SOME DEVONIAN BRACHIOPODS REPORTED FROM WESTERN CANADA

by

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ABSTRACT

The aim of this study was to compile a list of descriptions of genera and species of brachiopod fossils which have been reported by various authors from the Devonian rocks of Canada, West of the 110th meridian.

This thesis is divided into two parts. The first part is essentially bibliographical. The second part contains descriptions of genera and species of brachiopods.

The bibliography in Part I contains forty references from which brachiopod faunal lists were compiled. Part I also contains an index map showing the geographical location of outcrop areas from which the fossils were collected, and a chart showing the stratigraphic range of brachiopod genera in a typical Devonian section of the Southern Rocky Mountains.

In Part II, the brachiopod faunal lists have been arranged in a systematic manner. They are supplemented by detailed descriptions of fifty-one genera and ninety-eight species. The descriptions are prefaced by a short discussion of biological classification; a note on the modern concept of species; a glossary of brachiopod terminology, and a short list of important references on this group of fossils. All the descriptions are taken from the literature on the subject because none of the type material is presently at the University of British Columbia. The brachiopod descriptions are arranged by superfamilies.

Conclusions are drawn regarding the scope and limitations of this study. Some suggestions are offered for the further study of this group of fossils.

Many reports have been written during the past eighty-five years on the geology of Canada, west of the 110th meridian. In most of these reports reference is made to Devonian rocks and fossils.

Brachiopod fossils are very abundant, both in species and in numbers, in certain beds of these Devonian strata. The brachiopod faunas include species which have been reported from Devonian rocks in other parts of the world, and species that are peculiar to Western Canada. There exists today no work of reference in which the fossil brachiopods from Western Canada are described in detail. The descriptions of these fossils are scattered through the literature on the geology of Western Canada, and that describing the Devonian strata of other parts of the world. This thesis brings some of these descriptions together in a systematic manner.

Unidentified fossil collections are of little use to a geologist. Correctly identified fossils can further geological enquiry along three main lines.

First, if a given species is identified in a fossil collection from a given locality, this information will further knowledge of the geographical distribution of that species.

Second, a species may indicate the presence of a given faunal zone within a stratigraphic section.

Third, the detailed morphology of a species may suggest genetic affinities between it and other morphologically similar species. The accurate identification of the various species in a collection is therefore very important.

Three stages may be distinguished in the identification of a

fossil. These are:-

(a) Collection of fossils from a specific locality and horizon.

(b) Sorting fossils into their various phyla.

(c) Specific identification of individual fossils.

This thesis is compiled as an aid to the specific identification of brachiopods from the Devonian rocks of Western Canada.

A collection of these fossils, made by Dr. Okulitch during the field seasons of 1950 and 1951, is at present unidentified at the University of British Columbia. The author considered that a compilation of descriptions is prerequisite to the systematic study of the collection. It is hoped that this thesis will facilitate the identification of brachiopods in the collection.

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PART I

INTRODUCTION

This part of the thesis deals briefly with the general palaeontology of the brachiopods of Western Canada, and includes a bibliography of forty-three papers in which the Devonian rocks of Canada, west of the 110th meridian, are discussed. The general palaeontology is divided into two parts; the geographical distribution, and stratigraphical distribution of the brachiopod faunas. The former is illustrated by means of an index map, and the latter by means of a chart.

The Index Map.

The index map consists of an outline map of Western Canada on which the outcrop areas of Devonian rocks covered by this survey have been indicated.

Numbers on the index map refer to papers listed in the bibliography at the end of this part of the thesis. The numbers indicate the approximate location of the outcrops which were studied by the authors of papers cited in the bibliography.

Some of the papers are themselves compilations, and therefore could not be indicated on the map because the fossils listed in them were collected from several different localities.

The paper by Warren and Stelck (1950) is an example of a report of this type.

The Stratigraphic Chart.

The information on this chart was taken from the paper by de Wit and McLaren (1950).

The chart indicates the stratigraphic range of common brachiopod genera in a type Devonian section in the Southern Rocky Mountains.


130°
126°
122°
118°
114°
110°
106°
68°
64°
60°
56°
52°
GREAT BEAR LAKE
GREAT SLAVE LAKE
HARE INDIAN R.
G. BEAR R.
SOUTH NAHANNI R.
LIARD RIVER
HAY R.
PEACE R.
ATHABASKA R.
L. ATHABASKA
NORTH SASKATCHEWAN R.
EDMONTON
CALGARY
RED DEER R.
BOW R.
BELLY R.
12.
9
11.
10.
7.
8.
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DEVONO-CARBONIFEROUS OUTCROP AREAS
N

Two facts are apparent from the chart.

First, that the most varied brachiopod faunas are to be found in the central part of section in the Mount Hawk and Alexo Formations.

Second, that a stratigraphic break is indicated by the total absence of brachiopod fossils in the top beds of the Mount Hawk formation.

This chart is included here as an example of the varied stratigraphic range of common brachiopod genera in an outcrop area of the Devonian rocks of Western Canada.

References.

The references in the bibliography are numbered in chronological order, commencing with the paper by Meek (1869), which is numbered (I), and ending with that by Crickmay (1953) which is numbered (43).

The papers were numbered in this way for two reasons. First, to avoid constant repetition of authors' names and dates in the systematic faunal lists in Part II of this study, and second, to facilitate quick reference to the papers.

The author considers that the forty-three papers listed in the bibliography, are representative of papers written on the Devonian rocks of Western Canada, during the past eighty-five years.

Faunal lists of two papers which were written during the last century are included. One paper is by Meek (1869), in which he describes new Devonian brachiopod species which had been collected from the Mackenzie River area during Kennicott's last expedition. The other paper is by Whiteaves (1891), who describes all the Devonian fossils from the Mackenzie River basin, which were at that time in the collections of the geological survey of Canada.

Detailed papers recently published on the subject were written by

A GENERALIZED STRATIGRAPHICAL COLUMN OF THE DEVONIAN ROCKS IN THE SOUTHERN CANADIAN ROCKIES, SHOWING THE STRATIGRAPHIC RANGE OF THE VARIOUS BRACHIOPOD GENERA IDENTIFIED FROM THE ROCKS.
(AFTER DE WIT AND MC LAREN 1950).

DEVONIAN						MISS.	AGE	
				PALLISER				
FLUME	PER-DRIX	MOUNT HAWK	AL-EXO	MORRO	COSTI-GAN	EX-SHAW	STRATIGRAPHICAL DIVISIONS.	
150	600'	380'		950'	95'		GENUS	SPE-CIES
							CAMAROTOECHIA	4
							PAURORHYNCHA	-
							PUGNOIDES	2
							LEIORHYNCHUS	5
							LINGULA	-
							SCHIZOPHORIA	5
							"STROPHOEODONTA"	6
							"SCHUCHERTELLA"	2
							CHONETES	5
							PRODUCTELLA	11
							ATRYPA	11
							GRUNEWALDTIA	2
							CYRTOSPIRIFER	3
							TENTICOSPIRIFER	1
							"SPIRIFER"	8
							"MARTINA"	5
							'CYRTINIA'	1
							'ATHYRIS'	4
							GYPIDULA	2

Warren (1949), Warren and Stelck (1950), Crickmay (1952), and de Wit and McLaren (1950).

All the papers which are listed in the following bibliography are at present in the library of the University of British Columbia, with the exception of that by Meek (1869), which was secured on inter-library loan from the University of Michigan.

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Jour. Pal. Vol. 27, No. 4, pp. 596-600.

PART II

INTRODUCTION

This part of the thesis is divided into four sections, the first three of which are introductory to the last section.

Biological and palaeontological classifications are discussed first. In the second section a brief summary is given of the classification of the Phylum Brachiopoda. The third section is a glossary of common terminology used in the description of brachiopod shells. The fourth section includes systematic description of brachiopod genera and species.

These lists were compiled from references on Devonian rocks of Western Canada which are included in the bibliography to Part I of this thesis. The faunal lists are supplemented by detailed descriptions of fifty-one genera and ninety-eight species of brachiopods.

BIOLOGICAL AND PALAEONTOLOGICAL CLASSIFICATIONS.

In modern detailed studies of brachiopod fossils, attempts have been made to classify the fossils on the basis of phylogeny, rather than morphology.

The theory of evolution is the basis for phylogenetic classification. Phylogenetic classification is an attempt to classify organisms according to their genetic affinities.

In the "ideal" case a genus would be a taxonomic unit. The "genotype" of the genus would represent the original stock from which all the species included in the genus evolved. This "ideal" classification of fossils is seldom possible because of the fragmentary nature of the fossil record. Morphological classification was an older empirical approach to classification. A genus in such a classification was a receptacle into which morphologically similar species were placed regardless of their genetic

The modern trend in brachiopod classification is to split large compound genera into groups which are presumed to have genetic affinities. Examples of studies in which this has been done are those by Schuchert and Cooper (1931), Cloud (1945), and Williams (1953).

In order to attempt to trace the evolution of fossil species detailed, rather than general, descriptions of the type material are required. Both Thompson (1927) and Buckman (1918), have stressed this point. Thompson (1927) wrote:-

"Biological classification is now an attempt to express the degrees of affinity through descent. Instead of as few characters as possible being used to decide upon the generic position of a species, as many characters as possible, as are necessary, are employed to determine the relationship to other species. It has frequently been found that the species grouped together under the older wide genera form homoeomorphous series of polyphyletic origin."

and Buckman (1918) stated that:-

"It requires long and careful research to find the bases for proper definition (of the various homoeomorphous series) which is not only much more satisfactory in the end but gives a better idea of affinities and a far truer picture of the methods of evolution."

To sum up this discussion of classification, two principles may be stated:-

First, the description of type specific material should be as detailed as possible, in order that genetic affinities between similar species could be studied.

Second, species should be assigned to genera on a large number of characteristics.

These two principles must be considered when the specific descriptions, which are assembled in this thesis, are used for purposes of identification of unknown material.

Detailed discussion of evolution and the phylogenetic approach

to classicifation is given in Simpson (1953).

CLASSIFICATION OF THE PHYLUM BRACHIOPODA.

Historical.

The classification of the Phylum Brachiopoda has been attempted by many authors since Fabius Columna first described brachiopod shells in 1616. Historical accounts of the development of brachiopod classification are given in Schuchert (1897) and Thompson (1927).

Present day Brachiopod Classification.

There exists today no completely satisfactory classification of the Phylum Brachiopoda.

There is general agreement that the phylum may be divided into two groups; Class Articulata and Class Inarticulata. The further division of these classes is still subject to discussion.

Shrock and Twenhofel (1952) summed up the question of classification as follows:-

"No existing classification of the Brachiopoda should be considered as final. Most specialists feel that much more needs to be known about living and fossil brachiopods before a completely satisfactory classification can be devised."

Shrock and Twenhofel (1952) based their classification on the systems of classification suggested by three authors: Thompson (1927), Schuchert and La Vene (1929) and Cooper (1944). This classification is adopted here.

All descriptions of class, order and superfamilies in this thesis are taken from Shrock and Twenhofel (1952).

TERMINOLOGY OF FOSSIL BRACHIOPODA.

A glossary of brachiopod descriptive terms follows. The sources of these definitions are in works by Schuchert and Cooper (1931) and Moore, Lalliker, and Fisher (1952).

GLOSSARY OF BRACHIOPOD DESCRIPTIVE TERMS.

ADDUCTOR MUSCLES
Muscles which close the shell

ADVENTITIOUS DEPOSIT
Extra fibrous shell substance deposited by the mantle on the inside of the shell, filling up cavities and irregularities of the surface. By deposition of such adventitious shell in the umbonal cavities, the dental plates may be obliterated.

ALA
Lateral flange on outer side of crural lamellae.

ANTERIOR
That portion of the shell in front of the hinge line away from beaks.

APICAL PLATE
A small flat structure situated in the apex of the delthyrium and flush with the interareas. To the under side of it probably was attached the pedicle. This plate is not a relict of the deltidium.

APSACLINE
See Interareas.

AREA
See Interareas.

ARTICULATION
The locking together of the two valves, effected in the main by the teeth of the ventral valve moving in sockets of the dorsal valve, but maybe further assisted by the brachial parts.

BRACHIAL VALVE
See Dorsal Valve

BRACHIDIA
Calcareous brachial supports in the spire- and loop-bearing brachiopods.

BRACHIOPHORES
Plates that bound the notothyrial cavity (q.v.), also known as socket plates or brachial apparatus.

BRACHIOPHORE SUPPORTS
Plates attached to the dorsal face of the brachiophore, and used to strengthen the latter.

CARDINAL ANGLE
Angles formed at each of the extremities of the hinge between it and the foreward extension of the shell.

CARDINAL AREA
See Interarea and Palintrope.

CARDINAL EXTREMITY
Lateral terminus of hinge line.

CARDINAL PROCESS
A median unpaired process, lying immediately on the inner side of the dorsal umbo, and serving for the attachment of the diductor muscles.

CARDINACIA
Process near the posterior or cardinal margin in the interior of the dorsal valve, connected with articulation, muscle attachment, and attachment of brachial supports.

CATACLINE
See Interareas.

CHILIDIAL PLATES
Discrete plates, one on either side of the notothyrium, and partially closing it.

CHILIDIUM
The covering of the notothyrium, the dorsal equivalent of the ventral deltidium.

COMMISSURE
The boundary line between the anterior and lateral margin of the valves. See Plane of Commissure and Rectimarginate.

CONVEXITY
In describing the convexity of a brachiopod, the dorsal valve is named first; this is for the sake of making comparisons always in the same direction, namely, from dorsal above to ventral below. See Resupinate.

COSTA (COSTAE)
A coarse rib on the outer surface of a valve. Costae may be angular sub-angular or rounded.

COSTELLA (COSTELLAE)
Fine external ribs which may be angular, sub-angular or rounded.

CRURA (sing. CRUS)
Processes in the dorsal valve of the Telotremata to which are attached the fleshy brachia or the brachidia.

CRURAL BASE
Projection from hinge plate of brachial valve at edge of notothyrium for attachment of one of crura.

CRURAL PLATE
A general term commonly applied to the brachial processes of the orthids, strophomenids, and rhynchonellids, without regard to detailed structure, function, or homologies.

CRURALIUM
The dorsal equivalent of the ventral spondylium.

DELTARIUM
See Deltidial Plates

DELTHYRIAL CAVITY
Ventral umbonal cavity bounded by dental plates.

DELTHYRIUM
The triangular aperture which transects the ventral interarea medially, and through some portion of which the pedicle passes. The delthyrium may or may not be closed by a deltidium or deltidial plates. Its equivalent in the dorsal valve is the notothyrium (q.v).

DELTIDIAL PLATES
In Telotremata, two plates growing medially from the walls of the delthyrium after neanic growth. These often unite medially, closing the delthyrium more or less completely. When united they make a Deltarium = symphytium of Buckman, pseudodeltidium of Schuchert. In Protremata, similar plates are at times developed and these are called Lateral Plates (q.v.).

DELTIDIUM
An independent, more or less strongly arched plate in the ventral palintrope or cardinal area in many Protremata, growing from the apex toward the hinge-line and partly or completely covering the delthyrium. It is always delimited from the interarea by grooves. It is characteristic of primitive shells, and is formed by a flap of the ventral mantle.

DENTAL PLATES or DENTAL LAMELLAE
Vertical or nearly vertical plates associated with the teeth of the ventral valve, usually uniting the palintrope to the floor of the valve, and bounding the delthyrial cavity. They are separated from the walls of the shell by the umbonal cavities. When the latter have been filled by adventitious shell, the dental plates become OBSOLETE.

DENTAL SOCKETS
Excavations in the dorsal cardinal margin in which the teeth of the ventral valve articulate.

DENTICLES
Small processes on the posterior surface of the dorsal socket which are inserted into the accessory sockets in the ventral teeth.

DIDUCTOR MUSCLES
Muscles that open the valves.

DORSAL DIRECTION
Toward the dorsal valve at right angles to the plane of commissure.

DORSAL MEDIAN RIDGE
A low axial thickening on the dorsal interior of most orthids and rynchonellids. See Median Septum.

DORSAL VALVE
Usually the smaller valve and the one to which the brachia are always attached. Synonyms: BrachialValve
Socket Valve
Entering Valve
Haemal Valve

DUPLEX SPONDYLIUM
See Spondylium Simplex.

ENDOPUNCTAE
See Punctae

EXOPUNCTAE
See Punctae

FILAE
Fine elevated concentric lines.

FOLD
A broad median external undulation or plica that may be situated on either the dorsal or the ventral valve, hence dorsal or ventral fold. More common on the dorsal valve. Its counterpart is the SULCUS.

FORAMEN
See Pedicle Foramen

FOSSETTE
SeeCrural Fossette

FULCRAL PLATES
Small concave plates attached to the outside wall of the brachiophore support or brachiophore and inner wall of the shell. They serve to define the sockets and strengthen the brachiophore supports.

GERONIC
Signifying old age.

GROWTH LINE
Marking on shell surface parallel to valve margin, indicating former position of this margin.

HINGE LINE
Line along which articulation takes place.

HINGE PLATE
Divided or undivided platform in beak region of brachial interior, generally joined to dental sockets and crural bases; may be divided into inner and outer plates.

HINGE TOOTH
Projection on hinge line of pedicle valve which fits dental socket of brachial valve, serving as pivot in articulation.

INNER HINGE PLATE
Subhorizontal small plate extending medially from crural base.

INTERAREA
Posterior plane or curved surface lying between the apex and the line o of valve junction. Synonym: Cardinal Area.

JUGUM
Simple or complex connection between havles of a brachidium.

LATERAL AREAS
The parts of the valves on either side of the median axis or on either side of the fold and sulcus.

LATERAL PLATES
External marginal plates restricting the delthyrium and seen only in certain orthids and pentamerids. These discrete plates appear to be formed in exactly the same manner as deltidial plates.

LATERAL SEPTA
See Median Septum.

MEDIAN RIDGE
See dorsal median ridge and median septum.

MEDIAN SEPTUM
A longitudinal vertical plate between the ventral muscles. LATERAL SEPTA are rarely developed between the muscles of the same valve, but are moreoften present when spondylia are developed.

MULTICOSTATE
See Costae.

MUSCLE IMPRESSIONS
Marks ofmuscle attachment on the shell.

MUSCLE SCAR
A more or less well defined area representing the final or last muscle attachment.

MYOPHORE
The rugose surface of the muscle attachment on the cardinal process. See Shaft.

NEANIC
Signifying youth, or the stage in which specific characters being to develop.

NEPIONIC
Designating the smooth shell stage succeeding the protegulum.

NOTOTHYRIAL PLATFORM
Thickened shell matter in the umbonal interior of the dorsal valve between the brachiophore plates. It is the seat of diductor muscle attachment in primitive brachiopods not yet possessing a cardinal process; in other shells it is the place where the ventral cardinal process arises.

NOTOTHYRIUM and NOTOTHYRIAL CAVITY
The dorsal counterpart of the ventral delthyrium and delthyrial cavity.

OUTER HINGE PLATE
Part of hinge plate extending laterally outward from crural base.

PALINTROPE
The antero-ventrally or antero-dorsally directed shelf developed at the posterior end of the dorsal and ventral valves due to the progressive migration of the hinge margin in its growth. Formerly called cardinal area.

PALLIAL MARKING
Sinuous branching impression on parts of shell interior outside muscle scars, formed by fluid-filled passageways of mantle (pallial sinuses), which connect with body cavity in the posterior part of shell.

PEDICLE CALLIST
A callus of shell substance at the internal apex of the ventral valve between the dental lamellae, to which the postero-ventral surface of the pedicle was attached.

PEDICLE FORAMEN
A small or large round perforation at the apex or elsewhere through the deltidium for the protrusion of a small pedicle; with age, it may become large by abrasion. When this foramen is absent, the pedicle emerges between the deltidium and chilidium, or these coverings may completely close the delthyrium and notothyrium, in which case there is no known functional pedicle.

PEDICLE MUSCLES
Muscles which retract the pedicle.

PEDICLE VALVE
One of the two main parts of brachiopod shell which bears attachment of pedicle; by convention, defined as ventral in position.

PLANE OF COMMISSURE
The plane passing through the anterior commissure and the hinge-line.

PLICA
See fold.

PLICATE
Used of a shell that has undulations affecting both the interior and outer surfaces. The primary ornamentation is superposed over the plications.

POSTERIOR REGION
That region of the shell back of the transverse axis and toward the beak, or apex.

PROTEGULUM
The initial shell of all brachiopods.

PSUDOCURALIUM
See Notothyrial Platform.

PSEUDORESUPINATE
See Resupinate.

PSEUDOSPONDYLIUM
A callus resembling a spondylium, developed in some shells beneath the muscles of the ventral valve and confluent with the inner lower surfaces of the dental lamellae.

PUNCTAE
Any minute perforations of the test. Types of Punctate tests:
Punctate - The inner fibrous layer is perforated by small holes representing cavities occupied by minute caeca of the mantle.
Impunctate - Have the fibrous layer dense and imperforate.
Pseudopunctate - The fibrous layer surrounds and often covers internal calcareous spicules. In worn or exfolated specimens shell layers tear away from the spicules and leave coarse pits that simulatepunctae.

RECTIMARGINATE
Having a straight anterior commissure.

RESUPINATE
A condition wherein the relative convexity of the two valves is reversed, the convex ventral valve of the early growth stages becoming concave and the concave dorsal valve becoming strongly convex, producing thereby a convexo-concave shell.

ROSTRATE.
Having a long beak produced by narrowing of the hinge line.

RUGA
Concentric shell corrugation which affects both outer and inner surfaces.

SEPTUM
See Dorsal Median Ridge and Median Septum.

SESSILE CRURALIUM
SeeCruralium

SESSILE SPONDYLIUM
A spondylium which rests directly on the floor of the valve without the support of a median ridge.

SHAFT
The shaft or stalk of the cardinal process, which bears the myophore or seat of diductor muscle attachment.

SINUS
See Sulcus

SOCKETS
Sockets are found in both valves and are used in the articulation process.

SPINE
Long or short, straight or curved, solid or hollow projection of the shell surface.

SPIRALIUM
One of the pair of spiral brachidia on interior of some brachial valves.

SPONDYLIUM
A spoon shaped plate terminating more or less freely, located in the apex of the ventral valve of various stocks of articulate brachiopods. This plate serves as the seat of attachment of the muscles. It is supported by a more or less elevated, long or short, median septum. Kozlowski has recently shown (1929) that the spondylium may be divided into three different types.

SPONDYLIUM DISCRETUM
Dental plates do not converge and unite medially, but extend directly to the floor of the valve. Strictly speaking this is not a spondylium, but such a condition of the dental plates is primitive and deserves a designation.

SPONDYLIUM DUPLEX
See Spondylium Simplex.

SPONDYLIUM SIMPLEX
A term applied by Kozlowski to the type of spondylium in which the dental plates and the vertical septum are united into a single piece. This type is in contrast to the Spondylium Duplex of Pentamerus which is composed of two pieces each of which is borne on a basal septum.

SPONDYLOID
In this condition the dental plates are so thickened on their inner basal sides that the added testaceous deposit grows together and simulates a spondylium. This contrasts with the pseudospondylium, which is formed by a callous thickening on the floor of the valve.

STRIAE
Interspaces between costae and costellae. This term has been much abused and its current use for a radial rib is incorrect.

SULCUS (SULCATE)
A median depression in theconvexity of the shell, the opposite of a fold or plica. Replaces the term sinus.

TEETH
The two articulating processes of the ventral valve. There are also accessory small teeth in the dorsal valve in many brachiopoids, which are here called Denticles.

THICKNESS
Linear distance from farthest opposite points on surface of the two valves.

TRAIL
Anterior prolongation of some brachiopod shells, generally a strong angle to general plane of posterior portion of valves.

TRANSVERSE AXIS
A line through the widest part of the shell from left to right.

UMBO
Convex portion of valve adjacent to beak

UMBONAL CAVITIES
Chambers separating the dental lamellae from thewalls of the valve.

UNIPLICATE
A term applied to the anterior commissure when there is a fold in the dorsal valve opposed by a sulcus in theventral valve. UNISULCATE is the reverse condition.

VENTRAL
According to convention, direction away from position of brachial valve toward opposite valve; ventral valve is thus equivalent to pedicle valve.

VENTRAL DENTAL SOCKETS

Small sockets in the teeth of the ventral valve next to the hinge margin. Into these articulate small denticles on the outer wall of the dental socket. They are also called ACCESSORY DENTAL SOCKETS.

VENTRAL VALVE

The shell situated on the ventral side of the animal and in articulate forms having the teeth on each side of the delthyrium. Usually the larger and deeper of the two valves. Synonyms: Pedicle
Dental
Receiving
Neutral

WIDTH

Linear distance between farthest opposite points on lateral margins of a valve or shell.

THE LAYOUT OF THE SYSTEMATIC LISTS AND DESCRIPTIONS.

Descriptions of Classes, Orders and Superfamilies.

These are all taken from Shrock and Twenhofel (1952). The stratigraphic ranges of the various genera, where given, are taken from Shimer and Shrock (1944).

Systematic Lists of Genera and Species.

The generic and specific names in these lists are usually followed by a number (or numbers). The numbers refer to papers cited in the bibliography in Part I of this thesis. A few brachiopod species listed here were described by Thomlinson*, and do not appear in the references which were used for compiling the faunal lists.

An asterisk beside a specific name indicates that species is illustrated and described after the generic description of the genus to which it belongs.

Layout of Generic Descriptions.

Each generic description commences on a new page.

A generic description is headed by the name of the genus, under which is the name of the original author (if known), and the date that the genus was first described. Below the heading the reference from which the description following was taken, is listed. The description is usually followed by the name of the species on which the genus was based and the stratigraphic range of the genus, if it is known.

Layout of the Specific Descriptions.

Each specific description is laid out in a similar fashion to the generic descriptions, except that a line drawing of each species is included, with the text.

*Thomlinson and Geology 521 class 1952-53. (See Acknowledgments

Illustrations of the Genera.

Seven plates follow the brachiopod descriptions. On each plate line drawings of a typical species in each genus is illustrated. The brachiopod illustrations are grouped together in superfamilies.

PHYLUM BRACHIOPODA — Range

Class Inarticulata

Order Atremata

Superfamily Lingulacea, Lower Cambrian to Recent

Order Neotremata

Superfamily Craniacea

Class Articulata

Superfamily Dalmanellacea Middle Ordovician to Permian

Superfamily Pentameracea Middle Ordovician to Devonian

Superfamily Strophomenacea Lower Ordovician to Recent

Superfamily Chonetacea Ordovician to Permian

Superfamily Productacea Lower Devonian to Permian

Superfamily Rhynchonellacea Middle Ordovician to Recent

Superfamily Atrypacea Middle Ordovician to Upper

Superfamily Spiriferacea Ordovician to Triassic

Superfamily Terebratellacea Lower Silurian to Recent

PHYLUM BRACHIOPODA

Class Inarticulate.

"Inarticulate brachiopods have shells composed of conical or tongue-shaped valves that lack articulation and are held in apposition by muscles alone. The shell matter is chitinophosphatic or calcareous, and growth of the shell is either holoperipheral or mixoperipheral.

In the embryo the mantle lobes develop directly without revolution, and the pedicle develops during the free-swimming stage within the valves of the protegulum from the ventral mantle lobe. At a later stage the pedicle, which clearly is attached to the larger (pedicle) valve, is protruded and used for fixation.

Most inarticulate shells are circular or oval in outline and asymmetrically conical in profile, but some have a tongue-shaped outline and a flat lenticular profile. The conical forms, excepting the cemented Craniidae, are fixed by a short pedicle, whereas the lingulids have a long flexible pedicle and live in burrows with their setiferous anterior margin protruding. The development and migration of the pedicle are complex. The complicated muscle system leaves an equally complicated set of muscle marks."

Range: Lower Cambrian to Recent.

Order Atremata

"The Atremata are inarticulate, chitinophosphatic-shelled brachiopods of subtriangular, oval to subrounded, or tonguelike outline having the pedicle attached to the larger (or pedicle) valve, in which it occupies a groove. Specialized forms have heavy calcareous shells with internal platforms for muscle attachment.

Superfamily Lingulacea, (Shrock and Twenhofel).

"Elongate chitinophosphatic and thin-shelled atremates probably derived from the Obolacea, as the pedicle structures are similar. They have highly differentiated muscles and a wormlike tubular and flexible pedicle, both of which aid the animal in its free-living and burrowing habit. Modern Lingula a typical genus of the superfamily, has a long and ancient history. It appeared first in the Ordovician, as one of the earliest representatives of the superfamily, and has persisted to the present with little evident change.

Range: Lower Cambrian to Recent.

Genus Lingula Linn. 35, 36.

*L. Minuta Meek
L. Melie Hall. 23.
L. Spatulata Vanuxem. 34, 37.

Genus LINGULA

Bruguiere n. gen. (1797)

Meek (1876) Smith Contrib. to Knowl. 172, Pt. 1. p. 68

"Shell oblong or more or less oval, depressed, thin, gaping at each end, and rounded or subtruncate in front, and more or less pointed at the beak, consisting of alternate corneous and testaceous laminae, the former of which are fibrous and the latter tubular; composition largely phosphatic. Valves both moderately convex, held together by the action of muscles; beak of ventral valve more pointed and prominent than that of the other. Surface smooth or marked by concentric lines, sometimes crossed by radiating striae. Pedicle long thick cylindrical fleshy and flexible."

Genotype: Lingula Anatina.

MINUTA DEVONIAN BRACHIOPODA LINGULA

This is the smallest specimen of Lingula I have ever seen, and may possibly be a young shell. It resembles closely Lingula spatula Hall, from the Genesse slate of New York, but is rather wider in proportion to length, and has a more pointed beak. It is also more convex than any specimens I have seen of that species.

Locality: Near Fort Resolution, on Great Slave Lake.

Diagram: Ventral view.

LINGULA MINUTA Meek (1868)

Trans. Chic. Acad. Sci. Vol. 1, p. 87.

LINGULA MINUTA Meek

Description: Shell minute, extremely thin, ovate, rather convex; front rather narrowly rounded; sides most conved in outline slightly in front of the middle, thence narrowing with slight convexity to the beak, which is obtusely pointed. Surface polished, but showing, under a strong magnetfier, microscopic lines of growth.

Length, 0.06 inch, breadth, 0.05 inch.

CLASS INARTICULATA.

Order Neotremata.

"The Neotremata are a specialised and, to a certain extent, degenerate brachiopod, having small chitinous, chitinophosphatic (or, rarely, supposedly calcareophosphatic) or calcareous shells consisting typically of high or flattened conical valves. The pedicle when present, emerges through a perforation or sheath, or a triangular cleft, and in maturity in certain forms may be lost when the pedicle valve is cemented to the substratum. The protegulum is semicircular or semieliptical and the adult shells are circular or elliptical, because shell growth is holoperipheral. Range: Lower Cambrian to Recent."

Superfamily Craniaea. (Shrock and Twenhofel.)

Neotremates with flattened calcareous shells lacking a pedicle opening and usually cemented to some object by pedicle valve.

Range: Ordovician to Recent.

Genus Crania Retzius 19

C. hamiltonae Hall 2, 27.

Genus CRANIA

Retzius n. gen.

Retzius (1781) Schrifte der Berliner Gesellschaft Nat. Freunde, Vol. 2. p. 72.

Description from Nettleroth (1889) Kentucky Fossil Shells, p. 31.

"Shell smooth or striated by radiating striae; umbo of the dorsal valve sub central; umbo of the ventral valve sub-central, marginal or prominent and cap like with an obscure triangular area transversed by a central line. Shell usually attached to other shells or marine bodies. The large muscular impressions of the attached valve are sometimes convex in other species, deeply excavated; those of the upper valve are usually convex. In C. tripartita of Munster, the nasel process divides the fixed valve into three cells. Some of the species are entirely free or but slightly attached."

Genotype: Anomia Craniolaris (Linne)

Crania Baattensburgensis (Retzius).

Description from Thomson (1927), Brachiopod Morphology and Genera (Recent and Tertiary), New Zealand Board of Sci. and Art Manual.

"Shell inequivalue, ventral valve cemented to its support by almost its whole surface, dorsal valve more or less conical, apex sub central, directed posteriorly, outline subcircular to sub rectangular, posterior margin straight or slightly indented; test smooth or with radiating striae, ribs or spinules calcarious, penetrated by vertical canals which repeatedly branch toward the outer surface. Interior with muscular impressions generally strongly marked, especially the posterior adductors, which lie near the posterior margin some distance apart and the anterior adductors, which are only a little behind the centre of the valves and are close together. In front of the muscular impressions the interiors of the valves show 4-7 grooves on either side, being the impressions of the pallial sinuses. Mantle without marginal setae, branchia Spirolophus with the apices of the spires directed dorsally. Five to eight coils."

PHYLUM BRACHIOPODA

Class Articulata.

"Articulate brachiopods have oval and transverse calcareous shells composed of two typically convex but unequal-sized valves that are held together along the posterior hinge line by means of articulating devices. The shell is opened and closed by the action of specialized muscles, and the valves, like the leaves of a book, have only one motion, that of simple opening and closing on a single axis. Each valve has a triangular opening in the palintrope. The opening on the pedicle palintrope is the delthyrium, whereas that on the brachial is the notothyrium; both tend to be modified. The shell can be adjusted on the pedicle, and most articulates have the pedicle opening more or less modified. The shellmatter is dominantly calcium carbonate with fibrous prismatic structure, and growth is largely hemiperipheral.

In the development of the embryo the mantle lobes are revolved or reversed from a posterior to an anterior position. The pedicle is developed from the caudal part of the embryo and is never enclosed within the shell as in the Inarticulata. It is attached by muscles to both valves, but it belongs to the larger or pedicle valve. In no known articulate brachiopod does the pedicle lie in the brachial valve. Although the intestine lacks an anus in all living representatives, it may have had an anal opening in some ancient and extinct genera.

Most articulates show modifications of the delthyria and notothyria and development of many kinds of calcareous supports for the brachia. They also exhibit much variation in surface sculpture."

Range: Lower Cambrian (Palaeotremata) to Recent.

Superfamilies of the Phylum Brachiopoda here desribed from Shrock and Twenhofel (1952).

Superfamily Dalmanellacea

Superfamily Pentameracea

Superfamily Strophomenacea

Superfamily Chonetacea

Superfamily Productacea

Superfamily Rhynchonellacea

Superfamily Atrypacea

Superfamily Spiriferacea

Superfamily Terebratellacea

Superfamily Dalmanellacea (Shrock and Twenhofel, p. 325).

"Dalmanellids are endopunctuate orthoids with a lobed (usually trilobed) cardinal process. The superfamily is thought to have been derived from the Orthacea. Representatives appeared first in the Middle Ordovician; they spread widely and diversified greatly during the Silurian and Devonian; and the superfamily finally became extinct during the Permian."

Range: Middle Ordovician to Permian.

Genera Described:	Range:
I. Genus Aulacella Schuchert and Cooper	
II. Genus Cariniferella Schuchert and Cooper	Upper Devonian
III. Genus Phipidomella Oehlert	Silurian to Permian
IV. Genus Schizophoria King.	Silurian to Pennsylvanian

Reported occurrences of this superfamily in the literature reviewed in Part I of this thesis.

I. Genus Aulacella Schuchert and Cooper

A. infra. 38.

II. Genus Cariniferella Schuchert and Cooper

C. iowensis Stainbrook. 37.

III. Genus Phipidomella Oehlert. 36.

IV. Genus Schizophoria King. 10, 21, 24, 35, 37.

* S. allani Warren. 30.

S. athabaskensis Warren. 30, 38.

* S. iowensis Hall. 9, 30, 36, 37.

* S. lata Stainbrook. 30.

S. macfarlani Meek. 13, 15, 24, 34, 37.

S. striatula Schlotheim. 8, 10, 12, 13, 16, 18, 19, 20, 21, 22, 24, 26, 33, 34, 36, 37.

Genus AULACELLA

Schuchert and Cooper n. gen.

Schuchert and Cooper, Amer. Jour. Sci. (5), vol. 22, 1931, p.246.

"This genus externally resembles Rhipidomella and Thiemella but has a well marked fold on the ventral valve and a sulcus on the dorsal which are not reversed in the young stages. Internally the arrangement of the ventral muscle-scars is similar to that of Rhipidomella in the imprisonment of the adductor, field by the diductor scars. The diductor impressions are never broadly flabellate as in Rhipidomella and the adjustor marks are usually clearly visible as in Cariniferella. Furthermore, the diductor impressions are separated by a low ridge which is forked much as in Cariniferella. This is a feature never shown by Thiemella or Rhipidomella in which the median ridge is always direct and unforked.

In the dorsal valve the cardinalia are ponderous and strongly resemble those of Cariniferella and Rhipidomella but are totally unlike those of Thiemella which are delicate and confined. In our classification Aulacella is placed in association withDalmanella and Cariniferella because of the close similarity of the ventral musculature and dorsal cardinalia.

The only known species is the German Orthis eifelensis."

Genotype: Orthis eifelensis de Verneuil.

Range:

Genus CARINIFERELLA

Schuchert and Cooper n. genus.

Schuchert and Cooper, Amer. Jour. Sci. (5), vol. 22, 1931, p. 246.

"Transversely semicricular, margins rounded, cardinal angles obtusely rounded; hinge-line narrower than the greatest width of the shell; lateral profile convexo-concave to unequally biconvex; anterior commissure sulcate; fold narrow, subcarinate; sulcus deep, narrow; ventral interarea short, apsacline, beak not prominent, incurved, umbo low, convex and sulcate. Ornamentation multicostellate, with elevated growth-lines covering the whole surface. Test fibrous, punctate.

Ventral interior: Delthyrial cavity deep; teeth strong; dental plates thick, nearly obsolete in adults; muscle field bilobed in front; diductor scars elongate, expanded anteriorly; adductor track linear, not enclosed in front by the diductor scars. Aggregate adductor scar elliptical. Adjustor scars narrow, divergent, short, placed posterior to the diductor impressions. Short pallial sinuses extending antero-laterally for a short distance in frong of the diductor scars.

Dorsal interior: Cardinalia confined to the immediate vicinity of the hinge, sockets deep, oblique; brachiophore plates widely divergent and extending vertically to the floor of the valve, without fulcral plates; cardinal process very small, shaft short, myophore trilobed; median ridge low, extending to the anterior margin of the muscle area where it merges into the fold produced by the ventral sulcus. Muscle area small as a whole, not extending to the middle of the shell. Adductor scars separated by horizontal ridges; anterior adductors the smaller.

Genoholotype: Orthis carinata Hall

Range: Upper Devonian.

Distinguishing Characters: The distinctive features of this genus are the convexo-concave profile of the shell, the aberrant sharp fold and the corresponding deep, narrow sulcus, the Dalmanella-like ventral musculature, the strongly divergent brachiophore plates, and the small muscle area of the dorsal valve."

Genus RHIPIDOMELLA

Oehlert n. gen.

Oehlert, Jour. Conch. (3), vol. 30(38), 1890, p. 372. Hom. Rhipidomys Oehlert 1887.

"Exterior: Subtrigonal to circular, anterior margin not uncommonly emarginate, hingeline narrow; lateral profile unequally biconvex, the brachial valve having the greater convexity, with the ventral one concave at the front in many species; anterior commissure faintly uniplicate or rectimarginate; in some instances a sulcus on each valve; ventral interarea the longer, curved, apsacline, umbo swollen or gently convex, beak incurved; dorsal interarea greatly reduced, ortho- to apsacline; delthyrium open notothyrium usually closed by the cardinal process or partially by chilidial plates; surface multicostellate, hollow costellae numerous. Fibrous, punctate.

Ventral interior: Delthyrial cavity shallow; dental plates abbreviated, teeth strong, divergent, elongate; a broadly curved ridge extending from the bases of the low dental plates around the margin of the muscle field; muscle field large, flabellate, not confined to the delthyrial cavity, occupying from one-third to five-sixths the length of the valve and usually deeply impressed; diductor scars semiflabbelate, separated from each other by a sharp or low broad ridge, completely enclosing the adductor scars, which form an elliptical patch just anterior to the pedicle callist; adjustor scar commonly discernible on the outside of the diductor scar; pedicle callist occupying the delthyrial cavity.

Dorsal interior: Cardinalia confined, sockets wide, deep, without concave fulcral plates; brachiophores long, bluntly pointed, supported by adventitious substance deposited beneath their anterior edge; sharp processes or points on the ends of the brachiophores have been interpreted as crura; cardinal process large, myophore commonly ponderous, lobate; shaft short. Median ridge extending to the middle of the shell. Muscle field quadripartite, the posterior scars the larger. Ovarian and pallial impressions occupying the area of the shell not covered by the muscle marks.

Genotype: Terebratula michelini L'Eveille.

Range: Silurian (Clinton) to close of Permian.

Distinguishing Characters: Rhipidomella is characterized externally by its nearly circular, or, in later species, subtrigonal outline; the unequal convexity of the valves, of which the dorsal is almost always the more ventricose, and the ventral one usually either markedly concave or showing a tendency in that direction. The hinge-line is always very narrow. Internally the ventral musculature is very characteristic and the teeth are different from those in nearly all other genera of the orthids. The dorsal valve with its arched umbo, has a ponderous cardinal

process with a very short shaft but an expanded myophore. The cardinalia are distinctive and consist of widely divergent brachiophores supported by inconspicuous deposits of adventitious shell much as in Heterorthis.

Genus SCHIZOPHORIA

King new gen.

King, Mon. Perm. Foss., 1850, pp. 105, 106.

"Exterior: Externally like Hebertella; margins rounded, carindal extremities rounded, hinge-line usually narrower than the greatest width of the shell; lateral profile resupinate, convexity of valves varying, the dorsal valve always with the greater convexity; anterior commissure rectimarginate to uniplicate; dorsal valve frequently with a low fold; ventral valve frequently sulcate in front; ventral palintrope the longer, faintly or strongly apsacline, curved or plane, beak slightly or strongly incurved, umbo gently or strongly convex; dorsal palintrope short, curved very strongly apsacline so that it overhangs the ventral interarea; multicostellate, with abundant hollow costellae; test fibrous, punctate.

Ventral interior: Delthyrial cavity usually deep, teeth strong; crural fossettes oblique; dental plates strong, frequently obscured by adventitious deposit, extended about the margins of the muscle area as a low ridge; muscle area bilobate or obcordate; diductor scars long, divergent, separated by a wide or narrow ridge having its origin a short distance forward of the apex; adductors small, borne on the median ridge; adjustor impressions usually long and tenuous, situated on the outside margins of the diductors.

Dorsal interior: Cardinalia large; brachiophores scarcely separable from their supporting plates, vertical, or nearly so, strongly divergent, continued forward slightly as a ridge along the lateral margins of the muscle field; cardinal process in young shells like that of Rhipidomella, but in old shells largely resorbed, making a narrow ridge. In old shells an elevation is frequently formed on each side of the cardinal process in the notothyrial cavity. Muscle area quadripartite, the anterior pair of diductors being separated from the posterior pair by oblique ridges extending antero-laterally from the median ridge; peripheral margins thickened and elevated in some species. Pallial sinuses prominent, six in number, four of these taking their origin at the anterior extremity of the median ridge, starting as two trunks, then dividing into four and extending anteriorly in a subparallel arrangement, repeatedly branching near the anterior margin into subsidiary rami. Two other trunks originate, in some species, at the end of the ridge dividing the adductors, passing antero-laterally, bifurcating near the margin and then becoming arborescent at the margin.

Genoholotype: Conchyliolithus Anomites resupinatus Martin

Range: Silurian (Clinton) to Pennsylvanian, with a very wide geographic distribution.

Distinguishing Characters: Schizophoria is distinguished by its convexo-concave profile, the divergent or subparallel diductor scars in the ventral valve separated by a low median ridge (euseptoid) which bears the adductor marks, and in the dorsal valve by the widely divergent crural apparatus

characteristic muscle marks, and pallial trunks. The adductor muscles are separated by a curved, oblique ridge, a feature which at onces separates this genus from Proschizophoria. The pallial marks consist of four or six subparallel trunks. Schizophoria closely resembles Hebertella externally, but the fundamental difference in shell structure and cardinalia serves to differentiate them immediately. The similarities and differences between Orthotichia and the genus under discussion are pointed out under the former genus."

1

2

SCHIZOPHORIA ALLANI Warren (1944)

Warren, P.S.; Trans.Royal Soc.Can.,3rd Series, Vol. 38, Sect'n. IV, 1944

Schizophoria allani Warren

Description: Shell large, unequally bi-convex, subquadrate or rounded, greatest width about the mid-length or anterior to the mid-length of the shell, length and width about equal. Measurements of three specimens are: length 36 mm., 37 mm., and 38 mm.; width 3.4 mm., 3.9 mm., and 3.8 mm.; thickness 2.4 mm., 2.6 mm., and 2.7 mm.

Pedicle valve moderately convex in region of umbo but flat about the middle of the shell, where a wide shallow sinus commences to form which quickly deepens, becomes angular, and extends up into the brachial valve at the margin as a high sharp, angular projection. Hinge line short, about half the width of the shell. Cardinal area, broadly triangular; delthyrium higher than wide; beaks erect or slightly incurved.

Brachial valve very gibbous, strongly arched from the beak to the anterior margin. Transversely, the greatest curvature is along the midline of the shell, the sides of the valves falling away sharply to the lateral margins. Beaks small and strongly incurved, the area benind the beaks strongly inflated, sometimes projecting beyond the beak of the pedicle valve and sometimes touching or closing over the beak of the pedicle valve completely, masking the delthyrium and most of the cardinal area of that valve.

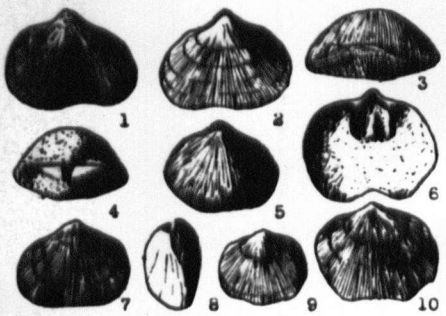
Surface of both valves ornamented by fine rounded costae, about five occupying the space of 2 mm. They are crossed by strong growth lines which are apt to become crowded near the front margin of the shell. Scattered large oval punota are present on the costae.

Remarks: This Schizophoria bears a considerable resemblance to Meek's S. macfarlanei, especially in the shape of the brachial valve. Meek's species, however, is always longer than wide and the curvature of the umbones of the brachial valve is greater. Whereas it appears to be certain that there are varieties of S. macfarlanei in the Upper Devonian, the only true specimen in our collection is from the Middle Devonian.

There is a variety or mutation of S.allani which differs from the species in having the brachial valve a little less convex and the extension of the sinus up into the brachial valve more rounded or linguloid rather than sharply angular.

Age and Locality: Upper Devonian. Waterways formation, Athabaska River, near McMurray, Alberta.

Diagram: Fig. 1 - Brachial valve of a syntype
Fig. 2 - Frontal view of a syntype



Schizophoria iowensis Hall (illustrations after Stainbrook 1940) 1-3. Pedicle, brachial and anterior views of a homeoytype. 4. Posterior view of a hypotype. 5, 7-8. Brachial, pedicle and lateral view of a hypotype. 6. Interior view of a pedicle valve. 9-10. Pedicle and brachial views, respectively, of two specimens of the type described as Rhipidomella suborbicularis by Hall

SCHIZOPHORIA IOWENSIS

Schizophoria iowensis Hall (this description after Stainbrook (1940), Amer. Midland Naturalist, Vol. 23, p. 483.)

Description.--Shell suborbicular in outline, subequally biconvex, wider than long, sinuous at the front margin. Measurements of three hypotypes are: length 19.6 mm., 19.6mm., and 17.1 mm.; width 36.5 mm., 33.9 mm., and 30.1mm.; thickness 15.5 mm., 14.5 mm., and 11.6 mm.

Pedicle valve most convex in the umbonal region, surface slopes rapidly to the cardinal margin and gently to lateral margins. Shallow mesial sinus begins near midlength, increases in width and depth anteriorly. Beak small, pointed, incurved, extends beyond that of other valve. Area broadly triangular, gently curved toward apex, diverging at 45° from plane of valve; delthyrium large, twice as high as wide. Internally 2 stout hinge teeth diverge widely and are supported by short dental lamellae which continue forward as elevated ridges bounding lateral and anterior margins of muscle area. Muscle scars deep, elongate, cordiform in outline with slight mesial emargination in front; divided longitudinally by rounded medial ridge arising shortly in front of beak, increasing in height and width to base of emargination, descending abruptly to floor of valve.

Brachial valve more convex, highest in central portion, slopes most abruptly on either side oe beak to cardinal margin; anterior median portion indented by sinus of opposite valve. Beak small, pointed, incurved. Area curved, half height of opposite area, lies in plane of valve; delthyrium small, wide in proportion to height.

Surface bears numerous, fine, rounded, radiating costae which increase in number by division, accomplished several times; at front margin, 2 occupy 1 mm. Intercostal depressions width greater, less, or equal to costae. Concentric striae of growth of variable strength cross costae and in some specimens are crowded toward the front.

Occurrence.--

Schizophoria lata Stainbrook, 1940, American Midland Naturalist, vol. 23, p. 487, pl.2. 1, 2, 3, Pedicle, posterior, and brachial views of the holotype. 4,5, Pedicle and lateral views of a small paratype.

SCHIZOPHORIA LATA

Schizophoria lata Stainbrook, 1940 American Midland Naturalist, vol. 23, p. 488,

Shell inequally biconvex, transversely subelliptical in outline with rounded postero and antero-lateral margins, considerably wider than long, broadest at midlength, moderately sinuous in front. Dimensions of the holotype are; length, 27.5 mm.; width, 37.1 mm.; thickness, 16 mm.; width of area 18.5 mm.; distance from beak to beak 3.7 mm.

Pedicle valve gently convex, highest a little anterior to beak, surface sloping rapidly from umbo to cardinal margins and gently and evenly to the lateral margins. A mesial sinus originates at the midlength, widens and deepens toward the front, where it attains a width half that of the valve. Umbo low, broadly convex from side to side, and increasing in height toward the beak. Beak large, pointed, a little incurving, elevated, and extended beyond that of opposite valve. Area high, broadly triangular, sharply defined at the sides, gently concave beneath the beak, half as wide as valve, slightly inclined toward opposite area. Delthyrium narrowly triangular, half as wide as high. Muscle scars broadly flabellate in outline, anteriorly quadrate with a median emargination, and less than half as long as the valve. They are sharply defined at the sides by a bound-in bridge which rises abruptly from floor of valve and is continuous posteriorly with the dental lamellae but obsolete anteriorly near the median line. Scars divided longitudinally by broad, conspicuous, parallel-sided ridge which, arising a short way in front of beak.

Brachial valve more convex than pedicle. Most prominent in umbonal region, whence surface slopes abruptly to cardinal margin and with moderate rapidity to the lateral and anterior margins. Depresses toward cardinal extremities and flattened mesially. Beak blunt slightly inclined toward opposite beak.

Surface marked by numerous radiating costae increasing by division and separated by spaces of variable width, usually narrower than costae. Approximately two costae per mm. at front margins of mature shells. A few concentric growth lines occur at irregular intervals but are more common near the front of the shells. Oblong punctae are scattered over the surface of the valves on the crests of the costae and are more numerous near the lines of increment.

Much larger than S. iowensis, wider and thinner, differs internally in the character of median ridge of pedicle valve. Subelliptical shape and proportionately broader shell distinguish this form from S. laudoni. Similar to S. striatula var. australis Kindle in general shape but is not as large, has finer costae and considerably higher area.

Superfamily Pentameracea. (Shrock and Twenhofel, p. 325).

"The pentamerids are typically large biconvex impunctuate shells with a spondylium duplex and usually a cruralium or two parallel vertical plates in the brachial valve. The hinge line is narrow, interareas small, and surface smooth or costate."

Range: Middle Ordovician to Devonian.

Genus Gypidula Hall

Genus Pentamerus Hall

Reported occurrence of this genus in the literature reviewed in Part I of this thesis.

Genus Gypidula Hall 10, 24, 32, 35.

G. comis Owen 8.

*G. cornuta Fenton and Fenton 22, 37, 38.

G. galeata Dalman 11, 25.

Genus Pentamerus

*P. borealis Meek 1.

Genus GYPIDULA

Hall n. gen.

Hall, N.Y. State Cab., 20th Rept., 1867, p. 163

"Exterior: Galeatiform, hinge-line short and straight; cardinal extremities rounded; lateral profile biconvex, the ventral valve usually having the greater convexity. Anterior commissure rectimarginate or sulcate; the ventral fold usually low and defined at the anterior only. Ventral interarea very narrow, defined by low ridges, curved, apsacline to anacline, delthyrium large, open; beak pointed, incurved strongly; umbo inflated. Dorsal interarea obsolete; beak pointed, incurved; umbo swollen. Surface smooth or multicostate; shell substance fibrous impunctate.

Ventral interior: Delthyrial cavity deep; teeth strong, narrow, elongate; dental plates convergent, forming a narrow spondylium, supported by a duplex septum for part of its length; free at the front end. Septum short.

Dorsal interior: Notothyrial cavity deep; crural apparatus consisting of three pairs of plates intimately united. At the posterior are two plates slightly convex inward, uniting with the poster-doraal wall of the valve at the back and their dorsal or distal edges uniting with the brachial supports. These form a sort of hinge-plate. The sockets are excavations in the lateral edges at the junction with the wall of the valve. A second set of plates are set off from those above by ridges. These are vertical, narrow, elongate bands with their front ends free, and are supported by septa which converge inward and unite directly with the wall of the valve. Cardinal process simple, absent, or present in some species. The diductors are usually borne in a narrow pit under the beak. A low septum divides the space between the septal plates into two, and on each side of the ridge obscure adductor impressions are visible.

Genolectotype: Pentamerus occidentalis Hall

Range: Silurian and Devonian of North America and Europe.

Distinguishing Characters: Gypidula is most readily recognized externally by its galeate from and the position of the fold on the ventral valve. Internally the differential characters are in the dorsal valve, in the discreteness of the brachial supports, which form a double track on the dorsal surface when the shell is eroded or seen in section."

GYPIDULA CORNUTA Fenton and Fenton 1924.

Fenton and Fenton (1924) Mich. Univ. Mus. Geol., Contrib. vol. 1, p. 121, pl. 25, figs. 26-31.

GYPIDULA CORNUTA Fenton and Fenton

Description: Shell of medium size or less, wider than long in younger specimens and longer than wide in old ones. Dimensions of three specimens, the second of which is the holotype: length of pedicle valve, 16.7 mm., 21.8 mm., and 23.6 mm.; length of brachial valve, 15.5 mm., 18.9 mm., and 19.5 mm.; width, 19.2 mm., 21.8 mm., and 23.3 mm.; thickness, 9.2 mm., 14.8 mm., and 16.2 mm.

Pedicle valve highly convex; beak large prominent, sharply pointed, strongly incurved. Cardinal area broadly triangular, strongly arched; pedicle opening seen only in young specimens, triangular and about as high as wide. Umbonal region high; postero-lateral slopes slightly flattened and concave; lateral slopes descend abruptly from the mesial portion, anterior margin sinuate. Mesial fold originates about 10 mm. from the beak and is low and broad, or narrow and prominent; scarcely distinguishable in small specimens since they are quite flat. On the fold are 2 or 3 low rounded plications separated by moderately broad shallow furrows. Lateral slopes of large specimens smooth or marked by 2 or more low rounded plications.

Brachial valve moderately convex in umbonal region; beak pointed, slightly incurved in small specimens but beneath the beak of opposite valve in mature ones. Cardinal area very low and slightly arched. Umbonal area moderately convex; posterolateral slopes flattened and slightly concave.

Surface of both valves marked by fine concentric lines and heavier growth wrinkles.

Diagrams: 1. Ventral view.
2. Doral view.
3. Lateral view.

Genus PENTAMERUS

Sowerby, n.gen. 1839

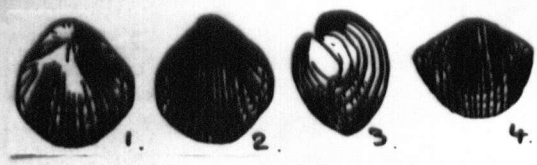
Hall (1894), Nat. His. of New York. Vol VIII Part II p.232.

"Shells elongate-subtrigonal or subpentagonal in outline, strongly inequivalve, biconvex; median fold and sinus faint, if at all developed. Anterior margins of contact usually straight, with sometimes a faint fold, at others a low sinus on both valves. Surface with numerous sharp or rounded, simple or divided plications extending from beaks to margins; cardinal slopes broad and usually smooth.

In the pedicle-valve the umbo is elevated, attenuated, more or less incurved, not prone upon the opposite valve. No cardinal area is developed. The delthyrium is very broad and bears a concave deltidium, which, however, is frequently wanting. Teeth small, supported by convergent lamellae which unite in the interior cavity and form a single median vertical septum of variable length; in the typical species usually extending almost, and sometimes quite to the anterior margin, and vertically, for fully one-half the depth of the combined valves. The spondylium is very narrow and deep; combined with the median septum the height of these plates equals fully two-thirds of the depth of the valves. The anterior margins of these plates are doubly incurved, the most projecting points being at the base of the septum, and at its line of union with the dental lamellae. The median septum consists of two vertical lamellae, each continuous with one of the component plates of the spondylium. The spondylium was the seat of muscular attachment and it bears a series of fine radiating lines along its median portion, and transvers or concentric lines over its lateral slopes; the former probably representing the scar of the adductor, and the latter the impressions of the diductor muscles. In the brachial valve the beak is obtuse and closely incurved into the deltidial cavity or spondylium of the opposite valve. The dental sockets are long and narrow, their inner margins being bordered by two broad, convergent crural plates, which extend toward the bottom of the valve, but do not reach it. These Sloping plates are supported by two vertical septa, with which they are united, not at their extremities, but obliquely, just within their free edges. At the anterior angles of these free edges, there are two long, straight or slightly curved, rod-like crural processes extending into the anterior cavity of the shell. Beneath the beak is a faintly developed, bilobate or multilobate cardinal process. The muscular scars lie on the surface of the valve between the two vertical septa, and extend for some distance in front of them. They are divided by a low axial ridge.

Shell-substance fibrous, impunctate."

Type, Conchidium biloculare, Linne (= Pentamerus conchidium Dalman)



PENTAMERUS BOREALIS Meek (1868)

Trans. Chic. Acad. Sci. Vol. 1.
p. 93.

PENTAMERUS BOREALIS Meek

Description: Shell subglobose, about as wide as long. Dorsal valve moderately convex, being most prominent in the central and umbonal regions; beak incurved, and not projecting much beyond the cardinal margin, which is rather straight; front depressed so as to form a shallow, flattened mesial sinus, extending but a short distance back from the margin. Ventral valve more gibbous than the other, particularly in the umbonal region, forming a nearly regular descending arch from the beak to the front, where there is a slight, flattened mesial prominence, causing a moderately distinct sinuosity in the margin, occupied by a corresponding projection of the edge of the other valve; beak prominent, rather ventricose, and closely incurved, so as to bring the point nearly or quite in contact with the umbo of the other valve. Surface with rather small, irregular, distinct radiating costae, which increase by division, each of the principal ones, particularly on the sides of the valves, giving off one or more smaller ribs on the outer side, which never equal theothers in size.

Length from the front to the beak of the dorsal valve, 0.97 inch; do. to the most prominent part of the umbo of the ventral valve, 1.13 inches; greatest breadth, 1.09 inches; convexity of the two valves, 0.91 inch.

Locality: Anderson river. Devonian (Hamilton group).

Diagrams: 1. Dorsal view
2. Ventral view
3. Side view.
4. Anterior view.

Superfamily Strophomenacea (Shrock and Twenhofel, p. 325).

"Strophomenids have flat transverse costellate shells with a profile that may be concavo-convex, convexo-concave, or resupinate. The shell is pseudopunctuate. The pedicle opening, if present, is an apical foramen in adult shells, but the pedicle seems never to have emerged through the delthyrium because in young shells it protruded through a tiny supra-apical foramen, surrounded by a sheath and anteriorly situated with reference to the deltidium. Commonly the pedicle atrophied and the shell lay free on the bottom or was attached by part of the surface of the pedicle valve. A deltidium and a chilidium were usually well developed, and short brachiophores supported the lophophore. The Strophomenacea were an important and prolific group during the Paleozoic, but since then have gradually declined until now only two living genera remain."

Range: Lower Ordovician to Recent.

Genera Described:	Range:
I. Genus Douvillina Oehlert	Devonian
II. Genus Douvillanaria Stainbrook	
III. Genus Leptaena Dalman	Middle Ordovician to Mississippian.
IV. Genus Leptostrophia Hall and Clarke.	Lower Devonian.
V. Genus Nervostrophia Caster.	Devonian.
VI. Genus Schuchertella Girty.	Lower Devonian to Permian.
VII. Genus Strapheodonta Hall.	Devonian.
VIII. Genus Strophonella Hall	Middle Silurian to Devonian.

Reported occurrences of this superfamily in the literature reviewed in Part I of this thesis.

I. Genus Douvillina Oehlert

D. arcuata Hall. 37.

* D. delicata Fenton and Fenton.

II. Genus Douvillinaria Stainbrook

D. veribiles Calvin. 37, 38.

III. Genus Leptaena Dalman

L. rhomboidulis Wilckens. 11.

IV. Genus Leptostrophia Hall and Clarke

L. Magnifica Hall

V. Genus Nervostrophia Caster

N. rockfordensis Fenton and Fenton

N. vesitita

VI. Genus Schuchertella Girty. 11, 12, 21, 24, 29, 31, 32, 35.

S. arctostriata Hall. 22.

* S. chemungensis Conrad. 9, 21.

* S. girtyi Shimer. 18, 22, 37.

* S. nevadensis Merriam. 37.

* S. parva Stainbrook. 38.

VII. Genus Strapheodonta Hall

* S. costata

S. demissa

* S. dorsata

* S. halli

S. inequistriata

S. inflexa

S. iowensis

S. perplana

* S. plicata

* S. subdemissa

* S. umbonata

* S. parva

VIII. Genus Strophonella Hall. 37.

Genus DOUVILLINA

Oehlert 1887 emended

Williams (1953) North American and European Strophеodontids: Their Morphology and Systematics, p. 43.

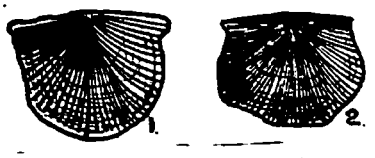
"Exterior: Outline semicircular to elongately semi-oval, mucronate; concavo-convex, with a varying strength of curvature but usually strong. Ventral interarea apsacline to orthocline in the later stages of stock development, dorsal interarea correspondingly anacline to hypercline; delthyrium progressively closed by pseudodeltidium which never loses the sharp median fold, chilidium initially large, progressively degenerate, in later stages vestigial. Unequally parvicostellate with incipient secondary costation represented by fine sharp folds usually along the primaries in end stock members. Pseudopunctae radial but very closely spaced in late forms.

Ventral Interior: Hinge line progressively denticulate; in late forms, portions of the denticulate area on either side of the umbo became isolated (secondary pseudoteeth) and fitted behind the laterally expanded cardinal process lobes; no dental plates. Process pits progressively deeper, strongly excavate in late forms; ventral process prolonged anteriorly into a median ridge, progressively stronger but never losing posterior concavity nor developing pseudoteeth. Muscle scar small, quadrate to subcircular in late forms; adductor scars lanceolate impressed on either side of the median ridge, diductor scars short bounded by strong lateral walls which fuse with a progressively developed transverse ridge anterior to the muscle scar area and with it eventually forming a shallow sub-circular cup.

Dorsal Interior: Cardinal process lobes initially rather elongate, conjunct, attachment faces directed postero-ventrally becoming progressively stouter and more disjunct; in ultimate forms deeply disjunct, directed posteriorly, each lobe expanded laterally. Socket plates abbreviated to obsolescent. Adductor scars initially lightly impressed on either side of the median ridge, bounded by faint curved lateral ridges and divided by a pair of low ridges diverging at a small angle and lying on either side of the median ridge. In later forms, scars progressively more deeply impressed, bounding walls higher, lateral ridges, high, tuberculate (braceplates) curving towards each other, each uniting posterocentrally with a branch of bifurcated strong median ridge.

Genotype: Leptaena dutertrei Murchison

Range: Middle Silurian to Upper Devonian.



DOUVILLINA DELICATA Fenton and Fenton.

Fenton and Fenton (1924), Mich. Univ. Mus. Geol. Contrib., vol. 1, p. 91, pl. 20, figs. 17-20.

DOUVILLINA DELICATA Fenton and Fenton

Description: Shell below medium size; semicircular in outline, broader than long with the greatest width near the mid-length; posteriorly there is an incurving of the margin which gives the hinge line a murconate appearance. Dimensions of one specimen; length, 19.5 mm.; width, 21.9 mm.; thickness, 5.2 mm.; height of cardinal area, 1.8 mm.

Pedicle valve moderately convex; mesial fold low and rounded. Cardinal area horizontal and moderately low; marked by fine vertical striae, which are crossed by coarse horizontal lines. Delthyrium flat, triangular, marked by fine growth lamellae. Brachial valve moderately concave; mesial sinus shallow and very indistinctly bounded. Cardinal area linear and vertical; marked as is that of the opposite valve. Surface of both valves marked by coarse angular costae. The costae are crossed by very fine irregular concentric striae whichform nodes on the costae. The surface appears to be punctate.

Remarks: This species differs markedly from the other American forms of this genus in size, degree of convexity, and coarseness of plications. The internal characters serve to establish the genus.

Diagrams: 1. Ventral view.
2. Dorsal view.

Genus DOUVILLINARIA

Stainbrook, n.gen.

Stainbrook (1945), Brachiopoda of the Independence Shale of Iowa.

"Shell small, thin, concavo-convex, broader than long with greatest width generally at midlength; subquadrate in outline with antero-lateral and front margins broadly rounded, postero-lateral margins concave and hinge-line less than greatest width, sometimes considerably so; angles slightly projecting, and anterior commissure sulcate.

Pedicle valve depressed convex, highest anterior to midlength, surface arching gently from the beak over greater portion of the valve but more strongly near front and lateral margins. Median fold strongly to weakly developed, originating at beak, angular, and sometimes causing an emargination at front. Umbo low and very gently convex. Beak small, scarcely projecting. Cardinal area low, apsacline, slightly curved, vertically marked by strong narrow ridges which decrease in size and height to a point about midway to extremities; upper ends of ridges directed toward beak. Remainder of area horizontally striated; in some examples it may be smooth or but slightly ridged. Delthyrium covered by a high narrow convex deltidium which may be open a little at base. In many examples there is a hole on either side due to wear caused by prongs of brachial process. Internally border of valve adjoining cardinal area strongly denticulate; denticulae short, parallel, strongly convex projections, the inner extensions of ridges on exterior of area. Denticulae decrease in size to a point a short distance from hinge extremity. Hinge-teeth apparently not developed. Delthyrial cavity nearly filled by a median ridge which bifurcates anteriorly; each lateral arm forms the posterior border of a diductor scar while the median portion appears to touch under surface of deltidium. On each side of posterior end of median ridge is a deep bulbous cavity in which an arm of brachial process articulates. Muscle area small, semicircular in outline, about a third as long asvalve; bordered on each side by a narrow ridge which originates a short way lateral to base of delthyrium, rises from floor of valve to its highest point on antero-lateral margin of muscle area, and, curving inward, decreases in height to its junction with the median ridge. These thin lateral ridges, deeply excavate anteriorly and laterally, outwardly overhang floor of valve to form a structure similar to that of Douvillina. Median septum arises in front of adductor scars, increases in height to junction with lateral ridges, and then descends abruptly to floor of valve. In some instances septum may be continued forward a short way. On each side of septum where joined by lateral ridges is a slight depression to accommodate a brachial braceplate. Muscle scars are seldom distinguishable as they are not strongly impressed on surface. Posterior adductors are radiately grooved and appear to be crescentic while the adductors are narrow and elongate. Ridges bordering muscle area are strongly papillose externally. Papillae large and resembling incipient endospines.

Genus LEPTAENA

Dalman, 1828, n. gen.

In Hall and Clarke, Nat. Hist. of New York, Vol. VIII, pt. 1. p. 276.

"Shells plano-convex when young, concavo-convex at maturity; convexity normal. Surface covered by conspicuous concentric corrugations or wrinkles over the flatter portions of the valves. Where these cease the surface is more or less abruptly and often rectangularly deflected, forming a conspicuous anterior slope. The whole exterior is covered with fine, even, radiating, thread-like, tubular striae, which, in well preserved specimens, are crenulated by finer concentric striae. Outline, transversely subquadrate or semioval. Hinge-line straight, its length making the greatest diameter of the shell; extremities often subauriculate. Cardinal area narrow, slightly wider on the pedicle-valve, not denticulate. In the pedicle-valve the delthyrium is covered by a convex deltidium, perforated at the apex by a foramen which is closed at maturity or encroaches upon the apex of the valve. This deltidium is most conspicuously developed in early stages of growth then having the form of a tube or sheath, which character becomes obliterated as maturity approaches, by the increase in the size of the cardinal process of the opposite valve, and the callosity formed about its base. In adult shells the foramen has become enclosed by the substance of the shell, its external opening being an oblique groove in front of the apex of the valve, and its inner aperture appearing in front of the pedicle-scar. Not infrequently the passage is closed at maturity. The teeth are very divergent and quite conspicuous, generally supported by lamellae which are continued around the subcircular muscular area of the narrow umbonal cavity. The muscular scars consist of a narrow median or adductor, enclosed by flabelliform diductors.

In the brachial valve the area is linear, the delthyrium is progressively filled by the growth of a callosity, which is often deeply grooved along the center, and sometimes perforated in the line of division between the branches of the cardinal process. The cardinal process consists of two sessile, diverging apophyses which have broad, flat, striated surfaces of attachment, and are extended beyond the hinge-line. The sockets are moderately deep; the crural plates are usually not sharply defined, but are continued in a curving line along the inner surface of the valve, partially embracing a pair of broad, ovate muscular impressions which are marked by arborescent ramifications; recurving and again incurving, these ridges partially surround a pair of smaller muscular areas, lying in front of the first. At the inner base of each branch of the cardinal process there arises a low elevation or callosity, which, extending obliquely forward, and uniting in the center, continues as a narrow median ridge dividing the posterior pair of muscular impressions. This ridge sometimes terminates in a point near the base of the first pair ofimpressions, and the second pair are separated by a low, slender median septum, which sometimes apparently takes its origin at this point, but which is in fact a continuation from the interrupted posterior ridge, and extends for some distance over the pallial region.

Remainder of valve marked by abundant papillae which are large near muscle area but smaller farther away. Slight pallial markings obscured by papillae radiate from muscle area. Depression below median fold is apparent on anterior half of valve only.

Brachial valve concave to nearly flat; umbonal region convex, occasionally strongly so, and highest anteriorly. Median sulcus originating near beak, subangular at bottom, narrow, and generally sharply depressed below remainder of valve. Area low, a little more than half as high as that of pedicle valve, flat, catacline, similarly marked by vertical ridges but they are narrower and interspaces broader. Chilidium narrow and gently convex. In the neanic stages brachial valve is convex but this condition is reversed when the shell is about one-third adult size.

Internally brachial process well developed, strongly bifurcate; each prong bifid and posteriorly curved beyond cardinal area. On each side of process is a short thin erect ridge, the brachiophore, laterally directed and attaining highest point at anterior end. Edge of area marked by strong denticles which are absent toward the extremities. Immediately in front of the process arises a strong median ridge which bifurcages about half way to midpoint and is deeply grooved there. Each arm or braceplate extends laterally and then anteriorly for a short way, disappearing abruptly at midlength. They are thin and inwardly slanted so as to partially enclose a deep cavity in which are the anterior adductor scars. Between these scars a slight ridge extends forward up onto ridge formed by inward reflection of the external sulcus. Posterior adductor scars larger, separated by posterior median ridge, and having no definite lateral bounding structure. Region immediately adjacent to scars depressed to form a definite visceral area. A radially grooved ridge is formed near front and lateral margins by thickening of valve; beyond this, the shell is thin. Surface has abundant papillae, those in visceral area larger and longer.

Exterior of both valves marked by numerous radiating costae which increase by intercalation. They are thin, acutely angular, variable in size as every fourth or fifth is larger, and widely separated. In the interspaces are from three to six fine costellae. Numerous minute wrinkles of growth cross costae and may give them a rugose appearance."

Genotype: Strophodonta variabilis Calvin

Described by Williams (1953), Geol. Soc. Am., Mem. 56, p. 45.

"This genus includes a third divergence from the douvillinids which has been affected by resupination. The relationships, however are complex and render the group distinct from the douvillinellids. In the first few millimeters of growth, the valves have normal concavo-convex relationship; this growth is superseded by a convexo-subplanate condition; and in maturity the concavo-convex condition returns. Specimens were accordingly truly biconvex for much of their lives, which is unusual in

stropheodontids. Again there is every indication that this stock originated from a normal low-convexity douvillinid radicle just prior to or during the deposition of the Independence shale."

Genotype: Stropheodonta variabilis Calvin

Genus LEPTOSTROPHIA

Hall and Clarke, n. genus.

Hall and Clarke, Nat. Hist. of New York, 1892, Vol. VIII, pt. 1. p. 287.

"The plano-convex species of Stropheodonta are distinguished from the group of S. demissa by more than contour alone. The characters of the deltidium show the same progressive development as in the concavo-convex Stropheodontas, the earliest species having the delthyrium sometimes open, sometimes partially closed by a convex plate; while in the Devonian species the deltidium is reduced to a flat, transverse lamina, supported within by the callosity about the cardinal apophyses. In the pedicle-valve are two very strongly pustulose, diverging ridges, bounding the muscular impressions on their lateral margins, while anteriorly these scars are broadly flabelliform and not strongly limited. The central adductors are small, relatively obscure and not divisible. Should it be found desirable or important to recognise the value of the characters above indicated, these forms may be separated under the term Leptostrophia.

Genotype: Stropheodonta magnifica, Hall.

The muscular area, when its features are most distinctly retained, shows a subdivision into the following scars: (a) A large posterior pair (the posterior adductors), the surface of which is covered with arborescent ridges; the anterior portion of each of these scars is smoother than the rest, generally much thickened and often extremely elevated at its outer margins. These may be regarded as accessory elements of the posterior adductors. (b) An anterior pair (anterior adductors), situated close together at about the center of the valve. The position of these is generally well defined but their outline is frequently obscure. (c) An elongate, narrow median scar, which is apparently divided for its entire length by a faint ridge. In front of the muscular area there are often a number of short protuberances on each side of the median septum, and the anterior pair of scars is frequently obliterated by prominent callosities. At the line of geniculation the interior surface is elevated into a very prominent, sharp, or abruptly rounded crest. Spiral callosities for the support of the brachia, similar to those in Davidsonia and Leptaenisca, havebeen observed by Dr. Davidson.

Shell substance strongly punctate."

Genotype: Leptaena rugosa, Dalman = Producta rugosa, Hisinger = Conchites rhomboidalis, Wilckens

Range: Upper Silurian.

Genus NERVOSTROPHIA

Caster, n. gen.

Caster (1939), Bull. Am. Pal. Vol. 24, No. 83, p. 79.

"This genus based on Stropheodonta nervosa (Hall) is characterized by exceedingly thin shells which are sub planate, the ventral one being usually only very slightly more convex than the dorsal one, which is in some cases correspondingly very slightly concave. The surface ornamentation of the genotype usually gives a first impression of hirsuteness, for the principal costellae are conspicuously discontinuous, and irregular in height where developed. The ornament is really comprised of delicate radial corrugations of the shell which usually are reflected in reverse on the interior. New radii originate by intercalation. Between the principal radii are usually from four to six very fine undulating radii which also originate by intercalation, but are essentially continuous. The hinge is crenulated for about two thirds of the width, the crenulations usually diverging from the median line toward the front of the shell. The delthyrium is closed by a convex deltidium which may be secondarily opened at the commissure plane for the reception of the cardinal process. Internally the ventral valve usually shows prominent paradental lamellae which ordinarily fail to reach the palintrope wall. The ventral process is strongly developed, but the anterior boundary of the pedicle pit is usually obscure, and may well be developed as a special feature. The median septum varies considerably in degree of development. The ventral muscle scars are usually not well defined. They are flabellate area, which in certain Upper Devonian species of large size are well differentiated by lateral borders of callous material. The adductors were attached in the Upper Devonian shells to elongate median sub parallel plates or platforms which are separated either by a median septum or by a sharply angular median fossa, which sometimes has a relict septum at the bottom. In the genotype the adductor scars are ordinarly not well shown."

Genotype: Stropheodonta Nervosa.

Described by Williams (1953), Geol. Soc. Am., Mem. 56, p. 41.

"Exterior: Outline semicircular to elongately semi-oval, hinge line mucronate; concavo-convex and varying from a low to high curvature; with or without a variable ventral median sulcus and corresponding fold. Ventral interarea wide, apsacline to hypercline, dorsal interarea narrow anacline to orthocline, delthyrium completely or almost completely filled by pseudodeltidium, medianly folded or smooth. Chilidium vestigial or absent. Ornamentation rather finely parvicostellate, variably nervate. Pseudopunctae fine in a close pattern.

Ventral Interior: Hinge line rather variably denticulate but generally almost completely so. Process pits deep. Ventral process strong, tapering anteriorly to a fine long median ridge. Diductor

muscle scar, moderately long, triangular (in high convexity forms more parallel sided). Lateral bounding ridges distinct and very strong posteriorly; adductor scars elongately oval, impressed especially posteriorly divided by median ridge.

Dorsal Interior: Cardinal process lobes imperfectly to completely disjunct, attachment faces directed posteriorly to dorso-posteriorly; socket plates parallel to the sides of, and ankylosed to, cardinal process lobes. Notothyrial platform low, muscle-bounding ridges, slightly divergent or subparallel, high posteriorly; adductor scars generally on low platform of secondary shell deposit which may obscure the median ridge. Posterolateral areas of both valves rather coarsely tuberculate.

Range: Middle Devonian (Late Erian) to Upper Devonian (Senecan), reported so far from America only.

Discussion: Caster's description has been emended to include forms such as Leptostrophia camerata Fenton and Fenton, L. rockfordensis Fenton and Fenton, and L. calvini Miller, (i.e., species which Caster would refer to Sulcatostrophia Caster 1939), and forms which Stainbrook would include in his genus Pseudodouvillina, genotype P. euglypha Stainbrook. There are no major internal differences between any of these groups, as Stainbrook (1945, p. 27) and Caster (1939, p. 81) have also noted, and the genera have been based on (a) degree of convexity attained, (b) presence or absence of sulcation, (c) the presence or absence of a median fold in the pseudodeltidium. Thus, in the restricted use of these characters as proposed by Stainbrook, Nervostrophia embraces low-convexity forms with a median fold to the pseudodeltidium. Stainbrook would place L. rockfordensis, which has a variably developed ventral sulcus, in this group because it has a medianly folded pseudodeltidium; Caster places L. rockfordensis in Sulcatostrophia irrespective of pseudodeltidial fold. Sulcatostrophia includes low- to high-convexity forms which are sulcate and have a smooth pseudodeltidium, and Pseudodouvillina high-convexity nonsulcate forms which also have a smooth pseudodeltidium.

From a study of other groups, it appears that none of those characters is of sound generic value. Strophomenoids generally are notorious for their variation in convexity even within a population. Sulcation also has not the stability necessary for use as a generic character; in the strophedontids at least, it seems to be a variable product of gerontomorphosis. For instance, a population of L. rockfordensis will show variation from a nonsulcate form to individuals with a greater sulcation than is present in some of the L. camerata forms. We have already seen that the medianly folded pseudodeltidium is a stage of development immediately preceding the smooth pseudodeltidium, and this is boren out by the fact that low-convexity nonsulcate forms found in the Sly Gap formation (i.e. Nervostrophias in the restricted sense) have a smooth pseudodeltidium.

If we accept Stainbrook's definition of Nervostrophia, these Sly Gap shells constitute a new genus, and there would be four genera.

erected to cover a closely related stock. In my estimation, it is preferable to relegate all these forms to Nervostrophia and regard the group as a main generic stock pursuing a normal course of development in respect of the production of a smooth pseudodeltidium and, in its gerontomorphic stages, giving rise to two subsidiary divergences, a sulcate species group and a high-convexity species group.

Genotype: Stropheodonta nervosa Hall.

Genus SCHUCHERTELLA

Stainbrook (1943), Jour. Paleontology, Volume 17, No. 1., p. 41.

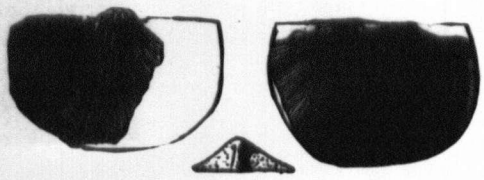
"Shells small to large, variable in shape, biconvex, plano-convex, or resupinate, broader than long, with the hinge line less than the greatest width.

Pedicle valve with moderately high umbo and beak, which in some species may be twisted. Palintrope variable in height, divided by a strongly convex deltidium, which completely covers the delthyrium and may be concave at the base; each half is divided into two areas by a line extending from the beak to the hinge line halfway to the extremities. The areas of the palintrope on either side of the deltidium are vertically and horizontally striated. The deltidium and the outer portions of the palintrope are only horizontally marked. Internally the hinge teeth are small, extend but little beyond the hingeline, and are unsupported below by lamellae; only the edges of the hinge plate are thickened. Muscle areas small, indistingly impressed on the floor of the valve, and separated by a faint median ridge. The remainder of the interior is quite smooth except near the lateral and anterior margins, where the costae are strongly expressed in reverse.

Brachial valve variable, convex, flat to slightly concave. Palintrope low but distinct, divided by a low chilidium, which embraces the cardinal process; each half of the palintrope is divided into regions as in the opposite valve. Internally the cardinal process is short, bifid, with each arm excavated a little on its posterior extremity. From the base of the process on either side a ridge diverges for a distance of one or two millimeters laterally and anteriorly; distally these ridges are expanded a little and posteriorly partially enclose a deep dental socket. Muscle area flabellate, usually not extending to the midlength; scars separated by a distinct median ridge, which is broadly rounded along the summit. The remainder of the valve is generally smooth or marked by obscure ridges and faint papillae. Near the lateral and anterior margins the valve is strongly costate. In neanic individuals the entire interior with the exception of the muscle scars may be costate. The above diagnosis is based on Schuchertella lens (White), with Schuchertella prava (Hall) and Schuchertella iowensis (Stainbrook) as examples.

Schuchertella was founded by Girty (1904) on Streptorhynchus lens White from the Louisiana limestone of Missouri. The characters of the genus were summed up by Weller (1914) who mentioned the biconvexity of the shell and the absence of dental lamellae as outstanding. These two characters he stated "as far as has been observed are always associated." The genus as thus defined is closely related to Schellwienella, which differs in possessing dental lamellae and a resupinate shell.

Genotype: S. lens White



1 3 2

Schuchertella chemungensis (Conrad) illustrations after Kindle. 1, Portion of a ventral valve showing striae and distorted beak. 2, Dorsal valve.(both X2) 3, Area of ventral valve.

SCHUCHERTELLA CHEMUNGENSIS

Schuchertella chemungensis Conrad (Kindle) 1909, U. S. Geol. Surv. Bull. 391, pl. III, p. 16.

The variable character of this species is well known. This is especially manifest in the striae, which are of three general types. In one of these the striae are subequal, fine, and threadlike, as in the variety figured by Girty. In another variety fine and coarse striae alternate more or less regularly. In a third variety, which has been observed at only one locality, the striae are arranged in fascicles of three or four fine striae separated by much coarser ones.

SCHUCHERTELLA GIRTYI (Shimer 1926)

Shimer, H.W. Geoc. Ser. Can. Bull. 42, p.34.

SCHUCHERTELLA GIRTYI

Description: Shell small, biconvex, wider than long, with hinge-line apparently shorter than the greatest width of the shell. Delthyrium slightly higher than wide. The dimensions of a somewhat imperfect shell are: length of pedicle valve 19 mm. of brachial valve 16 mm; greatest breadth (apparently near the midline of the shell) 24 mm. ; thickness 9.5 mm; length of hinge line 19 mm. length and basal breadth of delthyrium 5.5 mm. and 4.5 mm. A smaller pedicle valve was 13 mm. long and 17 mm. wide.

Pedicle valve arched from beak to front, distinctly so in the umbonal region, very slightly so or almost flat beyond. Transversely the valve is most convex in the umbonal region, from the highest point of which the valve decends in almost straight line to the cardinal margin. Anteriorly the valve is slightly flattened medially. Cardinal area high, transversely and ventically striae, straight below, arched above, the lower part inclined posteriorly so as to form an angle of about 110 degrees with the plane of the junction of the two valves. Beak twisted, projecting slightly over the cardinal area. Delthyrium covered by a convex, transversely ridged, and striated deltidium. Internally both dental lamellae and medium septum absent.

Brachial valve very gently and subequally convex both longitudinally and transversely. Cardinal area very narrow.

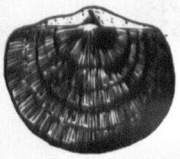
Surface of both valves marked by fine, rather sharply elevated radial costae, about 12 to 16 of which occupy the space of 5 mm.; interspaces wider than costae. These costae may be nearly equal in height and breadth, may alternate in size, or each third or fifth costa may be considerably stronger than the intermediate ones. Five concentric growth lines are faintly visible between the striae.

Remarks: Apparently identical with Orthothetes Chemungensis var. Girty; but differs in that the hinge line is always shorter than the width of the shell below, whereas in O. Chemungensis var. Girty the hinge line may be longer or shorter than the shell below.

Locality or Horizon: Upper Devonian (Ouray) of Colorado, in the Minnesaka region in the Upper Devonian Alberta.

Diagram

Fig. 1. Pedicle view of type specimen
Fig. 2. side view of type specimen
Fig. 3. cardinal view of type specimen.



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Schuchertella nevadaensis Merriam 1940, Holotype, brachial view, slightly reduced.

Measurements.-- Holotype, width 41 mm., length 35 mm., thickness 13.5 mm.
Occurrence.--

SCHUCHERTELLA NEVADAENSIS

Schuchertella nevadaensis Merriam (1940) Geol. Soc. Amer., Spec. Pap. No. 25, p. 80, pl. 6, fig. 5.

Description.-- This species is on the whole a much larger form than Schuchertella haguei and possesses coarser radial ornamentation and better developed concentric incremental ridges. Profile of ventral valve flattened in front of umbo; no reversal of curvature. Two well preserved specimens show straight anterior commissures. No individuals of this form show convexity of the ventral valve beyond the umbonal region.

Differs from ?S. deformis (Hall) and from S. chemungensis (Conrad) in its generally coarser ornamentation. The cardinal area of the new form appears to be relatively lower than that of S. lens White (genotype of Schuchertella) from the Louisiana limestone of Missouri.

The form from Lone Mountain regarded by Walcott (1884, p. 118) as Schuchertella chemungensis var. perversa (Hall) probably represents this species

1.

SCHUCHERTELLA PRAVA Stainbrook

Stainbrook, 1945, Geol. Soc. Amer., Mem. 14, p. 34, pl. 2, figs. 19, 20.

SCHUCHERTELLA PRAVA Stainbrook

Description: Shell medium sized, unequally biconvex, semi-elliptical in outline, with the cardinal extremities obtusely angular. Dimensions of the hypotype; length 14.0 mm., width 20.0 mm., thickness 5.0 mm.

Pedicle valve slightly convex, with maximum convexity in the umbonal region, thence the shell flattens to the anterior and lateral margins. Cardinal area 3 mm. in height, inclined 45 degrees posteriorly to the plane of the valve. The deltidium is strongly convex, and marked by sinuous growth lamellae.

Brachial valve more convex than thepedicle, being arched along the mid-length of the valve. Beak small and does not project beyond the cardinal margin; area linear.

The surface of both valves marked by finely rounded radiating costae which increase by division toward the anterior margin. The costae arecrossed by fine concentric growth lamellae which become apparent in the anterior portion of the shell.

Diagram: Dorsal view.

Genus STROPHEODONTA

Hall n. genus.

Hall (1852), Pal. of New York, Vol. II, p. 63.

"Shell with general form and characters of Leptaena (viz. one valve convex and the other concave, the concave one following the same curve, and nearly parallel to the convex one); cardinal area continuous, nearly linear, mostly occupied by the dorsal valve striated transversely; foramen decidedly closed; ventral valve with hinge line uninterrupted; margins of hinge line crenulated; area striated very strongly in the transverse and more slightly in the longitudinal direction. Muscular impressions somewhat bilateral.

The crenulated hinge line is a very strong distinctive character since in Leptaena this margin is smooth. In true Leptaena also the area is striated only longitudinally (that is in the direction of the hinge line) and the foreamen is in part occupied by a projection of the ventral valve which fills it; while in Stropheodonta, the foreamen, if it ever existed, is entirely closed by growth of the dorsal valve and the hinge line of the ventral valve is straight and continuous.

The striae of the shell in many species of Stropheodonta differ from those of Leptaena and some of the species are readily distinguished by this character alone."

Genotype: Leptaena demissa (Conrad)

Conrad (1842) description of Stropheomena demissa, Journal Academy Natural Sciences, Philadelphia, Vol. VIII, p. 258, pl. 14, fig. 14. is not in the Library of the University of British Columbia.

Described by Williams (1953), Geol. Soc. Am. Mem. 56.

"Exterior: Outline semicircular to elongately semi-oval, mucronate, concavo-convex with a high variability in strength of curvature. Ventral interarea apsacline in early members, orthocline in late forms, and dorsal interarea correspondingly anacline to hypercline; delthyrium progressively closed by pseudodeltidium evenutally entire and smooth, chilidium initially strongly convex progressively degenerate until it is lost. Unequally parvicostellate; in later forms a secondary but progressively dominant costation is superimposed. Pseudopunctae initially in an open radial pattern, in late forms more closely spaced.

Ventral Interior: Hinge line becoming progressively denticulate from initial stages of 4 to 6, supported by a pair of divergent dental plates subsequently lost, to an almost entirely denticulate stage. Process pits progressively deeper, strongly excavate in later forms. Ventral process prolonged anteriorly into a variably developed median ridge, initially obscure, progressively stronger, losing the concavity on the posterior face

and finally developing a pair of strong pseudoteeth. Diductor muscle scar elongately subcircular, antero-lateral to the lanceolate adductor scar, initially very faintly impressed but progressively more strongly so. No high-bounding muscle ridges.

Dorsal Interior: Cardinal process lobes initially plate-like, conjunct, with attachment faces directed postero-ventrally becoming progressively stouter and more disjunct until attachment faces are finally directed posteriorly to postero-dorsally. Socket plates initially strong, divergent, migrating towards hinge line and eventually parallel with it then abbreviated after loss of dental plates in the ventral valve and finally obsolescent. Adductor muscle scar, subcircular, divided by a median ridge and by 2 variably developed lateral ridges. Initially faintly impressed, in later forms scars, foliaceous, impressed on built-up areas of secondary deposit which buries posterior part of median ridge and often extends forward on either side of the visible part of the septum as two broad callosities."

Genotype: Leptaena demissa Conrad

Range: Upper Ordovician to the end of Upper Devonian.

1 2 3

Strophеodonta costata Owen 1, Pedicle view of a typical specimen. 2,3, Pedicle and brach- views of a hypotype.

STROPHEODONTA COSTATA

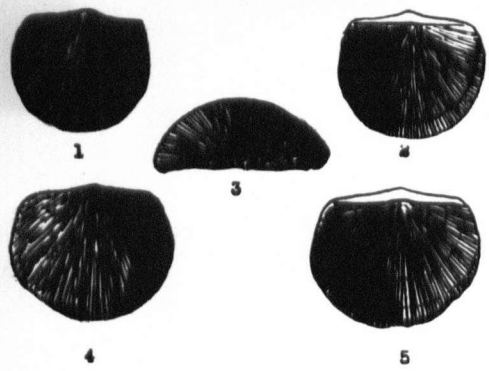
Strophеodonta costata Owen Stainbrook 1938 Jour. of Paleontology, vol. 12, p. 244 pl. 33, figs. 28-31.

Description.--Shell small, concavo-convex, wider than long, subquadrangular in outline, anterolateral margins rounded and cardinal angles auriculate, greatest width along the hinge line or in front of it. Dimensions of several hypotypes. length 13.5 mm., 15.2 mm., width, 16.6 mm., 18.7 mm., convexity of the pedicle valve, 5.5 mm., and 5 mm.

Pedicle valve convex, greatest convexity at the midpoint, the surface curving thence to the front and lateral margins and less rapidly to the hinge line, gently flattened or depressed in front of the umbo and depressed in front of the angles. Beak small, pointed, slightly incurved, cardinal area flat or gently concave, highest beneath the beak and maintaining the same height nearly to the extremities, vertically striated, and inclined posteriorly at an angle of about 45° to the plane of the valve. Interior unknown. Brachial valve concave, flat in umbonal region and curving strongly upward to the lateral and anterior margins. Area flat, vertically striated, making a right angle with the plane of the valve, and about half as high or more than half as high as the opposite area. Internally the bifid cardinal process is short and stout, the apophyses are close together and slightly divergent. Muscle area elevated, the adductor scars outlined by narrow rounded ridges, and the median ridge not strongly developed but extending beyond the centre of the valve. Near and parallel to the anterior and lateral margins is a low rounded ridge, beyond which the surface of the valve is abruptly deflected to the margins.

Surface of pedicle valve marked by moderately strong rounded to angular costae, which increase by intercalation accomplished three times from beak to front. Costae of brachial valve more rounded, wider, and increase by division. The costae on both valves vary in size, the longer ones being broader and more prominent. The intercostal spaces are as wide or wider than the costae and in most specimens are rounded at the bottom. Several prominent growth lines and numerous fine concentric striae cross the costae. Worn valves show the minutely punctate shell substance and numerous fine longitudinal radiating striae on the costae.

S. costata differs from S. plicata in being smaller, less convex, and in possessing a less strongly developed umbonal region.



Stropheodonta dorsata Stainbrook, 1,2, pedicle and brachial views of a paratype. 3,4,5, Posterior, pedicle and brachial views of the holotype.

STROPHEODONTA DORSATA

Stropheodonta dorsata Stainbrook, Jour. of Paleontology, 1938, vol. 12, p. 254.

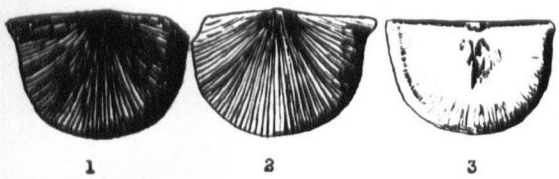
Description.--Shell of medium size, wider than long, with the greatest width anterior to the hinge line, subquadrate in outline, slightly rounded at the angles and broadly rounded at the front. Measurements of the holotype and of two paratypes: length, 27.5 mm., 30.1 mm., and 32.6 mm.; width, 31.5 mm., 37.2 mm., and 37.8 mm.; convexity of the pedicle valve, 11.6 mm., 13.3 mm, and 14.5 mm.

Pedicle valve strongly convex, the surface curving from the central point of the valve with equal rapidity to the margins, slightly auriculate at the angles; umbo a little convex; beak small and projecting a short distance beyond the hinge line; area flat, of nearly the same height throughout, and situated in the plane of the valve. Interior unknown.

Brachial valve deeply and evenly concave, but flattened in the umbonal region; area low and nearly at right angles to that of the pedicle valve.

Costae of both valves numerous, radiating, coarse, rounded to angular at the summits, and increasing by imbrication on the pedicle valve and by division on the brachial. Growth lines not uncommon and in many specimens conspicuous near the anterior margin.

Specimens at hand are noticeably lacking in costae, due in general to weathering but in some instances due to wear before entombment. The shells are usually reddish or purplish. The medium size, the proportionately greater convexity, and the thickness of the shells distinguish this species from S. halli, from S. cedarense, and S. littletonense.



Stropheodonta Halli Cleland. 1, 2, Pedicle views of two holotypes, M.A.S. 772, from Buffalo, Iowa 3, Internal view of a brachial valve, S.U.I. 6-367, from Linwood, Iowa.

STROPHEODONTA HALLI

Stropheodonta halli Cleland, Jour. of Paleontology 1938, vol. 12, p.243, pl. 35, figs.1-3

Description.--Shell large, wider than long, transversely subelliptical with rounded anterolateral margins, extended cardinal angles, widest along the hinge line.

Measurements.--Hypotype, length, 39.3 mm., width, 40.9 mm, thickness, 9.1 mm.

Pedicle valve convex, highest in the central part, surface sloping gently away from the midpoint in all direction, more rapidly on approching anterior and lateral margins, depressed anterior to the cardinal extremities and elevated in the umbonal region. Beak small, projecting a little beyond the hinge line, area flat, vertically striated, often attains height of more than 2 mm., gradually decreasing in height toward the extremities, inclined posteriorly and approaching the plane of the valve. Internally the broadly flabelliform muscle area extends anteriorly beyond the midlength, more than half as wide as the valve. Area marked by low angular radiating ridges and is distinct along posterolateral border and indistinctly set off from rest of valve toward front.

Brachial valve shallowly concave, flattened in the umbonal region, surface curving upward evenly to anterior and lateral margins and more abruptly to cardinal margin. Cardinal area 1/2 as high as that of opposite valve, flat, vertically striated, and at right angles to the plane of the valve. Internally the apophyses of the cardinal process are short, stout, grooved at the extremities, widely divergent, and extended a little beyond the hinge line. The muscle scars are variably developed in different specimens, weak in thin, strong in old or thick shells. Posterior adductor scars are bordered laterally and anteriorly by low narrow ridges, which, originating in front of and lateral to cardinal process, extend forward for some distance and, turning inward and backward, border the anterior scars a short way. Narrow median septum rises between front margins of the anterior adductors, increases in height toward front, ends abruptly shortly beyond middle of valve. Numerous papillae are scattered over remainder of valve but are more abundant and pronounced near muscle scars. Several mm. from the lateral and anterior margins the floor is elevated into a broad, low ridge marked by numerous transverse sinuses.

1 2 3 4 5

Strophеodonta plicata Hall. 1,2, Pedicle and brachial views of a holotype. 3, Brachial view of another. 4,5, Lateral and pedicle views of a large specimen, from Mid River, Johnson County, Iowa.

STROPHEODONTA PLICATA

Strophеodonta plicata Hall, Stainbrook 1938, Jour. of Paleontology, vol. 12, p.246, pl. 33, figs. 1-5

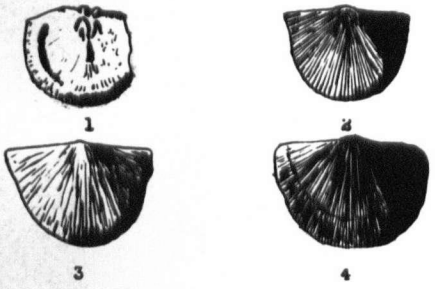
Description--Shell about medium size, mature specimens strongly concavo-convex, about as long as wide, subquadrate in outline with slightly auriculate cardinal angles and rounded anterolateral margins, widest near the mid-length, and with the hinge line generally less than the greatest width. Measurements of two hypotypes, length, 19.1 mm. and 19.1 mm., width, 20.9 mm. and 18.7 mm., thickness, 9.4 mm. and 7 mm.

Pedicle valve strongly convex, arched from beak to front and more strongly over the umbo, highest at the midpoint, from which the surface slopes rapidly to the anterior and lateral margins and more rapidly on each side of the umbo to the hinge line, a little flattened at the cardinal angles. Umbo strongly developed and projecting beyond the hinge line. Beak small, blunt, and extended beyond the cardinal margin. Area highest beneath the beak and decreasing in height rapidly toward the extremities, slightly concave, and situated in the plane of the valve. An incomplete valve shows the flabellate muscle scars and the crenulate hinge line characteristic of the genus.

Brachial valve gently to deeply concave, the surface depressed in the umbonal region and a little elevated at the angles, beak indistinguishable. Area low, of nearly the same height throughout, and at right angles to the opposite area.

Surface of both valves marked by numerous stout angular costae, which are separated by intercostal spaces nearly as wide as the costae. Increase is by division accomplished several times, the costae being larger near the beaks and smaller near the front margin. The costae, variable in size and length, are arranged in groups giving them a fasciculate appearance characteristic of this form.

Strophеodonta plicata is distinguished from Strophеodonta costata by larger size, by greater convexity of the pedicle valve, and by the much coarser costae arranged in groups.



1 2 3 4

Strophеodonta subdemissa Hall (illustrations after Stainbrook, 1938 pl. 35, figs. 14, 15, 17, 18.) 1, Internal view of a brachial valve, 2, 3, 4, Pedicle views, of three hypotypes.

STROPHEODONTA SUBDEMISSA

Strophеodonta subdemissa Hall (description after Stainbrook, Jour. of Paleontology, 1938, p. 246).

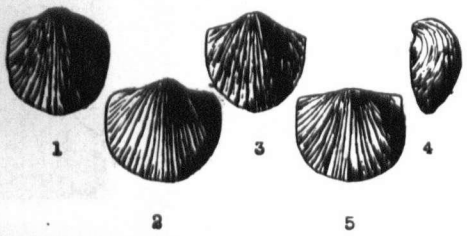
Description.--Shell medium to large, wider than long, with the greatest width along the hinge line, transversely subsemi-eliptical in outline with the cardinal angles extended and auriculate and the anterolateral margins rounded. Dimensions of a hypotype, a medium-sized, nearly complete shell: length, 19.8 mm.; width, 31.2 mm.; convexity of pedicle valve, 7.5 mm.

Pedicle valve moderately convex, attaining its highest point in the center of the valve, whence the surface slopes laterally and anteriorly with moderate rapidity; gently convex in the umbonal region and depressed toward the cardinal extremities so as to give them an auriculate appearance; beak small, scarcely projecting; cardinal area low and decreasing but little in height until near the extremities, flat, vertically striated, and posteriorly inclined a little to the plane of the valve. Interior not known.

Brachial valve moderately concave, the surface flattened centrally but curving upward strongly to the lateral and front margins; area flat, nearly half as high as the opposite area and making a right angle with it. The internal characters are similar to those of other members of the genus.

Surface of both valves marked by numerous angular fairly strong costae, which increase by intercalation and bifurcation. They are more rugose and closer together in the posterior part of the valves and anteriorly are evenly spaced, about two occupying the space of a millimeter at the front margin. The intercostal spaces are as wide as the costae or wider and, like them are marked by numerous puncatae where worn and by fine longitudinal radiating striae.

S. subdemissa differs from S. halli in the greater width in proportion to length and in the auriculate extention of the cardinal extremities.



Strophedonta umbonata Stainbrook, 1,Pedicle view of the holotype, S.U.I. 6-350A. 3,4, Pedicle and lateral views of a paratype, S.U.I. 6-350; both from Solon, Iowa. 2,5, Pedicle views of two paratypes, M.A.S. 27; both from Linder's boathouse, North of Iowa City, Iowa.

STROPHEODONTA UMBONATA

Strophedonta umbonata Stainbrook, 1938, Jour. of Paleontology, vol. 12, p.252, pl. 33, figs, 6-9, 19.

Description.--Shell less than medium size; highly concavo-convex; subquadrate in outline with angular cardinal extremities and rounded anterolateral margins, which meet in a gradual curve at the front; a little wider than long, and widest in front of the hinge line. Dimensions of the holotype and of a paratype: length, 20.5mm. and 22.4mm.; width, 21.7mm. and 22mm. (incomplete); convexity of the pedicle valve, 16.6 mm. and 10.2mm.

Pedicle valve strongly convex, the point of greatest convexity posterior to the midlength, whence the surface slopes rapidly to the anterior margin and more rapidly to the lateral margins, depressed a little in front of the cardinal angles; umbo large and conspicuous, projecting beyond the hinge line; beak small, incurving, and projecting a little cardinal area highest beneath the beak, decreasing in height toward the extremities, gently curved, and situated in the plane of the valve.

Brachial valve strongly concave, the umbonal region flattened or depressed, deepest in the central part, the surface curving upward rapidly near the margins, flattened toward the cardinal angles so as to form small triangular areas elevated above the central part of the valve; beak indistinguishable; area low, flat and at right angles to the plane of the valve.

Surface of both valves broken by numerous coarse angular radiating costae of variable size, which increase by implantation. The intercostal spaces are as wide or wider than the costae. Shell substance when worn is punctate and striate. Occasional growth lines cross the costae.

Occurrence.--Cedar Valley limestone. The type specimens are from the bellula zone (Megistocrinus beds of Calvin) and were collected in Johnson County between Solon and the Iowa River. Other examples have been found at Linder's boathouse, north of Iowa City, at Buffalo, and at Brandon, Iowa.

Types.--Holotype, S.U.I. 6-350A; Paratypes, 6-250B and C, and M.A.S. 475, 486, and 27.

Strophedonta parva Owen (illustrations after Stainbrook, 1938, pl. 33, figs. 25-27, 32-33.) 2,3, Pedicle and brachial views of a small hypotype, 1, 4, 5, Pedicle views of three hypotypes.

STROPHEODONTA PARVA

Strophedonta parva Owen (this description after Stainbrook, (1938), Jour. Paleontology, Vol. 12, p. 245.)

Description.-- Shell delicate, wider than long, depressed concavo-convex, subrectangular outline, angles a little auriculate, lateral margins straight and parallel for most part. Dimensions of 2 hypotypes: length, 15.4 mm., 12.1 mm.; width, 19 mm., 16 mm.; thickness, 5.6 mm., 3.9 mm.

Pedicle highest posterior to midlength, surface sloping thence to lateral and anterior margins and more strongly on each side of umbo to hinge line. Area low, highest beneath beak (about 1 mm.), flat, vertically striated, and situated in plane of valve.

Brachial valve shallowly concave, flattened centrally and gently depressed in the umbonal region; area flat, nearly as wide as that of opposite valve and forming an obtuse angle with it. Cardinal process short, muscle scars faintly impressed, and low median septum extends a short way beyond the midlength.

Surface of both valves broken by numerous fine angular costae, which are regular in appearance. Costae increasing by division and intercalation on the pedicle valve and by division on the brachial. Three to four in the space of a mm. at the front margin of a medium-sized specimen. Crossed by few strong lines of growth and numerous fine concentric striae. In worn specimens the shell substance is longitudinally striated and minutely punctate.

Owen's types of this species have not been recovered, but his brief description, his measurements, and his illustration indicate that he had at hand specimens described. However, Owen notes from 20 to 30 costae whereas some of our specimens show nearly twice that many. The small size, the numerous fine costae, and the characteristic shape distinguish S. parva from other Devonian species.

Occurrence.--

Genus STROPHONELLA

Hall 1879 emended.

Williams (1953), Geol. Soc. of Am. Memoir 56, p. 47.

"Exterior: Outline elongately semi-oval, mucronate, resupinate with a varying degree of curvature of geniculation. Ventral interarea wide, apsacline, dorsal interarea narrow anacline; delthyrium progressively closed by pseudodeltidium but never attaining the entire stage, chilidium initially highly arched, massive, becoming obsolescent but never absent. Basic ornamentation finely parvicostellate with widely spaced primaries, in some later forms shell ornamented by secondary costellae; often faintly rugate especially postero-laterally. Pseudopunctae open to closely radial in disposition.

Ventral Interior: Hinge line progressively denticulate from a few denticles on either side of umbo to about half the length of hinge line. Early forms with widely divergent dental plates, lost by fusion in later members of the stock. Process pits initially faint, progressively deeper; ventral process progressively stouter to form a massive support to pseudodeltidium, prolonged anteriorly as a fine strong median ridge. Muscle scar initially rather faintly impressed and subcircular, ultimately becoming quadrate and bounded laterally and anteriorly by low interrupted ridge with a "petaloid" appearance. Diductor scar flabellate lying lateral to a wide oval adductor scar.

Dorsal Interior: Cardinal process lobes initially long and plate-like, conjunct with postero-ventrally directed attachment faces; becoming massive and incipiently disjunct. Notothyrial platform initially absent, in later forms consisting of a low, triangular deposit of secondary shell substance. Socket plates initially long and widely divergent becoming short. Adductor muscle scar faint, subcircular, divided by a low median ridge and bounded by low indistinct ridges."

Genotype: Stropheodonta semifasciata Hall

Range: Lower Silurian (Gasworks Sandstone) to Middle Devonian (Hamilton).

Superfamily Chonetacea (Shrock and Twenhofel, p. 327).

"Flattish shells with concavo-convex profile, pseudo-punctate, and with spines along posterior margin of pedicle valve.

Range: Upper Ordovician to Permian.

Genera Described:	Range:
I. Genus Chonetes Fischer	
II. Genus Chonopectus Hall and Whitfield	Upper Devonian to Lower Mississippian.

Reported occurrence of this superfamily in the literature reviewed in Part I of this thesis.

I. Genus Chonetes Fischer. 8, 9, 10, 12, 21, 22, 26, 31, 34, 35.

* C. deflecta Hall. 18, 20, 22, 33.

C. logani Hall. 2.

C. setigera Kindle. 21.

II. Genus Chonopectus Hall and Whitfield.

C. horaeus Crickmay. 39.

Genus CHONETES

Fischer n. gen.

Description by Fischer (1837) in Hall (1852) Nat. Hist. N.Y., Vol. II, p.64.

"This genus has the same form as Leptaena and is distinguished principally by a row of tubular spires on the margin of the dorsal valve boardering the area."

Description by Davidson (1854) in British Fossil Brachipoda, p. 113.

"Shell inequivalue, compressed semicircular, with a straight hinge line, commonly as long as the width of the shell, or prolonged in the shape of auricular expansions; dental valve convex depressed towards the cardinal edge; socket valve always concave following the curves of the other; area distinct almost equal in both valves or larger or more produced in the dental one; the uppermost edge of the area in the larger valve is acute and provided with a row of delicate spinose hollow tubes, varying in number in different species and becoming gradually longer as they recede from the extremity of the beak, diverging obliquely from the hinge line; fissure covered by a pseudo-deltidium. In the socket valve the opening is entirely filled up by a projecting bifid or trifid cardinal process; surface ornamented with minute, longitudinal, dichotomised, or intercolated striae, rarely largely plaited, but transversely marked by concentric lines of growth.

Internally the valves articulate by means of teeth placed at the sides of the fissure of the dental valve, and corresponding sockets excavated on each side of the cardinal prominence already described. In the dental valve, a small longitudinal ridge divides the muscular impression situated on either side, the cardinal muscles probably occupied the greatest space, the adductor lying on either side close to the mesial ridge. In the socket valve a blunt medio-longitudinal ridge divides the quadruple impression of the adductor muscle, which forms on either side two oval scars between which (in some specimens) two short vascular impressions proceed in an outward oblique direction. When turning backwards and inwards, they terminate some distance from their origin. Interior of the valves is covered with minute granulous aperities, arranged in longitudinal lines; animal unknown, probably free or attached in the young by fibres issuing from the fissure."

Discussion: Davidson further adds: "In 1837 Fischer de Waldheim (1) proposed the genus Chonetes but did not characterise it sufficiently, and it was only after the publications of M. de Koninck (2) and de Vernueil (3) that its value became known."

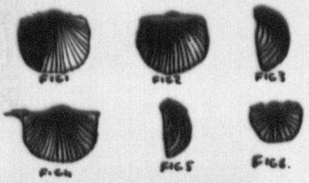
(1) Fischer de Waldheim (1837) Oryctographic du Gouv. de Moscow, p. 134.

(2) M. de Koninck (1843) Description des Anim. Foss. du Terrain. Carb. de Belgique.

(3) De Vernuèil (1845) Russia and the Ural Mountains, Vol. (ii).

Genotype: (According to Davidson) Chonetes Sarcinulata (Schloth).

DEFLECTA (Gibbosa) UPPER DEVONIAN BRACHIOPODA CHONETES



CHONETES DEFLECTA (Hall 1867)

J. Hall, Nat. Hist. New York. Vol. VII, p. 126.

CHONETES DEFLECTA (Hall)

Description: Shell semielliptical, length and width four to five or eight to nine, but rarely proportionally wider.

Ventral valve extremely gibbous, regularly arched to greatest elevation, being about the middle of the length; abruptly depressed towards the cardinal angles, which are flattened with extremities deflected toward the ventral side. The umbo is a little elevated above the cardinal margin, and the minute apex (in perfect specimens) projects a little over the area.

Dorsal valve deeply concave but not equalling the convexity of the ventral valve.

Area of the ventral valve narrow with the exterior margin declining in a gentle curve to the extremities: the triangular foreamen is partially closed by a pseudo deltidium and the apature occupied by the cardinal process of the opposite valve. Dorsal area more than half as wide as the ventral, and marked in the middle by a wide triangular callosity.

Surface of the ventral valve marked by from twenty six to thirtyfour sub angular or sometimes rounded striae, which are often irregularly increased by bifurcation or intercalation towards the margin. In those with fewer striae they are sharper, more abruptly elevated and only half as wide as the interspaces; while those with a larger number the striae and interspaces are equal but sometimes the striae become fuller and more rounded and the interspaces proportionally less in width. The striae on the dorsal valve correspond to those on the ventral, but there is considerable space at the cardinal angle devoid of striae. Fine closely arranged concentric striae are visible on the surface of well preserved specimens.

Geological Type Locality: Hamilton group, New York.

Diagrams:

Fig. 1. Ventral)
Fig. 2. Dorsal) views of the ordinary form and size.
Fig. 3. Profile)

Fig. 4. Ventral)
Fig. 5. Profile) views of a specimen referred to a
Fig. 6. Dorsal) c. gibbosa.

Genus CHONOPECTUS.

n. gen.

In Hall and Clarke, Nat. Hist. of New York, 1892, Vol. VIII, pt. 1. p. 312.

"This name is proposed for the species, Chonetes Fischeri, Norwood and Pratten, a large, normally concavo-convex shell, with a sub-semicircular outline; occurring in the oolitic limestone and yellow sandstone of the Burlington beds of Iowa. In this species the cardinal margin of the pedicle-valve bears a row of erect spines, as in Chonetes. The beak is often compressed or distorted in such a manner as to leave a flattened area, which resembles, and probably is a cicatrix from attachment in early growth. This character is more prominent in some individuals than in others, and appears to have become considerably obscured by the later growth of the shell. The surface ornamentation is also peculiar; the shell bearing a double oblique series of concentric lines, which give to the surface the appearance of engraving on a machine-turned watch case. These lines are wrinkles rather than striae, and are strongest over the umbonal and central region, where traces of them may sometimes be observed on internal casts of the valves. The wrinkles are crossed by a normal series of very fine concentric growth-lines, and beneath these, but not always exposed, are exceedingly fine, crowded, radiating striae, usually very much interrupted in their course from beak to margin, and often flexuous and irregular. Sometimes the surface is entirely free from the double series of concentric wrinkles, and marked only by the fine radiating and concentric striae.

The internal muscular impressions of the species have not been fully determined. Casts of the pedicle-valve show the impression of a short median septum dividing two broad obcordate flabelliform muscular scars, from the outer margin of which sometimes originates a series of irregularly radiating furrows or ridges, which were probably of vascular origin. Impressions of a very narrow cardinal area and exceedingly small hinge-teeth are also seen on internal casts of this valve."

Genotype: Chonetes fischeri, Norwood and Pratten

Superfamily Productacea (Shrock and Twenhofel, p. 328).

"Members of this superfamily, the productids, are pseudopunctate brachiopods, typically plano- or concave-convex, with conspicuous spines on the entire exterior of the shell. They are particularly abundant in Pennsylvanian rocks the world over, but range from Lower Devonian to the end of the Paleozoic.

Range: Lower Devonian to Permian.

Genera Described: Range:

I. Genus Devonoproductus Stainbrook

II. Genus Productella Hall Devonian to Mississippian

III. Genus Strophalosia King

Reported occurrence of this superfamily in the literature reviewed in Part I of this thesis.

I. Genus Devonoproductus Stainbrook

D. walcotti. 38

II. Genus Productella Hall. 8, 9, 10, 12, 16, 21, 24, 31, 34, 35, 37.

P. belanski Stainbrook. 37.

P. callawayensis Swallow. 26.

* P. coloradoensis Kindle. 16, 18, 20, 21, 22, 24, 29, 33, 36, 37.

* P. depressus Kindle. 21.

P. dissimilis Hall. 2.

P. girtyi Shimer. 36.

P. hallna Walcott. 20, 22, 26, 33.

P. hirsuta Hall. 25.

* P. lackrymossa Conrad. 2, 9, 15, 21, 37.

III. Genus Productella Hall (continued)

* P. laminatus Kindle

* P. lata Warren. 22.

* P. pyxidata Hall

P. shumardiana Hall. 22.

P. spinulicosta Hall. 2, 8, 11, 22, 24, 25. 36.

P. suboculata Hall. 2.

IV. Genus Strophalosia King

S. productoides Nicholson. 2.

Genus DEVONOPRODUCTUS

Stainbrook, n. gen.

Stainbrook (1943), Jour. Pal. Vol. 17, No. 1. p. 55.

"Shell small to medium in size, productiform, auriculate at the angles, strongly concavo-convex, with straight hinge line, which may be less than the greatest width; proportion of breadth to length and height variable among individuals of the same species; ephebic specimens are usually longer than wide.

Pedicle valve strongly arched from beak to front, more strongly so posteriorly, strongly arched transversely in the central part, and expanding toward the front. Cardinal angles depressed and slightly extended, at least in ephebic examples. Umbo prominent, high, extended beyond the hinge line, worn in most examples but apparently not attached. Palintrope extremely low, reduced, nearly linear; in specimens with closely appressed valves is often scarcely visible when examined with the unaided eye. It is divided into two parts by a low delthyrium, which is usually concealed by the beak. There is no evidence of a deltidium, the space being occupied by the cardinal process of the opposite valve. The exterior is marked by numerous small to minute costae, which increase by division several times from beak to front. Spine bases are usually subcircular, sometimes elongate, sparse, irregularly scattered over the surface, situated on one or morecostae, which pass through and not around the bases. Spines when present are erect, strong, hollow, cylindrical, and more or less perpendicular to the surface of the valve. They may have been several millimeters in length. Along the hingeline are four or five spine bases, which project upward and backward in a manner somewhat reminiscent of Chonetes.

Internally a deep visceral chamber is distinctly set off from the smaller remaining portion of the valve. It is semioval in shape and broadest anteriorly. The posterior and lateral borders are formed by a ridge, which diverges from the base of the hinge tooth on either side and swings outwardly in a broad curve toward the front, where it becomes indistinct. The posterior portion of the ridge may be projecting and shelflike. The muscle scars are weakly impressed on floor and are usually indistinct. As far as can be discerned they occupy a large part of the visceral disc and are marked by a few radial striae. The remainder of the valve, which may be designated as the trail, is narrow and marked by many minute rounded crowded papillae. The hinge teeth are greatly reduced, microscopic, being merely projections of the angle formed by the hingeline and a side of the delthyrium. In most specimens they are not evident, only two individuals show them unmistakably. Small dimples are present along the hingeline beneath the spines; they do not appear elsewhere on the valve interior.

The brachial valve is shallowly concave, deepest centrally, and

in an area which broadens laterally and anteriorly from the beak. Umbo concave; beak small, rounded, slightly elevated. Surface marked by numerous regularly spaced angular concentric wrinkles of growth, which are strongly laminose when well preserved. Between the laminae are numerous fine concentric striae. Close inspection also demonstrates the presence of faint radiating costae, which are interrupted by the growth laminae. The latter are homologous with the rugae of the pedicle valve and give the characteristic appearance to the valve. The shell substance where worn appears to be strongly pustulose. No palintrope is distinguishable.

In the interior the dental sockets are nearly obsolete and are hardly distinguishable as such, being merely niches between the apophyses of the process and the posterior edge of the valve. Interior distinguishable as a large visceral disc and narrow trail. The disc is subovate in outline, broadest anteriorly and bordered posteriorly on each side by a narrow ridge, which originates at the base of the cardinal process and curves anteriorly to disappear near the middle of the valve. Bisecting the visceral area is a narrow, thin median septum, which originates a short distance anterior to the process and extends a little beyond the midpoint. At this place it attains its maximum height. The anterior portion of the visceral disc in some examples is limited by narrow grooves originating at the anterior end of the septum and diverging laterally and posteriorly in broad curves to the region in front of the process, where they disappear. The muscle areas are faint and often imperceptible. The scars are elongate, flabellate, and do not reach the midpoint. Surface of the visceral disc generally smooth except toward the front, where it may be slightly marked by radial striae. That portion of the valve exterior to the visceral disc is marked, especially along the front, by numerous crowded pointed projections. They are spinose in appearance, apparently hollow where broken, pointed, and may be termed endospines.

Devonoproductus resembles Productella in shape, in the presence of a pedicle palintrope, a delthyrium, teeth, spinose pedicle and non-spinose brachial valves, in the possession of a median septum in the brachial valve, and in having rugae on the pedicle valve. It differs from Productella in having the exterior of the valves costate, the brachial valve strongly lamellose, and in not showing dimples on the brachial valve opposite the spines of the pedicle excepting along the hingeline. Devonoproductus lacks a palintrope in the brachial valve, has the teeth and sockets greatly reduced, has the visceral disc of each valve distinctly set off from the trail, and has a diaphragm in the pedicle valve in the form of shelves along the posterior borders of the visceral area. Devonoproductus has also endospines on the brachial interior on the trail.

This genus may be the radicle from which later genera of productids have been developed. It could easily lead to Productus by the development of reticulate umbonal regions, by establishment of continuous rugae, and by the loss of teeth and sockets and palintrope. It could also lead with few changes to Linoproductus by the reduction of the brachial growth lamella, palintrope and spines."

Genus PRODUCTELLA

Hall, sub gen.

Hall (1867), Pal. of New York, Vol. IV, p.153-160 and 162-184, pl. XXIII.

"Shells having the general form of Productus but uniformly with a narrow area on each valve, a foramen or callosity on the ventral area small teeth, and more or less distinct teeth sockets.

The reniform vascular impressions, rising between the anterior and posterior occlusor muscular impressions curves gently outwards, and following a curvature somewhat parallel with the margin of the shell to below the middle of its length, is abruptly recurved and the extremity turned a little backwards terminates about half way between the margin and the anterior extremity of the mesial septum.

The cardinal process seen from the inner side is bilobed and from the exterior side of each of these divisions is usually bilobed.

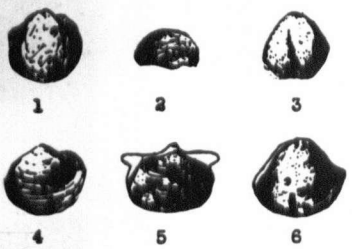
Discussion: In the specimens affording the most satisfactory evidence of area etc., the foreamen is open, but in some specimens the impression only remains, and there is the appearance of a narrow indentation below the beak so that it is impossible to determine whether the foreamen has been open, or closed by a deltidium."

Genotype: Productus Subaculateatus (Murcaison)

Hall (1867) description of Productus subaculateatus.

"Ventral valve gibbous; length and breadth about 7 to 8. Hinge extremities angulated and the margins being contracted a little below form small ears while below this contraction the sides are regularly curved and the front is broadly rounded. The umbo is considerably elevated above the hinge line, and the apex incurved.

Surface marked by closely arranged concentric striae, and studded with slender round spines. On the upper part of the shell and on the ears the spines are round at the base, and rise directly from the surface. On the middle and lower part of the valve there is a slight elevation of the surface a little above the base of the spine, but not a defined ridge."



Productella coloradensis Kindle 1909
1, 3, Two ventral valves. 2, Side profile view of ventral valve. 4, Ventral valve of the type specimen. 5, View of interior of dorsal valve. 6, Ventral valve showing a short plication near the front.

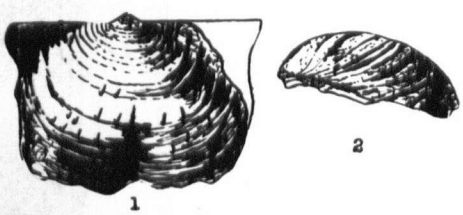
PRODUCTELLA COLORADENSIS

Productella coloradensis Kindle 1909, U. S. Geol. Surv. Bull. 391, pl. 1V p. 17.

Mature specimens show tendency toward a sinus in the ventral valve. Generally this amounts only to a flattening across the middle of the shell, but in some shells a distinct sinus is present, as shown in fig. 4. In p. semiglobosa ther is no such flattening, the shell presenting a regularly circular outline in front. The Colorado form is slightly more arched, the beak more strongly incurved and the shell descending more abruptly in front. However, the Colorado and the Louisville species are very closely allied, particularly in the scattered irregular spine bases of circular outline. Prominent ears similar to those of the Colorado specimens are preserved on one of the Louisville shells. The more arculate form and greater tendency to a geniculate front are the chief distinguishing features of this species.

Round spine bases mark the anterior 2/3 of the shell. On well-preserved specimens small round tubercles which do not seem to have been spines take the place of these in the umbonal region. In exfoliated shells small round pits mark the mold of the shell under the spine bases, indicating a thickening of the shell on the inner side at the base of the spines. In a few specimens the natural mold exhibits narrow elongated pits corresponding to similar elevations on the interior of the ventral valve. These however, do not appear on the outer surface of the valve. Fine concentric lines of growth mark the surface of well-preserved shells. Prominent concentric wrinkles mark the ears and less distinctly the umbonal region. They are absent or indistinct on the anterior 2/3 of the shell.

Dorsal valve distinctly geniculate in front and moderately concave in the middle and posterior portion. The surface is marked by small shallow pits about corresponding in number to the spine bases of the opposite valve. The cardinal process has two short, slightly diverging pronge.



Productella depressa Kindle, 1909. 1,2, Ventral valve showing exfoliated surface and the side profile.

PRODUCTELLA DEPRESSA

Productella depressa Kindle, 1909, U. S. Geol. Surv. Bull. 391, Pl. V. P.20.

Shell large, broader than long, the proportion being about 11 to 8. The ventral valve is only moderately convex in the median portions, depressed as compared with most species of Productella, and has broad flattened ears. A broad and rather deep sinus marks the anterior third of the shell, giving it a sinuate front. The beak and umbone are small and inconspicuous. The entire surface, with the possible exception of the umbonal region, which is exfoliated, is marked by small elongated spine bases pointing forward. These are rather numerous in the anterior portion of the shell and are comparatively scarce on the ears. Concentric wrinkles and very fine striae of growth complete the surface markings.

This species may be compared with P. bialveata, P. boydi, and P. lachrymosa var. lima of the Chemung, each of which is characterized by a sinus in the ventral valve. The limitation of the spines to the marginal region in the first species, however, distinguishes it from P. depressa. In P. boydi the sinus extends to the beak, instead of being limited to the anterior portion of the shell, as in this species. It seems also to have a greater proportional breadth at the hinge line than in P. boydi. The gibbous character of the ventral valve of P. lachrymosa var. lima distinguishes it from P. depressa, whose broad depressed valve has just been described. A similar and still more stricking contrast exists between this species and P. coloradensis, which is associated with it.


Fig. 1


Fig. 2


Fig. 3


Fig. 4.

PRODUCTELLA LACHRYMOSA var. LIMA (Hall 1867)

Hall Pal of New York, Vol. IV. P. 174

PRODUCTELLA LACHRYMOSA var. LIMA (Hall)

Description: (after Conrad)

Semi orbicular lower valve ventricose, depressed in the middle, most profound towards the base; surface with numerous elliptical tubercules disposed somewhat in quincunx order; umbo ventricose superior lateral surfaces much depressed.

Remarks: Differs from P. Lachrymosa in the depressed middle, much more numerous shorter tubicules. The size is nearly the same.

Locality: Chemung group, New York.

Diagrams: Fig. 1. Ventral valve, regularly convex.
Fig. 2. profile of same.
Fig. 3. shorter more quadrate form with mesial depression
Fig. 4. Cardinal view of same specimen showing muscle markings and cavities left by teeth.


1 2 3

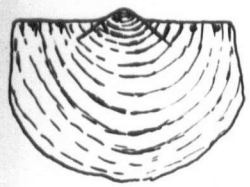
Productella laminatus Kindle 1909. 1, Ventral valve of the type specimen. 2, Hypothetical ventral valve. 3, View of a ventral valve of a small individual.

PRODUCTELLA LAMINATUS

Productella laminatus Kindle 1909, U. S. Geol. Surv. Bull. 391, pl. IV, figs. 13, 14, p. 18.

Shell rather small, subhemispheric in outline, with hinge line slightly shorter than greatest width of shell, and cardinal angles rounded.

Ventral valve moderately convex. Beak small, slightly overarching the hinge line. Surface studded with slender, closely placed spines, and marked by a series of 14 to 18 prominent concentric lamellose bands, having a width of from 1 to 1 1/2 mm. each, and by very fine concentric striae. Pedicle valve unknown. This species resembles in its numerous fine spines the next described species, P. spinigera, but the uniform character and regular spacing of the lamellose bands and the less highly arched ventral valve distinguish it from that form. The prominent lamellose bands, indeed, distinguish it sufficiently from any other species.



1

PRODUCTELLA LATA Warren (1927)

Warren, P.S., G.S.C. Memoir 153, 1927

Productella lata Warren

Description: Shell large, wider than long, moderately convex. Dimensions of an imperfect specimen: length at least 37 mm., width at least 55 mm., convexity of pedicle valve at least 15 mm.

Pedicle valve with greatest convexity a little posterior to the middle, the surface rounding a little more abruptly toward the beak than toward the anterior margin. Postero-lateral areas flattened. Beak small, pointed, and only very slightly produced beyond the hinge-line.

Surface marked by numerous, irregular, concentric wrinkles and fine lines of growth. Spine-bases few, limited to the lateral and postero-lateral slopes, a row of very prominent ones being situated near the hinge-line on either side of the beak.

Brachial valve unknown.

Remarks: The species is known from two rather imperfect pedicle valves, both of which are badly exfoliated. In some of its characters the shell resembles P. depressa Windle, from the Quray limestone, but differs in the absence of a sinus and in the distribution of the spines.

Age and Locality: Upper Devonian; upper beds of Minnewanka limestone.

. . . . .

Reference: Warren, P.S., 1927

Diagram: Fig. 1 - Incomplete pedicle valve

Fig 1. Fig 2. Fig 3.

PRODUCTELLA PYXIDATA (Hall 1858)

Weller (1914) Ill. Geol. Surv. Mon.1, p. 100, pl. 19.

PRODUCTELLA PYXIDATA

Description: Shell wider than long sub semi-elliptical in outline, hinge line a little shorter than the greatest width cardinal extremities rounded. Dimensions of an average sized specimen hinge line to front margin 14.4 mm; umbonal region of pedicle valve to front margin 16.4 mm; greatest width 19.1 mm. length of hinge line ± 17 mm; convexity of pedicle valve 17 mm.; depth of visceral cavity 4.6 mm.

Pedicle valve moderately conved greatest convexity posterior to the middle; umbonal region projects beyond hinge line, surface curving abruptly from the umbonal region to the cardinal margin curving less abruptly to the lateral margins and more gently to the anterior margin, strongly and rather abruptly compressed towards the cardinal extremities; mesial sinus absolute beak small and incurved.

Brachial valve rather deeply concave with the surface somewhat deflected towards the cardinal extremities, the concavity rather narrow at the beak and broadening rapidly anteriorly.

Surface of both valves marked by more or less crowded concentric lines of growth.

Spine bases extremely variable in their development; on the pedicle valve they are sometimes nearly absent except for a few near the cardinal margin and again they are more or less crowded and usually arranged in radiating series over the entire surface sometimes they are strong and elongate and the radiate arrangement is so well defined that the surface of the valve appears almost to be marked by radiating costae; upon the brachial valve the spine bases are never so conspicuous.

Internally the cardinal process is small bifid with each division longitudinally excavated along its posterior and outer surfaces. From the base of the cardinal process a pair of ill defined low broadly diverging ridges extend for one third or more of the distance to the posterior lateral margins their posterior slopes constituting rudimentary dental sockets. A medium septum reaches to just beyond the middle of the valve. The greater part of the inner surface is covered by closely crowded tubercules arranged more or less in a radiating series.

Locality and Horison: Lower Mississippian of Missouri.

Diagram:

Fig. 1. Pedicle valve.
Fig. 2. Brachial valve.
Fig. 3. Side view.

Genus STROPHALOSIA

King 1844, n. gen.

In Hall and Clarke, Nat. Hist. of New York, 1892, Vol. VIII, pt. 1. p.314.

"Shells productoid in general form; a cicatrix, usually apparent on the umbo of the pedicle-valve, indicates that they were attached to foreign bodies by the substance of the shell. Both valves have a well defined area and covered delthyrium, these features being much the more conspicuous in the pedicle-valve. In this valve the teeth are prominent, but not supported by lamellae; the muscular arrangement is the same as in Productus, though the cardinal impressions are relatively larger and more elongate, extending beyond the limits of the central adductors.

In the brachial valve the cardinal process is erect, bifid on its anterior, and quadrifid on its posterior face. It is supported on each side by short, arched crural plates, and is continued into a median septum which extends for half the length of the valve. Muscular impressions small, quadruple, not dendritic, the interior pair being sharply raised. The brachial ridges originate from between the adductor scars, curving gently outward, recurving, at first gradually and then abruptly to their anterior limit; then turning suddenly backward and again inward horizontally, meeting the median septum near its anterior extremity.

Surface of the pedicle-valve covered with spines, which near the beak are often curved backward, embracing some external object. In some species all the spines of the valve have evidently been at least of accessory importance in effecting its attachment. The surface of the brachial valve may be either spinous, lamellose or smooth."

Genotype: Orthis excavata, Geinitz, = S. Goldfussi, (Munster) Davidson.

Range: Permian of Europe.

Superfamily Rhynchonellacea (Shrock and Twenhofel, p. 329).

"The rhynchonellids are impunctate subtriangular, rostrate shells, characteristically costate, and the delthyrium is usually closed by deltidial plates. The small foramen lies just anterior to the beak. The lophophore is supported by crura. The Rhynchonellacea are supposedly the earliest and simplest telotrematous brachiopods."

Range: Middle Ordovician to Recent.

Genera Described:	Range:
I. Genus Calvinaria Stainbrook	
II. Genus Camarotoechia Hall and Clarke.	Silurian to Middle Mississippian.
III. Genus Etonia Hall	Lower Devonian
IV. Genus Hypothyridina Buckman	Middle to Upper Devonian.
V. Genus Leiorhynchus Hall	Middle Devonian to Permian
VI. Genus Paurorhyncha Cooper	Upper Devonian
VII. Genus Pugnax Hall	
VIII. Genus Pugnoides Weller	Upper Devonian to Mississippian.

Reported occurrences of this superfamily in the literature reviewed in Part I of this thesis.

I. Genus Calvinaria Stainbrook

* C. albertense (Bell). 18, 22, 33, 37, 38.

II. Genus Camarotaechia Hall and Clarke. 10, 19, 31, 32, 35.

C. allani Warren. 22.

* C. banffensis Warren. 18, 32.

* C. contracta Hall. 9, 12, 32, 37.

* C. horsfordi Hall. 18, 20, 21, 22, 33, 37.

C. jasperensis Kelly. 21.

* C. nordeggi Kindle. 21, 33, 36, 37.

* C. shimeri Warren. 18, 21

Note: C. endlichi Meek = Paurorhyncha endlichi Meek.

III. Genus Etonia Hall. 9, 37.

E. pecularis Conrad. 25.

E. veribilis Whiteaves. 2.

IV. Genus Hypothyridina Backman. 32.

* H. camerani Warren. 30, 33, 37.

* H. emmonsi Hall and Whitfield. 30, 32. 38

H. magister Balanski. 30.

Note: Hypothyris cuboides Sowerby the genotype of Genus Hypothyridina has been reported by authors 9, 10. 37.

V. Genus Leiorhynchus Hall. 8, 9, 10, 12, 30, 31, 33. 35.

* L. athabaskense Kindle. 21, 22, 23, 33.

L. basilicum Crickmay. 39.

* L. cascadensis Warren. 18, 36, 37.

* L. castanea Meek. 27, 30, 34, 37.

L. carya Crickmay. 39.

L. clarki Prosser. 11.

* L. glaber Kindle. 21, 22.

L. limitaris Hall. 21.

L. metacostale Merriam. 19.

* L. walcotti Merriam. 37. 38.

VI. Genus Paurorhyncha Cooper. 35

* P. endlichi Meek 38.

VII. Genus Pugnax Hall. 24, 33, 34, 36, 37.

* P. minutus Warren. 18. 22.

* P. pugnus Martin. 19, 20. 26.

VIII. Genus Pugnoides Weller. 32, 35.

* P. salon T. and S. (?) 34, 37.

* P. sandersoni Warren. 30, 34.

* P. subacuminata. 38.

Genus CALVINARIA

Stainbrook, n. gen.

Stainbrook, (1945) Geol. Soc. Amer. Mem. 14, p. 43.

"Shell large sub equally biconvex, transversely subelliptical in outline with broadly rounded anterolateral margins, truncate front margin and slightly more abruptly curved angles, much wider than long and longer than thick, anterior commissure strongly uniplicate.

Pedicle valve strongly and regularly curved from beak to front, gently arched transversely; anterior portion occupied by a broad shallow flat bottomed sulcus, originating in the front of the umbo and extended at the front as a broad lingual projection. Latural slopes gently convex from fold laterally but more strongly curved from back to front. Umbo broadly convex, rounded and projecting beyond the hinge line. Beak blunt, incurved, bearing an oval foramen which may or may not be concealed. Anterior portion marked by short sub angular plications, numbering from four to six on slopes and from one to three in the sulcus; those in the sulcus stronger than those on the slopes but none reaches the umbo. Area small scarcely distinguishable. Internal hinge teeth strong, far apart, unsupported by dental plates. Edges of cardinal shelf boardering the delthyrium thickened so that there are slight ridges leading inward and foreward to the edges of the muscle scar. There are, however, no lateral cavities between these ridges and the floor as in Pugnoides. Muscle area deeply impressed, elongate, extended to middle of valve and bordered laterally by slight outwardly curved ridges. Dividing the muscle scars is a long stout distinct median septum which originates a short way in front of the apex and reaches center of valve; it is highest and broadest at middle.

Brachial valve arching very gently from anterior margin to umbo and strongly thence to beak more strongly arched transversely in middle and depressed or slightly concave near lateral margins. Fold broad, highest near front, narrower and lower to middle, shortened by lingual extension of opposite valve, deeply indented by a median sulcus which divides it into two strong plications which, in turn, are generally divided into two short plications at front. Lateral slopes show two to six short plications, umbo broadly convex slightly projecting. Beak small, blunt, usually hidden by that opposite. Internally crural cavity is short, opens and briefly supported by a median septum. Crural ridges short, parallel to posterior commisure, and from anterior borders of sockets. Median septum thin, highest posteriorly, and gradually decreasing in height to its termination at or in front of mid point."

Discussion: Calvinaria externally resembles Pugnoides
Leionhynchus

Calvinaria internally, unlike those above does not have

dental lamellae but a low median ridge in the pedicle valve as well as one in the brachial and is more transverse in shape.

CALVINARIA (Leiorhynchus) ALBERTENSE Warren 1928.

Warren, P.S. (1928) Trans. Royal Soc. Canada, 3rd Ser., vol. 22, Pt. Sec. 4, p. 117, pl. 1, figs. 1-5.

CALVINARIA ALBERTENSE Warren

Description: Shell small for the genus and usually with smooth sides. Brachial valve gibbous with fold at anterior end supporting two sub-equal plications. Pedicle valve with broad sinus bearing a medial plication. Dimensions of average specimen Length 10 mm.; width, 13 mm.; convexity 7 mm.

Remarks: This little shell has much the appearance of a Pugnax, but the medial septum in the brachial valve prevents its inclusion with that genus. On three of the many specimens examined there is a tendency toward the development of plications along the edge of the lateral slopes, and on one specimen a third plication on the fold.

This species differs from L. glaber Kindle by its smaller size and sharper plications. It has close affinities with L. parviplicatum Kelly (MSS) from the Upper Devonian of the Mountain Park region, but may be distinguished by its comparatively narrower form and much smaller size. The largest specimen of the present series obtained approximates in size the smallest specimen of L. parviplicatum in our collections. It is possibly an immature form of the latter species.

Age and Locality: Reported by Warren and Stelk (1950) in the Maegeea proteus zone at Hay River, N. W. T., (L. cf. albertense). Warren (1928) lists it from the Crowsnest Pass section and de Wit and McLaren (1950) also record its presence.

Genus CAMAROTOECHIA

Hall & Clarke nom. nov.

Hall and Clarke (1894) Nat. Hist. of New York State, Vol. VIII, Pt. II, p. 189.

"By restricting the application of the term Stenoschisma to shells agreeing in hinge structure with Rhynchonella formoso, the necessity is created for a new designation for the large group of shells to which the term was applied in 1867"

Genus STENOCHISMA

Hall, n. gen.

Hall ( ) Nat. Hist. New York, Vol. IV, p; 335.

"Shells subtriangular, ovoid or subglobose; hinge line short, beak of ventral valve extended attenuate or more or less arcuate and appressed against the opposite valve. A mesial sinus and fold on the ventral and dorsal valves respectively. Surface plicated with simple or rarely bifurcating plications.

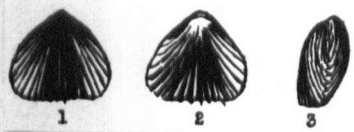
"The valves are articulated by teeth and sockets. Strong medial septum in the dorsal valve of many of the species, which becomes thickened in its upper part, with a shallow triangular pit in the centre and the crura supported on each side: dental sockets crenulate. The teeth are strong with lamellae extending to the bottom of the valve limiting the rostral cavity and sometimes partially surrounding the muscular area.

In casts of the ventral valve the cavities made by the diverging lamellae are very distinct; and in the dorsal valve the place of the septum is strongly marked, the space being wide above, and within this cavity at the upper part there is a small angular elevation of greater or less extent which originally filled a depression in the upper part of the septum."

Genotype: Camarotoechia Congregata (Conrad)

Conrad (1841) description of Atrypa Congregata quoted in Hall (1867).

"Sub orbicular with about fifteen rounded costae crossed by wrinkled lines lesser valve with central part flat, slightly elevated, except towards the base where it is more prominent, wide at base and rapidly narrowed above, with four flattened ribs; inferior valve with a regularly concave depression in the middle."



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CAMAROTOECHIA BANFFENSIS Warren (1927)

Warren, P.S., G.S.C. Memoir 153, 1927

Camarotoechia banffensis Warren

Description: Shell subtriangular in outline, wider than long, the greatest width in front of the mid-length of the shell; postero-lateral margins but slightly convex, meeting at the beak in an angle of about 110 degrees; anterior margin truncate, the antero-lateral margins rounding rather sharply to it. Dimensions of the only specimen: length 20 mm., width 23 mm., thickness about 13 mm.

Pedicle valve less convex than the brachial, rather flattened in the middle and sloping very abruptly to the postero-lateral margins. Mesial sinus obsolete in the posterior half of the valve, broad and shallow anteriorly and produced upward in a regularly rounded lingual extension to meet the fold of the brachial valve. Beak apparently pointed, but slightly incurved and produced beyond that of the brachial valve. Plications simple, angular, becoming nearly obsolete at the beak, about 36 in number, of which 12 occupy the mesial sinus.

Brachial valve quite strongly convex, the greatest convexity apparently in front of the mid-length of the shell; surface sloping abruptly to the postero-lateral margins. Mesial fold obsolete in the posterior part of the valve and rather broad and flat anteriorly. Plications similar to those of the pedicle valve, 6 occupying the flat top of the fold and 3 considerably smaller ones occupying the slope on either side.

Remarks: The form bears a close resemblance to Camarotoechia alleghania (Williams), but the plications are finer and more numerous than those of that species and the fold and sinus of our species are distinctly broader than that of the eastern form.

Age and Locality: Upper Devonian; upper beds of Minnewanka limestone.

Reference: Warren, P.S., 1927.

Diagram: Fig. 1 - Pedicle view
Fig. 2 - Brachial view
Fig. 3 - Lateral view

Fig 1 Fig 2 Fig 3 Fig 4 Fig 5.

CAMAROTOECHIA HORSFORDI (Hall 1867)

J. Hall. Nat. Hist. New York,
Part VI, Vol. IV.

CAMAROTOECHIA HORSFORDI

Description: Shell in full grown specimens transversly sub elliptical; rostral portion sometimes a little extended; front nearly straight or broadly rounded; length to width as about five to six or seven. Young shells ovoid subtrigonal.

Ventral valve moderately incurved, flattened and incurved in the frong; a slightly depressed sinus, appearing about the middle of the length which is flat in the bottom and curving abruptly upwards in frong; beak moderately extended abruptly acute and usually but little incurved.

Dorsal valve very gibbous in old shells sloping abruptly to the beak, depressed convex in young shells. Mesial elevation defined below the middle of the length.

Surface marked by fifteen to twentyfour well defined angular plications of which four to six or seven marks the mesial sinus or fold, which are deeply bifurcated in front. On the sides and towards the cardinal lateral margins of the shell the plications are less angular: concentrically marked by fine undulating striae which are seen towards the front but rarely on on other parts of the shell.

The size varies from a quarter of an inch in length and five sixteenths in width, to nine sixteenths in length and thirteen sixteenths of an inch in width, according to age.

Geological Formation: Hamilton group, Western New York.

Diagrams:

Fig. 1. Dorsal)
Fig. 2. Ventral) view of a large, well formed
Fig. 3. Profile) characteristic specimen of
Fig. 4. Cardinal) species.
Fig. 5. Front)

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CAMAROTOECHIA SHIMERI Warren (1927)

Warren, P.S., G.S.C. Memoir 153, 1927

Camarotoechia shimeri Warren

Description: Shell of medium size, subovate in outline; full grown specimens gibbous, the brachial valve being much more convex than the pedicle; greatest width about the mid-length of the shell. Dimensions of an average specimen: length 17 mm., width 20 mm., thickness 10 mm.

Pedicle valve moderately convex, the greatest convexity being near the umbo. Lateral area flattened. Beak small, pointed, acute, and but little incurved over that of the brachial valve. Sinus shallow, rounded in the bottom in young specimens but becoming flattened in more gibbous forms, commencing about the mid-length of the shell, rapidly broadening anteriorly and being produced upward in a lingual extension to meet the fold of the brachial valve.

Brachial valve more convex than the pedicle valve, the point of greatest convexity usually anterior to the mid-length of the shell; a tendency toward flattening evident along the lateral margin. Fold commencing about the middle of the shell and becoming quite pronounced at the anterior margin, flat on top on strongly convex forms, rounded and rather poorly defined on less convex forms.

Surface marked by from 40 to 50 rounded to subangular striae, from 12 to 16 occupying the top and sides of the fold and the bottom and sides of the sinus, 6 being the usual number on the flattened top of the fold on the more convex forms.

Remarks: This is apparently the same form described, but not named, by Shimer, from the Lake Minnewanka section. In some respects it resembles small forms of C. englichi, but the striae are much too fine and numerous and the lateral margins are not geniculate as in that species. It more closely resembles C. norsiordi, but may be distinguished from that species by the finer and more numerous striae.

Age and Locality: Upper Devonian; uppermost beds of Minnewanka limestone on Sulphur Mountain.

Reference: Warren, P.S., 1927

Diagram: Fig. 1 - Pedicle view of co-type
Fig. 2 - Brachial view of co-type

Genus EATONIA

Hall 1857 n. gen.

In Hall and Clarke, Nat. Hist. of New York, Vol. VIII, pt. 2, p. 204.

"Concavo-convex shells with median fold and sinus, and plicated or radiate-lineate exterior. Anterior margin deeply sinuate. From the beak of the pedicle-valve diverge two lateral cardinal ridges which limit a more or less distinct false area. On the interior the teeth are adnascent to the lateral walls of the valve, all traces of supporting lamellae being absent. Muscular area large, flabellate and deeply excavated in the substance of the shell. Pedicle impression broad, traversed medially by a longitudinal groove; diductors extending for about one-half of the length of the shell, their outer margins being elevated; they enclose a pair of small central adductor scars whose posterior margins are raised into prominent myophores. The scars are divided by a slight median septum which is continued posteriorly; this septum being often rendered very conspicuous by the growth of the shell about the apophyses of the cardinal process of the opposite valve, and in extreme cases its development is such that it rises above, and encloses the adductor scars, the latter being excavated in its substance.

In the brachial valve the dental sockets are long and narrow, the cardinal process very large and composed of a stout, erect stem resting upon a rather short median septum, and divided at its summit into two long, divergent, tooth-like branches, whose upper faces extend to the interior surface of the opposite valve; hence their greatest elevation is at their anterior extremities, whence they slope toward the beak of the valve, usually uniting before that point is reached. The surface of attachment of each of these apophyses is medially grooved. Below them, and at the base of the central stem, arise the crura, which are long, straight and slender, with expanded extremities. The muscular scars are clearly defined and consist of a pair of small posterior adductors, and in front of them a larger pair whose surface is radially striated, the entire area being elgonate-oval. Vascular impressions are occasionally retained in the pedicle-valve.

Genotype: Atrypa medialis, Vanuxem. Lower Helderberg group. (Delthyris shaly limestone).

Genus HYPOTHYRIDINA

Buckman 1906 n. nom.

Shimer and Shrock (1944), Index from N. America, p. 313.

"Subcuboidal in outline and globular in profile, ventral valve less deep than dorsal, and with long anterior tongue; costae low and rounded, separated by narrow striae; ventral interior with very short dental plates and small muscular field; dorsal interior without a median septum."

Genotype: Atrypa cuboides Sowerby

Range: Middle and Upper Devonian.

1 2

HYPOTHYRIDINA CAMERONI Warren (1944)

Warren, P. S., Trans. Roy. Soc. Can., 3rd Series, Vol. 38, Sect'n IV, 1944

Hypothyridina cameroni Warren

Description: This species is probably little more than a variant of H. venustula (Hall). It differs in that the pedicle valve is more ventricose near the beaks than Hall's species, the lingual extension of the sinus is not so prolonged upward, and the sides of the brachial valve are much more sloping toward the lateral margins. The number of costae on the tongue of the three specimens examined is seven, and the number on each lateral slope is about fourteen. The dimensions of three specimens are: length 24 mm., 21 mm. (incomplete), and 19 mm.; width 26 mm., 25 mm., and 21 mm; height 15 mm., 15 mm., and 13 mm.; width of tongue 16 mm., 14 mm., and 13 mm. There is a variation in the size of the specimens, but little variation in other features.

Age and Locality: Uppermost Middle Devonian. Two specimens from the Presqu'ile dolomite, Presqu'ile Point, Great Slave Lake and one from drift.

Diagram: Fig. 1 - Brachial view of syntype
Fig. 2 - Frontal view of syntype

HYPOTHYRIDINA EMMONSI Stainbrook.

Stainbrook, 1945, Geol. Soc. Amer., Mem. 14, p. 42, pl. 4, figs. 10-14.

HYPOTHYRIDINA EMMONSI Stainbrook.

Description: Shell variable in size, transversely subcuboidal to subelliptical in profile; generally subpentagonal in outline; very inequally biconvex; anterior margin truncate. Greatest width of the shell at mid-length or somewhat posterior to the mid-length; width greater than length; length and thickness approximately equal.

Pedicle valve gently convex, slightly elevated in the umbonal region, tending in some specimens to become flattened or gently concave near the posterolateral margin. A broad shallow sinus of variable width extends upward as a sharp quadrate lingual extension. Pedicle beak usually in contact with the brachial umbo; area obscured.

Brachial valve moderately convex to gibbous; fold subdued, sharply arched, with the surface sloping abruptly from the borders of the fold to the lateral margin. Exterior of both valves marked by numerous well-defined rounded plications which are separated by sharp narrow furrows.

Remarks: (Bell, 1951) Distribution of Hypothyridina in the Rocky Mountains shows that age determinations based on the genus are not reliable. In the Mackenzie River district it occurs as low as the base of the Stringocephalus zone, and in this case is obviously not indicative of the base of the Upper Devonian. It is also reported from Perdrix-Flume transitional beds, from the upper Perdrix, and from the Alexo member.

Diagrams: 1. Ventral view.
2. Anterior view.
3. Lateral view.

Genus LEIORHYNCHUS

Hall n. gen.

Hall (1860), Thirteenth Report on the State Cabinet, p. 75 (Not in the Library of the University of British Columbia.

Hall (1868) Genus Leiorhynchus, Nat. Hist. of N.Y., Pt. 6 Vol. 4. Pt. I, p. 355.

"The shells of this genus are ovate, circular or transverse, with a median sinus and fold in the ventral and dorsal valves respectively.

The surface is plicated by rounded bifurcating plications which are always more conspicuous on the mesial fold and sinus, while they often become obsolete on the lateral portion of the shell; concentrically marked by strong lines of growth. Substances of the shell fibrous usually thin.

Valves articulating by teeth and sockets; the apex of the ventral valve perforate at some period of its growth, the lower side being completed by deltidial plates. On the interior of the ventral valve two short diverging dental lamellae extend into and are joined to the sides or bottom of the rostral cavity; muscular impression occupies a narrow triangular or ovate-triangular space below the dental lamellae.

The dorsal valve has a well defined septum often reaching below the middle of the valve and divided above, leaving a triangular or spoon shaped depression. The hinge plates are narrow, strong processes, with sockets embracing the teeth of the opposite valve."

Genotype: Orthis Quadriscostata.

Hall (1867) description of Leiorhynchus Quadriscostata (Vanuxem).

"Shell broadly ovate, somewhat gibbous and with distinct mesial fold and sinus.

Ventral valve a little gibbous towards beak; sides nearly flat with a wide mesial sinus.

Dorsal valve more gibbous than the opposite greatest convexity in the middle of the valve; mesial fold prominent.

Surface of the mesial fold and sinus marked by three, four or five rounded plications which bifurcate above. Sides of the valves.

obscurely marked by rounded plications which become obsolete towards the margin, and sometimes this part of the shell is almost entirely free from any markings whatever.

FIG 1

FIG 2

FIG 3

LEIORHYNCHUS ATHABASCENSE (Kindle 1924)

Kindle, E.M., Pan. Am. Geol. Vol. XLII.

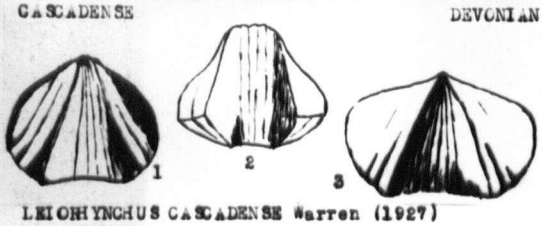
LEIORHYNCHUS ATHABASCENSE (Kindle)

Description: Resembles L. utahense Kindle in its non plicated sides, but in the proportions of its length and breadth which are about 3:5 it differs conspicuously. It is related to L. jeffersonense Haynes but in the wedgelike lateral margins of the shell and in the great elevation of the dorsal valve and very deep sinus shows a different shell expression. Three to eight plications characterise the fold and sinus which are boardered by the non plicated sides. The plications do not reach entirely to the beaks.

Age and Locality: L. athabascense in the upper part of the Banff limestone on the north side of Folding mountain 1½ miles south of Sulphur Springs Station, Jasper Park, Alberta. This shell occurs abundantly in the Athabasca River sections.

Diagram:

Fig. 1. Dorsal view
Fig. 2. Anterior view
Fig. 3. Dorsal view.



LEIORHYNCHUS CASCADENSE Warren (1927)

Warren, A.S., G.S.C. Memoir 153, 1927

Leiorhynchus cascadense Warren

Description: Shell large, ventricose, transversely subovate in outline. Brachial valve much more strongly convex than the pedicle valve. Proportions of length to width varying in different specimens. Dimensions of an average specimen: length 28 mm., width 32 mm., width 32 mm., thickness 25 mm.

Pedicle valve moderately convex, the point of greatest convexity being strongly incurved, and not extending beyond the beak of the brachial valve. Sinus deep, rounded at the bottom, commencing at the beak and rapidly widening anteriorly to about half the width of the shell and being produced upward in a broad lingual extension to meet the fold on the brachial valve. Lateral slopes rather abrupt in the umbonal region and more gently convex anteriorly. Plications in the sinus restricted to the centre, 3 in number, narrow and rounded; plications on the lateral slopes restricted to the area bordering the sinus, in some cases nearly obsolete, from 2 to 3 in number and much wider than the plications occupying the sinus.

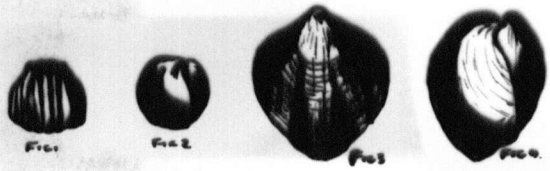
Brachial valve strongly convex, the point of greatest convexity being a little posterior pointed and incurved. Fold strong and well defined, commencing near the beak and becoming high and prominent anteriorly; top rounded and bearing from 2 to 3 narrow, rounded plications in the centre. Lateral slopes rounding abruptly to the cardinal margins and more gently to the lateral and anterior margins. Plications on the lateral slopes large, about 2 in number, and in some cases nearly obsolete.

Remarks: This form varies considerably in dimensions, but the most characteristic features are constant. It most closely resembles L. inferiorensis Hayne, but differs from that species in its greater convexity, the rounded top of the fold and concave bottom of the sinus, and the fewer number of plications on the fold and sinus. Some specimens suggest small forms of whamplophia englishi (Meek), but the sinus of our specimens never attains so great a width relative to the width of the shell, and the plications are never developed so abundantly as in Meek's shell.

Age and locality: Upper Devonian; uppermost beds of Minnewanka limestone on Cascade Mountain.

References: Warren, A.S., 1927.

Diagram: Fig. 1 - anterior view
Fig. 2 - brachial view
Fig. 3 - pedicle view of a much wider specimen.



RHYNCHONELLA CASTANEA (Meek 1868)

Trans. Chic. Acad. Sci. Vol. 1.
p. 93. pl XIII, figs. 9a-c.

RHYNCHONELLA CASTANEA (Walcot) U.S.G.S. Mon.8. 1884, p. 153, pl. 15, figs. 11a and 14a.

Description: Shell sub globose, ventricose on the dorsal side and somewhat flattened on the ventral length and breadth sub equal or a little longer than wide.

Ventral valve slightly convex on the umbo, flattened or slightly convex on the sides with a more or less well defined sinus which is first seen about the centre of the valve. The sinus has from three to six depressed rounded plications and varies from the sub quadrate, linguiform extension with sub parallel sides on the smaller shells where it is strongly incurved, to the shorter depression outlined by the elevated, actute, margins of the lower part, which is not curved beneath even in large individuals. Beak abruptly incurved over that of the opposite valve.

Dorsal valve gibbous sloping somewhat abruptly to the margin of the opposite valve; the mesial fold prominent in younger shells and marked with three or four plications which extend to the upper third of the valve. In older specimens the fold is scarcely traceable above the middle of the valve, and the plications, six or eight, are usually short and confined to the lower part.

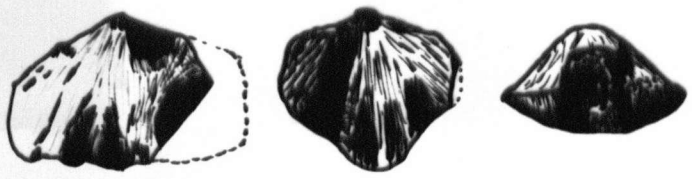
Surface of the younger shells with obscure plications on the sides and stronger depressed (rounded plications on the mesial fold and sinus. Concentric lines of growth mark the upper part of each valve. The surface of the older shells is smooth with the exception of theplications on the mesial fold and sinus and a few lines of growth.

Type Locality: Lockhart River, British America. lat. 67°15'; long 126 W.

Formations and Localities: Upper Devonian limestone of Descue Hill and Lower Devonian of West slope of County peak Eureka district, Nevada.

Diagrams:

Fig. 1. Front view of small sub cuboidal specimen.
Fig. 2. Lateral view of sub cuboidal specimen.
Fig. 3. Ventral view of adult shell.
Fig. 4. Ventral and lateral view of adult shell.



LEIORHYNCHUS GLABER (Kindle 1924)

Kindle, E.M. Pan.Am. Geol. Vol. XLII.

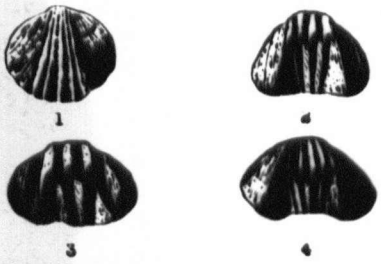
LEIORHYNCHUS GLABER (Kindle)

Description: Shell large, with prominent fold marked by two rounded rounded plications and sinus with a weak single plication on anterior half. Fold sinus and plications are absent on the posterior half of the shell. Sides of shell smooth. The paucity and poor development of plications distinguish this from other species of the genus.

Age and Locality: The types are from the upper part of the Banff limestone on the north side of Folding Mountain 1½ miles south east of Sulphur Springs Station, Jasper Park, Alberta.

Diagram:

Fig. 1. Ventral view
Fig. 2. Dorsal view
Fig. 3. Anterior view.



Leiorhynchus walcotti Merriam 1940, 1, Dorsal view of holotype, slightly reduced. 2-4, Anterior views of paratypes, slightly reduced.

LEIORHYNCHUS WALCOTTI

Leiorhynchus walcotti Merriam (1940) Geol. Soc. Amer. Special paper 25, p. 88, pl. 9, figs. 4-8.

Mature shell, large and robust, inequivalved, convexity of dorsal valve greater than that of ventral. Radial ribbing of fold very heavy in some individuals, ribs varying from two to about six, commonly three; sulcus deep at commissure; ribbing of sulcus extremely variable but usually heavy.

The large size, ventricosity of the dorsal valve, and great weight of radial ribbing on fold and sulcus of many variants are characteristic features of this extremely variable species. Leiorhynchus walcotti includes individuals which resemble forms from the Three Forks shale of Montana; these include Leiorhynchus jeffersonense Haynes, L. madisonense gibbosum Haynes, and L. madisonense Haynes.

Within the range of variation of Leiorhynchus walcotti occur individuals having somewhat the appearance of Pugnax.

Measurements.-- Holotype, width 27 mm., length 23 mm., thickness 16.5 mm.

Genus PAURORHYNCHA

Cooper n. gen.

Cooper (1942) Wash. Acad. Sci. Jour. 32-33 Vol. 8, p. 231.

"Large, subtriangular, with unequally deep valves, the ventral one slightly convex but the dorsal one very deep, uniplicate multicostellate.

Ventral interior with much reduced dental plates and small teeth. Muscular area small, elongate-oval. Foramen minute, beak closely pressed onto dorsal umbo. Deltidial plates vestigial. Dorsal interior with long median septum supporting a small V-shaped chamber to which the divided hinge-plate is attached. Socket plates elevated, crural bases concave, often swollen.

Discussion: Differs from Leiorhynchus in the presence of a deep V-shaped chamber. From Plethorhyncha it differs in the slighter development of the dorsal median septum, smaller ventral muscular field and mode of thickening of hinge-plate."

Genotype: Rhynchonella endlichi Meek.

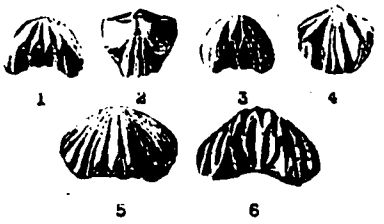
Genus PUGNAX

Hall n. gen.

Hall (1894) Nat. Hist. of New York, Vol. 8, Brachiopida II, p. 202.

"Shells with deep fold and sinus; elevated and often accuminate on the anterior margin; more or less sharply plicated, the plications usually being simple, those of the fold and sinus the strongest, those of the lateral slopes often obscure or obsolete. Pedicle valve shallow; brachial valve deep. Teeth supported by vertical lamellae; hinge plate similar in structure to that of Hypothyris; the median septum of the brachial valve is extremely feint when present, but is usually undeveloped. Muscular impressions not large but well defined and clearly subdivided. Vascular sinuses sometimes retained on the pedicle valve, always obscure on the brachial valve."

Genotype: Conchyliolithus Anomites.



Pugnax pugnus Martin, illustrations after Kindle 1909. 1, Front profile view. 2, 3, 4, Dorsal, front, and ventral views of an individual. 5, 6, Views of the largest and most abundantly plicated shell observed.

PUGNAX PUGNUS

Pugnax pugnus Martin, description after Kindle (1909), U. S. Geol. Survey Bull. No. 381, p. 22, pl. VI, figs. 3-8a.

Shell transversely ovate and elevated in front. Proportions of length and breadth are about 6 to 7. Ventral valve slightly concave in umbonal region, but nearly flat on either side of the sinus. Beak of ventral valve pointed and incurved over beak of opposite valve. Sinus broad, deep in front, begins about 1/4 the distance from the beak to the front and bends sharply upward as a broad linguiform extension into the opposite valve. From two to four strong radiating plications generally occupy the sinus, and two rounded plications are present on each side of it. All of these become obsolete before reaching the beak. Plications in sinus arise in some shells independently. In others the later plications are the result of bifurcation.

Dorsal valve greatly elevated at front of the fold, from which it slopes abruptly downward to the lateral margins and more gently forward to the beak. Fold marked by three to five plications, which are sharply angular at the front but are rounded posteriorly. These generally become obsolete about 1/3 of the distance from the beak to the front. They generally increase through bifurcation. From two to three rounded plications which are developed only near the margin of the shell are present on each side of the sinus. The line of contact between the plications and their intermediate troughs forms a series of very acute angles along the anterior margin of the valves.

In some well preserved specimens the surface of both valves is covered by fine radiating striae, probably an evanescent character, as striae not clear on other well preserved specimens. Radiating striae tend to show temporary and local development which became fully developed in such Carboniferous forms as Pugnax missouriensis. Some shells show indistinct, lamellose, concentric striae.

The largest individual observed, which appears to represent a gerontic shell, differs from the above discription in the greater number and prominence of the plications. There are 14 on each valve, 5 of which occupy the fold and 4 the sinus. The lateral plications are well developed nearly to the beaks. This specimen has a length of 20 mm. and a breadth of 28 mm.

Genus PUGNOIDES

Weller, n. gen.

Weller (1910), Bull. G.S.A. Vol. 21, p. 512.

"One of the rhynchonelloid shells which has been commonly referred to by recent authors to the genus Pugnax is Rhynchonella ottumwa (White). A series of cross sections of this species is reproduced (Plate) in which it is shown to possess all the essential characters of Camarotoechia. If, however, it is legitimate to recognise such genera as Wilsonia and Leiorhynchus, genera possessing essentially the same internal structure as Camarotoechia, and based primarily upon external form and ornamentation of the shell , then R. ottumwa with its external aspect of Pugnax must also be excluded from Camarotoechia and there is no genus in which it can be placed, it becomes necessary to establish a new one for its reception. This genus may be called Pugnoides with P. ottumwa as genotype."

Genotype: P. ottumwa.

Occurrence: Reported by Warren and Stelk (1950) from the Cyrtina panda zone in the Beaverfoil Limestone at Ceresjou Rock, below Fort Norman, N.W.T.

Diagrams: 1. Ventral view.
2. Anterior view.
3. Lateral view.

PUGNOIDES SOLON Thomas and Stainbrook

Fenton and Fenton, 1924, Mich. Univ. Mus. Geol. Contrib. vol. 1, p. 129, pl. 35, figs. 9-12.

PUGNOIDES SOLON Thomas and Stainbrook

Description: Deminsions taken from two typical specimens collected at Solon, Ia.; length 11.6 mm. and 12.8 mm.; width, 15 mm. and 17.4 mm.; thickness, 11.7 mm. and 13.2 mm. From these it will be seen that, in proportion, the species differs from P. calvini in greater width, lesser thickness, more abrupt, flat bottomed sinus, smoother umbonal region, flatter, lower and more flattened fold, and greater general compactness of proportion.

PUGNOIDES SUBACUMINATA Webster

Stainbrook, 1945, Geol. Soc. Amer., Mem. 14, p. 43, pl. 4, figs. 20-21.

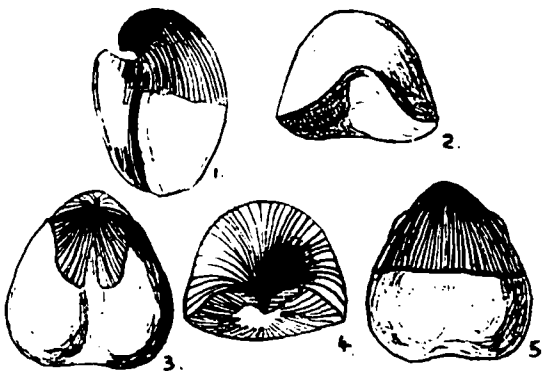
PUGNOIDES SUBACUMINATA Webster.

Description: Shell somewhat variable; subtriangular in marginal outline; greatest width above the centre of the shell; contracting quite rapidly to the front, where it terminates in three sharp angles, which are produced by the sharply angular folds on the front of the valves.

Dorsal valve strongly convex in the center; furnished with three prominent angular sharp folds at the front, which usually become obsolete before reaching the center of the shell; sinus large, deep and broadly rounded; margined in front by from two to three sharp, short folds; front and cardinal margins sharply serrate. Surface of shell smooth; texture fibrous. In young specimens of this species folds or elevations are not present on any portion of the shell.

Age and Occurrence: Noted by Stainbrook from the Lime Creek Formation (Hackberry Stage); and from the Perdrix at Ram Gap in the Rocky Mountains.

Diagrams: 1. Anterior views of
2. two individuals.



ORTHIS McFARLANEI Meek (1868)

Trans. Chic.Acad. Sci. Vol. 1. p. 88.

ORTHIS McFARLANEI Meek

Description: Shell subcordate, resupinate, very gibbous; length (in adult examples) greater than the breadth; cardinal and umbonal regions very narrow; postero-lateral margins straight, and rapidly diverging forward to the widest part of the valves, which is a little in advance of the middle; hinge line short, or scarcely equaling half the greatest breadth of the valves; cardinal areasmoderate, nearly twice as high in the ventral valve as in the other, strongly arched in the dorsal valve, and slightly in the ventral, where it is less than half as high as wide, and ranges nearly at right angles to the plane of the valves; foramen triangular, and about two-thirds as wide as high. Smaller or ventral valve convex in the lateral and umbonal regions, the most gibbous part being near the beak, which is short and a little incurved at the point; provided with a broad rounded mesial sinus, which commences very shallow near the middle of the valve, and widens and deepens rather rapidly towards the front margin to which it imparts a broadly emarginate outline. Larger or dorsal valve extremely gibbous, particularly in the region of the umbo, which, in adult specimens, projects considerably beyond that of the other, and is at all ages strongly incurved. Surface marked with fine radiating striae, some nine or ten of which may be counted in the space of 0.10 inch.

Breadth of an adult, 1.50 inches; length from the most prominent part of the umbo of the ventral valve to the front, 1.60 inches. Greatest convexity of the two valves, 1.16 inches; length of hinge, 0.77 inch.

Locality: Forty miles below Fort Good Hope on Mackenzie river, and on Lockhart river, lat. 67 deg. 15 min. N., long. 126 deg. W., in the Devonian (Hamilton group.) I have also seen specimens which I believe to belong to this species from the Hamilton group beds of Iowa and Illinois.

Diagrams: 1. Side view
2. Anterior view
3. Dorsal view
4. Posterior view
5. Ventral view.

Superfamily Atrypacea (Shrock and Twenhofel, p. 330).

"Atrypids are subquadrate spiriferoids with a complex brachidium. The primary lamellae follow themargins of the shell, and the spiralia are directed inward or toward the floor of the brachial valve.

Range: Middle Ordovician to Upper Devonian.

Genera Described:	Range:
I. Genus Atrypa Dalman	Silurian to Devonian
II. Genus Grunewaldtia Tschernyschew	

Reported occurrences of this superfamily in the literature reviewed in Part I of the thesis.

I. Genus Atrypa Dalman. 24, 31, 32, 33, 35, 36.

* A. albertensis Warren. 30, 37, 38.

* A. andersonensis Warren. 30, 34, 37.

* A. artica Warren. 30, 34, 37.

A. aspera Schlotheim. 11.

A. bentonensis Stainbrook. 37.

* A. borealis Warren. 37.

A. bremerensis Stainbrook. 37.

* A. clarkei Warren. 30, 37, 38.

A. cosmeta Crickmay. 39.

* A. devoniana Webster. 30, 37, 38.

* A. gigantea Webster. 37, 38.

A. gregeri Rowley. 26.

A. hayriverensis Warren. 38.

A. huckelberryensis Fenton and Fenton. 37.

* A. independensis Webster. 37

* A. missouriensis Miller. 18, 20, 22, 31, 36.

I. Genus Atrypa Dalman (Continued)

A. montanensis 37.

A. owensis 37.

A. pechiensis Grabau. 37.

A. reticularis Linn. 2, 8, 9, 11, 12, 13, 15, 16, 19, 20, 22, 24, 25, 26, 35, 36.

*A. scutiformis Stainbrook. 37.

*A. spinosa. Hall. 8, 9, 10, 12, 19, 20, 22, 25, 26, 36.

II. Genus Grunewaldtia Tschernyschew. 35.

Genus ATRYPA

Dalman, 1828 n. gen.

In Hall and Clarke, Nat. Hist. of New York, Vol. VIII, pt. 2, p. 163.

"Diagnosis: Shells subcircular or longitudinally suboval in outline. Gibbous, strongly inequivalve. Hinge-line short, straight; cardinal extremities rounded. Beaks not prominent.

Pedicle-valve the smaller; convex in the umbonal region, but depressed and often deeply sinuate anteriorly. Beak small, usually incurved in advanced growth-stages, concealing the foramen and deltidium. The foramen is triangular in young shells, extending to the hinge-line, but becoming gradually closed by the growth of deltidial plates, and at maturity is circular and apical, encroaching slightly on the substance of the valve. The plates of the deltidium are not coalesced along the median sature. On the interior the umbonal cavity is short but very broad. The teeth are large, widely separated and doubly grooved, first by an oblique furrow at the base, into which is fitted a crenulated ridge of the other valve, then by a short longitudinal depression on the summit; the tooth is doubly curved and reflected, making the articulation of the valves very firm. These teeth arise from the inner surface of the lateral slopes of the valve, and are hence unsupported by lamellae. The muscular impressions are sharply defined; the triangular pedicle-scar is followed in front, by a median elongate double scar of the adductors, outside of which are strong, radiately striate, flabellate diductors, which frequently extend beyond the middle of the valve.

Brachial valve convex or rotund in the middle, with a median fold which is rarely developed except toward the anterior margin. Beak incurved and concealed. No cardinal area. The hinge-plate is composed of two diverging processes which may or may not meet at the apex. Each of these processes is obliquely grooved, forming an inner and outer lobe. The latter forms the upper portion of the socket wall which is curved downward and unites with the lateral surface of the valve, forming a broad dental socket which is traversed by an oblique crenulated ridge. The inner lobes of the hinge-plate are short, their extremities free, bearing the crura.

These crura are long and narrow, diverge laterally and are attached to the primary lamellae near their ante-lateral curvature. The mode of attachment is peculiar, the crural lamellae bending upward and then abruptly downward, greatly widening at the line of contact and touching the spiral ribbon only at its outer margin. The demarkation between the crura and the ribbon of the coils is therefore very distinct. The spirals have, in a general sense, their bases parallel to the inner surface of the pedicle-valve and the apices directed toward the deepest point of the opposite valve. Their axes are more or less convergent, so that the approximate surfaces of the cones are flattened. The basal section of these cones is hemicordate, the anterior extremity being much the narrower, but the upper volutions are more nearly elliptical. The

ribbon is broad, being conspicuously so on the anterior curves of the first few volutions, each one extending considerably beyond the next following. These anterior curves may be more or less distinctly fimbriated. The loop is composed of two processes which are continuations of the primary lamellae without angulation. These processes are situated posteriorly, directed toward the center of the shell, and are, in effect, the starting points of the spirals. They have the following structure: the ribbon maintains its usual width for a considerable distance within the point of attachment to the crura, then narrows rather abruptly, the processes ascending as they approach each other. Their terminations in mature shells are broadened, thickened, erect and recurved at the tips, having a clavate appearance. In immature growth-stages or undeveloped adult conditions this thickening is absent, the extremities of the processes are in close apposition, or may form a continuous lamella. The muscular impressions consist of four large adductor scars divided by a low median ridge.

Ovarian pittings and vascular sinuses occur over the inner surfaces of both valves. The latter consist of twomain trunks, sending two branches posteriorly, and two longer, converging branches anteriorly.

External surface covered with radial plications crossed by concentric growth-lines; at the crossing of the two series of lines the external layers of the shell may be produced into broad lamellar expansions or hollow spines.

Shell-substance fibrous, impunctate.

Genotype: Anomia reticularis, Linne. From the Clinton to Waverly groups inclusive.

ATRYPA ALBERTENSIS (Warren 1944)

Warren, P.S. Trans. Royal Soc. Canada. 3rd Series, Vol. XXXVIII, Section IV. p. 118.

ATRYPA ALBERTENSIS (Warren)

Description: Shell small to medium sized, equally convex and sub circular to sub quadrate length and width about equal, greatest width about the midlength of the shell, may be slightly sinuous along the front margin in old specimens. Dimensions of 3 specimens, length 20 mm. 18 mm. 17 mm.; width 21 mm. 19 mm. and 18 mm.; thickness 10 mm. 11 mm. 9 mm.

Pedicle valve moderately convex throughout with no tendency to flatten towards the margins, but in some specimens may develop a broad, very shallow sinus near the front margin. Cardinal shoulders rounded to sub angular; beak erect and not curved over that of the opposite valve. (The beak in old specimens is usually worn back and the foramen is accordingly large.)

Brachial valve moderately convex with a tendency to flatten at the posterio lateral margins if the cardinal angles are not rounded. No definite fold produced, beak small and sharply incurved.

Surface of both valves ornamented by coarse rounded costae of which 8 or 9 reach the beak.. They increase in number by bifurcation or implantation to fifteen or eighteen along the margin. They are crossed by numerous imbricating lamellae which in mature specimens may become crowded at the front margin and are there is little evidence that the lamellae are produced into spines on the crest of the costae.

Remarks: This species is distinguished by its moderate convexity, the equal convexity of the two valves, its erect beak in the pedicle valve (worn in mature specimens) the sub circular form coarse costae and the absence of spines.

Geological Horizon: Waterways Formation.

Locality: Athabaska River at McMurry, Alberta.

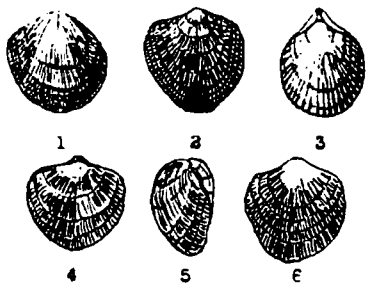
Types: Syntypes Dv. 861-864.

Diagrams:

Fig. 1. Pedicle valve.

Fig. 2. Side View.

Fig. 3. Brachial valve.



1 Atrypa devoniana Webster (Form A), brachial view of a thick specimen. (After Fenton and Fenton, 1935, pl.37, fig. 1)
2 A. devoniana Webster (Form B), pedicle view of a specimen whose lamellae are not preserved. (After Fenton and Fenton, 1935, pl.37, fig.2)
3 A.devoniana Webster (Form C), brachial view. (After Fenton and Fenton, 1935, pl.37, fig.7)
4-6 A. devoniana Webster, brachial, side, and pedicle views. (After Shimer and Shrock, pl. 121, Figs. 16-18)

ATRYPA DEVONIANA

Description: Like A. waterlooensis this species shows such great variation that it may be considered by groups or "forms". Unlike that species its forms differ so greatly that no general description seems advisable, though the characters of ornamentation specified under form A may be regarded as typical. Specimens illustrating forms are regarded as hypotypes of the species.

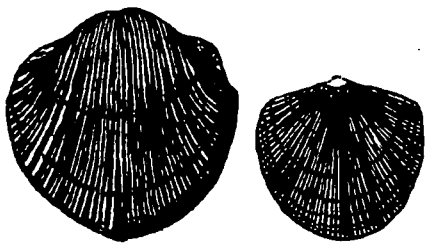
Form A (Fig. 1)

Shell medium to large; width as great as length or, more typically, greater than length, especially where lamellae are preserved. Dimensions of two typical specimens without lamellae: length of both pedicle and brachial valves, 23.3, 24.6 mm.; width, 23.3, 25.3 mm.; thickness, 15, 18.2 mm.

Pedicle valve quite convex in early stages; lateral areas slope gently from central convexity to margins; in some specimens, especially those whose lamellae are preserved, a concavity is formed in the lateral regions; sinus appears 13 to 15 mm. from the beak, broad and shallow, 7.5 to 10 mm. wide in typical shells.

Brachial valve highly convex; lamellae, laterally, extend outward and recurve; fold indistinct except near anterior margin; cardinal areas rounded, hinge line straight; beak hidden by recurved beak of pedicle valve: indistinct furrow on umbo.

Surface marked by plications that increase in number by both bifurcation and implantation; 7 to 9 in 5 mm. at 10 mm. from pedicle beak; growth lines numerous, especially near anterior margins.



1 2

1,2 Atrypa gigantea Webster, brachial view of a large specimen and pedicle view of a smaller one. (After Stainbrook, 1938, pl.30, figs 5, 13.)

ATRYPA GIGANTEA Webster

Atrypa gigantea Webster, 1921, Am. Midland Nat., vol.7, p. 16.- Fenton and Fenton, 1935, Jour. Paleontology, vol. 12, p.233.

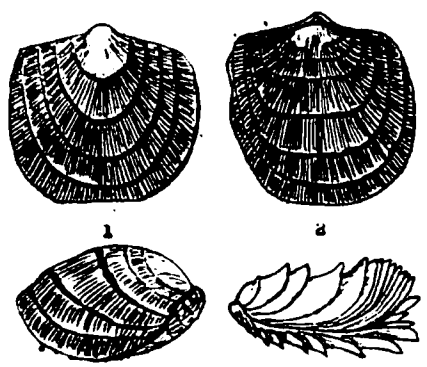
Shell large, suborbicular, lateral margins broadly rounded, very unequally biconvex, wider than long, broadest to the midlength, hinge line straight and less than the greatest width, rounded at the angles. Dimensions of two hypotypes: length, 50mm., and 38mm.; width, 58.7., and 45.5mm.; thickness, 27.6mm., and 21.8mm.

Pedicle valve gently concave, a little convex in the umbonal region, whence the surface slopes gently anteriorly and laterally, and then rises to the margins. Beak short, pointed, incurved, pierced by a foramen at the apex. Greatly thickened interiorly. Muscle scars deeply sunken.

Brachial valve longer and more convex than pecicle, greatest convexity posterior to the midlength; highest in the umbonal region; surface sloping with moderate rapidity to the front and lateral margins, flattened slightly near the angles, incurved beneath the beak. Umbonal region prominent, projecting a little beyond the hinge line.

Radiating costae numerous, less than medium size, increasing by division, about four or five in five millimeters on the umbonal region of a large specimen. Growth lines prominent, more crowded and lamellose near the anterior and lateral margins.

This species resembles Atrypa waterlooensis in shape, but is readily separated by its smaller costae, which are about half as large. It lies above that form in much of the Cedar Valley area. The form described as A. waterlooensis websteri Fenton and Fenton is probably the same.



1,2 A. independencis Webster, pedicle and brachial views.
3 A. independencis Webster, lateral view (After Shimer and Shrock pl. 120, fig. 69)
4 A. independencis Webster, lateral view of shell with lamellae restored. (After Fenton and Fenton, 1935, p. 377, fig. 1.A.)

Atrypa expansa Webster, 1921, Am. Midland Nat., vol. 7, p. 15.—A. independencis Webster, Fenton and Fenton, 1935, Jour. Paleontology, vol. 9., p.377.

Description: Shells large; mature specimens subquadrate, usually wider than long even when lacking the lamellar extensions; young specimens longer than wide. Dimensions of one of Webster's syntypes; length of pedicle valve 37 mm., length of brachial valve. 35 mm.; maximum width, 37.7 mm.; thickness at the midlength 20.3.

Pedicle valve convex umbonally; in young specimens, 10 to 25 mm. long, equal to the brachial; postero-lateral areas flattened on either side of the umbo. In the neanic stages extremities rounded, in ephebic and gerontic stages angular or subangular; hinge line straight or nearly so throughout; in neanic stage pedicle beak prominent, extending beyond brachial valve, with very small foramen. With growth, beak becomes incurved, finally bent closely over beak of brachial valve, with foramen closed. Cardinal area small; in ephebic and gerontic stages, like the foramen, it is more or less hidden by the very convex brachial umbo. About 20 mm. from the beak the shallow, rather broad sinus arises; lamellae obscure it, giving pedicle valve in general a flat appearance. In a hypotype, a slight concavity appears between growth lamellae 17 to 24 mm. from the beak; at 24 mm. a lamella extends outward until (in one place) it is 12.5 mm. beyond the margin of the brachial valve.

Brachial valve regularly convex umbonally, recurved toward the extremities, flattened laterally; fold, a broad, rounded to subangular elevation not clearly demarked from the general convexity of the shell.

Plications increase by bifurcations on the body of the pedicle valve, by bifurcation and implantation on that of the brachial. Plications of valves or figured syntype same in size at comparable distances from the beaks. Great variations in size of plications among the many specimens at hand. On both valves, lamellae extend outwards from structures usually considered growth lines; lamellae have the same type of plication and appearance as the body of the shell except that "growth lines" are lacking. On brachial valves the lamellae apparently were more conservative than on pedicle valves, and in most cases not well preserved. Variation in spacing and prominence of growth lamellae are well shown by the illustrations; on brachial valves these lamellae are commonly 5 to 7 mm. apart.

MISSOURIENSIS DEVONIAN BRACHIOPODA ATRYPA

1 2 3 4

ATRYPA MISSOURIENSIS Miller (1894)

Laird, W.M., Journ. Paleon., Vol. 21, 1927

Atrypa missouriensis Miller

Description: Shell small, subcircular to nearly circular in outline. Slightly longer than wide with an average length of 12 mm. for five well preserved specimens running from 11 to 14 mm. The average width is 11.4 mm., running from 10 to 13 mm.

The shells are biconvex with only slightly elevated umbos on both valves. The greatest thickness is in the umbonal region and averages 6.4 mm. The beak of the pedicle valve slightly overhangs the cardinal area which is very small.

The surface of both valves is covered with 60-70 radiating striations which bifurcate toward the anterior margin of the valve. Indistinct growth lines concentric with the anterior edge are also present. A very indistinct medial sinus is present on the ventral valve with an opposing medial fold on the dorsal valve.

Remarks: This form is very distinct from Atrypa montanensis Windle which is found at a similar stratigraphic horizon. This form has striations and an indistinct fold and sinus whereas Atrypa montanensis has coarse costae and a distinct medial fold and sinus.

Age and locality: Upper Devonian. Limestone member of Jefferson formation, Montana.

Diagram: Fig. 1 and 3 - dorsal view
Fig. 2 and 4 - Ventral view

1-3 Atrypa scutiformis Stainbrook, Pedicle, brachial, and anterior views of the holotype. (after Stainbrook, 1938, pl.31, figs. 16, 19, 20.)

Description: Shell above medium size, subequally biconvex; with nearly straight posterior margins, abruptly rounded angles and broadly curved anterolateral margins; wider than long, broadest posterior to the midlength, strongly sinuous along the front margin. Dimensions of the holotype: length, 38.3 mm., width, 39.9 mm., thickness, 15.9 mm.

Pedicle valve strongly arched from beak to front along the midline, gently arched transversely at the midlength; a little elevated in the umbonal region, depressed on either side of it and flattened toward the cardinal angles. A broad shallow sinus, gently concave at the bottom and indistinctly defined at the sides, originates at the midlength and, widening and deepening toward the front, forms there a broadly rounded lingual extension. Beak small, pointed, incurving over the opposite beak and pierced at the apex by a small circular foramen.

Brachial valve moderately arched along the hingeline, with the curvature greatest in the umbonal region, strongly arched transversely; the surface elevated and gently flattened along the surface elevated and gently flattened along the midline, sloping abruptly thence to the lateral margins, a little flattened near the cardinal angles. Beak small, slightly projecting, and concealed by that of the pedicle valve.

Exterior of both valves marked by numerous, fine radiating costae, regular in appearance, increasing by intercalation and division, and separated by spaces of equal width. About five costae occupy the space of three millimeters at the front margin. Growth lines widely spaced in the posterior portion of the shell, more numerous and closer together anteriorly, and occasionaly so strongly lamellose as to interrupt the continuity of the costae.

Resembles Atrypa independensis in shape and appearance but averages smaller and has finer costae. A. independensis averages about three costae in the space of three millimeters at the anterior margin.

Genus GRUENEWALDTIA

Tschernyschew 1885, n. gen.

In Hall and Clarke, Nat. Hist. of New York, Vol. VIII, pt. 2, p. 175

"This name has been proposed for the species Terebratula latilinguis, Schnur, originally described from the middle Devonian at Gerolstein. This species was considered by Kayser as a variety of Atrypa reticularis. The Russian specimens have the pedicle-valve very convex, the relative convexity of the valve in A. reticularis being reversed in this species. From the description and figures given by Tschernyschew, the spiral cones have their bases lying against the lateral slopes of the pedicle-valve, and thus the outer face of the cones is parallel to, and just within the surface of the brachial valve. It is such a modification of the brachial apparatus as must necessarily ensue from the variation in the contour of the shell. The character of the loop has not been determined."

Genotype: Terebratula latilinguis

Superfamily Spiriferacea (Shrock and Twenhofel, p. 330).

"Spiriferids, or spirifers as they are most commonly called, are typically transverse shells having calcareous spiralia of the spiriferoid type. The interareas are commonly well developed, and the delthyrium is modified by a deltidium or by deltidial plates. The shell may be smooth, costellate or costate, and in many genera it is also plicate and sulcate.

Range: Ordovician to Triassic.

Genera Described:	Range:
I. Genus Ambocoelia Hall	Devonian to Mississippian
II. Genus Ambothyris George	
III. Genus Athyris McCoy	Middle Devonian to Mississippian
IV. Genus Choristites Fischer	
V. Genus Crurithyris George	
VI. Genus Cyrtia Dalman	Middle Silurian
VII. Genus Cyrtina Davidson	
VIII. Genus Cyrtiopsis Grabau	
IX. Genus Cyrtospirifer Nalivkin	Upper Devonian
X. Genus Eleutherokomma Crickmay	
XI. Genus Elytha Fredericks	Devonian
XII. Genus Martinia	
XIII. Genus Martiopsis Waagen	Middle Devonian
XIV. Genus Meristella Hall	Upper Silurian to Middle Devonian
XV. Genus Platyrachella Fenton and Fenton	
XVI. Genus Reticularia	
XVII. Genus Spirifer	
XVIII. Genus Tenticospirifer Tien	
XIX. Genus Tylothyris North	
XX. Genus Warrenella Crickmay.	

Reported occurrences of this superfamily in literature reviewed in Part I of this thesis.

I. Genus Ambocoelia Hall . 9, 24.

* A. meristoides. 37.

II. Genus Ambothyris George

A. halli Branson. 37.

III. Genus Athyris McCoy

* A. angelica Hall. 2, 9, 18, 19, 20, 21, 22, 26, 29, 31, 34.

* A. angelicoides Merriam. 32, 36.

A. brandonensis Stainbrook. 37.

A. buffaloensis Stainbrook. 34.

A. fultonensis Swallow. 22.

A. parvula Whiteaves. 2, 36.

A. vittata Stainbrook. 34, 37.

IV. Genus Choristites Fischer

C. protistus Crickmay. 39.

C. glennfoxi Crickmay. 39.

V. Genus Crurithyris George

C. youngstownensis Crickmay. 39.

VI. Genus Cyrtia

C. cyrtiniformis Hall and Whitfield. 4.

C. rockymontana Warren. 20, 22.

* C. stanleyensis Shimer. 36.

VII. Genus Cyrtina Davidson. 8, 11, 12, 21, 36, 37.

* C. billingsi Meek. 1, 19, 26, 30, 37.

* C. glabra Kindle. 7, 37.

C. hamiltonensis Hall. 2, 8, 26, 33, 34.

VII. Genus Cyrtina Davidson (Continued)

C. heteroclita Davidson. 37.

* C. inulata Hall (?) 38.

* C. panda Meek. 1, 3, 4.

* C. rockymountana Warren. 33, 35, 38.

C. triquetra Hall. 37.

VIII. Genus Cyrtiopsis Grabau

C. nehannieniensis Crickmay. 39.

C. minetes Crickmay. 39.

C. hiraethlynae Crickmay. 39.

C. normandvillana Crickmay. 39.

C. prepta Crickmay. 39.

IX. Genus Cyrtospirifer Nalivkin. 35.

C. alexandrae Crickmay. 39.

C. animasensis Girty. 32.

C. charitopes Crickmay. 39.

C. glaucus Crickmay. 39.

C. kennecotti. Meek. 1, 30.

C. plicatus Stainbrook. 37.

C. portae Merriam. 32.

C. thalattodoxa Crickmay. 39.

* C. whitneyi Hall. 30, 31, 33, 37, 38.

X. Genus Eleutherokomma Crickmay

* E. beardi Crickmay. 37.

* E. hamiltoni Crickmay. 37.

* E. killeri Crickmay. 37.

* E. leducensis Crickmay. 37.

X. Genus Eleutherokomma Crickmay (Continued)

E. raymondi Haynes. 37.

* E. reidfordi Crickmay. 37.

XI. Genus Elytha Fredricks

E. compacta Meek. 1, 15, 37.

E. "undifera" Roemer. 37.

XII. Genus Martinia 9, 21, 29, 31, 35, 36.

* M. franklini Meek. 1, 30, 37.

* M. kirki Merriam. 34, 37.

* M. maia Billings. 24.

M. nevadensis Walcott. 33.

M. occidentalis Merriam. 3, 34.

M. richardsoni Meek. 1, 8, 24, 34, 37.

* M. sublineata Meek. 1, 8, 30, 34, 37.

XIII. Genus Martinopsis Waagen

M. sublineata Meek. 33.

XIV. Genus Meristella Hall. 32.

XV. Genus Platyrachella Fenton and Fenton. 36.

P. cyrtinaformis Hall and Whitfield. 21, 37.

XVI. Genus Reticularia

(P. fimbriata Meek. 13, 24. - Elytha fimbriata)

XVII. Genus Spirifer 8, 21, 24, 29, 34, 35, 36, 37.

*S. allani Warren. 30, 37.

S. animanensis Girty. 6, 18, 19, 21, 29, 36.

*S. argentarus

(S. compactus see Elytha compactas)

*S. disgunctus Sowerby. 2, 5, 9, 10, 12, 14, 25, 29, 37.

XVII. Genus Spirifer (Continued)

S.davisi Williams. 14.

* S. engelmani. 28.

S. euryteines Owen. 34, 37.

S. eudonus Crickmay. 39.

S. gallatiensis Haynes. 18.

* S. glabra Whiteaves. 2.

S. fimbriata Meek. 24.

S. hungerfordi Hall. 36.

(S. inutilis Hall see Tylothyris inutilis)

S. jasperensis Warren. 22, 28, 33, 36, 38.

S. macronatus Conrad. 33.

(S. meristoides see Ambocoelia meristoides)

* S. notabilis Kindle. 6.

* S. richardonsi. Whiteaves.. 2.

* S. raymondi Haynes. 16, 28, 33, 36.

S. subattenuata Hall. 2.

S. orstes Hall and Whitfield. 32.

S. parryanus Hall. 29.

* S. pinyonensis Warren. 28.

* S. strigosus Meek. 37, 38.

S. tullia Hall. 2, 13, 14, 26.

* S. whitneyi Hall. 9, 10, 18, 19, 20, 21, 22, 27, 29, 36.

S. zantedeshii Crickmay. 39.

XVIII. Genus Tenticospirifer Tien. 35.

* T. cyrtinaformis. 32.

T. keleticus Crickmay. 39.

XIX. Genus Tylothyris North. 33.

T. inutilis Hall. 2, 37.

XX. Genus Warrenella Crickmay 41.

* W. adodecta Crickmay 41.

* W. eclectea Crickmay. 41.

Genus AMBOCŒLIA

Hall 1860, n. gen.

In Hall and Clarke, Nat. Hist. of New York, Vol. VIII, pt. 2, p. 54.

"Diagnosis: Shells small, concavo-, or plano-convex. Marginal outline nearly semicircular. Hinge-line long and straight, its length nearly or quite equaling the greatest transverse diameter of the shell.

Pedicle-valve greatly elevated; umbo arched and incurved; with a narrow median groove which becomes fainter or disappears towards the anterior margin. Cardinal area well defined and arched; divided medially by an open delthyrium, whose lateral margins bear incomplete deltidial plates. Teeth priminent, erect, strongly recurved at the tips; not supported by dental plates. Muscular area quite restricted, consisting of narrow, elongate diductors, enclosing an almost linear adductor. The entire area is sometimes divided by a faint median ridge. The interior surface about the muscular area is strongly pitted.

Brachial valve convex at the beak, becoming depressed over the pallial region and reflexed near the margin. Cardinal area comparatively broad and standing at nearly right angles to the area of the opposite valve. Delthyrium open, the deltidial covering attaining the same degree of development as in the pedicle-valve. Cardinal process narrow and much elongated, resting on the bottom of the valve except at its posterior extremity which is simply bifurcated. Crural plates erect, parallel; taking their origin in the deltidial plates and extending about one-fourth the distance across the valve. The spirals are attached by long crura, the ribbon making a few volutions only, thus forming loose coils directed laterally. The loop has apparently the same incipient condition of development as in Spirifer. According to Œhlert, the spiral ribbon bears spinules on its outer margins. Muscular impressions anterior and composed of four well defined adductor scars.

Surface smooth or with fine concentric striae crossed by indistinct radiating lines; rarely spinous. Shell substance fibrous, impunctate."

Genotype: Orthis umbonata, Conrad. Hamilton group.

SPIRIFER (MARTINIA) MERISTOIDES Meek (1869)

Trans. Chic. Acad. Sci. Vol. 1, 1867-9, p. 106.

SPIRIFER (MARTINIA) MERISTOIDES Meek

Shell varying from longitudinally subovel to suborbicular, being sometimes longer than wide, and in other examples slightly wider than long, generally rather ventricose in adult specimens; hinge line very short and passing so gradually into the regularly rounded lateral margins as scarcely to appear straight at all; front narrowly, or more or less regularly rounded. Dorsal valve convex, but less so than the other, without a trace of a mesial fold, though the immediate margin at the middle of the front is very slightly raised to give room for an obscure projection of that of the narrow and curved. Ventral valve gibbous, sometimes rather strongly so, without a mesial sinus; beak prominent, incurved, in ventricose specimens sometimes almost folded down upon the other so as to close and hide the foramen; area very small and obscure, often nearly obsolete; foramen triangular, rather higher than wide, and not closed by a pseudo-deltidium. Surface marked by fine, rather obscure concentric strise, with a few rather strong concentric ridges of growth, usually passing over the middle of the ventral valve, and between that and the front. Internal cast showing distinct radiating markings. Internal spires rather large, and consisting (in a small specimen) of about six turns. Socket plates of dorsal valve thin, prominent, approximate, and but slightly diverging forward.

Length of a mature specimen, 0.73 inch; breadth, 0.65 inch; convexity, 0.47 inch.

Locality: Anderson and Lockhart rivers, lat. 67 deg. 15 min. N., long. 126 deg. W.

Diagrams:

1. Dorsal view
2. Ventral view
3. Side view
4. Anterior view

Genus ATHYRIS

McCoy 1844, n. gen.

In Hall and Clarke, Nat. Hist. of New York, Vol. VIII, pt. 2, p. 83

"Diagnosis: Shells subequally biconvex; outline transversely elliptical, subcircular or elongate-subovate; surface medially sinuate.

In the pedicle-valve the beak is inconspicuous and incurved, usually concealing the foramen and deltidial plates; frequently, however, the former is exposed. Cardinal slopes not well defined in the typical group. The convexity of the valve is greatest in the umbonal region, the surface sloping evenly to the sides, and becoming depressed on the median line into a sinus, which is most conspicuous on the anterior margin. Beak of the brachial valve not prominent; a median fold corresponds in strength to the sinus of the opposite valve.

In the interior of the pedicle-valve the deltidial plates are usually absent; the teeth are prominent, recurved at the tips, and supported by stout dental lamellae, which are not produced anteriorly about the muscular area. Between them lies a deep, transversely striated pedicle-cavity, and in front of this an ovate muscular scar extending about one-half the length of the valve and divided into flabellate diductors (which are frequently very indistinct) and narrow, cordate adductors. The pallial region is covered with ovarian pittings and branching sinuses.

In the brachial valve the dental sockets are broad and deep. The hinge-plate varies considerably in form; in the typical division of the genus it is subtriangular in outline, and supported by stout crural plates. The median portion is flat or concave, the lateral margins thickened and elevated. At the apex of the plate and just within the beak of the valve is a circular perforation (visceral foramen), which is continued beneath the plate into the cavity of the valve. The anterior margin of the plate is straight or slightly concave, occasionally trilobate, and the crura are attached at the extremities of the lateral ridges. Sometimes the outline of the hinge-plate is rendered subquadrate by the development of two post-lateral expansions.

The brachidium consists of spiral cones lying base to base, with their apices directed laterally. The form of these cones varies with that of the internal cavity, but as a rule they are much compressed vertically, the posterior curvature being short and convex, while the anterior curve is long and sometimes depressed. The crura originate from the hinge-plate at a large angle, are long and convergent; the primary lamellae arising from their extremities, make an angular curve at their origin, thence, in the typical species, curving deeply upward and backward, to form the first volution. The spirals are connected by a loop, which takes its origin on the first half of theprimary lamellae, the two lateral lamellae converging, and uniting at about half the distance across the base of the cones, to form a broad saddle with a convex upper surface; the anterior extremity of this saddle may be simple or divided; its posterior

portion is narrowed, inclined downward or toward the beak of the brachial valve for a short distance, thence it rises abruptly toward the umbo of the pedicle-valve, and bifurcates near the extremities of the crura, each branch following the curvature of the primary lamellae and continuing for only a part of the distance between the ends of the crura and the origin of the loop. These accessory lamellae vary somewhat in form, are narrower than the ribbon of the coil, and lie between the primary, and the first band of the secondary lamellae.

The muscular area consists of a long, ovate scar, which is divided into a subquadrate posterior pair, and a subcordate anterior pair of adductor impressions. These are separated longitudinally by a very faint median ridge. On casts of the interior the filling of the visceral foramen in the hinge-plate frequently shows a cross-striation like that of the pedicle-cavity of the opposite valve, and also indicates that the median ridge is continued throughout the extent of this passage.

The surface of the valves is variously ornamented; in the typical group, at each concentric growth-line, there is a broad lamellar expansion; in some cases this expansion is striated longitudinally, or it may be divided into flat spines, which merge into the lamella at their bases; again the spines may be long and tubular, but connected by the laminar expansions. The surface frequently appears to be smooth, or covered only with concentric striae, and in one of the largest subdivisions of the genus (Seminula) this is a normal condition, while in other divisions it is often altogether casual.

Shell-substance fibrous, impunctate.

Genotype: Terebratula concentrica, von Buch. Middle Devonian.

ATHYRIS ANGELICA (Hall 1862)

Hall and Clarke 1893, Pal. N.Y. State, pt. 2, p. 90, pl. 45, figs. 26-30.

ATHYRIS ANGELICA

Description: Small 13-25 mm. wide, subpentagonal in outline; sulcus deep, fold prominent on anterior half of valve. Surface marked by regular fine concentric lamellae.

Locality and Horizon: Upper Devonian of the Appalachian region and Nevada.

1 2 3

Athyris angelicoides Merriam 1940, 1-3 anterior, ventral and dorsal views of paratypes, slightly reduced.

ATHYRIS ANGELICOIDES

Athyris angelicoides Merriam(1940) Geol. Soc. Amer., Spec. Pap. 25, p. 84, pl. 10, figs. 1,2,4.

Description.-- Average shell size small; varying from transverse to narrow; biconvex, with convexity of dorsal and ventral valve about equal; sulcus and dorsal fold well developed; commissure parasulcate; radial ornamentation absent; concentric incremental lines numerous and closely spaced.

Athyris angelicoides differs from the New York A. angelica in its generally smaller size, greater ventricosity of many individuals, and frequently more profound development of the lateral sulcation on either side of the dorsal fold.

Measurements.-- Holotype, width 14.2 mm., length 14.2 mm., thickness 10.7 mm.

Occurrence.-- Upper Devils Gate formation, Cyrtospirifer zone: in association with Cyrtospirifer portae, Schizophoria simpsoni, and Leiorhynchus walcotti.

Genus CYRTINA

Davidson, n. gen.

Davidson (1858), Monograph of British Carboniferous Brachiopoda, Pt. V, p. 66.

Sub Genus Cyrtia Dalman (1827) and Cyrtina Davidson (1858).

"In the eighty third page of my general introduction, doubts were expressed as to the value of Dalman's Cyrtia and his diagnosis is there stated to be unsatisfactory and equally applicable to several species of Spirifer. In fact the genus appears to have been created simply to receive those few species of Spirifer which possess a circular foreamen in the deltidium of the larger valve, for the author did not furnish any information regardingthe internal arrangements of his two named types C. exporrecta and C. trapezoidalis. Subsequently to 1827 several other species were added (by different authors) to the genus Cyrtia and amongst these are some whose shell structure has been stated to be punctate, while that of Dalman's type is unpunctate, as in Spirifer proper, and although it has always appeared to me probable that a difference in shell structure would be accompanied by some important interior modification, it was not until very lately that I was enabled to discover some of the characters of the following species. C. exporrecta, C. trapezoidalis, C. Murchisoniana, C. cuspidata, C. heteroclyta, C. Demarlii and C. septosa.

The results show that in the first four, which belong to Dalman's genus, the internal characters are similar, but different from the last three, which cannot be properly retained under the same generic denomination, for it is evident that considerable dissimilarities in the arrangements of the plates of the ventral valve must have carried along with them some important difference in the soft part of the animal, and I therefore propose at least provisionally to distinguish the little groups of spiriform shells of which C. heteroclyta,C. Demarlii and C. septosa are examples under the generic or sub generic apellation of Cyrtina, and to leave that of Cyrtia to those which agree with Dalman's C. exporrecta, C. trapezoidalis and C. Murchisoniana, etc.; but it is necessary to observe that the last named genus is of itself of such little value that it will remain a question of further discussion whether it should be retained or added to the synonyms of Sowerby's Spirifer.

In Cyrtia a short hinge tooth is situated on either side of the base of the fissure supported by vertically shelly plates which diverge and extend from the extremity of the beak forming the fissure walls and occupying about one third of the length of the bottom of the valve. There exists in Cyrtia no median plate or septum, the arch-like deltidium which covers the entire fissure is generally, but not always, perforated by a circular foreamen. In the smaller valve the spiral

appendages and their mode of attachment is exactly similar to what we find in Spirifer and with which the plates in the ventral valve also very closely agree. Therefore Cyrtia (Dalman) presents no other feature by which it can be separated from Spirifer proper, than that of its deltidium and foreamen, which are characters of hardly sufficient importance to warrant the creation of a separate genus.

In Cyrtina the diverging plates already described do not exist, but we find in the interior of the ventral valve (of C. heteroclyta and C. septosa) two contiguous vertical septa which coalesce into one median plate which extends from the extremity of the beak to within a short distance of the frontal margin and then diverges to form the dental plates in a very similar manner to what we perceive in Pentamerus.

The fissure is covered by an arched shaped deltidium; but in C. Demarlii Mr. Bouchard has remarked that the median septum is continued as the under surface of the deltidium, and the dental plates are fixed to the sides instead of the upper edge as in C. heteroclyta and C. septosa. The arrangements in the smaller or more important valve are still unknown notwithstanding many efforts I have made to pry into their interior; and it is certain that no vestage of spiral coils have hitherto been noticed by an author. Therefore, although we possess no proof that these three species of Cyrtina were possessed of spirals, and consequently true Spiriferidae, it will be necessary to pause before admitting the shells in question into the Genus Pentamerus."

Genotypes: C. heteroclyta
C. Demarlii
C. septosa - [illegible].

CYRTINA BILLINGSI Meek (1868)

Trans. Chic. Acad. Sci. Vol.1. p. 97.

CYRTINA BILLINGSI Meek

Description: Shell of medium size; hinge line less than the greatest breath, and obtusely angular, or somewhat rounded at the extremities. Ventral valve prominent at the umbo, from which it slopes abruptly, with a moderately convex outline, to the anterior and lateral margins; provided with a broad, very shallow, undefined mesial sinus in front; beak obtusely angular and a little curved backwards; area triangular, somewhat longer on the hinge line than on either of angular lateral margins, slightly arched and inclined backwards over the hinge, and showing more or less distinct transverse marks of growth; foramen very narrow, or less than half as wide as high, closed below the middle by a moderately convex deltidium which (in the specimen examined), is deeply emarginated above by a large oval aperture with beveled margins. Dorsal valve wider than long, truncato-subeliptical, much compressed or nearly flat, or a little concave; front very slightly raised by the shallow sinus of the opposite valve. Surface ornamented by about forty rounded and faintly defined radiating costae on each valve, ten or eleven of which occupy the very shallow mesial sinus of the dorsal valve, and about the same number the corresponding slight prominence of the ventral valve. These costae sometimes bifurcate, or increase by theintercalation of others, which die out before reaching the beaks, particularly on the middle portions of the valves. Faint traces of very fine crowded concentric striae, and a few stronger lines of growth mark the valves in the opposite direct on; while, with a good magnifier, minute granules may be seen on all parts of the surface. Exfoliated surfaces also show, under a magnifier, the minutely punctate structure characteristic of the genus.

Length from the front to the hinge, 0.60 inch; do. from front to point of beak of ventral valve, 0.60 inch; breadth, 0.60 inch. Length of hinge, 0.50 inch; convexity of the two valves, 0.33 inch, about four-fifths of which is occupied by the ventral valve alone.

Locality: Clear Water river, a tributary of Athabasca river. Devonian of the age of the Hamilton group.

Diagrams: 1. Side view
2. Ventral view
3. Posterior view
4. Dorsal view.

CYRTINA GLABRA Kindle

Kindle (1919) Geol. Surv. Canada, Mus. Bull. 29, pl. 1, figs. 1-3.

CYRTINA GLABRA Kindle.

Description: Shell small with subpyramidal pedicle valve. Sides of ventral valve sloping regularly to the margin with a broad shallow sinus not reaching quite to the beak. Brachial valve convex in the umbonal and median portion and slightly convex near the anterior and lateral margins. Fold on pedicle valve showing only at front margin of shell. Cardinal area transversely striated and inclined forward. Deltidial plate not observed. Deltidial opening extending to the apex.

The perfectly smooth surface of this shell distinguishes it from other species of Cyrtina.

Horizon and Locality: Simpson shale, bank of Mackenzie River 5 miles above Rabbitskin River, N.W.T.

Diagrams: 1. Dorsal view.
2. Posterior view.
3. Ventral view.

CYRTINA INULATA Stainbrook

Stainbrook, 1945, Geol. Soc. Amer., Mem. 14, p. 59, pl. 6, figs. 26-29.

CYRTINA INULATA Stainbrook

Description: Shell small, subpyramidal in shape, subquadrate in outline with rounded antero-lateral margins; having greatest width generally along the hinge-line or slightly anterior in some specimens, angles usually extended, and anterior commissure strongly uniplicate.

Pedicle valve strongly convex, subpyramidal in shape, highest in the umbonal region almost directly posterior to the beaks. Slopes slightly curved from back to front and from sulcus to angles. Cardinal area flat for the greater part, high, and slightly to considerably curved near the beak.

Brachial nearly flat, gently convex centrally. Fold strong, originating at the beak, elevated above remainder of valve, highest at front, gently convex or flattened along summit, bordered on each side by a deep furrow; some specimens show a slight medial depression at the front or posteriorly. Interior unknown.

Diagrams: 1. Ventral view.
2. Dorsal view.
3. Anterior view.
4. Posterior view.

CYRTINA PANDA Meek (1868)

Trans. Chic. Acad. Sci. Vol. 1. p. 100.

CYRTINA PANDA Meek

Description: Shell pyramidal, wider than long; hinge line less than the greatest breadth of the valves in adult examples; lateral extremities obtusely angular or somewhat rounded. Dorsal valve truncato-subelliptic, nearly flat, or but little convex; beak not prominent; mesial fold rounded, nearly flat, excepting at the front, where it is a little raised, occupying distinctly more than one-third of the entire breadth of the valve at the anterior margin, but narrowing very abruptly to the beak. Ventral valve very convex; sides sloping abruptly from the beak to the front and lateral margin; beak high, not incurved but sometimes twisted to one side; area large, well-defined, triangular, nearly flat, or slightly arched, and finely and regularly striated both ways; deltidium narrow, a little convex, and at the upper extremity perforated; mesial sinus very shallow and rounded, causing slight projection into a corresponding recess in the margin of the other valve in front. Surface ornamented by 10 to 12 small, regular, simple radiating costae on each side of the mesial sinus and fold, which latter are without costae, but marked with very fine, obscure radiating striae. Fine, obscure lines of growth also mark the entire surface concentrically, in well preserved specimens.

Length, 0.45 inch; breadth, 0.66 inch; convexity, 0.51 inch.

Locality: Onion river, long. 125 deg. W., lat., 67 deg. N.

Diagrams: 1. Side view
2. Ventral view
3. Dorsal view
4. Posterior view.

CYRTINA ROCKYMONTANA Warren

Warren, 1928. Trans.Royal Soc. Canada, 3rd Ser., vol. 22, pt.1. Sec. 4, p. 118, pl. 1, figs.6-13.

CYRTINA ROCKYMONTANA Warren

Description: Shell small, smooth subpyramidal in shape, subquadrate in outline with rounded antero-lateral margins; greatest width anterior to the hinge-line; postero-lateral margins rounded, and anterior commisure uniplicate. Dimensions; length, 6.8 mm., width 9.8 mm., thickness, 6.4 mm.

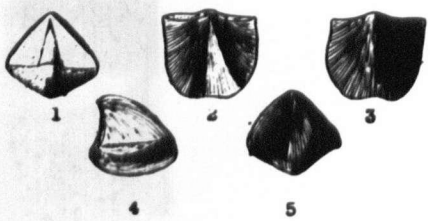
Pedicle valve subpyramidal, thickest in the umbonal region; surface slightly curved, and descends abruptly to the anterior and lateral margins. The sulcus originates at the beak and passes forward into a low rounded lingual extension. Cardinal area high, flat, subperpendicular to the plane of commisure, and transversely lammelose. Delthyrium higher than wide.

The surface of both valves is finely lammelose, consisting of fine concentric ornament. Brachial valve gently convex, with a uniformly rounded fold appearing at the anterior margin in mature specimens.

Remarks: Stainbrook (1945, p. 59) has suggested that the species be referred to Thomasaria. Some support to this view is provided by the occurrence of an indefinitely formed delthyrial plate.

Diagrams: 1. Ventral view.
2. Anterior view.
3. Posterior view.
4. Lateral view.

STANDLYENSIS UPPER DEVONIAN BRACHIOPODA CYRTIA



Cyrtia standlyensis Shimer, 1926, Geol. Survey of Canada, Mus. Bull. 44, pl. 1, figs. 2 a, b, c, d, e; 1, 2, 3, 4, 5. Cardinal, pedicle, brachial, side, and anterior views of the type specimen.

CYRTIA STANDLYENSIS

Cyrtia standlyensis Shimer, 1926.

Shell medium size, subpyramidal with greatest convexity at umbo. Hinge-line equals greatest width, cardinal extremities angular. Dimensions of the type shell: length from hinge-line to frontal margin, 20 mm., from beak of brachial valve to frontal margin 21 mm. greatest width (at hinge-line) 21 mm., thickness, 19 mm., of pedicle valve 13 mm., of brachial valve 6 mm. , delthyrium 6 mm. wide at base and 10 mm. high.

Pedicle valve subpyramidal, greatest convexity near beak from which the surface curves abruptly anteriorly and laterally to the margin of the valve. Beak pointed, very slightly incurved, at times slightly twisted. Cardinal area broad, extending to the cardinal extremities, almost straight below, more distinctly arched in upper half, vertically striate over its entire area. Delthyrium considerably higher than wide (base 1/3 height), bounded by the thickened margins, of the strongly developed dental plates; these plates extend about half distance to frontal margin. Median sinus narrow and smooth at beak, becoming broad, of moderate depth, and plicated anteriorly; these plications entering in the umbonal region bifurcate rapidly, resulting in about 20 low, rounded plications at the front of the valve. Lateral slopes of valve each with about 20 low, rounded, simple plications.

Brachial valve much less convex than the pedicle, with the greatest convexity at the umbo; cardinal extremities flattened. Median fold low, broadly rounded, increasing in breadth rapidly towars the front. Plications similar in number, character, and size to those of corresponding positions upon the opposite valve.

The finer surface markings consist of minute radiating, papillose lines, covering the entire shell.

Larger than C. cyrtiniformis, increased number of plications in the sinus, and more highly arched cardinal area. Cyrtia norwoodi smaller in size, has narrower delthyrium, narrower and shallower median sinus, and fewer plications (30-40 instead of 60). Spirifer disjunctus animaecensis Girty is broader, has broader delthyrium, and has 20-25 plications upon each lateral slope and only 5-10 in the sinus. Spirifer disjunctus occidentalis Whiteaves is distinctly alate with coarse plications.

Occurrence.--In Upper Devonian sections in the Minnewanka region.

Genus ELEUTHEROKOMMA

Crickmay n. gen.

Crickmay (1950), Jour. Pal. Vol. 24, No. 2, pp. 219-225, plts. 36, 37.

"Description: Medium ridged, subequally biconvex, strongly transverse and mucronate Spiriferidae, with non plicate fold and sulcus and costae (or plicate) lateral slopes. Hinge-line straight and equal to the greatest width of the valve.

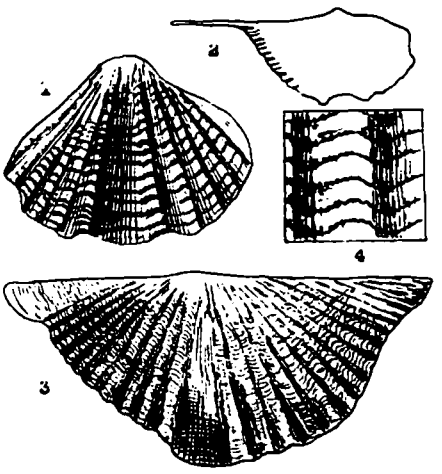
Ventral valve with short interarea, medium broad delthyrium and incurved beak; interiorly with strong straight dental lamellae diverging toward their bases with long straight hinge teeth and in some a small adventilious deposit of nacre producing in some specimens the appearance of a transverse delthyrial plate but not a true plate; usually possessing a low, thin, sharp median ridge but not a true septum.

Dorsal valve with very short interarea and low, sharp beak; interiorly with deep narrow sockets and strong oblique socket plates, a short, broad, rounded, undivided, vertically striate cardinal process and a low median ridge but not a true septum.

Exterior of lateral slopes ornamented by few to many costae (or plicae); and on the whole shell concentric lamellae. Micro ornament of the whole shell (except the interarea) fine radial threads (or striae) crossed by fine regular concentric mico-fila and in some irregularly spaced micro-spines.

Distinction from most other Miriferid genera lies in the exaggeratedly transgerse and mucronate character. From Mucrospirifer as from all other genera it is separated by its complex micro-ornament.

Genotype: Eleutherokomma hamiltoni Crickmay.



1-4,--Eleutherokomma beardi Crickmay, 1, Paratype No. 2, from Imperial Paddle River No. 1 borehole, at 8090-8110 feet depth, mold of exterior of pedicle valve. The posterior margin is incomplete. Magnified to show micro-ornament, x10.0. 2, Paratype No. 1, from same source, mold of part of interior of pedicle valve, with some shell substance preserving the left mucro, x3.0. 3, Holotype, from same source, mold of exterior of brachial valve, with some shell substance still in place. The dorsal parintrope and the excessively fine mucrones have been lost in breaking the matrix. Magnified to show micro-ornament, x6.0. 4, Paratype No.3, a small portion of the surface more highly magnified to show micro-ornament, x20.0.

Eleutherokomma beardi Crickmay, 1950, Jour. of Paleontology, vol. 24, p.223, pl. 37, figs. 1-3, 10.

Description.--Shell subequally biconvex, outline semicircular, extremities fine aculeiform mucrones. Lateral slopes with 9 to 12 delicate rounded costae, whose strength decreases with distance from fold and sulcus. Costae show on internal surface.

Ventral valve strongly convex. Sulcus bounded by strong costae, narrow, unmarked. Beak strongly incurved. Interarea short. Delthyrium about 60°; open, without callus. Hinge teeth fine. Dental lamellae strong, diverging parallel to first furrow, about 1/4 length of valve.

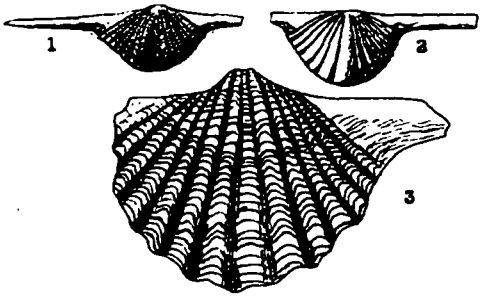
Dorsal valve slightly less convex. Fold wider than in other species, evenly tapered, prominent, flat upon the culmen. Beak slightly more prominent than in other species. Interarea very short. Notothyrium not wide; very short. Cardinal process rounded, vertically finely striate. Socket plates strong. Inconspicuous internal median ridge in central region of valve.

Exterior covered with fine concentric lamellae, 3 to 6 to the mm. Between each pair are 3 or 4 fine concentric microfila. Surface covered with fine radial threads (micro-striae), 10 or 12 to the mm. Intersection of these two fine ornaments produces a sharp, delicate, fimbriate pattern, and from stronger intersections, short, delicate micro-spines arise.

Measurements.--Holotype, width, 42.5 mm.; length (dorsal valve), 9.5 mm. (the corresponding ventral valve 10.5 mm.); depth (dorsal valve), 3 mm.

Occurrence.--In fine dark limestone zone below the black shale, in Imperial Paddle River No. 1 borehole, at depth 8090 to 8110 feet.

Age.--Later than E. leducensis and E. killeri, below black shale zone carrying Tentaculites sp., Manticoceras cf. simulator Hall, Bactrites sp.



1-3, Eleutherokomma hamiltoni Crickmay, 1, Holotype, from La Saline Rock, pedicle valve, external aspect. Left mucro fully preserved, right broken off at less than mid-length. x1.8. 2, Paratype No.1, from La Saline Rock, brachial valve, external aspect. Both mucrones broken off; impression of right mucro is preserved for about 7/8 of its full length. x2.0. 3, Paratype No. 2, from La Saline Rock, pedicle valve, external aspect, magnified to show micro-ornament, x5.0.

ELEUTHEROKOMMA HAMILTONI

Eleutherokomma hamiltoni Crickmay, 1950, Jour. Paleontology, vol. 24, p.220, pl.36, figs. 1-3.

Description.--Shell somewhat smaller than other species, subequally biconvex, approximately semicircular in outline, each extremity produced sharply into a very long, slender, needle-like mucro. Lateral slopes with eight to ten rounded costae and narrower furrows, strength of costae decreasing with distance from fold and sulcus. Costae weak on interior of shell.

Ventral valve strongly convex. Sulcus bounded by strong costae, narrow, deep, marked by trace of a median costa within. Beak strongly incurved. Interarea short. Delthyrium about 60°, open except for a small irregular deposit of adventitious nacre forming a callus which often resembles a transverse delthyrial plate. Hinge teeth long, sharp, straight. Dental lamellae strong, less than 1/4 length of valve, diverging from beak parallel to 2nd costa. Internal surface with low, blunt median ridge through central region of valve.

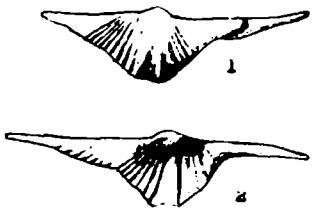
Dorsal valve less convex, more rounded, less angular. Fold narrow, not prominent, non-plicate except at anterior commissure, where a faint trace of a median furrow appears. Beak low, inconspicuous. Interarea very short, Notothyrium wide and short. Cardinal process small, low rounded, vertically finely striate. Socket plates large and massive. Rostral chamber with adventitious nacre. No dorsal median ridge.

Exterior except palintrope covered with fine concentric lamellae, 3.5 to mm., more closely spaced at anterior edge, each lamella projecting 0.2 to 0.3 mm. above surface. Between each pair of lamellae are 4 to 6 concentric micro-fila. Surface (except interarea) also covered with micro-striae, 12 to 16 to mm.

Measurements.--Holotype, width, 42mm.; length 8 mm.; depth (ventral valve) 3mm.

Occurrence.--Uppermost zone of the Waterways formation at La Saline Rock.

Age.--Late but not necessarily latest, Middle Devonian.



1-3, Eleutherokomma killeri Crickmay 1, Holotype, from Imperial Egremont No. 1 well at 4430-4446 feet depth, mold of interior of a pedicle valve, with part of the right mucro of the brachial valve of the same individual. The mucrones are mostly, but not perfectly, preserved. x1.5. 2, Holotype, reverse of same specimen. x1.6.

ELEUTHEROKOMMA KILLERI

Eleutherokomma killeri Crickmay, 1950, Jour. of Paleontology, vol. 24, p.222.pl. 36, figs. 4,5.

Description.--Shell, average size for genus, subequally biconvex, angularly aliform in outline, each extremity produced into strongly tapering, needle-sharp mucro. Lateral slopes narrow, with 9 to 12 fine, rounded costae and furrows of like width, strength of costae decreasing gradually with distance from fold and sulcus. Costae show strongly on interior.

Ventral valve stronglyconvex. Sulcus narrow, bounded by strong costae, unmarked except for micro-ornament. Beak incurved. Interarea short. Delthyrium about 60°, open except for linear callus upon the inner face of the dental lamellae; the two opposing calluses remaining discrete. Hinge teeth small. Dental lamellae varies in length, stout, diverging toward bases and toward anterior. No trace of a median ridge.

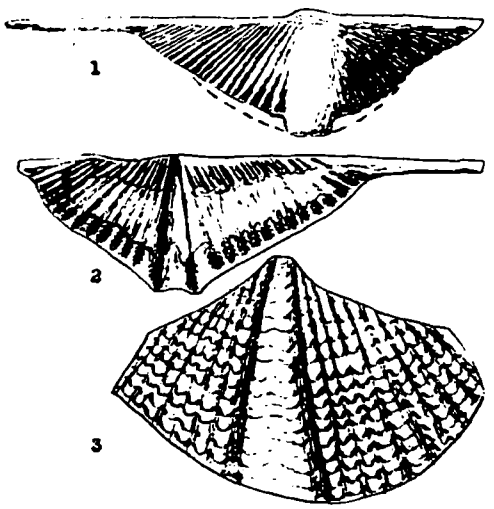
Dorsal valve slightly less convex. Fold narrow, flaring broadly at its anterior end, prominent, its culmen flat to shallowly furrowed. Beak low, inconspicuous. Notothyrium wide, short. Cardinal process small, rounded, vertically striate. Sockets narrow. Socket plates thin. Anterior to the umbonal region is a low, thin, dorsal median ridge.

Exterior with fine, close, concentric lamellae. Between lamellae are faint, fine, concentric micro-fila. Entire surface covered with micro-striae, about 10 to mm.

Measurements.--Holotype, width 29 mm.; length, 10 mm.; depth (ventral valve), 3 mm.

Occurrence.--In fine grained limestone zone below the reefs, at a depth of 4430 to 4446 feet in Imperial Egremont No. 1 well.

Age.--Later than E. hamiltoni. Earlier than E. beardi which occurs in latest Middle to earliest Upper Devonian.



1-3, Eleutherokomma leducensis Crickmay, 1, from Millet-Leduc No. 16-6 borehole at 6058-6078 feet depth, mold of interior of brachial valve with some shell substance showing ribbing and other surface marks attached to it in places. Outline completed in broken black line. Interior dorsal median ridge is faintly discernible. x2.5. 2, Holotype. reverse of same specimen. Some micro-ornament is shown as an impression in the matrix, x2.8. 3, Paratype No.1, from the same source, mold of part of exterior of a small pedicle valve. Specimen is a deeply concave impression. Magnified to show micro-ornament, x5.5

Eleutherokomma leducensis Crickmay, 1950, Jour. of Paleontology, vol.24, p.222, pl.36, figs.6-8.

Description.--Larger than average of the genus, subequally biconvex, strongly transverse extremities produced into a long slender mucro. Lateral slopes wide, flattened, with 12 to 15 fine, rounded,prominent costae, which become increasingly slender with distance from fold and sulcus. Costae scarcely show on internal surface of shell.

Ventral valve strongly convex, angular. Sulcus bounded by strong costae, narrow, flaring at anterior edge, unmarked. Beak prominent, less incurved than in other species. Interarea notably longer than average for genus Delthyrium 50° , open except for faint development of linear callus. Hinge teeth strong. Dental lamrllae strong, 1/3 length of valve diverging widely toward anterior, parallel to third costa. Strong, sharp median ridge from near beak across center of internal surface.

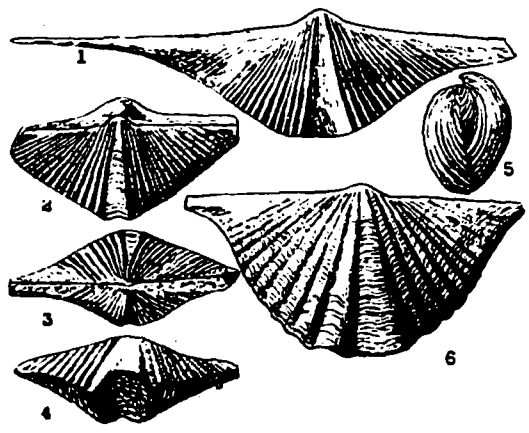
Dorsal valve less convex; less angular. Fold narrow, prominent, with broad shallow median furrow in its anterior half. Beak sharp, not conspicuous. Interarea short. Notothyrium wide, short. Cardinal process low, flat, vertically striate. Socket plates large and massive. Umbonal region little or no callus. Short,sharp median ridge extends anteriorly from inferior edge of the cardinal process for a short distance.

Fine concentric lamellae, 2.3 to mm. cover surface. Between each pair are about 6 regular, concentric micro-fila. Fine radial threads cover surface, about 15 to mm. Makes microscopic quadrille pattern

Measurements.--Holotype, width 60 mm.; length 11 mm.; depth 2.5 mm. (dorsal valve). length ventral valve 13 mm.

Occurence.--In fine limestone zone below dark shale zone,at depth of 6058-6078 feet in Millet Leduc No.16-6 borehole, sec.6, T.48, R.24, west of 4th Meridian. Occurs rarely with E. killeri

Age.--Latest Middle to earliest Upper Devonian.



Eleutherokomma reidfordi Crickmay, 1, Holotype, Hay River, Northwest Territories, 14 miles from mouth, pedicle valve. Shell substance encrusted with minute coralline and bryozoan calcareous deposits. The left mucro is complete. x2.2. 2-5, Paratype No.1, from the same locality, a specimen with both valves, much encrusted, extremities broken, x2.0. 2, Dorsal aspect. 3, posterior aspect. 4, anterior aspect. 5, left lateral aspect. 6, Paratype No. 2, from same locality, brachial valve, external aspect. Both mucrones broken off. Magnified to show some micro-ornament, x3.2.

ELEUTHEROKOMMA REIDFORDI

Eleutherokomma reidfordi Crickmay, 1950, Jour. Paleontology, vol.24, p.224, pl.37, figs. 4-9

Description.--Shell average size or larger, subequally biconvex, angularly alliform, long, needle-like mucrones. Lateral slopes wide, with 18 to 30 rounded costae and slightly narrower furrows. Costae decrease in strength with distance from fold and sulcus; beyond the 12th costae, they decrease greatly in length, tending to run not radially but parallel. On the internal surface of the shell costae show mainly toward the anterior edge; they are faint or absent in other regions. Shell substance thick.

Ventral valve strongly convex. Sulcus average width, evenly tapered, deep, sloping within to a narrow bottom, unmarked. Beak strongly incurved. Interarea short. Delthyrium about 50°, open except for a regular , massive callus. Hinge teeth stout, long. Dental lamellae strong, 1/3 length of valve, reinforced with considerable callus in the umbonal cavities and with a very regular callus in the delthyrial chamber, diverging strongly toward their bases, and diverging from the beak parallel to the second costa. Low median ridge only in young stages.

Dorsal valve less convex. Fold narrow, slightly flaring, marked by a shallow furrow. Beak stronger , more conspicuous than other species. Cardinal process divided by a slight central concavity, vertically striate. Sockets short, deep, roundish. Socket plates massive, curved, reinforced with callus in the rostral cavity. Median ridge varies.

Exterior has fine, close concentric lamellae, irregularly spaced. Lamellae farther apart on umbonal region, closer in anterior region. Surface covered with micro-striae, 7 to 10 per mm. Tend to obliterate micro-fila.

Measurements.--Holotype, width 59mm.; length 11.5mm.; depth, 4 mm.

Age.--Finger Lakes age (early to mid-Frasnian).

Genus MERISTELLA

Hall 1859, n. gen.

In Hall and Clarke, Nat. Hist. of New York, Vol. VIII, pt 2, p. 54.

"Diagnosis: Shells having the same general external characters as Merista. Valves convex, often inflated, cardinal areas obscure. The umbo of the pedicle valve is incurved at maturity, concealing most, if not all of the foramen; in early stages of growth, however, the beak is more erect and exposes the deltidial plates in an elementary condition of development. The anterior margin of the shell is sinuate, and usually there is a sinus on the pedicle-valve, with a less conspicuous fold on the brachial valve; sometimes both valves bear a low sinus, or the sinus on the pedicle-valve may be absent, while the fold on the brachial valve is present, thus giving the shell a nasute anterior extension; again, fold and sinus may be absent on both valves.

In the interior of the pedicle-valve the delthyrium is wide, its margins being thickened into dental ridges. The teeth are conspicuous, often much thickened and curved backward at their tips, interlocking with the opposite valve in such a manner as to make a very firm articulation. The teeth are supported by lamellae which rest upon the bottom of the valve, and are continued for a short distance about the posterior margin of the muscular impression. In old shells this portion of the valve becomes greatly thickened, the muscular impression correspondingly deepened, and the identity of the dental lamellae is obscured by their becoming merged with the substance of the valve. The pedicle-cavity is deep and frequently shows a strong muscular scar. The impression of the diductor muscles is subquadrate-ovate or subtriangular in outline, very strongly impressed and usually clearly divisible into its two lateral components. The central adductor scar is faint, but linear when retained. The lateral scars are deeply striated longitudinally. The anterior margin of the muscular area is frequently obscure but is not infrequently a ridge from which radiate fine, anastomosing pallial sinuses. In the post-lateral regions the ovarian sinuses are sometimes retained.

In the brachial valve the beak is depressed and sometimes obscured by the incurvature of the umbo of the opposite valve. The dental sockets are narrow and divergent. The hinge-plate is subject to some unessential variation in form. Usually it is triangular, concave on the upper surface, and divided into two lobes by a median groove. The crura take their origin from just within the anterior margins of the lobes thus formed. In some species the hinge-plate is more subquadrate in outline, the variation being produced by the development of post-lateral expansions. This plate is supported by a median septum, which extends for somewhat more than one-third of the length of the valve. The crura are short and stright, and the primary lamellae of the brachidium originate from them at an acute angle, and come into closest appoistion at the anterior extremity of the median septum.

In the mature individual, the spiral ribbon makes about fifteen volutions, the bases of the cones being subparallel to the longitudinal axis of the shell and their apices directed toward its lateral margins. In their general shape the cones conform to the character of the interior cavity, and in the less convex species (M. Walcotti, M. lenta), they are appressed on the side of the flatter or brachial valve. The structure of the loop is the same as described for the genus Merista, with this difference, however: the circular arms of the loop curve first outward in the horizontal plane, then backward and abruptly downward to the inner edges of the primary lamellae; in their return the same curvature is reversed and they therefore meet the stem of the loop in the horizontal plane, their point of union being invariably above the point of coalescence of the lateral branches of the loop.

The muscular area is elongate-ovate, and extends for the entire length of the median septum; the four adductor scars are sometimes distinctly seen, the posterior pair being broader and embracing the posterior extremities of the anterior scars.

External surface of the valves smooth or with concentric striae. Shell structure fibrous, impunctate."

Genotype: Merista laevis, Hall. Lower Helderberg group.

Genus PLATYRACHELLA

Fenton and Fenton, n. gen.

Fenton and Fenton (1924) The Stratigraphy and Fauna of the Hackberry Stage of the Upper Devonian, MacMillan, p. 158.

"Description: Shell spiriferoid, small to large, with high and nearly flat cardinal area. Surface marked by strong plications, which may be either fine or coarse. Diagnostic characters are the presence of a well-defined delthyrial plate and impunctate shell structure. The former separates the genus from Spirifer, and the latter from Pseudosyrinx, with the genotype being most like the latter genus in general appearance.

It seems probable that many, if not most, of the Spirifer-like shells possessing delthyrial plates should be referred to this new genus. Certainly, the assumption of Hall and Clarke to the effect that pustulose surface indicates punctate structure is not to be relied upon, for P. macbridei, which is strongly pustulose, does not show the slightest trace of punctae. That this is not a matter of preservation is shown by the fact that associated species, such as Cyrtina iowaensis, show the punctae very plainly. Apparently this new genus occupies a position ancestral to Weller's Pseudosyrinx, which possesses the plate very strongly developed, and coarse punctae. It, in turn, appears to be ancestral to Syringothyris, which is punctate, and possesses both delthyrial plate and syrinx.

Genotype: Spirifer macbridei Calvin

Genus SPIRIFER

Sowerby, 1815 n. gen.

Description from Geol. Surv. of New York, Part II, p. 5.

"Shells transversely elongate, rarely produced axially; with or without median fold and sinus. Hinge-line straight, usually forming the greatest diameter of the shell, but in some of the subdivisions of the genus, short and inconspicuous. Cardinal extremities alate, acuminate or rounded.

Surface covered with granulations, striae, plications or costae, variously grouped and which may be present or absent on the median fold and sinus; these are crossed by concentric growth-lines which may take the form of varices or expanded lamellae, or be modified into frimbriae of simple or compound spines. In the subgenera Martiniaand Martiniopsis the surface is smooth except for the concentric striae. Shell substance fibrous, impunctate except as below described; in the smooth species the epidermal layer is minutely pitted.

The pedicle-valve has the umbo more or less elevated over the hinge-line, the apex acute, erect or incurved. The cardinal slopes show a slight tendency to concavity or excavation, and the median portion of the valve is more or less strongly depressed by a sinus. The cardinal area is broad, flat or incurved and its surface is transversely striated; the inner shell-layers bear a series of longitudinal or vertical canals at whose marginal extremities the fibrous tissue is produced into a row of denticles, corresponding to a row of pits on the opposite valve; thus forming an accessory articulation of the valves. The essential articulation is effected by means of stout, simple teeth lying at the marginal extremities of the triangular deltidium and supported by dental plates which are usually short, but, in rare types, may be produced even to the anterior margin of the valve. The pedicle-passage or delthyrium is usually open. Normally it is closed by a pair of deltidial plates having the form of scalene triangles, which develop from the sides of the delthyrium and meeting, enclose wholly or partially a circular or oval pedicle foramen. At normal maturity these plates become anchylosed along the median suture and form a single convex plate (the so-called Pseudodeltidium).

The usual absence of the deltidium may be due either to accidental removal or to resorption with advancing growth. In the adult and senile stages of development many species, especially in the line of development to Syringothyris, form a testaceous callosity in the pedicle-cavity, thickening the umbo and extending across the delthyrium, reaching in extreme cases, nearly to the cardinal margin.

The muscular area consists of a subtriangular pedicle-impression occupying the pedicle-cavity, and continuous with a deeply impressed oval or obcordate area, which is posteriorly situated and divisible into a

narrow median adductor and broad lateral diductors, the surface of the latter being marked by radiating or racemose furrows. The posterior and anterior members of the diductors may frequently be distinguished, the former being of less extent and their surface markings somewhat different from those of the latter.

A median septum in this valve is usually absent; occasionally it is in a condition of incipient development, and in certain species having the aspect of SPIRIFERINA and belonging to the line of descent of which this genus may be regarded as the final or accessory product, it forms a most conspicuous feature of the interior.

In the brachial valve the umbo is inconspicuous, the apex only being incurved over the cardinal area; a median fold corresponds to the sinus of the opposite valve. The cardinal area is narrow and divided by a broadly triangular delthyrium. The dental sockets are narrow, moderately deep and bounded interiorly by highly developed socket walls, the extremities of which support the crural bases.

The cardinal process is a low, transverse, sessile apophysis, having its surface vertically striated; occasionally it is bipartite or it may be wholly resorbed.

The crura are long, straight and slightly divergent; their union with theprimary lamellae of the spiral ribbon is at a broadly obtuse angle. The brachial coils are directed outward and upward toward the cardinal angles of the valves and their variation in size and direction is in keeping with the differences in the marginal outline of the shell. The number of revolutions of the ribbon exceeds that in any other genus of brachiopods. There is no loop; its position, however, is indicated by a pair of short spinous processes originating on the primary lamellae soon after their junction with the crura, and which are directed inward with a slight convergence.

The muscular area has about the same extent as that of the pedicle-valve, though less distinctly impressed and generally more elongated. It is constituted of two pairs of adductor impressions with their surfaces radiately or palmately striated. The anterior pair are central, narrow at their posterior extremities which are embraced by the broader posterior scars.

A faint median septum is sometimes present. In some instances of importance the socket walls are supported by septa which may be considerably produced over the bottom of the valve.

In both valves the genital region is distinctly punctated, but vascular markings are rarely observed."

Genotype: Anomites striatus, Martin.

1 2 3

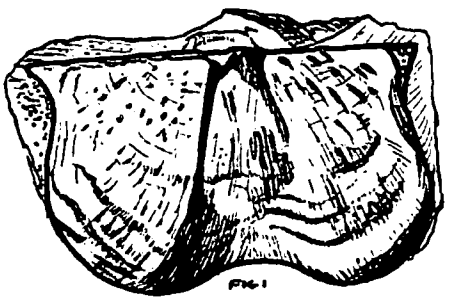
Spirifer argentarius Meek, 1877, 1. A ventral view. 2, Cardinal view of same specimen, showing its low, strongly incurved area, foramen, etc. 3, A dorsal view of same.

SPIRIFER ARGENTARIUS

Spirifer argentarius Meek, 1877, Part I, Paleontology U. S. Geol. Expl. 40 th Par. (King) Vol. 4. p. 443, pl. 3, figs. 4, 4 a, and 4 b.

Shell rather small, moderately convex, wider than long, and having a general subsemicircular or subtrigonal outline, with the greatest breadth on the hinge-line. Lateral extremities acutely angular. Valves nearly equally convex. Ventral valve with the most convexity between the middle and the umbo. Beak strongly incurved. Area low, with nearly parallel sides near the beak, but somewhat abruptly narrowed at the lateral extremities, though continued the entire length of the hinge. foramen wider than high. Mesial sinus shallow and narrow, but well defined by the marginal rib on each side extending quite to the beak, and without costae. Lateral slopes each occupied by from 12 to 14 simple radiating costae, which diminish very gradually in size toward the lateral extremities. Dorsal valve most convex near the middle. Beak rather distinctly incurved. Mesial fold corresponding in size to the sinus of the other valve, being rather low, and flattened on top along its whole length with a furrow along its middle. Lateral slopes costate, as in the other valve. Surface of both valves marked with very fine, regular, undulating lines of growth, most distinct between the costae.

Length, 0.55 inch; breadth, 0.80 inch; convexity, 0.44 inch.



SPIRIFER DISJUNCTUS (Sowerby 1840).

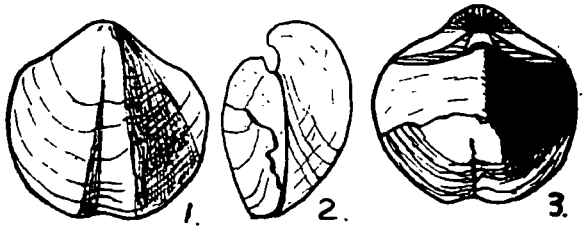
Trans. Geol. Soc. London, 2nd Ser.Vol.5. pl. liii,figs 1, 2 and 13.

SPIRIFER DISJUNCTUS (Sowerby)

Description: Semicircular with an emarginate front, very convex radiated upper valve with stout 12 ribs much raised in front, forming a rounded elevation; ribs rounded, numerous, about 25 on each side of middle, beaks remote; hinge area broad curved, its edges nearly parallel.

Locality: Barnstaple, England.

Diagram: Fig. 1. Central view
Fig. 2. Vorsal view.



SPIRIFER (MARTINIA) FRANKLINII Meek (1869)

Trans. Chic. Acad. Sci. Vol. 1, 1867-9, p. 107.

SPIRIFER (MARTINIA) FRANKLINII Meek

Shell rather large, orbicular, subquadrate in outline, moderately gibbous; hinge equaling about three-fourths of the greatest breadth, and rounded at the extremities. Dorsal valve moderately convex, (the most prominent part being in the central and umbonal regions), provided near the front with a low, undefined mesial prominence which scarcely reaches the middle, and is marked by a shallow longitudinal depression; beak extending a little beyond the hinge and rather distinctly incurved; area narrow and not extended to the extremities of the hinge, and distinctly arched. Ventral valve more gibbous than the other, its most prominent part being between the middle and the beak, which is produced beyond that of the other valve, and distinctly incurved; mesial sinus very narrow, shallow, and extended nearly to the beak, forming a short semicircular projection in front, fitting into a corresponding sinuosity in the front of the opposite valve; area moderate, continued to the extremities of the hinge; finely striated both ways, and distinctly arched and inclined back over the cardinal line - its lateral margins at first sloping from the beak, then extending out parallel to the hinge margin for a short distance, after which they again slope to the extremities of the hinge; foramen broad at the base and narrowing rapidly to the beak, closed for half the distance down by a rather convex pseudodeltidium, which is arched on the lower margin. Surface apparently nearly smooth, excepting a few small marks of growth, but showing, under a magnifier, very fine, obscure, closely arranged concentric striae, with some appearance of minute radiating striae.

Length from front to beak of dorsal valve, 1.47 inches; do. to beak of ventral valve, 1.80 inches; greatest breadth, 1.94 inches; convexity of the two valves, 1.24 inches; length of hinge, 1.54 inches.

Locality: Mackenzie river, forty miles below the "Ramparts."

Diagrams: 1. Ventral view
2. Side view
3. Dorsal view.

SPIRIFER KENNICOTTI Meek (1869)

Trans. Chic. Acad. Sci. Vol. 1, 1867-9, p. 101.

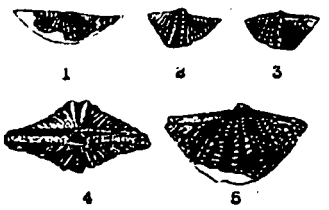
SPIRIFER KENNICOTTI Meek

Shell subsemicircular, rather compressed; valves nearly equally convex; length less than half the breadth; greatest breadth on the hinge line, which is extended apparently into a point at each extremity. Dorsal valve most convex near the middle, thence curving more rapidly to the beak than to the front; sides sloping very gradually and becoming rather flattened near the extremities; beak somewhat compressed, scarcely projecting beyond the hinge line, and with the linear area a little incurved; mesial fold narrow and scarcely distinct from the general convexity of the central region, excepting near the front. Ventral valve very slightly less convex than the other, most prominent between the middle and the beak; lateral slopes a little less flattened than in the dorsal valve; mesial sinus narrow, rather shallow, with rounded margins, continued nearly to the beak, from which it widens and deepens very gradually to the anterior margin, where it produces a moderately distinct, narrow emargination; beak a little incurved and more prominent than that of the other valve, but not produced much beyond the margin of its own area, which is narrow, with nearly parallel margins, and inclined, with a slight curve, back over the hinge; foramen presenting nearly the form of an equilateral triangle. Surface with about twenty-six to thirty simple, regular, well-defined, radiating costae, on each side of the mesial fold and sinus, separated by depressions of their own breadth. The mesial sinus and depression are also each occupied by six or seven more or less bifurcating costae. By the aid of a good magnifier, faint traces of numerous minute, closely arranged concentric striae and granules are also seen on all parts of the surface.

Length, 0.64 inch; breadth, 1.45 inches; convexity, 0.38 inch; height of area in ventral valve, 0.10 inch.

Locality: Liard's river, lat. 60 deg. 15 min. N., long. 123 deg. W. It was found loose, but most probably belongs to rocks of about the age of the Hamilton group in the immediate neighbourhood.

Diagrams: 1. Ventral view
2. Dorsal view
3. Side view.



Spirifer notabilis Kindle. 1, Fragmentary dorsal valve. 2, 3, Ventral and dorsal views of a specimen. 4, Beaks and area, showing delthyrium, ×2. 5, Dorsal valve, showing fine lamellose striae. The shell is tilted slightly forward, showing beak and area of ventral valve.

SPIRIFER NOTABILIS

Spirifer notabilis Kindle, 1909, U. S. Geol. Surv. Bull. 391, Pl. VII, p. 86.

Shell moderately gibbous, terminating laterally in slender mucronate extensions. Width three or four times the length. A triangular delthyrium covered by a convex deltidium reaches to the beak of the ventral valve. The small pointed beak of the ventral valve. The small pointed beak of the ventral valve is incurved over the delthyrium.

The valves are distinctly gibbous in the median region and show a slightly concave profile between this and the extended mucronate expansions. A rather narrow fold and sinus extend from the beak to the front of valves. A plication is in some shells present in the bottom of the sinus. The fold is generally marked by a slight median depression which is obsolete in the posterior third of the fold. The two plications limiting the sinus are much stronger than those on either side.

Surface of each valve marked by 24 to 30 plications. Of these three to six on either side of the fold and sinus originate at the hinge near the beaks and diverge toward the front of the valves after the usual manner in Spirifer. The remainder of the plications which lie between these and the extremities of the hinge, have the remarkable peculiarity of extending forward normal or nearly normal to the hinge line. These lateral plications have, moreover, the peculiarity of being of the same or greater size at the hinge line than in front, being thus much stronger and more prominent at the hinge line than the others. In some specimens one of the strong nodelike outer plications adjacent to the finer series coalesces with one of the latter a short distance from the hinge line. The diverse directions of growth of the two series of plications result in three or four of the outer series bending abruptly in conformity with the direction of the diverging series on coming into contact with them. The plications are crossed by a series of lamellose striae which are exfoliated in most specimens.

The peculiar series of plications on the mucronate expansion of the shell distinguish it from any other Spirifer. In other respects it closely resembles S. bimesialis Hall.

1 2 3

SPIRIFER RAYMONDI Haynes (1916)

Laird, W.M., Journ. Paleon., Vol. 21, 1927

Spirifer raymondi Haynes

Description: This Spirifer is most abundantly represented in the collections from Montana.

The valves have an average width of 23 mm. within the limits of 16 to 44 mm. The length of the valve runs from 7 to 18 mm. averaging 12 mm. The ratio of width to length is about 1.80 to 1. The average thickness of two specimen is 9 mm.

The shells are triangular in outline and some of the shells, particularly the larger ones, tend to be very alate.

The surface of the valves is covered with strong subrounded costae. The average number of costae on the ventral valve is 18, running from 14 to 26. The average number of costae on the dorsal valve is 17, running from 16 to 20. The number of costae appear to increase with the size of the individual. No striations parallel to the costae were observed. Growth lines concentric with the anterior part of the shell are indistinctly present in a few specimens.

The ventral valve is only moderately elevated in the umbonal region and has a distinct non-costate sinus. The dorsal valve is low, only slightly elevated, and has a somewhat flattened median fold. The cardinal area is flat and is not triangular in shape.

Remarks: With the exception of size, this form appears almost identical with the Spirifer jasperensis Warren which in turn appears to be identical with the Spirifer argentarius Meek. Certainly much revision of the Spirifers of the Rocky Mountain area is needed.

Age and Locality: Upper Devonian. Limestone member of Jefferson formation, Montana.

Diagram: Fig. 1 and 3 - Dorsal view
Fig. 2 - Ventral view

1 2 3

SPIRIFER (MARTINIA) RICHARDSONI Meek (1869)

Trans. Chic. Acad. Sci. Vol. 1, 1867-9, p. 104.

SPIRIFER (MARTINIA) RICHARDSONI Meek

Shell small, wider than long, rather gibbous, hinge line about as long as half the transverse diameter of the valves; lateral margins rounding somewhat abruptly into the hinge margin, and converging with a slightly convex outline to the front, which is a little truncated, or very faintly sinuous in the middle. Ventral valve about one-third more convex than the other, provided in front with a shallow, subangular, undefined mesial sinus, which dies out before reaching the middle of the valve; beak rather pointed, moderately prominent, and incurved but not projecting more than one-eighth the entire length of the shell beyond that of the other valve, from which it stands a little remote; area broadly triangular, not distinctly defined, arcuate; foramen triangular, uncloaed, higher than wide. Dorsal valve moderately convex, and without a mesial fold even at the immediate front; beak small, projecting little beyond the hinge, and not distinctly incurved, provided with a narrow area. Surface (of internal cast) showing faint indications of eighteen to twenty remote linear, radiating ridges on each valve, so indistinct as to leave doubts whether or not they were connected with external costae.

Length, 0.55 inch; breadth, 0.65 inch; convexity, 0.44 inch.

Locality: Fort Good Hope, on Mackenzie river, lat. 66 deg. N., long. 128 deg. W.

Diagrams: 1. Ventral view
2. Dorsal view
3. Posterior view.

1 2 3

Spirifer pinonensis Meek 1877, 1, Profile view, natural size. 2, Dorsal view of same. 3, Ventral view of same.

SPIRIFER PINONENSIS

Spirifer pinonensis Meek 1877, Part I, Paleontology U. S. Geol. Expl. 40 th Par. (King) Vol. 4. p. 45. pl. 1, figs. 9, 9 a, 9 b.

Shell attaining about a medium size, somewhat wider than long, varying from transversely-suboval to a nearly semicircular general outline, rather gibbous in adult examples. Cardinal margin nearly or quite equaling the greatest breadth, and terminating in rectangular or rather more obtuse extremities. Lateral margins rounding to the front, which is sometimes rounded, sometimes slightly sinuous, or in other examples more prominent and subangular in the middle. Ventral valve generally rather more gibbous than the other, its greatest convexity being in the umbonal region, from which it rounds off evenly toward the front and lateral margins as well as to the beak, which projects beyond that of the other valve, and is rather distinctly incurved. Cardinal area of moderate height, narrowed to the lateral and strongly arched with the beak. Foramen having nearly the form of an equilateral triangle, and provided with slightly-raised sharp, lateral margins. Mesial sinus shallow, rounded, smooth, and of moderate breadth, narrowed regularly, and well defined to the apex of the beak. Dorsal valve generally more than semicircular, most convex in the central and anterior regions. Beak projecting little beyond the cardinal margin, and with the narrow area incurved. Mesial ridge depressed, smooth, and faintly furrowed along the middle, corresponding in outline to the form of the sinus in the other valve. Surface of each valve ornamented by from 11 to 14 simple, regular, rounded, radiating plications on each side of the mesial fold and sinus, and also showing, under a magnifier, minute, regular, crowded, radiating striae, crossed near the front by stronger undulating lines of growth.

Length of a medium-sized specimen, 0.93 inch; breadth of the same, 1.30 inches; convexity, 0.72 inch.

1 2 3

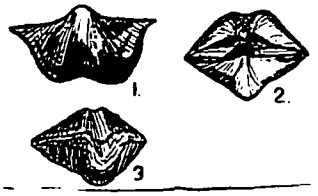
Spirifer strigosus Meek 1877. 1, View of ventral valve. 2, View of dorsal valve. 3, Profile view of same.

SPIRIFER STRIGOSUS

Spirifer strigosus Meek 1877, U. S. Geol. Expl. of 40th Par. Pt. 1, Pl. 3, Figs. 5, 5a, 5b.

Shell under medium size, convex, subtrigonal, or approching subsemicircular, with the greatest breadth on the hinge-line. Lateral extremities generally acutely angular. Lateral margins converging to the prominent, subangular middle of the front, with a somewhat straightened or convex outline. Dorsal valve convex in the middle, and compressed toward the lateral extremities. Mesial fold narrow, prominent, and sometimes subangular near the front, continued to the beak. Ventral valve scarcely more convex than the dorsal, most gibbous in the umbonal region, with convex lateral slopes. Beak moderately prominent, and distinctly incurved. Area narrow, well defined, and narrowing off laterally, so as not quite to reach the extremities of the hinge, arched, and directed obliquely backward with the beak, rather distinctly striated viertically. Mesial sinus corresponding in size to the fold of the other valve. Surface of each valve with 20-26 radiating costae, some of which are simple, while other bifurcate. About 6 or 7 usually occupy the mesial fold and sinus. 2 or 3 of those within each margin of the sinus usually coalesce with the two marginal ones, which also generally each give off a lateral rib on the outer side. Costae of the mesial fold more or less bifurcating, while those of the lateral slopes of both valves are more frequently simple, but sometimes divided. Finer surface-markings unknown.

Length, 0.63 inch. Breadth, 1.18 inch. Convexity, 0.57 inch.



SPIRIFER WHITNEYI Hall

Fenton and Fenton (1924) Mich. Univ. Mus. Geol., Contrib. vol. 1, p. 146, pl. 28, figs. 1-9, pl. 30, figs. 14-19.

SPIRIFER WHITNEYI Hall

Description: Shell of medium or large size, with greatest width along the hinge-line. Length of pedicle valve, 17 mm., brachial valve, 16.9 mm. width, 30 mm. thickness 16 mm., height of cardinal area 5.mm.

Pedicle valve moderately convex in the anterior two thirds, with the curvature increasing in the umbonal area. Beak prominent, recurved. Shell curves abruptly to the cardinal margin in the region of the beak, less so laterally, and is flattened near the extremities, which are produced to form sharp, though short mucronations. Area high, flattened below and arched near the beak, marked by fine vertical striae. Delthyrium broadly triangular.

Brachial valve less convex than the pedicle, with maximum convexity near the umbo. Shell slopes abruptly to the cardinal margin in the umbonal region but is depressed laterally. Surface of the shell marked by fine, irregular, radiating striae.

Remarks: Spirifer whitneyi and its varieties are (the Hackberry representatives) of the group to which belong S. disjunctus, S. verneuili, S. archiaci, and other specimens both European and American.

Diagrams: 1. Ventral view.
2. Posterior view.
3. Anterior view.

Spirifer whitneyi var. animasensis (Girty) 1,2, Dorsal and ventral views of a small specimen showing twisted beaks. 3, Dorsal valve. 4, Ventral view showing the greatly elevated area of this variety.

SPIRIFER WHITNEYI var. ANIMASENSIS

Spirifer whitneyi var. animasensis (Girty) Kindle 1909, U. S. Geol. Surv. Bull. 391, Pl. II, P. 25,

This variety represents a type which can generally be distinguished from S. whitneyi by its smaller size, the more elevated area of the ventral valve, the slightly twisted and but slightly incurved ventral beak, and the more rounded plications. Perfectly preserved specimens from New Mexico which seem to be identical with this variety, as described by Girty from Colorado, show granulose plications covered with very fine radiating striae. There is wide variation in the character of the area of the ventral valve. This variation includes specimens in which the area is moderately concave, vertical, and inclined forward.

Genus TYLOTHYRIS

North (n. gen.) 1920.

Description fromStainbrook, Jour. Pal. Vol. 17, No. 5. p. 438.

"Shell of medium size to small, biconvex, spiriferoid in shape, with angles extended to rounded, generally with the greatest width along the hinge line, semielliptical to subquadrate in outline.

Pedicle valve the moreconvex, gently to strongly curved from beak to front. Sinus originating at the beak, deep, in most cases with a median plication or occasionally flat and not plicate at the bottom. Slopes marked by numerous simple strong subangular plications, separated by narrower furrows, and only a few reaching the beak. Palintrope variable, often high, nearly flat to strongly curved, horizontally and vertically striated; usually the outer portion on either side is horizontally marked only. A strong groove extends from the beak to the hinge line along the immediate margins of the pedicle opening. No deltidium was observed in any of the numerous specimens at hand. Beak pointed, often elevated, incurved in some and not at all in others. Internally the delthyrial supporting plates are strongly developed, concave anteriorly and toward the angles, and extended a short way forward along the floor of the valve. They are also slightly excavated below the margins of the palintrope as in Spinocyrtia. Between the delthyrial supporting plates is a transverse structure varying from a callus to a true plate concave anteriorly and extending a short distance forward. A thin erect median septum extends to the midpoint, where it generally attains its greatest height.

Brachial valve generally gently to moderately convex. Fold strong, extending from beak to front, elevated, broadly convex, depressed mesially by a deep sinus in most species, in others the sinus may be obsolete. Slopes marked by plications as in the opposite valve. Internally the cardinal process is subquadrate to semielliptical in outline, broadly convex, and vertically grooved. The sockets are deep, narrow and laterally directed. A thin slight median septum is variably developed in most species.

Exterior of the valves excepting the palintropes marked by numerous concentric growth laminae. The shell substance is fibrous and impunctate.

Our species differ from the genotype, Tylothyris laminosa, in but few details. The mesial septum of the pedicle valve is not as strongly developed and is highest anteriorly. The apical callosity is not as strong in most species, and the apical chambers formed by the union of the callosity with the median septum are very small. Most of our species have a mesial sinus on the fold and a plication in the pedicle sinus, but one species does not and in others there occur examples in which neither is present. These differences seem to be due to evolutionary trends and

probably are not of generic importance.

Genotype: Tylothyris laminosa.

Genus WARRENELLA

Crickmay, n. gen.

Crickmay, (1953) Jour. Pol. Vol. 27, No. 4, pp.596-600,

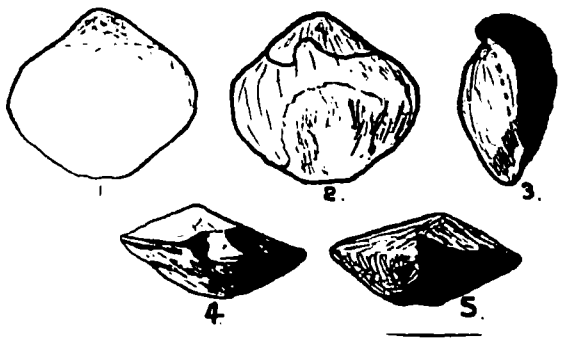
"Smooth, robust, strongly umbonate Martiniidae with umboral callus extending in anterior direction over much of the interior.

Ventral valve strongly convex sulcate lined interiorly with thick, extensive, symmetrically developed callus. Teeth well developed. Dental lamellae long, approximate slightly divergent dying out basally in umbonal callus. Delthyrium of medium width, closed by a strong, short deltidium.

Dorsal valve convex, uniplicate, lined with much callus. Cardinal process short sagittally striate. Hinge plate deeply cleft. Sockets large, deep, with prominent bordering ridges. Spiralia with seven to nine turns.

Discussion. Since one species W. Franklinii has a micro-ornament, it is probable that this will prove to be a generic characteristic, though without very superior preservation it will not be observed. Warrenella is distinct from Martinia which lacks dental lamellae, and from Martinopsis and Martiniella which lack the extensive internal callus and such associated structural modifications as reduced dental lamellae. Warrenella is one of the few Devonian representatives of this family other genera being Mississippian to Permian".

Genotype: Warrenella eclectea (Crickmay).



WARRENELLA APODECTA - Crickmay (1953)

Jour. Pal. Vol. 27, No. 4. pp. 596-600
25 text figs.

WARRENELLA APODECTA (Crickmay)

Shell of small or sub medium size, smooth, not strongly, nor very unequally biconvex. Anterior commissure gently uniplicate. Hinge-line 52% of total width.

Ventral valve gently convex, of medium depth slightly wider than long. Beak strongly incurved abruptly tapered, acute regular in median section symmetrical. Interarea short not delimited in any way. Delthyrium of medium width (60°); deltidium very short. Sulcus beginning much anterior to umbo, inconspicuous, shallow and of moderate width even at anterior end. Apical callus thick, extending more than half way to anterior borders basally in callus appearing to extend at one stage of development to floor of valve; joined by a transverse structure which becomes anteriorly the convex surface of the median fore of the callus. Teeth small.

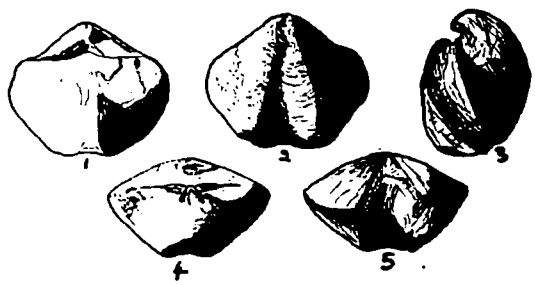
Brachial valve of low convexity. Beak and dorsal interarea less conspicuous than in other species. Fold very inconspicuous at all stages. Cardinal process prominent with a small concave crown very deeply and finely striate. Sockets small. Apical callus thick only in umbonal region extending thinly over interior more than half way to anterior border thinner than in median fore with low square cut walls. Spiralea with seven to eight turns.

Holotype: Width 23 mm.; length 20 mm.; length of brachial valve 16 mm.; depth valves together 10.5 mm.

Occurrence: West upper slope of Rocks a Perdrix, Township 69, Range 27, West of 5th Meridian, Alberta, Canada; uppermost bed of Flume formation.

Diagram of Holotype x 2.2

1. Dorsal view
2. Ventral view
3. Left Lateral view.
4. Anterior view.
5. Posterior view.



WARRENELLA ECLECTEA - Crickmay (1953)

Jour. Pal. Vol. 27, pp. 596-600
Figs. 1 - 5.

WARRENELLA ELECTEA (Crickmay)

Shell of small or sub-medium size, smooth strongly but unequally biconvex. Anterior commissure strongly uniplicate to faintly parasulcate. Hinge line 75% of total width.

Ventral valve strongly convex, deep and wide in ratio with length. Beak incurved abruptly, tapered, acute, regular in median section symmetrical. Interarea long (24% of hinge length), not sharply delimited. Delthyrium of medium width, deltidium short. Sulcus beginning immediately anterior to umbo, inconspicuous and shallow in posterior region, expanding and deepening at a rate greater than the normal growth curves. Apical callus very thick extending more than half way to anterior boarders pieced by small apical and umbonal vaults. Dental lamellae sub parallel ending basally in a rounded arch. Teeth large.

Brachial valve of medium convexity. Beak and dorsal interarea conspicuous. Fold beginning anterior to umbo, expanding similarly to sulcus markedly flaring at anterior end. Cardinal process small round boss like, deeply and finely striate boardered by greater striae. Sockets large boardered by sharp ridges apical callus thick extending one halfway to anterior border; thinner in a narrow median zone with square cut walls. Spiralia with seven to eight turns.

Holotype: Width 22.5 mm.; length 18 mm.; length of brachial valve 14.5 mm.; depth (valves together) 14 mm.

Occurrence: West upper slope of Mount Mackenzie, Township 45, Range 23, West of 5th Meridian, Alberta, Canada; lower 40 ft. of Cheviot formation.

Diagram of Holotype x 2.2.

Fig. 1. Dorsal view
Fig. 2. Ventral view
Fig. 3. Left lateral view
Fig. 4. Posterior view
Fig. 5. Anterior view.

Genera of the Superfamily SPIRIFERACEA, detailed descriptions of which were not found in the literature. The brief descriptions below are taken from Shimer and Shrock (1944).

Genus Ambothyris - not described here.

Genus Choristites - not described here.

Genus Crurithyris - George 1931.

"(Spirifer urei Fleming). Like Ambocoelia, small, hinge narrower than greatest width; ventral umbo incurved; surface smooth to spinose; cardinal process sessile, elevated, triangular, tuberculate; dorsal musculature located just anterior to cardinals; scars elongate.
Dev.-Perm. (Ohio, Ind., Midcontinent, Tex.)"

Genus Cyrtiopsis - not described here.

Genus Cyrtospirifer Nalivkin 1918.

Genotype: Spirifer verneuili Murchison. Generally medium-sized shells, often very wide, with costate fold and sulcus; dental plates strong; spire attached to socket plates; no supporting lamellae under socket plates. U. Dev. (Chemung-Conewango) (N.Y., Appalachians, Ia., Mont.; Mackenzie Valley; Canadian Rockies; Great Basin.)

Genus Elytha Fredericks 1918.

Genotype: Delthyris fimbriatus Conrad. Transversely elliptical in outline; biconvex, valves subequal in depth; costate, with low rounded costae crossed by distant lamellae bearing one row of long double-barreled spines; ventral valve with strong dental plates and median septum; dorsal valve with strong socket plates supported by short septa; no median septum. Dev. (Hamilton) (N.Y., Appalachians, Mich., Ohio, Ind., Ky., Ia., Great Basin; Mackenzie Valley.)

E. fimbriata Conrad. Hamilton and Tully: Ont.; N.Y., Appalachians, Mich., Ind., Ky., Tenn., Ill."

Genus Martinia - not described here.

Genus Martinopsis Waagen 1883.

Genotype: M. inflata. Shells of about medium size with smooth exterior; a shallow ventral sulcus and low dorsal fold; beak strongly incurved; delthyrium covered with a deltidium; ventral

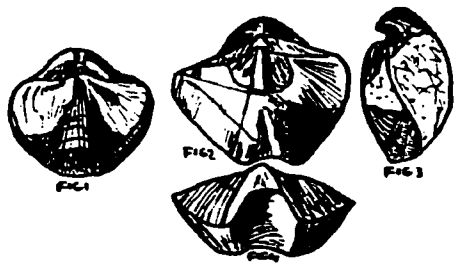
interior with long dental plates. M. Dev. (Ont., Ohio, Nev.).

Genotype: "M" maia Billings.

Genus Reticularia - not described here.

Genus Tenticospirifer Tien 1938

Genotype: Spirifer tenticulum Verneuil. Small spiriferoids with fold and sulous costate; ventral valve hemipyramidal and with long dental plates. U. Dev. (Ia., Mont., Wyo., Utah, Nev.).



SPIRIFER (M.)GLABRA var. NEVADENSIS

Walcott. Pal. of the Eureka District U.S.G.S. Mon. 8. 1884.

MARTINA GLABRA var. NEVADENSIS (Walcott)

Description: The range of variation is considerable, the specimens differ in the strength and angularity of the mesial fold and sinus. The depression along the middle of the mesial fold may be strong, or entirely absent, even in large sized specimens.

Some shells are also much more transverse than others and the relative length of the hinge line varies.

The surface is usually smooth, owing to the condition of preservation of the shell. Examples show, however, that it was marked in some instances by obscrue radiating plications concentric strise 1 mm. distant, also fine radiating interrupted striae. These vary and in some shells are entirely absent.

Notes: This variety differs from typical specimens of S(M.) glabra in having the greatest transverse diameter higher up on the shell and the mesial fold and sulcus more usually angular. It also averages smaller in size, the largest specimen having a height of 30 mm. a breadth of 38 mm. and the average about 25 mm. by 30 mm.

Locality: Upper Devonian Limestone, Eureka District, Nevada.

Diagrams:

Fig. 1.) Dorsal views.
Fig. 2.)

Fig. 3. Side view.
Fig. 4. Anterior view.

KIRKI UPPER DEVONIAN BRACHIOPODA MARTINIA

1 2 3 4

Martinia Kirki Merriam 1940, 1, Ventral view of paratype, slightly reduced. 2, Dorsal view of holotype, slightly reduced. 3, 4, Dorsal and lateral views of paratypes, slightly reduced.

MARTINIA KIRKI

Martinia Kirki Merriam 1940, Geol. Soc. of America Special Papers No. 25, p. 85, pl. 8, figs. 26-29.

Shell of medium size, width about 9/10ths of length, in some individuals equal to or exceeding length. Shell deeply biconvex, convexity of ventral valve greater than that of dorsal. Ventral valve with well-defined median sulcus extending from tip of umbo to commissure. Dorsal valve frequently showing a rather broad fold which is divided by a median sulcus. Dorsal fold and median sulcus may be undeveloped in immature stages. Shell either smooth or showing faint radial striations, particularly on sulcus of ventral valve. Axes of spiralia appear to be almost parallel to hinge margin, not inclined posteriorly as in Reticularia. Dental plates are well developed. Ventral muscle scars narrow.

This form is provisionally placed in the genus Martinia M'Coy, the genolectotype (George, 1947, p. 110)of which, Martinia glabra (Martin), shows an entire mesial fold and, according to George, does not have dental plates. Resembles Tingella Grabau but does not show crenulated margins of growth lamellae found in Tingella reticularioides Grabau. Dorsal valve differs from that of Martiniopsis Waagen and Tingella Grabau in absence of septa. Martinia nevadensis (Walcott) is more transverse and has more extensive cardinal area. May be conspecific with spiriferoids of the Eureka district, referred to Martinia maia Billings by Walcott. M. meristoides from the Lockhart River, Canada, is more rounded in outline, with less prominent ventral umbo. M. Kirki is specifically distinct from M. franklini meek of the Mackenzie River Devonian, Canada, which has a less prominent ventral umbo. As in some individuals of Kirki the dorsal fold of franklini is divided by a median sulcus.

Measurements.-- Holotype, width 33 mm., length 35 mm., thickness 15 mm. Paratypes:

width	length	thickness
38.0 mm.	38.0mm.	21.0 mm.
19.5 mm.	32.0mm.	13.0 mm.
28.0 mm.	27.0mm.	16.0 mm.

Occurrence.--

SPIRIFER MAIA (Hall 1867)

J.Hall, Nat. Hist. New York. Vol. VI, p. 416.

SPIRIFER MAIA

Description: Shell below medium generic size ventricose with rounded cardinal angles giving a longitudinally ovate outline with depressed sub-gluhose form; hinge line very short; cardinal area narrow and sometimes hidden by beak.

Dorsal valve sub orbicular moderately ventricose with a distinctly elevated rounded mesial fold.

Ventral valve more ventricose than the opposite with a large tumid incurved beak and a moderate sub angular mesial sinus.

Surface destitude of plications but marked by more or less distinct strise of growth.

Geological formation: Corniferous limestone of Ohio and Canada west.

Diagrams:

Fig. 1. Dorsal)
Fig. 2. Ventral) of an elongate specimen.
Fig. 3. Profile)
Fig. 4. Front view)

SPIRIFER (MARTINIA) SUBLINEATUS Meek (1869)

Trans. Chic. Acad. Sci. Vol. 1., 1867-9, p. 103.

SPIRIFER (MARTINIA) SUBLINEATUS Meek

Shell small, subcircular, or truncato-orbicular, moderately convex in adult specimens; lateral margins rounding gradually into the more or less regularly rounded front, and more abruptly into the short hinge; cardinal margin considerably shorter than the greatest breadth of the valves. Dorsal valve subsemi-circular, rather compressed and without any traces of a mesial fold; beak small, projecting little beyond the cardinal margin; area small. Ventral valve twice or three times as convex as the other, and without a mesial sinus; area triangular, moderately high, not very sharply defined; foramen triangular, higher than wide, uncloased in all the specimens examined. Surface very nearly smooth, but showing, under a magnifier, faint traces of very fine concentric striae, and obscure indications of radiating lines. Internal casts of the ventral valve with a faint furrow extending along the middle, on each side of which there is a shallow, flat impression, extending from the umbonal region to each antero-lateral margin.

Breadth of a large individual, 0.62 inch; length, 0.60 inch; convexity, 0.34 inch.

Locality: Common in the dark bituminous limestone, near Fort Resolution, on the south side of the Great Slave Lake.

Diagrams: 1. Side view
2. Dorsal view
3. Ventral view of cast.

TENTICOSPIRIFER CYRTINIFORMIS Hall and Whitfield

Cooper, 1947, in Index Fossils of North America, p. 321, pl. 121, figs. 41-44.

TENTICOSPIRIFER CYRTINIFORMIS Hall and Whitfield

Description: Shell small, wider than long, submesothyrid, cardinal extremities angular. Dimensions: length 12.8 mm, width 14.8 mm, thickness 9.7 mm.

Pedicle valve pyramidal, the surface sloping evenly to the lateral margins and curving slightly to the anterior margin. The median sulcus originates at the beak, extends forwards as a shallow depression broadening to the front margin. Beak pointed, very slightly to moderately incurved; cardinal area about two thirds as high as wide, nearly flat and marked by fine vertical striae. Delthyrium about three times as high as wide.

Brachial valve slightly convex, the greatest convexity being in the umbonal region; the surface is evenly arched in the central portion of the valve, and slopes evenly to all margins. An indistinct medial fold originates at the mid-length of the valve, and projects forward to form a moderately prominent rounded ridge.

The surface of both valves is ornamented by a series of low rounded plications, about ten of these restricted to the sulcus and fold, and the lateral slopes bear from 16-18.

Occurrence: Cheviot Formation (Mount Hawk member) in eastern ranges of Rocky Mountains near Nordegg, Alberta.

Diagrams: 1. Ventral view.
2. Dorsal view.
3. Posterior view.
4. Lateral view.

UTAHENSIS UPPER DEVONIAN BRACHIOPODA SPIRIFER

Spirifer utahensis Meek 1877, pl. III, figs. 1, 1 a, 1 b, 1 c, 1 d, 1 e. 1, Antero-ventral view, natural size. 2, Dorsal view of same specimen. 3, Side view of smaller specimen. 4, Cardinal view of another specimen, showing area and foramen. 5, Cardinal view of the ventral valve of the largest specimen seen. 6, Antero-ventral view of same.

SPIRIFER UTAHENSIS

Spirifer utahensis Meek 1877, Part I, Paleontology U. S. Geol. Expl. 40 th Par. (King) Vol. 4. p. 39, pl. III, figs. 1-1 e.

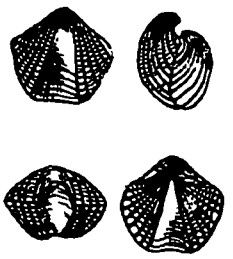
Shell small, inequivalve, convex, sometimes subpyramidal, with outline forming rather more than a semicircle. Length about 1/2 to 2/3 the breadth. Lateral extremities obtusely angular.

Ventral valve elevated at umbo, and sloping off abruptly to the front and lateral margins, with usually a slightly convex outline, especially on the anterior slope, sometimes with one of the lateral slopes concave in outline posteriorly. Mesial sinus shallow, narrow, rounded within, and extended to apex of beak. Beak elevated, abruptly pointed, and slightly arched. Area high, or with height equaling about half its breadth, triangular, and continued to the extremities of the hinge, well-defined or angular, lateral slopes, ranging at about right angles to the plane of the shell, and usually a little arched. Foramen proportionally very narrow, or sometimes twice as high as wide.

Dorsal valve much depressed, or but moderately and evenly convex. Beak small, indistinct from cardinal margin, somewhat incurved. Area merely linear. Mesial fold depressed. Surface of each valve marked by 30 to 40 small simple, radiating costae, or striae, 8 to 10 of which occupy the mesial sinus, and about as many the mesial fold, where they sometimes bifurcate.

In general form, as well as in its high, large area, it has more the aspect of a Cyrtia or Cyrtina than of a Trigonotretra. But as none of the specimens show any indications of the foramen being closed by a false deltidium, or of a punctate structure, I have preferred to refer it provisionally to the typical section of the genus Spirifer.

Occurrence.--Rare in the Enshaw shale.



SPIRIFER COMPACTUS Meek (1869)

Trans. Chic. Acad. Sci. Vol. 1.
1867-9, p. 102.

SPIRIFER COMPACTUS Meek

Shell subglobose, a little wider than long, greatest transverse diameter usually at some point between the middle and the cardinal margin; hinge line equaling about two-thirds the greatest breadth of the valves; lateral margins scarcely ever even obtusely angular at their connections with the hinge, but rounding regularly into the front, which is sometimes very faintly sinuous at the termination of the mesial fold. Dorsal valve rather gibbous, but a little less so than the ventral; mesial fold rounded, depressed or moderately prominent, and without costae; beak projecting a little beyond the hinge line, and rather distinctly incurved over its narrow cardinal area. Ventral valve most gibbous in the umbonal region; beak prominent and distinctly incurved; mesial sinus moderate, extending to the beak, rounded or very faintly subangular, widening gradually forward without very distinctly defined margins to the front, where it terminates in a semicircular projection, filling a corresponding recess in the margin of the other valve; area moderately high and arching with the beak, rather well defined, but without angular margins, and marked by distinct transverse striae, crossed by very minute vertical lines; foramen presenting nearly the form of an equilateral triangle, or rather higher than wide. Surface with about nine to ten simple, rounded, rather depressed costae on each side of the mesial fold and sinus, and numerous fine, very regularly arranged, equal crowded concentric striae, which are regularly arched in crossing the ribs. Under a good magnifier, on protected portions of well preserved specimens, traces of extremely small radiating striae, apparently produced by regularly disposed granules, may also be seen.

Length of a medium sized specimen, 0.90 inch; breadth, 0.96 inch; convexity, 0.70 inch; breadth of mesial fold and sinus of the front, 0.35 inch. Some specimens are proportionally more gibbous.

Locality: Lockhart river, lat. 67 deg. 65 min. N., long. 126 deg. W.

Superfamily Terebratulacea (Shrock and Twenhofel, p. 332)

Terebratulaceans are endopunctate articulates with a looplike brachidium, with hinge plates or a cardinal plate in the brachial valve, without a notothyrium or chilidium, and with the deltyrium usually more or less restricted by deltidial plates.

Range: Lower Silurian to Recent.

Genera Described:	Range:
I. Genus Cranaena Hall and Clarke	Middle Devonian to Mississippian.
II. Genus Cryptonella Hall	Devonian
III. Genus Renselandia Hall	Middle Devonian
IV. Genus Stringocphalis Defrance	Middle Devonian

Reported occurrence of this superfamily in the literature reviewed in Part I of this thesis.

I. Genus Cranaena Hall and Clarke. 11, 32, 37.

II. Genus Cryptonella Hall

Calvini Hall and Whitfield. 2

III. Genus Renselandia Hall. 33.

* R. leavis Meek. 1, 30, 37.

IV. Genus Stringocphalis Defrance. 2, 12, 30, 33, 34, 37.

S. burtena Defrance. 6, 8.

Genus CRANAENA

Hall and Clarke, n. gen. 1893

This description is taken from Cloud, P.E., Geol. Soc. of Am. Special Paper No. 38, p. 132.

"Diagnosis: Shell small to moderately large, smooth, terebratuliform. Pedicle foramen typically permesothyrid. Cardinal plate free and perforate. Loop short, consisting of simple lateral bands joined by a short, posteroventrally recurved transverse band. Median septa absent. Dental plates present.

General Characters: Shell smooth or marked by growth lines only; ranging in length from less than 10 mm. to about 40 mm. and in proportion from longer than wide to subcircular or, rarely, to wider than long; subequally biconvex with ventral valve the deeper. Ventral sulcus and dorsal fold present or lacking, or a sulcus may be present without a fold. Anterior commissure rectimarginate to sulcate, entire to emarginate. Lateral commissures rectimarginate to sinuate. Cardinal margin terebratulid. Beak long or short, suberect to incurved. Foramen typically permesothyrid (rarely mesothyrid) commonly marginate or labiate. Deltidial plates conjunct, plane or slightly convex externally, punctate.

Ventral valve with short but well-developed dental plates. Muscle field long and narrow; individual marks not clearly separable but seemingly divisible into narrow linear adductor scars in the center, bounded laterally by longer and larger diductor impressions.

Dorsal valve with a cranaeniform loop as described for the subfamily and a free, perforate cardinal plate. The apex of the cardinal plate, behind the dorsal foramen, occasionally displays a pair of small, faintly rugose, myophore surfaces, presumably the diductor impressions. Muscle field narrow and elongate and muscle pattern ordinarily indistinct. Where marks of individual muscles are distinguishable a pair of small, subovate, medial adductor impressions can be seen lying at the anterior ends of muscle tracks which are offset a bit from the center of the valve by a pair of medial pallial trunks; a second pair of somewhat obliquely elongate, linear adductor scars lies outside the first pair, bounding it laterally with its anterior ends. Myophragm present or absent.

Comparison: Cranaena has been confused with Cryptonella but the two genera actually differ widely in characters of the loop and in features of the beak and pedicle foramen. The beak of Cryptonella is relatively long and straight to nearly straight or scarcely suberect, whereas that of Cranaena varies from distinctly suberect to so strongly incurved that the deltidial plates are concealed. The pedicle foramen of Cranaena is almost invariably permesothyrid and commonly marginate or labiate. In Cryptonella on the other hand, the foramen is submesothyrid, telate or partially attrite, with an unthickened margin, and knicks a small V-shaped re-entrant in the ends of the conspicuous, long, conjunct deltidial plates. Internally the long and complex loop of Cryptonella contrasts strongly with the short and simple loop of Cranaena. The pattern of the ventral muscle field of

Cryptonella is generally similar to that of the Centronellidae and is possibly more primative than the linear arrangement found in Cranaena; the dorsal muscle fields in the two genera are similar in general but differ in that the anteromedial adductor scars of Cryptonella are relatively larger and closer to the middle of the valve than in Cranaena.

Important internal distinctions exist between Cranaena and Hamburgia, Dielasma, Beecheria, Girtyella, Septothyris, and "Harttella". Hamburgia has an apically sessile, imperforate, cardinal plate; Dielasma and Beecheria have imperforate, sessile cardinal plates; Girtyella, Septothyris and "Harttella" have imperforate cardinal plates supported by median septa; dental plates are absent in "Harttella" and obsolescent in Beecheria.

The only other genera needing comparison are Dielasmoides and Dielasmella; Dielasmoides has a typically sulciplicate enterior commissure and apparently discrete hinge plates. Dielasmella is characteristically a much compressed shell with a straight beak and a low median sulcus bounded by a pair of low folds in each valve; the range of variation of Cranaena (see Cranaena praecursor) but differs from most species of that genus in that the dorsal foramen is proportionately large and the median portion of the cardinal plate is very short, while the socket bases subtend relatively large angles with the posterolateral margins and a relatively small one between themselves."

Genotype: (by subsequent designation of Hall and Clarke, 1894, loc. cit.) Terebratula romingeri Hall,[7] 1863.

Range: Devonian and Mississippian (rocks of Onondaga or Oriskany age to at least as high as the Spergen limestone) of North America. In the rest of the world the range is less certain, for Devonian species probably assignable to Cranaena have been called Cryptonella or Dielasma. The genus is definitely present in the Devonian of Europe and perhaps ofAsia, Africa, andSouth America as well.

Genus CRYPTONELLA

Hall 1861 n. gen.

Description in Cloud, P.E., Geol. Soc. Amer. Special Paper No. 38. p. 127.

"Diagnosis: Shell small to moderately large, terebratuliform. Test commonly unornamented but faint costellae may occur anteriorly. Pedicle foramen submesothyrid. Cardinal plate free; loop cryptonelliform; dental plates present.

General Characters: Cryptonella ranges in size from C. attenuata the adults of which average about 10 mm. in length, to C. planirostra, large specimens of which may exceed 30 mm. in length. Shell subequally biconvex; outline subcircular to elongate-subpentagonal to lozenge-shaped, profile commonly depressed sublenticular. Anterior commissure rectimarginate; margin subtruncate, rounded or emarginate. Lateral commissures rectimarginate; lateral margins rounded or with postero-lateral portions straight and defining a wedge-shaped beak. Cardinal margin characteristically terebratulid. Beak straight to nearly straight or barely suberect, Pedicle foramen submesothyrid, margin unthickened and telate or somewhat attrite. Deltidial plates conjunct, prominent, having a re-entrant knicked into their apices by the base of the foramen. Shell ordinarily lacking ornamentation except for growth lines, but in Cryptonella melonica individuals which are marked anteriorly by a rather numerous, simple, faint, radial costellae are not uncommon. This is not a feature of exfoliation or the impressions of pallial sinuses, for the costellae occur on well-preserved shell surfaces as well as exfoliated ones.

Ventral interior with well-developed dental plates terminating in moderately strong hinge teeth. Muscle field one-third to one-fifth as long and one-third to one-fourth as wide as the valve; consisting of a pair of moderately small subovate diductors scars lying at the front end of elongate muscle tracks and bounding the posterolateral edges of a small subovate, scarcely divided adductor scar. A low and narrow myophragm is commonly present. A pair of impressions of radial main pallial trunks extend anteriorly from the ends of the diductor scars while a second pair bound the sides of the muscle field and extend forward from there.

In the dorsal valve the cardinal plate is free, perforate, and unthickened. Muscle field from one-fifth to about one-third as long and one-fifth to one-fourth as wide as the valve. It consists of narrow, elongate, posterolateral adductor scars offset nearly twice their width from the center and bounding anteriorly a pair of obliquely subovate, anteromedial adductor impressions whose posterior ends nearly meet at the center of the valve. These anteromedial scars are larger and broader but commonly not so long as the posterolateral ones. One pair of traces of main pallial trunks extends anteriorly from between the muscles near the middle of the valve and a second pair bounds the lateral edges of the muscle field. Myophragm commonly present. Loop described under C. planirostra.

Comparison: From all known genera except Cryptacanthia, Cryptonella differs in the combination of its cryptonelliform loop, free and perforate cardinal plate, submesothyrid foramen, and straight to slightly suberect beak. Cryptacanthia differs in its small size, its gibbous shape with depressed dorsal and strongly convex ventral valve, its dorsal sulcus and ventral fold, and probably in internal details. A detailed comparison with Cranaena will be found under the discussion of that genus."

Genotype (by subsequent designation of Hall and Clarke, 1864, op cit., p. 861): Terebratula rectirostra Hall.

Range: Lower, Middle and probably Upper Devonian of North America. Outside of North America it is known from the Lower Devonian and possibly higher strata in Europe. Other reported occurrences uncertain.

Genus RENSSELANDIA

Hall, 1867, n. gen.

In Cloud, P.E., Geol. Soc. of Am. Special Paper No. 38, p.94.

"Diagnosis: Biconvex Rensselandiinae of elongate-subovate or subcircular outline. Cardinal margin subterebratulid to submegathyrid; anterior commissure consistently rectimarginate. Hinge plates discrete, not supported by crural plates. Loop very long, ordinarily more or less widened anteriorly, with or without a long or short vertical plate or process projecting backward from the median anterior portion. Dental plates obsolete or obsolescent. Ventral muscle field shaped like a show-shoe with the broad end posterior.

General Characters: Shells subovate to subcircular in outline, subequally biconvex or with ventral valve the deeper, ranging in length from about 35 mm. to over 90 mm. Anterior commissure rectimarginate. Anterior and lateral margins rounded, cardinal margin subterebratulid to submegathyrid. Beak rather short to long, suberect to incurved. Deltidial plates small, linear, discrete. Pedicle foramen mesothyrid, telate to somewhat attrite. Ordinarily low ventral palintropes, each about half as wide as the cardinal margin, are present but a narrow true interarea may develop. A dorsal palintrope or a narrow dorsal interarea may be present. Shell surface typically smooth except for growth lines, but the anterior portions of some very well-preserved surfaces are radially capillate.

Dental plates obsolescent, hinge teeth strong and medially incurved. Ventral muscle field elongately subpyriform, resembling in outline a snowshoe with the broad end posterior. A narrow, elongate, undivided or scarcely divided adductor impression forms the anterior end of the muscle field, while the posterior end is composed of a pair of broader, subovate diductor scars commonly divided by a myophragm. Impressions of pallial sinuses in radial pairs.

Hinge plates discrete, ventrally concave, extending free anteriorly from psterior margin. Dorsal muscle field subtrapezoidal, moderately large, and divided by a myophragm. It is composed of a single pair of conspicuous, subtrapezoidal or somewhat elongately subrectangular, radially striated adductor impressions lying in front of a pair of long or short, smooth muscle tracks. Impressions of pallial trunks in radial pairs.

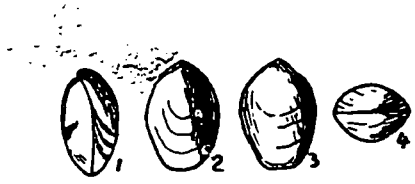
Loop long and marginal. Crura very short with greatest width horizontal, typically expressed as a simple narrowing of the hinge plates. The crura give rise, by abrupt dorsolateral geniculation, to the main bands of the loop, and the crural points are simply the flat-lying, anterior points at the place of geniculation. Main bands of loop follow posterior border from crura to posterolateral corners and then curve around parallel to lateral borders, twisting at the same time, so that their edges become reversed and the one that started on the inside comes to lie on the outside. The loop continues anteriorly, just dorsal to

plane commissure and a short distance inside shell margins, for two-thirds or more the length of the valve. Ordinarily the main bands curve somewhat ventrad and posteriorly before they meet, and quite commonly they are somewhat widened to form a subhorizontal transverse plate. A vertical plate or process may rise on ventral side of transverse plate at point of suture and extend posteriorly for a greater or less distance. Whether the complete loop is subcircular or subovate in outline depends on the shape of the shell that bears it.

Comparison: Family and subfamily characters will delimit Rensselandia from Rensselaeria and Amphigenia. Within the subfamily Subrensselandia is distinguished from Rensselandia by thepresence of crural plates, while Chascothyris differs in being a typically transverse shell with ventral sulcus and dorsal fold."

Genotype: (by subsequent designation of Schuchert, 1879, p. 271) Rensselaeria ? johanni = Rensselandia johanni Hall, 1867, loc. cit.

Range: Middle Devonian of North America (post Marcellus beds) and Europe (Stringocephalus zone).



RENSSELAERIA LAEVIS Meek (1869)

Trans. Chic. Acad. Sci. Vol. 1., 1867-0, p. 108.

RENSSELAERIA LAEVIS Meek

Shell rather above medium size, longitudinally ovate or subelliptic in outline, moderately convex in young examples, and very gibbous in adult specimens; front generally rather narrowly rounded; lateral margins forming broad semiovate or semielliptical curves, not inflected. Dorsal valve a little les convex than theother; beak incurved. Ventral valve most convex somewhat behind the middle; beak small, moderately prominent, and closely curved over that of the opposite valve; foramen small. Surface smooth, with a few veryobscure traces of ridges of growth. Some of the specimens also show, under a magnifier, very faint indications of radiating strise, but it is not clear that they are surface markings.

Length of medium sized adult specimen, 1.77 inches; breadth, 1.13 inches; convexity about 1.10 inches. Smaller specimens proportionally less convex.

Locality and position: Onion river, lat. 67 deg. N., long. 124 deg. W., and forty miles below Good Hope, Mackenzie river, lat. 65 deg. 50 min. N., long. 130 W.; also Lockhart river, lat. 67 deg. 15 min. N., long. 126 deg. W. The specimens are all casts, in a hard, gray dolomitic rock, breaking with a rough, irregular fracture, and presenting a harsh granular appearance, that might at a glance, cause it to be mistaken for a sandstone, or at any rate for a silidous rock. As this differs from the matrix of the other fossils from the same locality, I suspect that this species belongs to a different rock, possibly older than the Hamilton group. It seems to be abundant at both localities, and is the only recognizable fossil in the masses collected.

Diagram: 1. Lateral view.
2. Dorsal view.
3. Ventral view.
4. Anterior view.

Genus STRINGOCEPHALUS

Defrance, n. gen. 1825

This description is taken from Cloud, P.E., Geol. Soc. of Am. Special Paper No. 38, p. 104.

"Diagnosis: Large, subglobular to transversely sublenticular Stringocephalidae. Beak prominent, deltidial plates conjunct in adults, foramen hypothyrid, ventral interarea or planareas present and ordinarily well developed. Having prominent median septa in both valves and a long, rodlike, terminally bifid cardinal process in the dorsal valve. Hinge plates discrete, not supported by crural plates.

General Characters: Shell ranging in length from 60 mm. to over 150 mm. subequally biconvex or with ventral valve the deeper, subglobular to transversely subelliptical, commonly slightly asymmetrical. Anterior commissure rectimarginate to gently sulcate or gently uniplicate. Anterior margin evenly rounded or emarginate; lateral margins rounded; cardinal margin submegathyrid. Beak long, pointed, prominent, suberect to strongly incurved. Pedicle foramen subovate, variably hypothyrid in position. Delthyrium of adult shells closed by conjunct deltidial plates, but a henidium may be present as well. The deltidium, whether of deltidial plates alone or in combination with a henidium, commonly has a concave surface due to interference by the incurving beak of the dorsal valve. Ventral interarea or planareas ordinarily present and well developed; dorsal plaintrope generally, but not invariably, present. Shell surface characteristically unornamented except for growth lines; but some individuals, particularly young specimens of S. dorsalis, areradially capillate. Punctae of very small diameter and densely crowded. Shell substance apparently in two layers; a very thick inner layer, with component fibers at a steep angle, and an outer layer about one-third as thick, with fibers at a slight angle to the shell surface. In some specimens, alternating concentric bands of fibers in the outer layer seem to be differently oriented with respect to the length of the valve, causing a peculiar exfoliation phenomenon resembling concentric color banding.

The ventral valve lacks dental plates, but the hinge teeth are large and strong and are buttressed by thick deposits of secondary shell. Denticula assist articulation. A prominent median septum is present, extending at least three-fourths the length of the valve from the beak and becoming higher anteriorly. Diductor scars mark sides of septum toward its high anterior end, the muscles themselves apparently having extended posteriorly, and somewhat ventrally, from there to anterior faces of clavate lateral extensions of cardinal process. Wide irregularly rugose areas of adductor attachment extend from each side of median septum about halfway to lateral margins. Pedicle tube present or absent; in some individuals it is a ponderous hollow process nearly closed at the anteroventral end, pointing to atrophy of the pedicle. The pedicle appears to have been attached to the broad posterior end of the median septum. Pallial impressions not distinct; shallow, irregular depressions in the postero-

lateral corners of some shells could be of pallial or genital origin.

Dorsal median septum of variable height and length. Compared to t that of the ventral valve it is ordinarily low and short, being only about half as long as the valve and not reaching as high as the hinge plates. In a specimen of the Asiatic S. obesus (U.S.N.M.), however, the dorsal septum is nearly three-fourths as long as the valve and almost as high as long, extending ventrad to the plane of commissure at its posterior end. The cardinal process is a remarkable structure, rather similar to that of the Triplesiidae. It is very long, thick, rodlike, transversely flattened at its ventral end, and split into two clavate extensions which fit on either side of the ventral median septum and nearly meet the floor of the ventral valve. The great cardinal process and median septum almost fill the space between the hinge plates and tend to conceal the fact that they are discrete structures. Like those of Bornhardtina, the hinge plates of Stringocephalus are ventrally convex and unsupported by crural plates, though commonly buttressed by secondary umbonal thickening. Dental sockets long and deep; lateral accessory sockets receive denticula of ventral valve. Muscle field about half as long and one-third as wide as the valve; divided by the median septum into a pair of elongately subovate adductor impressions somewhat resembling the wings of a maple seed and longitudinally striate like those of Bornhardtina. Diductor muscle scars borne on flattened ventral ends of cardinal process. Impressions of main pallial sinuses border muscle field and extend posterolaterally, but further vascular detail is unknown.

The spinose, marginal loop of Stringocephalus is, in general, well known,; but the course of the crura and the posteromedial arms of the main bands is commonly represented as being rather strongly inclined to the plane of commissure and largely ventral to it. In at least one nearly complete loop (Y.C.S.-3493), however, the course of the loop is almost entirely within the dorsal valve, and no part of it is at very much of an angle to the plane of commissure. Further detail will be found under the description of S. burtini.

Comparison: A spinose marginal loop, median septa, rodlike cardinal process, discrete hinge plates, and general external appearance are such a unique combination that formal comparison would be superfluous."

Genotype: (by original designation) Terebratula burtini = Strygocephale burtini DeFrance, 1825.

Range: Middle Devonian of the Northern Hemisphere.

CONCLUSIONS

The concluding remarks of this study are arranged under three headings dealing with the contributions, limitations, and suggestions for further research.

General Conclusions.

1. This thesis brings together for the first time, faunal lists and detailed descriptions of some brachiopod fossils reported from Canada, west of the 110th meridian.

2. Fossil descriptions could be added to this thesis to form a complete list of Devonian Brachiopod Fossils from Western Canada.

3. The lists and descriptions included here will be of use in the identification of brachiopod collections at the University of British Columbia.

Limitations of this Study.

1. These lists of Devonian brachiopod faunas are not complete. The lists were compiled from forty-one papers only. Many papers on the Devonian strata of Western Canada were not examined.

2. All the fossils listed have not been described.

3. The question of synonomy of each brachiopod fossil listed here is not discussed.

4. Varieties of species have not been listed.

5. Descriptions listed here are taken partly from older works and may be limited in detail.

Suggestions for further study of Devonian Brachiopod faunas from Western Canada.

1. Important information on the stratigraphic value and geographical extent of individual species might be obtained from a study of the stratigraphical palaeontology of these fossils.

2. A study of the palaeoecology of these fossils might give information on the tolerance of various species to changes of lithological environment. The relative importance of individual species in a fauna might become apparent from such a study.

3. The author considers that an attempt should be made to systematize morphological descriptions of these brachiopods. If the morphological features of all brachiopod species were laid out in a similar systematic manner, together with photographs and serial sections of the type material, the identification, morphological limits and generic affinities of individual species might be facilitated.

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This bibliography does not duplicate the references from which the brachiopod descriptions were taken, except where such a reference includes descriptions of other important Devonian brachiopod fossils.

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PLATE I.

Superfamily Dalmanellacea.

Genus *Aulacella* Schuchert and Cooper.

A. eifelensis Verneuil

1, 2, dorsal and ventral views of exterior x 1½.

3, ventral mould x 2.

Genus *Cariniferella* Schuchert and Cooper.

C. carinata Hall.

4, 6, ventral and dorsal exteriors x 1½.

C. daumonti Verneuil.

5 Ventral interior x 1½.

Genus *Rhipidomella* Oehlert

R. vanuxemi Hall.

7 exterior view of ventral valve x 1.

8 dorsal interior x 1.

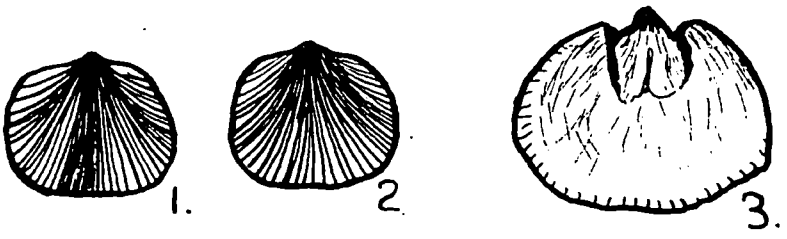
Genus *Schizophoria* King.

S. aff. striatula Schlotheim

9 dorsal view x 1.

10 lateral view x 1.

SUPERFAMILY DALMANELLACEA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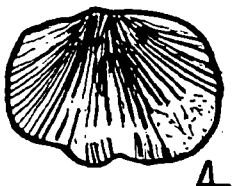
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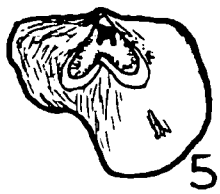
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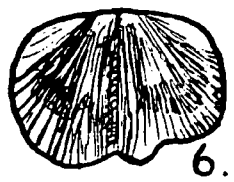
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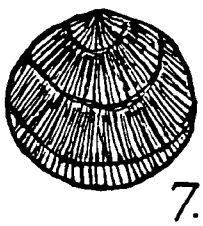
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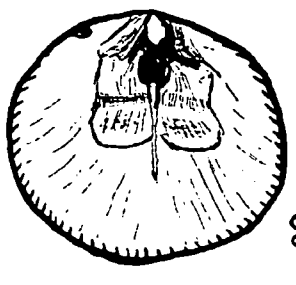
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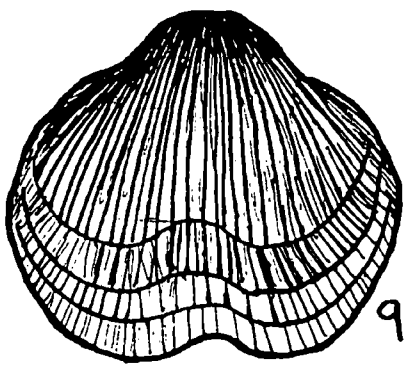
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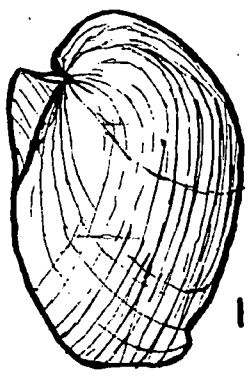
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PLATE II.

Superfamily Pentameracea.

Genus Cypidula Hall.

C. occidentalis Hall.

1-5 Dorsal, ventral, lateral, anterior and cardinal views of a specimen showing plications extending some distance from the margin of the shell x 1.

6-7 Lateral and anterior views of another individual destitute of plications x 1.

8 Enlargement of upper half of the shell showing area and foramen.

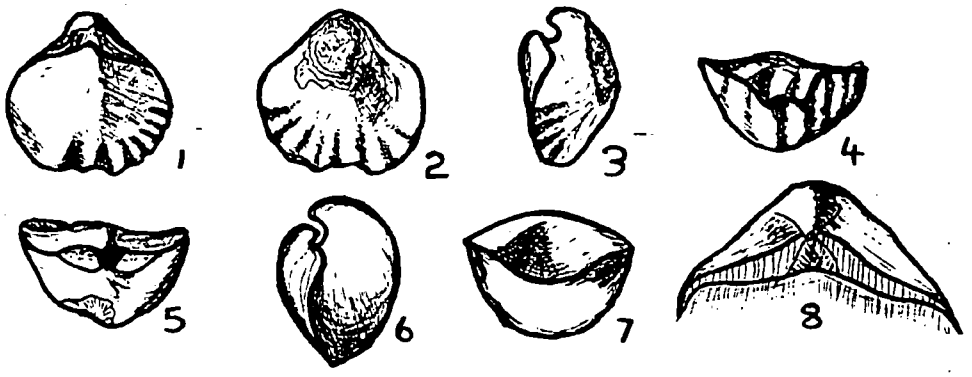
Superfamily Strophomenacea.

Genus Strophonella. Hall.

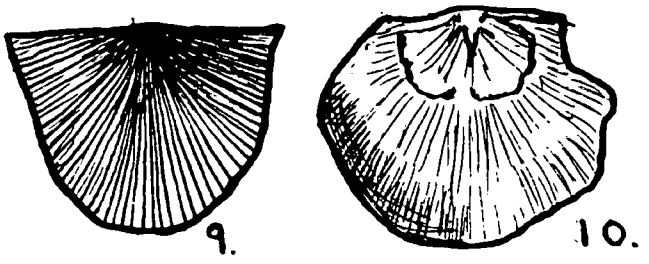
9 Sp. Ventral view of complete specimen x 1½.

10 Sp. Ventral interior x 1 approx.

SUPERFAMILY PENTAMERACEA



SUPERFAMILY STROPHOMENACEA



P L A T E III.

Superfamily Strophomenacea.

Genus Douvillina Ochlert.

D. arcuata Hall.

1. Ventral view x 1½.

2. Ventral interior x 1½.

D. subinterstrialis seretensis Kozlowski

3. Ventral interior.

D. newsomensis Foerste

4. Posterior-lateral and ventral aspects of cardinalia (x 3 approx.)

Genus Douvillanaria Stainbrook.

D. veriabilis Calvin.

5. Ventral view of hypotype x 2.

6. Dorsal view of another x 2.

7. Internal view of brachial valve x 2.

Genus Leptaena Dalman.

L. depressa Sowerby.

8. Ventral view x 1.

9. Ventral interior x 1.

Genus Leptostrophia Hall and Clarke.

L. magnifica Hall.

10. Interior of brachial valve - cast x 1.

L. Becki

11. Exterior of brachial valve showing exterior corrogations x 1.

P L A T E III (CONTINUED).

Genus Nervostrophia Caster.

N. rockfordensis Fenton and Fenton.

12. Ventral interior x 1½.

13. Ventral view of complete specimen x 1.

14. Dorsal interior x 2.

Genus Schuchertella Girty.

S. Desiderata

15. Dorsal exterior x 1.

S. Woolworthana

16. Ventral interior x 1.

17. Dorsal interior x 1.

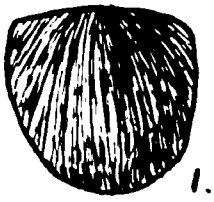
Genus Stropheodonta Hall.

18. sp. ventral view of complete specimen x 2.

19. sp. ventral interior.

20. sp. dorsal interior.

SUPERFAMILY STROPHOMENACEA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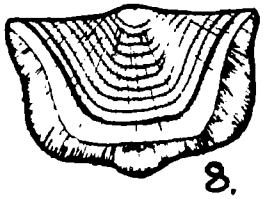
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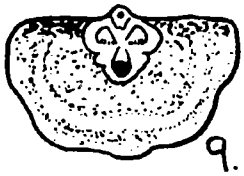
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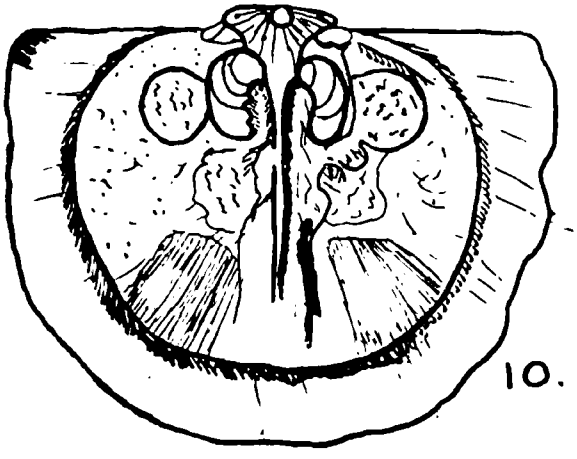
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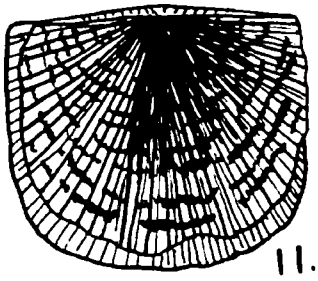
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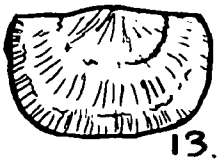
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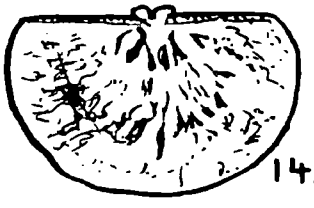
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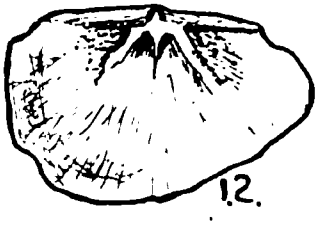
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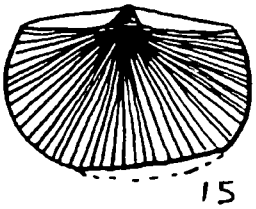
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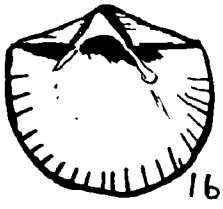
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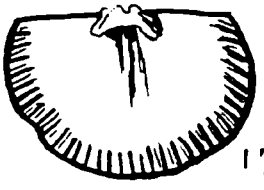
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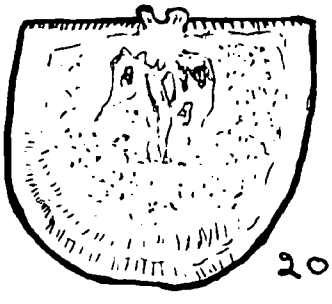
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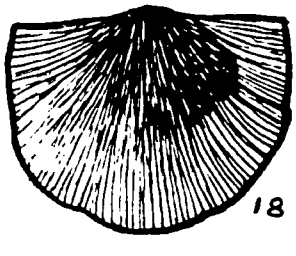
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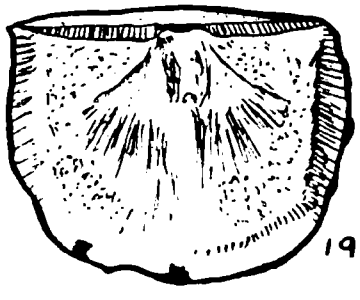

19

PLATE IV (CONTINUED).

C. ambiguata

1, 2, 3 dorsal, ventral and anterior views x 1.

Genus Camarotoechia Hall and Clarke.

C. congregata Contrad

4, 5, 6, 7 ventral, dorsal, lateral and anterior views.

Genus Etonia Hall.

E. medialis Vanuxem

8, 9, 10 dorsal, lateral and anterior view of a large shell.

PLATE IV.

Superfamily Productacea.

Genus Devonoproductus Stainbrook

D. walcotti Fenton and Fenton

1, 2, 3, Dorsal, ventral and side views x 1.

Genus Productella Hall

P. subaculeata

4, Ventral view shows one large spine x 1.
5, Dorsal view x 1.

Genus Strophalosia King

S. truncata Hall

6, Interior of brachial valve to show cardinal process x 2.

7, 8, Pedicle valve ventral and posterior views to show truncation of beak x 2.

Superfamily Chonetacea.

Genus Chonetes Fischer

C. macronata Hall

1, Pedicle valve destitute of spines.

2, Pedicle valve with divergent spines.

Genus Chonopectus

C. fischeri Norwood and Patten

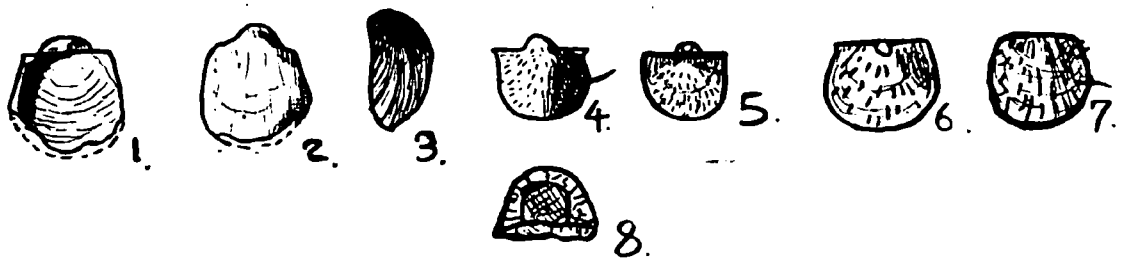
3, Small pedicle valve with cardinal spines x 1.

4, Pedicle valve with reticulate ornamentation no spines x 2.

Superfamily Rhynchonellacea.

Genus Calvinaria Stainbrook

SUPERFAMILY PRODUCTACEA



SUPERFAMILY CHONETACEA

SUPERFAMILY RHYCHONELLACEA

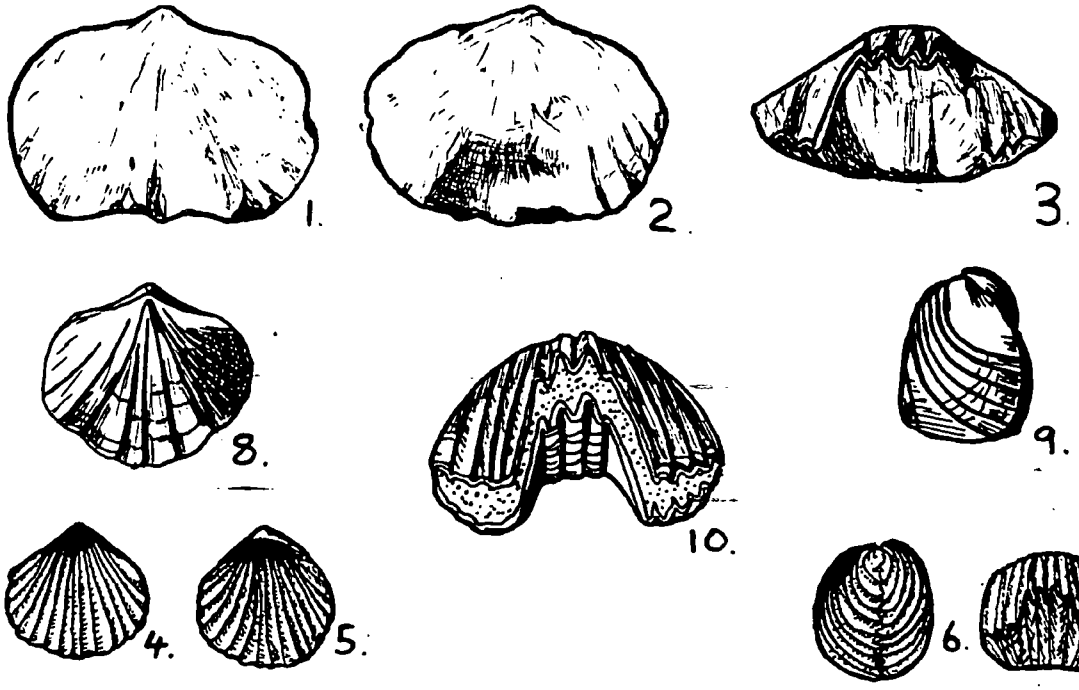


PLATE V.

Superfamily Rhychonellacea. (Continued.)

Genus Hypothyridina Buchman

H. cuboides Sowerby

1, 2, Posterior and dorsal view x 1.

Genus Leiorhynchus Hall

L. sp.

3, 4, 5, 6, Dorsal valves to show gradation in size x 1.

Genus Pugnus Hall

P. pugnax

7, 9, Ventral and dorsal views x 1.
8a. and 7b. anterior views x 1.
10, lateral view x 1.

Genus Pugnoides Weller

P. ottumwa White

11 a - k Cross sections of rostral portion of a paratype x $2\frac{1}{2}$.

Superfamily Atrypacea.

Genus Atrypa Dalman

A. reticularis Sowerby

1, 2, Dorsal and lateral views of a gibbons specimen.
3, 4, Dorsal and lateral views of a normal specimen.

Genus Gruenewaldtia Tschernyschew

G. latilingius Schnur

5, 6, 7, Dorsal lateral and anterior views.

SUPERFAMILY RHYCHONELLACEA


1.


3.


4.


9.


8A.

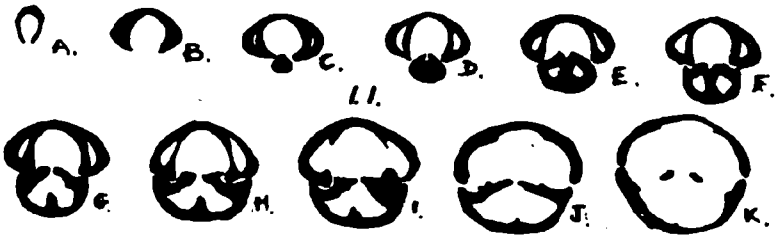

2.


5.


6.


7.


8B.

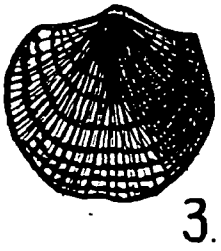



10.

SUPERFAMILY ATRYPACEA


1.


2.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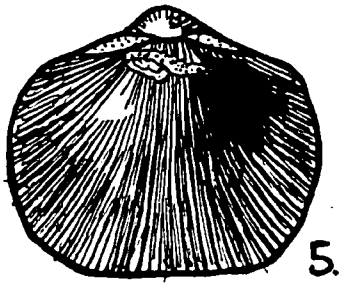
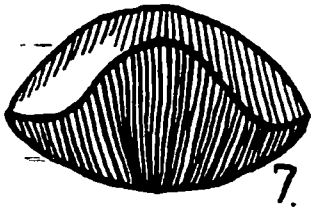

5.


6.


7.

P L A T E VI (CONTINUED.)

20. Internal longitudinal view.

Genus *Tenticospirifer* Tien

T. *cyrtiniformis* Hall and Whitfield

21, 22, 23, 24, Ventral, dorsal, posterior and lateral views.

Genus *Tylothyris* North

T. *missouriensis* Weller

25, 26, Ventral, interior and dorsal exterior x 2.

P L A T E VI.

Superfamily Spiriferacea.

Genus *Ambocoelia* Hall

A. umbonata Conrad

1, 2, 3, Dorsal, ventral and lateral views x 1.
4, 5, Anterior of a pedicle and a dorsal valve x 3.

Genus *Athyris* McCoy

A. cora Hall

6, 7, 8, 9, Dorsal, lateral, ventral anterior views.

Genus *Cyrtina* Davidson

C. septosa Phillips

10, 11, 12, Posterior, anterior and lateral views.

Genus *Elytha* Fredricks

E. fimbriatus Conrad

13, 14, 15, Ventral, dorsal and lateral views.

Genus *Martinopsis* Waagen

"*M*" *laevis* Hall

16, 17, Posterior and dorsal views of an interior cast.

Genus *Meristella* Hall

M. bella Hall

18, Interior of pedicle valve showing teeth deeply excavated muscular area and the testateous thichening which fills the pedicle cavity except along the median line.

M. laevis Hall

Single plate showing sub-triangular medium cavity and supporting septum x 3

M. walcotti Hall

PLATE VI

SUPERFAMILY SPIRIFERACEA

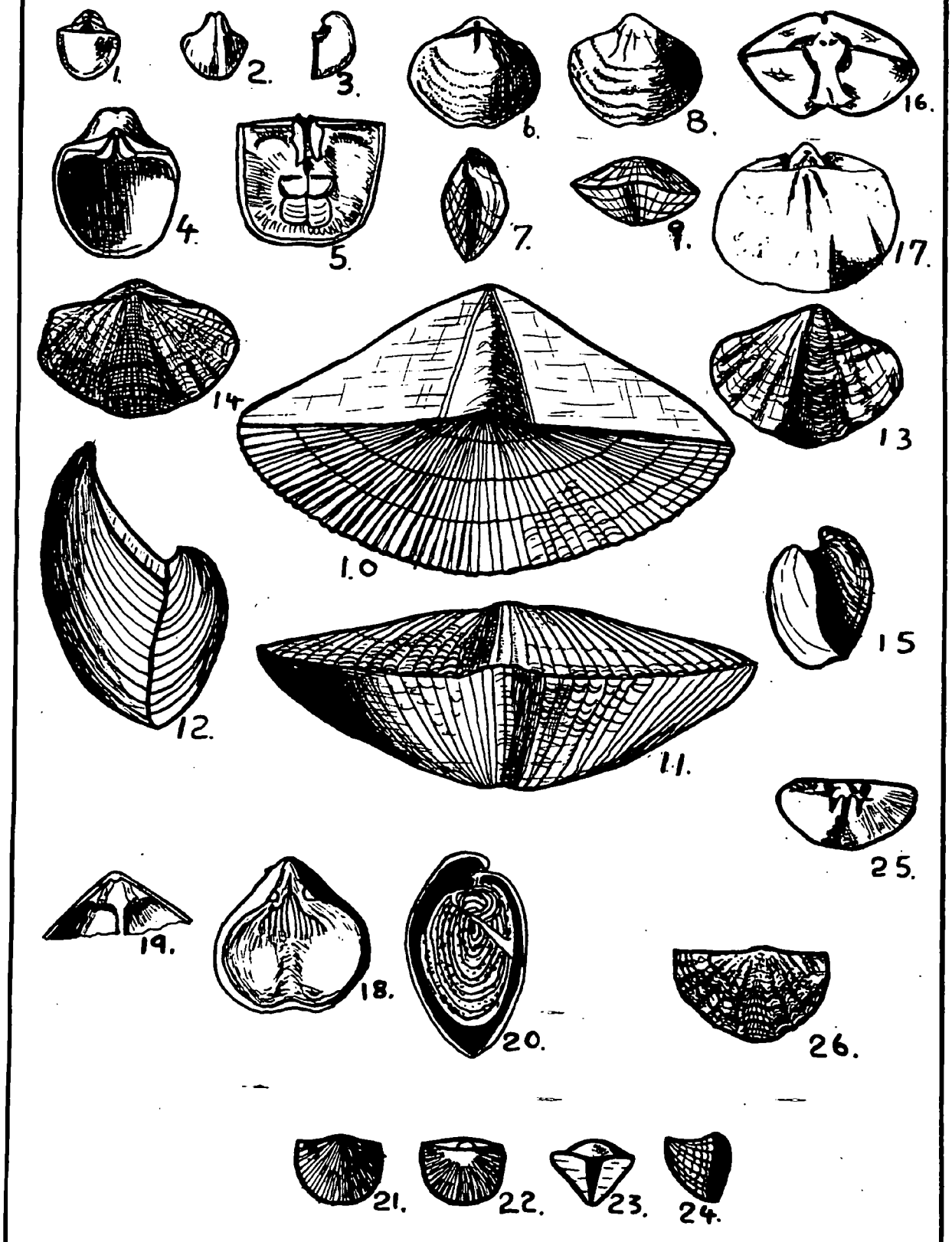


PLATE VII.

Superfamily Terebratulacae.

Genus Cranaena Hall and Clarke

C. schucherti Cloud

1, 2, 3, 4, Dorsal, ventral, lateral and anterior views of holotype.

Genus Cryptonella Hall

C. planirostra Hall

5, 6, Lateral and dorsal views of a solicied shell.

C. reimanni Cloud

7, 8, Ventral and dorsal view of holotype.

C. eximia Hall

9, Dorsal view x 3.

Genus Renselandia Hall

R. johanni Hall

10, 11, 12, 13, Ventral, dorsal, posterior and lateral views of a typical specimen.

Genus Stringocephalus DeFrance

S. burtini DeFrance

14, 15, Dorsal and posterior views of a medium-sized specimen.

PLATE VII

SUPERFAMILY TEREBRATELLACEA