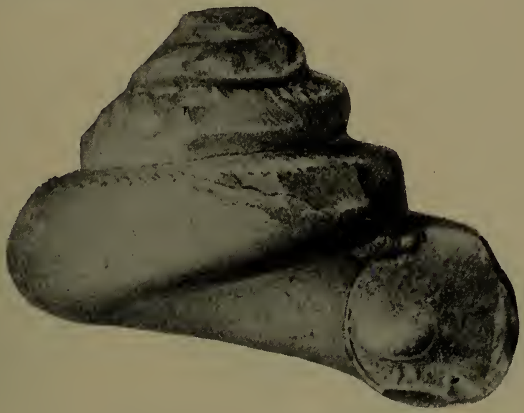


Fig. 923. *Omphalotrochus springvalensis.* (After Keyes.)

Whorls rounded, except for a slight flattening of the shoulder; gradually enlarging; height 55 mm., basal diameter 70 mm.

Kinderhook and Burlington of Iowa and Missouri.

LXII. Poleumita Clarke and Ruedemann.

Small, and with the round whorls merely touching, and strongly marked by spirals. Siluric.

195. **P. scamnata** Cl. and R. (Fig. 924, *b.*) Siluric.

With numerous sharp spirals; faint transverse markings.

Guelph of New York and Canada. Monroe of Michigan?

196. **P. crenulata** (Whiteaves). (Fig. 924, *a.*) Siluric.

Few and coarser spirals; strong transverse sculpture. Guelph of New York and Canada.

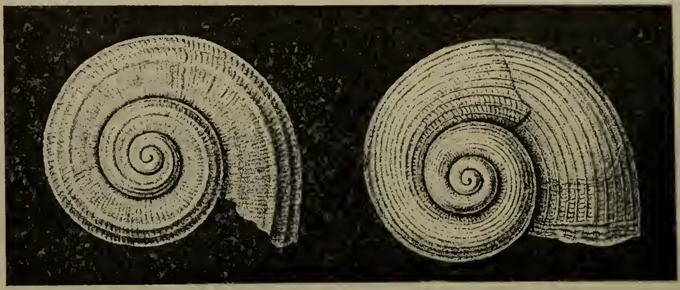


FIG. 924. *a*, *Polenmita crenulata*; *b*, *P. scamnata* (right). (After Clarke and Ruedemann, Guelph Fauna.)

LXIII. Cyclonema Hall.

Shell of ventricose whorls, turbinate or conical, with numerous spirals, an oblique aperture, and a thickened, reflected, and flattened or excavated columellar lip and no umbilicus. Ordovicic–Devonic.

197. **C. bilix** Conrad. (Fig. 925, *a*, *b*.) Ordovicic.

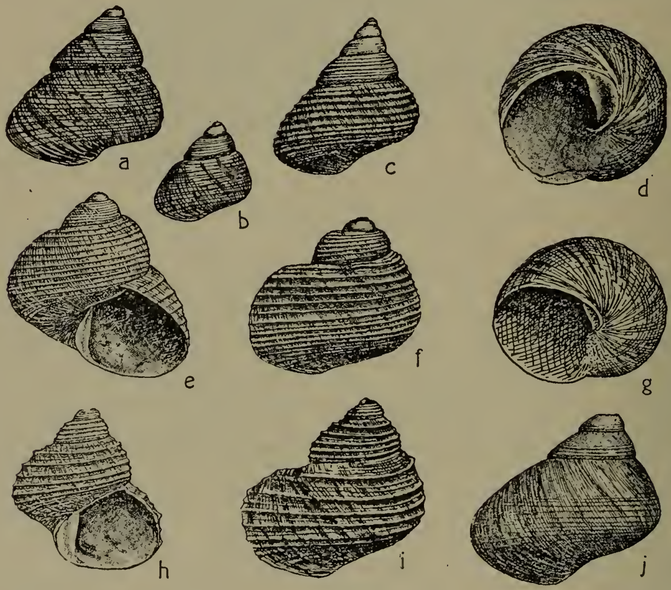


FIG. 925. *a*, *b*, *Cyclonema bilix*; *c*, *d*, *C. mediale*; *e–g*, *C. humerosum*; *h*, *i*, *C. varicosum*; *j*, *C. sublave*. (After Ulrich & Scofield, Pal. Minn.)

Whorls embracing to ambitus; suture slightly excavated; shoulder nearly flat; spirals comparatively simple, an intercalated series occurring on the body whorl; sharp oblique lines of growth, often strongly marked and crowded.

Richmond group of Indiana, Ohio, Illinois, and Minnesota.

198. **C. mediale** Ulrich. (Fig. 925, *c*, *d*.) Ordovicic.

Whorls more ventricose than preceding, spirals coarser, suture shallow.

Lower and Upper (*C. humorosum*) Lorraine of Ohio, Kentucky, and Indiana. In those of the upper beds, the whorls embrace more strongly, the form becoming more compact and wider angled (*C. humorosum* Ulrich, Fig. 925, *e–g*).

199. **C. varicosum** Hall. (Fig. 925, *h*, *i*.) Ordovicic.

Round-whorled, primary spirals coarse, with several finer between.

Trenton of Kentucky, Tennessee, Michigan, etc.

200. **C. sublæve** Ulrich. (Fig. 925, *j*.) Ordovicic.

Similar to *C. mediale* but with spirals more or less obsolete especially on the shoulder.

Lower Lorraine of the Cincinnati dome region.

LXIV. Trochonema Salter.

Turbinate shells with angulated whorls and a wide peripheral band bounded by more or less sharply-defined carinæ. Additional carinæ at suture and umbilicus often present. Aperture oblique and umbilicus wide. Ordovicic–Siluric.

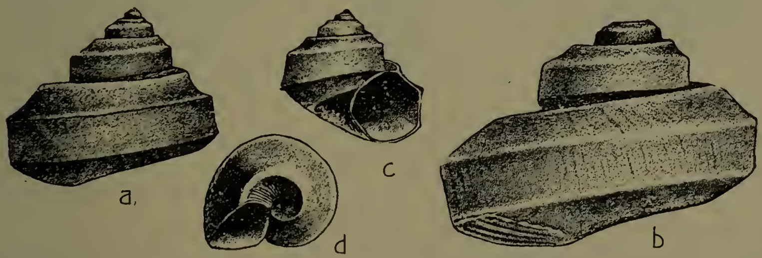


Fig. 926. *a*, *b*, *Trochonema umbilicatum*; *c*, *d*, *T. umbilicatum* var. (After Ulrich and Scofield, Pal. Minn.)

201. **T. umbilicatum** Hall. (Fig. 926.) Ordovicic.

Shoulder flat or slightly concave; peripheral band vertical, rarely concave; umbilicus bounded by well-marked angulation, between which and the peripheral band is a nearly flat, sloping surface. Last whorl often partially loosened.

Trenton of Canada, New York, Kentucky, Tennessee, Wisconsin, and Illinois. Several varieties are recognized.

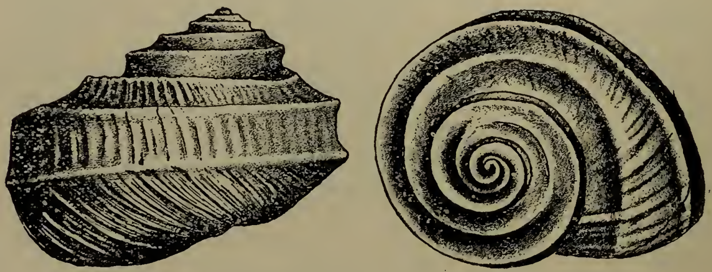


FIG. 927. *Trochonema beloitense.* (After Ulrich, Pal. Minn.)

202. **T. beloitense** Whitf. (Fig. 927.) Ordovicic.

More rapidly expanding, higher volutions, thicker test, coarser surface markings, more prominent angles, and smaller umbilicus.

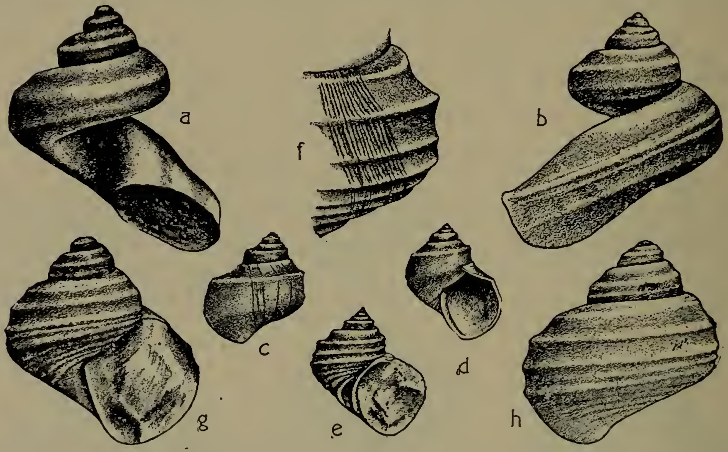


FIG. 928. *a, b, Trochonema vagrans; c, d, T. (Eunema) nitidum; e, f, T. (Gyronema) pulchellum; g, h, T. (Gyronema) duplicatum.* (After Ulrich, Pal. Minn.)

Stones River of Minnesota, Wisconsin, and Illinois.

203. **T. vagrans** U. and S. (Fig. 928, *a, b.*) Ordovicic.

Similar to *T. beloitense*, but whorls somewhat more slender, and the last more than half free.

Stones River group, Minnesota.

204. **T. (Eunema) nitidum** Ulrich. (Fig. 928, *c, d.*) Ordovicic.

Small, high-spired, shoulder concave, lower peripheral carina obsolete. In *T. salteri* U. and S. the spire is still higher (less embracing), and the lower peripheral carina almost as strong as the upper.

Trenton of Minnesota (*T. salteri*); Utica of Cincinnati region (*T. nitidum*).

205. **T. (Gyronema) pulchellum** Ulrich and Scofield. (Fig. 928, *e*, *f*.) Ordovicic.

Small, rather high-spired, with apical angle about 85°. In the body whorl occurs a spiral on the shoulder near the suture, between the two peripheral ones, and five or six on the basal portion of the whorl. Intercarinal space convex.

Black River of Minnesota and Kentucky.

206. **T. (Gyronema) duplicatum** U. and S. (Fig. 928, *g*, *h*.) Ordovicic.

Larger than preceding, with closed umbilicus, carina fainter, shoulder carina often obsolete, central peripheral one sometimes double or with an additional one ; lower 6 or 7 faint.

Black River of Wisconsin, Minnesota, and Illinois.

LXV. Anomphalus Meek and Worthen.

Shell naticoid, small, but without umbilicus ; low spire and incomplete aperture. Carbonic.

207. **A. rotulus** M. and W. (Fig. 929.) Carbonic.

Fig. 929. *Anomphalus rotulus*, side and under views, × 2½. (After Meek and Worthen, Ill., V.)

Fig. 930. *Anomphalus* (*Protospirialis*) *minutissima*, × 5. (After Clarke.)

Small, depressed, with scarcely visible spire ; volutions increasing rather rapidly ; aperture transversely suboval ; surface smooth.

Coal measures of Illinois, Iowa, and Missouri.

208. **A. (Protospirialis) minutissima** Clarke. (Fig. 930.) Devonic.

Minute (1.5 mm. in height and width) with three or four rapidly expanding whorls, last one ventricose; aperture subcircular, outer lip thin, inner lip slightly reflexed, scarcely covering umbilicus.

Abundant in Portage (Naples) beds throughout western New York, etc. Pelagic. (Clarke refers them to the pteropods. They may be pelagic protoconch stage of other gastropods.)

LXVI. Pycnomphalus Lindström.

Round-whorled, strongly embracing shells, with the umbilicus covered by an inner flange-like expansion of the shell, which thus appears non-umbilicate. In the internal mold a large umbilicus is seen. Siluric.

209. **P. solarioides** (Hall). (Fig. 931.) Siluric.

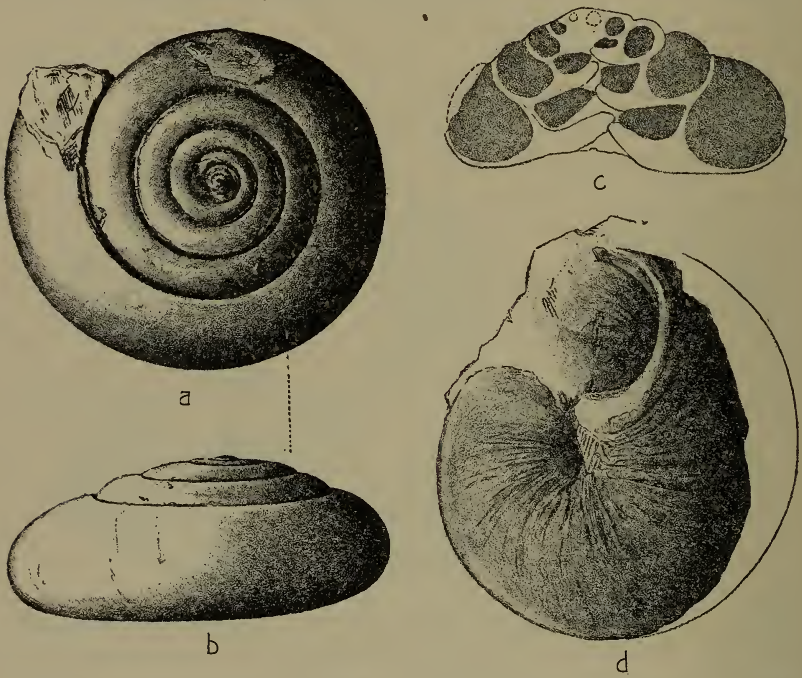


FIG. 931. *Pycnomphalus solarioides.* *a*, apical view of internal mold; *b*, lateral views of same; *c*, vertical section, showing prominent inner spiral lamella; *d*, umbilical views of shell. (After Whiteaves, Pal. Fossils, III.)

Large, rather low-spired whorls strongly embracing, viewed from above, very gradually enlarging, and numerous. Base broad, flat, without umbilicus in shell.

Guelph of Canada, New York, Ohio (?).

Family NATICOPSIDÆ * Gr. & Sh.

LXVII. CYCLORA Hall.

Minute spiral shells of rounded whorls, loosely embracing so as to leave deep suture and umbilicus; surface smooth, lip thin, aperture circular. Ordovicic–Devonic.

210. **C. minuta** Hall. (Fig. 932.) Ordovicic.

FIG. 932. *Cyclora minuta*, × 6. (After Meek, Pal. Ohio, I.)

Subglobose, wider than high, with much depressed spire, three rapidly increasing volutions; suture almost channeled; umbilicus small. (Possibly pelagic protoconchs of other gastropods.)

Cincinnati group of Ohio and Kentucky, etc. Abundant.

LXVIII. NATICOPSIS McCoy.

Oval to globose non-umbilicated shells, with small spire, large body whorl, oval aperture, and with inner lip more or less callous, flattened, and sometimes transversely striated. Operculum non-spiral. Devonic–Triassic.

211. **N. ziczac** Whitf. (Fig. 933.) Mississippic.

FIG. 933. *Naticopsis ziczac*, natural size and enlarged. (After Whitfield, N. Y. Acad. Science Proc.)

FIG. 934. *Naticopsis ventricosus*, opposite views. (After Meek and Worthen, Ill. Geol., V.)

Small, whorls regularly though rapidly increasing in size, surface of body whorl with marked zigzag striæ.

Chester (Maxville) of Ohio.

212. **N. ventricosa** Norwood and Pratten. (Fig. 934.) Mississippic–Carbonic.

Whorls rapidly enlarging, last one ventricose-elongate, and strongly concave below the suture.

Archimedes limestone of Illinois; Coal measures of Indiana and Missouri.

213. **N. altonensis** McChesney. (Fig. 935.) Carbonic.

Larger than the preceding, spire more sunken, body whorl more rounded, concavity proportionately less broad and at greater angle with axis of shell. Var. *giganteus* M. and W. is larger and concave shoulder broader.

Coal measures of Illinois and New Mexico.

214. **N. torta** (Meek). (Fig. 936.) Carbonic.

FIG. 935. *Naticopsis altonensis.* (After Meek and Worthen, Ill. Geol., V.)

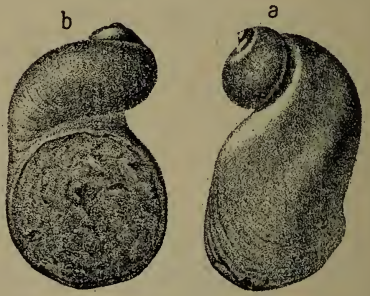


FIG. 936. *Naticopsis torta.* (After Meek, Ohio Pal., II.)

Early whorls close-coiled, adult whorls loose; aperture circular, a slight rounded ridge on the outer part of the last whorl, and a faint flattening above is observable.

Coal measures of Ohio.

LXIX. TRACHYDOMIA M. and W.

Like *Naticopsis*, but with nodose surface. Devonic ?–Carbonic.

215. **T. (?) præcursor** (Clarke). (Fig. 937.) Devonic.

Early whorls round, adult flattened and angulate below; adult ornamentation of numerous regular spiral rows of nodes.

Portage (Naples) and Chemung of New York, Maryland, etc.

216. **T. wheeleri** (Swallow). (Fig. 938.) Carbonic.

Rapidly-enlarging whorls, body whorl gibbous, aperture subovate; surface with numerous revolving rows of small tubercles increasing in size with the whorls.

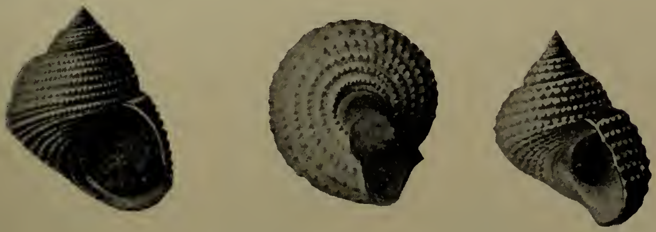


FIG. 937. *Trachydomia præ ursor.* (After Clarke.)

Coal measures of Indiana, Illinois, Iowa, Missouri, and New Mexico.

217. **T. nodosum** M. and W. (Fig. 939.) Carbonic.

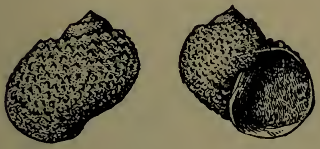


FIG. 938. *Trachydomia wheeleri.* (After White, 13th Ind.)

FIG. 939. *Trachydomia nodosum.* (After Meek and Worthen, Ill. Pal., II.)

Larger, more rapidly enlarging, nodes irregularly scattered or arranged in vertical instead of horizontal rows.

Coal measures of Ohio, Illinois, and Missouri.

LXX. TURBONOPSIS* Grabau and Shimer.

Young shell as in *Naticopsis;* adult whorls expanding; with wrinkles or ribs, and a median carina. Devonic.

FIG. 940. *Turbonopsis shumardi*, young and adult, × ⅔. (After Hall, Pal. N Y., V.)

218. **T. shumardi** (de Verneuil). (*Turbo shumardi.*) (Fig. 940.) Devonic.

Large, last two whorls with strong oblique folds on shoulder portion, these appear gradually and progressively increase in strength; median carina strong, blunt; aperture subpentahedral.

Onondaga of Ohio, Falls of Ohio, Indiana, Kentucky, and New York (?).

Family STROPHOSTYLIDÆ * Grabau & Shimer.

LXXI. HOLOPEA Hall.

Spirally coiled shells with round whorls generally smooth, and complete aperture. Ordovicic–Mississippic?

219. **H. ampla** U. and S. (Fig. 941.) Ordovicic.

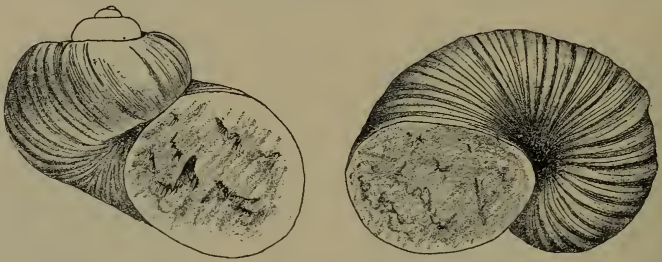


FIG. 941. *Holopea ampla*, × ⅔. (After Ulrich, Pal. Minn.)

Large, umbilicated, growth lines frequently fasciculate and coarse.
Stones River of Minnesota and Wisconsin.

220. **H. similis** U. and S. (Fig. 942, *a* (left).) Ordovicic.
Smaller, higher spired, more slender and with smooth whorls.
Black River of Minnesota, Lorraine of Kentucky.

221. **H. rotunda** U. and S. (Fig. 942, *b* (right).) Ordovicic.
Small, whorls higher, spire less obtuse, umbilicus smaller than in preceding.
Stones River of Illinois; Trenton of Tennessee.

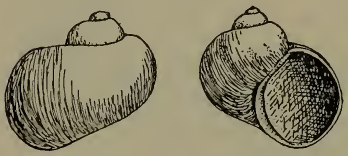


FIG. 942. *Holopea similis* (left); *H. rotunda* (right). (After Ulrich and Scofield, Pal. Minn.)

FIG. 943. *Holopea* (?) *textilis*. (After Ulrich and Scofield, Pal. Minn.)

222. **H. textilis** (Ulrich and Scofield). (*Strophostylus textilis* U. and S.) (Fig. 943.) Ordovicic.

High-spired (apical angle 60°–70°), six or seven whorls; revolving lines cancellated by oblique lines.

Black River and Trenton of Minnesota; Trenton of Kentucky.

223. **H. antiqua** (Vanuxem). (Fig. 944.) Siluric.

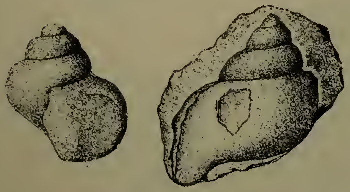


FIG. 944. *Holopea antiqua*, internal molds. (Pal. N. Y., III.)

FIG. 945. *Holopea pervetusta*, complete shell and internal mold. (Pal. N. Y., III.)

High-spired, suture depressed, smooth except for lines of growth.

Manlius of New York, New Jersey, etc. Upper Monroe of Michigan.

224. **H. pervetusta** Hall. (Fig. 945.) Siluric.

More slender and higher spired than preceding. Occurs with preceding.

225. **H. (?) proutana** Hall. (Fig. 946.) Mississippic.

Very high-spired for the genus, apical angle acute, aperture round-ovate, no umbilicus.

St. Louis (Spergen) of Illinois and Indiana.

FIG. 946. *Holopea* (?) *proutana*. (After Whitfield, Am. Mus. Nat. Hist. Bull.)

LXXII. Strophostylus Hall.

Round-whorled shells, generally with low spire and very ventricose body whorl; peristome round; columellar lip twisted and grooved; surface often finely cancellated, though frequently only lines of growth appear. Ordovicic–Carbonic.

FIG. 947. *Strophostylus cyclostomus*. (After Hall.)

226. **S. cyclostomus** Hall. (Fig. 947.) Siluric.

Of medium size, whorls gradually enlarging; body whorl enlarging rather rapidly; strong vertical and rather fainter revolving striæ.

Niagaran of Indiana; Monroan of Michigan.

227. **S. expansus** Hall. (Fig. 948.) Devonic.

FIG. 948. *Strophostylus expansus.* (After Hall.)

Large, with a few small apical whorls and a very large and rapidly-expanding body whorl.

Oriskany of New York.

228. **S. carleyanus** (Hall). (Fig. 949.) Mississippic.

Small, subglobose, final whorl expanded most vertically; aperture ovate; sutures deep.

St. Louis (Spergen) of Illinois and Indiana.

229. **S. nanus** (M. and W.). (Fig. 950, *a*, *b*.) Carbonic.

Small; differs from preceding in greater horizontal and less vertical diameter, and in shallow sutures.

Coal measures of Illinois, Indiana, Ohio, Iowa, Missouri, Arkansas, and Nevada.

230. **S. remex** (White). (Fig. 950, *c*.) Carbonic.

Medium-sized, of four volutions, very oblique through loose coiling, last one partly free; expanding rapidly, but more uniformly than in most species.

Carbonic limestones of Missouri, Texas, and Utah.

FIG. 949. *Strophostylus carleyanus.* (After Whitfield, Am. Mus. Nat. Hist. Bull.)

FIG. 950. *Strophostylus nanus*, *a*, *b*, 2 views; *c* (right), *S. remex.* (Ind. Surv. & Bull. 77, U. S. G. S.)

LXXIII. DIAPHOROSTOMA Fisher. (*Platyostoma* Conrad.)

Differs from *Strophostylus* in the regular enlargements of the whorls, the last not being ventricose; columellar lip smooth. Siluric–Devonic.

231. **D. niagarense** Hall. (Fig. 951.) Siluric.

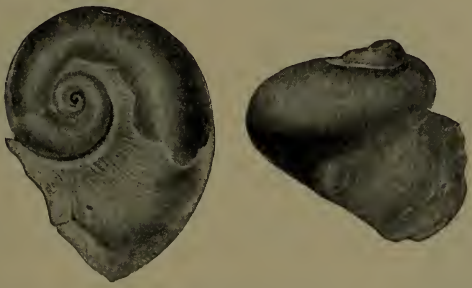


FIG. 951. *Diaphorostoma niagarense.* (After Hall.)

Body-whorl inflated toward aperture; sutures deeply depressed; 3–4 volutions; fine spiral and strong transverse striæ.

Niagaran and Guelph of New York and nearly all other exposures.

232. **D. ventricosum** Conrad. (Fig. 952.) Devonic.

Larger and more ventricose than preceding; aperture nearly circular.

Helderbergian and Oriskanian of New York, etc.

FIG. 952. *Diaphorostoma ventricosum*. (After Hall.)

233. **D. lineatum** (Conrad). (Fig. 953.) Devonic.

Regularly enlarging whorls, forming moderate spire; scarcely depressed sutures; fine regular spirals and transverse striæ.

Onondaga and Hamilton of New York, Indiana, and elsewhere in eastern North America.

FIG. 953. *Diaphorostoma lineatum*. (After Hall.)

LXXIV. PLATYCERAS Conrad.

Young shell coiled as in *Diaphorostoma*, late stages non-coiling, often spinous. (In this polyphyletic genus are commonly included non-coiling shells of diverse origin; the typical species are derived from *Diaphorostoma*.) Siluric–Carbonic.

FIG. 954. *Platyceras niagarense*. (After Hall.)

234. **P. niagarense** (Hall). (Fig. 954.) Siluric.

Apex only enrolled in one volution; remainder rather rapidly expanding, last portion longitudinally undulated.

Niagara of New York and elsewhere.

235. **P. gebhardi** Hall. (Fig. 955, 956.) Devonic.

Like *Diaphorostoma ventricosa*, but loose-coiling, last whorl partly free.

Helderbergian of New York, etc.; Oriskany of Maryland, etc.

236. **P. ventricosum** Conrad. (Fig. 957.) Devonic.

FIG. 955. *Platyceras gebhardi.* (After Hall.)

FIG. 956. *Platyceras gebhardi*, side view. (After Hall.)

Probably derived from a *Strophostylus.* Last whorl partly free, and extremely ventricose.

Helderbergian of New York, etc. Oriskany of Maryland.

237. **P. tenuiliratum** Hall. Devonic.

FIG. 957. *Platyceras ventricosum.* (After Hall.)

Like a small *P. ventricosum*, with reflexed inner lip, sinuous margin, and surface cancellation by fine revolving and transverse striæ.

Helderbergian of New York.

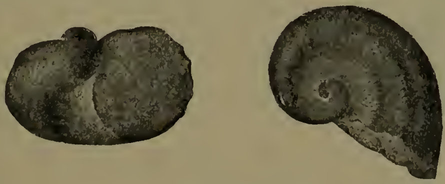


FIG. 958. *Platyceras multisinuatum.* (After Hall.)

238. **P. multisinuatum** Hall. (Fig. 958.) Devonic.

Like a small *P. gebhardi*, with longitudinal folds and strongly sinuous margin.

Helderbergian of New York.

239. **P. unguiforme** Hall. (Fig. 959, *a–c*.) Devonic.

FIG. 959. *a–c*, *Platyceras unguiforme* var. *multicarinatum*; *b*, *P. unguiforme*; *d–f*, *P. dilatatum*, showing varieties (*e*, *f*, opposite views of same specimen). (Pal. N. Y., III.)

Like preceding, but mostly non-coiling.

Helderbergian of New York.

240. **P. dilatatum** Hall. (Fig. 959, *d–f*.) Devonic.

Like *P. tenuiliratum*, but only apex coiled; sometimes carinate.

Helderbergian of New York.

241. **P. spirale** Hall. (Fig. 960.) Devonic.

Non-coiling except at apex, but with a few irregular twists; somewhat plicate.

Helderbergian of New York. (A more slender, less plicate form occurs in the Oriskany (*P. tortuosum*), and a similar one making only half a twist (*P. dentalium*) in the Onondaga of New York.)

FIG. 960. *Platyceras spirale*. (After Hall.)

242. **P. magnificum** Hall. (Fig. 961.) Devonic.

Like *P. ventricosum* with apex only coiled.
Oriskany of Maryland, etc.

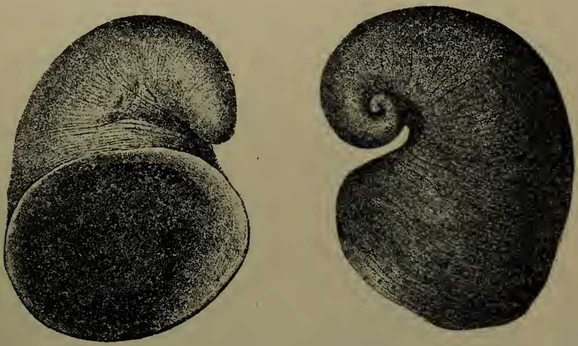


FIG. 961. *Platyceras magnificum*, a small individual. (Pal. N. Y., III.)

243. **P. reflexum** Hall. (Fig. 962.) Devonic.
Like *P. gebhardi*, but only coiled apically.
Oriskany of Maryland, etc.

244. **P. arkonense** Shimer and Grabau. Devonic.

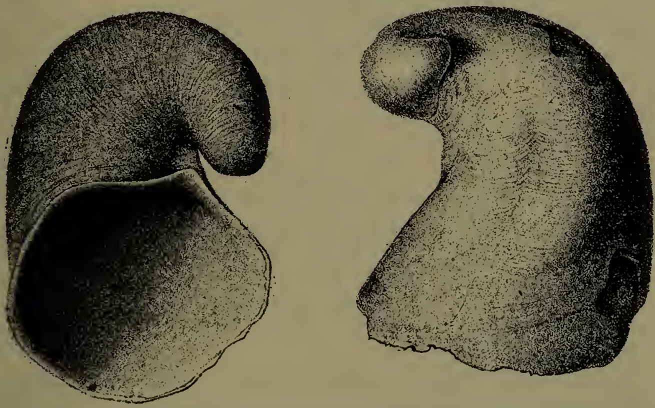


FIG. 962. *Platyceras reflexum*, opposite views of two individuals. (Pal. N. Y., III.)

Similar to the next, but with scattered slender spines.
Hamilton of Ontario, Michigan, and Iowa, Charlestown, Indiana.

245. **P. erectum** Hall. (Fig. 963, *a*.) Devonic.
Like *Diaphorostoma lineata*, with last whorl free, and margin oblique and sinuous.
Hamilton of New York, Ontario, etc.

246. **P. carinatum** Hall. (Fig. 963, *b*.) Devonic.

Like *P. multisinuatum*, but with compressed or carinated periphery and very oblique aperture.

Hamilton of New York, Ontario, etc.; Sellersburg of Indiana.

247. **P. symmetricum** Hall. (Fig. 964.) Devonic.

Like *P. erectum*, but only apically coiled; margin sinuous.

Hamilton of New York, etc.

248. **P. thetis.** (Fig. 963, *d.*) Devonic.

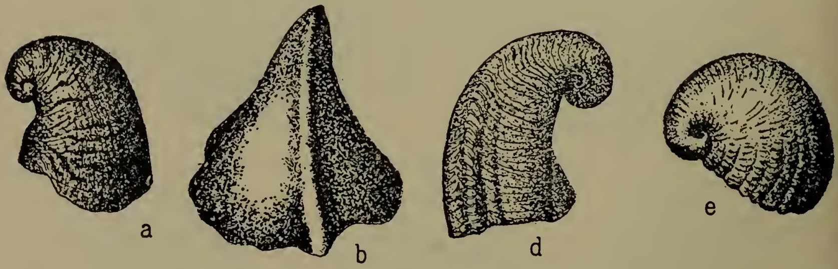


FIG. 963. *a, Platyceras erectum; b, P. carinatum; d, P. thetis; e, P. bucculentum.* (Copied from Hall.)

More slender than preceding and strongly plicate.

Hamilton of New York, Ontario, etc.; Sellersburg of Indiana.

249. **P. bucculentum.** (Fig. 963, *e.*) Devonic.

Rapidly enlarging, lip strongly sinuate, especially on one side.

Hamilton of New York, Ontario, etc.; Sellersburg of Indiana.

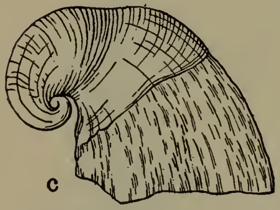


FIG. 964. *Platyceras symmetricum.* (Copied from Hall.)

250. **P. nodosum** Conrad. (Fig. 965.) Devonic.

Like *P. gebhardi* when young, but with last volution bearing numerous strong rounded nodes. Adult molds generally without coiled young, and strongly nodose.

Helderbergian and Oriskanian of New York, etc.

251. **P. dumosum** Conrad. (Fig. 966.) Devonic.

Coiled only apically, rapidly expanding, numerous nodes (in molds) and hollow spines corresponding to them.

Onondaga of New York and Ontario; Columbus of Ohio and Michigan; Jeffersonville of Falls of the Ohio.

252. **P. vomerium** Winchell. Mississippic.

General form as in *P. bucculentum*, but apex merely incurved instead of enrolled.

Kinderhook of Iowa; Waverly of Ohio.

253. **P. tribulosum** White. (Fig. 967.) Mississippic.

FIG. 965. *Platyceras nodosum*, mold of a large scarcely coiled form. (After Hall.)

Similar to preceding, with strong sinuosities in lip, and three rows of hollow spines.

Burlington of Iowa and Missouri.

254. **P. haliotoides** Meek and Worthen. (Fig. 968.) Mississippic.

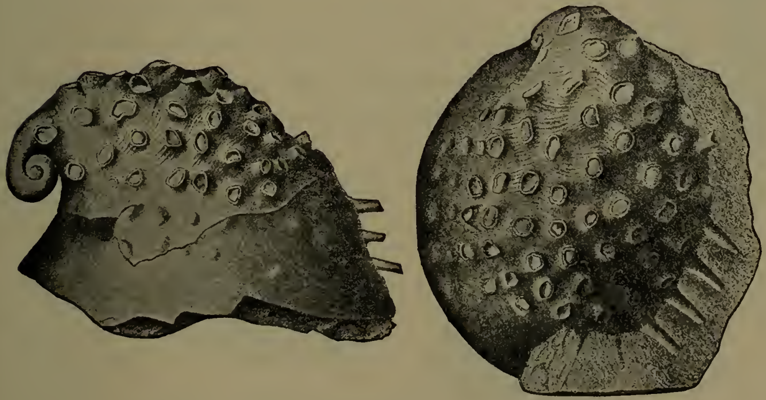


FIG. 966. *Platyceras dumosum*, × ⅔. (After Hall.)

Haliotis- like ; resembling vertically compressed small *P. ventricosum* with very oblique aperture.

Waverly of Ohio ; Choteau of Missouri.

255. **P. paralius** White and Whitf. (Fig. 969.) Mississippic.

Small, apex slightly enrolled, lower portion strongly plicate.

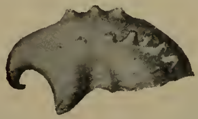


FIG. 967. *Platyceras tribulosum.* (After Keyes.)

FIG. 968. *Platyceras haliotoides.* (After Keyes.)

FIG. 969. *Platyceras paralius*, type. (After Keyes.)

Kinderhook of Iowa and Missouri ; Waverly of Ohio ; Burlington of Missouri.

256. **P. parvum** (Swallow). (Fig. 970.) Carbonic.

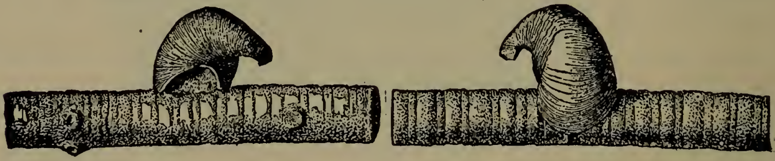


FIG. 970. *Platyceras parvum*, opposite views of a specimen attached to a crinoid stem. (After White, 13th Ind.)

Entire shell making about one loose volution ; aperture very sinuous.

Coal measures of Kansas, Nebraska, Illinois, New Mexico, Indiana, Iowa, Missouri.

LXXV. PALÆOCAPULUS * Grabau and Shimer.

Symmetrical platyceroids with the beak incurved but scarcely enrolled in the median line or slightly deflected. (Possibly derived from *Cyrtolites.*) Type *P. lodiensis.* Devonic–Mississippic.

257. **P. expansus** Hall. (Fig. 971.) Devonic.

FIG. 971. *Paleocapulus expansus.* (Pal. N. Y., III.)

Apex strongly incurved, shell rapidly expanding, ventricose and dorsally carinate; aperture nearly circular.

Oriskany of New York and Pennsylvania; Decewville of Ohio.

258. **P. equilateralis** (Hall). Mississippic.

Symmetrically expanding from incurved but not enrolled apex. Generally attached to crinoids.

Keokuk of Iowa, Illinois, Maryland, Missouri; Burlington of Iowa and Missouri.

259. **P. lodiensis** (Meek). (Fig. 972.) Mississippic.

FIG. 972. *Palæocapulus lodiensis.* (After Meek, Pal. Ohio, II.)

Symmetrical, with slightly overhanging but scarcely incurved beak and strong dorsal fold from beak to base. (Type of genus.)

Waverly of Ohio.

LXXVI. ORTHONYCHIA Hall.

Platyceroid shells with apex incurved but not enrolled, and generally long, slender, though not symmetrical body portion. A polyphyletic group. Devonic–Carbonic.

FIG. 973. *Orthonychia subrectum.* (After Hall, Pal. N. Y., V.)

260. **O. subrectum** Hall. (Fig. 973.) Devonic.

Minute (and solid) apex, abruptly incurved; shell long and slender, nearly straight; no plications.

Onondaga of New York, etc.

261. **O. formosum** Keyes. (Fig. 974.) Mississippic.

Elongate; strongly and regularly curved, lower portion plicate. Transitional to Igoceras.

Kinderhook of Iowa; Burlington of Missouri. Attached to crinoids.

262. **O. cyrtolites** McChesney. (Fig. 975.) Mississippic.
Slender, smooth, with apex curved over strongly; dorsally subangular.

Burlington of Illinois, Iowa, and Missouri.

263. **O. chesterensis** M. and W. Mississippic.

FIG. 974. *Orthonychia formosum*, attached to crinoid. (After Keyes.)

FIG. 975. *Orthonychia cyrtolites.* (After Keyes.)

Small, strongly curved, with about five grooves and very sinuous aperture.

Chester of Illinois, Missouri, and Kentucky.

264. **O. acutirostris** Hall. (Fig. 976, 977.)
Mississippic–Carbonic.
Apex making about a single volution, not in contact; shell

FIG. 976. *Orthonychia acutirostris* on *Pterotocrinus acutus.* (After Keyes.)

widening abruptly below apex, often with shallow plications; aperture subcircular with sinuate margin.

Keokuk and Warsaw of Illinois, Indiana, and Alabama; St.

FIG. 977. *Orthonychia acutirostris.* (After Whitfield, Mus. Comp. Zoöl. Bull.)

Louis of Indiana, Illinois; Chester of Arkansas; Coal measures of Pennsylvania.

LXXVII. Igoceras Hall.

More or less broadly conical platyceroids with apex not incurved; body portion plicate. (Probably a polyphyletic group.) Devonic–Carbonic.

265. **I. plicatum** (Conrad). (Fig. 978.) Devonic.

Apex sublateral, one side more strongly curved; height about

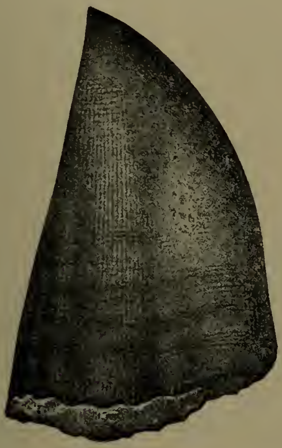


Fig. 978. *Igoceras plicatum*. (After Hall.)

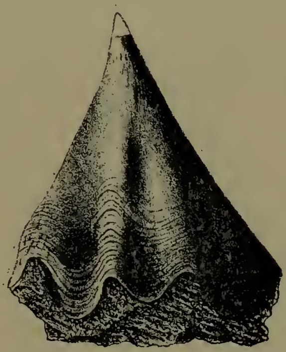


Fig. 979. *Igoceras conicum*. (After Hall, Pal. N. Y., V.)

one and one half times greatest diameter; plications few and shallow, generally only on straight side.

Helderbergian of New York, etc.

266. **I. conicum** (Hall). (Fig. 979.) Devonic.

Irregularly conical, with apex pointed and subcentral or excentric; height equal to or less than basal diameter; plications strong, rounded, sometimes obsolete.

Onondaga and Hamilton of New York, Ontario, and Falls of Ohio.

267. **I. capulus** (Hall). (Fig. 980.) Mississippic.

Subregularly conical, with nearly central apex; a slight flattening and very faint undulations occur on one side; height less than basal diameter; aperture nearly circular.

Burlington of Iowa, Missouri, and Illinois.

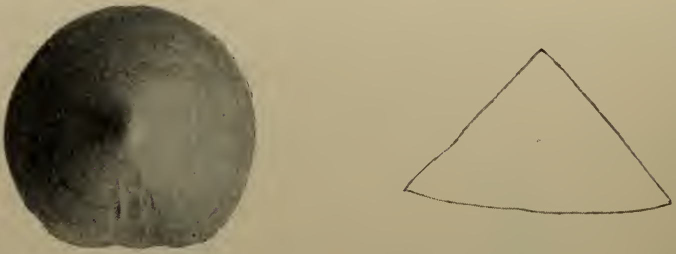


FIG. 980. *Igoceras capulus.* (After Keyes.)

268. **I. quincyense** (McChesney). (Fig. 981.) Mississippic.
Height nearly equal to basal diameter; lower half deeply and coarsely plicate; apex subcentral.

FIG. 981. *Igoceras quincyense*, attached to calyx of crinoid. (After Keyes.)

FIG. 982. *Igoceras fissurella.* (After Keyes.)

FIG. 983. *Igoceras pabulocrinus* on *Platycrinus hemisphericus.* (After Keyes.)

Burlington of Illinois, Iowa, and Missouri.

269. **I. fissurella** Hall. (Fig. 982.) Mississippic.

Higher, somewhat more strongly plicate, and with more excentric apex than *I. capulus.* Aperture more sinuate.

Burlington of Iowa; Keokuk of Illinois.

270. **I. pabulocrinus** Owen. (Fig. 983.) Mississippic.

FIG. 984. *Igoceras subplicatum.* (After Keyes.)

Like *I. fissurella*, but more slender and with attenuated, often bent apex;

folds indistinct; lines of growth often undulating and imbricating in adult portion. Commonly adhering to crinoids.

Burlington of Iowa and Missouri; Keokuk of Iowa, Illinois, and Indiana.

271. **I. subplicatum** Meek and Worthen. (Fig. 984.) Mississippic.

Small, depressed conical, rapidly expanding, beak excentric; folds coarse, irregular, few.

Waverly of Ohio; Chester of Illinois.

Family LOXONEMATIDÆ Koken.

LXXVIII. ACANTHONEMA Grabau.

Turreted shells, with gradually enlarging round whorls marked by three (rarely two) spirals, one or more of which are nodose. Type *A. holopiforme* Grabau. Siluric.

272. **A. holopiforme** Grabau. Siluric.

Short, rather thick, round whorled, lower spiral covered except on body whorl; upper two nodose. (Middle one absent in var. *obsoleta*.)

Upper Monroe of Michigan, Ohio, and Canada.

273. **A. laxum** Grabau. Siluric.

Long and slender, whorls six or more, all three spirals visible, upper two nodoso-spinose.

Upper Monroe of Michigan, Ohio, etc.

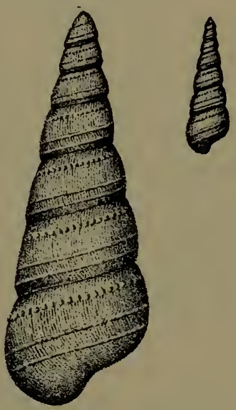


FIG. 985. *Acanthonema newberryi*, nat. size and enlarged. (After Meek, Pal. Ohio, I.)

274. **A. newberryi** (Meek). (Fig. 985.) Siluric.

More slender than preceding; nodulations chiefly confined to upper spiral.

Upper Monroe of Ohio and Michigan.

LXXIX. CALLONEMA Hall.

Broad and rather low-spired, umbilicated shells with round or subangular whorls, thin outer lip, and thickened columellar lip spread over volution above and extended below. Surface with regular, sharp, transverse striæ. Devonic.

275. **C. bellatulum** Hall. (Fig. 986.) Devonic.

Whorls (six or seven) round to flattened on the shoulder and subangular below. In form and size like *Cyclonema bilix*, but readily distinguished by its transverse striæ.

Onondaga of northern Ohio, Michigan, and Falls of the Ohio.

276. **C. lichas** Hall. Devonic.

FIG. 986. *Callonema bellatulum.* (After Hall, Pal. N. Y., V.)

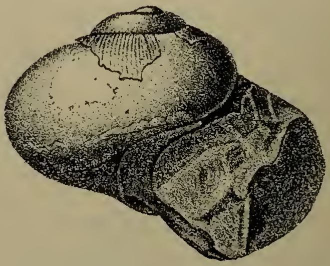


FIG. 987. *Callonema humile.* (After Meek, Pal. Ohio, I.)

Larger, with larger apical angle and last volution more ventricose.

Onondaga of New York and Ohio and Falls of the Ohio.

277. **C. humile** Meek. (Fig. 987.) Devonic.

Spire broad and low; whorls strongly embracing, rounded, and rapidly enlarging; striæ finer and more crowded on adult portion than in preceding.

Onondaga of Ohio and Falls of the Ohio.

LXXX. Isonema Meek and Worthen.

Differs from *Callonema* in its compressed whorls and angular periphery, and in the obsolescence of the striæ below the angulation. Devonic.

278. **I. depressum** M. and W. Devonic.

Small, depressed, whorls embracing above periphery.

Hamilton of Illinois.

LXXXI. Loxonema Phillips

Turreted shells, the high spire of many whorls, non-umbilicated; transverse striæ forming a double curve. Siluric ?–Carbonic.

279. **L. robustum** Hall. Devonic.

Robust, last volution ventricose, nearly an inch in diameter, length about 4 inches.

Schoharie and Onondaga of New York.

280. **L. pexatum** Hall. (Fig. 988.) Devonic.

More slender than preceding, with deeper sutures, volutions slightly flattened below suture; striæ gently curved.

Onondaga of New York and northern Ohio.

281. **L. hamiltoniæ** Hall. (Fig. 989.) Devonic.

FIG. 988. *Loxonema pexata*. (After Hall, Pal. N. Y., V.)

FIG. 989. *Loxonema hamiltoniæ*. (After Hall, Pal. N. Y., V.)

Very slender, volutions flattened or slightly concave below, deep sutures, embracing to about one half shoulder width of periphery. Striæ strongly marked.

Hamilton of New York, etc.

282. **L. delphicola** Hall. (Fig. 990.) Devonic.

FIG. 990. *Loxonema delphicola*. (After Hall, Pal. N. Y., V.)

With distinct subsutural band.

Hamilton of New York, etc.; Bedford shale of Ohio.

283. **L. noe** Clarke. (Fig. 991.) Devonic.

Very slender, round-whorled; concavity of striæ in upper third of whorl.

Portage (Naples) of New York.

284. **L. terebra** Hall. (Fig. 992.) Devonic.

Whorls embracing to just below periphery; shoulder flat or concave; spire slender; striæ strong.

Chemung of New York.

285. **L. yandellana** Hall. (Fig. 993.) Mississippic.

FIG. 991. *Loxonema noe*, × 3, and apical portion enlarged, × 13. (After Clarke.)

FIG. 992. *Loxonema terebra.* (After Hall, Pal. N. Y., V.)

Small, with gently convex whorls and deep sutures; striæ very gently undulating, not curved.

St. Louis (Spergen) of Indiana; Waverly of Ohio (?).

286. **L. multicostatum** M. and W. (Fig. 994.) Carbonic.

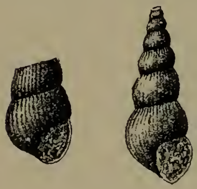


FIG. 993. *Loxonema yandellana.* (After Whitfield, Amer. Mus. Nat. Hist.)

FIG. 994. *Loxonema multicostatum*, × 2. (After Meek and Worthen, Pal. Ill., II.)

FIG. 995. *Loxonema rugosum*, × 2. (After Meek and Worthen, Pal. Ill., II.)

Small, round-whorled, rather broad-spired, with numerous gently and simply curved striæ, about 30 on the body whorl.

Coal measures of Illinois, Iowa, and Missouri.

287. **L. rugosum** M. and W. (Fig. 995.) Carbonic.

Like the preceding, but the striæ stronger, scarcely curved and almost rib-like, about 18 to a whorl.

Coal measures of Illinois, New Mexico, etc.

288. **L. scitulum** M. and W. (Fig. 996.) Carbonic.

FIG. 996. *Loxonema scitulum.* (After Meek and Worthen, Pal. Ill., II.)

FIG. 997. *Loxonema* (*Streptaxis*) *whitfieldi*, × 4, with protoconch and body whorl further enlarged.

Smaller than preceding, suture more deeply impressed, costæ about 14 to a whorl, obsolete on base of body whorl.

Coal measures of Illinois, Iowa, and Missouri.

289. **L. (Streptaxis) whitfieldi** Meek. (Fig. 997.) Carbonic.

Minute, slender, loose-coiled, with 8 or 9 long slender whorls and deep suture, aperture oval; surface striæ fine, numerous, and doubly curved; apex erect.

Coal measures of Illinois and Iowa (roof of Danville coal).

LXXXII. ACLISINA de Koninck.

Like *Loxonema*, but with spiral lines on the whorls, the vertical sigmoid lines weak. Carbonic.

290. **A. robusta** Stevens. (Fig. 998.) Carbonic.

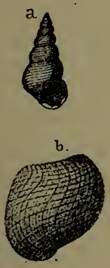


FIG. 998. *Aclisina robusta*, × 2½, and body whorl much enlarged. (After Meek and Worthen, Ill. Geol., V.)

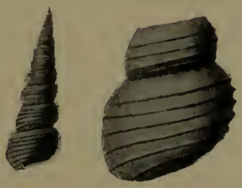


FIG. 999. *Aclisina stevensana*, complete individual, × 3; body whorl greatly enlarged. (After Meek and Worthen, Ill. Pal., II.)

Minute (5 mm. long), rather broad-spired, round-whorled, with numerous fine revolving lines and sigmoid lines of growth.

Coal measures of Illinois, Iowa, and Missouri.

291. **A. stevensana** M. and W. (Fig. 999.) Carbonic.

Minute, 6.5 mm. long, rather slender, deep-sutured, with 5 or 6 strong, slender, and distant spirals, the lower generally covered, except in the body whorl.

Coal measures, Illinois, Missouri, and New Mexico.

292. **A. minuta** Stevens. Carbonic.

Minute, slender, deep-sutured, of nine or more volutions; aperture subcircular; surface with numerous fine spirals.

Coal measurers of Illinois, Iowa, and Missouri.

LXXXIII. Orthonema M. and W.

Whorls more or less angulate and marked by a few revolving spirals. Otherwise as in preceding. Carbonic.

Fig. 1000. *Orthonema conicum.* (After Meek and Worthen, Ill. V.)

293. **O. conicum** M. and W. (Fig. 1000.) Carbonic.

Small; whorls flattened, angulated below; sutures moderately deep; spirals three, very faint, the lower below angulation, covered except in body whorl.

Coal measures of Iowa and Illinois.

294. **O. subtæniatum** Geinitz. Carbonic.

With three subequally spaced revolving carinæ, the lower one covered in all but the body whorl.

Coal measures of Iowa, Nebraska, etc.

Family Subulitidæ Lindström.

LXXXIV. Subulites Conrad.

Thin, slender, subulate or fusiform shells, with high, flat, or slightly convex whorls, faintly impressed suture, elongate narrow aperture, acuminate above and wider or somewhat truncate below, with lip strongly recurved. Surface smooth. Ordovicic.

295. **S. elongatus** Conrad. Ordovicic.

Six or more flattened or very gently convex volutions; spire tapering gently, body more rapidly enlarging.

Trenton of New York, Canada, etc.

296. **S. regularis** U. and S. (Fig. 1001, *a*.) Ordovicic.

Large; more slender than preceding; eight or ten whorls, rapidly contracting in lower half of body whorl.

Stones River and Black River of Minnesota, Tennessee, Kentucky, and Canada.

297. **S. nanus** Ulrich. (Fig. 1001, *b.*) Ordovicic.

Minute, not over 15 mm. high, very acute apex, and narrow elongate aperture not quite the length of the spire.

Stones River of Tennessee and Kentucky.

FIG. 1001. *Subulites regularis, S. nanus.* (After Ulrich and Scof., Pal. Minn.)

LXXXV. Fusispira Hall.

Differs from *Subulites* in the heavier shell, broader and shorter aperture, more rounded whorls, and deeper sutures. Ordovicic.

298. **F. inflata** M. and W. (Fig. 1002, *a.*) Ordovicic.

Short, concave-spired, whorls embracing to ambitus, body whorl large, inflated.

Trenton of Minnesota, Wisconsin, and Illinois.

299. **F. subbrevis** U. and S. (Fig. 1002, *b.*) Ordovicic.

Thicker spire, whorls less embracing, body whorl large and long, but not inflated.

Trenton of Minnesota and Iowa.

300. **F. subfusiformis** Hall. (Fig. 1002, *c.*) Ordovicic.

Slender, whorls gradually enlarging, convex, body whorl not proportionately larger; apical angle about 25°.

Trenton of Minnesota, Kentucky, New York, and Canada.

301. **F. convexa** U. and S. (Fig. 1002, *d.*) Ordovicic.

Like preceding, but apical angle 33° to 37°; whorls more convex, shorter, and with deeper sutures; aperture relatively wider; occasionally with distant revolving spirals.

Trenton of New York and Minnesota.

302. **F. angusta** U. and S. (Fig. 1002, *e.*) Ordovicic.

More slender, less closely-coiled, and with longer and less convex volutions than in *F. subfusiformis*.

Trenton of Minnesota and Kentucky.

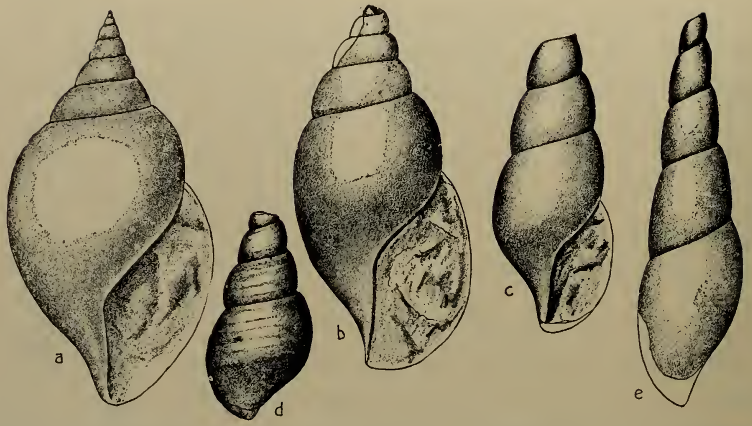


FIG. 1002. *a*, *Fusispira inflata*; *b*, *F. subbrevis*; *c*, *F. subfusiformis*; *d*, *F. convexa*; *e*, *F. angusta*, all × ⅔. (After Ulrich, Pal. Minn.)

LXXXVI. MEEKOSPIRA Ulrich.

Whorls nearly flat, embracing to ambitus, regularly enlarging; aperture short, rounded below, acute above; inner lip visible generally only in lower half of aperture. Ordovicic ?–Carbonic.

303. **M. peracuta** M. and W. (Fig. 1003, *a, b*.) Carbonic.

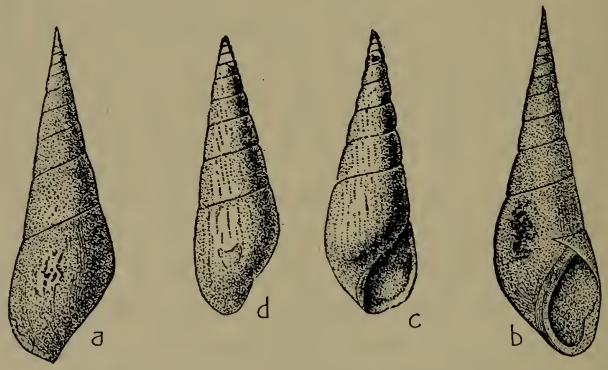


FIG. 1003. *a*, *b*, *Meekospira peracuta*; *c*, *d*, *M. nitidula*. (After White, 13th Ind. Rep.)

Slender, with acute apex, 12 or more volutions, nearly flat; sutures scarcely impressed.

Coal measures of Illinois, Indiana (?), and Missouri.

304. **M. nitidula** M. and W. (Fig. 1003, *c, d*.) Carbonic.

Less slender, with 8 or more somewhat more convex volutions last one somewhat longer than half the length of the shell.

Coal measures of Illinois and Indiana.

305. **M. inornata** M. and W. Carbonic.

Shorter and somewhat broader than the preceding, sutures less deeply impressed, body whorl nearly two thirds the length of the shell.

Coal measures of Illinois, Ohio, Missouri, and Arkansas.

LXXXVII. Bulimorpha Whitfield.

Like *Meekospira*, but with more convex volutions, base of aperture acute and notched; outer lip with slight notch at suture. Mississippic–Carbonic.

306. **B. bulimiformis** (Hall). (Fig. 1004.) Mississippic.

Fig. 1004. *Bulimorpha bulimiformis.* (After Whitfield, Am. Mus. Nat. Hist. Bull.)

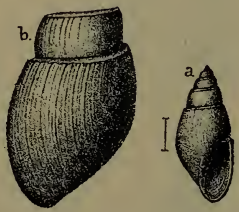


Fig. 1005. *Bulimorpha minuta* (*a*), × 4; *b*, body whorl greatly enlarged. (After Meek and Worthen, Ill., V.)

Small, spire nearly half the length of the shell, volutions convex, suture impressed, surface smooth.

St. Louis (Spergen) of Indiana and Missouri.

307. **B. minuta** (Stevens). (Fig. 1005.) Carbonic.

Minute, with distinct flat but narrow sutural shelf.

Coal measures of Illinois, Iowa, etc.

LXXXVIII. Soleniscus M. and W.

Like *Bulimorpha*, but with base produced into a short, straight canal, and with a more or less distinct columellar fold. Carbonic.

308. **S. typicus** M. and W. (Fig. 1006, *a*, *b*.) Carbonic.

Small, slender, acute spire, base much produced, last whorl nearly three fourths length of shell; fold strong within.

Coal measures of Illinois and Missouri.

309. **S. fusiformis** Hall. (Fig. 1006, *c*, *d*.) Carbonic.

Whorls regularly enlarging, spire more than half length of shell; columellar fold broad and low externally; inner lip with strong callus.

Coal measures of Iowa, Indiana, Illinois, Ohio, and Arkansas.

310. **S. planus** White. (Fig. 1006, *e*, *f*.) Carbonic.

Shorter and more convex than *S. fusiformis*; columellar fold strong.

Coal measures of Ohio, Illinois, and New Mexico.

311. **S. newberryi** Stevens. (Fig. 1006, *g*, *h*.) Carbonic.

Shorter and more convex than preceding; columellar folds double.

Coal measures of Illinois, Iowa, and Missouri.

312. **S. paludinæformis** Hall. (Fig. 1006, *i*.) Carbonic.

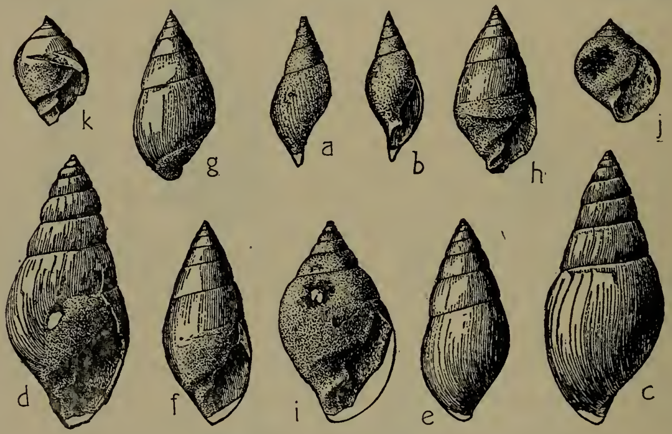


FIG. 1006. *a*, *b*, *Soleniscus typicus*; *c*, *d*, *S. fusiformis*; *e*, *f*, *S. planus*; *g*, *h*, *S. newberryi*; *i*, *S. paludinæformis*; *j*, *k*, *S. brevis*. (All after White, 13th Ind. Rep.)

Short and thick; spire short but gently concave; body whorl large, ventricose; columellar fold strong.

Coal measures of Iowa, Indiana, Ohio, and Missouri.

313. **S. brevis** White. (Fig. 1006, *j*, *k*.) Carbonic.

Small, short and thick, with very convex body whorl. Approaches *Sphærodoma*.

Coal measures of Iowa, Missouri, Illinois, and New Mexico.

314. **S. gracilis** Cox. Carbonic.

Like the preceding, but more slender and with much higher spire.

Coal measures of Iowa, Missouri, and Kentucky.

315. **S. regularis** Cox. (Fig. 1007.) Carbonic.

Large, with long spire of nine convex volutions. Body whorl

comparatively short and contracted. Columellar fold strong.
Coal measures of Ohio and Kentucky.

FIG. 1007. *Soleniscus regularis.* (After Whitfield, N. Y. Acad. Sci. Proc.)

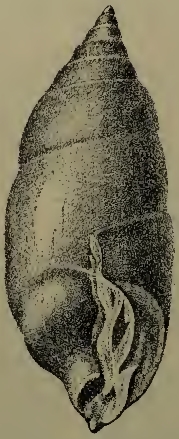


FIG. 1008. *Soleniscus klipparti.* (Pal. Ohio, II.)

316. **S. klipparti** Meek. (Fig. 1008.) Carbonic.
Last few whorls irregular, elongate, flattened, upper part of spire normal; columellar fold strong.
Coal measures of Ohio.

LXXXIX. SPHÆRODOMA Keyes.

Like *Soleniscus*, but short, thick, and more or less globular; body whorl generally very convex. Devonic–Carbonic.

317. **S. hamiltoniæ** Hall. Devonic.
Four or five volutions rapidly enlarging, body whorl ventricose; base of lip scarcely notched.
Hamilton of New York, Pennsylvania, etc.

318. **S. intercalare** (M. and W.). (Fig. 1009.) Carbonic.
Medium-sized, with regularly but rapidly enlarging whorls, the last one about two thirds the entire length.
Coal measures of Nebraska, Illinois, Pennsylvania, and West Virginia.

FIG. 1009. *Sphærodoma intercalare.* (After Meek and Worthen, Ill. Pal., II.)

319. **S. mediale** M. and W. (Fig. 1010, *a*, *b*.) Carbonic.
Subovate, spire short, gently convex, body whorl moderately ventricose, columellar fold obtuse, notch shallow.

Coal measures of Illinois, Indiana, Ohio, Iowa, and Missouri.

320. **S. texanum** Shumard. (Fig. 1010, *c*, *d*.) Carbonic.

Shorter and more globose; notch strong; columellar callus strong.

Coal measures of Texas and Illinois.

321. **S. primigenium** (Conrad). (Fig. 1010, *e*.) Carbonic.

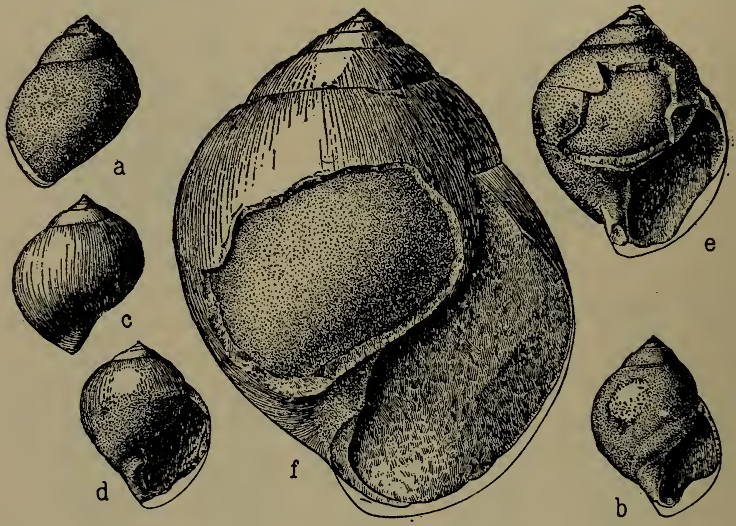


FIG. 1010. *a*, *b*, *Sphærodoma mediale*; *c*, *d*, *S. texanum*; *e*, *S. primigenium*; *f*, *S. ponderosum*. (After White, 13th Ind. Rep.)

Larger, and with scarcely developed columellar fold; thick shell; otherwise like preceding.

Coal measures of Pennsylvania, Ohio, Indiana, Illinois, Iowa, Missouri, and Arkansas.

322. **S. ponderosum** Swallow. (Fig. 1010, *f*.) Carbonic.

Very large, with deeply sinuous inner lip but no fold; whorls convex, embracing to above ambitus.

Coal measures of Kansas, Iowa, Missouri, and Ohio.

Family TROCHIDÆ Adams.

XC. GIBBULA Risso.

Trochoid, rarely round-whorled, usually umbilicated shells, embracing to ambitus, with angle and aperture rounded. Tertiary–Recent.

323. **G. glandula** (Conrad). (Fig. 1011, *a.*) Eocenic.

With deeply impressed suture and numerous fine spirals; several angulations due to coarser spirals; right lip toothed at base within.

Aquia formation, Maryland, etc.

XCI. Calliostoma Swainson.

Trochoid shells, with abrupt basal deflection, peripheral keel, and flattened shoulders; surface with ribs or spirals. The umbilicated forms are referable to *Eutrochus* A. Adams. Triassic–Recent.

324. **C. philanthropus** (Conrad). (Fig. 1011, *b.*) Miocenic.

With pronounced peripheral keel, the upper spirals beaded or

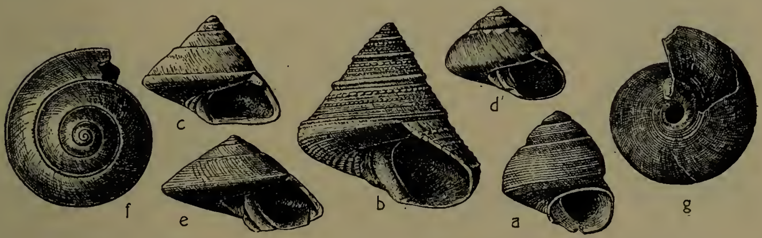


FIG. 1011. *a, Gibbula glandula,* $\times$ 4; *b, Calliostoma philanthropus,* $\times \frac{4}{3}$; *c, C. eboreum,* $\times$ 3½; *d, C. aphelium,* $\times$ 2; *e–g, C.* (*Eutrochus*) *humeli,* $\times \frac{8}{7}$. (After Martin, Md. Survey.)

nodulated. Some varieties have three beaded or nodulated spirals, with sometimes intercalated smaller smoother ones.

Chesapeakean (St. Mary's, Choptank, and Calvert formations) of Maryland.

325. **C. eboreum** (Wagner). (Fig. 1011, *c.*) Miocenic.

Mostly smooth, with faint concavity in upper part of shoulder, and, rarely, fine spirals, except below the obtuse keel, which is seen on the body whorl. (*C. aphelium* Dall (Fig. 1011, *d*) has somewhat more rounded whorls and subsutural row of white spots.)

Choptank and Calvert formations of Maryland.

326. **C. (Eutrochus) humile** (Conrad). (Fig. 1011, *e–g.*) Miocenic.

Umbilicated, broad, low-spired; keel faint; spirals fine; aperture subrhomboidal.

St. Mary's formation, Maryland; common.

XCII. MARGARITA Leach.

Trochoid umbilicated shells, with rounded whorls and impressed suture. Cretacic–Recent.

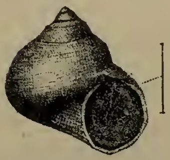


FIG. 1012. *Margarita ornatissima*, enlarged. (After Gabb.)

327. **M. ornatissima** (Gabb). (Fig. 1012.) Cretacic.

Of naticoid form, umbilicus moderate, apical angle less than in *M. abyssina*, suture moderately impressed, surface finely spiralled.

Nanaimo group of Vancouver ; Chico of California, etc.

328. **M. abyssina** (Gabb). (Fig. 1013.) Cretacic.

Four or more volutions ; apical angle 70° or 75° ; umbilicus

FIG. 1013. *Margarita abyssina*. (After Whitfield.)

broad and open ; shell thin, with very fine spirals, and apparently a stronger peripheral one.

Ripleyan of New Jersey.

Family ADEORBIIDÆ Fischer.

XCIII. TEINOSTOMATA Adams.

Low-spired or discoidal shells, with the broad umbilicus covered by callus in the adult ; whorls flattened vertically ; surface smooth. Miocenic–Recent.

329. **T. nanum** (Lea). (Fig. 1014.) Miocenic.

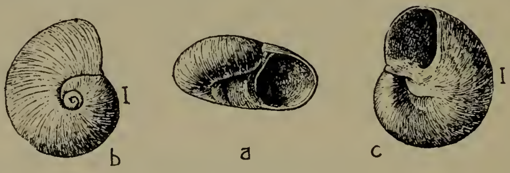


FIG. 1014. *Teinostomata nanum*, much enlarged. (Md. Survey.)

Shell smooth and highly polished, umbilicus covered by thick callus, bounded by faint impressed line ; spire very low.

Chesapeakean of Atlantic coast.

330. **T. milium** Dall. Miocenic–Pliocenic.

Of three whorls; suture not impressed; open umbilicus of young bounded by obscure angular ridge; in adult, with callus having concave surface; aperture nearly round.

Chesapeakean of North Carolina, Pliocenic of Caloosahatchie and Shell Creek, Florida.

XCIV. Adeorbis Wood.

In form like the preceding, but with large open umbilicus and surface generally spirally sculptured, often angulated, and sometimes ribbed. Oligocenic–Recent.

331. **A. supranitidus** Wood. (Fig. 1015.) Oligocenic–Recent.

With three strong carinæ, one medially placed, and one each on upper and lower side; surfaces between mostly flat.

Oligocenic of Santo Domingo and of Florida (Chipola beds); Chesapeakean of Maryland and North Carolina; Pliocenic (Waccamaw beds) of South Carolina and of Europe. Recent on both sides of the Atlantic.

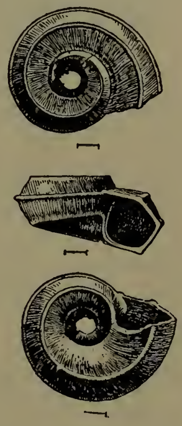


Fig. 1015. *Adeorbis supranitidus*, much enlarged. (Md. Survey.)

332. **A. concavus** Lea. Miocenic–Pliocenic.

Smooth, except for angulated periphery, with flat spire and strongly embracing whorls, large part of aperture being applied to the body.

Chesapeakean of Virginia and North Carolina; Pliocenic of North Carolina and Florida.

Family Neritopsidæ Fischer.

XCV. Neritopsis Grateloup.

Naticoid shells, non-umbilicate, with depressed spire and large body whorl; surface with ribs and spirals; inner lip thick, angularly emarginate in the middle. Operculum calcareous, not spiral. Triassic–Recent.

333. **N. biangulata** Shumard. Cretacic.

Depressed, wider than high, spire about one fifth of the height of shell. Volutions three to three and one half, angulated, with narrow, flat shoulder, declining very gradually from angle of periphery to suture. Body whorl very convex, angulated below as well as above, but less sharply; surface with coarse, oblique striæ of growth; height 1.1 in., width 1.42 inches.

Eagle Ford formation of Texas.

Family NERITIDÆ Lam.

XCVI. NERITA Linn.

Semi-globose, non-umbilicate, naticoid shells, with minute spire and large body whorl; inner lip callous, and with straight, commonly denticulate border. Triassic ?–Holocenic.

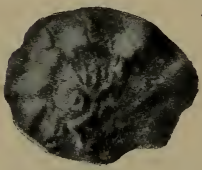


FIG. 1016. *Nerita nodilirata.* (After Cragin, Bull. U. S. G. S., 266.)

334. **N. nodilirata** Cragin. (Fig. 1016.) Jurassic.

With strong rounded folds on upper part of whorls.

Malone formation of Texas.

335. **N. nebrascensis** M. and H. (Fig. 1017, *a–c.*) Jurassic.

Small; inner lip smooth; surface with zigzag color bands.

Upper Jurassic? of Dakota (Black Hills).

336. **N. (Neretina) naticiformis** White. (Fig. 1017, *d, e.*) Cretacic.

Small, surface smooth, inner lip faint.

Bear River formation of Wyoming and Utah.

337. **N. crebrilineata** White. (Fig. 1017, *f, g.*) Cretacic.

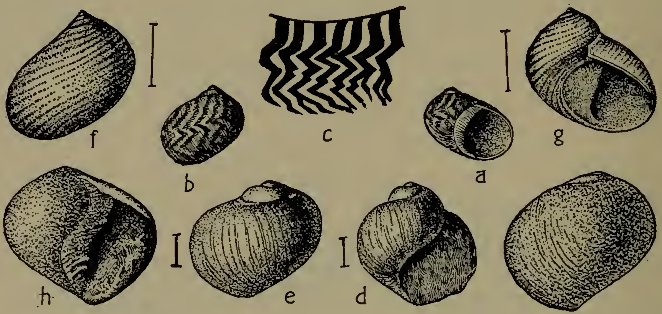


FIG. 1017. *a–c, Nerita nebrascensis; d, e, N.* (*Neritina*) *naticiformis; f, g, N. crebrilineata; h, i, N. pisum.* (After White, U. S. G. S.)

Larger than preceding; spire minute; callus of inner lip strong; surface with regular fine spirals.

Laramie of Wyoming and Colorado.

338. **N. pisum** Meek. (Fig. 1017, *h*, *i*.) Cretacic.
Small (height 0.22 in.), smooth, with four denticles on inner lip, in groups of two.
Colorado of Coalville, Utah.

XCVII. Velatella Meek.

Neritoid shells, depressed-convex above, flattened on apertural side, with large inner lip; enlargement of body whorl such as to give the shell a patelliform aspect; with minute, slightly incurved apex. Cretacic.

339. **V. patelliformis** Meek. (Fig. 1018, *a*, *b*.) Cretacic.

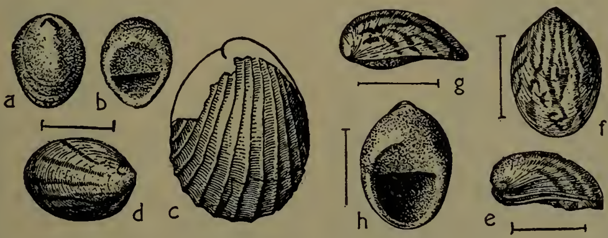


FIG. 1018. *a*, *b*, *Velatella patelliformis*; *c*, *V. carditoides*; *d–h*, *V. baptista*. (After White, U. S. G. S.)

Small, thick, oval, almost perfectly bilateral; inner lip broad and thick, faintly denticulate, extending more than half the length of the base of the shell; surface with growth lines.
Lower Colorado of Coalville, Utah, and Bear River, Wyoming. Common.

340. **V. carditoides** Meek. (Fig. 1018, *c*.) Cretacic.
Surface with well-marked radiating rib-like spirals.
Upper Colorado, Coalville, Utah.

341. **V. baptista** White. (Fig. 1018, *d–h*.) Cretacic.
Enrolled apex prominent; surface smooth except for color bands, which are sometimes preserved. Edge of inner lip smooth.
Laramie of Wyoming and the region of the Bow and Belly rivers, Canada.

Family Fissurellidæ Risso.

XCVIII. Emarginula Lam.

Subconic shells with submedian or posterior apex, and anterior marginal slit. (These characters are also those of young *Fissuridea*.) Carbonic–Recent.

342. **E. arata** Conrad. (Fig. 1019.) Eocenic.

Oblong-ovate, slit large but not deep, on narrower end; apex central, strongly incurved; surface with angular ridges, largest on posterior (broad) end and increasing by intercalation or division.

Claibornian of Alabama, rare.

343. **E. marylandica** Martin. (Fig. 1020.) Miocenic.

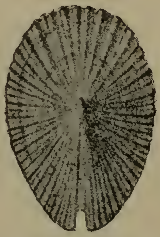


FIG. 1019. *Emarginula arata.* (After Conrad.)

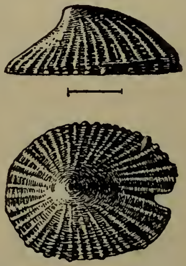


FIG. 1020. *Emarginula marylandica.* (Md. Survey.)

Smaller than preceding and more nearly oval, beak nearer the posterior end, radiating ridges round, uniform on all parts of shell, distant with smaller ones between.

Choptank formation of Maryland.

XCIX. FISSURIDEA Swains. (*Fissurella* in part of authors.)

Subconical or subcapuliform shells of oval base and the apex anterior to the middle and replaced by a perforation with a callus on the interior. Carbonic (?)–Recent.

344. **F. griscombi** (Conrad). (Fig. 1021, *a–d.*) Miocenic.

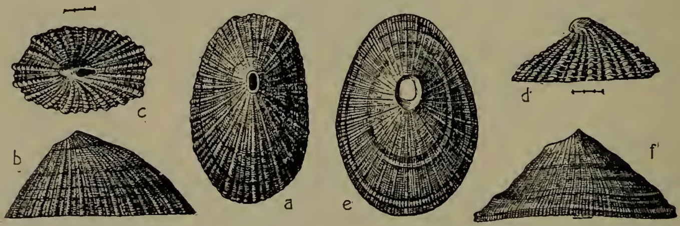


FIG. 1021. *a–d, Fissuridea griscombi, a, b,* × ⅔, *c, d,* young, × 5; *e, f, F. marylnadica,* × ⅔. (Md. Survey.)

Young with enrolled protoconch, later resorbed by advancing fissure; moderately high, subconical laterally compressed surface, plicæ strong, alternating, generally two or three finer ones between two coarser.

Chesapeakean of Maryland and New Jersey.

345. **F. marylandica** (Conrad). (Fig. 1021, *e, f.*) Miocenic.

Differs from the preceding chiefly in its finer radiating plications or striations, in not being compressed laterally and in the larger apical fissure.

Chesapeakean of Atlantic coast.

Family EULIMIDÆ Fischer.

C. EULIMA Risso.

Small, turreted, smooth and lustrous non-umbilicated shells with dextral protoconch. (A columellar tooth occurs in *Syrnola* Adams.) Triassic–Recent.

346. **E. eborea** (Conrad). (Fig. 1022, *a.*) Miocenic.

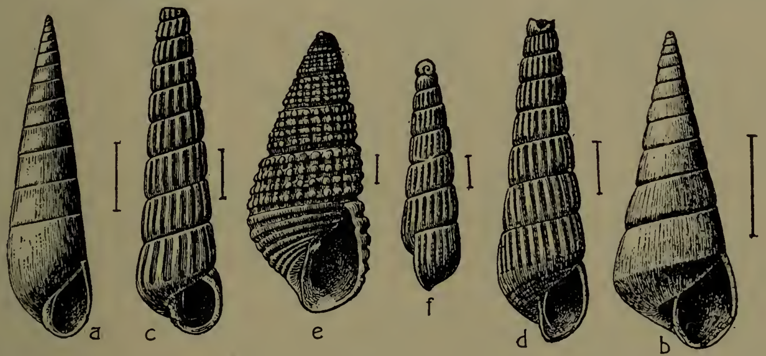


FIG. 1022. *a, Eulima eborea; b, Niso lineata; c, Turbonilla nivea; d, T. interrupta; e, Chrysallida melanoides; f, Odostomia conoidea.* (After Md. Survey.)

Long, slender (13 whorls), sides of whorls flat, suture flush, surface smooth, base of body whorl curving.

St. Mary's and Calvert formations of Maryland.

CI. NISO Risso.

Like the preceding, but deeply umbilicated. Triassic–Recent.

347. **N. lineata** Conrad. (Fig. 1022, *b.*) Miocenic.

Sides (shoulders) of whorl nearly flat and smooth; peripheral angulation pronounced, generally visible only on body whorl.

Calvert formation of Maryland.

Family PYRAMIDELLIDÆ Gray.

CII. TURBONILLA Risso. (*Chemnitzia* d'Orb.)

Like *Eulima*, but with depressed suture, protoconch coiling in vertical plane, and smooth or ribbed. Columellar tooth present in *Pyrgulina*. Tertiary–Recent.

348. **T. nivea** Stimpson. (Fig. 1022, *c.*) Miocenic ?–Pleistocenic.
Long and slender with regular rigid vertical ribs.
St. Mary's of Maryland, Pliocenic and Pleistocenic of the Carolinas.

349. **T. interrupta** (Totten). (Fig. 1022, *d.*) Miocenic.
With narrower intercostal spaces occupied by interrupted spirals; spirals marked on base of body whorl.
St. Mary's, Choptank, and Calvert formations of Maryland.

CIII. Chrysallida Carpenter.

Like *Turbonilla* but with both ribs and spirals and columellar tooth. Tertiary.

350. **C. melanoides** (Conrad). (Fig. 1022, *e.*) Miocenic.
Small, rather broad; spirals on side (shoulders) of whorls nodulated by ribs; simple on body of whorl.
St. Mary's formation of Maryland.

CIV. Odostomia Fleming.

Like *Eulima*, but with more depressed sutures and columellar tooth; surface smooth. Differs from *Syrnola* in convex whorls and depressed sutures. Tertiary–Recent.

351. **O. conoidea** (Brocchi). (Fig. 1022, *f.*) Miocenic.
Small, short, with elongate body whorl; angle of young greater than of adult.
Choptank and St. Mary's (?) of Maryland; Calvert of New Jersey; Sub-Apennine of Italy.

Family Scalariidæ Broderip.

CV. Scalaria Lam. (*Scala* Klein.)

Turreted non-umbilicated shells, with deep sutures and convex whorls, marked at regular and frequent intervals by smooth varices. Triassic–Recent.

352. **S. sillmani** Morton. (Fig. 1023.) Cretacic.
Broad-spired and rather closely coiled, with very oblique sharp varices and very fine spirals. Internal mold smooth, with deep sutures.
Ripleyan of New Jersey and Alabama.

353. **S. sayana** Dall. (Fig. 1024, *a.*) Miocenic.

Varices about 9 (7 to 11) to a whorl, sharp and slightly oblique; interspaces smooth.

St. Mary's and Choptank formations of Maryland.

354. **S. (Sthenorhytes) pachypleura** Conrad. (Fig. 1024, *b*.) Miocenic.

Short and thick, with large body whorl. Varices thick, sub-

FIG. 1023. *Scalaria sillmani*. (After Whitfield.)

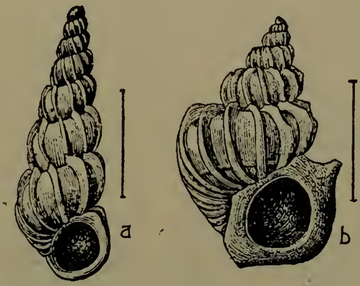


FIG. 1024. *a*, *Scalaria sayana*; *b*, *S.* (*Sthenorhytes*) *pachypleura*. (Md. Surv.)

spinose above; body whorl with a cingulum or discontinuous spiral in the interspaces; mouth nearly circular, lips expanded.

St. Mary's, Choptank, and Calvert formations of Maryland, etc.

Family SOLARIIDÆ Chenu.

CVI. SOLARIUM Lam.

Depressed-conical to flat and deeply umbilicated shells with strong peripheral angulation in the most specialized species; nuclear whorls heterostrophic; surface smooth or with spirals, etc.; aperture quadrilateral; umbilicus with notched margins or spiral; operculum horny. Jurassic–Recent.

355. **S. ? planorbis** Roem. (Fig. 1025.) Comanchic.

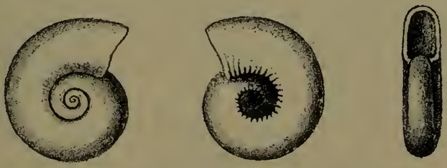


FIG. 1025. *Solarium planorbis*. (After Roemer.)

Depressed, spire flat or sunken; whorls dorsoventrally compressed, slightly embracing; surface smooth except for a line of notches along the umbilical edge.

Edwards limestone of Texas, etc.

FIG. 1026. *Solarium alveatum.* (After Conrad.)

356. **S. alveatum** Conrad. (Fig. 1026.)
Eocenic.

Spire trochiform; sutures not impressed; whorls flat, smooth, with two spirals near suture; angulation sharp, base flattened with peripheral grooved lines; umbilicus profound, margined by ring of triangular dentations.

Abundant in Claibornian of Alabama.

357. **S. trilineatum** Conr. (Fig. 1027.)
Miocenic.

Periphery with smooth carina, beneath which on the body is another smooth carina; gently convex shoulder with two beaded spirals, one close to each bounding suture.

Calvert formation of Maryland.

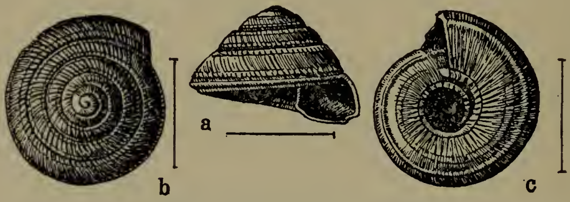


FIG. 1027. *Solarium trilineatum.* (After Md. Survey.)

Family CAPULIDÆ Cuvier.

CVII. CAPULUS Montfort.

Conical or cap-shaped shells with apex curving towards the posterior end, and often slightly enrolled. A horse-shoe shaped muscle impression on the interior? (This is probabably a polyphyletic group; the Palæozoic species referred here belong elsewhere.) Triassic–Recent.

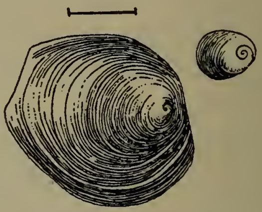


FIG. 1028. *Capulus expansus.* (After Harris.)

358. **C. expansus** (Whitf.). (Fig. 1028.)
Eocenic.

Small, broadly expanded, apical volutions one to two; surface with growth lines.

Chickasawan (Lignitic) of Alabama.

CVIII. CALYPTRÆA Lam. (*Galerus* Gray.)

Thin, conical spiral shells, with the last whorl greatly expanded, bearing a wide aperture with flat periphery; whorls often spinose. Cretacic–Recent.

359. **C. centralis** Conrad. (Fig. 1029, *a–c*.)

Oligocenic–Miocenic.

Conical, with apertural rim projecting beyond the last whorl; surface smooth except for a few irregular spiral lines and growth lines.

Chipolan of Gulf States; St. Mary's of Maryland.

360. **C. aperta** Solander. (Fig. 1029, *d*.) Miocenic.

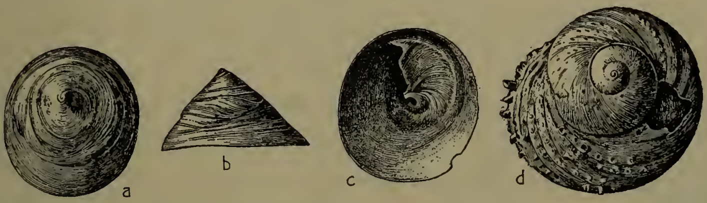


FIG. 1029. *a–c*, *Calyptræa centralis*, nat. size; *d*, *C. aperta*, × ⅔. (Md. Survey.

Large, gibbous, with regularly enlarging spirals, the later ones strongly spinose.

Choptank and Calvert formations of Maryland; Shiloh marls of New Jersey.

CIX. CREPIDULA Lam.

Slipper-shaped, with beak nearly or quite marginal, and often enrolled. The elongate aperture is partly covered by a platform or thin lamellar expansion of the inner lip. Cretacic–Recent.

361. **C. lirata** Conrad. (Fig. 1030.) Eocenic.

Beak much produced, strongly curved to side and forward, with subspiral apex; form narrow, elongate and deep; surface with irregular striæ or costæ and transverse wrinkles.

Claibornian of Alabama, very common.

FIG. 1030. *Crepidula lirata*. (After Conrad.)

362. **C. plana** Say. (Fig. 1031, *a*, *b*.)

Oligocenic–Recent.

Flat; apex marginal, not enrolled; shell elongate; platform covering about half the length of shell.

Chipolan of Gulf States; St. Mary's and Calvert formations of Maryland; Miocenic and Pliocenic of Virginia, the Carolinas, etc.; modern seas.

363. **C. fornicata** (Linné). (Fig. 1031, *c*, *d*.) Miocenic–Recent.

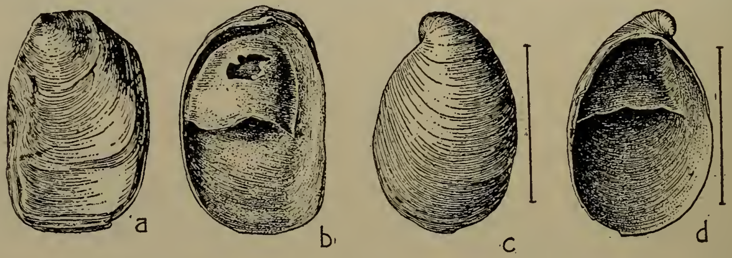


Fig. 1031. *a*, *b*, *Crepidula plana*, nat. size; *c*, *d*, *C. fornicata*, enlarged. (Md. Survey.)

Convex, with enrolled apex, and deep-set platform.

Widely distributed in marine Miocenic and Pliocenic of America and abundant on modern coasts.

CX. Crucibulum Schum.

Patelloid shells with coiled protoconch and strongly expanding body whorl. Platform deeply concave, producing the cup and saucer aspect. Tertiary–Recent.

364. **C. chipolanum** Dall. Oligocenic.

Like *C. auricula*, but radiating striæ sharply cut and stronger,

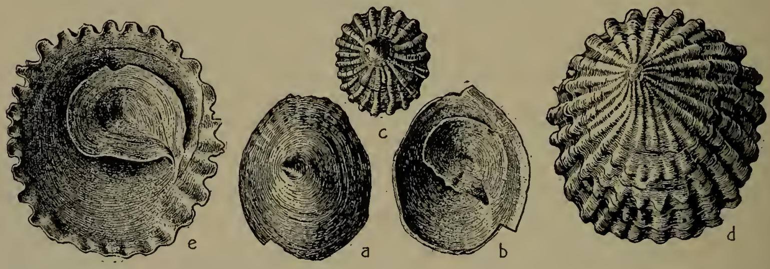


Fig. 1032. *a*, *b*, *Crucibulum costatum*, × ⅔; *c–e*, *C. pileolum*; *c*, young, × 1¾; *d*, *e*, adult, × ⅔. (Md. Survey.)

though not as strong as in *C. pileolum*; rarely dichotomous.

Chipolan of Gulf States.

365. **C. costatum** (Say). (Fig. 1032, *a*, *b*.) Miocenic.

Mostly smooth, with faint costæ near margin, cup attached on one side.

Miocenic of Maryland.

366. **C. pileolum** (Lea). (Fig. 1032, *c–e.*) Miocenic.

With strong plications, often extending to beak; cup free at periphery in adult.

St. Mary's of Maryland, Virginia, etc.

367. **C. auricula** Gmelin. Pliocenic-Recent.

Depressed, with fine radiating, frequently dichotomous lines on upper surface.

Waccamaw beds of South Carolina; Caloosahatchie beds of Florida. Living west coast of Florida to northern Brazil, 25 to 100 fathoms.

Family Naticidæ Forbes.

CXI. Sigaretus Lam.

Broad-spired naticoid shell with rapidly enlarging whorls, distended aperture with horny operculum, and spiral surface sculpture. Tertiary–Recent.

Fig. 1033.
Sigaretus bilix.
(After Harris.)

368. **S. bilix** (Conr.). (Fig. 1033.) Eocenic.

Rotund; umbilicus large; spirals crowded and in pairs.

Chickasawan and Claibornian of Alabama.

369. **S. fragilis** (Conr.). (Fig. 1034.) Miocenic.

Fig. 1034. *Sigaretus fragilis.* (Md. Surv.)

Larger than preceding (22 mm. high), aperture about four fifths of length of shell; inner lip less prominent, umbilicus small, spirals uniform, crowded.

Miocenic of Atlantic coast.

CXII. Vanikoropsis Meek.

Practically non-umbilicated shells of naticoid form; inner lip thin, smooth, adhering to columella; surface with spirals and oblique rib-like folds.

370. **V. suciensis** White. Cretacic.

Small, subovoid, with small spire and blunt apex; volutions four or five; body whorl much expanded, with large oval aperture; surface with fine spirals throughout.

Nannaimo of Vancouver; similar beds of California, etc.

371. **V. tuomeyana** (M. and H.). (Fig. 1035.) Cretacic.

FIG. 1035. *Vanikoropsis tuomeyana*, with enlargement of surface. (After Meek.)

Thick, few whorled, last whorl large, rounded; aperture ovate; faint umbilical indentation; spirals numerous; ribs on body whorl only.

Claggett formation of Montana and Canada.

CXIII. Natica Lam.

Varying in form from globose to pyramidal, with smooth and lustrous (rarely striated) surface, typically with umbilicus, which is often more or less covered by a callus; some groups non-umbilicated. Aperture semicircular to oval with thickened inner

FIG. 1036. *Natica williamsi*. (After Cragin, Bull. U. G. S., 266.)

and sharper outer lip. (A number of subgenera are recognized.) Triassic–Recent.

372. **N. williamsi** Cragin. (Fig. 1036.) Jurassic.

Non-umbilicate, of five whorls, the spire short, of much embraced somewhat sunken whorls and large body whorl, with long aperture narrowing upwards.

Malone formation, Texas.

373. **N. (Lunatia) pedernalis** Roemer. (Fig. 1037.) Comanchic.

Very large, whorls embracing to a little above the middle, last one ventricose, somewhat separated.

Glen Rose, Comanche Peak of Texas, etc.

FIG. 1037. *Lunatia* (*Tylostoma*) *pedernalis*, × ½? (After Hill.)

374. **N. (Lunatia) halli** Gabb. (Fig. 1038.) Cretacic.

Spire elevated, height about one and one half times the diameter; suture of internal molds deep; umbilicus large; aperture acute above, acutely rounded below.

Ripleyan formation of New Jersey, Alabama, Mississippi.

FIG. 1038. *Lunatia halli.* (After Whitfield.)

375. **N. (Lunatia) avellana** Gabb. (Fig. 1039.) Cretacic.

Subglobose, embracing to above the ambitus, with impressed suture, moderate spire, large, minutely umbilicated body whorl; inner lip slightly callous, aperture acute above.

Horsetown of California, etc.

FIG. 1039. *Lunatia avellana.* (After Gabb.)

376. **N. (Lunatia) shumardiana** Gabb. (Fig. 1040.) Cretacic–Eocenic.

Body whorl more convex than in preceding; base more extended at aperture; inner lip more strongly callous; umbilicus small.

Nanaimo of Vancouver; Chico and Tejon of California.

377. **N. (Lunatia) marylandica** Conr. (Fig. 1041.) Eocenic.

Suborbicular to subovate, with low, broad spire of five volu-

FIG. 1040. *Lunatia shumardiana.* (After Gabb.)

FIG. 1041. *Lunatia marylandica.* (Md. Survey.)

tions; whorls slightly depressed below the suture; the aperture with a faint posterior canaliculation; umbilicus moderate.

Nanjemoy and Aquia of Maryland, Virginia, etc. A closely related form, *N. eminula*, occurs in the Chickasawan and Clai-bornian of Alabama and Texas.

378. **N. (Lunatia) semilunata** Lea. (Fig. 1042.) Eocenic.

Smaller than *N. heros* and with higher spire; callus of inner lip partly covering umbilicus, which is normally surrounded by a carination.

Chickasawan (Lignitic) of Alabama and Texas.

379. **N. mediavia** Harris. Eocenic.

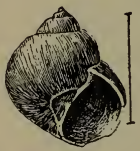


FIG. 1042. *Natica semilunata.* (After Harris.)

FIG. 1043. *Natica* (*Cryptonatica*) *floridana*, $\times 4$. (After Dall.)

With about 5 whorls, slightly shouldered or flattened near the depressed sutures; large globular body whorl; aperture elliptical, with thickened lip forming a varix.

Midwayan of Georgia and Alabama.

380. **N. (Ampullina) mississippiensis** Conrad. Oligocenic.

Large; spire somewhat elevated; suture deeply canaliculate;

body whorl somewhat depressed-convex; aperture ovoid; inner lip expanded over umbilical region.

Claibornian of Alabama; Upper Eocenic of Mississippi.

381. **N. (Cryptonatica) floridana** Dall. (Fig. 1043.) Oligocenic.

Differs from *N. duplicata* in its somewhat more globular form, more elongate aperture, and smaller callus; from *N. heros*, in its smaller size, absence of shoulder concavity or flattening, somewhat narrower aperture, and the callus.

Chipolan and Orthaulax beds of Florida.

382. **N. (Lunatia) heros** (Say). Miocenic–Recent.

Large, with globular whorls strongly embracing, and generally slightly depressed below the suture, especially in adult; umbilicus large, scarcely encroached upon by callus of inner lip.

Chesapeake group of Atlantic coast; Pliocenic of southern United States; Pleistocenic of South Carolina and Canada. Widely distributed on modern Atlantic coast of North America.

383. **N. (Neverita) duplicata.** Miocenic–Recent.

Strongly embracing, spire with scarcely impressed sutures; callus of inner lip large, nearly or quite covering the umbilicus.

Chesapeake of Atlantic coast; Pliocenic of southern United States; Pleistocenic of Atlantic coast from Virginia south; Recent from Massachusetts Bay southward.

CXIV. Gyrodes Conrad.

Naticoid shells with broad and deep umbilicus generally surrounded by an angulation, and a flattened or concave band at the suture in the later whorls. Cretacic.

384. **G. depressa** Meek. (Fig. 1044, *a*.) Cretacic.

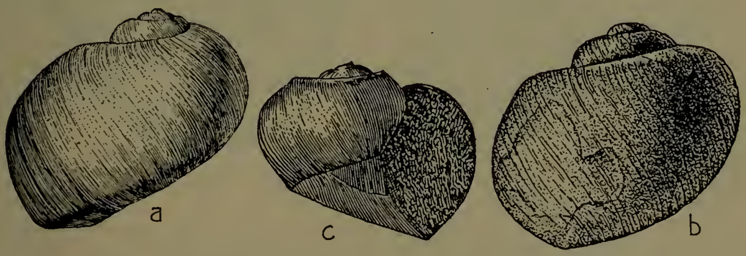


Fig. 1044. *a, Gyrodes depressa; b, c, G. conradi.* (After Stanton.)

Spire depressed or somewhat elevated. Body whorl rapidly enlarging, subangular or narrowly rounded below, with large umbilicus; aperture ear-shaped.

Colorado formation of Colorado, Utah, etc.

385. **G. conradi** Meek. (Fig. 1044, *b*, *c*.) Cretacic.

Low spire, broadly rounded body whorl with a subsutural angulation and a narrow flattened or concave band between this and the suture; strongly carinate in the central basal portion, while a further angulation margins the broad funnel-shaped umbilicus; aperture subrhombic, about twice as wide as high.

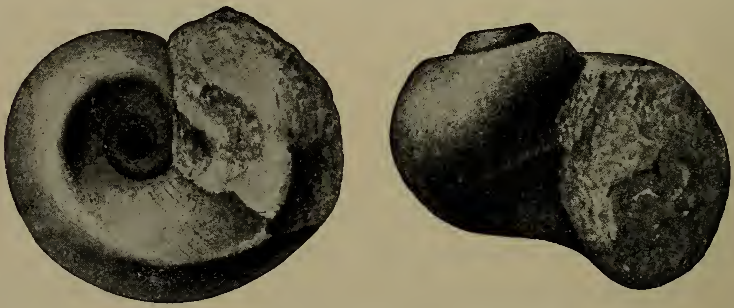


FIG. 1045. *Gyrodes crenata.* (After Whitfield.)

Colorado formation (Benton, and Pugnellus sandstone), of South Dakota and Colorado.

386. **G. crenata** Conrad. (Fig. 1045.) Cretacic.

Like the former but with the carination below the suture crenulated or nodulated, generally not shown in the internal mold.

Ripleyan of New Jersey, Alabama, Mississippi.

387. **G. abyssina** (Morton). (Fig. 1046.) Cretacic.

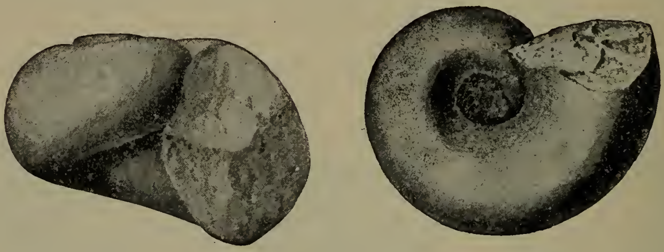


FIG. 1046. *Gyrodes abyssina.* (After Whitfield.)

Like the preceding, but without the basal carination.

Ripleyan of New Jersey, Alabama, Texas.

388. **G. petrosa** (Morton). (Fig. 1047.) Cretacic.

Like *G. abyssina* but smaller and with the space below the suture flat instead of concave.

Ripleyan of New Jersey, Alabama, Mississippi, Texas.

389. **G. conradiana** Gabb. Cretacic.

Like *G. conradi* but without the inner angulation around the umbilicus.

Vancouver group of Washington and Canada, Chico of California.

FIG. 1047. *Gyrodes petrosa.* (After Whitfield.)

390. **G. expansa** Gabb. (Fig. 1048.) Cretacic.

Whorls flattened at suture and flat or slightly concave below the sutural angulation, basal portion without angulation.

Chico of the Pacific Coast.

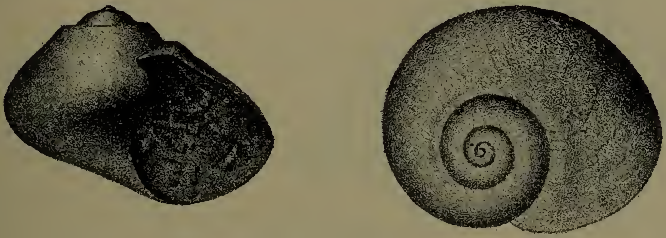


FIG. 1048. *Gyrodes expansa.* (After Gabb.)

CXV. AMAUROPSIS Mörch.

High-spired, non-umbilicate, sides of whorls more or less flattened; those of the body whorl often parallel to axis; sutural flattening or shelf often nearly rectangular to sides. Comanchic–Tertiary.

391. **A. avellana** Roemer. (Fig. 1049.) Comanchic.

Small, subglobular with five or six whorls closely embracing the last one. Large, rounded aperture, semilunar, narrowing upwards; outer lip slightly reflexed, inner lip strong; surface smooth.

Edwards limestone of Texas.

FIG. 1049. *Amauropsis avellana.* (After Roemer.)

392. **A. bulbiformis** (Sowerby). (Fig. 1050.) Cretacic.

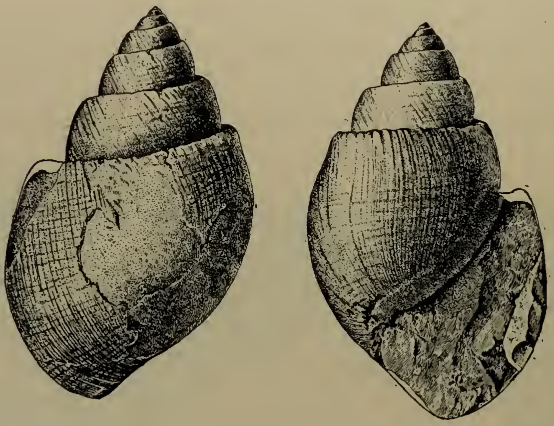


FIG. 1050. *Amauropsis bulbiformis*, × ⅔. (After Stanton.)

FIG. 1051. *Amauropsis alveata.* (After Gabb.)

Large, whorls moderately convex, slightly depressed below sutural angulation; sutural shelf depressed or canaliculate, outer lip nearly vertical.

Colorado group (Pugnellus sandstone and Benton shale) of Colorado. Widely distributed in Europe and Asia.

393. **A. alveata** (Gabb). (Fig. 1051.) Cretacic (?)–Tertiary.

Like preceding but with more convex whorls and broader not depressed sutural shelf.

Chico (?) and Tejon formation of Pacific coast.

Family RISSOIDÆ Troschel.

CXVI. RISSOINA d'Orbigny.

Small turreted shells with arcuate outer lip thickened and slightly notched or drawn out below, and angular above. Surface with ribs, more rarely smooth. Jurassic–Recent.

394. **R. lævigata** Adams. Oligocenic–Recent.

Smooth, with sutures scarcely depressed; body whorl rounding below; protoconch of several whorls, shaped like a small *Vertigo.*

Chipolan and Caloosahatchie beds of Florida; living from Cape Hatteras to the Antilles, also Indo-Pacific.

395. **R. decussata** Montague. Oligocenic–Recent.

Moderately high-spired, whorls slightly rounded, sutures slightly impressed; fine, flat, slightly curved ribs, fine spirals visible only between the ribs, except near the base of body whorl; anterior notch faint, outer lip moderately thickened, length 7–8 mm.

Chipolan (Oligocenic) beds of Florida; Miocenic of France, Italy, and Austria; Coloosahatchie (Pliocenic) of Florida and Italy; Recent: Antilles, Mediterranean, Panama, Indo-Pacific region.

Family Xexophoridæ Desh.

CXVII. Xenophora Fischer.

Broadly conical or trochiform, whorls flat, abruptly angulated; angulation often prolonged as a sharp, sometimes spinous, rim or carina; basal portion flat or rounded, surface commonly with agglutinated foreign particles. Cretacic–Recent.

396. **X. leprosa** (Morton). (Fig. 1052, *b.*) Cretacic.

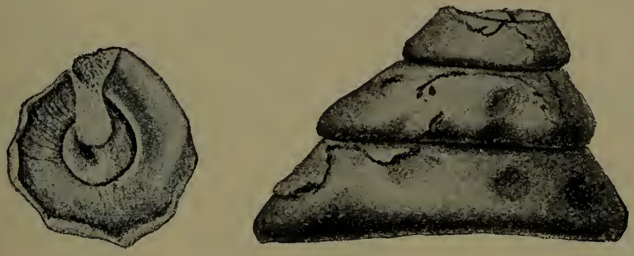


Fig. 1052. *Endoptygma umbilicata* (left); *Xenophora leprosa* (right). (After Whitfield.)

Carina apparently absent, the internal molds appearing rounded at the angle; embracing of whorls not quite to angle; surface generally showing cicatrices where foreign particles were attached.

Ripleyan of New Jersey, Alabama.

397. **X. (Endoptygma) umbilicata** (Tuomey). (Fig. 1052, *a.*) Cretacic.

Smaller than *X. leprosa*, with open umbilicus and a revolving furrow on basal portion, a third of the distance from umbilicus to periphery.

Ripleyan of New Jersey, Mississippi, Alabama.

398. **X. conchyliophora** (Born.). (Fig. 1053.) Oligocenic–Recent.

With moderately overhanging carina, emarginate on outer (lower) side; umbilicus covered by callus. Generally covered with shell fragments.

Chipolan (Oligocenic) of Gulf States; Chesapeakean (Miocenic) of Atlantic coast.

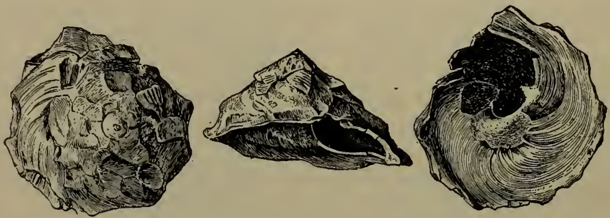


FIG. 1053. *Xenophora conchyliophora*, × ⅔. (Md. Survey.)

Family VALVATIDÆ Gray.

CXVIII. VALVATA Müller.

Small umbilicated shells, of naticoid form with few regularly enlarging whorls, forming a conical or discoidal spire; aperture circular, peristome continuous; operculum horny, multispiral. Habitat fresh water. Jurassic–Recent.

399. **V. scabrida** M. and H. (Fig. 1054, *a–c*.) Jurassic.

Minute, rather loose-coiled, with obtuse conical spire and deeply impressed sutures; aperture circular.

Como (Atlantosaurus) beds of Black Hills, Morrison of Colorado.

400. **V. nana** Meek. (Fig. 1054, *d*, *e*.) Cretacic.

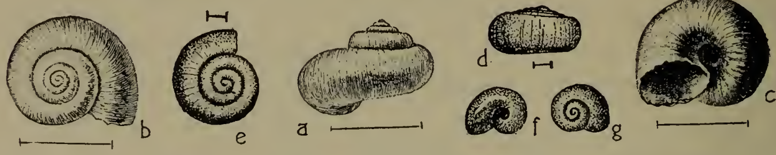


FIG. 1054. *a–c*, *Valvata scabrida*; *d*, *e*, *V. nana*; *f*, *g*, *V. subumbilicata*. (All enlarged.) (U. S. G. S.)

Minute, spire very low, approaching flatness, whorls in contact but not impressed.

Coalville (Coloradoan) of Utah.

401. **V. subumbilicata** M. and H. (Fig. 1054, *f*, *g*.) Cretacic.

Larger than preceding (nearly three times as large), few-whorled, spire low, umbilicus small.

Laramie formation of the upper Missouri River region.

Family Viviparidæ Gill.

CXIX. Viviparus Montford. (*Paludina* Lam.)

Conical or turbinate shells with acute spire of rounded or flattened whorls; suture depressed, and often accentuated by thickening of shell below its aperture, with continuous peristome; umbilicus minute or absent. Angulated forms are generally referred to *Tulotoma;* the smooth, thick shelled species with thick inner lip are referred to *Campeloma* Rafinesque. Habitat fresh water. Jurassic–Recent.

402. **V. gilli** M. and H. (Fig. 1055, *a*, *b*.) Jurassic.

Small, of about four rounded volutions, increasing rather rapidly; suture simply impressed; aperture oval; growth lines faint.

Upper Jurassic (Morrison) of Black Hills.

403. **V. couesii** White. (Fig. 1056, *a*.) Cretacic.

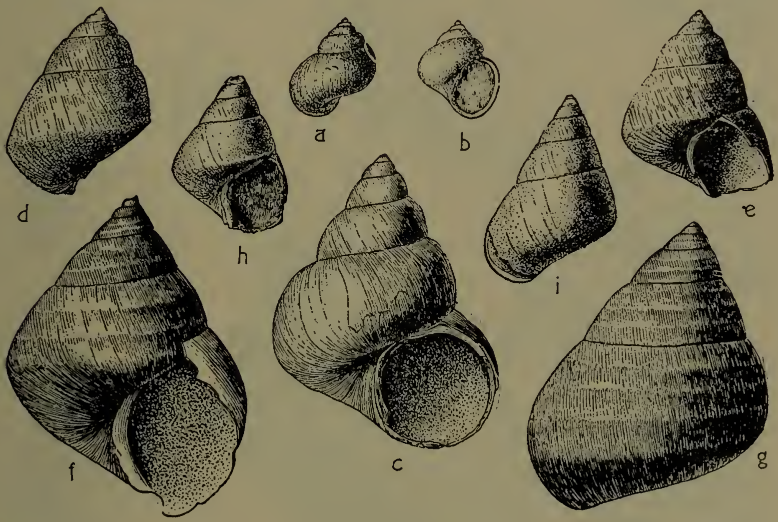


Fig. 1055. *a*, *b*, *Viviparus gilli;* *c*, *V. reynoldsianus;* *d*, *e*, *V. trochiformis;* *f*, *g*, *V. formosa;* *h*, *i*, *V. conradi.* (U. S. Geol. Surv.)

Large, high-spired, whorls round, sutures deep, body whorl somewhat flattened and slightly shouldered without angulation.

Bear River formation of Wyoming.

404. **V. conradi** M. and H. (Fig. 1055, *h*, *i*.) Cretacic.

Apical angle from 45–60 degrees; sutures scarcely impressed, whorls nearly flat, angulated below.

Judith River formation of Wyoming, Montana, and Bow River region, Canada.

405. **V. leai** M. and H. (Fig. 1056, *b*, *c*.) Cretacic.

Broader and shorter than *V. conradi;* sutures somewhat more impressed, whorls gently rounded not angulated below, faintly umbilicated.

Laramie of Colorado, N. Dakota and the Upper Missouri River region generally, also the Bow River region and elsewhere in Canada.

406. **V. leidyi** M. and H. (Fig. 1056, *d*.) Cretacic.

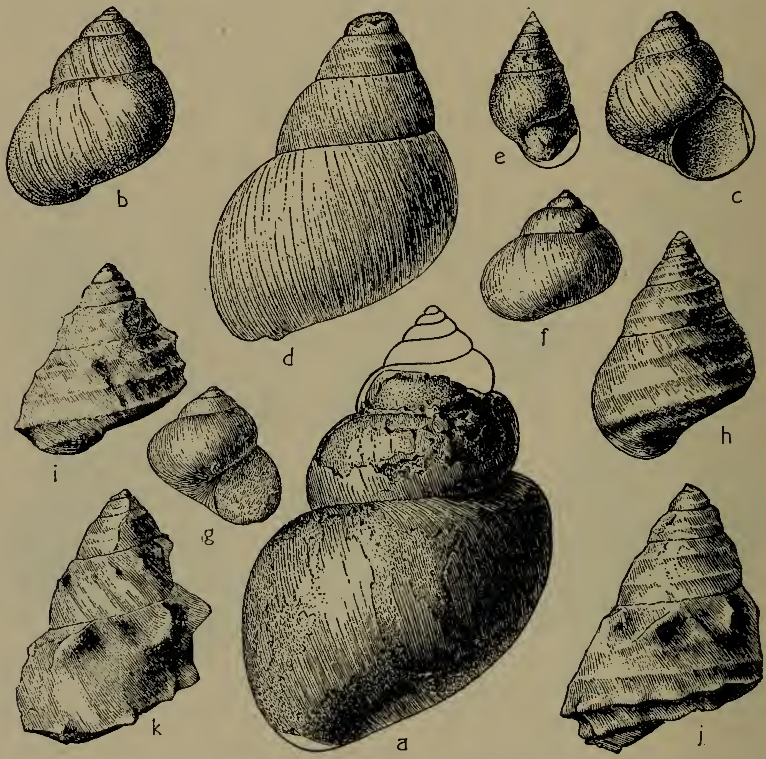


FIG. 1056. *a*, *Viviparus couesii; b*, *c*, *V. leai; d*, *V. leidyi; e*, *V. plicapressus; f*, *g*, *V. prudentia; h–k*, *V.* (*Tulotoma*) *thompsoni.* (After White, U. S. G. S.)

Large, apical angle about 45 degrees; sutures impressed, whorls uniformly rounded.

Laramie of Dakota and Montana, and the Upper Missouri river region generally.

407. **V. plicapressus** White. (Fig. 1056, *e.*) Cretacic.
High-spired, whorls embracing to ambitus, slightly shelved at the suture; aperture nearer axial line than in most species.
Laramie of Colorado and Wyoming.

408. **V. prudentia** White. (Fig. 1056, *f, g.*) Cretacic.
Broad and low-spired, apical angle approaching 90 degrees; whorls few, round, suture moderately impressed.
Laramie of Colorado and the Canadian region.

409. **V. raynoldsiannus** M. and H. (Fig. 1055, *c.*) Eocenic.
Smooth, round-whorled with apical angle 60–65 degrees, nearly circular aperture and small umbilicus.
Fort Union beds of Montana, etc.

410. **V. trochiformis** M. and H. (Fig. 1055, *d, e.*) Eocenic.
With three revolving spirals, or angulations between which the shell is flattened.
Fort Union beds of Montana. A biangulate mutation occurs in Wasatch of Utah.

411. **V. formosa** Meek. (Fig. 1055, *f, g.*) Eocenic.
Broad with shallow sutures and three to four spirals.
Fort Union beds of Montana.

412. **V. (Tulotoma) thompsoni** White. (Fig. 1056, *h–k.*)
Like *V. trochiformis* but with more accentuated spirals which in some of the specialized mutations become more or less strongly nodose.

CXX. Campeloma Rafinesque.

Like *Viviparus* but thick-shelled and with thickened inner lip. Smooth, rarely with exceedingly fine spirals. Cretacic–Recent.

413. **C. macrospira** Meek. (Fig. 1057, *a, b.*) Cretacic.
Large, rather long-spired, volutions round, smooth and with moderately impressed sutures; aperture ovate; inner lip thickened.
Bear River (Coloradoan), Wyoming, Idaho, etc.

414. **C. vetulum** M. and H. (Fig. 1057, *c, d.*) Cretacic.
Like preceding but smaller and slightly more acute, inner lip scarcely thickened, umbilical region indented; surface obscurely spiraled.
Judith River beds, Montana, and Canada.

415. **C. multilineatum** M. and H. (Fig. 1057, *e–g.*) Cretacic.

Rather high-spired, with more or less distinct sutural shelf and exceedingly fine spiral lines.

Laramie of the Upper Missouri Region, and of the Bow and Belly River regions of Canada.

416. **C. multistriatum** M. and H. (Fig. 1057, *h.*) Cretacic.

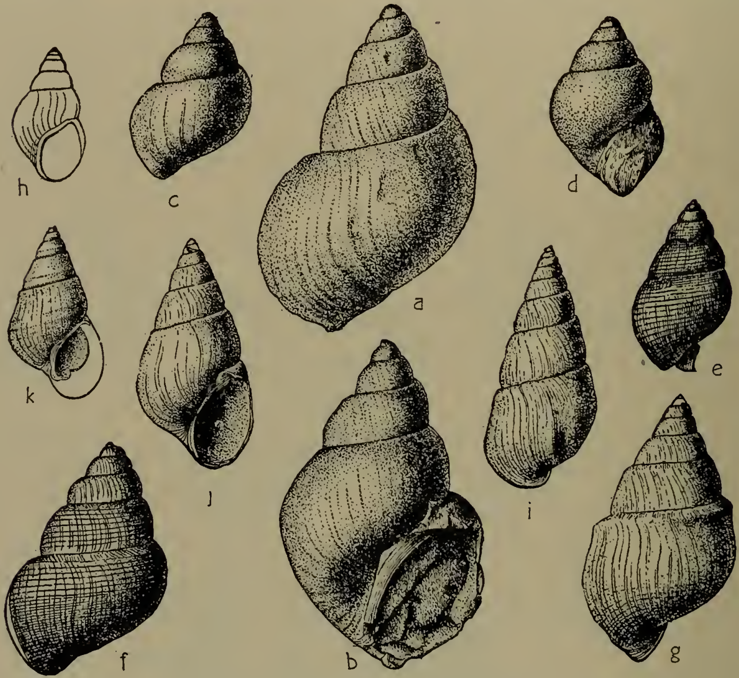


FIG. 1057. *a*, *b*, *Campeloma macrospira*; *c*, *d*, *C. vetulum*; *e–g*, *C. multilineatum*; *h*, *C. multistriatum*; *i–k*, *C. productum*. (After White, U. S. G. S.)

Rather small, many-whorled, apical angle about 45 degrees; sutures impressed, no shelf, whorls round.

Laramie of Colorado, Wyoming, and the Upper Missouri River region generally.

417. **C. productum** White. (Fig. 1057, *i–k.*) Cretacic.

Long and slender, approaching *Goniobasis*. Apical angle 30–40 degrees, in some cases with very faint sutural shelf, rarely faintly angulate and with few faint spires.

Laramie of the Yellow Stone River region, and in the Bow River region and elsewhere in Canada.

Family TURRITELLIDÆ Gray.

CXXI. TURRITELLA Lamarck.

Shell with high turreted and acuminate spire, numerous, variously spiraled whorls, separated by sutures of moderate depth and a round, oval, or quadrangular aperture, with thin outer lip and no plications.

418. **T. (Mesalia) seriatim-granulata** (Roem). (Fig. 1058.) Comanchic.

Large, slender, elongate, with numerous whorls flattened on the side, each later projecting basally over the preceding. Alternating spirals noded, varying in number; the nodes low and round or elongate, with spirals rather coarse and well separated.

Fredericksburg of Texas; in corresponding horizons of California, Mexico, etc.

419. **T. (Mesalia) belviderei** Cragin. Comanchic.

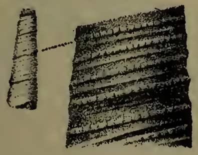


FIG. 1058. *Turritella seriatim-granulata.* (After Gabb, Pal. Cal., I.)

FIG. 1059. *Turritella whitei.* (After Stanton.)

Differs from the preceding in its smaller size, finer granules, which are prominent, numerous, and crowded, their greatest diameter transverse or oblique to the abruptly elevated spirals. Lines of growth show strong sinuosity in lip.

Kiowa shales of Kansas. Common.

420. **T. kansasensis** Meek. Comanchic.

Similar to the preceding, but the spirals without nodes or granulations.

Kiowa shales of Kansas, etc.

421. **T. whitei** Stanton. (Fig. 1059.) Cretacic.

About thirty slender whorls, when full grown, embracing nearly or quite to the moderate angulation. Sides (shoulder) flat or gently convex; primary spirals 6–8, minutely nodose in later

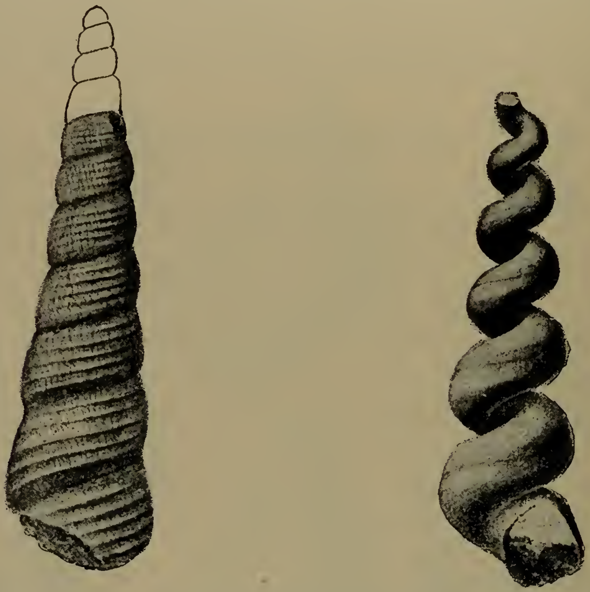


FIG. 1060. *Turritella vertebroides*, shell surface, and internal mold. (After Whitfield.)

whorls and subspinous in adult; secondary spirals generally present.

Coloradoan of Utah and Colorado.

422. **T. vertebroides** Morton. (Figs. 1060, 1061.) Cretacic.

FIG. 1061. *Turritella vertebroides*, enlargement of part of surface of the type. (After Whitfield.)

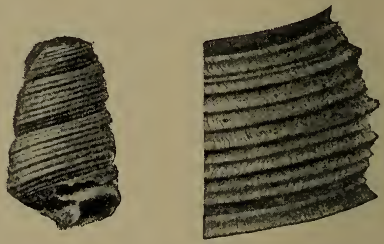


FIG. 1062. *Turritella encrinoides*, fragment of shell, and enlargement of surface. (After Whitfield.)

Slender, long, apical angle about 12 degrees; volutions gently convex with 5 or 6 strong primary spirals, with weaker secondaries, and still fainter tertiaries. Suture depressed.

Ripleyan (Monmouth) of New Jersey and Alabama.

423. **T. encrinoides** Morton. (Fig. 1062.) Cretacic.

Center of whorl flattened, basal angle pronounced, whorls embracing to within a short distance of the angle. About 3 or 4 strong primary spirals, with strong secondary ones between. Internal mold more compact than in *T. vertebroides*.

Ripleyan (Navesink) of New Jersey and Alabama.

424. **T. trilira** Conrad. (*T. trilineata* H. and V.) (Fig. 1063.) Cretacic.

Whorls slightly convex, sutures depressed, three strong spirals, a fourth generally covered at the suture.

Ripleyan of New Jersey, Alabama, Mississippi, Navarro of Texas, Arkansas, etc.

FIG. 1063. *Turritella trilira.* (After Hill.)

425. **T. tippana** Conrad. Cretacic.

Differs from the preceding in the scarcely depressed suture and in having four spirals, the lower three equidistant, the upper more distant and stronger, and in the presence of a few intercalated spirals.

Ripleyan of New Jersey and Mississippi.

426. **T. mortoni** Conrad. (Fig. 1064.) Eocenic.

Volutions angulated, shoulder slightly concave, with two or three primary and several secondary spirals. Keel very angulate in specialized varieties (*T. postmortoni*, Fig. 1064, *d*). Body whorl, below angulation, mostly covered by succeeding whorl. Aperture subquadrangular.

In the lower Pamunkey (Aquia formation) of Maryland and Virginia — especially abundant on Aquia Creek. Midwayan of Alabama, Texas, Arkansas, Mississippi, Tennessee. Occurs often as internal mold (Fig. 1064, *b*).

427. **T. (Mesalia) vetusta** Conrad. Eocenic.

Sutures sharply impressed, but shallow, spirals fine, alternating in size; ribs arcuate, indistinct, generally obsolete; whorls slightly

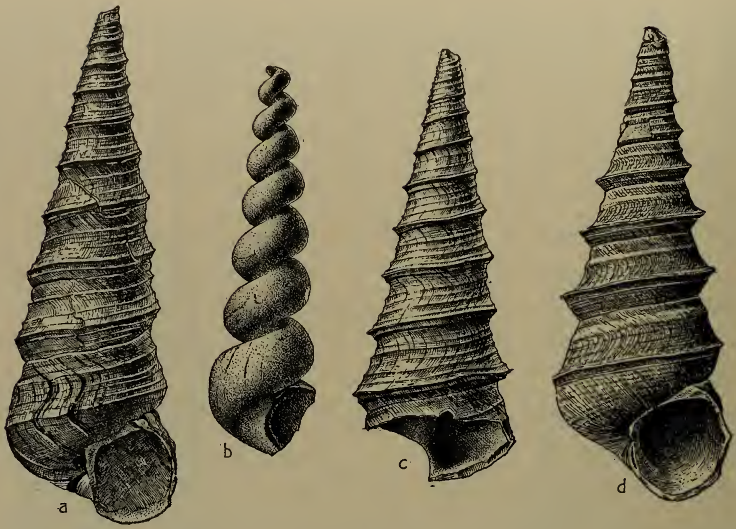


FIG. 1064. *Turritella mortoni*, three varieties and internal mold, × ⅔ ; *d* is mutation *postmortoni*, × ⅔. (Md. Survey.)

angulated just below the suture, aperture obliquely elliptical, effuse ; inner lip somewhat folded, slightly reflected at the base.

Claibornian of Alabama, abundant.

428. **T. humerosa** Conrad. (Fig. 1065.) Eocenic.

Whorls nearly flat in the center, with strong primary and fainter secondary spirals ; an angulation near the base, visible only in the body whorl, and a strong subsutural thickening carinated by two spirals. Aperture subquadrate.

In the Aquia formation less common than *T. mortoni.* Midwayan, of Texas, Alabama, Arkansas.

429. **T. tampæ** Heilprin. (Fig. 1066.) Oligocenic.

Center of whorls slightly concave with a zone of two sunken spirals or three spiral grooves, basal angle pronounced and slightly carinate. Sutures scarcely depressed except final gerontic stages. Whole surface of shell covered with fine, sharp but almost microscopic spirals.

Orthaulax bed of Florida, etc.

430. **T. gatunensis** Conrad. (Fig. 1067.) Oligocenic.

Whorls convex, but convexity marred by three strong spirals.

Vicksburgian, and Orthaulax beds of Florida. Isthmus of Darien, Panama, Costa Rica, etc.

FIG. 1065. *Turritella humerosa*, × ⅔. (Md. Survey.)

FIG. 1066. *Turritella tampæ.*

FIG. 1067. *Turritella gatunensis.*

431. **T. indenta** Conrad. (Fig. 1068, *b, c.*)

Oligocenic and Miocenic.

With very deep sutures in older whorls owing to abrupt lower and upper angulations of whorls, and slight, loose coiling; young whorls in contact. Sides concave, faintly spiraled.

Chipolan beds of Chipola River, Florida, and Chesapeake beds of Maryland.

432. **T. æquistriata** Conrad. (Fig. 1068, *a.*) Miocenic.

Small, whorls embracing nearly up to the angulation, above which they are almost flat, except for a second faint angulation or strong spiral some distance below the suture, and very fine spirals. Aperture longer than wide.

Shiloh marls of New Jersey, Chesapeakean (Calvert) of Maryland.

433. **T. plebeia** Say. (Fig. 1068, *d–f*.) Miocenic.

Whorls convex, suture depressed ; spirals numerous. A variety has the whorls flattened (Fig. 1068, *e*). Another variety, *octonaria*, has one strong spiral, the others variable (Fig. 1868, *f*).

Chesapeake formation of New Jersey, Maryland, Virginia.

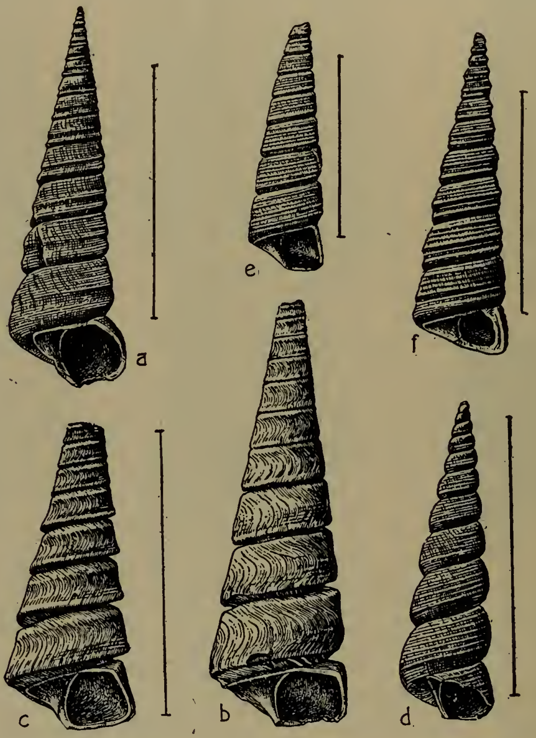


FIG. 1068. *a*, *Turritella æquistriata ; b*, *c*, *T. indenta ; d–f*, *T. plebeia.* (After Martin, Md. Survey.)

434. **T. variabilis** Conrad. (Fig. 1069, *a*.) Miocenic.

Very long and slender, sutures scarcely impressed, four primary spirals thick, rounded, in pairs, separated by secondary finer ones.

Chesapeake formation of Maryland, Virginia, etc.

435. **T. cumberlandia** Conrad. (Figs. 1069, *b*, and 1070.) Miocenic.

With two, rarely three, strong spirals and numerous finer ones. Suture closed or depressed.

Chesapeake of New Jersey, Maryland, etc.

436. **T. exaltata** Conrad. (Fig. 1069, *c.*) Miocenic.
Slender like the preceding, with strongly carinate angle overhanging; shoulder concave with faint spirals, one near suture.

Chesapeake (Calvert) formation of Maryland, etc.

FIG. 1069. *a, Turritella variabilis; b, T. cumberlandia; c, T. exaltata.* (After Martin, Md. Surv.)

437. **T. subannulata** Heilprin. (Fig. 1071, *c.*)
Oligocenic–Pliocenic.

Main angulation at the center of whorl pronounced, whorls flat and sloping above, vertical below to the second carina, after which the whorl rounds downward; whorls embracing nearly to the second carina; a strong spiral above suture.

Abundant in Caloosahatchie marls of Florida, and the Waccamaw beds of Carolina. Also in the Chipolan beds (Oligocenic) of Florida.

438. **T. perattenuata** Heilprin. (Fig. 1071, *a.*) Pliocenic.
Very long and slender, whorls deeply concave in the middle, a

FIG. 1070. *Turritella cumberlandia.* (Md. Survey.)

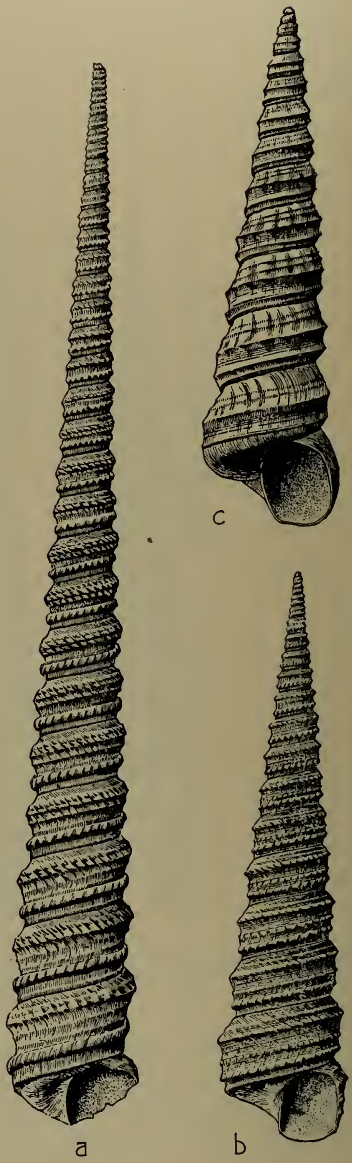


FIG. 1071. *a, Turritella perattenuata*, $\times \frac{7}{6}$; *b, T. apicalis*, $\times$ 1.8; *c, T. subannulata* $\times$ 2⅓.

strong rounded, commonly cancellated, spiral above the basal angulation, and a stronger double or triple one at a similar distance below the suture, which is broadly depressed. One or two faint spirals in concave space of adult whorls.

Caloosahatchie beds of Florida.

439. **T. apicalis** Heilprin. (Fig. 1071, *b*.) Pliocenic.

Shorter and more rapidly tapering than the preceding, with a similar cancellated median spiral; upper carina single.

Caloosahatchie beds of Florida.

CXXII. Vermetus Adams.

Young shell like *Turritella*, adult portion loose and variously twisted; the young shell gradually disappearing and the aperture becoming round. (The species are mostly terminals of various genetic lines of *Turritella*.) Eocenic–Recent.

440. **V. (Petaloconchus) varians** d'Orbigny.
Oligocenic–Recent.

Irregularly convoluted, forming a loosely glomerated mass with longitudinal rugose ridges or costæ, or smooth. On the inside of tube, two scarcely curved lamellæ extend obliquely inward from

FIG. 1072. *a*, *Vermetus graniferus*; *b*, part of same enlarged; *c*, *V. virginicus*. (After Martin, Md. Survey.)

the ends of the more flattened side, with often a short one arising between them.

Oligocenic of Florida. Pliocenic of Carolina (Waccamaw beds) and Florida (Caloosahatchie beds). Post Pliocenic, Florida reefs; living southwest Florida to Rio Janeiro.

441. **V. graniferus** (Say). (Fig. 1072, *a*, *b*.) Miocenic.

Turritelloid portion short, non-coiling portion very much contorted and vermetoid, in complex clusters; surface with longitudinal, granulose striæ; size varying according to age.

Chesapeake formation of Maryland, New Jersey, etc.

442. **V. virginicus** (Conrad). (Fig. 1072, *c*.) Miocenic.
Differs from the preceding in being less intricately coiled, and in the absence of surface sculpture, except lines and wrinkles of growth.

Chesapeake formation of Maryland, Virginia, etc.

CXXIII. Laxispira Gabb.

Vermetoid shells of subregular, loose coils, forming a corkscrew spire. Cretacic–Tertiary.

443. **L. lumbricalis** Gabb. (Fig. 1073, *a*.) Cretacic.

Fig. 1073. *a, Laxispira lumbricalis* (left); *b, Siliquaria pauperata* (right). (After Whitfield.)

Loose-coiled spirals, the section of shell nearly circular except in last volution; surface with fine spirals and lines of growth.

Ripleyan of New Jersey and southern states.

CXXIV. Siliquaria Bruguiere.

Like the preceding but with a continuous cleft or row of pores along one side of the entire shell. Cretacic–Recent.

444. **S. pauperata** Whitfield. (Fig. 1073, *b*.) Cretacic.
Coil loose, surface apparently smooth, cleft on upper side of whorls.

Ripleyan of New Jersey.

CXXV. Glauconia Giebel.

Turritelloid shells with faintly canaliculated aperture, the outer lip of which has an anterior and a median notch or emargination. Comanchic–Cretacic.

445. **G. (Vicarya) branneri** (Hill). (Fig. 1074.) Cretacic.

Whorls close, sides flat or concave, the later whorls with a row of strong nodes on each side next to the sutures.

Glen Rose beds of Texas.

446. **G. coalvillensis** (Meek). (Fig. 1075.) Cretacic.

FIG. 1074. *Glauconia branneri.* (After Hill.)

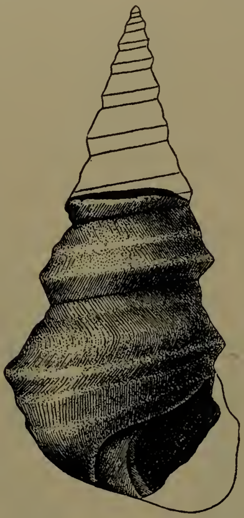


FIG. 1075. *Glauconia coalvillensis,* × ⅔. (After Stanton.)

Often large; whorls strongly angular, embracing so as to leave a rather pronounced space exposed below the carina; shoulder with a submedian strong spiral, body with two fainter ones below the carina.

Colorado of Utah.

Family MELANIIDÆ Lam.

CXXVI. HYPSIPLEURA Koken.

Turreted shells with entire oval aperture, scarcely impressed sutures, and gently convex whorls. Surface ribbed.

447. **H. ? occidentalis** Stanton. (Fig. 1076, *a.*) Comanchic.

Small, with strong curved ribs, separated by more than their width; fine revolving spirals, especially visible between the ribs.

Abundant in beds near the top of the Knoxville near Paskenta, California.

448. **H. gregaria** Stanton. (Fig. 1076, *b.*) Comanchic.

Smaller than the preceding and with the ribs only partly developed below the suture. Spirals absent.

Upper part of Knoxville near Paskenta, California.

CXXVII. MELANIA Lamarck. (Compare *Goniobasis.*)

Turreted shells with surface varying from smooth to spirally striate, ribbed or with sharp nodes upon the angulation of the whorls. Aperture oval, rounded anteriorly. Operculum horny, apex usually dehiscent. Form less slender and whorls more strongly individualized than in *Turritella.* Jurassic–Recent.

449. **M. insculpta** Meek. (Fig. 1076, *c.*) Cretacic.

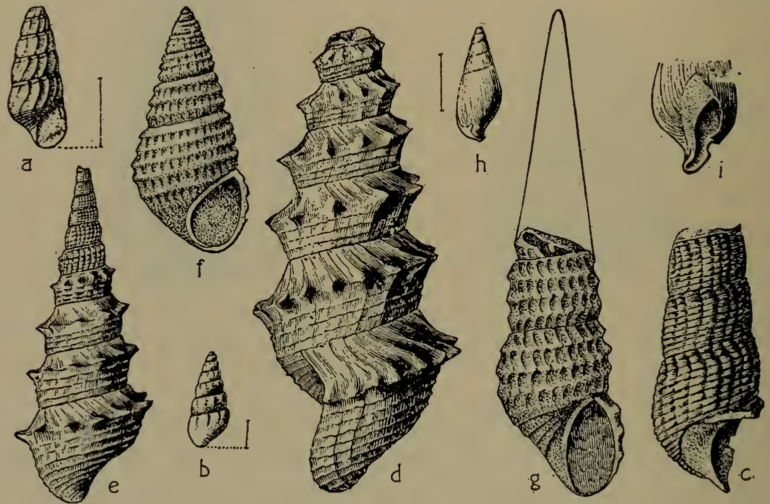


FIG. 1076. *a*, *Hypsipleura occidentalis*, enlarged; *b*, *H. gregaria*; *c*, *Melania insculpta*; *d*, *e*, *M. wyomingensis*; *f*, *M. sculptilis*; *g*, *M. taylori*; *h*, *i*, *Melanopsis americana*. (*a*, *b*, after Stanton, the others after White, U. S. G. S., III.)

Sutures scarcely impressed, ribs continuous on the flattened whorls, thick, round and separated by impressed lines only.

Laramie of Wyoming.

450. **M. (Pachychilus) wyomingensis.** (Fig. 1076, *d*, *e.*) Cretacic.

Young like the adult of the preceding species; later whorls abruptly angulated, with concave shoulders, and the ribs replaced by spinose nodes on the angulation. Spirals simple, not strong.

Laramie of Wyoming and Colorado.

451. **M. sculptilis** Meek. (Fig. 1076, *f.*) Miocenic.

Short, with comparatively few whorls. Sutures with a false shelf due to prominence of spiral. Five strong spirals, of which the upper three appear on all whorls. Faint vertical sculpture between these. Aperture ovoid.

Fresh-water Miocenic of Idado, Nevada.

452. **M. taylori** Gabb. (Fig. 1076, *g.*) Miocenic.

High-spired with three strong spires visible on all whorls, suture impressed, vertical sculpture moderate between spirals; aperture oval.

Fresh-water Miocenic of Idaho.

CXXVIII. Melanopsis Lamarck.

Shell generally shorter and thicker than *Melania*, with aperture bearing strong basal notch and with inner lip callous. Surface smooth or ornamented as in *Melania*. Cretacic–Recent.

453. **M. americana** White. (Fig. 1076, *h*, *i.*) Cretacic.

Small, sutures not impressed, whorls flattened, shell gently tapering from middle of body whorl; canal short, slightly reflexed; surface smooth.

Laramie of Colorado.

CXXIX. Pyrgulifera Meek.

Thick, elongate, oval shells, whorls with narrow shoulder bounded by strong angulation on which the ribs are produced as

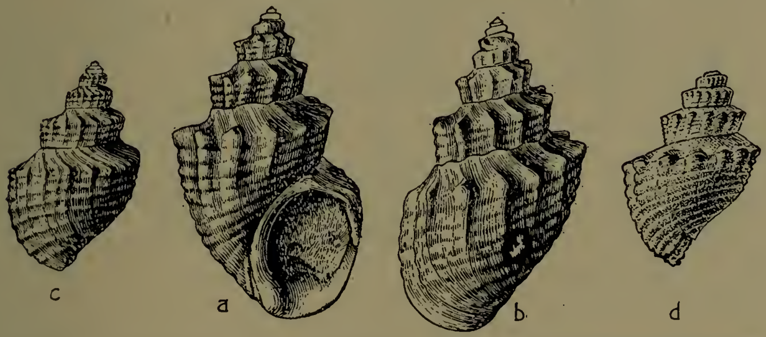


Fig. 1077. *Pyrgulifera humerosa*, opposite views of two specimens showing variation. (U. S. G. S.)

spinose tubercles; spirals numerous but subdued, aperture oval, sometimes with very faint canal. Cretacic.

454. **P. humerosa** Meek. (Fig. 1077, *a–d.*) Cretacic.

Shoulder concave, tubercles strong, blunt, and produced downwards as ribs which die away on lower body whorl; spirals broad but generally faint; a faint indication of anterior notch in aperture.

Bear River formation of Wyoming and Utah.

CXXX. Goniobasis Lea.

Shell characters like those of *Melania* from which these shells are practically indistinguishable. This genus is the American representative of the Old World genus *Melania* which is doubtfully represented in the American Eocenic. The chief differences are that *Melania* is viviparous and *Goniobasis* is oviparous. Both are fluviatile animals.

455. **G. (Pachymelania) chrysallis** Meek. (Fig. 1078, *a*.) Cretacic.

Whorls flattened to slightly concave, sutures not impressed but margined below by blunt carina which is often crenulated. Surface with spirals.

Bear River formation of Wyoming and Utah.

456. **G. (Pachymelania) chrysalloidea** White. (Fig. 1078, *b*.) Cretacic.

Short and thick, whorls flat, sutures with faint shelf, surface with rounded ribs and few faint spirals.

Bear River formation of Wyoming and Utah.

457. **G. (Pachymelania) cleburni** White. (Fig. 1078, *c*.) Cretacic.

Large, gently tapering, sutures faintly impressed, surface with low rounded ribs, gently concave forward, extending from suture to suture, and generally separated by wider interspaces; no spirals.

Bear River formation of Wyoming and Utah.

458. **G. convexa** M. and H. (Fig. 1078, *d*.) Cretacic.

Smooth, slender, suture not impressed, surfaces flat, spirals faint. Variety *impressa* has the sutures slightly impressed.

Laramie, mouth of Judith River, Montana.

459. **G. endlichi** White. (Fig. 1078, *e*, *f*.) Cretacic.

Short and thick, whorls round and smooth and sutures strongly impressed.

Bear River formations of Wyoming and Utah.

460. **G. gracilenta** Meek. (Fig. 1078, *g*.) Cretacic.

Small, smooth, sutures slightly impressed, surfaces gently convex; faint vertical striæ.

Laramie of Colorado, Wyoming.

461. **G. invenusta** M. and H. (Fig. 1078, *h.*)

Smooth, with somewhat larger apical angle than preceding.

Laramie of Montana (upper Missouri River region).

462. **G. macilenta** White. (Fig. 1078, *i.*) Cretacic.

Whorls flattened, sutures not impressed, marked by faintest of shelves, surface smooth.

Bear River formation of Wyoming and Utah.

463. **G. nebrascensis** M. and H. (Fig. 1078, *j.*) Cretacic.

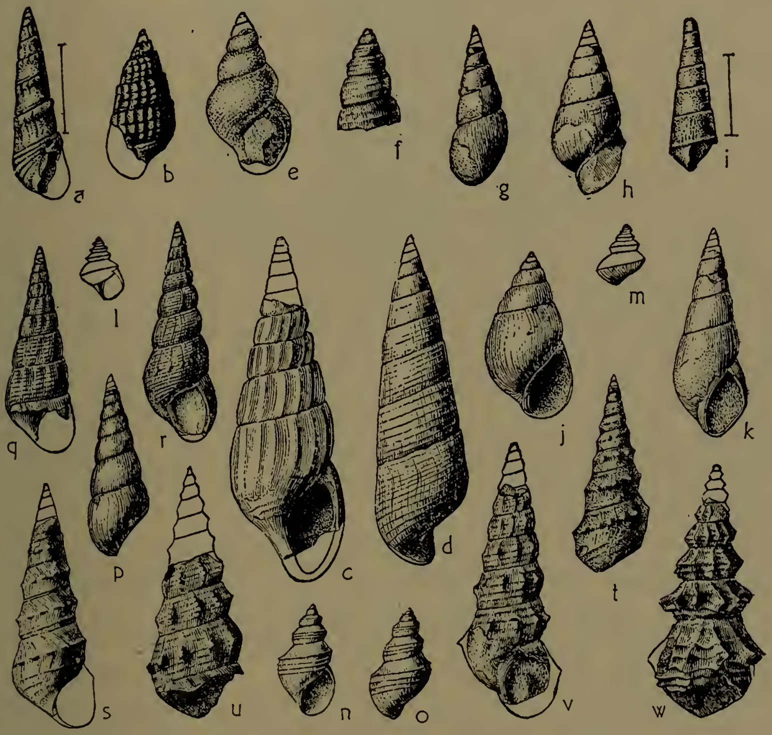


FIG. 1078. *a*, *Goniobasis chrysallis*; *b*, *G. chrysalloides*; *c*, *G. cleburni*; *d*, *G. convexa*; *e*, *f*, *G. endlichi*; *g*, *G. gracilenta*; *h*, *G. invenusta*; *i*, *G. macilenta*; *j*, *G. nebrascensis*; *k*, *G. sublævis*; *l*, *m*, *G. subtortuosa*; *n*, *o*, *G. tenuicarinata*; *p*, *G. simpsoni*; *q*, *G. tenera*; *r–t*, *G. nodulifera*; *u*, *v*, *G. carteri*; *w*, *G. columinis*. (After Whitf., U. S. G. S., III.)

Smooth, broad, thick, sutures slightly impressed, surfaces gently convex; lines of growth the only surface marking.

Laramie of Yellowstone River region; Canada, upper Missouri River region; Colorado and Utah.

464. **G. sublævis** M. and H. (Fig. 1078, *k.*) Cretacic.
Larger and somewhat more slender than *G. gracilenta* and suture slightly impressed.
Laramie (Judith River) of Upper Missouri River region.

465. **G. subtortuosa** M. and H. (Fig. 1078, *l, m.*) Cretacic.
Small, low-spired, strongly angulated near the middle, shoulder nearly flat; no ribs or spirals.
Laramie of Upper Missouri River region and the Bow and Belly River regions of Canada.

466. **G. tenuicarinata** M. and H. (Fig. 1078, *n, o.*) Cretacic.
Angulated, short and thick-set, shoulder flat, limited by sharp carina, below which are two or three sharp spirals.
Laramie of Montana, the Upper Missouri River region, Colorado, east of Rockies, Utah and various localities in Canada.

467. **G. simpsoni** Meek. (Fig. 1078, *p.*) Eocenic.
Smooth, whorls convex, suture impressed.
Bridger Eocenic, Wyoming.

468. **G. tenera** Hall. (Fig. 1078, *q.*) Eocenic.
Like the preceding but with faint ribs extending part way below the suture, and with faint spirals.
Eocenic, Utah.

469. **G. nodulifera** Meek. (Fig. 1078, *r–t.*) Eocenic.
Ribs mostly replaced by faint nodulations on the median angulation. Shoulder flat.
Fresh-water Eocenic of Rocky Mountain region.

470. **G. carteri** Conrad. (Fig. 1078, *u, v.*) Eocenic.
Nodules strong, ribs not altogether obsolete.
Fresh-water Eocenic of Rocky Mountain region.

471. **G. columinis** White. (Fig. 1078, *w.*) Eocenic.
Strongly angular, nodes large and sharp and continued in ribs nearly to sutures; spirals strong.
Fresh-water Eocenic of Rocky Mountain region.

Family Nerineidæ Zittel.

CXXXI. Nerinea Defrance.

Like *Turritella* in form, but aperture with short anterior notch, columella with simple folds which are also commonly found on both inner and outer lip. Jurassic–Cretacic.

472. **N. goodelli** Cragin. (Fig. 1079, *a*, *b*.) Jurassic.

Sides of whorls concave, strongly carinated at base, with three to four rather marked spirals; outer wall with one prominent, thin, acute fold internally, extending scarcely half way across the chamber (well seen in longitudinal sections). Columella partly

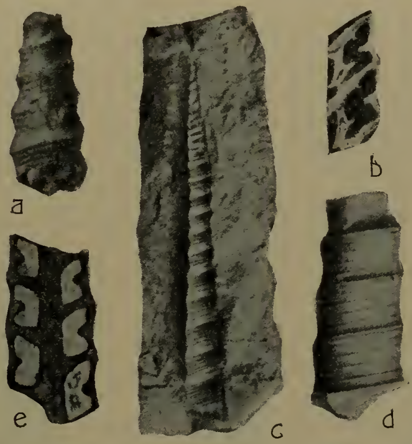


FIG. 1079. *a*, *b*, *Nerinea goodelli; c–e*, *Nerinella stantoni*, with enlargement and section. (After Cragin, Bull. U. S. G. S., 266.)

hollow and with a smaller fold, while a third one occurs near the middle of the upper side of the chamber.

Malone formation of Texas; a related, if not identical form appears in the Upper Jurassic (Sequanien?) of the Mazapil region of Mexico.

473. **N. austinensis** Roemer. (Fig. 1080, *a*.) Comanchic.

Large, apical angle about 20°, whorls gently concave, smooth, basal angulation nodose. Columella with two or three sharp folds, the middle one, if present, smallest, outer lip with one sharp fold directed downwards.

Edwards limestone of Texas.

474. **N. cultrispira** Roemer. (Fig. 1080, *b*.) Comanchic.

Much more slender than preceding; whorls smooth, strongly concave; basal carina a sharp, blade-like keel. Columella with a single fold and outer lip with a faint one, obsolete in the adult shell.

Edwards limestone of Texas.

CXXXII. Nerinella Sharpe.

Like *Nerinea* but with columellar fold generally wanting; a fold commonly occurs on the inside of the outer lip. Jurassic–Comanchic.

475. **N. stantoni** Craigin. (Fig. 1079, *c–e*.) Jurassic.

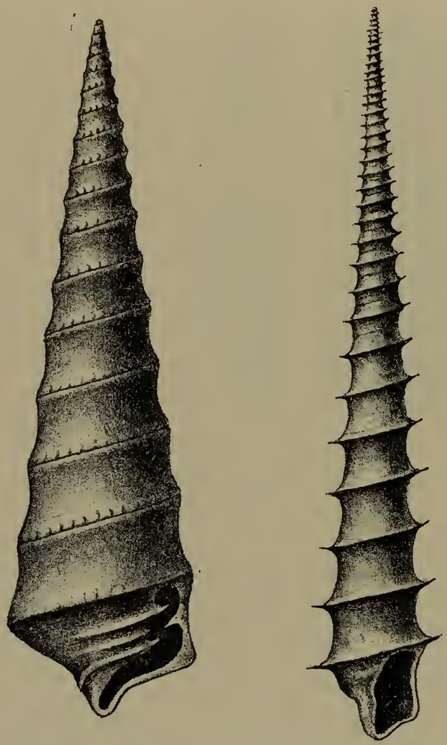


Fig. 1080. *a, Nerinea austinensis; b, N. cultrispira.* (After Roemer.)

Fig. 1081. *Nerinella subula.* (After Roemer.)

Exceedingly slender; whorls with gently concave sides bearing four equidistant spirals; upper and lower angulations sharp and appearing as spirals. No columellar fold but a blunt one on inner side of outer lip.

Malone formation of Texas.

476. **N. subula** (Roemer). (Fig. 1081.) Comanchic.

Slender and subulate; suture scarcely depressed; sides of whorls flat with two (more rarely three) rows of small tubercles on the basal portion of the body whorl; aperture elongate. No columellar or labial folds.

Family CERITHIIDÆ Menke.

CXXXIII. BITTIUM Leach.

Turreted shells with spirals and costæ which generally cancellate each other. Aperture with short, straight canal and sharp outer lip. Jurassic–Recent.

477. **B. permutabile** Dall. (Fig. 1082, *c.*) Oligocenic.

Greatest convexity of the whorls below the middle of the exposed part; costæ strong but becoming obsolescent towards the suture; spiral fine, often compound. Aperture with feeble canal.

Chipolan marls of Florida.

478. **B. cossmannii** Dall. (Fig. 1082, *b.*) Oligocenic.

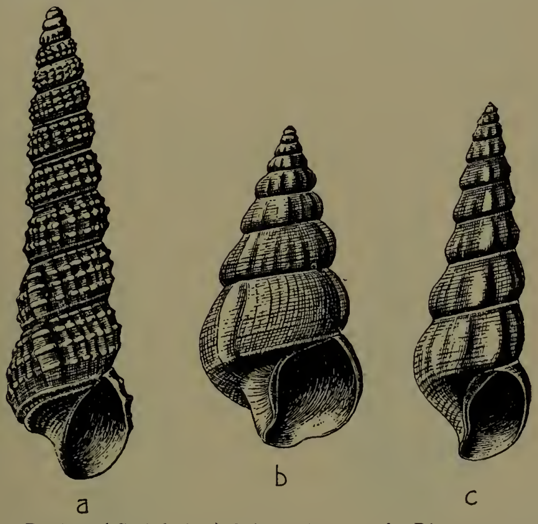


FIG. 1082. *a, Bittium* (*Styliferina*) *boiplex*, × 7.3; *b, Bittium cossmannii*, × 3¾; *c, B. permutabile*, × 4.6.

Shorter and stouter than preceding, rather inflated, with ribs mostly obsolete on adult whorls except here and there a strong varix-like one.

Chipolan marls of Florida.

479. **B. (Styliferina) boiplex** Dall. (Fig. 1082, *a.*) Oligocenic.

Long, slender, round-whorled; three strong spirals cancellating the ribs; occasionally strong varix-like ribs; simple spirals on body of last whorl, and sometimes above suture. Aperture without canal.

Chipolan marls of Florida.

480. **B. (Styliferina) cerithidioides** Dall. (Fig. 1083.)
Oligocenic–Recent.

Upper whorls angular; later rounded, with only close-set rounded ribs; aperture with very faint anterior notch.

Bowden beds of Jamaica, W. I., Caloosahatchie (Pliocenic); Florida and Costa Rica; Post-Pliocenic, South Carolina; living off the southeastern coast of the United States.

CXXXIV. Cerithium Bruguiere.

Turreted, non-umbilicate, variously sculptured, and with the aperture bearing a short, backwardly-curved canal, and frequently a notch or short canal, on upper or posterior side of aperture. Columella concave, often with one or two folds. Numerous subgenera. Jurassic–Recent.

481. **C. bosquense** Shumard. Comanchic.

Large; apical angle 22–25°; whorls flattened with 11–12 broad rounded ribs on each; moderately distinct above, but be-

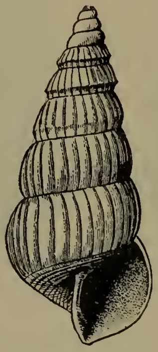


Fig. 1083. *Bittium* (*Styliferina*) *cerithidioides* Dall, × 13. (After Dall.)

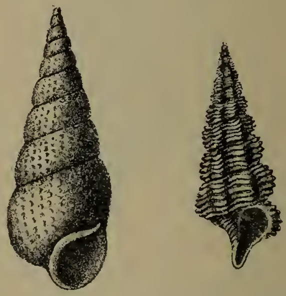


Fig. 1084. *a*, *Cerithium obliterato-granosum*; *b*, *C. austinense*. (After Roemer.)

coming obsolete towards lower suture; aperture ovate, oblique, widest below the middle.

Walnut shale and Comanche Peak and Goodland limestones of Texas.

482. **C. (Fibula) obliterato-granosum** Roemer. (Fig. 1084, *a*.)
Comanchic.

Round-whorled with somewhat depressed sutures and oblique ovate aperture with faint anterior canal (not always preserved) and a reflexed inner lip. Sculpture in the form of vertical rows of fine nodules.

Edwards limestone of Texas.

483. **C. (?) austinensis** Roemer. (Fig. 1084, *b*.) Comanchic.

Round-whorled with pronounced round ribs and 6–8 strong spirals, continuous across the ribs, and frequently with intercalated finer ones. Aperture with short, curved canal.

Edwards limestone of Texas.

484. **C. (Newtoniella) conicum** Aldrich. Eocenic.

Small and slender, sutures depressed; sides of whorls nearly flat with uniform distant ribs, crossed and somewhat rounded by three strong spirals; a fourth, nearly covered at the suture by the succeeding whorl, gives the characteristic appearance to the shell.

Claibornian of Alabama.

FIG. 1085. *Cerithium* (*Seila*) *adamsii*. (Md. Surv.)

485. **C. (Cerithiopsis) fluviatile** Aldrich. Eocenic.

Differs from the preceding in the absence of the spiral at the suture and the freedom from nodes of the first spiral above the suture.

Chickasawan (Lignitic) of Alabama.

486. **C. (Seila) adamsii** H. C. Lea. (Fig. 1085.) Oligocenic to Recent.

Small (length 7 mm.), slender, whorls flat, suture not impressed, about four equal spirals with equal interspaces, strong anterior and fainter posterior notch in aperture.

Chipolan beds of Florida, Miocenic of Virginia and North Carolina, Croatan beds (Pliocenic) of North Carolina; Waccamaw beds of South Carolina, Caloosahatchie of Florida, Post-Pliocenic of Atlantic and Gulf States; living on South Atlantic coast of U. S.

487. **C. (Potamides [Tympanotonus]) hillsboroënse** Heilprin. (Fig. 1086.) Oligocenic.

Suture loose; whorls flat or slightly concave; upper spiral strongly nodose; next below, thin and finely granulose; third, coarser and nodose and the fourth, just above the suture, smooth.

Orbitoides limestone of Florida.

488. **C. (Rhinoclavis) caloosaënsis** Dall. (Fig. 1087.) Pliocenic.

Ornamentation of whorls complex, consisting of coarse and fine spirals, some traversed by ribs, others noded. The body whorl is non-angulate, the preceding two or three are angulate ; while the earlier ones are more or less flat and ribbed. Lip drawn out at each end to form a narrow, deep canal.

Caloosahatchie beds of Florida.

489. **C. (Potamides) scalatum** Heilprin. (Fig. 1088.) Pliocenic.

FIG. 1086. *a*, *Cerithium hillsboroënse*, × 1.3. (After Dall.)

FIG. 1087. *b*, *Cerithium caloosaënse*, × ⅔. (After Dall.)

FIG. 1088. *c*, *Potamides* (*Pyrazisinus*) *scalatus*, × ⅚. (After Dall.)

Whorls round, slightly concave below the suture, ribs simple, not reaching to upper suture ; faint spirals between ribs ; outer lip broadly notched.

Caloosahatchie beds of Florida, etc.

Family APORRHAIDÆ Philippi.

CXXXV. ANCHURA Conrad.

Turreted shells with the base drawn out into a long canal, and the outer lip prolonged into a single wing-like expansion which may divide terminally, but is often broken away in the specimens. Comanchic–Cretacic.

490. **A. kiowana** Cragin. Comanchic.

Differs from the next in its somewhat shorter spire, more pronounced costæ, roundness of body whorl, and restriction of carina nearly to falcate process of lip, which is only slightly upturned.

Kiowa shales (Washita) of Kansas.

491. **A. exilis** Gabb. (Fig. 1089.) Cretacic.

Small, whorls rounded except for strong median carina of body whorl, above which shoulder is concave ; ribs low and faint.

Nanaimo formation of Vancouver and Martinez.

492. **A. rostrata** Gabb. (Fig. 1090.) Cretacic.

Apical angle about 35°; early whorls round with slightly impressed suture and obliquely forward-curving, round and close-set ribs; body whorl with ribs more distant and becoming obsolete; lip broadly expanded, upper angle somewhat produced.

Ripleyan formation of New Jersey, Mississippi, Texas.

FIG. 1089. *Anchura exilis*, enlarged. (After Gabb.)

FIG. 1090. *Anchura rostrata*. (After Whitfield.)

493. **A. pennata** (Morton). (Fig. 1091.) Cretacic.

Larger and with sharper and more distant ribs on the younger whorls, obsolete on body whorl; lip with two upper corners more

FIG. 1091. *Anchura pennata*. (After Whitfield.)

FIG. 1092. *Anchura abrupta*. (After Whitfield.)

strongly prolonged upwards. Internal molds with deep sutures.

Ripleyan of New Jersey and Alabama.

494. **A. abrupta** Conrad. (Fig. 1092.) Cretacic.

Whorls more rounded than preceding; ribs like those of *A. rostrata*, but fainter; a faint spiral sculpture, becoming an angulation on body whorl and lip.

Ripleyan of New Jersey, Alabama, Mississippi.

495. **A. sublævis** (M. and H.). (Fig. 1093.) Cretacic.

Much smaller than preceding; high-spired with round whorls

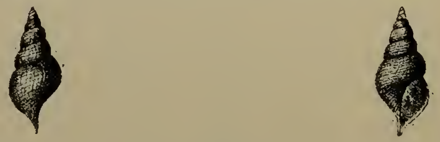


FIG. 1093. *Anchura sublævis*, type of species. With apertural expansion wanting. (After Meek.)

marked by faint spirals only.

Pierre of Yellowstone and Black Hills.

CXXXVI. CALYPTRAPHORUS Conrad.

Differs from *Anchura* in having the entire shell more or less covered by the expansion of the lips; this hides the character of the whorls. Tertiary–Recent.

496. **C. velatus** Conrad. (Fig. 1094.) Eocenic.

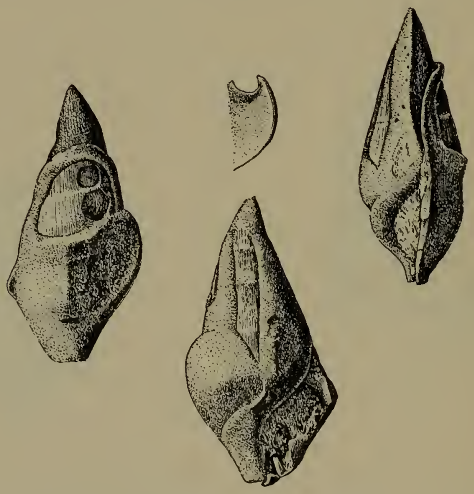


FIG. 1094. *Calyptraphorus velatus* var. *compressus*. (After Harris.)

Expanded but rounded lip, the enamel covering most of the whorls, leaving only the upper part of the spire exposed; rostrum long and pointed. In the variety *compressus* Aldrich, large gaps remain in the enamel covering the upper edge of the lip which is much prolonged and pointed.

Claibornian and Jacksonian of the Gulf States; the variety occurs in the Midway horizon of the Gulf States from Georgia to Texas.

497. **C. trinodiferus** Conrad. (Fig. 1095, *a, b.*) Eocenic.

FIG. 1095. *a, b, Calyptraphorus trinodiferus; c, d, C. jacksoni.* (All × ⅔.) (Md. Survey.)

With ornamentation of early whorls faint, and with great prolongation of the reflected upper angle of the lip.

Pamunkey formation of Atlantic coast. Lignitic (Chickasawan) of Alabama and Texas.

498. **C. jacksoni** Clark. (Fig. 1095, *c, d.*) Eocenic.

Large, solid, whorl wholly covered by subsequent expansions.

Aquia of Atlantic coast.

CXXXVII. APORRHAIS da Costa.

Like *Anchura* but lip with posterior canal either closely adhering to the spire, or free from same; outer lip expanded, lobed or digitate. Jurassic–Recent.

499. **A. (Perissoptera) prolabiata** White. (Fig. 1096, *a.*) Cretacic.

Spire with rounded whorls marked by rounded ribs more than their width apart; lip with strong, acute spine, separated by a rounded sinus from the broader subquadrate portion of the lip; expansion of lip partly covering penultimate whorl.

Colorado formation of Utah and New Mexico (?).

500. **A. (Lispodesthes) nuptialis** White. (Fig. 1096, *b, c.*) Cretacic.
Body whorl with angulation that extends into the spinose posterior prolongation of the lip; anterior canal straight and rapidly

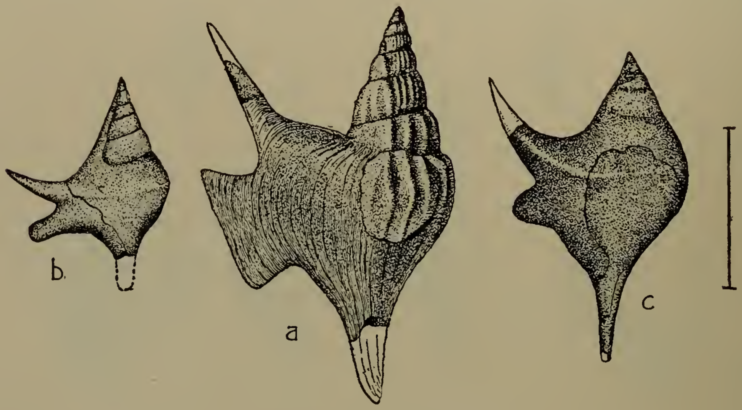


FIG. 1096. *a, Aporrhais (Perissoptera) prolabiata; b, c, A. (Lispodesthes) nuptialis.* (After Stanton.)

tapering; surface of whorls generally completely enveloped in callous deposits.

Colorado formation of New Mexico, Arizona, etc.

501. **A. (Tessarolax) distorta** Gabb. (Fig. 1097.) Cretacic.
Spire concealed by smooth surface deposits; body whorl with two carinations, each of which bears an irregular blunt node, the lower one formed after the upper one, and each extending into

FIG. 1097. *Aporrhais (Tessarolax) distorta*, slightly reduced. (After Gabb.)

a canaliculate spine; anterior and posterior ends of aperture drawn out into similar curved canaliculate spines.

Nanaimo of Vancouver, B. C., and Chico of California.

502. **A. (Pterocerella) tippana** Conrad. (Fig. 1098.) Cretacic.

Spire angulated, with keel and flattened shoulder; lip with six finger-like processes somewhat winged by marginal expansions.

Ripleyan of New Jersey, Mississippi, Texas.

503. **A. falciformis** Gabb. (Fig. 1099.) Cretacic.

FIG. 1098. *Aporrhais* (*Pterocerella*) *tippana*. (After Weller.)

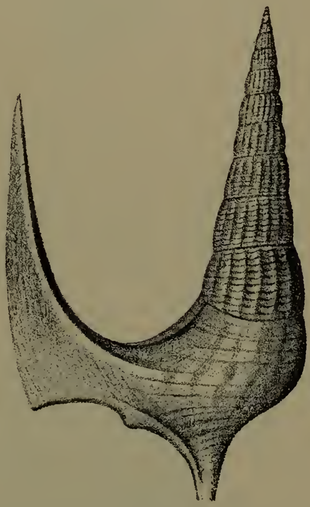


FIG. 1099. *Aporrhais falciformis*, slightly reduced. (After Gabb.)

High, slender spire, round whorls, scarcely impressed sutures, narrow rounded and distant ribs gently concave forward, and cancellated by simple spirals. Body whorl nearly smooth; aperture with long, falciform expansion.

Upper Cretacic of California.

Family STROMBIDÆ d'Orbigny.

CXXXVIII. PUGNELLUS Conrad.

Young shell fusiform; adult suboval; inner lip massive, extending as a callus over the whorls; outer lip variously lobed. Cretacic.

504. **P. fusiformis** Meek. (Fig. 1100.) Cretacic.

Spire somewhat curved; body whorl somewhat nodose; outer lip with falciform extension and several pronounced lobes.

Coloradoan (especially Pugnellus sandstone) of Colorado, Utah, Wyoming.

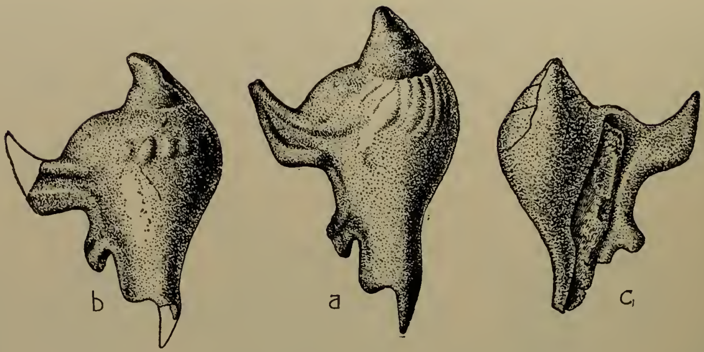


FIG. 1100. *Pugnellus fusiformis.* (After Stanton.)

CXXXIX. ORTHAULAX Gabb.

Spire of smooth whorls, lip simple, extending at each end into a canal; spire mostly enclosed by a deposit of enamel. Eocenic–Miocenic.

505. **O. gabbi** Dall. (Fig. 1101.) Oligocenic–Miocenic.

Young showing many whorls, lip expanding posteriorly and covering spire; later whorls each with three irregular varices;

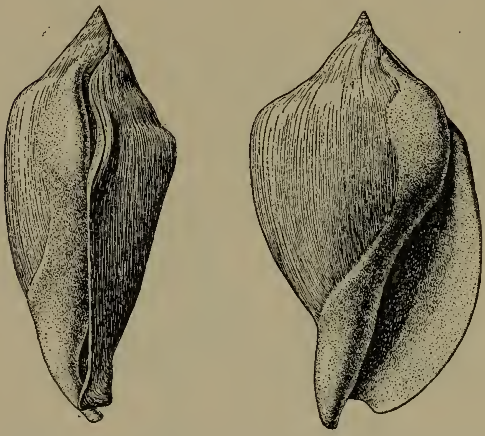


FIG. 1101. *Orthaulax gabbi*, about three fourths nat. size. (After Dall.)

FIG. 1102. *Rimella laqueata.* (After Conrad.)

columellar pillar thick, slightly recurved, canal short, the outer lip somewhat thickened.

Chipolan and Alum Bluff beds of Gulf States.

CXL. Rimella Agassiz.

More or less high-spired shells; base drawn out into short sharp canal; inner lip with expansion covering part of spire, outer lip with thick but scarcely expanded margin, entire or crenulated and with anterior notch. Cretacic–Recent.

506. **R. laqueata** Conrad. (Fig. 1102.) Eocenic.

High spired; sutures scarcely impressed; ribs acute, slightly curved, restricted to upper part of whorl; spirals fine; outer lip smooth.

Claibornian of Alabama.

CXLI. Strombus Linné.

Young shell more or less fusiform with conical spire variously ornamented by ribs, spires and tubercles; adult with large body whorl, and thick, expanded but not spinose outer lip, often pro-

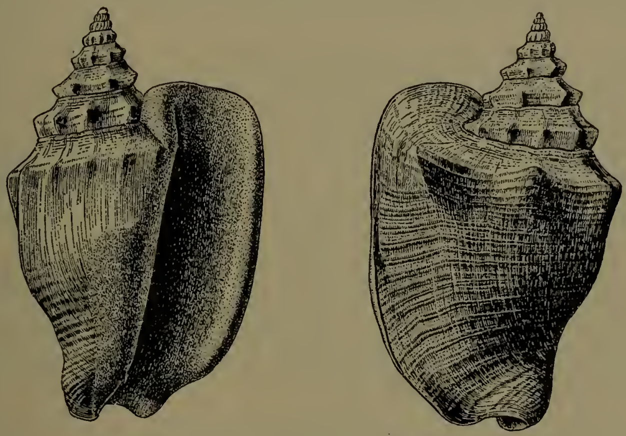


Fig. 1103. *Strombus aldrichi*, slightly reduced, $\times \frac{6}{7}$. (After Dall.)

duced posteriorly, sinuate or channelled anteriorly; columellar area smooth, enameled. Cretacic–Recent.

507. **S. aldrichi** Dall. (Fig. 1103.) Oligocenic.

Youngest whorls round and ribbed, later ones angular, the ribs becoming concentrated as tubercles on the angle, and coarse on body whorl; lip moderately expanded, subrectangular above (posteriorly) with slight posterior, and strong broad anterior (lower) channel.

Abundant in the Chipolan beds of Florida.

508. **S. chipolanus** Dall. (Fig. 1104.) Oligocenic.

Differs from the preceding in its larger size, stronger and sharper shoulder nodules, more slender spire and less thickened

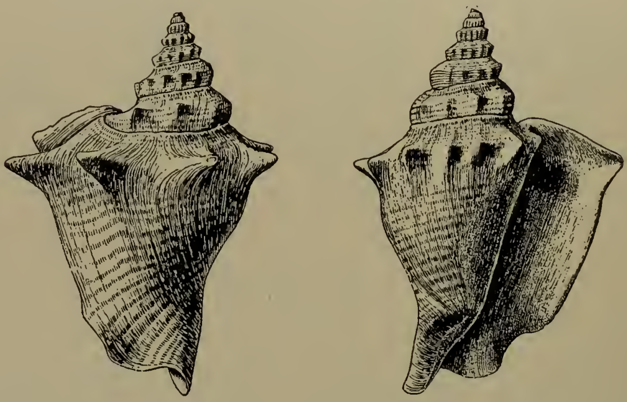


FIG. 1104. *Strombus chipolanus*, about three fourths nat. size. (After Dall.)

outer lip, with stronger posterior and larger anterior notch, and less elevation posteriorly. Body and throat lirate.

Occurs with the preceding.

509. **S. pugilis** Linné. Miocenic–Recent.

Larger than the preceding; spire low, strongly spinose; body whorl tapering, outer lip not strongly expanded, with deep antero-lateral, and strong anterior notch. Callus of inner lip extensive.

Miocenic of Haiti, Jamaica, and Costa Rica; Pliocenic of Costa Rica and Florida; Pleistocenic and Recent from the Carolinas to Florida and the West Indies.

Family CYPRÆIDÆ Gray.

CXLII. CYPRÆA Linné.

Spires of adult wholly covered by expanded outer lip, which curves inward, leaving a narrow, elongate aperture, both sides of which are strongly lirate; entire surface smooth and polished. Jurassic–Recent.

510. **C. mortoni** Gabb. Cretacic.

Small, ovate; margins of aperture finely crenulated.

Ripleyan (generally internal mold) of New Jersey and Alabama.

511. **C. pinguis** Conrad. (Fig. 1105.) Eocenic–Miocenic.

Ventricose near the middle; outer lip strongly curved at the spire; crenulation thick; basal callus rather marked.

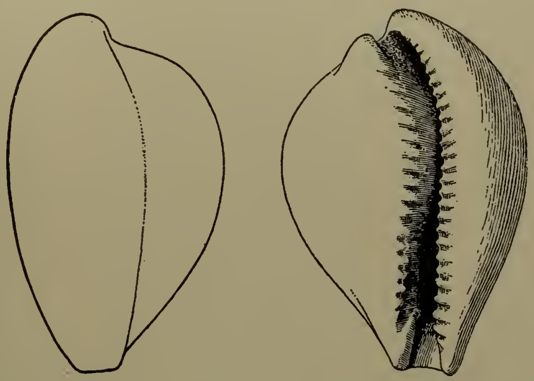


FIG. 1105. *Cypræa pinguis*, profile and apertural views, × 1.4. (After Dall.)

Eocenic of Louisiana, Oligocenic and Miocenic of Florida and North Carolina.

CXLIII. ERATO Risso.

Small shells with some of the characteristics of the young *Cypræa;* the spire only partly covered; columellar surface partly denticulate; outer lip strongly so. Cretacic–Recent.

512. **E. perexigua** (Conrad). (Fig. 1107, *a.*) Miocenic.

Spire with a few smooth whorls embracing to above ambitus; outer lip thick, with numerous strong denticulations; those of columella small, few and scattered.

Chesapeakean of Maryland and Shiloh marls of New Jersey.

Family CASSIDIDÆ Adams.

CXLIV. CASSIDARIA Lamarck.

Shells with short, conical or turbinate spires; large body whorl drawn out anteriorly into a twisted canal which is bent sideways or backward; expanded inner and reflected outer lip, often crenulated, the columellar border plicate. Cretacic–Recent.

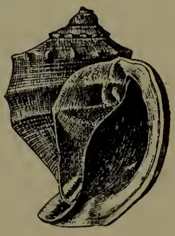


FIG. 1106. *Cassidaria brevidentata.* (After Harris.)

513. **C. brevidentata** Aldrich. (Fig. 1106.) Eocenic.

Whorls embracing to just below the shoulder angle, which is regularly nodulated. Two strong non-nodose spirals produce a marked biangulation of the body whorl; inner lip with three plications in the (posterior) upper part.

Chickasawan (Lignitic) of Alabama.

Family DOLIIDÆ Adams.

CXLV. PYRULA Lamarck.

Thin, low-spired shells with strongly embracing whorls, drawn out anteriorly into a canal; aperture indented with sharp outer lip; surface spirally sculptured. Comanchic–Recent.

514. **P. (Ficus) penita** Conrad. (Fig. 1108.) Eocenic.

Spire conical; sutures scarcely impressed; body whorl round except for three faint carinæ; surface cancellated by spirals and vertical striæ; lip thickened towards the margin.

Claibornian of Alabama, Nanjemoy of Maryland.

515. **P. mississippiensis** Conrad. Oligocenic.

Thin, pyriform, with short spire and convex whorls; the body whorl flattened on top; surface latticed by large distant spirals and finer ones between, and closely arranged, vertical lines.

Vicksburgian of Mississippi.

516. **P. harrisi** Martin. (Fig. 1107, *b*.) Miocenic.

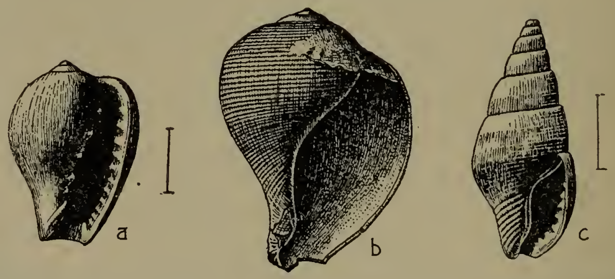


FIG. 1107. *a*, *Erato perexigua*; *b*, *Pyrula harrisi*; *c*, *Columbella communis*. (After Martin, Md. Mioc.)

Inflated with rather short canal, large aperture, and short spire; surface sculptured by fine spiral lines.

Chesapeake Miocene of Maryland.

Family Columbellidæ Troschel.

CXLVI. Columbella Lamarck.

Small, ovate or fusiform shells, with narrow aperture, lirate or denticulate outer lip. Tertiary–Recent.

517. **C. (Astyris) communis** (Conrad). (Fig. 1107, *c*.) Miocenic.

Rather high spire, smooth or with spirals visible only under lens, except on spindle. Outer lip strongly denticulate within.

Chesapeakean of Maryland and New Jersey.

Family Buccinidæ Troschel.

CXLVII. Buccinum Linn.

Stout inflated shells, smooth or ribbed and spiraled; spire short,

Fig. 1108. *Pyrula penita*, × ⅔. (After Conrad.)

Fig. 1109. *Buccinofusus parilis*, × ⅔. (Md. Survey.)

aperture wide, anterior canal short; outer lip sharp, thin, smooth; inner lip with callus. Tertiary–Recent.

518. **B. mississippiensis** Conrad. Oligocenic.

Small, spire rather high, with distant narrow ribs and raised alternating spirals. Outer lip lirate within; columella striate.

Vicksburgian of Mississippi.

CXLVIII. Buccinofusus Conrad.

Large and stout fusoid shells with round, rapidly increasing whorls, short canal scarcely contracted at the anterior end which is slightly reflected; ribs and spirals coarse, the former becoming fainter in the adult shell. Differs from *Siphonalia* chiefly in its straighter canal, and wider more patulous aperture.

519. **B. parilis** Conrad. (Fig. 1109.) Miocenic.

Whorls round, contracted rather rapidly to long, slightly reflected canal; aperture wide; ribs strong on younger, weaker on adult whorls; round and broad spirals uniformly strong, with numerous threadlike intercalated secondary spirals between each pair of primary.

Chesapeakean of Atlantic coast.

CXLIX. Siphonalia Adams.

Short, thick-set fusoid shells with ribs and spirals, or with spirals only and with short, strongly reflected anterior canal. Eocenic–Recent.

520. **S. devexa** (Conrad). (Fig. 1110, *a*.) Miocenic.

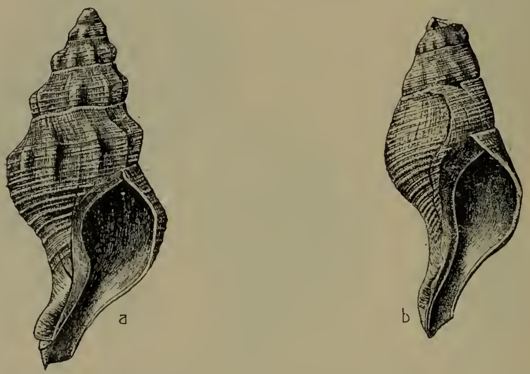


Fig. 1110. *a, Siphonalia devexa; b, S. migrans*, both × ⅔. (Md. Survey.)

Shoulders concave; angle blunt; ribs concentrated on angle, dying away in either direction; spirals numerous; frequent intercalations; canal sinuous.

Chesapeakean of Atlantic coast.

521. **S. migrans** (Conrad). (Fig. 1110, *b*.) Miocenic.

Last whorls non-angulate, without ribs, with numerous spirals; angulation of early whorls less pronounced.

Chesapeakean of Maryland.

CL. Neptunea Bolton.

Fusoid shells with long, slender, many-whorled spire, and rather short, often bent canal. Eocenic–Recent.

522. **N. bella** (Conrad). Eocenic.

Small, high spired; whorls round; suture depressed; canal short, strongly curved; ribs narrow, round, widely separated; spirals, fine, regular.

Claibornian of Alabama.

CLI. Nassa Martini.

Differs from *Buccinum* in its higher spire, shorter aperture with short, reverted canal, and lirate outer lip. Cretacic–Recent.

523. **N. trivittatoides** (Whitfield). (Fig. 1112, *a.*) Miocenic.

Small (half an inch or less in length), with moderately high spire and faint sutures; whorls with strong ribs, cancellated by

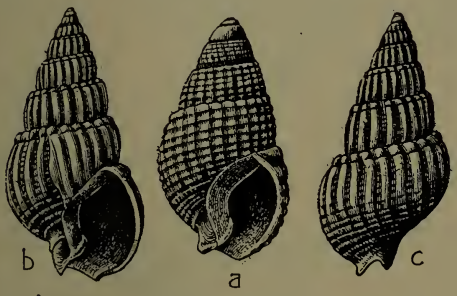


Fig. 1112. *a, Nassa trivittatoides,* × 5; *b, c, N. peralta,* × 2. (Md. Survey.)

Fig. 1113. *Nassa bidentata,* × 4.3. (After Dall.)

continuous strong spirals; canal very short; outer lip thick; liræ strong; columella with faint plaits.

Chesapeakean of Maryland and Shiloh of New Jersey.

524. **N. peralta** (Conrad). (Fig. 1112, *b.*) Miocenic.

Larger and more elongate than the preceding; the ribs crowded and smooth; interspaces with fine spirals; a single small spiral beads the ribs just below the suture.

Chesapeakean of Maryland.

525. **N. vibex** Say. Pliocenic–Recent.

Rather small; suture not impressed; whorls almost flat, ribs and spirals obsolete or very faint; aperture subcicular.

Caloosahatchie (Pliocenic) of Florida; living off Atlantic coast.

526. **N. bidentata** Emmons. (Fig. 1113.) Miocenic and Pliocenic.

Like *N. trivittatoides,* but stouter with coarser ribs and proportionally finer spirals; outer lip with two strong teeth (liræ) on inner side.

Miocenic marls of North Carolina and New Jersey (Shiloh). Caloosahatchie and Shell Creek Pliocenic of Florida, abundant.

527. **N. harpuloides** Conrad. Miocenic.

Whorls square-sided, spire elevated; spirals on shoulder oblique to suture; labial callus thick, outer lip thick, somewhat reflected, and lirate; a subsutural ridge occurs.

Chesapeakean of Virginia, North Carolina.

528. **N. scalaspira** Conrad. Miocenic.

Shorter and more acute spire than preceding; last whorl inflated; spiral sculpture on latest whorl parallel with the suture.

Chesapeakean of Virginia, North Carolina, etc.

Family FULGURIDÆ* Grabau and Shimer.

CLII. TUDICLA Bolten.

Shell with papillose protoconch, and rapidly enlarging whorls, with nearly flat almost horizontal shoulder, and spinose angulation, the whorls embracing to the angle; a second row of spines often

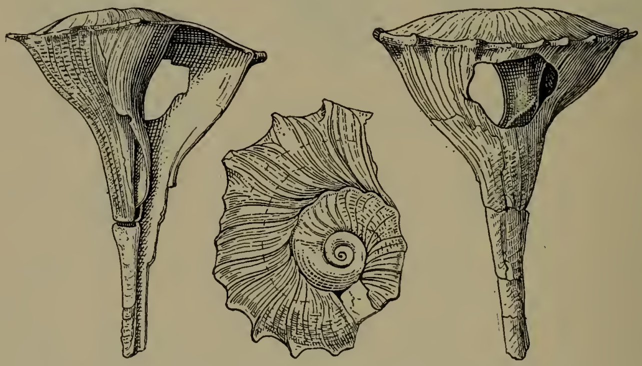


FIG. 1114. *Tudicla marylandica,* × ⅔. (Md. Survey.)

occurs on body of whorl. Anteriorly drawn out into long fusiform canal; columellar lip plicate near the base; outer lip lirate. Tertiary–Recent.

529. **T. marylandica** Clark and Martin. (Fig. 1114.) Eocenic.
Young whorls round, sunken; shoulder of body whorl convex near suture, concave near the strongly spinose angulation.
Aquia formation of Maryland.

CLIII. Pyropsis Conrad.

Differs from *Tudicla* in its non-papillose apex, and the absence of liræ and columellar plication. Cretacic–Eocenic.

530. **P. coloradoensis** Stanton. (Fig. 1115.) Cretacic.
Rather robust; canal gently curved, umbilicated; body whorl not abruptly contracted below, biangulate, the angles with small, rounded nodes, both covered in early whorls; spirals numerous;

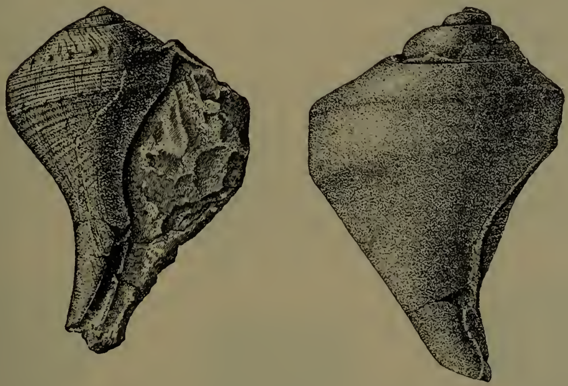


Fig. 1115. *Pyropsis coloradoensis*, shell and internal mold, × 2/3. (After Stanton.)

lip with posterior canal producing a slight channeling of the suture.
Colorado group (Pugnellus sandstone) of Colorado and Utah?

531. **P. richardsoni** (Tuomey). (Fig. 1116.) Cretacic.
Spire depressed, low, often almost flat (angle about 135°); shoulder angle strong with irregular flat nodes; lower angulation fainter, also noded (angulations appear smooth in internal molds); spirals numerous, strong, alternating in size, those between the angulations more or less crenate.
Ripleyan of New Jersey, Alabama, Georgia and Mississippi.

532. **P. trochiformis** (Tuomey). (Fig. 1117.) Cretacic.
Spire depressed, early volutions almost flat; body whorl gibbous, without angulations, rather abruptly contracted into the anterior

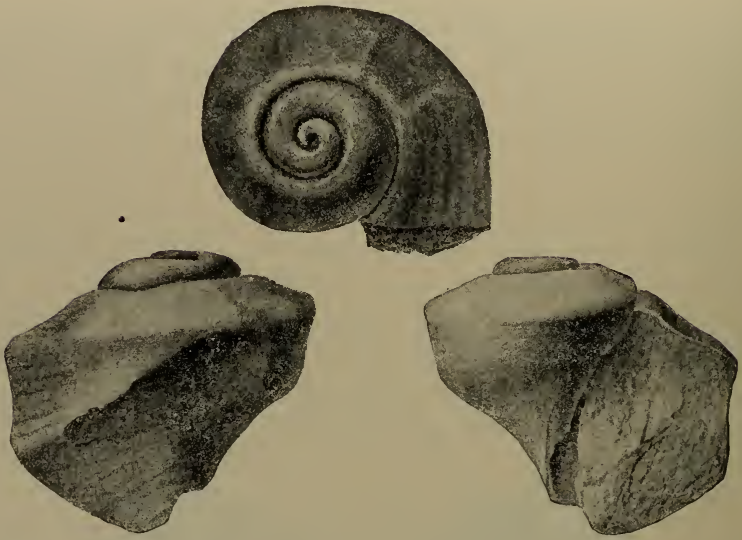


FIG. 1116. *Pyropsis richardsoni*, × ⅔. (After Whitfield.)

canal; spirals numerous, alternating, the primary ones noded. Internal molds with loose sutures and smooth surfaces.

Ripleyan of New Jersey, Alabama and Mississippi.

FIG. 1117. *Pyropsis trochiformis*, internal mold and fragment showing surface, × ⅔. (After Whitfield.)

533. **P. whitfieldi** Weller. (Fig. 1118.) Cretacic.

Small; whorls round; later whorls embracing only to ambitus; flattened below the suture; spirals simple, rather coarse, noded by ribs of equal size.

Ripleyan of New Jersey and Alabama.

534. **P. octolirata** (Conrad). Cretacic.

Like the preceding but body whorl somewhat more abruptly contracted; without sutural flattening or ribs, though one of the 8 or 9 spirals is slightly noded.

Ripleyan of New Jersey and Mississippi.

CLIV. Perissolax Gabb.

Spire conical and smooth; canal long; last whorl inflated; biangular, and ornamented by ribs and spirals; columella without plaits. Differs from *Pyropsis* chiefly in its long spire. Cretacic.

535. **P. brevirostris** Gabb. (Fig. 1119.) Cretacic.

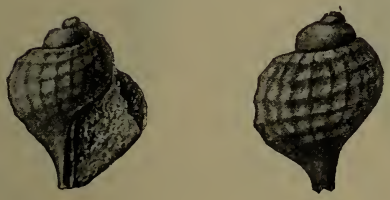


Fig. 1118. *Pyropsis whitfieldi*. (After Whitfield.)

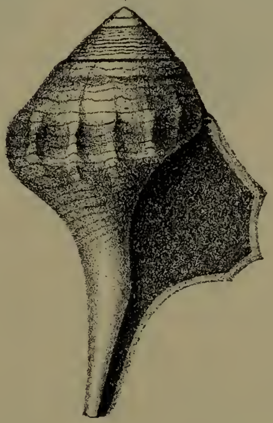


Fig. 1119. *Perissolax brevirostris*, nat. size. (After Gabb.)

Shoulders of whorls flat, spiraled, whorls embracing to shoulder angle, forming conical spire of nearly 90° apical angle. Last whorl with two strong angulations, a third towards the end; traversed by distant, narrow ribs which are nodose on the angles.

Nanaimo group of Vancouver; Chico of California.

CLV. Fulgur Montford.

Whorls (except very young) angulate with flat shoulder and nodose or spinose angulation; rarely round and smooth whorls generally embracing to shoulder angle; aperture not abruptly contracted, but canal long. Protoconch oblique, smooth. Eocenic(?)–Recent.

536. **F. fusiforme** Conrad. (Fig. 1120, *a* and *c*.) Miocenic.

Whorls embracing to angle which bears small nodes; shoulder gently concave; aperture moderately contracted.

Chesapeakean of Atlantic coast.

537. **F. tuberculatum** Conrad. (Fig. 1120, *b*.) Miocenic.

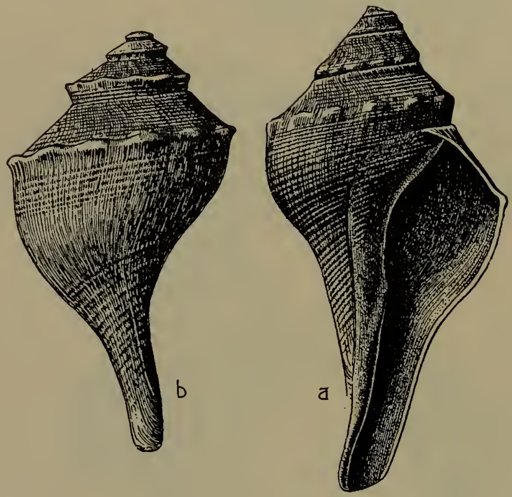


FIG. 1120. *a*, *c*, *Fulgur fusiforme*; *d*, *F. tuberculatum*. (Md. Survey.)

Later whorls embracing only part way to angle; nodes flat and wide; spirals numerous; aperture more abruptly contracted.

Chesapeakean of Atlantic coast.

538. **F. maximum** Conrad. (Fig. 1121, *c*.)

Miocenic and Pliocenic.

Large; young whorls tubercled, adult whorls smooth, rounded; shoulder slightly concave.

Chesapeake Miocenic of Virginia. A more slender, elongate form of same character (*F. rapum* var., Fig. 1121, *a*) occurs in the Caloosahatchie beds of Florida and Duplin beds of North Carolina.

539. **F. tritonis** Conrad. (Fig. 1121, *b*.) Miocenic.

Earliest whorls tubercled as in *F. tuberculatum*, intermediate smooth as in *F. maximum*, adult whorls regularly spinose on shoulder angle.

Chesapeake Miocenic of Atlantic coast. A slender form [*F. rapum* Conrad of another genetic series] with these characters occurs in the Pliocenic of the Carolinas and Florida.

540. **F. caricum** (Gmelin). Pliocenic–Recent.

Large (length up to 223 mm., width up to 120 mm.) with all the whorls strongly spinose on the shoulder angle, except the earliest which bear only round nodes.

Pliocenic of the Carolinas; Pleistocenic and living Atlantic coast from Cape Cod to West Indies.

541. **F. contrarium** Conrad. (Fig. 1121, *d*.) Miocenic–Pliocenic.

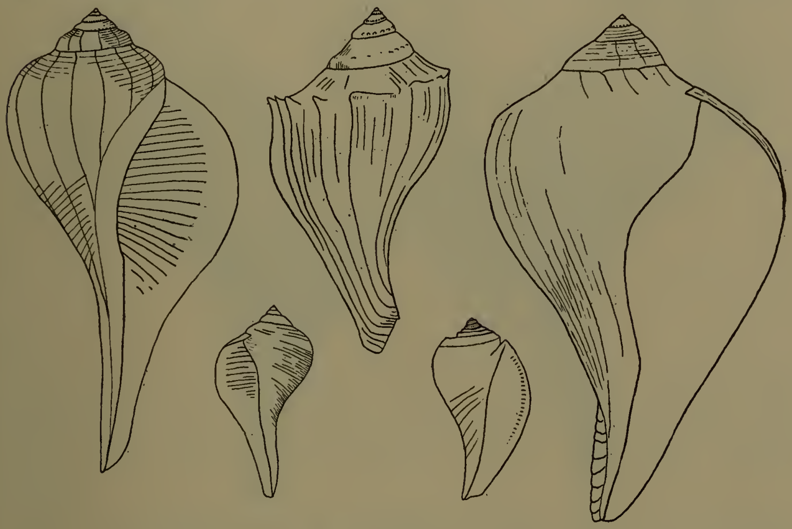


FIG. 1121. (*a–c*, upper three, left to right; *d*, *e*, lower two); *a*, *Fulgur rapum* var.; *b*, *F. tritonis*; *c*, *F. maximus*; *d*, *F. contrarium*; *e*, *Sycotypus excavatus*. All × ½. (After Grabau.)

Reversed; earliest whorls noded, adult smooth.

Duplin beds of the Carolinas; Caloosahatchie beds of Florida. (Reversed species with the character of *F. tritonis* or *F. rapum* (*F. obrapum* Grabau) and one with the characters of *F. caricum* (*F. perversum*) occur in the Pliocenic–Recent deposits of the Atlantic coast.

CLVI. SYCOTYPUS Browne.

Like *Fulgur* in form, but with a canaliculate suture and typically without spines, the tubercles of the young often uniting into a smooth keel in the adult. Miocenic–Recent.

542. **S. rugosus** (Conrad). (Fig. 1122.) Miocenic.

Shoulder angle nodulated throughout, the nodes in the adult becoming broad and subconfluent.

Chesapeakean formation of the Atlantic coast.

543. **S. canaliculatus** (Linn.). Pliocenic–Recent.

Young whorls nodulated, adult with more or less strongly developed carina.

Pliocenic of the Carolinas; Pleistocenic and Recent, Cape Cod to Gulf of Mexico.

544. **S. pyriformis** (Conrad). Miocenic.

Young whorls tubercled, later keeled; adult with rounded whorls.

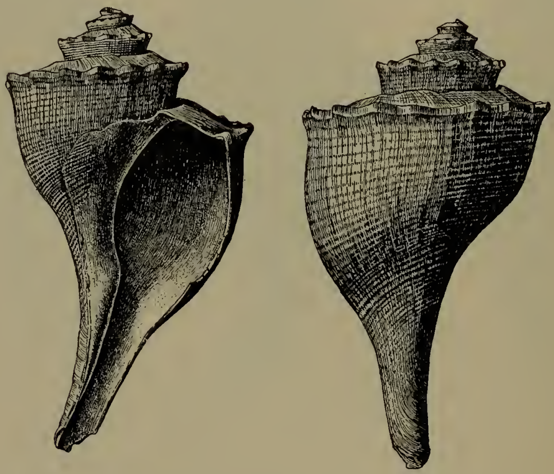


FIG. 1122. *Sycotypus rugosus*, × ⅔. (Md. Survey.)

Miocenic of North Carolina. In *S. pyrus* of the modern fauna the rounded outer lip begins early, the curvature being continuous from the sutural canal.

545. **S. excavatus** Conrad. (Fig. 1121, *e*.) Miocenic–Pliocenic.

Differs from the preceding in having the outer lip of last whorl continuous without shoulder angle, and with sharp posterior notch.

Duplin beds of Carolinas.

CLVII. STREPSIDURA Swainson.

Like *Fulgur* but with short, curved canal, higher spire, and whorls often ribbed. Eocenic–Miocenic.

546. **S. subscalarina** Heilprin. (Fig. 1123, *a–c*.) Eocenic.

Primitive varieties (Fig. 1123, *a*) high-spired; whorls rounded or subangular, and ribbed, specialized varieties (Figs. 1123, *c, b*) with later whorls strongly embracing, angular, the ribs reduced to sharp nodes and the shoulder flat. Spirals numerous, intercalated; inner lip callous; outer lip lirate.

Pamunkey formation of Maryland and Virginia.

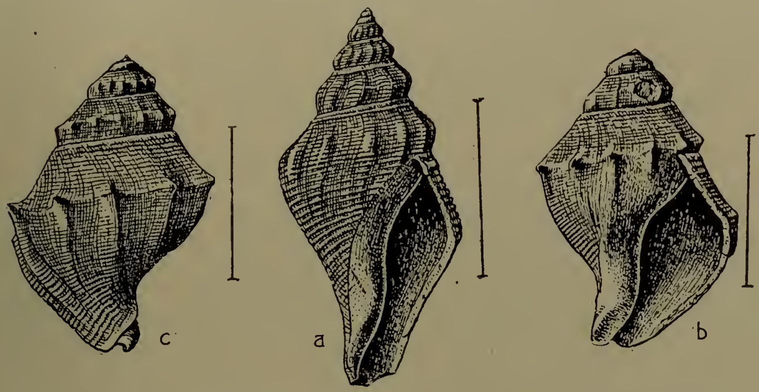


FIG. 1123. *a*, *Strepsidura subscalarina*; *b*, *c*, var. *nodosus*. (Md. Survey.)

CLVIII. LEVIFUSUS Conrad.

General form like a small *Fulgur* but generally with a second angulation on the body of the whorl; canal of varying length, outer lip lirate; protoconch of several gradually increasing, smooth whorls.

547. **L. trabeatus** Conrad. (Fig. 1124, *a*.) Eocenic.

Whorls of spire exposing part of body below the angulation; a second angulation in line with posterior end of lip, flat nodules on both angulations, outer lip strongly lirate. Canal slightly bent.

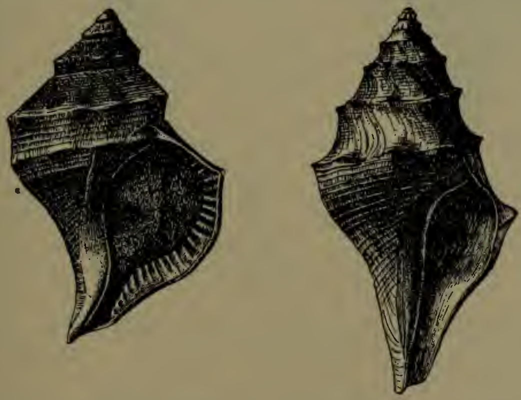


FIG. 1124. *a*, *Levifusus trabeatus*; *b*, *L. pagodiformis*. (After Harris.)

Midwayan to Claibornian from Alabama to Texas; Nanjemoy of Maryland (?).

548. **L. pagodiformis** Heilprin. (Fig. 1124, *b*.) Eocenic.

Whorls embracing to angulation, the flat tubercles of which show just above the suture; shoulder concave, steep, second angulation wanting, canal straight.

Midwayan and Chickasawan of Alabama.

CLIX. Fasciolaria Lamarck.

Protoconch and the young whorls typically of the fusoid type, later whorls ribbed and spiraled, with a sharp angulation and flat shoulder or with rounded whorls. Canal shorter than in *Fulgur* and spire longer. Columella with two or three oblique plications in anterior end, and in typical forms with a strong, oblique anterior angulation. Cretacic–Recent.

549. **F. (Cryptorhytis) utahensis** (Meek). (Fig. 1125.) Cretacic.

Whorls embracing to shoulder angle, shoulder of later whorls flat, earlier ones rounded; ribs faint or condensed to tubercles; body whorl gradually contracting to slightly bent canal. Columella with one strong fold so far back that it is hardly visible in a perfect specimen.

Fig. 1125. *Fasciolaria* (*Cryptorhytis*) *utahensis*. (After Stanton.)

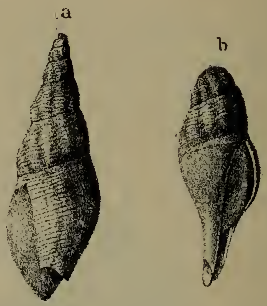


Fig. 1126. *Fasciolaria* (*Piestrocheilus*) *culbertsoni*, views of two fragmentary specimens; *a*, type broken below; *b*, not showing columellar plaits and with broken spire. (After Meek.)

Colorado formation of Utah and Colorado. (Pugnellus sandstone.)

550. **F. (Piestrocheilus) culbertsoni** M. and H. (Fig. 1126.)
Cretacic.

Fusiform spire of length of aperture; whorls round; suture scarcely impressed; surface with rounded, low ribs which become obsolete in adult of many specimens; spirals uniform; from one to four plaits on columella, not visible at aperture.

Fox Hills of Moreau River, and of Black Hills of Dakota.

Family Fusidæ.

CLX. Fusus Lamarck.

Spindle-shaped, with spire and canaliculate rostrum of about equal length in typical forms; protoconch oblique and smooth in early, ribbed in later whorls; abruptly defined from conch which

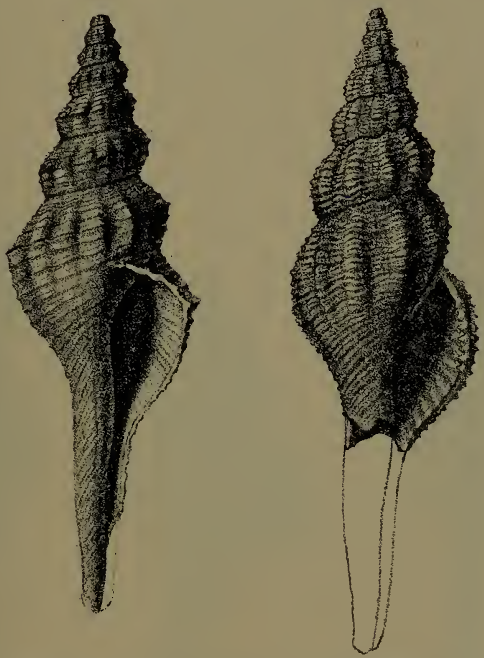


Fig. 1127. *a*, *Fusus haitensis*; *b*, *F. henekeni*. (After Guppy, Q. J. G. S., XXXII.)

begins with round ribbed whorls; later whorls often angular and nodose; body whorl abruptly contracted to canal; lips smooth. Eocenic–Recent.

551. **F. henekeni** Sowerby. (Fig. 1127, *b*.) Oligocenic.
Whorls round, rather closely embracing, with stout round ribs and simple spirals, with intercalated secondary ones in the later whorls.

Bowden beds of San Domingo and Jamaica.

552. **F. haitensis** Sowerby. (Fig. 1127, *a*.) Oligocenic.
Like the preceding, except that the last two whorls show flattening of the shoulders and peripheral angulation, with rude nodes.

Occurs with the preceding.

Fusoid Shells of Undetermined Relationship.

CLXI. Falsifusus Grabau.

Like *Fusus* in general form, but with protoconch consisting of a number of gradually enlarging, smooth whorls merging into the conch, the whorls of which early become angular. Eocenic.

553. **F. meyeri** (Aldrich). (Fig. 1128.) Eocenic.

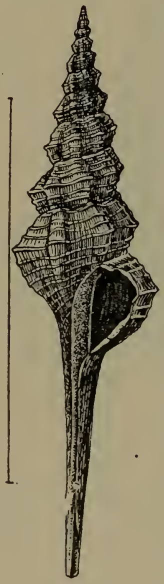


Fig. 1128. *Falsifusus meyeri.* (After Harris.)

Fig. 1129. *Fulgurofusus quercollis.* (After Harris.)

Fig. 1130. *Fulgurofusus rugatus.* (After Harris.)

Whorls angular almost throughout; ribs and simple spirals continue to lip; spire and canal of equal length, very slender.

Midwayan and Chickasawan of Gulf States.

CLXII. Fulgurofusus Grabau.

Like *Fusus* in form; protoconch oblique and without ribs as in *Fulgur,* merging into an angulate conch which throughout has concave or flat shoulders and a sharp, peripheral keel bearing nodes. Eocenic.

554. **F. quercollis** (Harris). (Fig. 1129.) Eocenic.

Carina with sharp, flat nodes; spirals faint; sutures very deep.

Lower Eocenic of Alabama, etc.

555. **F. rugatus** (Aldrich). (Fig. 1130.) Eocenic.

Nodes of keel spinose in adult; spirals on body strong, sometimes spinulose; suture less depressed than in preceding.

With the preceding.

CLXIII. Heilprinia Grabau.

Fusoid shells with protoconch ribbed throughout, body whorl more or less abruptly contracted into the canal. Columella usually plicate in adult, outer lip commonly lirate. Pliocenic–Recent.

The more loose-coiled forms with larger spire and less contracted aperture are referred to *Barbarofusus* Grabau and Shimer gen nov., type *B. barbarensis.*

556. **H. equalis** (Emmons). (Fig. 1131, *b.*) Miocenic.

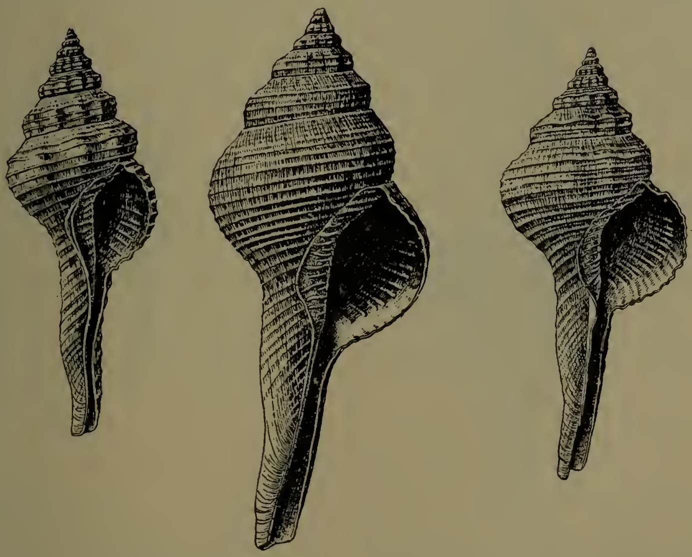


Fig. 1131. *a, Heilprinia caloosaensis; b, H. equalis; c, H. caloosaensis* var.; all about $\frac{1}{3}$ nat. size. (After Dall.)

Differs from *H. caloosaensis* in having the last whorls free from indications of ribs, well rounded and strongly marked by spirals. Both outer and inner lip strongly lirate on apertural side.

Cape Fear River Miocenic of North Carolina.

557. **H. (Barbarofusus) exilis** (Conrad). Miocenic.

Later whorls rounded, owing to prominence of first shoulder spiral; ribs disappear in later whorls; spirals compound; aperture less sharply contracted than in preceding.

Miocenic or Upper Oligocenic of Florida.

558. **H. caloosaensis** (Heilprin). (Fig. 1131, *a* and *c*.) Pliocenic.

Shoulder of later whorls flat but angle not pronounced, ribs faint on later whorls; spirals mostly primary, more rarely fine secondary ones intercalated; aperture and whorl abruptly contracted to the slender canal which is slightly sinuous; inner lip strong, multiplicate; outer lip strongly lirate.

Pliocenic of Florida and the Carolinas.

559. **H. (Barbarofusus) barbarensis** (Trask). (Fig. 1132). Pliocenic.

Spire slender, whorls round, sutures deep, apical angle 30° or

FIG. 1132. *Heilprinia* (*Barbarofusus*) *barbarensis*, × 1.5. (After Arnold.)

FIG. 1133. *Exilia pergracilis.* (After Harris.)

more, ribs narrow, twice their width apart, often obsolete on last whorl; spirals strong; canal of moderate length, outer lip lirate within.

Pliocenic of California coast.

560. **H. (Barbarofusus) robusta** (Trask). Pliocenic–Recent.

Like the preceding but shoulders more flattened and whorls more bulging in adult; shell shorter and less slender.

Pliocenic–Recent of California coast.

CLXIV. Exilia Conrad.

Slender, fusoid shells with sutures not deeply impressed, surface with regular ribs and aperture gradually contracted to long canal. Eocenic.

561. **E. pergracilis** Conrad. (Fig. 1133.) Eocenic.

About twelve rounded volutions with faintly sigmoidal ribs, more than their width apart; straight canal, shorter than spire; spirals fine.

Midwayan of Alabama and Mississippi.

CLXV. Lathyrus Montford.

Fusiform but thicker and more solid than *Fusus;* generally with a straight canal shorter than in *Fusus;* columella with two or three plaits anteriorly; sometimes umbilicated; whorls with ribs and spirals; outer lip lirate within; generally angulated. Cretacic–Recent.

562. **L. floridanus** Heilprin. (Fig. 1134.) Eocenic–Miocenic.

Whorls round but shoulder flattened; ribs dying away towards suture; spirals pronounced with very fine secondary ones; liræ strong; columella with two obscure plaits; outer lip with additional liræ in adult specimens.

Nummulitic (Eocenic) beds of Tampa and Miocenic silex beds of Ballast Point, Florida.

CLXVI. Streptolathyrus Cossman.

Differs from *Lathryus* in its strongly twisted canal which produces a corresponding change in columella; surface with or without ribs. Eocenic.

563. **S. interstriatus** (Heilprin). (Fig. 1135.) Eocenic.

Whorls round; suture moderately deep; ribs simple and continuous from suture to suture, about their width apart; spirals

FIG. 1134. *Lathyrus floridanus*, × 1.13. (After Dall.)

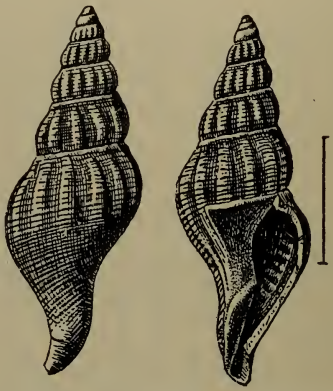


FIG. 1135. *Streptolathyrus interstriatus*, enlarged. (Md. Survey.)

numerous; compound columella with one strong oblique plication; liræ of outer lip rather strong.

Pamunkey formation of Maryland and Virginia; Chickasawan (Lignitic) of Alabama.

CLXVII. PSEUDOLATHYRUS Bellardi.

Shell fusiform, with protoconch of *Falsifusus* type. Whorls mostly angular with ribs and spirals, the former often becoming obsolete except on angle. Canal straight, not twisted, non-umbilicate; columella plicate in adult. Eocenic–Pliocenic.

564. **P. tortilis** (Whitfield). (Fig. 1136.) Eocenic.

Whorls angulated; shoulder flat; ribs weak, far apart, scarcely extending below angulation; embracing of whorls falls short of angulation by half the shoulder width; contraction to canal gradual; columella with two plicæ, the upper one faint. Spirals compound.

Midwayan of Alabama, Georgia and Mississippi.

CLXVIII. LIROFUSUS Conrad.

Short, thick-spired, fusoid shells with short, somewhat inflated canal, pyriform aperture, and lirate outer lip; no columellar plications. Eocenic.

565. **L. subtenuis** (Heilprin). (Fig. 1137.) Eocenic.

Whorls rounded but with a flattening above the last spiral, and below the strong subsutural spiral, which sometimes produces a channeling of the suture; spirals strong and simple. Ribs well defined on young whorls, but fainter or obsolete on the adult.

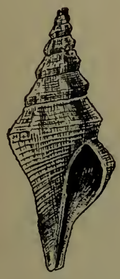


FIG. 1136. *Pseudolathyrus tortilis.* (After Harris.)

FIG. 1137. *Lirofusus subtenuis*, enlarged. (Md. Survey.)

Pamunkey of Maryland and Virginia; Chickasawan (Lignitic) of Alabama.

CLXIX. FULGUROFICUS Sacco.

Shell small, fulguroid, with low spire, and patulous, wide canal, and several peripheral angulations. Surface with ribs which become sharply nodose on the angulations. Eocenic.

566. **F. argutus** Clark. (Fig. 1138, *a, b.*) Eocenic.

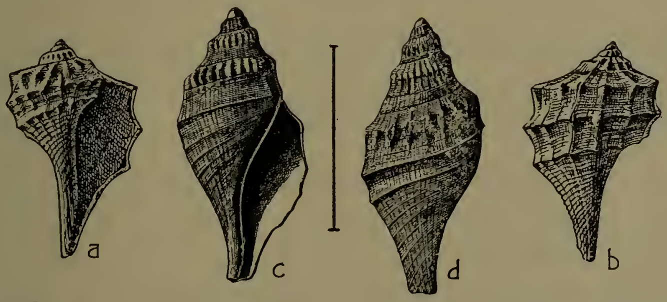


FIG. 1138. *a, b, Fulguroficus argutus ; c, d, Fusoficula juvenis.* (Md. Survey.)

Body whorl with three strong angulations rather far apart, and nodose where they cross the thin, rather sharp and distinct ribs; early whorls more or less rounded.

Pamunkey of Maryland and Virginia; Chickasawan (Lignitic) of Alabama.

CLXX. Fusoficula Sacco.

Differs from the preceding in its higher spire, less pronounced angulations and less patulous aperture. Eocenic.

567. **F. juvenis** (Whitfield). (Fig. 1138, *c, d.*) Eocenic.

Shoulder flat to concave with ribs nodose on angle and extending a short distance above and below; whorls embracing to a second, sharp, smooth, peripheral angulation below which is a third fainter one; space between angulations concave, marked by numerous fine spirals.

Pamunkey (Aquia) of Maryland; Chickasawan of Alabama and Texas.

CLXXI. Odontofusus Whitfield.

Fusiform, round-whorled, ribbed shells, with rather short canal and a single oblique plication near the center of the columella. Cretacic.

568. **O. medians** Whitfield. (Fig. 1139.) Cretacic.

Fig. 1139. *Odontofusus medians.* (After Whitfield.)

Whorls round; ribs straight, thin and distant; aperture broad; canal short.

Ripleyan of New Jersey and Mississippi.

CLXXII. Clavilithes Swainson.

Fusiform shells with cylindrical protoconch of many whorls; early whorls ribbed and spiraled, later ones generally smooth, more elongate and flattened; a posterior canaliculation with sutural shelf generally occurs.

569. **C. kennedyanus** Harris. (Fig. 1140.) Eocenic.

Early whorls strongly ribbed, somewhat concave below the suture; later whorls smooth, flat, with scarcely impressed suture; outer lip gently rounded; body whorl abruptly constricted to canal.

Chickasawan and lower Claibornian of Alabama and Texas.

CLXXIII. Lacinia Conrad.

Melongenoid shells, with body whorl marked by angulations or spirals, umbilicated aperture with callous columellar lip. Eocenic.

570. **L. alveata** Conrad. (Fig. 1141.) Eocenic.

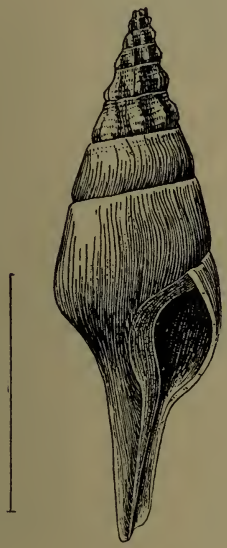


Fig. 1140. *Clavilithes kennedyanus* var. (After Harris.)

Fig. 1141. *Lacinia alveata.* (After Conrad.)

Large, subglobose, thick body whorl with channeled suture; several angulations with flat or concave interspaces, a strong obtuse carina around umbilicus; aperture, large, patulous; inner lip strongly callous, reflected.

Claibornian of Alabama.

Family Turbinellidæ Swainson.

CLXXIV. Turbinella Lamarck.

Similar to *Clavilithes* but generally without shelf, and with strong columellar folds; protoconch long and papillose. A dis-

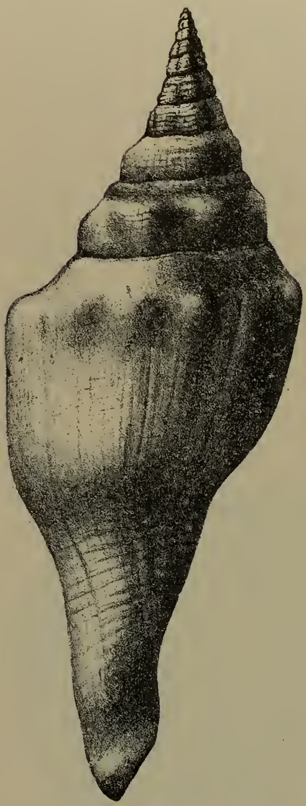


FIG. 1142. *Turbinella wilsoni.* (After Conrad.)

tinct shoulder occurs in some species, with the ribs noded on the angle. The last whorl generally smooth, but may retain the ribs and nodes as irregular folds. Oligocenic–Recent.

571. **T. wilsoni** Conrad. (Fig. 1142.) Oligocenic–Miocenic.

Differs from the next species in its smooth, somewhat subcylindrical, or flattened last whorl, in the number of ribbed young whorls (7 or more); concave shoulder, rather steeply inclined, angle rounded and faintly and bluntly nodulated; faint spirals on lower part of body whorl.

Vicksburgian of Mississippi; Alum Bluff beds of Florida.

572. **T. chipolana** Dall. (Fig. 1143.) Oligocenic–Miocenic.

Young whorls (two or three) with coarse ribs which become obsolete later on; last whorl round; intercalated spirals between the strong primary ones; columella with three oblique folds; protoconch cylindrical, of many whorls.

Chipolan and Alum Bluff beds of Florida.

CLXXV. VASUM Link. (*Cynodonta* Schum.)

Like *Turbinella* but with flat or concave shoulder and angle with strong, coarse and flat spines; one or more additional rows of spines on the lower part of whorl. Oligocenic–Recent.

573. **V. haitense** Sowerby. (Fig. 1144.) Oligocenic–Miocenic.

Spire high, acute, of flat-ribbed whorls, rapidly broadening out in last 2 or 3 whorls which have concave shoulder and strong, triangular, compressed spines; a second row of smaller, sharp spines near base; spirals faint. The variety *engonatum* (Dall) has more spines and less elevated and less acute young spire.

Lower Miocenic (Oligocenic?) of Santo Domingo, Chipolan beds and Alum Bluff beds of Florida.

574. **V. horridum** Heilprin. Pliocenic.

FIG. 1143. *Turbinella chipolana*, young shell, × 1.2. (After Dall.)

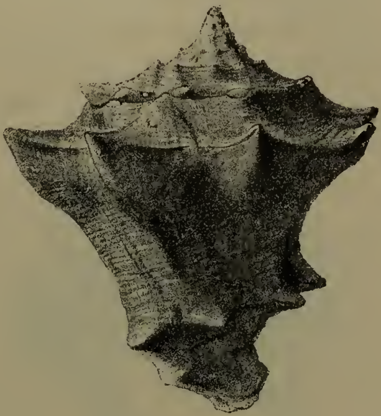


FIG. 1144. *Vasum haitense*, × 2/3. (After Sowerby.)

With numerous, strong, compressed, slightly upward curving spines opening forward, and covering most of the spire and body whorl.

Caloosahatchie beds of Florida.

CLXXVI. MAZZALINA Conrad.

Shells thick, of smooth, strongly convex whorls contracted below to a curved canal; outer lip regularly curved; a faint posterior canal generally developed; typically with columellar plaits. Eocenic–Recent.

575. **M. (Bulbifusus) inaurata** (Conrad). (Fig. 1145.) Eocenic.

Suture sunken from thickening of whorl just below; columella smooth.

Represented by numerous varieties in Chickasawan, Claibornian and Jacksonian beds of the Gulf States.

FIG. 1145. *Mazzalina* (*Bulbifusus*) *inaurata* var. *plena*. (After Harris.)

Family Muricidæ Tryon.

CLXXVII. Urosalpinx Stimpson.

Short and thick fusiform shells with spire of few regularly enlarging whorls, and with an anterior canal of moderate length, often slightly bent; aperture pyriform, outer lip often denticulate. Surface with ribs and spirals. Tertiary–Recent.

576. **U. rustica** (Conrad). (Fig. 1146, *a, b.*) Miocenic.

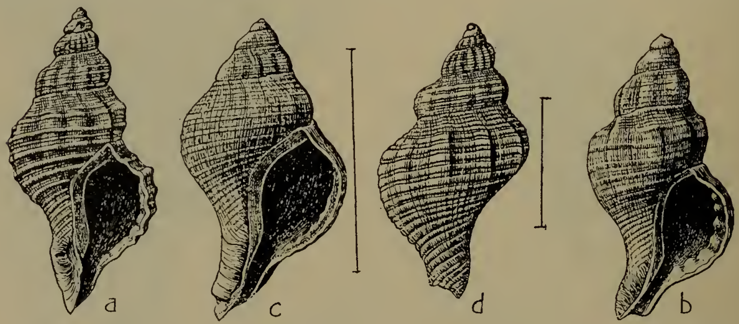


Fig. 1146. *a*, *b*, *Urosalpinx rustica*; *c*, *d*, *U. cinerea*. (Md. Survey.)

More slender than *U. cinereus,* shoulder somewhat flatter, primary spirals strong, secondary and later numerous. Inside of outer lip strongly toothed or lirate.

Chesapeakean of Atlantic coast.

577. **U. cinerea** Say. (Fig. 1146, *c, d.*) Miocenic–Recent.

Whorls rounded, rarely with a shoulder flattening, no angulation, ribs narrow, round and distant, becoming obsolete above and

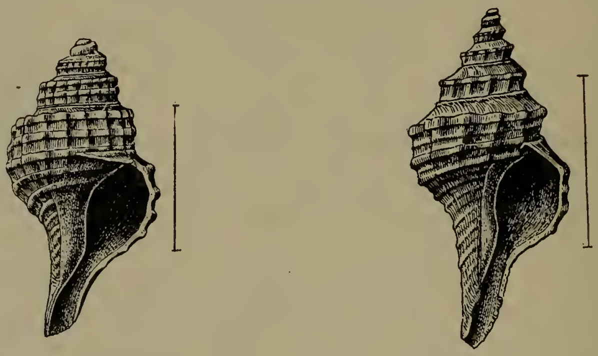


Fig. 1147. *Urosalpinx* (*Scalaspira*) *strumosa*, two varieties. (Md. Survey.)

below, often wanting on body whorl; spirals numerous, not coarse, in several cycles.

Chesapeakean of Maryland and Virginia; Pliocenic–Recent on southern Atlantic coast of United States.

578. **U. (Scalaspira) strumosa** (Conrad). (Fig. 1147.) Miocenic.

Differs from the other species in its flat shoulder and flat sides of whorls, marked by two or three very strong spirals, the lower one covered at the suture and cancellated by narrow, distant, vertical ribs.

Chesapeakean of Maryland and Virginia, etc.

CLXXVIII. Murex Linn.

Round whorled or angular whorled fusiform shells, the spire ribbed and with spirals, aperture drawn out anteriorly into a straight or curved canal; outer lip expanded into a varix with or without simple or compound spines; varices of former aperture persistent, three or more to a volution. This includes a number of distinct genetic series. Cretacic–Recent.

579. **M. mississippiensis** Conrad. (Fig. 1148.) Oligocenic–Recent.

Small, with three non-spinous varices and often two or more faint, rounded ribs between the varices; spirals compound, strong, often crowded; canal strongly deflected, very narrow.

Vicksburgian beds of Mississippi; Chipolan and Silex beds of Florida.

580. **M. (Chicoreus) rufus** Lamarck. Miocenic?–Recent.

Of moderate size, with three varices of much divided or fron-

Fig. 1148. *Murex mississippiensis.* (After Conrad.)

Fig. 1149. *Typhis curvirostratus.* (After Conrad.)

dose spines, with a single large rib between the varices, anterior end of canal deflected.

Miocenic of North Carolina; Pliocenic of Florida; Post-Pliocenic of Antilles; living from Cape Fear, N. C., to the Gulf.

CLXXIX. Typhis Montfort.

Like *Murex,* but the varices are rib-like, the spines are hollow and less regular, and the short anterior canal is completely closed. Cretacic–Recent.

581. **T. curvirostratus** Conrad. (Fig. 1149.) Oligocenic.

Spire somewhat lower than the next; sides of whorls more nearly straight; ribs strong and ending in vertical spines; aperture small and round; anterior beak strongly curved.

Vicksburgian of Mississippi.

582. **T. acuticosta** Conrad. (Fig. 1150, *a, b.*) Miocenic.

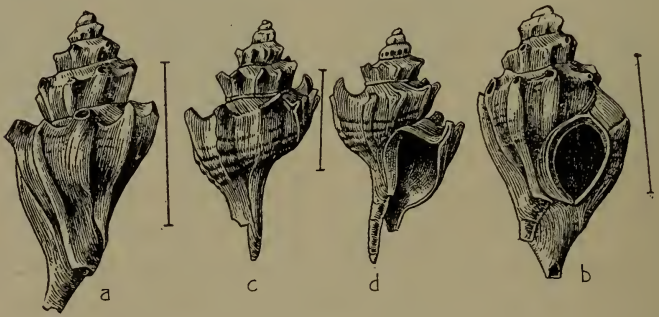


Fig. 1150. *a, b, Typhis acuticosta ; c, d, Trophon tetricus.* (Md. Survey.)

Whorls with four or five varices ending at the shoulder angle in compressed spines, alternating with four shorter, rounded varices ending in hollow spines or tubes. Rostrum slightly reflected.

Chesapeakean formation of Atlantic coast.

583. **T. obesus** Gabb. Oligocenic–Pliocenic.

Short and broad with low spire; whorls sharply angulated, concave above and convex below suture; four varices to each whorl, acute-angular on their margins and ending in blunt process on upper angle of whorl; shell swollen at base of tubular spines; surface polished, with few spirals.

Chipolan beds of Jamaica and Florida; Miocenic of Haiti; Pliocenic of Trinidad.

CLXXX. Trophon Montfort.

Like the preceding, but the varices are lamellose and the canal open. Tertiary–Recent.

584. **T. tetricus** Conrad. (Fig. 1150, *c, d.*) Miocenic.

With 9–12 varices which are sharp and end at the shoulder angle in compressed open spines; canal long and straight.

Chesapeakean of Atlantic coast.

Family Purpuridæ Gray.

CLXXXI. Ecphora Conrad.

Large, short and thick shells, rather loosely coiled towards the last, leaving a wide umbilicus. Aperture more or less pyriform, extended into a short anterior canal. Surface marked by coarse spiral folds, rarely by finer spirals. Miocenic.

585. **E. quadricostata** (Say). (Fig. 1151.) Miocenic.

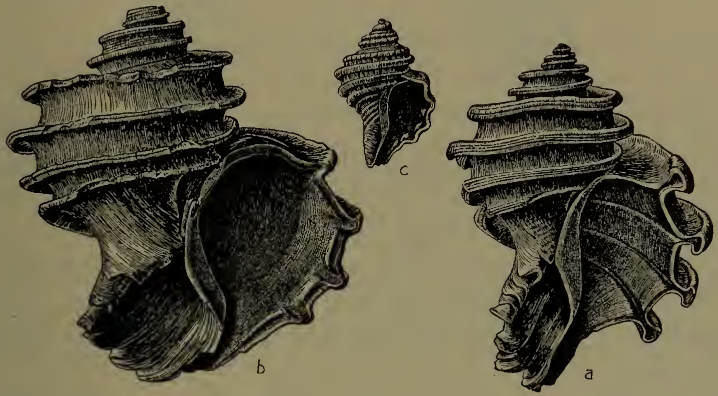


Fig. 1151. *a, Ecphora quadricostata,* × ⅔; *b,* var. *umbilicata,* × ⅔; *c,* young, × 2. (Md. Survey.)

Adult shell deeply umbilicated, with four very prominent, projecting spiral folds, often T-shaped in section, less prominent and somewhat noded in the young. Variety *umbilicata* (Fig. 1151, *b*) has a larger umbilicus, looser coil, thinner, not T-shaped spirals. *E. tricostata* (Fig. 1152, *b*) has the lower spiral weak or absent.

Chesapeakean formation of Maryland and Virginia.

586. **E. tampaensis** (Dall). (Fig. 1152, *a.*) Miocenic.

Resembles the young of *E. quadricostata;* spiral folds moderate, numerous on anterior portion, on main part of whorl with finer intercalated ones; growth lines lamellose between spirals.

Silex beds of Florida; Chesapeake beds of Maryland.

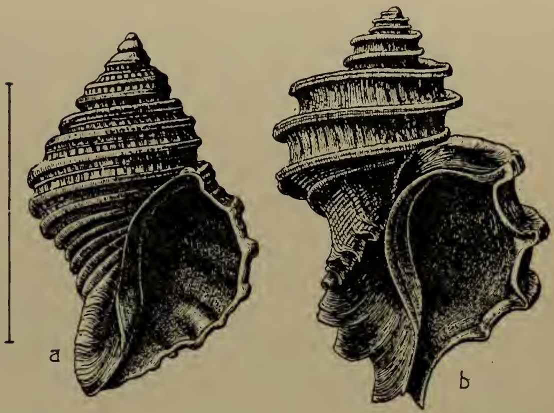


FIG. 1152. *a*, *Ecphora tampaensis*; *b*, *E. tricostata*. (Md. Survey.)

Family MARGINELLIDÆ Jousseaume.

CLXXXII. MARGINELLA Lamarck.

Oval or long shells with smooth exterior, low spire and elongate aperture which is slightly canaliculate anteriorly; three to four equal oblique folds on the columella; outer lip often thickened and dentate. Eocenic–Recent.

587. **M. minuta** Pfeiffer. (Fig. 1153, *a*.) Miocenic–Recent.

Spire very low, sunken; last whorl rounded, smooth; aperture elongate; columella with four folds in anterior end; outer lip thickened, smooth.

Chesapeakean of Maryland and Virginia; Pliocenic of North Carolina and Florida; Recent on southern Atlantic coast of North America and Cuba.

588. **M. virginiana** Conrad. Miocenic–Recent.

Larger than the preceding, with the spire low but not sunken; body whorl tapering forward, giving the shell a *Conus*-like aspect.

Chesapeakean of Virginia; Caloosahatchie beds of Florida; Recent off coast of North America from North Carolina to Yucatan.

589. **M. limatula** Conrad. Miocenic–Recent.

Small, with low spire and apertural part of last whorl reaching up and bending over on the spire; four plications near the base of columella; outer lip denticulate within; aperture widening regularly forward.

Miocenic of the Carolinas and Virginia; Pliocenic of South Carolina and Florida; Recent off Carolina coast.

590. **M. denticulata** Conrad. (Fig. 1153, *b*.) Miocenic–Recent.

Small; spire high for the genus, of about 5 regularly enlarging whorls, nearly flat, with suture slightly depressed; body whorl narrowing towards front; aperture narrow and ovoid, widest in the middle, with four strong plicæ on columella and denticulations on the outer lip; no anterior notch.

Chesapeakean of Maryland and Virginia; Caloosahatchie beds

FIG. 1153. *a*, *Marginella minuta*; *b*, *M. denticulata*. (Md. Survey.)

(Pliocenic) of Florida; Recent from Cape Hatteras to Florida and Barbadoes.

Family MITRIDÆ.

CLXXXIII. MITRA Lamarck.

Differs from *Marginella* in having its spire drawn out, so as to be longer than aperture, which is slightly notched anteriorly. Tertiary–Recent.

591. **M. holmesii** Dall. (Fig. 1154.) Pliocenic.

Spire about twice the length of aperture; sutures moderately depressed; whorls somewhat flattened and marked by strong, nar-

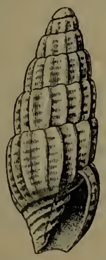


FIG. 1154. *Mitra holmesii*, × 8. (After Dall.)

FIG. 1155. *Conomitra staminea*, × 1.8. (After Dall.)

row ribs about twice their width apart. Columella with three plications, the posterior straight; spirals rounded, equal.

Caloosahatchie beds of Florida.

592. **M. (Conomitra) staminea** Conrad. (Fig. 1155.)

Oligocenic–Recent.

Spire and aperture about equal; whorls rounded; suture moderately depressed; ribs faint; columella with four plications.

Vicksburgian of Mississippi; Miocenic of Florida.

Family Volutidæ Gray.

CLXXXIV. Volutilithes Swainson.

Fusiform or *Fulgur*-shaped shells with more or less conical spire; protoconch of several increasing whorls, acute; whorls costate; aperture elongate and with broad but short canal; columella plicate, more strongly near anterior end. Cretacic–Recent. (A number of subgenera, better perhaps regarded as genera, are included here.)

593. **V. petrosus** (Conrad). (Fig. 1156.) Eocenic.

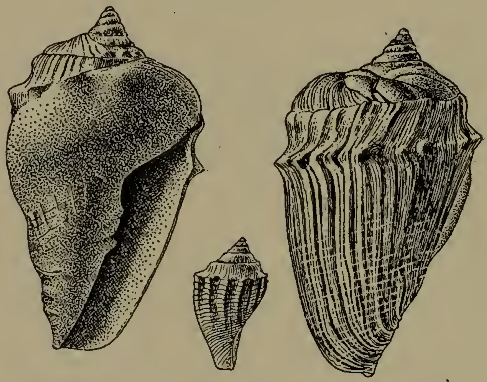


Fig. 1156. *Volutilithes petrosus*, opposite views, and young. (Md. Survey.)

Fig. 1157. *Volutilithes sayana*. (After Conrad.)

Young shell Fulguroid, whorls embracing to angle which is spinose, the spines continued downward as ribs; shoulder changing from round to concave; in adult the whorls are more irregular; last one with strong spines on the angle; callus of inner lip large, covering part of whorl and shoulder; presence of earlier calluses indicated on shoulder of preceding whorls; columella with three plications.

Pamunkey of Maryland, etc.; Chickasawan and Claibornian of Alabama, Texas, etc.

594. **V. sayanus** (Conrad). (Fig. 1157.) Eocenic.

Shoulder angle rather blunt, ribs extending over it, but dying out on shoulder and short distance below the angle on body whorl; surface with spirals which cancellate the ribs; columella with four plications, one of which is obsolete.

Claibornian of Alabama.

595. **V. rugatus** (Conrad). (Fig. 1158, *a*.) Eocenic.

Whorls round, with rounded, strong and rather distant ribs crossed by compound spirals; callus of inner lip reaching only part way over the whorl; columella with three folds, the middle one obsolete.

Midwayan of Texas and Alabama.

596. **V. limopsis** (Conrad). (Fig. 1158, *b*.) Eocenic.

FIG. 1158. *a*, *Volutilithes rugatus*, left; *b*, *V. limopsis*, right. (After Harris.)

FIG. 1159. *Volutomorpha conradi.* (After Whitfield.)

Like the preceding, but with more numerous, narrower and sharper ribs cancellated and spinulated by strong, sharp spirals, especially marked on the ribs.

Midwayan and Claibornian of Texas and Alabama.

597. **V. (Volutomorpha) conradi** Gabb. (Figs. 1159–1161.) Cretacic.

Rather large; spire moderate, of rounded whorls with impressed sutures, sometimes a slight subsutural flattening; body whorl four fifths of length, varying in convexity, but contracted to the short

FIG. 1160. *Volutomorpha conradi*, internal mold. (After Whitfield.)

FIG. 1161. *Volutomorpha conradi*, internal mold (After Whitfield.)

anterior canal; ribs narrow, far apart, cancellated by strong spirals; internal molds commonly smooth.

Ripleyan of New Jersey.

598. **V. (Rostellites) biconicus** Whitfield. (Fig. 1162.) Cretacic.

Spire elongated, forming about half the total length, somewhat strongly flattened at the suture which in the internal molds is deep.

Ripleyan of New Jersey, etc.

599. **V. (Rostellites) texturatus** Whitfield. Cretacic.

With short spire and very long, slender body whorl forming about six sevenths of entire length; aperture long and narrow;

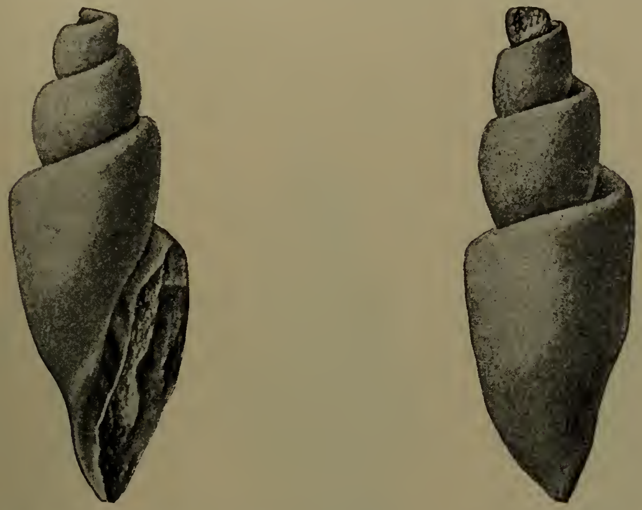


FIG. 1162. *Rostellites biconicus*, internal mold. (After Whitfield.)

surface marked by strong spirals and weaker lip-like ridges, which sometimes node the spirals.

Ripleyan of New Jersey, Alabama and Mississippi.

600. **V. (Rostellites) dalli** Stanton. (Fig. 1163, *a, b.*) Cretacic.

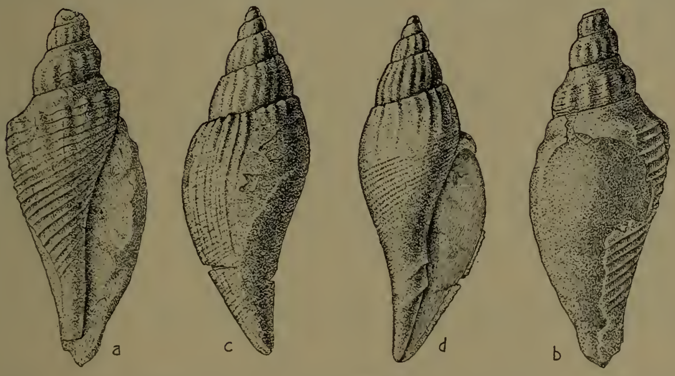


FIG. 1163. *a, b, Rostellites dalli; c, d, R. ambigulus.* All × ⅔. (After Stanton.)

Spire moderate; shoulder concave; angle with nodes which continue downwards as ribs for a short distance; early whorls rounded and ribbed. Spirals numerous and compound; canal nearly straight.

Colorado formation (Pugnellus sandstone) of Colorado, also in New Mexico(?).

601. **V. (Rostellites) ambigulus** Stanton. (Fig. 1163, *c, d.*) Cretacic.

Whorls round but not bulging; sutures moderately depressed; earlier whorls with regular, somewhat oblique ribs rather close together; body whorl with ribs only near suture; canal slightly curved; two strong oblique plications on the columella, with faint indications of others.

Colorado formation (Pugnellus sandstone, abundant) of Colorado; Benton of Kansas, also New Mexico(?).

CLXXXV. Voluta Linn.

Fusiform or Fulguroid shells with moderate spire of angulated (except the earliest) whorls, ribbed and generally tubercled on the angle; adult whorls smooth in certain subgenera; aperture narrow, canaliculate behind; inner lip often with a thin callus; columella with numerous plaits of varying strength. Tertiary–Recent.

602. **V. musica** Linn. Pliocenic–Recent.

Protoconch many-whorled, round, increasing regularly; later whorls with spirals; early conch whorls round with round ribs, later ones ribbed and subsequently noded; last whorl with strong nodes bounding concave shoulder; columellar plications numerous; surface marking chiefly in lines and spots resembling musical notes.

Pliocenic of Costa Rica; Recent in West Indies.

CLXXXVI. Caricella Conrad.

Like *Aurinia,* but with four strong columellar plaits. Eocenic.

603. **C. pyruloides** Conrad. (Fig. 1164.) Eocenic.

Pyriform, smooth, spire low, shoulder flat; body whorl rounded, tapering regularly to anterior end; columellar plaits four, distant and oblique.

Claibornian of Alabama; Aquia of Maryland(?).

CLXXXVII. Aurinia Adams.

Like *Voluta* but generally with rounded adult whorls, which are free from ribs or spirals; outer lip regularly curved. Tertiary–Recent.

604. **A. mutabilis** (Conrad). (Fig. 1165.) Miocenic.

Long and rather slender; last two or more whorls smooth, but with concave shoulder; angle rounded; aperture long; canal somewhat curved; plicæ, two strong and a fainter one between.

Chesapeakean of Maryland, etc.

605. **A. typus** (Conrad). (Fig. 1166.) Miocenic.

FIG. 1164. *Caricella pyruloides*, × 2/3. (After Conrad.)

FIG. 1165. *Aurinia mutabilis*, × 2/3. (Md. Survey.)

FIG. 1166. *Aurinia typus*, × 2/3. (Md. Survey.)

Shorter and more robust than preceding; aperture broadening towards the front. Two columellar plications present.

Chesapeakean of Maryland, Virginia, etc.

Family OLIVIDÆ d'Orb.

CLXXXVIII. OLIVA Brug.

Shell of subcylindrical outline, smooth and shining, with short spire and long body whorl; sutures sharply depressed; aperture narrow; columella with oblique folds. Cretacic–Recent.

606. **O. litterata** Lamarck. (Fig. 1167.) Miocenic–Recent.

Slightly inflated above the middle; suture canaliculate; columella plaited throughout.

Miocenic of New Jersey, Maryland, North Carolina, west of Florida to San Domingo, Jamaica; Pliocenic of the Carolinas and

Caloosahatchie beds of Florida; Pleistocenic of South Carolina and Florida; Recent off North Carolina and West Indies.

607. **O. (Olivella) alabamensis** Conrad. (Fig. 1168.) Eocenic.

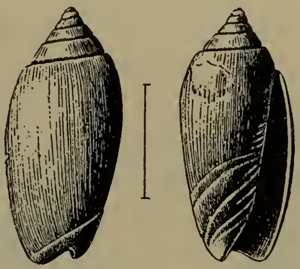


FIG. 1167. *Oliva litterata.* (Md. Survey.)

FIG. 1168. *Olivella alabamensis.* (After Conrad.)

Spire acute, elevated, whorls scarcely round and suture faintly impressed, a notched spiral above the suture; aperture rather broad; a notched band near base of body whorl.

Claibornian of Alabama, abundant and variable, especially in length of spire.

608. **O. (Olivella [Dactylidia]) mutica** Say. Miocenic–Recent.

Small, tapering towards both ends; spire proportionally high; aperture about half the length of the shell, narrow; columella smooth.

Miocenic of San Domingo, to North Carolina; Pliocenic of

FIG. 1169. *Olivula staminea*, × ⅔. (After Conrad.)

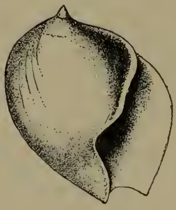


FIG. 1170. *Ancillopsis subglobosa*, × ⅔. (After Conrad.)

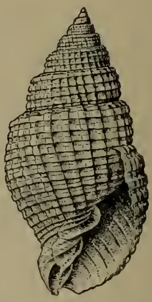


FIG. 1171. *Cancellaria conradiana*, nat. size. (After Dall.)

Florida; Pleistocenic of Florida to South Carolina; Recent, West Indies to Carolina coast.

CLXXXIX. Olivula Conrad.

Vertically striate, *Oliva*-like shells with somewhat channeled suture.

609. **O. staminea** Conrad. (Fig. 1169.) Eocenic.

An impressed line just below the suture constricts off a subsutural band; aperture rather broad posteriorly; columella anteriorly with striated callus; surface with strong vertical, and faint revolving lines.

Claibornian of Alabama and Texas.

CXC. Ancillopsis Conrad.

Subglobular; with short spire and large body whorl; inner lip with strong callus. Differs from *Ancilla* chiefly in its subglobose form. Eocenic.

610. **A. subglobosa** Conrad. (Fig. 1170.) Eocenic.

Subglobose to suboval; apex sharply pointed; suture obsolete; columella with profound callus projecting in the middle.

Claibornian of Alabama.

Family Cancellariidæ Adams.

CXCI. Cancellaria Lamarck.

Moderately spired shells, with generally round whorls; inflated body whorl; broad aperture with short canal or notch; columella

Fig. 1172. *a*, *Cancellaria graciloides*, $\times \frac{4}{3}$; *b*, *C. alternata*, $\times \frac{3}{2}$; *c*, *C. alternata* var., $\times \frac{7}{5}$; *d*, *C. lunata*, $\times \frac{3}{2}$; *e*, *C.* (*Trigonostoma*) *biplicifera*, $\times \frac{2}{3}$. (Md. Survey.)

with several strong oblique plicæ; ribs commonly cancellated by the spirals. Cretacic–Recent.

611. **C. graciloides** Aldrich. (Fig. 1172, *a*.) Eocenic.

Whorls elongate-rounded; suture deeply depressed, with a slight subsutural flattening; spirals numerous, finely nodulated; no ribs; outer lip expanded and toothed; columella with three folds.

Aquia formation of Atlantic coast; Chickasawan of Gulf coast.

612. **C. conradiana** Dall. (Fig. 1171.) Oligocenic.

Whorls somewhat flattened on the side, and with a rather pronounced subsutural flattening; ribs strong, distant; spirals of almost equal strength, numerous; columella with three sharp plaits.

Chipolan beds of eastern United States.

613. **C. alternata** Conrad. (Fig. 1172, *b, c.*) Miocenic.

Round-whorled, subglobose; with strong round ribs, thicker in the middle, crossed by sharp spirals; aperture broad; outer lip lirate; columella with two strong folds.

Chesapeakean of Atlantic coast.

614. **C. lunata** Conrad. (Fig. 1172, *d.*) Miocenic.

Higher spired than preceding though low coiling; ribs farther apart; aperture drawn out into a somewhat longer canal.

Chesapeakean of Atlantic coast.

615. **C. (Trigonostoma) biplicifera** Conrad. (Fig. 1172, *e.*) Miocenic.

Larger, with a well developed subsutural shelf, rather strongly channeled; coarse irregular ribs on the body whorl; the aperture with both anterior and posterior canaliculation; the outer lip lirate; the columella with strong callus and two plications.

Chesapeakean of Maryland.

Family Terebridæ Adams.

CXCII. Terebra Lamarck.

Shell usually high-spired, slender and acuminate, whorls regularly enlarging, body whorl not inflated; aperture with short, curved canal, generally sharp or slightly canaliculate posteriorly. Surface of whorls smooth or ribbed; a depressed spiral occurs a short distance below the suture constricting off a subsutural band; this is weak or wanting in the subgenus *Acus,* Humphrey. Tertiary–Recent.

616. **T. unilineata** Conrad. (Fig. 1173, *a, b.*) Miocenic.

Constricting spiral prominent, the space between it and the suture above, being marked by short, oblique, rib-like undulations generally wanting in the older whorls. Surface otherwise smooth, except for oblique lines of growth.

Chesapeakean of Maryland; corresponding beds of North Carolina.

617. **T. (Acus) curvilineata** Dall. (Fig. 1173, *c–f*.) Miocenic.

Shorter and less tapering spire than preceding, whorls with

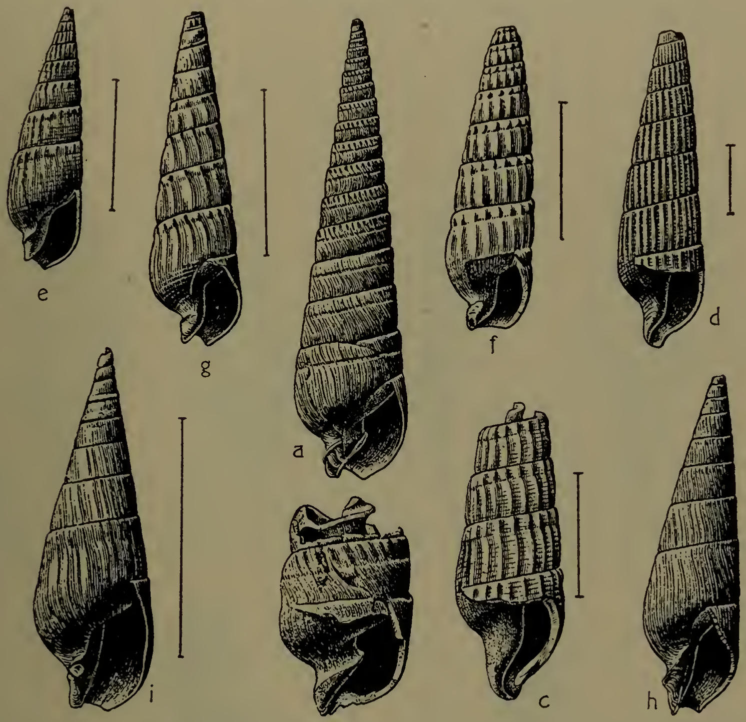


FIG. 1173. *a*, *b*, *Terebra unilineata* ; *c–f*, *T.* (*Acus*) *curvilineata*, showing variations; *g*, *T. curvilirata* ; *h*, *T.* (*Hastula*) *simplex* ; *i*, var. *sublirata*. (All from Md. Survey.)

vertical ribs, the subsutural depressed spiral faint or obsolete. In variety *whitfieldi*, Martin (Fig. 1173, *c, d*) the ribs are strong but narrow and vertical, while fine sharp spirals mark the spaces between the ribs. Aperture narrow. In variety *dalli* Martin (Fig. 1173, *e*) the ribs are obsolete except just below the suture; while in the variety *calvertensis* Martin (Fig. 1173, *f*), the subsutural, depressed spiral is rather strong, the ribs being nodulated upon the band thus produced.

Chesapeakean of Atlantic coast from New Jersey south.

618. **T. curvilirata** Conrad. (Fig. 1173, *g*.) Miocenic.

With ribs curving backwards and slightly nodose on subsutural band.

Chesapeakean of Atlantic coast.

619. **T. (Hastula) simplex** Conrad. (Fig. 1173, *h, i*.) Miocenic.

With broader apical angle (broadest in var. *sublirata* Conrad, Fig. 1173, *i*). Surface smooth except for curving lines of growth.

Chesapeakean of Atlantic coast.

Family Pleurotomidæ Stoliczka.

CXCIII. Pleurotoma Lamarck.

Fusiform shells with rather high spire, and more or less constricted anterior canal of equal length with the spire; whorls variously ornamented with ribs and spirals, rarely smooth; outer lip with a notch or more or less deep slit, generally on the shoulder angle; columella smooth; operculum horny, with apical nucleus. Cretacic–Recent.

(This group contains a large number of distinct genetic series, which include many distinct genera.)

620. **P. (Surcula) persa** Whitfield. (Fig. 1174.) Eocenic.

Volutions rounded below but with concave shoulder, embracing to lower side of rounded angle which is prominent above the

Fig. 1174. *Surcula persa.* (After Harris.)

Fig. 1175. *Surcula ostrarupis.* (After Harris.)

suture; notch broad on the shoulder; surface marked only by spirals and lines of growth.

Midwayan of Alabama.

621. **P. (Surcula) ostrarupis** Harris. (Fig. 1175.) Eocenic.

Broader than preceding, with shorter, more curved canal, more concave shoulders and short, sharp riblets on the shoulder angle and just below it.

Midwayan of Alabama and Texas.

622. **P. (Hemipleurotoma) childrani** Lea. (Fig. 1176.) Eocenic.

Aperture one third of the length of the shell; shoulder concave with moderate sinus in lip; angle pronounced, strongly tubercled; suture channeled; surface with strong spirals, generally granulated.

Aquia formation of Atlantic coast; Chickasawan of Gulf coast.

623. **P. moorii** Gabb. (Fig. 1177.) Eocenic.

Slender, with long, contracted canal, shoulders moderately concave, with notch; shoulder angle carinate, a second weaker carina

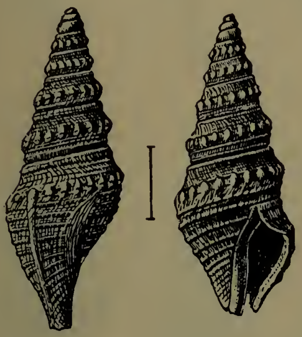


FIG. 1176. *Pleurotoma* (*Hemipleurotoma*) *childrani*, much enlarged. (Md. Survey.)

FIG. 1177. *Pleurotoma moorii.* (After Harris.)

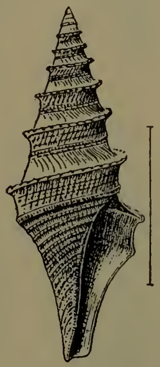


FIG. 1178. *Pleurotoma terebralis.* (After Harris.)

on body of whorl, just above the suture, the space between the two being concave; surface with spirals and lines of growth only.

Chickasawan (Lignitic) of Alabama and Texas.

624. **P. terebralis** Lamarck. (Fig. 1178.) Eocenic.

Like the preceding but broader, the upper angle more strongly carinate and faintly tubercled; the lower carina and the stronger spirals also granulate.

Midwayan of Gulf States, also European.

625. **P. (Hemipleurotoma) albida** Perry. (Fig. 1179, *a.*) Oligocenic–Miocenic.

Canal less than half the length of the shell; shoulder with a marked median angulation; body with a strong carina at the suture and a fainter one between this and the main angulation which bears the notch; additional spirals on body whorl.

Chipolan beds of the Gulf States; Chesapeakean of Maryland.

626. **P. (Hemipleurotoma) communis** Conrad. (Fig. 1179, *b, c.*) Miocenic.

Whorls divided midway by a strong, slender carina which bears

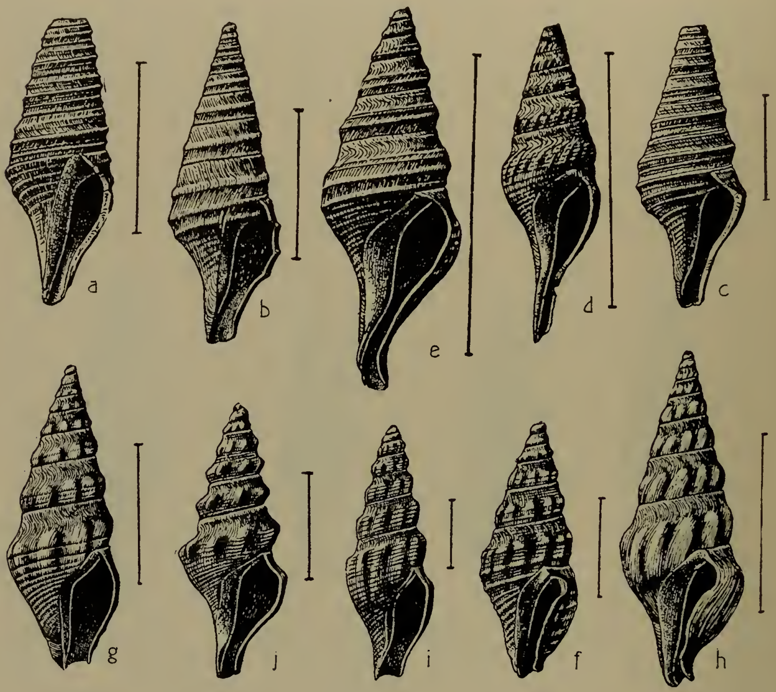


FIG. 1179. *a, Pleurotoma (Hemipleurotoma) albida; b, c, P. (H.) communis; d, P. (Surcula) marylandica; e, P. (S.) biscatenaria; f, Drillia incilifera; g, D. incilifera-distans; h, D. limatula; i, Mangilia parva; j, Surcula engonata.*

the notch; surface on either side flat or concave; a second stronger spiral just at or above the suture, and a third below this on the body whorl; canal less than half the length of the shell. In variety *protocommunis* Martin (Fig. 1179, *c*), additional intercalated spirals occur.

Chesapeakean of Atlantic coast.

627. **P. (Surcula) marylandica** Conrad. (Fig. 1179, *d.*) Miocenic.

Slender, with attenuated canal; deep reëntrant shown by growth lines on shoulder which is concave but not limited by an angulation, the whorls being regularly rounded below; growth lines lamellose at intervals, giving a rib-like appearance; spirals numerous but faint; whorls appressed below the suture, forming a subsutural band.

Chesapeakean of Atlantic coast.

628. **P. (Surcula) biscatenaria** Conrad. (Fig. 1179, *e*.) Miocenic.

Larger and more robust than preceding, with three strong spirals at the ambitus of the whorls, the upper one double, the lower one commonly divided at the suture; interspiral spaces concave; canal curved at the base.

Chesapeakean of Atlantic coast.

629. **P. (Surcula) engonata** Conrad. (Fig. 1179, *j*.) Miocenic.

Fusiform, with strong nodules on the shoulder angle and concave shoulder; nodes not continued as ribs.

Chesapeakean (St. Mary's) of Maryland.

CXCIV. Drillia Gray.

Like *Pleurotoma* in general form but with a short canal; apertural notch gentle. Tertiary–Recent.

630. **D. ostrearum** Stearns. Oligocenic–Recent.

Fusiform, high-spired, with narrow, concave shoulder bounded by a subsutural spiral; ribs numerous, close-set, cancellated by spirals. Length, 16 mm.

Chipolan beds of Florida; Caloosahatchie (Pliocenic) of Florida; Recent from North Carolina to Yucatan.

631. **D. abundans** Conrad. Oligocenic–Recent.

Canal about half as long as the spire; nearly straight; whorls depressed convex, with a subsutural concavity, and a crenulated spiral; ribs acute, nearly straight.

Vicksburgian of Mississippi; Caloosahatchie (Pliocenic) of Florida.

632. **D. incilifera** (Conrad). (Fig. 1179, *f*, *g*.) Miocenic.

Shoulder concave, with three strong spirals, the lower covered except in body whorl, the upper two noded by incomplete ribs. In the variety *angulata* Martin the angle is marked by coarse, round regular nodes which appear just above the suture, and the apical angle is broader. In var. *distans* Conrad, the apical angle is higher, the spire is higher and the nodes elongated downwards. The shell is also less abruptly contracted at the base.

Chesapeakean of Atlantic coast.

633. **D. ebenina** Dall. (Fig. 1180.) Miocenic–Recent.

Whorls round, a sharp, revolving keel flanked by concave surfaces at the suture. Ribs narrow, widely separated, gently convex forward; spirals fine; aperture elongate; canal very short.

Miocenic of San Domingo; Caloosahatchie (Pliocenic) of Florida; Recent in Gulf of Mexico.

634. **D. limatula** (Conrad). (Fig. 1179, *h.*) Miocenic.

With concave shoulder and strong, nodulose ribs which begin at the angulation and extend below the suture; no spirals; var. *dissimilis* Conrad has the ribs obsolete on the later whorls, sometimes

FIG. 1180. *Drillia ebenina*, × 2.4. (After Dall.)

FIG. 1181. *Mangilia infans.* (After Harris.)

wholly wanting; in var. *pyramidalis* Martin the ribs are strong but the apical angle is much greater than in the typical form.

Chesapeakean of Atlantic coast.

CXCV. MANGILIA Risso.

Small, differs from *Pleurotoma* in having the notch at the suture, and in its short truncate canal; inner margin varicose. Eocenic–Recent.

635. **M. infans** Meyer. (Fig. 1181.) Eocenic.

Aperture and canal about one third of the length; shoulder concave, with a spiral just below the suture, and several just below the median (main) carination; of these only one is visible on the earlier whorls, being covered by the later ones.

Chickasawan and Claibornian of Gulf coast.

636. **M. parva** (Conrad). (Fig. 1179, *i.*) Miocenic.

Concave portion of shoulder very narrow, and near the suture;

ribs extending beyond the lower suture; spirals fine, numerous.
Chesapeakean of Maryland, etc.

Family Conidæ Adams.

CXCVI. Conus Linn.

Whorls with a narrow shoulder and straight sides, the angle between the two being more or less pronounced; the whorls embrace to the shoulder angle thus making a continuously sloping spire, which is generally steepest in the young, and may be at right angles to the axis; forward, the tapering of the shell is a regular one, producing the conical form; aperture long, narrow, with anterior and posterior canaliculation; outer lip sharp. Cretacic–Recent.

637. **C. planiceps.** (Fig. 1182.) Oligocenic.

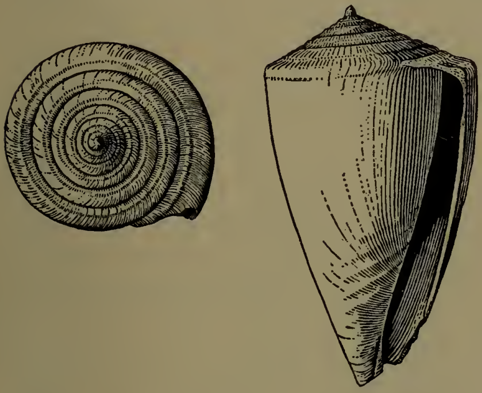


Fig. 1182. *Conus planiceps*, summit and apertural views, young shell, × 2.3. (After Dall.)

Fig. 1183. *Conus diluvianus*, × ⅔. (After Dall.)

Spire low, conical, with papillose apex; shoulder surfaces gently concave with a strong revolving spiral near the suture.

Vicksburgian of Florida; Chipolan beds of Gulf States.

638. **C. diluvianus** Green. (Fig. 1183.) Miocenic.

Spire steep, slightly terraced in the young from failure of the whorls to embrace freely to the angle; surface faintly grooved just below the suture, and concave above the angle; base of columella slightly twisted inwards.

Chesapeakean of Atlantic coast.

OPISTHOBRANCHIA.

Family Actæonidæ d'Orbigny.

CXCVII. Tornatellæa Conrad.

Shells with short, thick spire of rounded whorls, embracing half way or more; aperture with both anterior and posterior notch. Columella with two plications near the front and outer lip thick and crenulated near the margin. Surface strongly spiraled. Jurassic–Miocenic.

639. **T. lata** Conrad. Eocenic.

Aperture more than half the length of the entire shell; columellar plications distant; spirals rounded and close together.

Eocenic of Shark River, New Jersey, and of Alabama.

640. **T. bella** Conrad. (Fig. 1185, *a*.) Eocenic.

Less ventricose than preceding; sutures less pronounced; interspiral depressions punctate.

Eocenic (Pamunkey) of Maryland and Virginia; Midwayan and Chickasawan of Gulf region.

CXCVIII. Actæon Montford.

Shell with sinistral protoconch differing from *Tornatellæa* chiefly in the deeper sutures and consequently more pronounced whorls of the spire and in having only one plication on the columella. Cretacic–Recent.

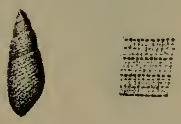


Fig. 1184. *Actæon attenuatus*, view of the type and surface enlarged. (After Meek.)

641. **A. attenuatus** (M. and H.). (Fig. 1184.) Cretacic.

Small, whorls elongate, slightly convex; suture scarcely depressed but distinct; surface with spirals and faint growth lines.

Pierre of Yellowstone River and Canada.

642. **A. shilohensis** Whitfield. (Fig. 1185, *b*.) Miocenic.

Spire appearing almost steplike from impressed sutures, rather short; body whorl ventricose with narrow, long aperture; spirals alternating, obsolete above the middle of whorl; plication pronounced.

Shiloh marls of New Jersey; Chesapeakean of Maryland.

643. **A. ovoides** Conrad. (Fig. 1185, *c*.) Miocenic.
Differs from *A. shilohensis* in its straighter sides, proportion-

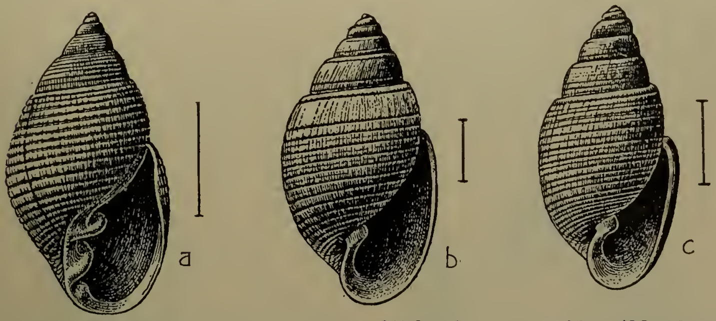


FIG. 1185. *a*, *Tornatellæa bella*; *b*, *Actæon shilohensis*; *c*, *A. ovoides*. (Md. Survey.)

ately higher whorl, and stronger subsutural shelf; spirals alternating over entire shell.

Chesapeakean of Atlantic coast.

CXCIX. ACTÆONINA d'Orbigny.

Shell elongately spired, with large body whorl, becoming narrower towards the base; columella without folds; outer lip sharp. Carbonic–Recent.

644. **A. californica** Gabb. (Fig. 1186.) Comanchic.

Shell large; body whorl about three fourths of entire length of the shell. Surface smooth; inner lip with basal callus.

Horsetown beds of California.

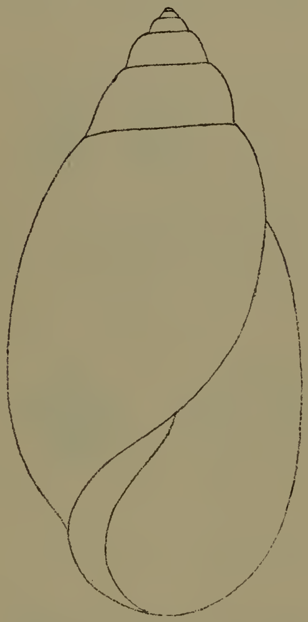


FIG. 1186. *Actæonina californica*, nat. size. (After Gabb.)

Family RINGICULIDÆ.

CC. CINULIA Gray.

Globose shells with short spire and inflated body whorl; outer lip reflected, thickened; columella with numerous folds; surface spirally grooved or punctate. Comanchic–Cretacic.

645. **C. mathewsoni** Gabb. (Fig. 1187.) Comanchic.

Shell of four and a half whorls, the body whorl expanded;

outer lip thick and extended; surface with uniform fine spirals, slightly crenulated; columellar lip thick with three narrow, equal and prominent folds.

Horsetown of California, etc.

646. **C. (Ringinella) polita** Gabb. (Fig. 1188.) Comanchic.

Spires higher, whorls rounder, and sutures more impressed than

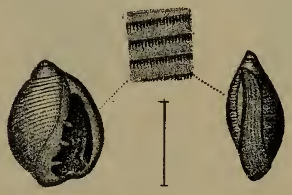


FIG. 1187. *Cinulia matthewsoni*, with enlargement of surface. (After Gabb.)

FIG. 1188. *Cinulia* (*Ringinella*) *polita*, enlarged. (After Gabb.)

in preceding; outer lip scarcely thickened, not extended; columella without callus and with two unequal columellar teeth. Surface with spirals.

Horsetown of California, etc.

647. **C. obliqua** Gabb. (Fig. 1189.) Cretacic.

More globular than *C. mathewsoni;* spire shorter, almost covered; body whorl large; outer and inner lips strongly thickened, the latter

FIG. 1189. *Cinulia obliqua*. (After Gabb.)

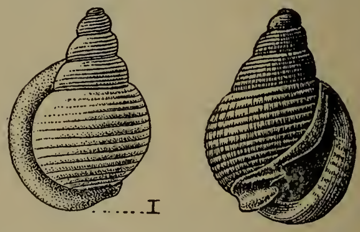


FIG. 1190. *Ringicula dalli*, much enlarged. (Md. Survey.)

with one large columellar fold and slight intumescence; surface with spirals; interspiral space with crossbars.

Upper Cretacic beds of Pacific coast and Canada.

CCI. RINGICULA Deshayes.

Thick-shelled, with mamillose protoconch, short spire, large body whorl and outer lip with reflected and greatly thickened margin; columella with callus and two to four plicæ. Cretacic-Recent.

648. **R. dalli** Clark. (Fig. 1190.) Eocenic.

Minute, five-whorled; suture moderately impressed; surface with regular close-set spirals; outer lip thick, ornamented within; columella with thick callus and two plicæ.

Pamunkey formation of Maryland and Virginia.

Family Akeratidæ Pilsbry.

CCII. Haminea Leach.

Thin and brittle shells with concealed spire, oval in contour; surface mostly with spirals. Cretacic–Recent.

649. **H. subcylindrica** M. and H. (Fig. 1191.) Cretacic.

Subcylindrical, large for the genus (about one inch long); very

Fig. 1191. *Haminea subcylindrica.* (After Meek.)

Fig. 1192. *Haminea occidentalis*, two internal molds. (After Meek.)

thin; summit with slight pit over apex; lip extended below.

Pierre of upper Missouri and Black Hills.

650. **H. occidentalis** (M. and H.). (Fig. 1192.) Cretacic.

Smaller and less cylindrical than preceding; widest below middle; upper end obliquely truncated, with minute, central pit.

Pierre of Yellowstone, near Platte River, and in the Saskatchewan region of Canada.

Family Bullidæ Pilsbry.

CCIII. Bulla Klein.

Smooth, involute shells with sunken spire and inflated body whorl; aperture rounded at both ends; outer lip sharp. Jurassic (?)–Recent.

651. **B. macrostoma** Gabb. Cretacic.

Subglobular, with two or three volutions; aperture very broad, broadly rounded in front, narrowly so posteriorly; surface smooth except for lines of growth.

Ripleyan of New Jersey, Alabama and Mississippi.

Family TORNATINIDÆ Fischer.

CCIV. VOLVULA Adams.

Cylindrical with concealed spire; long, narrow aperture, pointed above, rounded below. Eocenic–Recent.

652. **V. iota** (Conrad). (Fig. 1193, *a, b*.) Miocenic.

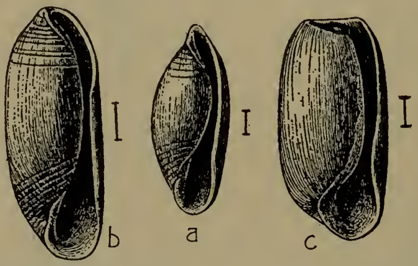


FIG. 1193. *a, Volvula iota marylandica; b, V. iota diminuta; c, Cylichna calvertensis.* (Md. Survey.)

Minute; a few impressed spirals near each end, aperture narrowest at center; in var. *marylandica* Martin, apertural end is strongly pointed above, shell narrowing towards each end; variety *diminuta* Martin is more cylindrical, the upper end less pointed, base of aperture broad; var. *calverta* Martin has a proportionally greater diameter than *diminuta,* and variety *patuxentia* Martin is wider below than above.

Chesapeakean of Atlantic coast.

Family SCAPHANDRIDÆ.

CCV. CYLICHNA Lovén.

Like the preceding, but spire deeply sunken leaving apical perforation; columella with plications, often umbilicated. Triassic–Recent.

653. **C. costata** Gabb. Cretacic.

Rather large, with aperture widening towards base; whorls more nearly cylindrical than in the next species; a single fold near the base of the columellar lip; surface with broad spirals.

Nanaimo of Vancouver and northwestern United States.

654. **C. scitula** M. and H. (Fig. 1194.) Cretacic.

Oval, widest in the middle, summit truncated with large depression; aperture narrow; a small, indistinct fold near the base of the inner lip; surface with spirals cancellated by growth lines.

Upper Cretacic of Nebraska, South Dakota and Colorado.

655. **C. galba** Conrad. Eocenic.

Cylindrical except for slight contraction near the middle; pro-

FIG. 1194. *Cylichna scitula*, × 3. (After Meek.)

portionally larger and more slender than the other species; inner lip reflected at base; obsolete spirals near anterior (basal) end.

Claibornian of Alabama.

656. **C. calvertensis** Martin. (Fig. 1193, *c*.) Miocenic.

Minute; apical end with sunken spire nearly flat.

Chesapeakean of Maryland, etc.

PULMONATA.

(Air-breathing Snails.)

Family SIPHONARIIDÆ Gray.

CCVI. HERCYNELLA Keyser.

Non-spiral, more or less cap- or bowl-shaped, unsymmetrical, somewhat patelliform shells; often truncated at one end and usually with an umbonal angulation. Siluric–Devonic.

657. **H. canadensis** Grabau. Siluric.

Beak curved towards truncated end, which is asymmetrical; angulation regularly curved.

Upper Monroe of Canada.

CCVII. ANISOMYON Meek and Hayden.

Shell patelliform with oval or circular (rarely ovoid) aperture, centren, or between center and anterior end; beak pointed, more or less strongly recurved, but not spiral, generally broken away.

Muscle scar horseshoe-shaped, open in front, in the form of a strong band on the left and a weak or broken line on the right (see Figs. 1195 and 1196, *c*). Surface smooth, sometimes with a

FIG. 1195. *Anisomyon alveolus*, top and side view. (After Meek.)

few coarse plications, more rarely finely striate. Jurassic–Cretacic.

658. **A. meeki** Gabb. Comanchic–Cretacic.

Elliptical, apex nearly centren, strongly pointed and curved, surface flat, with faint, concentric undulations.

Horsetown of California; Nanaimo of Vancouver.

659. **A. centrale** Meek. Cretacic.

Broader than the preceding, more nearly circular; slopes, except anterior one, nearly straight. Surface with fine radiating striæ and a few, coarse, radiating grooves.

Colorado formation of New Mexico and Colorado; also in western Canada.

660. **A. alveolus** (M. and H.). (Fig. 1195.) Cretacic.

FIG. 1196. *Anisomyon patelliformis; a, b,* side and front view of a specimen; *c,* top view of the type specimen. (After Meek.)

Elliptical, beak excentric; surface slopes very gently convex.

Pierre of Yellowstone, Black Hills and Canada.

661. **A. patelliformis** Meek and Hayden. (Figs. 1196–1197.) Cretacic.

Subovate, broadest posteriorly, high, with beak rather sharp, slopes irregularly convex.

Pierre of Nebraska, Yellowstone and Black Hills.

662. **A. subovatus** M. and H. (Fig. 1198.) Cretacic.
Somewhat more elongate than preceding; sides somewhat par-

FIG. 1197. *Anisomyon patelliformis* var. (After Meek.)

FIG. 1198. *Anisomyon subovatus.* (After Meek.)

allel; beak more anterior; apical angle larger, slopes gently convex. Pierre of Yellowstone River and of Black Hills.

663. **A. sexsulcatus** (M. and H.). (Fig. 1199.) Cretacic.

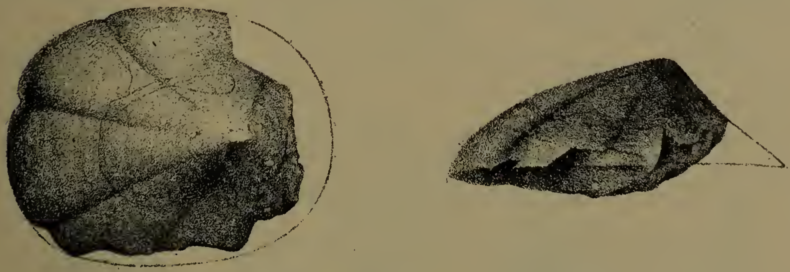


FIG. 1199. *Anisomyon sexsulcatus.* (After Meek.)

Large; beak in anterior third; surface with six radiating grooves. Pierre of Yellowstone River and of Colorado.

664. **A. borealis** (Morton). (Figs. 1200–1201.) Cretacic.
Very large; beak excentric, sometimes almost anterior; a regular rounded fold from beak to posterior end.

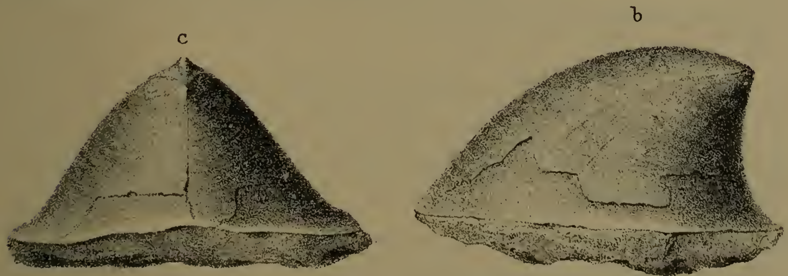


FIG. 1200. *b, c, Anisomyon borealis,* side and anterior view of Fig. 1201, *a.* (After Meek.)

Pierre of New Mexico, Colorado, Black Hills, etc.

665. **A. shumardi** M. & H. (Fig. 1202.) Cretacic.

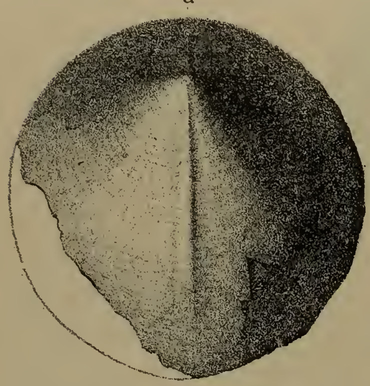


FIG. 1201. *a, Anisomyon borealis*, view from above. (After Meek.)

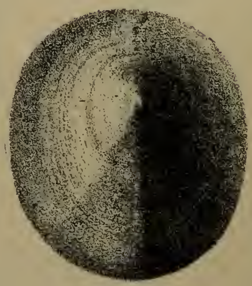


FIG. 1202. *Anisomyon shumardi.* (After Meek.)

Somewhat smaller and more elongate than preceding, with beak nearer the center.

Pierre of Missouri River.

Family AURICULIDÆ Blainville.

CCVIII. MELAMPUS Montfort.

Shell ovate-conical, with short, obtuse spire and entire, narrow, elongate aperture. Columellar lip with several plications; outer lip sharp, lirate within. Surface smooth. Jurassic (?)–Recent.

666. **M. olivaceus** Carpenter. Pliocenic–Recent.

Spire conical, barely elevated, of 4–5 flat whorls, slightly angulated below the shoulder. Columella and inner lip with one strong and several weaker plications; length, 12 mm.

Pliocenic–Recent in California.

CCIX. RHYTOPHORUS Meek.

Like *Melampus* but with shoulder bearing small, rib-like crenulations. Columella with two plications; outer lip smooth within. Cretacic.

667. **R. meeki** White. (Fig. 1203, *d.*) Cretacic.

Narrower and more slender than *R. priscus* with whorls rounded; aperture wider anteriorly.

Bear River formation of Wyoming.

668. **R. priscus** Meek. (Fig. 1203, *e*.) Cretacic.

Obovate, about once and a half as long as wide; shoulder somewhat pronounced and slightly angulated.

Bear River formation of Utah and Wyoming.

CCX. Alexia Leach.

Differs from *Melampus* in its higher spire of round whorls embracing to above the ambitus, the absence of a shoulder, and in ovoid aperture. Protoconch erect. Cretacic–Recent.

669. **A. antiqua** (Meek). (Fig. 1203, *a–c*.) Cretacic.

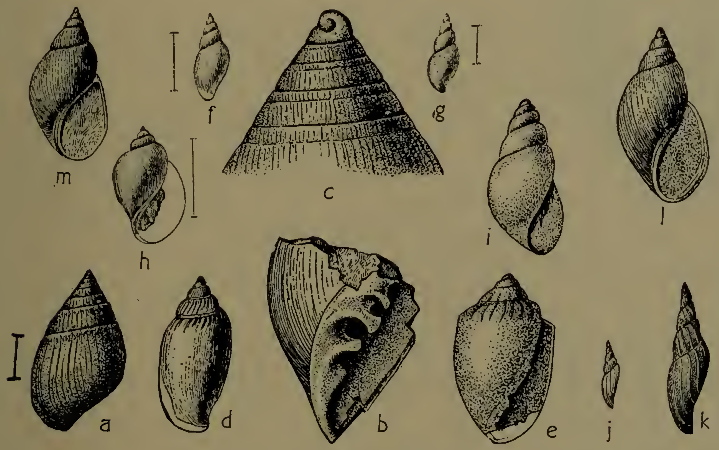


Fig. 1203. *a–c*, *Alexia antiqua*, with enlargement; *d*, *Rhytophorus meeki; e*, *R. priscus; f*, *g*, *Limnæa altivuncula; h*, *L. consortis; i*, *L. nitidula; j*, *k*, *L. tenuicostata; l*, *L. meeki; m*, *L. shumardi.* (After White, U. S. G. S.)

Smooth, with whorls gently convex and four columellar plications, the median one strong.

Colorado formation of Coalville, Utah.

Family Physidæ Dall.

CCXI. Physa Drap.

Shell thin, reversed (sinistral); aperture large; columella twisted or simple; surface smooth. Jurassic–Recent (fresh-water).

670. **P. carltoni** Meek. (Fig. 1205, *a*.) Cretacic.

Of moderate size, last whorl with pronounced shoulder.

Belly River beds of Utah.

671. **P. copei** White. (Fig. 1205, *b, c.*) Cretacic.
Large, elongate; spire small; body whorl relatively slender.
Upper Cretacic (Judith River beds) of Upper Missouri River region of Montana, and the Bow and Belly River regions of Canada.

672. **P. felix** White. Cretacic.
Large; body whorl strongly shouldered; sides straight and vertical; growth lamellæ often with serrate edges.
Laramie of Colorado.

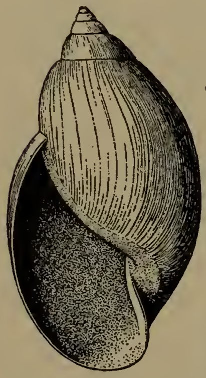


FIG. 1204. *Physa meigsii*, × 1.2. (After Dall.)

673. **P. bridgerensis** Meek. (Fig. 1205, *e.*) Eocenic.
Smaller than preceding, with higher spire and less rounded whorls.
Bridger beds of southern Wyoming.

674. **P. pleromatis** White. (Fig. 1205, *d.*) Eocenic.
Shorter and stouter than *P. copei,* with aperture wider and shorter.
Wahsatch group of southern Wyoming, Colorado and Utah.

675. **P. meigsii** Dall. (Fig. 1204.) Pliocenic.
Spire higher and of more volutions than in *P. copei;* lip much prolonged anteriorly.
Caloosahatchie marls of Florida.

Family LIMNÆIDÆ Brod.

CCXII. LIMNÆA Lamarck.

Shell very thin, translucent, with small acute spire and large body whorl; aperture wide, with sharp outer lip. Jurassic–Recent; (fresh-water).

676. **L. altivuncula** White. (Fig. 1203, *f, g.*) Jurassic.
Small, slender, embracing part way to middle only; aperture somewhat drawn out anteriorly.
Morrison formation near Canyon City, Colorado.

677. **L. consortis** White. (Fig. 1203, *h.*) Jurassic.
Somewhat larger than preceding; whorls ventricose; spire short; suture deep; nearly rectangular depression between the whorls.
With the preceding.

678. **L. (Lymnophysa) nitidula** (Meek). (Fig. 1203, *i.*) Cretacic.

Of medium size, high-spired; whorls rounded; sutures deep; spire as long as or longer than aperture, rather thick-set in aspect.

Bear River formation of Wyoming.

679. **L. (Pleurolymnæa) tenuicostata** M. and H. (Fig. 1203, *j, k.*) Eocenic.

Very slender, anterior end of lip extended, surface with sharp, narrow, flexuous costæ.

Fort Union beds of Upper Missouri country.

680. **L. meeki** Evans & Shumard. (Fig. 1203, *l.*) Oligocenic.

Of medium size; spire of about four rapidly tapering, rounded whorls; body whorl round, large, sutures moderately impressed.

White River group of Upper Missouri region.

681. **L. shumardi** Meek & Hayden. (Fig. 1203, *m.*) Oligocenic.

Body whorl somewhat shorter than in preceding; aperture proportionally somewhat broader.

White River group of Upper Missouri region.

CCXIII. Vorticifex Meek.

Heliciform or Planorbiform shells of ventricose aspect, open, but small umbilicus and somewhat angulated whorls, one of the angulations bounding the umbilicus; strong costæ of growth, especially in the young. Miocenic.

682. **V. binneyi** Meek. (Fig. 1205, *f, g.*) Miocenic.

Umbilicus large; spire flat; surface with regular variciform growth lines.

Miocenic of Kawsoh Mountains, Nevada.

683. **V. tryoni** Meek. (Fig. 1205, *h–j.*) Miocenic.

Smaller than preceding, surface ornamentation fainter; umbilicus small.

Occurs with the preceding.

CCXIV. Planorbis Guettard.

Coiled typically in a discoid manner, the entire spire below the body whorl, but not symmetrically involute; aperture oval, varying to crescent-shaped and with a sharp outer margin. Lias–Recent.

FIG. 1205. *a, Physa carltoni; b, c, P. copei; d, P. pleromatis; e, P. bridgerensis; f, g, Carinifex binneyi; h–j, C. tryoni.*

684. **P. veternus** M. and H. (Fig. 1206, *a–f.*) Jurassic.
Small; whorls numerous, regularly enlarging, coiled nearly in a single plane.

Non-marine Jurassic of Colorado, Dakota (Black Hills) and British Columbia.

685. **P. convolutus** M. and H. (Fig. 1206, *g–i.*) Cretacic.
Larger than preceding, with less symmetrical disposition of whorls.

Judith River beds of upper Missouri River region.

686. **P. (Bathyomphalus) amplexus** (M. and H.). (Fig. 1206, *j, k.*) Cretacic.

Numerous whorls, very gradually enlarging, deep umbilicus, with shell slightly angulated around it.

Judith River beds of Nebraska.

687. **P. (Bathyomphalus) planoconvexus** (M. and H.). (Fig. 1206, *l.*) Eocenic.

Spire flat, whorls depressed above, angulated externally and around the umbilicus; umbilicus very large.

Fort Union beds of upper Missouri River region.

688. **P. utahensis** Meek. (Fig. 1206, *m–o*.) Eocenic.

Large and much compressed vertically; aperture transverse; outer margin subangular; variety *spectabilis* (Fig. 1206, *p*) has the outer margin more rounded.

Bridger group of southern Wyoming.

689. **P. cirratus** White. (Fig. 1206, *q–s*.) Eocenic.

FIG. 1206. *a–f*, *Planorbis veternus*; small (*a–c*) and larger form; *g–i*, *P. convolutus*; *j*, *k*, *P.* (*Bathyomphalus*) *amplexus*; *l*, *P.* (*B.*) *planiconvexus*; *m–o*, *P. utahensis*, *P.* var. *spectabilis*; *q–s*, *P. cirratus*; *t–v*, *P. vetustus*; *w*, *x*, *P. leidyi*; *y*, *z*, *P. lunata*. (All after White, U. S. G. S., III.)

Small, of numerous, very slightly increasing whorls coiling nearly in a plane; upper and lower aspect much the same.

Green River of southern Wyoming.

690. **P. vetustus** Meek & Hayden. (Fig. 1206, *t–v*.) Oligocenic.

Smaller than *T. utahensis* and the outer side of last whorls more sharply angulated; spire less depressed.

White River beds of Dakota.

691. **P. leidyi** Meek and Hayden. (Fig. 1206, *w*, *x*.) Oligocenic.
Stout and thick with much embracing whorls, small umbilicus and flat spire.
White River group of Dakota.

692. **P. lunatus** Conrad. (Fig. 1206, *y*, *z*.) Miocenic?
Similar to *P. leidyi*, but more nearly symmetrical in plane of coiling.
Miocenic (?) of Oregon.

693. **P. conanti** Dall. (Fig. 1207, *a*, *b*.) Pliocenic.

FIG. 1207. *a*, *b* (left and upper middle), *Planorbis conanti*; *c*, *d* (right and lower middle), *Planorbis disstoni*, × 1.3. (After Dall.)

Spire sunken; whorls embracing to moderate extent, upper surface with angulation below the suture; height and width of aperture nearly the same.
Caloosahatchie marls of Florida, especially in Planorbis bed.

694. **P. disstoni** Dall. (Fig. 1207, *c*, *d*.) Pliocenic.
Angulation more distant from suture and more pronounced; shell proportionally higher, aperture higher than wide.
Caloosahatchie marls of Florida.

Family PUPADÆ Gray.

CCXV. PUPA Lamarck.

Cylindrical, generally narrowing towards both ends, with suture scarcely depressed and with semicircular aperture which is commonly constricted by teeth on columella and on the inner and outer lip. Carbonic–Recent.

695. **P. vermilionensis** Bradley. (Fig. 1208, *f*, *g*.) Carbonic.
Few rounded, gradually enlarging whorls, with deep sutures; aperture with one basal and one strong columellar tooth.
Coal measures of Indiana.

696. **P. arenula** White. (Fig. 1209, *a, b*.) Eocenic.

Small, short and thick, with much contracted aperture.

Green River beds of southern Wyoming.

CCXVI. Anthracopupa Whitfield.

Minute pupiform shells with few volutions, imperforate axis and nearly vertical aperture; peristome thickened, with inner lip forming a nearly transverse callus, bearing teeth; inner margin of lip also with teeth and a nearly circular notch. Carbonic.

697. **A. ohioensis** Whitfield. (Fig. 1208, *a–c*.) Carbonic.

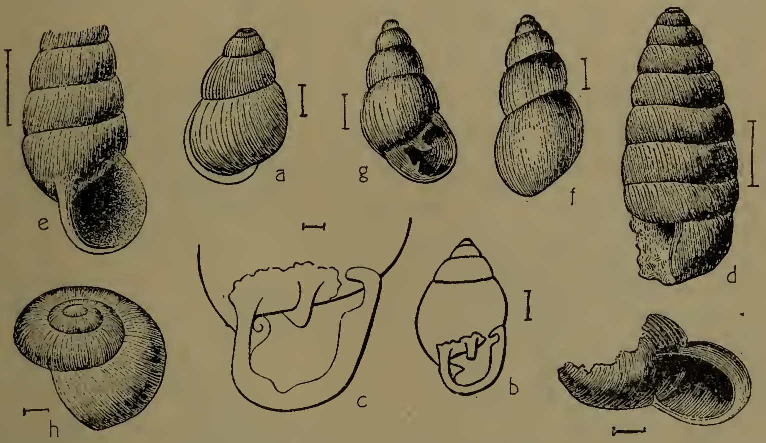


FIG. 1208. *a–c, Anthrocopupa ohioensis ; d, e, Dendropupa vetusta ; f, g, D. vermilionensis ; h, i, Archæozonites priscus*. (All after White; 3d Ann. U. S. G. S.)

Small, with 3 or 4 strongly embracing whorls, reflected thickened lip, bearing a tooth antero-laterally, and inner lip callous, also bearing a single tooth. Surface with fine growth lines; length about 3.3 mm.

Upper Coal measures of Ohio.

CCXVII. Dendropupa Dawson.

Like *Pupa*, but with aperture toothless. Carbonic (fresh-water).

698. **D. vetusta** Dawson. (Fig. 1208, *d, e*.) Carbonic.

Long, subcylindrical, of numerous, rather irregular whorls, slightly convex, with moderately impressed suture; aperture produced with reflexed lower lip.

Coal measures of Nova Scotia (Joggins beds).

Family Zonitidæ.

CCXVIII. Archæozonites Sandberger.

Thick-shelled, globose, Helix-like shells, with rather high spire, and deep umbilicus; outer lip sharp; surface smooth. Carbonic–Miocenic.

699. **A. priscus** Dawson. (Fig. 1208, *h, i.*) Carbonic.

Small; spire rather low and broad; whorls compound and rounded; surface with fine growth lines.

Coal measures of Nova Scotia (Joggins).

Family Helicidæ Keferstein.

CCXIX. Helix Linné.

Generally thin-shelled, of several whorls, more or less regularly increasing, flat- or low-spired (obtuse); aperture incomplete, with disconnected margin; umbilicus present or absent; lip simple or with terminal varix. Many subgenera are recognized. More than 3,400 species. Terrestrial. Eocenic–Recent.

700. **H. leidyi** Hall and Meek. (Fig. 1209, *c, d.*) Miocenic.

High-spired; apical angle approaching 90°. Many whorled; body whorl subglobose.

701. **H. diespiter** Dall. Pliocenic.

Many-whorled, low-spired; base horizontally flattened; umbilicus small, partly covered; oval aperture with pronounced expansion, where lip joins body whorl; a terminal deflection or varix.

Silex bed of Ballast Point, Florida.

702. **H. crusta** Dall. Pliocenic.

Smaller with umbilicus less covered, aperture smaller and less oval.

Associated with preceding.

703. **H. (Polygyra) albolabris** (Say). Pleistocenic–Holocenic.

Larger than preceding, non-umbilicate; spire low, finely striate; lip sharply reflected; strong umbilical covering.

Loess of southern Mississippi Valley; living in eastern North America.

704. **H. (Pyramidula) alternata** (Say). Pleistocenic–Holocenic.

Low-spired, deeply and broadly umbilicate, with 5 or more whorls, with sharp growth lamallæ above, smooth below, last one sometimes carinated; with broken color lines; oblique aperture with a sharp lip; suture slightly impressed.

Loess of Mississippi Valley; living in eastern North America to Labrador.

HETEROPODA.

CCXX. Pelagiella Matthew.

Small thin shells, coiled nearly or quite in a single plane of few whorls; compressed and with wide entire aperture; probably pelagic like modern *Atlanta* to which it seems most nearly related. Cambric.

705. **P. atlantoides** Matthew. (Fig. 1210.) Cambric.

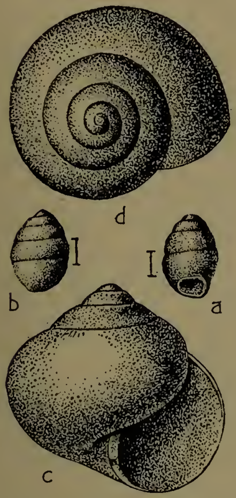


Fig. 1209. *a*, *b*, *Pupa arenula*; *c*, *d*, *Helix leidyi*. (After White, U. S. G. S., III.)

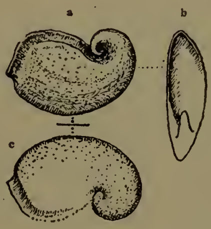


Fig. 1210. *Pelagiella atlantoides*. (After Matthew.)

Rapidly enlarging, one side less convex than other, making a slightly asymmetric coil; margin with somewhat constricted rim.

Protolenus bed at base of Middle Cambric, New Brunswick.

INDEX OF GENERA.

VOLUME I.

This includes likewise names of subgenera, families, orders, classes and phyla. All numbers refer to pages. Names of genera and subgenera regarded as synonyms are printed in *italics*.

INDEX OF SPECIES.

VOLUME I.

Varieties are printed as species. When a species name of adjective form is followed by two or more genera or subgenera of differing gender, there are placed after it the appropriate endings in the order—masculine, feminine and neuter. All numbers refer to pages. Name of genera, subgenera and species regarded as synonyms are, when possible, printed in *italics*.