Brachiopoda from the Madison limestone in Montana

D. L. Blackstone

The University of Montana

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BRACHIOPODA FROM THE MADISON
LIMESTONE IN MONTANA.

by

Donald L. Blackstone, Jr.

Submitted in partial fulfillment of the requirement for the degree of Master of Arts.

State University of Montana

1934

Approved:

Chairman of Examining Committee

Chairman of Graduate Committee
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ACKNOWLEDGMENTS

The writer is deeply indebted to Dr. C. F. Doiss both for the direction and criticism given during the course of his studies; and for the use of the collections of brachiopoda from northwestern Montana that were placed at the writer's disposal. The writer also wishes to express his appreciation of the aid given by Dr. W. T. Thom, Jr. of Princeton University which made possible the collections from the Pryor Mountains in southern Montana. Dr. Carey Croneis of the University of Chicago contributed valuable criticism of material sent to him for checking. Dr. Charles W. Wilson of Vanderbilt University contributed faunal lists of the localities on the Stillwater River for comparison.

INTRODUCTION

Brachiopods are important fossils in a study of the stratigraphy of the Madison limestone because they are abundant and relatively well preserved. The writer originally intended to figure and describe all the available brachiopods from the Madison formation in Montana, and to make correlations between localities in the State where the exact stratigraphic position of the fossils could be determined. Because the collections were found too large to be described completely only the new species are figured and described at this time. However, in order to identify the new species every specimen in the collections was carefully studied. The previously known species, as well as new species, are presented in the form of a faunal chart. See page 85.
A discussion of the anatomy of the Brachiopoda is unnecessary in this paper, because the class is well known to paleontologists. For this reason descriptions of the families of the class Brachiopoda have also been omitted. Generic descriptions are given only of the genera to which the new species belong.

The fossils studied by the writer were collected from eighteen localities in the State. The principal collections were made by C. F. Deiss in northwestern Montana for the State Bureau of Mines and Geology. The specimens catalogued and deposited in the Museum of Paleontology of the State University were collected by J. P. Rowe, R. G. Rowe, J. H. Bradley Jr., and Earl Douglass. Edward L. Broadwater made a collection from the Yakiniak limestone in Flathead County. The writer made collections from the Madison limestone in the Pryor Mountains.

**HISTORICAL REVIEW**

The Madison formation is of lower Mississippian age, consists predominantly of blue or grey massive limestones, and occurs over a large portion of the state. Those papers which discuss only extent and lithology of the Madison formation without contributing specifically to the paleontology of its fauna have been omitted in the following historical review.

The first description of the brachiopod fauna from the Madison limestone in Montana was by Meek in 1873. He collected fossils from the formation at the outlet of Mystic Lake; on the east side of Madison River.

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1An adequate discussion of Brachiopod morphology may be found in, Carl von Zittel, "Textbook of Paleontology," 2nd. ed. pp. 355-69, 1913.

Canyon; on Bridger Peak; near Fort Ellis; near Black-Tail Deer Creek; on the north side of Gros Ventees Butte; on Flathead Pass; on the north side of Henry's Lake; and in the canyon west of Gallatin River. Concerning this material Meek stated, 3

"In looking over the collections from these localities, I have been impressed with the similarity of their general facies, without being quite sure that any of them are identical, to the fauna of the Waverly Group of Ohio, now known to belong to the Carboniferous. At the same time that I would refer the beds from which these fossils were obtained to the Carboniferous, it should be remarked that we have every reason to believe that they belong to a lower horizon in the series than those from which nearly all of the collections from 'Old Baldy' Montana were obtained; also, than the fossiliferous beds on the divide between Ross Fork and Lincoln, Montana."

Meek recognized the existence of Upper and Lower Carboniferous horizons; and attempted to place exactly the age relationship of the Lower Carboniferous strata. He also gave faunal lists and inadequate descriptions of two new species of brachiopods.

In 1893 Peale 4 applied the formalional name Madison to the Lower Carboniferous strata exposed in the Three Forks region. C. D. Walcott identified the collected fossils and called them Lower Carboniferous though the basal collections had a distinct Devonian affinity. After Peale named the Madison formation, the name was applied to Lower Mississippian rocks throughout the greater portion of Montana, Wyoming;

3Idem, p. 433


*Old Baldy Mountain is situated seven miles S. 10° W. of Virginia City, Madison County, Three Forks quadrangle, Montana."
southeastern Idaho, and northern Utah. No new forms were described in Peale's report but faunal lists were given.

In 1899 Girty\(^5\) contributed an excellent description of the fauna of the Madison limestone as represented in the collections made by the Arnold Hague survey of Yellowstone National Park. Girty regarded the Madison as representing the Kinderhook and Osage epochs. He also gave a thorough discussion of the age relationships, part of which follows,\(^6\)

"We may therefore conclude that the Madison limestone does not probably represent the period of the Genevieve group; but, while showing distinct affinities with the Kinderhook, may have persisted through the period of the Osage as well."

Girty figured and discussed a large number of known species of brachiopods and described 11 new species and varieties.

In 1905\(^7\) Earl Douglass made several collections in southwestern Montana. Part of these collections are in the Museum of Natural Science of the State University. The fossils are practically valueless because they were not catalogued, and many of the locality labels have been lost. With the exception of the collections, faunal lists of Madison brachiopods were Douglass' only contribution to the problem.

In 1917 Clark collected Madison fossils from Old Baldy Mountain near


\(^6\)\textit{Idem} p. 494.


Virginia City, and described one new genus and four new species of brachiopods.

No other writers have contributed to the paleontology of the Madison limestone except for those who have given faunal lists in various publications of the U. S. Geological Survey and other reports.

Recent work in neighboring regions deserves mention here. In 1927 Girty described two new species of brachiopods from the Rundle limestone, which is tentatively correlated with the Madison of Montana. In 1932 the same writer described four species from the Banff shale.

In 1927 Girty described nine new species of brachiopods from the Mississippian limestones of southeastern Idaho. In the same paper he gave an excellent discussion concerning the relation of the Madison formation to the type section of the Mississippian formations.

**Technique of Observation and Study**

Many of the specimens studied were embedded in hard crystalline limestone. The best method of removing the matrix and exposing the specimen was by the use of a fine chisel and light hammer. Chisels were made by filing large phonograph needles to an edge; then mounting them in a stylus tipped with a chuck.

---


The material was examined under a bimocular microscope in order to observe minute structures. Brushing with a stiff short haired brush was helpful in cleaning some surfaces. A very thin film of oil smeared on some of the specimens and then briskly brushed made some minute details more readily observable.

**ARTIFICIAL KEYS FOR THE IDENTIFICATION OF GENERA AND SPECIES**

The following keys form an important part of the technique of studying a large number of fossils species. The generic and specific characters were taken from the original description, if available, or from other sources and tabulated on charts. By analyzing these charts for distinctive characters keys were constructed which eliminated inaccuracies in determining the differences between closely related forms. The construction of these keys formed a large part of the work necessary for accurate specific determinations. The large variety of forms handled required the use of a rapid method of identifying species. These keys provided such a method. Genera which contained five or fewer species were not keyed because a comparison of the specimen with the original descriptions and figures could be made readily. Practically all the descriptions of North American Mississippian brachiopoda were made available by the cooperation of the library staff. The following keys are given in this paper in order to place them on record for future use. Omissions of genera or species are noted at the end of each key.
Key to North American genera of Mississippian Brachiopoda

I. SHELL ENCUSTING
#. Conforming to shape of object to which attached ------- CRANIA
##. Not conforming; shape subconical --------------------- ORICULIOIDEA

II. SHELL CONCAVO-CONVEX TO PLANO-CONVEX

C. Cardinal area present

d. valves spinose
   k. spines limited to a single row along cardinal margin
      t. double set of concentric oblique markings present-- CHONETINA
      tt. double set of concentric oblique markings absent
      h. pedicle valves strongly convex; with narrow sinus
         hh. pedicle valve not strongly convex; sinus generally absent ----------------------------- CHONETES
   kk. spines irregularly distributed over surface of valves
      e. with cicatrix on pedicle valve ------------------ STROPHOSORIA
      ee. without cicatrix on pedicle valve
         **. plano-convex; pseudoresupinate ---------------- SCHIZOPHORIA
         ***. concavo-convex; moderately convex --------- PRODUCTELLA

dd. valves aspinose
   f. shell smooth
      sa. high cardinal area; linguloid ------------------ BARROISELLA
      sal. low cardinal area; rounded --------------------- AMBOCOELIA
      FFF. shell striate; lamellae present or absent
      e. strong wrinkles concentric to anterior margin --- LEPTAENIA
      ee. no strong wrinkles concentric to anterior margin
         r. resupinate; nonseptate pedicle valve:--------- SCHELLWIESELLA
         rr. not resupinate
            tr. triangular rostral cavity in pedicle valve -- ORTHOTETES
            ttr. no triangular rostral cavity in pedicle valve DERBYIA

CC. Cardinal area absent

d. valves spinose
   kk. spines irregularly distributed over surface of valves
      q. with long tubular extension of pedicle valve ---- PROBOSCIDELLA
      qq. without long tubular extension of pedicle valve --
      O. strong flexuous growth lines on both valves ---- ETHERIDGINA
      OO. no strong, flexuous growth lines
         n. with diaphragm arising from brachial valve ---- DIAPHRAGMUS
         nn. without diaphragm arising from brachial valve --- PRODUCTUS
      kkk. spines situated on concentric bands ------------ ECHINOCHONCHUS

dd. valves aspinose
   f. shell smooth
III. SHELL BICONVEX
1. Hinge line short; posterior part of shell pointed
   a. Fold and sinus absent
      f. Shell smooth, terebratuloid;
         sl. Short loop formed direct, united in median line
            forming a broad plate
            -------------------------------
            -------------------------------
            SELENELLA
            ROMINGERNINA
            CRYPTONELLA
            PTERITINA
            GRANAENA*
            HAMBURGIA*
            ROXLEYELLA*
            DIELASMA*
            RHYPIDONELLA
   sl. Long crura; with ascending branches or fringes
   sall. Short loops, cruralia often present
   fff. Shell striate; lamellae present or absent
   fff. Shell strongly plicated; lamellae present or absent
   pa. Very coarse subangular plications (5-6)
      i. Punctate
      ii. Impunctate, (strongly serrate edge but not a
            true fold and sinus)
      pr. Plications numerous, rounded, non-bifurcating
      -------------------------------
      -------------------------------
      -------------------------------
      -------------------------------
      RHYNCHOSPIRINA
      RUSTEDIA
      PTYCHOSPIRA
      EUMETRIA
      ACAULONA
      TETRACAMERA
      MOOREFIELDELLA
   aa. Fold and sinus present
      f. Shell smooth
         g. Terebratuliform
            ax. Fold and sinus simple
               s. With median septum
               ss. Without median septum
                  i. Punctate
                  ii. Impunctate
            axx. Fold or sinus, or both of biplicate character
               i. Punctate
               ii. Impunctate
            exx. Rhynohonelliform, (plications obsolete or
                 broadly rounded)
               exx. Subsquare; sharply rostrate

*See key to genera of family Dielasmatidae.
fff. shell striate; lamellae present or absent

ffff. shell plicate; lamellae present or absent

i. punctate
  pa. coarse, subangular plications
  pr. numerous rounded simple plications

ii. impunctate
  ps. plications bearing fine radiating striae
  ps. plications not bearing fine radiating striae

b. plications not extending to beaks; obsolete in posterior portion

bb. plications extending to beaks.
  pr. numerous, simple, rounded plications
  po. few, broad, rounded, obsolete plications
  pa. angular to subangular plications
  s. with median septum in brachial valve
  ss. without median septum in brachial valve

2. Hinge line medium; length of hinge line less than, but occasionally subequal to greatest width of shell
a. fold and sinus absent
d. shell spinoce
  kk. spines irregularly distributed over surface of valves
  kkk. spines on concentric bands

dd. shell aspinose
  f. shell smooth
  w. fine concentric lines parallel to anterior margin
  ww. shell with strong lamellar expansions at each growth line

fff. shell striate; lamellae present or absent
e. with strong wrinkles concentric to anterior margin
ee. without strong wrinkles concentric to anterior margin
  s. with median septum
  ss. without median septum

ffff. shell strongly plicate; lamellae present or absent

j. lamellae present

aa. fold and sinus present
d. shell spinoce
  kk. spines irregularly distributed over surface of valves

---

RHIPIDOMELLA
RHYNCHOPORA
EUMETRIA
AXTODEANEA
PARAPHRHYNCHUS
RHYNCHOTETRA
CAMAROPHORIA
PUGNAX
PUGNIDES
MOOREFITHELLA
SIUJARELLA
CAMAROJOECHIA
TETRAGAMERA
ALLORHYNCHUS
SCHIZOPHORIA
CLIOThIRIDINA
CAMAROPORELLA
ATHYRIS
COMPOSITA
STREPTORHYNCHUS
ORTHOETES
DERBYIA
SCHELLVITENELLA
SCHUCHERTELLA
ATHYPA
NUCLEOSPIRA
k. Spines on concentric bands

n. Double tubed spines

nn. Flat imbricate spines

nnn. Fine hollow tubulose costae, produced into spines

dd. Shell aspinose

f. Shell smooth

w. Shell with fine concentric growth lines

cc. Cardinal area present

cc. Cardinal area absent or obsolete

ww. Shell with broad lamellar extensions at each growth line

fff. Shell strongly plicate; lamellae present or absent

g. Rhynchonelliform

h. Punctate

ii. Impunctate

cl. Cardinal extremities rounded

cla. Cardinal extremities angular

3. Hinge line long; length of hinge line equal or subequal to the greatest width of shell

a. Fold and sinus absent

aa. Fold and sinus present

ia. Punctate

ia. With syrinx

ia. Without syrinx

ya. Cardinal area differentiated into three areas

yas. Cardinal area not differentiated into three areas

ca. Cardinal area high

cal. Cardinal area low

ii. Impunctate

ka. Spines on plications

kpp. Without spines on plications

cal. Cardinal area high

fold and sinus nonpllicate, or single one

fold and sinus plicate
Key to Genera of family Dielasmidae

I. Without fold or sinus in either valve
   A. with median septum supporting hinge plate
   A. without median septum supporting hinge plate
      d. dental plates present in pedicle valve
      x. hinge plate in brachial valve not attached along median line
      xx. hinge plate in brachial valve attached directly to valve along median line
      dd. without dental plates in pedicle valve

II. Sinus present in both pedicle and brachial valves
   A. with median septum supporting hinge plate
      (Composita laevis Weller characterized by same condition of fold and sinus)
      COMPOSITA

III. Sinus present in pedicle valve; neither fold nor sinus present in brachial valve

III. Fold and sinus present
   a. fold in brachial valve of bisinuate character; low median fold in broad shallow sinus
   (Dielasma inflata Weller has same character)
   V. Sinus in pedicle valve of bisinuate character; developed only in anterior portion of shell, and there weakly
      DIELASMOIDES
   b. Fold and sinus of simple (single) character, lying in brachial and pedicle valves respectively
      k. beak straight, erect, slightly incurved; valves much compressed
      kk. beak strongly incurved; large foremen encroaching on umbonal region; valves moderately compressed to tumid

Key to Mississippian species of genus Brachythyris

X. Size of shell small
   a. sinus bears plications
      p. plications continuous from beak to anterior margin
         1. single fine median plication
         3. three plications in sinus
            lp. 5 lateral plications on each slope
            1p. 11 lateral plications on each slope
         4. four plications in sinus
            pp. plications not continuous from beak to anterior margin
               obsolete past midlength
      aa. sinus does not bear plications
         c. with well defined false cardinal area
            n. sp. 1
            n. sp. 2
            n. sp. 3
            altonensis
            semiplicata
            peculiaris
<table>
<thead>
<tr>
<th>Condition</th>
<th>Species</th>
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</thead>
<tbody>
<tr>
<td>Without well defined false cardinal area</td>
<td></td>
</tr>
<tr>
<td>L. lateral slopes strongly convex at anterior margin (90° to plane of valve)</td>
<td>fernglenensis</td>
</tr>
<tr>
<td>LL. lateral slopes less convex at anterior margin</td>
<td></td>
</tr>
<tr>
<td>lp. 5-6 lateral plications on each slope of valve</td>
<td>similans</td>
</tr>
<tr>
<td>lp. 8-10 lateral plications on each lateral slope</td>
<td>burlingtonensis</td>
</tr>
<tr>
<td>XX. Size of shell medium</td>
<td></td>
</tr>
<tr>
<td>c. well defined false cardinal area</td>
<td></td>
</tr>
<tr>
<td>ee. without false cardinal area</td>
<td></td>
</tr>
<tr>
<td>p. plications continuous from beak to anterior margin</td>
<td></td>
</tr>
<tr>
<td>1. single plication in sinus</td>
<td></td>
</tr>
<tr>
<td>4. four plications in sinus originating from bounding</td>
<td></td>
</tr>
<tr>
<td>pl. 7-8 lateral plications on each slope</td>
<td></td>
</tr>
<tr>
<td>pl. 5 lateral plications on each slope</td>
<td></td>
</tr>
<tr>
<td>XXX. Size of shell large</td>
<td></td>
</tr>
<tr>
<td>y. plications essentially obsolete on fold and sinus</td>
<td></td>
</tr>
<tr>
<td>yy. plications rounded (3), well defined on fold and sinus</td>
<td></td>
</tr>
<tr>
<td>Key to some Mississippian species of genus Camarotoeochia</td>
<td></td>
</tr>
<tr>
<td>A. Angle at beak, formed by lateral margins less than 90°</td>
<td></td>
</tr>
<tr>
<td>L. Length of shell less than width</td>
<td>tuta</td>
</tr>
<tr>
<td>LL. Length of shell greater than width</td>
<td></td>
</tr>
<tr>
<td>uu. with prominent umbonal cap</td>
<td>n. sp. 2</td>
</tr>
<tr>
<td>uu. without prominent umbonal cap</td>
<td></td>
</tr>
<tr>
<td>p. 2 plications in sinus</td>
<td>n. sp. 1</td>
</tr>
<tr>
<td>p. 3 plications in sinus</td>
<td>camarifera</td>
</tr>
<tr>
<td>p. 4 plications in sinus</td>
<td></td>
</tr>
<tr>
<td>pl. 7-8 lateral plications on each slope</td>
<td>grosvenori</td>
</tr>
<tr>
<td>pl. 5 lateral plications on each slope</td>
<td>n. sp. 3</td>
</tr>
<tr>
<td>AA. Angle at beak 90° or less</td>
<td></td>
</tr>
<tr>
<td>L. Length of shell less than width</td>
<td>tuta</td>
</tr>
<tr>
<td>LL. Length of shell greater than width</td>
<td>grosvenori</td>
</tr>
<tr>
<td>III. Shell strongly globose in outline</td>
<td>subglobosa</td>
</tr>
<tr>
<td>AAA. Angle at beak, formed by lateral margins, 90° or more</td>
<td></td>
</tr>
<tr>
<td>n. shell flat or subplanate</td>
<td></td>
</tr>
<tr>
<td>m. deep groove in umbonal region of brachial</td>
<td>marahellensis</td>
</tr>
<tr>
<td>mm. without deep groove in umbonal region</td>
<td>sappho</td>
</tr>
<tr>
<td>nn. shell subglobose</td>
<td></td>
</tr>
<tr>
<td>r. fold marked by a longitudinal median depression</td>
<td></td>
</tr>
<tr>
<td>extending 1/3 distance from beak to anterior margin</td>
<td></td>
</tr>
<tr>
<td>pa. with angular plications</td>
<td>choteauensis</td>
</tr>
<tr>
<td>pr. with rounded plications</td>
<td>tuta</td>
</tr>
<tr>
<td>rr. fold not marked by a median depression</td>
<td></td>
</tr>
<tr>
<td>L. length of shell less than width</td>
<td></td>
</tr>
<tr>
<td>at. anterior margin truncate</td>
<td>mitata</td>
</tr>
</tbody>
</table>
ar. anterior margin rounded  
pr. rounded plications  
LL. length of shell greater than width  
p. 2 plications in sinus  
p. 3 plications in sinus  
p. 4-5 plications in sinus  

Note: Following species omitted from key: *allani*, *sageriana*, 3 varieties of *purduel*, *contracta*, *endlichii*.

**Key to Mississippian species of genus Camarophoria**

N. Strong numerous plications  
s. sinus bearing 2-3 very broad, depressed plications  
ss. sinus bearing 7-8 depressed, rounded plications  

NN. Few, broad, rounded to obsolete plications  
w. with plications on lateral slopes  
L. length of shell less than width  
(wide sinus)  
LL. Length of shell greater than width  
(narrow sinus; prominent beak)  
ww. without plications on lateral slopes  

NNN. Non-plicate; concentric growth lines  
(figure and description make form seem more probably an *Athyris* or *Composita*.)

**Key to some Mississippian species of genus Chonetes**

A. Greatest width of shell lying along hinge line  
s. sinus present  
cc. cardinal extremities acutely angular  
ii. costae not bearing spine bases (impunctate)  
cc. cardinal extremities rectangular or obtusely angular  
ss. sinus absent  

cc. cardinal extremities acutely angular  
p. radiating costae essentially obsolete; subordinate to concentric ornamentation  

---

**---**
pp. radiating costae broad, depressed, not originating at beak

pp. costae extending to beak

i. costae bear spine bases

ii. costae not bearing spine bases

iii. strongly depressed, extended, auriculations

m. shell minute

mm. shell small; not minute

ee. auriculations small; not extended

c. cardinal extremities rectangular to obtusely angular

k. fine radiating costae not extended to beak

p. 100 costae at anterior margin

p. 55-40 costae at anterior margin

kk. fine radiating costae extended to beak

i. costae bearing spine bases

p. 5-9 costae per mm.

p. 5-4 costae per mm.

ii. costae not bearing spine bases

p. 5-9 per mm.

p. 2-4 per mm.

AA. Greatest width of shell not along hinge line

s. sinus present

p. 5-4 costae per mm.

p. 5 costae per mm.

ss. sinus absent

i. costae bear spine bases

o. pits in intercostal furrows

co. no pits in intercostal furrows

ii. costae do not bear spine bases

p. 55-40 costae at anterior margin

p. 75-100 costae at anterior margin

p. 170 plus costae at anterior margin

Note: Following species omitted: pulchellus, tumidus.
### Key to some Mississippian species of the genus Cliothyridina

<table>
<thead>
<tr>
<th>X. Size small</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L. length greater than width</td>
<td>---------------</td>
<td>sublamellosa</td>
</tr>
<tr>
<td>L. length less than width</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dd. sinus very shallow, not prominent</td>
<td>----------</td>
<td>elegans</td>
</tr>
<tr>
<td>III. width and length subequal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>v. valves subequally convex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>oo. outline distinctly sub-pentagonal</td>
<td>----------</td>
<td>parvirostris</td>
</tr>
<tr>
<td>oo. outline tending from subpentagonal to circular</td>
<td>-----</td>
<td>hirsuta</td>
</tr>
<tr>
<td>(possibly synonymous)</td>
<td></td>
<td>temulinata</td>
</tr>
<tr>
<td>vv. not subequally convex; brachial valve more convex</td>
<td>-----</td>
<td>sublamellosa</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>XX. Size medium</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L. length less than width</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. sinus deep anteriorly</td>
<td>---------------</td>
<td>prouti</td>
</tr>
<tr>
<td>dd. sinus shallow ill defined anteriorly</td>
<td>----------</td>
<td>glenparkensis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>XXX. Size large</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L. length greater than width</td>
<td>---------------</td>
<td>incrassata</td>
</tr>
<tr>
<td>L. length less than width</td>
<td>---------------</td>
<td>obmaxima</td>
</tr>
</tbody>
</table>

Following species omitted: squamosa, roysii.

### Key to Mississippian species of genus Composita

<table>
<thead>
<tr>
<th>X. Size small</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L. length greater than width</td>
<td></td>
<td></td>
</tr>
<tr>
<td>s. with fold and sinus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. distinct groove along the median line in sinus</td>
<td>----</td>
<td>trinuclea</td>
</tr>
<tr>
<td>g2. without median groove in sinus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. fold in brachial valve replaced by sinus</td>
<td>--------</td>
<td>laevis</td>
</tr>
<tr>
<td>ff. fold in brachial valve obsolete</td>
<td>--------</td>
<td>lawisensis</td>
</tr>
<tr>
<td>ss. without fold and sinus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(very poorly developed or obsolete though may be present)</td>
<td>---------------</td>
<td>corpulenta</td>
</tr>
<tr>
<td>u. extenuate, pointed umbonal region</td>
<td>----------</td>
<td>n. sp. 4</td>
</tr>
<tr>
<td>uu. umbo: not extenuate; high rounded prominent</td>
<td>-----</td>
<td>n. sp. 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>II. length less than width</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>s. with fold and sinus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>t. sinus strong, tripartite in pedicle valve</td>
<td>--------</td>
<td>oppsita</td>
</tr>
<tr>
<td>tt. sinus simple</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. with fine concentric growth lines</td>
<td>--------</td>
<td>globosa</td>
</tr>
<tr>
<td>aa. with coarse heavy concentric growth lines</td>
<td>--------</td>
<td>pentagonia</td>
</tr>
<tr>
<td>ss. without fold and sinus</td>
<td>--------</td>
<td>n. sp. 1</td>
</tr>
<tr>
<td>XXX. Length and width subequal</td>
<td>n. sp. 2</td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>XX. Size medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Sinus deep anteriorly</td>
<td>sulcata</td>
<td></td>
</tr>
<tr>
<td>dd. Sinus shallow anteriorly</td>
<td>subquadrata</td>
<td></td>
</tr>
</tbody>
</table>

**Key to some Mississippian species of genus Dielasma**

**X. Size small**

| f. Fold and sinus of tripartite character | inflata |
| ff. Fold and sinus narrow and single     | illinoisensis |
| e. Greatest convexity in brachial valve  | occidentalis |
| cc. Greatest convexity in pedicle valve  |          |
| ss. Without fold and sinus              |          |
| o. Triangular in outline                | subspatulatum |
| oo. Elongate oval in outline            | formosum  |

**XX. Size medium**

| s. With fold and sinus               |          |
| l. Sinus originating at beak, extending anteriorly | ahumardanus |
| ll. Sinus originating at midlength    |          |
| uu. Umbo prominent projecting conspicuously beyond beak of opposite valve | sinuata |
| uuu. Umbo prominent but not projecting | arkansanum |
| lll. Sinus originating close to anterior margin | n. sp. 1 |
| ss. Without fold and sinus            |          |
| p. Fine depressed radiating costae    | choteauensis |
| pp. Without fine radiating costae     | utah formosum |

**XXX. Size large**

| i. Shell punctate |          |
|                  |          |
| o. Subtriangular in outline            | femglenensis |
| oo. Subelliptical in outline            | gorbyi |
| ii. Impunctate                         | burlingtonensis |

Note: The following species are omitted: hastata, osceolensis, sacculus.
Key to some Mississippian species of genus *Eumetria*

X. Size small
   pa. angular plications ____________________________ acuticosta
   pr. rounded plications
      v. shell ventricose ____________________________ verneuiliana
      vv. not ventricose ____________________________ peristrialis

XX. Size medium
   p. plications broad and rounded ____________________ altirostris
   pp. plications narrow rounded; subangular at times
      c. 50-40 costae on each valve ____________________ costata
      e. 42-46 costae on each valve ____________________ vera
   ppp. plications lacking __________________________ osagensis
       (may be E. vera if lack is not constant feature)

Note: The following species are omitted: marcyi, woosteri.

Key to Mississippian species of genus *Girtyella*

I. Sinus originating in umbonal region
   f. fold and sinus of tripartite character __________ brevilobata
e. without fold on brachial valve __________ turgida
   ff. fold and sinus not of tripartite character ________ n. sp. 1

II. Sinus originating approximately at midlength, or posterior to middle of valve

   fff. without fold on brachial valve __________ cedarencis
       f. fold and sinus of tripartite character ________ intermedia
       e. without fold on brachial valve __________ indianaensis
       e. fold and sinus of tripartite character ________ woodworthi

Key to some Mississippian species of genus *Productus*

I. WIDTH OF SHELL GREATER THAN LENGTH
   x. size of shell small
      A. hinge line equal to greatest width of shell
         a. mesial sinus present
            x. costae essentially absent ____________________ adairensis
            xx. costae not continuous; interrupted or elongate
                pustules __________________________ dolorosus
                xxx. coarse, continuous radiating costae _______ richardsei
                    _______ mesialis
                xxxxx. fine, continuous, radiating costae _________ inflatus var.
                    _______ coloradoensis
aa. mesial sinus absent
   i. finely punctate (in slightly exfoliated cond.) —— altonensis
   ii. impunctate 12
      r. costae essentially absent ———— subsulcatus
   11. impunctate ———— subsulcatus var
      m. costae per mm. ———— moorefieldanus
      n. costae per mm., also enrolled margin ———— moorefieldanus var. pusillus
      o. fine, continuous, radiating costae
         c. 6 costae per mm. ———— scitulus
         cc. 3 costae per mm., also enrolled margin ———— parviformis
            two following species belong in this group ———— gallatinensis
   g. hinge line less than greatest width of shell
      a. mesial sinus present ———— dolorosus
      aa. mesial sinus absent
         p. with conspicuous mesial costa ———— mesicostalis
         pp. without conspicuous mesial costa
         m. pronounced, inflated enrolled margin ———— martinicinctus
         mm. without enrolled margin 12 ———— subsulcatus
            subsulcatus var. jenius
            moorefieldanus
            moorefieldanus var. pusillus
   xx. Size of shell small
      A. hinge line equal to greatest width of shell
         a. mesial sinus present
            z. costae absent on lateral and anterior slopes of valve ——— semistriatus
            zz. costae present on lateral and anterior slopes of valve
            ww. concentric wrinkles absent ——— lowei
            ww. concentric wrinkles present
            e. auriculations small, not extended
               b. strongly incurved beak ———— burlingtonensis
               bb. moderately incurved beak
                  rrrr. costae fine ———— inflatus
                  rrrr. costae coarse ———— inflatus var.
                     ———— coloradoensis
                     ———— semireticulatus
                     ———— mississippianus
                     ———— depressus
                     ———— mesialis
            ee. auriculations large, extended ———— multistriatus

12 For discussion of these four species see: U. S. G. S. Bull. 439, pp. 47-50.
aa. mesial sinus absent
  m. enrolled margin on pedicle valve ------------------  wortheni
  mm. without enrolled margin ------------------------  scabriculus

C. Hinge line less than the greatest width of shell
a. mesial sinus present
  n. elongate nodes ----------------------------------  blairi
  nn. fasciculate nodes anterior to spine bases ------  fernglenensis
  subsulcatus
  -----  var. janus

aa. mesial sinus absent ----------------------------------  sedaliensis

xxx. Size of shell large
A. hinge line equal to greatest width of shell
  ww. concentric wrinkles absent ---------------------  multistriatus
  w. concentric wrinkles present
  b. strong band of spines around valve joining
  cardinal extremities -------------------------------  crawfordsvillensis
  bb. group of spines in oblique rows along cardinal
  extremities ----------------------------------------  magnus
  bbb. spines irregularly disposed ------------------  semirreticulatus
  position uncertain -------------------------------  giganteus

II. LENGTH OF SHELL GREATER THAN WIDTH
x. Size of shell small
A. hinge line equal to greatest width of shell
  a. sinus present ----------------------------------  subhorridus
  aa. sinus absent ----------------------------------  parvulus

C. hinge line less than greatest width of shell
  c. costae regular and radiating -------------------  arcuatus
  cc. costae not regular and radiating --------------  sampsoni
  indiensiensis
  subhorridus

xx. size of shell medium
A. hinge line equal to greatest width of shell --------
  ---

C. hinge line less than greatest width of the shell
  g. concentric wrinkles confined to portion of valve
  near cardinal extremities -------------------------  ovatus
  gg. concentric wrinkles distributed over entire valve
  ---

III. WIDTH AND LENGTH SUBEQUAL
x. Size of shell small
A. hinge line equal to greatest width of shell
  a. sinus present ----------------------------------  dolorosus
  -----  multistriatus
  moorefieldanus
  moorefieldanus
  var. pusillus
  parvus

  aa. sinus absent ----------------------------------  parvus
C. hinge line less than greatest width of shell

XX. size of shell medium
A. hinge line equal to greatest width

C. hinge line less than greatest width of shell

XXX. size of shell large
A. hinge line equal to greatest width of the shell
C. hinge line less than greatest width of the shell

Note: The following species of Productus have been omitted from the key because the literature in which they are described is not available: carbonarius, confregosus, compressus, amplicostata, giganteus, gracilis, granulosus, incurvus, ivesi, latissimus, leuchtenbergensis, lineolatus, margaritaceus, martini, nodocostatus, occidentalis, pectenoides, phillipsi, raricostatus, rushvillensis, subacerratus, spinosus, swallowi, villiersi.

Key to Mississippian species of genus Rhipidomella

X. Size of shell small
a. sinus absent
f. with a broad low fold (brachial valve has sinus) ——— jerseyensis
ff. without broad low fold ———— tenuecostata
incertae sedis ———— pulchella
aa. fold and sinus present
c. cardinal area present, well developed
m. minute shell, (5-6 mm.); gibbous ———— perminuta
mm. not minute (10-25 mm.); lenticular
t. subquadrate
s. sinus ill defined ———— diminutiva
ss. sinus strong, mod. deep ———— thiemi
cc. cardinal area absent ———— dubia

XX. Size of shell medium
k. pedicle valve with sinus
e. with fine costae, 9-13 per mm. ———— arkansana
cc. with moderately coarse costae, 2-3 per mm. ———— burlingtonensis
kk. pedicle valve without sinus ———— missouriensis

XXX. Size of shell large
0. subcircular in outline
kn. with sinus in brachial valve ———— oweni
kns. without sinus in brachial valve ———— burlingtonensis
00. not subcircular in outline; subquadramcular ———— nevadensis
Key to Mississippian species of genus Rhynchotetra

XX. Size of shell medium
   a. siphum absent; or obsolete
      b. plications extending to beak (4-5 in number) —— missouriensis
      bb. plications essentially obsolete on beak and in umbonal region —— elongatum
   a. siphum present —— gibbosum

XXX. Size of shell large
   p. plications simple —— ovatum
   pp. plications not simple; but dividing
      k. plications generally simple, only 2-3 divide —— caputtestudenris
      kk. plications with frequent bifurcations —— gibbosum

Key to Mississippian species of genus Rhynchopora

I. Size of shell small
   i. punctate
      p. 2-3 plications in sinus —— perryensis
      pp. 3-6 plications in sinus
         0. plications in sinus marked by a median groove extending some distance from the anterior margin —— pustulosa
         00. plications in sinus not marked by a median groove
            t. punctate probably confined to the tops of plications —— beecheri
            tt. punctate usually in single row on each side of plications —— hamburgensis
         ppp. 6-10 plications on sinus —— pinguis
         pppp. 7 plications on sinus —— persimua
   ii. impunctate —— cooperinua

XX. Size of shell medium —— rowleyi

Key to Mississippian species of genus Schellwienella

XX. Size of shell medium
   k. costae coarse (2 per mm.) —— choteauensis
   kk. costae fine (2-5 per mm.)
      lc. posterior margins of cardinal area lying almost in a straight line
         v. pedicle valve concave throughout entire length —— cremulicostata
         vv. pedicle valve concave only at the anterior margin —— inasqualis
      lce. posterior margins of valve are not in a straight line —— inflata
XXX. Size of shell large
   w. greatest width at hinge line ------------------------ burlingtonensis
   ww. greatest width not along hinge line
   k. concentric markings crossing costae are stronger
      in the intercostal furrows than on the summits
      of the costae -------------------------------- altamontana
   kxxx. concentric markings crossing the costae are
      stronger on the summits of costae than in
      intercostal furrows
   le. posterior margins of cardinal area lying
      almost in a straight line --------------------- inaequalis
   loc. posterior margins not in a straight line --- inflata
   kxxx. without concentric markings crossing the costae -- planumbona

Key to some Mississippian species of genus Spirifer

I. WIDTH GREATER THAN LENGTH

x. Size of shell small
   1. sinus marked by a simple non bifurcating median
      plication
      A. Cardinal extremities rounded or obtusely angular
         r. cardinal area high --------------------- jeffersonensis
         rr. cardinal area moderately high
            d. sinus deep --------------------------- bifurcatissimus
            dd. sinus shallow ----------------------- annectans
      B. Cardinal extremities sharply angular
         s. with fine radiating striae
            d. sinus deep (profound anteriorly) ------- leydi
            dd. sinus shallow
               ca. cardinal area low and narrow
                  lp. lateral plications not bifurcating --- emtronatus
                  lp. lateral plications bifurcating -------- albertensis
               caa. cardinal area triangulate and slightly
                   arched ------------------------------ louisianensis
                   --- osagensis
         ss. without fine radiating striae
            m. cardinal area vertically striate -------- platynotus
            mm. cardinal area not vertically striate ---- latior
                   --- agelaius
                   --- kellogi
      C. Cardinal extremities macroscopic
         bs. fold and sinus distinctly bifurcate -------- biciplicatus
         bbs. fold and sinus not bifurcate; bears additional
             plications on lateral slopes of sinus
             kp. 1 plic. on lateral slope of sinus ------- n. sp. 3
             --- osagensis
D. Cardinal extremities right angled -- bifurcatus

11. Sinus marked by a bifurcating median plica
   A. Cardinal extremities rounded or obtusely angular
      
      rr. cardinal area moderately high -- marshallensis
      rrr. cardinal area low, small -- tenuimarginatus
   B. Cardinal extremities sharply angular
      jzh. 16-20 rounded depressed plications on lateral
      slope -- platynotus
      jzh. 8-10 depressed rounded plications -- albertensis
      jzh. 28-34 depressed rounded plications -- n. sp. 4

111. Sinus without median plication; or any lateral
     plications in sinus --
     
     --- n. sp. 8
     --- n. sp. 9

XX. Size of shell medium

1. Sinus marked by a simple non bifurcating median
   plication
   A. Cardinal extremities rounded or obtusely angular -- martiniiformis
   B. Cardinal extremities acutely angular
      
      r. cardinal area high
      jyh. 18-18 simple rounded plications on each
      lateral slope of valve -- legrandensis
      jyh. 9-10 plications on each lateral slope -- n. sp. 1
      jyh. 12-14 plications on each lateral slope -- calvini
      rrr. cardinal area moderately high
      ss. with fine radiating striae
      
      ca. with fine concentric striae -- washingtonensis
      cca. without fine concentric striae -- increbecens
      cca. without fine radiating striae
      
      ca. cardinal area long and narrow; lateral
      margins subparallel to hinge line -- marionensis
      cca. cardinal area not long and narrow; broadly
      triangular
      
      kl. plications extending to beak, well defined
      1-2 plications on each lateral slope of sinus -- platynotus
      2-3 plications on each lateral slope of sinus -- n. sp. 5
      3-4 plications on each lateral slope of sinus -- vernonensis
      5-6 plications on each lateral slope of sinus -- shepardii
      kkl. plications extending to beak but poorly defined --
      n. sp. 7
      kkk. plications in sinus not extending to beak --
      albapinensis
   C. Cardinal extremities mucronate
      jzh. 20-23 bifurcating rounded plications on each
      lateral slope of valve -- shepardii
      jzh. 18-18 nonbifurcating radiating plications on
      lateral slopes of each valve -- mysticensis
   D. Cardinal extremities right angled
      jyh. 11-15 nonbifurcating rounded plications on
      each lateral slope -- keokuk
jzh. 15-20 bifurcating, rounded plicae on each lateral slope of valve

floydensis

jya. 5-8 simple angular plicae on each lateral slope

bifurcatus

leydi

11. sinus marked by a bifurcating median plication

A. Cardinal extremities rounded or obtusely angular

rutherfordi

B. Cardinal extremities sharply angular

albertensis

centronatus

C. Cardinal extremities mucronate

rutherfordi

D. Cardinal extremities rounded or obtusely angular

kalvini

XXX. Size of shell large

1. sinus marked by a simple nonbifurcating median plica

calvini
<table>
<thead>
<tr>
<th>rrr. cardinal area low; small</th>
<th>haydenianus</th>
</tr>
</thead>
<tbody>
<tr>
<td>jzh. valve covered by bifurcating plicae, fasciculate</td>
<td>crawfordsvillensis</td>
</tr>
<tr>
<td>in groups of three</td>
<td>incertus</td>
</tr>
<tr>
<td>jzh. valve covered with nonbifurcating plicae</td>
<td>incertiformis</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>C. Cardinal areas mucronate</td>
<td>desiderata</td>
</tr>
<tr>
<td>11. sinus marked by a bifurcating median plication</td>
<td></td>
</tr>
<tr>
<td>A. Cardinal extremities rounded or obtusely angular</td>
<td></td>
</tr>
<tr>
<td>r. cardinal area high</td>
<td>brazerianus</td>
</tr>
<tr>
<td>rrr. cardinal area moderately high</td>
<td></td>
</tr>
<tr>
<td>dd. sinus shallow; broad</td>
<td>grimesi</td>
</tr>
<tr>
<td>d. sinus narrower, deeper, and more sharply defined</td>
<td>rowleyi</td>
</tr>
<tr>
<td>d. smaller shell than grimesi, with more rotund form and narrower median simus</td>
<td>gregeri</td>
</tr>
<tr>
<td>rrr. cardinal area low and small</td>
<td>striatus</td>
</tr>
<tr>
<td></td>
<td>pikensis</td>
</tr>
<tr>
<td></td>
<td>n. sp. 14</td>
</tr>
<tr>
<td>B. Cardinal extremities acutely angular</td>
<td></td>
</tr>
<tr>
<td>r. cardinal area high</td>
<td>lateralis</td>
</tr>
<tr>
<td>f. fold acuminate</td>
<td></td>
</tr>
<tr>
<td>ff. fold not acuminate</td>
<td></td>
</tr>
<tr>
<td>ssp. sinus plicate</td>
<td></td>
</tr>
<tr>
<td>asp. sinus not plicated</td>
<td></td>
</tr>
<tr>
<td>rrr. cardinal area moderately high</td>
<td></td>
</tr>
<tr>
<td>kkzh. 20-25 bifurcating, rounded plications in simus</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>kkzh. 16-20 bifurcating rounded plicae in simus</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>kkza. 15 bifurcating angular plicae in simus</td>
<td></td>
</tr>
<tr>
<td>rrr. cardinal area low</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>111. No median plication on sinus</td>
<td></td>
</tr>
</tbody>
</table>

II. WIDTH LESS THAN LENGTH

X. size of shell small

A. Cardinal extremities rounded or obtusely angular

<table>
<thead>
<tr>
<th>d. sinus deep</th>
<th>littoni</th>
</tr>
</thead>
<tbody>
<tr>
<td>dd. sinus shallow</td>
<td>indepensia</td>
</tr>
<tr>
<td>XX. size of shell medium</td>
<td>subrotundus</td>
</tr>
<tr>
<td>XXX. size of shell large</td>
<td>mapleness</td>
</tr>
<tr>
<td></td>
<td>grimesi</td>
</tr>
</tbody>
</table>
III. WIDTH AND LENGTH SUBEQUAL
X. size of shell small
  I. sinus marked by a simple nonbifurcating median
    plicae --------------------------------------------- brokenridgensis
  II. sinus marked by a median bifurcating plication ------ rostellatus
XX. size of shell medium --------------------------------- albertensis
XXX. size of shell large --------------------------------- brazeriamus

Note: The following species have been omitted from the key: elavatula, duplicatus, psilavii, kellogi, ovalis, waverlyensis, trigonals.

Key to some Mississippian species of genus Spiriferina

I. Size of shell small
   I. width of shell greater than length
     pp. with median plica in sinus --------------------- solidirostris
     pp. without median plica in sinus
       d. diameter not exceeding 5.5 mm. ----------------- norwoodana
       dd. diameter ranging from 5.5 mm. to 25 mm.
         c. 7-9 plicae on each lateral slope -------------- subtexta
         cc. less than 7 plicae on each lateral slope ----
            t. surface of valve crowded with tubercles
               (spine bases) -------------------------------- erinosan
            tt. surface of valve not bearing tubercles ------
   II. Width of shell equals twice the length ------------ subelliptica

XX. Size of shell medium --------------------------------

Note: The following species have been omitted from this key: binacuta, cristata, depressa, octoplicata, pulchella, praetansversa.

Key to some Mississippian species of genus Syringothyris

I. Size of shell small
   p. 16 plicae on each lateral slope ------------------- halli
   pp. less than 16 plicae on each lateral slope --------

XXX. Size of shell large

I. width of shell approximately 3 times the length ------ extenuatus
II. width of shell approximately 2 times the length
   cs. cardinal area sloping posteriorly at an angle of
      40° from the hinge line ------------------------ platypleurus
   css. cardinal area sloping posteriorly at an angle
        greater than 40° from the hinge line
27. b. brachial valve moderately convex -------------- newarkensis
   bb. brachial valve strongly convex -------------- textus

III. width and length approximately subequal

   cs. cardinal area sloping posteriorly at an angle of 40° from the hinge line -------------- bushbergensis

   css. cardinal area sloping posteriorly at an angle greater than 40° from the hinge line 50–60 degrees

   k. with secondary cardinal area ------------------ typus

   kk. without secondary cardinal area -------------- hannibalenis

   90 plus degrees

   f. flat cardinal area -------------------------- subcuspidatus

   ff. concave cardinal area ------------------------ solidirostris

Note: The following species have been omitted from the key:
   herricki, giga.

DESCRIPTIONS OF GENERA

Genus ATRYPA Dalman

1767. Anomia, Linnaeus. Systema Naturae, ed. xii, p. 1152.

1820. Terebratulites, Schlotheim. Petrefactenkunde, p. 262, Nachtr., pl. xvii, fig. 2; pl. xviii, fig. 2; pl. xx, fig. 4.


DESCRIPTION: Shell subcircular in outline, strongly inequivalved with the brachial valve gibbous or with the valves subequally convex, the hinge-line short and the cardinal extremities rounded, surface radially plicate and usually marked by more or less conspicuous, concentric, lamelllose lines of growth. Pedicle valve with a small, incurved beak with the foramen and
delthyrium hidden except in young individuals; internally the hinge teeth are large and widely separated, and the muscular impressions are sharply defined. In the brachial valve the crura are long, narrow and widely divergent, the jugum consists of two processes situated posteriorly at the junction of the crura with the primary lamellae, directed towards the center of the shell and not joined at their inner extremities, the spirals have their bases subparallel with the inner surface of the pedicle valve, and their apices convergent towards the center of the brachial valve.


**Genus BRACHYTHYRIS** McCoy


**DESCRIPTION:** Shells varying in size from small to large, the length and breadth subequal, the outline ovate to subcircular; the hinge-line straight, much shorter than the greatest width of the shell, the cardinal extremities rounded. Mesial sinus of the pedicle valve and the fold of the brachial valve more or less well developed. Surface of both valves marked by radiating plications which are simple upon the lateral slopes of the valves, those of the fold and sinus increasing in number in passing from the beak to the front margin. The pedicle valve with the beak usually only moderately elevated above the hinge-line, and the cardinal area strongly arched. Internally, the dental lamellae supporting the hinge-teeth are short, commonly being only ridge-like thickenings of the inner surface of
the valve on each side of the delthyrium, the muscular scars ill-defined.

The brachial valve commonly less convex than the pedicle, with a very narrow, inconspicuous cardinal area, the cardinal process low, with its anterior surface vertically striated; the form of the brachidium as in Spirifer."


Genus CAMAROTONCHIA Hall and Clarke


1843. Atrypa, Hall, Geology of New York; Rept. Fourth Dist.; Tables of Organic Remains, No. 66, figs. 3, 4; No. 67, fig. 2.


1852. Atrypa, Hall. Paleontology of New York, vol. 2, p. 70, pl. 25, figs. 4, 5; p. 274, pl. 57, fig. 1; p. 279, pl. 58, figs. 3, 4.


1867. Rhynehonella (Stenoeisma). Hall. Paleontology of New York, vol. 4, pp. 335-345, 348-353, pl. 54, figs. 1-59; pl. 54a, figs. 1-23, 44-49; pl. 55, figs. 1-52.


1884. Rhynehonella, Walcott. Monogr. U. S. Geol. Survey, vol. 8, p. 152, pl. 14, fig. 3; pl. 25, fig. 6; p. 155, pl. 14, fig. 8.


1888. Rhynehonella, Herrick. Bulletin Labor. Denison University, vol. 5, pp. 39, 40, pl. 5, fig. 1; pl. 7, fig. 25; pl. 10, fig. 9.


DESCRIPTION: "By restricting the application of the term Stenoschisma to shells agreeing in hinge-structure with Rhynehonella formosa; the necessity is created for a new designation for the large group of shells to which that term was applied in 1867. While these shells are susceptible to considerable variation in exterior, they usually maintain a full trihedral contour with shallow pedicle, and convex brachial valves, evincing little, if any evidence at maturity, of a reversal of the relative convexity of early growth, a feature so apparent in some of the other groups of rhynehonellids. Their distinctive characters, however, are internal; the median septum of the brachial valve is divided posteriorly in such a manner as to form an elongate cavity, which does not extend to the bottom of the valve. Each branch of the septum supports one of the lateral divisions of the hinge-plate, to which are attached the curved crural processes. In normal conditions of development the median interspace of the hinge-plate is not closed. The dental sockets, bordering the hinge-plate, are crenulated in the species which are assumed as representing the typical characters of the group. There is no cardinal process."
In the pedicle-valve slender vertical lamellae support the rather small teeth and extend well into the cavity of the valve, enclosing a deep and narrow pedicle-scar.

This is a group of shells highly developed in species, and eminently characteristic of the Devonian faunas, and hence Rhynchonella congregata, Conrad, is designated as the type of the genus.”

Genotype: Rhynchonella congregata Conrad.

Genus COMPOSITE Brown


DESCRIPTION: "Shells small or of medium size, subovate, subquadrangular to subpentagonal in outline, the valves biconvex, with the fold and sinus developed in the anterior portion of the shell or sometimes extending posteriorly to the umbonal region, both the fold and sinus may be marked by a rather sharp mesial sulcus. The surface of the valves smooth or marked only by concentric lines of growth which are never extended into lamellae. The beak of the pedicle valve incurved so as to conceal the delthyrium, but the foramen is usually exposed, encroaching upon the umbonal region of the valve. Internally the dental lamellae and muscular scars resemble those of Athyris, but with the diductor impressions usually more faintly developed. In the brachial valve the hinge-plate is similar to that of Athyris, but with its posterior margin extended posteriorly beyond the margin of the valve into the umbonal cavity of the opposite valve; the brachidium, including the jugum, with its accessory lamellae
similar to that of *Athyris*.


Genus *DEELASMA* King


1857. *Terebratula*, Davidson. British Permian Brachiopoda, pp. 3-11, pl. 1, figs. 5-22; pl. 11, fig. 2.


DESCRIPTION: "The apex of the pedicle-valve is closely incurved, so that in adult shells but little remains of the deltidial plates. The foramen is large, quite generally encroaching upon the umbo and often becoming very oblique to the longitudinal axis; with the increase of this obliquity the dental plates are thickened in their inner surface, which thus becomes more or less protruded. The inverted sheath or collar within the foramen is highly developed and clearly shown on internal casts. On the interior the dental plates are conspicuous, as in Cryptonella, but they stand vertically upon the bottom of the valve, not showing the convergence and often actual union occurring in that genus.

In the brachial valve the dental-sockets are quite deep and narrow, the socket-walls rising abruptly, though not attaining the height of the dental plates of the opposite valve. They are distinctly separated from the crural plates or margins of the hinge-plate, and converge toward the apex where they merge into a slightly elevated cardinal process; the latter usually appearing as a crescentic submarginal wall, though when best preserved is seen to be composed of two lateral, somewhat rounded lobes. The crural plates are two divergent vertical lamellae, originating just below the cardinal process, and attaining a length equal to the distance between their extremities, which is about one-third the width of the valve at that point. Between these plates lies the long shallow hinge-plate, which is raised but little above the bottom of the valve, and is sometimes actually adherent to it. This plate attains its greatest width at the extremities of the vertical crural plates, its margins converging
thence anteriorly, its full length often equalling one-third that of the valve. To this plate are attached all the muscles of the brachial valve, the scars of both anterior and posterior adductors being frequently clearly defined upon its surface."


Genus ECHINOCHEONCHUS Weller

1809. Anomites punctatus Martin. Patrefacta Derbiensa; p. 8, pl. 37, fig. 6.


1929. Echinochonchus, Schuchert and LeVene, Fossilium Catalogus, pars 42, p. 5. Weller does not give synonymy of the genus in the original description. It has been reconstructed here from the synonymy of the genotype.

DESCRIPTION: Original from Weller 1914, description. - "Shell productoid in form and with internal characters as in the genus Productus. The external surface of the valves marked by more or less sharply differentiated concentric bands which commonly grow broader in passing from the beak to outer margins, each band bearing numerous, crowded, fine, appressed, imbricating spines, either subequal or unequal in size, which are produced from elongate, node-like bases."
Remarks.—This genus is proposed to include those shells which have heretofore been placed in the genus Productus in the group typified by *P. punctatus*. This whole group of species differs so fundamentally from the members of the genus Productus as typified by the genotype *P. semireticulatus*, in their surface markings, that it has long seemed to the writer that they should be separated under a different generic name, although their internal characters are essentially alike. The genus is represented in the Mississippian faunas under consideration by several species, none of which suggest any intergradation with those of the restricted *Productus*.

Genotype: *Anomites punctatus* Martin 1809, Petref. Derb., p. 8, pl. 37, fig. 6.

Genus *GIRTYELLA* Weller


DESCRIPTION: Original from Weller 1911, "Shell terebratuliform. The pedicle valve sinuate, with a large, subcircular or subovate, oblique foramen which encroaches upon the umbo; the brachial valve frequently sinuate and often with a slight median fold in the bottom of the sinus. Internally the dental lamellae are well developed in the pedicle valve. In the brachial valve the socket plates are joined by a concave hinge-plate which is imperforate at the apex and is supported by a median septum; the inner sides of the dental sockets retreat from the margins of the
valve anteriorly beyond the point of articulation, and become the bases of the crura which are still joined by the concave hinge-plate and are also supported by lamellae resting against the inner surface of the lateral slopes of the valve. The brachidium short, its free portion apparently being like that of *Dielasma* and not reaching to the middle of the shell.

**Remarks.** Members of this genus have commonly been included in the genus *Dielasma* but they differ fundamentally from that genus in the presence of a median septum supporting the hinge-plate of the brachial valve, and in the origin of the bases of the crura from the socket-plates. In his description of the species which is selected as the genotype, Girty referred the form to the genus *Harttina* on account of the presence of a median septum in the brachial valve, but the brachidium of *Harttina* is elongate, like that of *Cryptonella*, reaching nearly to the front of the shell, while that of *Girtyella* is short, like the brachidium of *Dielasma*.


**Genus SPIRIFER Sowerby**

1793. *Conchylolithus (striatus) Anomiæ Martin.* Figures and descriptions of petrifactions collected in Derbyshire, pl. 23. 1793.


The generic description is taken from two sources. The first quotation is the original description of the genotype as quoted in Marcou's
"Geology of North America". The second quotation is from Weller's "Mississippian Brachiopoda".

The complete description given by Marcou is as follows: "Description.- This species is well known and found wherever the Mountain Limestone exists. The following is the description of it given by William Martin in 1793.

'Conchylolithus (striatus) Anomiae a fossil shell-valves convex, semi-orbicular, longitudinally striated; the striae strongly marked, close and numerous. Beak of the larger valve pointed, and curved over the hinge, which extends on a straight line, the whole breadth of the shell. Margin obsolesly waved. A convex fold down the middle of the smaller valve, proceeding from the valve of the margin to the beak—in the larger valve, a concave fold. The folds slight; that of the larger valve scarcely distinguishable. A triangular aperture under the beak of the larger valve.'

(See: Figures and Descriptions of Petrifactions collected in Derbyshire, by William Martin, plate 23; Wigan, 1793.)"

The following description is taken from Weller, 1914. "Description.—Shells varying in size from small to very large, usually wider than long, rarely longer than wide, the hinge-line straight, shorter than the greatest width of the shell and the cardinal extremities rounded; or more frequently the greatest width of the shell along the hinge-line and the cardinal extremities angular and more or less extended, sometimes conspicuously acuminate. Mesial sinus in the pedicle valve and fold in the brachial

Jules Marcou, "Geology of North America; with two reports on the prairies of Arkansas and Texas, the Rocky Mountains of New Mexico, and the Sierra Nevada of California," Paleontology, Chap. III, p. 49., pl. 7, fig. 2. 1858.

valve usually well developed, more rarely without fold or sinus. Surface of both valves marked by radiating plications which may be simple without division from the point of origin to the anterior margin, or may divide in various manners; the plications may be present upon the lateral slopes only or upon both the lateral slopes and the fold and sinus. Besides the plications the surface may also be marked by fine, radiating striae or by fine or coarse concentric growth lines, or by both radiating and concentric markings. The pedicle valve with the beak variously elevated above the hinge-line and variously incurved, the cardinal area varying from very narrow to high, usually arched but sometimes nearly or quite flat, the delthyrium rather broadly triangular and open; the surface of the cardinal area is transversely striate and the inner layers bear a series of vertical canals at whose extremities along the hinge-line the shell tissue is sometimes produced in a row of denticles which articulate with a row of pits in the opposite valve. Internally the hinge teeth are strong and are supported by short dental lamellae; the muscular area is of moderate size and is often deeply impressed, ovate or subcordate in outline, occupied in large part by the diductor scars which are usually marked by radiating or branching furrows. The brachial valve with a very narrow cardinal area divided by a broadly triangular delthyrium; the cardinal process is a low, transverse, sessile apophysis with its surface vertically striated; the muscular impressions much less strongly marked than in the pedicle valve; the dental sockets narrow and of moderate depth, the socket plates well developed and at their extremities supporting the crural bases; the crura are long, straight, and slightly divergent, the spiral
somes are directed obliquely outward and posteriorly towards the cardinal extremities, the primary lamellae are not united by a jugum, but the position of the jugum is indicated by the presence of a pair of spine-like processes upon the primary lamellae a little in front of their junction with the crura.

Remarks:- This genus has the largest specific representation of any in our Mississippian faunas, and the species themselves are usually very characteristic of the horizon in which they occur. As a whole the Mississippian species are characterized by the presence of plications in the fold and sinus of the valves, and in a large number of species the plications upon the lateral slopes exhibit more or less bifurcation.


Genus *SYRINGOTHYRIS* Winchell


1809. *Conchylolithus anomites*, Martin. Petrefacta Derbiensa, pl. 46, fig. 34; pl. 47, fig. 5.


1858. *Spirifer*, Hall. Geology of Iowa, vol. 1, part 2, pp. 520, 603, 646, 647, pl. 7, fig. 6; pl. 13, fig. 4; pl. 20, fig. 5.


"Shells varying in size from small to very large, spiriferoid in form, with a much elevated cardinal area, the hinge-line straight and elongate, representing the greatest width of the shell, the fold and sinus well developed and usually non-plicate. The pedicle valve subsemipyramidal in form, the high cardinal area either flat, concave or convex, differentiated into three regions, a central including the delthyrium, and two lateral; by a pair of lines originating at the apex and passing obliquely to the cardinal margin, which they intersect at equal distances from the basal angles of the delthyrium; the central region is distinctly marked by vertical striae, while the lateral regions are marked only by the horizontal lines of growth; internally the dental lamellae are moderately well developed, they rest upon the floor of the valve and are a little produced anteriorly along the lateral margins of the muscular scar; they are united transversely by a delthyrial plate whose position is subparallel with the cardinal area but somewhat depressed below it; this plate extends to various distances from the apex of the delthyrium towards the hinge-line and at the middle point of its cardinal margin it is produced still further towards the cardinal margin of the valve as a free spine-like process; on the inner side of the spine-like extension of the delthyrial plate, and continuing along the median line of the inner surface of the plate towards the apex of the valve, is a tube which is split longitudinally internally, this split tube, together with the extension of the delthyrial plate, being
termed the syrinx. In some cases the syrinx is solid. A pseudodeltidial covering of the delthyrium entirely separate from the delthyrial plate and syrinx is sometimes present. The muscular scars as in Spirifer. The brachial valve essentially as in Spirifer, both internally and externally. Shell structure punctate throughout except in the central, vertically striated region of the cardinal area. The external surface covered with a minute, textile-like ornamentation except upon the central region of the cardinal area.*


**DESCRIPTION OF SPECIES**

A few recent terms describing brachiopod morphology are employed in the descriptions of new species. Reference is made at the first use of the term to the publication in which the definition of the term is given. Throughout the descriptions three terms describing the sizes of the brachiopods are used: small specimens are those whose diameter varies from 1 mm. to 25 mm; medium specimens from 25-40 mm.; and large specimens 40 mm. or more. The number of lateral plicae always refers to the number of plicae on one lateral slope excluding the plica that bounds the sinus.

New species and varieties have not been given names. It seems advisable to wait until the new species may be checked against the type specimens of related specimens before applying specific names.

All species described in this paper are preserved in the Museum of Paleontology of the State University.
Genus ATRYPA Dalman

For generic description see page 27

ATRYPHA sp. undet.

Plate I, Figs. 1-3.

Species known from several complete specimens.

DESCRIPTION: Shell small; pseudoresupinate; fold and sinus present; postero-lateral margins straight, subparallel; anterior margin deeply rounded; hinge line very short. Dimensions of average sized specimen, length of pedicle valve 20 mm.; length of brachial valve 18.5 mm.; greatest width of shell 20 mm.; thickness of complete specimen 11 mm.; length of hinge line 6 mm.

Pedicle valve subplano-convex; greatest convexity in umbonal region. Umbo moderately prominent curving rapidly to cardinal margin; sloping gently to postero-lateral margins; beak obtusely pointed, projecting slightly beyond hinge line. Mesial sinus present anteriorly; shallow, ill defined; arising approximately 5 mm. from anterior margin. Cardinal area concealed, but small.

Brachial valve more convex than the pedicle valve; greatest convexity in middle of valve; profile of valve semicircular along midline from beak to anterior margin. Umbo essentially absent; beak small inconspicuous; extending posteriorly only to hinge line. Mesial fold present; not defined posteriorly; arises approximately 7 mm. from anterior margin.

Fifteen to 16 plicae on each valve; strong, rounded; four plicae on fold; three on sinus, originate by bifurcation of one plicae near beaks; remaining plicae bifurcate close to beaks, or occasionally at midlength;
thence continuing without division to anterior margin. Plicae crossed at irregular intervals, 2 mm. plus or minus, by strong concentric raised ridges that form small, rounded nodes at the point where they cross plicae.

REMARKS:— Only one species of the genus, Atrypa infrequens has been reported from the Mississippian. Weller described the form as a rare member of the Kinderhook fauna. The species here described does not agree with Weller's description, and has not been identified because the genus Atrypa is typically a Devonian form. It is possible that the Madison species represents a new occurrence of a known, long ranged Devonian form.

Locality and Formation: Locality 21, zone 2; and loose. Basin Butte, north of Dahaner Creek, Powell County, Montana. Madison limestone; Rooney chert member.

Genus BRACHYTHYRIS McCoy

For generic description see page 23

Brachythyrhis n. sp. 1

Plate I, Figs. 4, 5.

Species known from several pedicle valves.

DESCRIPTION: Pedicle valve small; fold and sinus present; cardinal extremities rounded; hinge line less than greatest width. Dimensions, length of pedicle valve 12 mm.; width 12 mm.; thickness 4 mm.

Pedicle valve strongly convex; greatest convexity in anterior portion of umbo; surface sloping uniformly from umbonal region to point on posterior margin. Beak sharply pointed, curved over cardinal area but
not projected beyond hinge line. Cardinal area rounded into postero-lateral
top of valve; not sharply defined. Delthyrium not observed. Mesial
sinus sharply defined to beak; angular in cross section; bounded by strong
angular plications.

Five lateral plicae on each slope; originate at beak; do not bifurcate;
plicae bounding sinus bifurcate; give rise to first lateral plicae on
slope; sinus bears single fine median plica, weaker than lateral plicae.
Remarks:- The generic position of this shell is difficult to determine.
The form is close to the genus *Spirifer* as characterized by the species
*S. bifurcatus* Hall and might be considered as a variety of that species.
The genus *Brachythyris* was described to include those spiriferoid shells
characterized by a hinge line less than the greatest width of the shell,
broad rounded plications, rounded cardinal extremities and generally with
a broad, nonplicate fold and sinus. The species here described appears
to fit this description except for the nature of the plicae which are
angular and sharply defined and thus agree closely with those of *S. bi-
furcatus*. In view of the fact that *S. bifurcatus* exhibits a variation
in the nature of the cardinal extremities from rounded to subrectangular
which would place it in the genus *Brachythyris*; the writer believes it
advisable to place the new species in the genus *Brachythyris* rather than
in the genus *Spirifer*.

*Brachythyris n. sp. 1* may be distinguished from other species of the
genus by the fine, single median plica of the sinus, the bifurcating
bounding plicae of the sinus, and in the angularity of the lateral plicae.
Locality and Formation: Locality 7, zone 2. On Yakinikak Creek, in the NE 1/4 sec. 30; T. 57 N.; R. 22 W., 20 feet above the contact of the Yakinikak limestone and quartzites of Kintla age. Flathead County, Montana. Yakinikak limestone. (Broadwater)

Brachythyria n. sp. 2
Plate I; Figs. 6, 7.
Species known from several pedicle valves.

DESCRIPTION: Pedicle valve small; fold and sinus present; cardinal extremities rounded; hinge line less than the greatest width of valve. Dimensions, length of pedicle valve 17 mm.; width 16 mm.; thickness 4 mm.

Pedicle valve depressed convex; greatest convexity opposite mid-length; umbonal region not strongly differentiated from general curvature of valve; surface curving rapidly from umbo to cardinal margin. Beak pointed; tip incurved but not protuberant beyond hinge line. Cardinal area apsacline; delthyrium higher than wide; extending to beak. Sinus sharply defined to beak.

Six lateral plicae on each slope; first lateral plica originates from plica bounding sinus by bifurcation in umbonal region; sinus bears strong median plica that originates at beak; two weaker plicae on lateral slopes of sinus derived from inner side of bounding plicae. Concentric markings absent.

REMARKS: This species is characterized by the strong plicae, rounded cardinal extremities, and the presence of three plicae in the sinus. The closest allied species is *Brachythyris n. sp. 1*, from which it differs in having three plicae instead of a single median one.

Locality and Formations: Locality 7, zone 2, on Yakinikak Creek, in the NE. ¼ sec. 30; T. 37 N., R. 22 W., 20 feet above the contact of the Yakinikak limestone and quartzites of Kintla age. Flathead County, Montana. Yakinikak limestone. (Broadwater)

*Brachythyris n. sp. 3*

Plate I, Figs. 8, 9.

Species known from a single pedicle valve.

DESCRIPTION: Specimen small; fold and sinus present; cardinal extremities rounded; hinge line less than greatest width of shell. Dimensions, length of pedicle valve 21 mm.; width 20 mm.; thickness 8 mm.

Pedicle valve strongly convex; greatest depth approximately in middle; umbonal region high and prominent; surface curving rapidly from umbo to cardinal margin. Beak pointed; tip incurved but not projecting beyond hinge line. Cardinal area well defined along cardinal margin; 3.5 mm. in height; apsacline.

Delthyrium equilateral in outline, extending to beak. Sinus poorly defined at beak; shallow throughout.

Eleven discernable lateral plicae on each slope; but on cardinal extremities additional plicae may have existed; plicae broad, flattened, separated by narrow, fine furrows. Sinus bears nonbifurcating median plica; lateral slopes of sinus each bear single plica of equal strength.
to median one; bounding plicae slightly stronger than lateral ones. Concentric growth lines of varying strength present.

REMARKS: This species is closely related to *Brachythryris choctauensis* Weller, but may be distinguished from that species by the greater prominence of the umbo; the larger number of plicae on the lateral slopes; the presence of three plicae in the sinus in place of four; and the smaller size. The median plica in the sinus is not derived from the bounding plicae as in *B. choctauensis* but originates at the beak.

Locality and Formation: Locality 17, Rattler Gulch, west of Drummond, Granite County, Montana. Madison limestone, Rooney chert ? member.

Genus *Camarotoechia* Hall and Clarke

For generic description see page 29

*Camarotoechia n. sp. 1*

Plate I, Figs. 10-14.

Species known from three incomplete specimens that show portions of both valves.

DESCRIPTION: Shell small; fold and sinus present; hinge line very short; rostral angle less than 90°. Dimensions, length of pedicle valve 9 mm.; length of brachial valve 6 mm.; greatest width of specimen 8 mm.; thickness 4 mm.

Pedicle valve moderately convex; greatest convexity in middle; umbonal region not differentiated from general curvature of valve. Surface curving abruptly to posterior lateral margins; inflected approximately at 90° to plane of valve. Beak pointed, slightly incurved over beak of opposite valve. Cardinal area concealed by beak of brachial valve;
dalthyrium not observable. Mesial sinus not defined at beak; may originate anterior to middle; recognizable at midlength, at which point it widens rapidly.

Brachial and pedicle valves subequally convex. Umbonal region not developed. Beak small, pointed; incurved beneath that of pedicle valve; projecting slightly beyond hinge line. Cardinal area absent. Mesial fold scarcely differentiated from surface of valve; fold develops and widens in manner similar to sinus of pedicle valve; more strongly marked by furrows at point of widening.

Five to six lateral plicae on each slope of pedicle valve and seven on each lateral slope of brachial valve; plicae rounded; become stronger and more prominent after passing midlength of shell.

REMARKS: This species is most similar to C. herrickana Girty, the only other species of Camarotoechia which is characterized by two plicae in the sinus. It is distinguished from C. herrickana by the rostral angle. The angle formed by the postero-lateral slopes of C. herrickana is approximately 120° while that of the above described species is less than 90°.

Locality and Formation: Locality 33-3, Big Saddle, on knob at elevation of 7750 feet, northeast of large saddle separating East Pryor Mt. from its northeast spur, in the SW ¼ sec. 25; T. 7 S.; R. 26 E., Pryor Mt. division, Custer National Forest, Carbon County, Montana. Madison limestone, basal 50 feet.
Camarotoechia n. sp. 2
Plate I, Figs. 15-17.

Species known from several pedicle valves.

DESCRIPTION: Shell small; fold and sinus very slightly developed; rostral angle less than 90°. Dimensions, length of pedicle valve 7 mm.; width 6 mm.; thickness 3 mm.

Pedicle valve convex, greatest convexity in umbonal region; umbonal region prominent and elevated above and separated from general curvature of valve by strong concentric ridge 3 mm. from beak, giving to umbo appearance of Cap on valve. Beak pointed; slightly incurved. Cardinal area not observed. Mesial sinus not present but flattened area extends longitudinally along median line of valve, in part gently depressed below surface of valve.

Brachial valve convex; greatest convexity at anterior of umbonal region; umbo prominent, set off by concentric ridge similar to that of pedicle valve but less pronounced; surface of umbonal region flat, making an angle of approximately 120° with anterior slope of valve. Beak small, pointed; extending only to hinge line. Cardinal area absent. Mesial fold differentiated from surface of valve by two furrows stronger than those separating lateral plisae.

Total of ten lateral plisae on pedicle valve; all originate close to beak; plisae strongly marked anteriorly to ridge which sets off umbo from rest of valve; continue without bifurcation to anterior margin. Brachial valve carries 12 lateral plisae similar to those of opposite valve; concentric markings consist of few indistinct growth lines immediately anterior to umbonal ridge.
REMARKS: This group of peculiarly "sapped" brachiopods was submitted to Dr. Carey Cronis, Walker Museum, University of Chicago for comment. Dr. Cronis placed the forms in the genus Camarotoechia and said in regard to the specific identification, 16

"I am not at all certain in regard to the specific determination but some of the individuals resemble some specimens of C. Choteauensis Weller which we have in our collections. They also resemble some of our specimens of C. mutata Hall. I think that you would be safe for the time being in describing them as belonging to a new species."

The writer thinks that the peculiarly sapped umbonal region is a character of specific importance and therefore has described the form as a new species. It differs from C. choteauensis and C. mutata in having a rostral angle less than 90° instead of a wider angle. From C. mutata it may be separated by the rounded anterior margin, as opposed to the truncate margin of C. mutata.

Locality and Formation: Locality 33-3, Big Saddle, on knob at elevation of 7750 feet, northeast of large saddle separating East Pryor M't. from its northeast spur, in the SW 1/4 sec. 25; T. 7 S., R. 27 E., Pryor M't. division, Custer National Forest, Carbon County, Montana. Madison limestone, basal 50 feet.

Camarotoechia n. sp. 3
Plate I, Figs. 18, 19.

Species known from a single pedicle valve.

DESCRIPTION: Pedicle valve small; fold and sinus present; hinge line very short; rostral angle 70°. Dimensions, length of pedicle valve 13-14 mm.; width 8-9 mm.; thickness 4 mm.

16 Personal communication.
Pedicle valve convex, arched in semicircle from beak to anterior margin along median line, greatest convexity at midlength; umbonal region prominent; sloping rapidly to postero-lateral margins and curving steeply to hinge line. Beak pointed sharply; tip slightly incurved. Cardinal area not observed. Sinus originating at beak; poorly defined posteriorly; stronger anterior to midlength.

Total of 10 lateral plicae; originate at beak; bifurcate close to beak. Sinus bears four distinct plicae in bottom; originate at beak; derived from single plica; lateral slopes of sinus carry one indistinct plica derived from inner side of plicae that bound sinus.

REMARKS: The species is characterized by smaller rostral angle and relatively larger size than is possessed by any other Mississippian members of the genus. Camarotoechia subglobosa Weller is similar to Camarotoechia n sp. 3 although it differs in possessing a smaller rostral angle; a more elongate form; and a more sharply defined sinus.

Locality and Formation: Locality, 33-3, Rig Saddle, on knob at elevation of 1750 feet, north of large saddle separating East Pryor Mt. from its northeast spur, in the SW. 1/4, sec. 25; T. 7 S., R. 27 E. Pryor Mt. division, Custer Nat. Forest, Carbon County Montana. Madison limestone, basal 50 feet.

Genus COMPOSITA Brown.

For generic description see page 31

**Composita n. sp. 1**

Plate I, Figs. 20-24.

Species known from several pedicle valves and a few doubtful brachial valves.
DESCRIPTION: Pedicle valve small; without sinus; hinge-line short; rostral angle 100°. Dimensions, length of pedicle valve 12 mm.; width 14 mm.; thickness 4 mm.

Pedicle valve moderately convex; greatest convexity in middle; surface describing semi-circle from beak to anterior margin along median line; surface curving abruptly to posterior lateral margins; inflected in smooth curve to edges of delthyrium, forming poorly defined cardinal area. Umbonal region not differentiated from general curvature of valve; beak obtusely pointed; perforated at apex by pedicle foramen. Foramen joined to delthyrium at its apex. Delthyrium broadly triangular, presence of delthyrial covering not observed.

Shell smooth, without external ornamentation except concentric growth lines which become stronger near anterior margin.

REMARKS: This species has been placed in the genus Composita because of the smoothness of the shell in the anterior portion, the lack of strong lamellar banding which is characteristic of the allied genus Athyris, and the absence of imbricating, flat spines of the genus Cliothyridina to which it bears a strong resemblance. From other species of the genus Composita, C. n. sp. I may be distinguished by its lack of fold and sinus.

Locality and Formation: Locality 55-2, Big Saddle, on knob at elevation of 7750 feet, northeast of large saddle separating East Pryor Mt. from its northeast spur, in the SW. 1/4 sec. 25; T. 7 S., R. 27 E. Pryor Mt. division, Custer National Forest, Carbon County, Montana. Madison limestone, basal 50 feet.
Species known from three pedicle valves.

DESCRIPTION: Pedicle valve small; without sinus; hinge-line very little shorter than greatest width of valve; rostral angle approximately 130°. Dimensions, length of pedicle valve 9 mm.; width 8-9 mm.; thickness 4 mm.

Pedicle valve strongly convex; greatest convexity at midlength.

Umbonal region prominent, strongly elevated; surface curves abruptly to hinge-line, but less so to postero-lateral margins; slightly compressed to form small auricular expansions. Beak rather sharply pointed, perforated by pedicle foramen. Cardinal area poorly defined; rounded into lateral slopes of valve; delthyrium present but concealed by beak.

Shell smooth except for few, fine, concentric growth lines.

REMARKS: This species is closely allied to *Composita n. sp. 1* by reason of the absence of the fold and sinus. It differs from that species in the large rostral angle; the hishor, tumid, more prominent umbonal region; and in the small compressed auricular extensions of the pedicle valve.

Locality and Formation: Locality 33-3, Big Saddle, on knob at elevation of 7750 feet, northeast of large saddle separating East Pryor Mt. from its northeast spur, in the SW. ¼ sec. 25; T. 7 S.; R. 27 E. Pryor Mt. division, Custer National Forest, Carbon County, Montana. Madison limestone, basal 50 feet.
**Composita n. sp. 3**

Plate I, Figs. 27-29.

Species known from three pedicle valves.

**DESCRIPTION:** Pedicle valve small; without sinus; hinge line short; rostral angle 90°. Dimensions, length of pedicle valve 13 mm.; width 10 mm.; thickness 4.5 mm.

Pedicle valve convex in posterior portion of valve; surface curving abruptly to hinge line and to cardinal extremities, but gently to anterior margin. Umbonal region strongly arched; prominent; beak incurved moderately; perforated by a foramen. Cardinal area and dalthyrium not observed.

Shell smooth; marked by clearly defined concentric growth lines; disposed at 1 mm. intervals from beak to anterior margin.

**REMARKS:** This species is characterized by the lack of a mesial sinus. It differs from the nonsinuate species of this genus which are described in this paper, by reason of the small rostral angle; the high, tumid, umbonal region; and elongate shape.

Locality and Formation: Locality 33-3, Big Saddle, on knob at elevation of 7750 feet, northeast of large saddle separating East Pryor Mt. from its northeast spur, in the SW. 1/4 sec. 25; T. 7 S., R. 27 E. Pryor division, Custer National Forest, Carbon County, Montana. Madison limestone, basal 50 feet.

**Composita n. sp. 4**

Plate I, Figs. 30-32.

Species known from two pedicle valves.

**DESCRIPTION:** Pedicle valve small; without sinus; hinge-line short; rostral
angle 75-80°. Dimensions, length of pedicle valve 12 mm.; width 10 mm.; thickness 4 mm.

Pedicle valve flatly convex; surface of valve curving abruptly to cardinal margins; gently to anterior margin. Umbonal region narrow; strongly convex; standing well above curvature of valve; extended posteriorly approximately one-third length of specimen. Beak sharply pointed, incurved; perforated by small foramen. Cardinal area not defined; rather rounded region lying beneath beak; delthyrium joining foramen.

Shell smooth except for fine concentric growth lines.

REMARKS: Species is characterized by lack of a sinus, in which character it closely resembles the other species of the genus described in this paper. The most similar species is Composita lewisensis Weller from which it is easily distinguished by the lack of sinus in the pedicle valve. It may be distinguished from the nonsinuate forms by the narrow, extended, pointed umbonal region.

Locality and Formation: Locality 33-3, Big Saddle, on knob at elevation of 7750 feet, northeast of large saddle separating East Pryor Mt. from its northeast spur, in the SW. 1/4 sec. 25; T. 7 S., R. 27 E.; Pryor Mt. division, Custer National Forest, Carbon County, Montana. Madison limestone, basal 50 feet.

Genus DIELASMA King.

For generic description see page 32

Dielasma n. sp. 1

Plate I, Figs. 1, 2.

Species known from single pedicle valve.
DESCRIPTION: Specimen of medium size; sinus slight; outline pentagonal; greatest width of shell anterior to middle; rostral angle approximately 45°. Dimensions, length of pedicle valve 30 mm.; width 19–20 mm.; thickness 8 mm.

Pedicle valve moderately convex; middle third of surface essentially parallel to plane of valve; sloping anteriorly and posteriorly at equal angles from flattened area; curving abruptly to posterior lateral margins; inflected so as to lie at acute angle to plane of valve. Umbonal region not differentiated from posterior portion of valve; beak bluntly pointed; incurved. Mesial sinus present only in extreme anterior portion of valve; originates at point where rapid curvature to anterior margin begins.

Shell smooth except for strong concentric growth lines which extend from beak around shell to anterior margin. Entire shell finely punctate.

REMARKS: *Dielasma n. sp. 1* is closely allied to *Dielasma arkansanum* Weller, from which it differs in the subgeniculate bend near the anterior margin. *Dielasma n. sp. 1* also has a more distinctly pentagonal outline; and more angularly inflected posterior lateral margins. The sinus of *D. arkansanum* originates much higher on the slope of the valve than the sinus of the new species.

Locality and Formation: Locality 33-6, Wells Pasture, south rim of Dryhead canyon, 50 feet below Forest Service triangulation cairn, lying in sec. 23; T. 7 S., R. 27 E. Pryor Mt. Division, Custer National Forest, Carbon County, Montana. Madison limestone, upper 100 feet.
Genus ECHINOCHONCHUS Weller

For generic description see page 34

Echinochonchus n. sp. 1.

Plate II, Fig. 3.

Species known from a single specimen.

DESCRIPTION: Specimen of medium size; without sinus; cardinal extremities rounded; hinge-line long; width greater than length. Dimensions, length of pedicle valve 28-30 mm.; width 40 mm.; thickness approximately 10 mm.

Pedicle valve strongly convex; greatest convexity in posterior portion. Umbo prominent; extending beyond hinge-line; beak pointed; strongly incurved over hinge line. Surface strongly curved to cardinal margins from umbonal region; sloping less strongly to postero-lateral areas which are strongly compressed, and distinctly differentiated from general surface of valve. Sinus absent.

Shell marked by strong concentric bands; separated 1 mm. on umbo; 2.5 mm. on anterior portion; bands of uniform strength; 1 mm. in width; angular in cross section; steepest slope directed anteriorly. Spines originate as fine radial costae on posterior slopes of concentric bands; develop into round spines at crest of bands; not continuing down anterior slope; radial ornamentation gives appearance of continuous ribbing.

REMARKS: This species resembles Echinochonchus genevievensis Weller but differs in the lack of the mesial sinus, and in the large compressed auricular extensions of the valves. The extensions are strongly differentiated from the convexity of the valve, and are broadly extended. This feature clearly distinguishes Echinochonchus n. sp. 1 from all previously described species of the genus.
Locality and Formation: Locality 21, zone 2. Basin Butte, north of Danaher Creek, Powell County, Montana. Madison Limestone, Dean Lake chert member.

Echinochonechus n. sp. 3
Plate II, Figs. 4, 5.

Species known from single pedicle valve.

DESCRIPTION: Specimen large; without sinus; hinge line long; width and length subequal. Dimensions, length of pedicle valve 45 mm.; width 50-55 mm.; thickness 25 mm.

Pedicle valve strongly tumid; greatest convexity at midlength. Umbo large, prominent; protruding beyond hinge line; beak pointed, strongly incurved, apparently twisted to left. Surface of valve curving strongly to all margins from midline, but more strongly to postero-lateral than to anterior margin. Cardinal extremities rounded; slightly compressed. Mesial sinus absent; slight mesial depression exists along the median line near point of maximum curvature of valve; not extended to beak or to anterior margin.

Ornamentation consists of closely crowded concentric bands of varying strength; crossed by fine anastomosing radial lines which tend to develop into fine spines at point where the lines cross concentric bands.

REMARKS: This form closely approaches an unnamed, undescribed, but figured specimen by Weller. Echinochonechus n. sp. 2 differs from that form in having the width greater than the length; cardinal extremities

rounded in place of obtusely angular; and in the subgeniculate angle of the pedicle valve.

Locality and Formation: Along roadway at diversion dam, North Fork Sun River Canyon, Lewis and Clark County, Montana. Madison limestones, undifferentiated.

**Genus Girtyella Weller**

For generic description see page 35

**Girtyella n. sp. 1**

Plate II, Figs. 6-10.

Species known from a single, complete individual.

**DESCRIPTION:** Specimen small; sinus present; hinge line short; shell longer than wide; subcircular in cross section; rostral angle 70°. Dimensions, length of pedicle valve 11 mm.; length of brachial valve 10 mm.; width of specimen 9 mm.; thickness of complete specimen 9 mm.

Pedicle valve strongly convex; greatest convexity in middle; curvature of surface describing semi-circle from beak to anterior margin along median line. Umbo prominent; surface inflected along postero-lateral margins adjacent to umbonal region so as to lie at right angles to plane of valve; beak sharply pointed; incurved over beak of brachial valve; foramen not observed though probably present. Mesial sinus originates in umbonal region; poorly defined laterally; deeper anteriorly; rounded in cross section.

Brachial valve subequally convex to pedicle valve; greatest convexity in middle; umbo prominent, curving rapidly to postero-lateral margins which are inflected at right angles to plane of valve; mid-portion of valve
flattened parallel to commissure, then sloping gently to anterior margin.
Beak pointed; incurved beneath beak of pedicle valve. Mesial fold absent;
fold replaced by alight median sinus bounded by two low ridges which extend
posteriorly one-third length of valve; sinus and adjacent fold produce
triptite condition reflected in anterior commissure; bounding ridges of
sinus in turn bordered by extremely illy defined, shallow, short sinusities
of shell; extended less posteriorly than ridges.

Shell smooth throughout; finely punctate, which condition not found
in any other described member of genus.

REMARKS: This species is closely allied to Girtyella turgida (Hall) but
differs in the character of the brachial valve. G. turgida has a low
median fold in the brachial valve, the fold situated in a broad, illy de­
defined sinus. Girtyella n. sp. 1 has an opposite character, a small low
 sinus in the brachial valve bordered by two low ridges.

Locality and Formation: Locality 7, zone 2. On Yakinikak Creek, in the
NE. $\frac{1}{4}$ sec. 30; T. 37 N., R. 22 W. 20 feet above the contact of Yakinikak
 limestone with quartzites of Kintla ? age, Flathead County, Montana.
Yakinikak limestone. (Broadwater).

Genus SPIRIFER Sowerby.

For generic description see page 56

Spirifer calvini n. var. 1

Plate II, Figs. 11, 12.

Variety known from a single incomplete pedicle valve.

DESCRIPTION: Specimen medium; fold and sinus present; hinge line apparent­
ly equaling greatest width of valve. Dimensions, length of pedicle valve
25 mm.; width 40 mm.; thickness 15 mm.

**REMARKS:** *Spirifer salvini* Weller is characterized by the elevated, high cardinal area, and the greatly flattened plicae of the fold and sinus. *Spirifer salvini* var. 1 is closely related to *S. salvini* in the first two characters. However, the plications of the new variety are more rounded and not flattened, and are also more numerous in the sinus. The striking feature of the variety is the wide cardinal area, and the thick shell material. Because the variety has the wide cardinal area, and general contour of *S. salvini* it has not been described as a new species.

**Locality and Formation:** Locality 13 west side of Monitor Mt., east of the Continental Divide between the Dearborn River and the South Fork of Falls Creek, in the Coopers Lake quadrangle, Montana. Madison limestone.

*Spirifer salvini* var. 2

Plate II, Figs. 13-15

Variety known from a single pedicle valve.

**DESCRIPTION:** Valve approximately medium in size; fold and sinus present; hinge line equalling greatest width of shell. Dimensions, length of pedicle valve 30 mm.; width 40 mm.; thickness 12 mm.

**REMARKS:** Because of the high cardinal area, the general shell shape and the nature of the delthyrium, this variety has been referred to the species *Spirifer salvini* Weller. It differs from that species in the more angular plicae, and in the very sharply defined mesial sinus. *Spirifer salvini* n. var. 2 differs from *S. salvini* n. var. 1 in the thinner shell material, the larger delthyrium, and the more sharply defined sinus.
Locality and Formation: Locality 32-8, east of the head of Ruby Creek, elevation 8600 feet, lying in the SW. ¼ sec. 35; T. 7 S.; R. 26 E.
Pryor Mt. division, Custer National Forest, Carbon County, Montana. Madison limestone, middle portion.

**Spirifer centronatus Winchell**

Plate III, Figs. 1, 2.

Figure 1 illustrates a large brachial valve which agrees in shape, number of plicae, presence of fine radiating striae, and in the ratio of width to length, with *Spirifer centronatus* Winchell. The striking character is the larger size, the dimensions being twice those given as average for the species.


Figure 2 illustrates a second example of the large size attained by *S. centronatus*, and is characterized further by the larger number of plicae than Girty [13] gives as specific variation for the species. This form may prove to be a new species, but the specimen at hand is not well enough preserved to warrant description.


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**Spirifer increbescens n. var. 1**

Plate II, Figs. 16-18.

Variety known from single pedicle valve.

REMARKS: This form agrees very closely with the form described by Weller as *Spirifer increbescens*. The striking difference is the complete lack of either radial or concentric striae on the plications. Because of this difference it has been designated a new variety.


**Spirifer forbesi n. var. 1.**

Plate III, Fig. 8.

Variety known from two pedicle valves.

REMARKS: This variety differs from *Spirifer forbesi* Norwood and Pratten as described by Weller in the following respects; 1, more transverse along the hinge line; 2, lack of subimbricating concentric growth lines; and 3, narrow cardinal area of pedicle valve.


**Spirifer forbesi var. 2.**

Plate III, Fig. 9.

Variety known from single pedicle valve.

REMARKS: This variety is characterized by the greatly elevated umbonal region, and the generally tumid character of the valve. The examples of the species
figured by Weller have a low umbonal region with the beak only slightly elevated. In other characters this variety agrees closely with *Spirifer forbesi* Norwood and Pratten.

Locality and Formation: Locality 32–2, East of head of Ruby Creek, elevation 8500 feet, lying in the SW. ¼ sec. 35; T. 7 S., R. 26 E., Pryor Mts. division, Custer National Forest, Carbon County, Montana. Madison limestone.

*Spirifer missouriensis* Swallow

Plate III, Fig. 7.

Species known from several pedicle valves.

REMARKS: The specimen figured on Plate III was also figured in the unpublished thesis of R. C. Rowe as the holotype of a new species, *Spirifer fissilplicatus*. Rowe distinguished this specimen from *S. missouriensis* by the greater number of lateral plicae. Rowe cites 24 plicae as compared to 20 for Swallow's form. In a form noted for numerous bifurcations of the plicae this discrepancy does not appear significant to the writer. Rowe also uses the character of the cardinal extremities to distinguish between the two species. Inasmuch as the cardinal extremities of the figured specimen are damaged this character becomes useless. For these reasons the author has referred the form to the previously described species *S. missouriensis*.

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20 R. C. Rowe, "Description and correlative evidence of the brachiopoda and other faunal members of the Montana Madison limestone," Unpub. thesis, University of Montana. 1927.
Locality and Formation: Dupuyer Creek, Pondera County, Montana, Madison limestone.

**Spirifer n. sp. 1**

Plate IV, Figs. 1-3

Species known from a single pedicle valve.

DESCRIPTION: Pedicle valve medium sized; outline subquadrate; fold and sinus present; hinge line equal to greatest width; cardinal extremities acutely angular. Dimensions, length of pedicle valve 25 mm.; width approximately 34 mm.; thickness 9 mm.

Pedicle valve moderately convex; greatest convexity opposite mid-length; umbonal region prominent, elevated above cardinal margin; beak pointed, incurved slightly over wide cardinal area; area orthocline; lateral margins sharply defined, curving rapidly from beak to point two-thirds from beak to cardinal extremities, from which point they continue essentially parallel to hinge line until extremities of valve are reached. Delthyrium large; broader than high. Surface of valve describing semicircle from beak to anterior margin along median line; curving rapidly from umbonal region to lateral margins of cardinal area; gently to posterolateral margins.

Nine to ten lateral plicae on each slope; plicae distinctly rounded; not bifurcated; extend to beak; furrows narrower than plicae; median plica of sinus does not bifurcate, originates near beak; lateral slopes of sinus bear one or two plicae of equal strength to median one.

REMARKS: This species belongs to a small group of Mississippian spirifers that is characterized by the wide or high cardinal area. **Spirifer n. sp. 1**
resembles Spirifer legrandensis Weller and Spirifer calvini n. var. 1 in this feature. However both the latter species have apsacline areas while Spirifer n. sp. 1 has an orthocline area, thus clearly distinguishing it from the other two.

Locality and Formation: Locality 17, Rattler Gulch, 5 miles west of Drummond, Granite County, Montana. Fossils were collected from the upper portion of the formation at a point two miles from the mouth of Rattler Gulch. Madison limestone, Rooney chert 7 member.

Spirifer n. sp. 2
Plate IV, Figs. 4, 5.

Species known from a single pedicle valve.

DESCRIPTION: Specimen of medium size; outline triangular; fold and sinus present; hinge line equalling greatest width; cardinal extremities acutely angular. Dimensions, length of pedicle valve 25 mm; width 25 mm; thickness 10 mm.

Pedicle valve moderately convex, greatest convexity in umbonal region; umbo prominent, protruberant beyond hinge line. Surface of valve curved abruptly from umbo to lateral margins of cardinal area, and to point half way to cardinal extremities. Cardinal extremities compressed. Beak pointed, sharply incurved over cardinal area; cardinal area not observed. Sinus sharply defined throughout length, V shaped in cross section at beak; bottom flatter and wider anteriorly.

Sixteen or 17 lateral plicae on each slope; plicae distinctly angular; two plicae bifurcate; first lateral plica derived from one bounding sinus, at point 2 mm. from beak; third lateral plica bifurcates at point approximate-
ly one-half distance from beak to anterior margin; stronger plicae bound sinus; strong median plica in sinus bifurcates at midlength; originates at beak; lateral slopes of sinus bear weaker plicae derived from inner side of plicae that bound sinus. Concentric ornamentation never developed or removed by exfoliation.

REMARKS: The most similar species is *Spirifer washingtonensis* Weller, from which *Spirifer n. sp. 2* may be distinguished by the sharply defined sinus, the bifurcate median plica of the sinus and the more acuminate cardinal extremities. The plicae of *Spirifer n. sp. 2* are more angular and finer.

Locality and Formation: Locality 17, Rattler Gulch, five miles west of Drummond, Granite County, Montana. Fossils were collected from the upper part of the formation at a point two miles from the mouth of the gulch. Madison limestone, Rooney chert ? member.

**Spirifer n. sp. 3**

Plate IV, Figs. 6, 7.

Species known from two pedicle valves.

DESCRIPTION: Specimen small; outline transversely triangular; fold and sinus present; hinge line equals greatest width; cardinal extremities compressed; acutely angular. Dimensions, length of pedicle valve 15 mm.; width 30 mm.; thickness 5 mm.

Pedicle valve moderately convex, greatest convexity in umbonal region; umbo prominent, extends beyond lateral margin of cardinal area; beak sharply pointed; strongly incurved. Cardinal area narrow, well defined; epipside; delthyrium small, higher than wide. Surface of valve curving abruptly from umbo to lateral margins of cardinal area, gently to postero-lateral and
anterior margins. Sinus sharply defined at beak; broader and shallower
anteriorly where it is scarcely depressed below surface of valve.

Nine lateral plicae that do not bifurcate, except first lateral plica
derived from outer side of plica bounding sinus at point close to beak.
Plicae subangular to rounded in cross section; separated by narrower furrows. Sinus bears strong median plica which extends from beak to anterior margin; lateral slopes of sinus bear one weaker plica derived from inner side of plica bounding sinus; at point near anterior portion of umbonal region; plicae bounding sinus stronger than lateral ones; concentric markings absent.

REMARKS: This species is closely allied to *Spirifer biplicoides* Weller, but may be distinguished from it by the more strongly developed umbo, the strong median plica that extends to beak; the less rounded nature of the plicae that bound the sinus, and by the lack of micronate cardinal extremities.

Locality and Formation: Locality 17, Rattler Gulch, five miles west of Drummond, Granite County, Montana. Fossils were collected from upper part of formation at a point two miles from mouth of gulch. Madison limestone, Rooney chert 7 member.

*Spirifer n. sp. 4.*

Plate IV, Figs. 8, 9.

Species known from a single pedicle valve.

DESCRIPTION: Specimen poorly preserved; medium sized; outline transversely triangular; fold and sinus present; hinge line probably equalling greatest width of shell. Dimensions, length of pedicle valve 20 mm.; width 35–40 mm.;
Pedicle valve very slightly convex; greatest convexity in umbonal region; surface of valve sloping rapidly from umbonal region to lateral margins of cardinal area; extended essentially without curve to postero-lateral and anterior margins. Umbo not differentiated from surface of valve; beak pointed; incurved slightly over cardinal area. Cardinal area 5 mm. in height, orthocline; vertically striated; lateral margins sharply defined; delthyrium higher than wide, medium size. Sinus scarcely differentiated from surface of valve; widened anteriorly.

Fourteen lateral plicae on each slope; not bifurcated; extended to beak; plicae small, rounded; separated by narrower furrows. Sinus carries simple median plica originating at beak; lateral slopes of sinus bear weaker plicae derived from bounding plicae of sinus. Surface exfoliated so that any finer markings that have been present are destroyed.

REMARKS: Because the specimen is poorly preserved, the conclusion that it is a new specimen may be unwise. The fine plicae ally this form to Spirifer tenuimarginatus Hall, and to Spirifer tenuicostus Hall. Spirifer n. sp. 4 may be distinguished from the former by its lack of rounded extremities, and from the latter by its greater number of lateral plicae; 28-34 on Spirifer n. sp. 4 in place of 14.18 on Spirifer tenuicostus. Spirifer n. sp. 4 is characterized by the moderately high orthocline cardinal area, the fineness of plicae, and the flatly convex character of the pedicle valve.

Locality and Formation: Locality 17, Rattler Gulch, five miles west of Drummond, Granite County, Montana. Fossils collected from the upper part of the formation at a point two miles from mouth of gulch. Madison lime-
DESCRIPTION: Specimen small; outline broadly triangular; fold and sinus present; hinge line equalling greatest width of valve; cardinal extremities slightly compressed. Dimensions, length of pedicle valve 22 mm.; width 17 mm.; thickness 8 mm.

Pedicle valve strongly convex; greatest convexity at anterior portion of umbo; surface of valve curving abruptly from umbo to point one-half distance from beak to cardinal extremities, curving uniformly to anterior margin. Umbo projecting beyond cardinal area; beak pointed, incurved. Cardinal area small; apsacline; delthyrium small; higher than wide.

Thirteen lateral plicae, rounded and somewhat flattened; bifurcate close to beak; first lateral plica derived from outer margin of plica that bounds sinus; sinus bears single fine, nonbifurcate, median plica; lateral slopes of sinus bear two or three plicae derived by bifurcation from inner margins of plicae that bound sinus; plicae bounding sinus stronger than lateral plicae. Concentric markings absent.

REMARKS: This species is closely related to Spirifer vernonensis Swallow from which it differs in the finer median plica of the sinus, the more rotund transverse section, lesser length, and lack of lamellar concentric ornamentation.

Locality and Formation: Locality 13, west side of Monitor Mt., situated east of Continental Divide between the Dearborn River and the South Fork of Falls Creek; in Coopers Lake quadrangle, Montana. Madison limestone.
Spirifer sp. sp. 6.
Plate V, Figs. 1-3

Species known from one complete specimen.

DESCRIPTION: Specimen large; outline subquadrangular; fold and sinus present; hinge line equalling greatest width; cardinal extremities subrectangular with slight acuminate extension. Dimensions: length of pedicle valve 50-55 mm.; length of brachial valve not determinable; greatest width of specimen 92-96 mm.; thickness of complete specimen 50-53 mm.

Pedicle valve strongly convex; greatest convexity at midlength. Umbonal region strongly elevated; terminated posteriorly by lateral margin of cardinal area; surface of valve curving rather gently to postero-lateral and antero-lateral margins. Beak obtusely pointed; scarcely incurved. Cardinal area high, large; apsacline; horizontally striated; delthyrium large; higher than wide; closed by deltidium; extends from hinge line to beak.

Sinus broad shallow; rounding into lateral slopes of valve; apparently without plicae; deflected in anterior portion to form an extension. Crushed condition of shell does not permit of accurate description of sinus extension.

Brachial valve more strongly convex than pedicle; greatest convexity approximately at midlength; umbonal region not prominent; flattened; surface of valve curving gently to the cardinal extremities. Beak obtusely pointed. Cardinal area not observed. Mesial fold well defined by reason of elevation; semicircular in cross section; strongly elevated anteriorly.

Twenty, coarse, rounded, nonbifurcating plicae on each lateral slope; plicae 4 mm. from crest to crest; furrows shallow, narrower than plicae;
plicae originate near beak.

REMARKS: This species is closely allied to the form *Spirifer logani* Hall, from which it differs in having a cardinal area approximately twice the height of that of *S. logani*, and in having 20 plications instead of 30 on each lateral slope.

Locality and Formation: Locality 8, Pentagon Mt. situated approximately two miles north west of the Continental Divide, in the north-central part of the Lewis and Clark Range, in sec. 14; T. 25 N., R. 12 W. Fossils collected on southeast slope of mountain at elevation of 8600 feet. Madison limestone.

*Spirifer n. sp. 7.*

Plate IV, Figs. 12-14.

Species known from a single pedicle valve.

DESCRIPTION: Specimen of medium size; greatest convexity opposite midlength; outline transversely triangular; fold and sinus present; hinge line equal to greatest width. Dimensions, length of pedicle valve 19-20 mm.; width 30 mm.; thickness 11 mm.

Pedicle valve strongly convex; surface describing semi-circle from beak to anterior margin along median line. Umbo not differentiated from general surface of valve; surface sloping in straight line from beak to cardinal extremities. Beak pointed; incurved slightly; projecting beyond lateral margins of cardinal area. Cardinal area wide; triangular; apsacline; delthyrium large; higher than wide; 5 mm. in width. Sinus sharply defined from beak to anterior margin by strong subangular plicae; broadly V-shaped in cross section.
Fourteen lateral plicae on each slope; progressively smaller toward cardinal extremities; subangular in cross section; furrows separating plicae narrower; sinus bears nonbifurcating median plica; lateral slopes of sinus carry two faint plicae derived from inner side of plicae bounding sinus. Finer surface markings destroyed by exfoliation.

REMARKS: This species is characterized by the wide cardinal area; but is not close to the other species of *Spirifer* which exhibit this feature. The form may be distinguished from the other spirifers bearing a high cardinal area, by the very weak plicae in the sharply defined sinus.


*Spirifer n. sp.*

Plate IV, Figs. 15-18.

Species known from several well preserved, entire specimens and pedicle valves.

DESCRIPTION: Shell small to medium size; outline triangular; fold and sinus present; hinge line equal to greatest width of shell; cardinal extremities acutely angular, tending to become mucronate. Dimensions, length of pedicle valve 15 mm.; length of brachial valve 13 mm.; greatest width of specimen 30 mm.; thickness of complete specimen 10 mm.

Pedicle valve moderately convex; greatest convexity in umbonal region; surface sloping rapidly from umbonal region to cardinal margins and to postero-lateral margins. Umbo prominent; beak pointed, incurved. Cardinal
area narrow; lateral margins subparallel to hinge line; delthyrium not observed. Sinus broadly U-shaped; sharply defined; nonplicate; extending to beak; produced anteriorly as short extension beyond general curvature of anterior margin.

Brachial valve less convex than pedicle; greatest convexity near mid-length. Umbo low; beak small; pointed; only slightly incurved. Cardinal area narrow; lateral margins subparallel to hinge line. Fold rises at beak; well defined by furrows; becoming strongly elevated anteriorly; sub-rectangular in cross section; marked by incipient median furrow that originates anterior to middle of shell.

Twelve lateral plicae on each slope of valve; nonbifurcating, except for first lateral plica on each slope of pedicle valve, derived from the outer margin of bounding plica of sinus; plicae progressively smaller toward cardinal extremities. Brachial valve bears plicae similar in form and number to pedicle valve. Concentric ornamentation lacking.

REMARKS: This form is tentatively designated a new species. Its most striking character is the smooth nonplicate fold and sinus; but this character is found among the Devonian spirifers so that the condition is not unique to the genus. Until the Devonian forms of the genus may be checked by means of specific keys, the form is considered as a new Mississippian species.

Locality and Formation: Locality 21; zone 2. Basin Butte, north of Danaher Creek, Powell County, Montana. Madison limestone, Dean Lake chert member.

*Spirifer n. sp. 9.*

Plate VI, Figs. 2, 3.

Species known from single pedicle valve.
DESCRIPTION: Pedicle valve small; fold and sinus present; hinge line equaling greatest width; cardinal extremities angular. Dimensions, length of pedicle valve 15 mm.; width 25-27 mm.; thickness 6 mm.

Pedicle valve flatly convex; greatest convexity opposite hinge line; umbonal region not differentiated from surface of valve; surface sloping essentially in one plane from beak to anterior margin; surface sloping uniformly from beak to cardinal extremities, line of slope defined as a sharp ridge between lateral slopes of valve and upper surface of cardinal area. Beak obtusely pointed; very slightly incurved. Cardinal area high; sharply defined; apsaeoline; horizontally striate; delthyrium large; higher than wide; apex reaches beak. Sinus defined to beak; broad; shallow; flat in bottom anteriorly; margins diverge from beak at angle of 30°.

Eight or nine lateral plicae; nonbifurcating, rounded, originating at beak. Furrows separating plicae narrower; more sharply angular in bottom than tops of plicae. Sinus bears no radiating plicae; bottom in anterior portion shows a few fine striae; plicae bounding sinus equal in strength to those on lateral slopes.

REMARKS: This species is close to Spirifer legrandensis Weller but differs from that species by having 8-9 lateral plicae in place of 16-18. The nonplicate sinus is the most distinctive feature of the species but as has been stated previously, species of Spirifer exhibiting this character are known from the Devonian. Until a key of Devonian species of the genus is made and this form carefully studied it is described tentatively as a new species.
Locality and Formation: Locality 33-3, Big Saddle on knob at elevation of 7750 feet, northeast of large saddle separating East Pryor Mt. from its northeast spur, in the SW \( \frac{1}{4} \) sec. 25., T. 7 S., R. 27 E. Pryor Mt. division Custer National Forest, Carbon County, Montana. Madison limestone, basal 50 feet.

* Spirifer n. sp. 10 *

Plate VI, Figs. 1, 4.

Species known from a single pedicle valve.

**DESCRIPTION:** Valve large; outline broadly triangular; hinge line equal to greatest width; fold and sinus present; cardinal extremities acuminate; small. Dimensions, length of pedicle valve 75 mm.; width 135 mm.; thickness 25 mm.

Pedicle valve flatly convex; umbonal region prominent; extending posteriorly beyond hinge line a distance equal to height of cardinal area; surface of valve slopes at angle of 25° from beak to point two-thirds distance from median line to cardinal extremities; slope to anterior margin not pronounced in any distinct region. Beak pointed, incurved. Cardinal area 25 mm. in height; orthocline except immediately beneath beak where it becomes 10° apsacline; horizontally furrowed; cardinal extremities extended in short acuminate points; immediately anterior to extremities shallow sinuosity is present extending toward beak and terminating at point where slope from beak meets horizontal line made by lateral margin of cardinal area. Sinus extending to tip of beak; angular in cross section on umbonal region; broad and flat in bottom where sinus approaches anterior margin.
Lateral plicae exist, but exfoliated condition allows no definite observation of their character; appear relatively coarse and extended to beak; not bifurcated. Bottom of sinus in umbonal region marked by fine radiating striae. Prominent concentric growth lines show upon the mould of interior where shell material has been removed. Growth lines strong; deflected outward as they approach postero-lateral margins; following outline of acuminat cardinal extremities.

REMARKS: The form here described is the largest of all known Mississippian spirifers. The great size coupled with the extremely flatly convex character of the shell makes *Spirifer n. sp. 10* distinctive. *Spirifer logani* Hall approaches it most closely in size, but is a strongly tumid form, and does not exhibit acuminat cardinal extremities.


*Spirifer n. sp. 11*
Plate VI, Fig. 5

Species known from several pedicle valves.

DESCRIPTION: Specimen large; outline triangular; fold and sinus present; hinge line equal to greatest width of shell. Dimensions, length of pedicle valve approximately 60 mm.; width 90 mm.; thickness 15 mm.

Pedicle valve flatly convex; greatest convexity in umbonal region; surface of valve curving abruptly to cardinal margin, gently to postero-lateral margins. Cardinal extremities acutely angular; greatly compressed. Umbo prominent elevated well above general curvature of valve; beak pointed; tip incurved over cardinal area. Cardinal area moderately high; vertically
striated; orthoclone. Deltthyrium narrow and high; apex at beak; delthyrial covering not observed. Sinus present; originates at beak; ill defined throughout entire length; broadly V-shaped in cross section.

Twenty-five to 27 plicae on each lateral slope; plicae originate at beak, few bifurcate in umbonal region; flatly rounded; separated by furrows narrower than plicae. Sinus bears bifurcate median plica that originates at beak; each lateral slope of sinus bears three to four plicae derived from inner margin of plicae bounding sinus, or by the bifurcation of plicae so derived. Concentric markings consist of strong growth lines which diverge outward to cardinal extremities and reflect acuminate character of extremities.

REMARKS: This species rather closely resembles Spirifer subaequalis Hall but differs in being much larger in size, in having a greater width in proportion to its length, and in having fewer plicae in the sinus. Spirifer n. sp. 11 is more similar to Spirifer haydenius Girty than to any other species. The principal difference between these two forms is the greater number of plicae on the latter. Girty lists 100 or more, slightly fasciculate plicae for the pedicle valve of S. haydenius instead of approximately 60 nonfasciculate plicae for Spirifer n. sp. 11.


**Spirifer n. sp. 12**
Plate VII, Figs. 1, 4.

Species known from several pedicle valves.

DESCRIPTION: Pedicle valve large; fold and sinus present; hinge line equaling
greatest width of shell; cardinal extremities acutely angular, 75–80°;
slightly more acuminate at point. Dimensions, length of specimen figured
in Fig. 1, Plate VII; 65–70 mm.; width of pedicle valve 110 mm.; thickness
approximately 18 mm.

Pedicle valve flatly convex; greatest convexity one-third distance
from beak to anterior margin; umbonal region not differentiated from gen-
eral surface of valve; surface curves rather steeply to the cardinal mar-
gin for a distance of 20 mm. on each side of beak; surface sloping gently;
uniformly; to postero-lateral and antero-lateral margins. Beak pointed but
only moderately incurved over cardinal area; cardinal margins meet at
beak to form angle of approximately 150°. Cardinal area high; orthocline;
vertically striated; lateral margins clearly defined, sloping uniformly
from beak to extremities. Delthyrium moderate size; higher than wide. Sinus
extends to beak; sharply defined for distance of approximately 30 mm. an-
teriorly from beak, at which point becomes shallow; rounded into lateral
slopes of valve; scarcely discernable.

Thirty-five discernable lateral plicae; cardinal extremities exfoli-
ated, not permitting observation; plicae derived from smaller number at
beak; bifurcate close to beak, also on lateral slopes; plicae rounded; sep-
arated by furrows slightly narrower than plicae. Sinus bears bifurcating
median plica, first bifurcation close to beak, second occurs near anterior
margin. Lateral slopes of sinus bear six or seven bifurcated plicae de-
rived from lesser number near beak. Exact bounding plicae of sinus ap-
parently absent; replaced by a group of plicae. Strong concentric growth
lines in anterior portion of shell following acuminate outline of cardinal
extremities.
REMARKS: This species is characterized by the large size, and flatly convex condition of the pedicle valve. The flatness of the pedicle valve distinguishes *Spirifer n. sp. 12* from all other spirifers of the type exemplified by *Spirifer loganii* Hall. *Spirifer n. sp. 10* most closely resembles *Spirifer n. sp. 12* but may be distinguished from it by the presence of smaller plicae on the latter; the illly defined sinus; and by the presence of plicae in the sinus. R. C. Rowe\(^2\) illustrated a specimen which is catalogued No. 5074 in the Museum of Paleontology of the State University, as a variety of *Spirifer loganii* Hall. The writer has already pointed out the differences between *S. logani* and *Spirifer n. sp. 12*. Other specimens have been added to the collection, one of which is figured in this paper.

Locality and Formation: Locality 8, Pentagon Mt., approximately two miles northwest of the Continental Divide, in the north-central part of the Lewis and Clark range, in sec. 14; T. 25 N., R. 12 W. Fossil locality on southeast slope of mountain at elevation of 8600 feet.

*Spirifer n. sp. 13*

Plate III, Figs. 3-5.

Species known from several pedicle valves.

DESCRIPTION: Pedicle valve large; fold and sinus present; outline broadly triangular; hinge line equalling greatest width of shell. Dimensions; length of pedicle valve 24 mm.; width 55 mm.; thickness 6 mm.

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\(^2\)R. C. Rowe, "Description and Correlative evidence of the Brachio poda and other faunal members of the Montana Madison Limestone," Unpub. thesis, University of Montana, p. 64, Pl. 11, fig. 11. 1927.
Pedicle valve slightly convex; greatest depth in umbonal region; umbonal region prominent; beak pointed; strongly incurved. Cardinal area not observed; cardinal extremities acutely angular. Surface curving rapidly to lateral margins of cardinal area, gently to postero-lateral and anterior margins. Mesial sinus sharply defined at beak, clearly defined throughout; shallow, scarcely depressed below surface of the valve in anterior portion of valve.

Twenty to 22 plicae on each lateral slope; nonbifurcating, except for first lateral plica, derived from outer margin of plica bounding sinus; originate at beak; plicae and furrows of approximately equal strength; slightly rounded in cross section. Sinus marked by bifurcated median plica originating at beak; three plicae on each lateral slope of sinus derived by repeated bifurcation of inner margin of bounding plicae of sinus; plicae in sinus of equal strength to lateral plicae. Concentric ornamentation absent.

REMARKS: This species closely resembles Spirifer forbesi Norwood and Pratten. It differs from that species in having a bifurcating median plica in sinus, 20 plications in place of 25-30 on each lateral slope; and less lamellate ornamentation.

Locality and Formation: Locality 17, Rattler Gulch, five miles west of Drummond, Granite County, Montana. Fossils collected from upper portion of formation at a point two miles from mouth of gulch. Madison limestone, Rooney chert 7 member.

Spirifer n. sp. 14
Plate III, Fig. 6.
Species known from single pedicle valve.
DESCRIPTION: Specimen of large size; fold and sinus present; hinge line equalling greatest width of valve. Dimensions, length 25 mm.; width 43-50 mm.; thickness 7 mm.

Pedicle valve depressed convex; greatest convexity in umbalonal region; umbo flattened, not prominent; beak pointed; incurved over cardinal area; cardinal area not observed. Surface of valve sloping steeply to cardinal margin at each side of umbo; gradually to the postero-lateral and anterior margins. Sinus sharply defined at beak; rounded into lateral slopes anteriorly; barely depressed below surface of valve.

Eighteen discernable, rounded, lateral plicae on each slope. Plicae on compressed cardinal extremities either obsolete or nonexistent; furrows narrower than plicae; plicae indistinctly fasciculate on umbo; originate in groups of three near beak by bifurcation of center plica of group; fasciculations becoming less marked anteriorly until at margin bundles are scarcely recognizable. Sinus carries bifurcating median plica that originates close to beak; tends to bifurcate on inner margin at approximately midlength; sinus not bounded by distinct costae but by bundle of three plicae. Concentric ornamentation consists of few strong growth lines.

REMARKS: Spirifer n. sp. 14 belongs to a small group of Mississippian spirifers characterized by the fasciculation of plicae, which includes Spirifer missouriensis Swallow, Spirifer mortonanus Miller, and Spirifer montgomeryensis Weller. Spirifer n. sp. 14 differs from these species in that the fasciculations, though pronounced on posterior portion of the shell are essentially absent at the anterior margin. The most similar form is Spirifer cameratus Morton, a fasciculate Pennsylvanian form. From this form Spirifer n. sp. 14 differs in the bifurcating median plica of
the sinus, the more flatly convex character of the pedicle valve, and par-
ticularly in the narrower and much shallower sinus.

Locality and Formation: Locality 5, Spotted Bear Mt., four miles S. 75° E.
of the junction of Spotted Bear River and South Fork of Flathead River.
Fossils collected at an elevation of 7000 feet on south point of mountain
in sec. 25; T. 25 N.; R. 15 W. Madison limestone.

Genus SYRINGOTHIRIS Winchell
For generic description see page 39

Syringothyris n. sp. 1
Plate VII, Figs. 2, 3, 5.

Species known from single incomplete specimen.

DESCRIPTION: Shell large; outline transversely triangular; fold and sinus
present; hinge line equaling greatest width of valve; cardinal extrem-
ities acutely angular. Approximate dimensions; length of pedicle valve 30
mm.; length of brachial valve 25 mm.; greatest width of shell 47 mm.;
thickness 40 mm.

Pedicle valve strongly convex; greatest convexity at midlength; umbon-

al region well developed; surface curving rapidly to cardinal margin for
a distance of 15 mm. on each side of beak; curving uniformly to postero-
lateral and anterior margins. Beak broken; apparently broadly pointed;
slightly incurved. Cardinal area large, 15 mm. in height; well defined
laterally; apsacline. Delthyrium large; higher than wide; extending to
beak; covered by a delthyrial plate, which is perforated in central region
by subcircular opening, external representation of syrinx. Sinus extending
to beak; well defined; rounded in bottom; complicated; becomes deep anteriorly, extended toward brachial valve.

Brachial valve strongly convex; less convex than pedicle valve; umbonal region not prominent; curvature of valve stronger from umbonal region to hinge line than to margins. Beak obtuse; insurved to fill base of delthyrium. Cardinal area absent or essentially so. Fold defined to beak; relatively weaker than sinus; subcircular in cross section. Short median septum extending anteriorly 10 mm. from beak; exposed by exfoliation of shell; only observable internal feature.

Shell material almost completely exfoliated, traces of 15 lateral plicae can be seen, though faint. Plicae appear to have been broadly rounded, separated by narrower furrows. Shell material not punctate.

Remarks: Though the specimen described lacks some of the features of the genus Syringothyris the writer believes it to be more closely related to Syringothyris than to Spirifer. The characters in which it is not in agreement with the genus Syringothyris are: 1, lack of three differentiated regions of the cardinal area which may be due to exfoliation, 2, lack of punctate shell structure, and 3, absence of so called "twilled" ornamentation. The shell agrees closely in being spiriferoid, large, having a wide cardinal area, large delthyrium, and external evidence for syrinx.

Syringothyris n. sp. 1 is most closely related to Syringothyris textus Hall from which it differs in having a lower cardinal area, being 18 mm. in height in place of 30 mm. S. textus has a catacline cardinal area while Syringothyris n. sp. 1 is characterized by an apsaciline cardinal area.

Locality and Formation: Locality 13, west side of Monior Mt., east of the Continental divide between the Dearborn River and the South Fork of Falls Creek, in the Coopers Lake quadrangle, Montana. Madison limestone.
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LIST OF LOCALITIES

Localities

7. On Yakinikak Creek, in the NE. ¼ sec. 30; T. 37 N., R. 22 W., 20 feet above the contact of the Yakinikak limestone and quartzites of Kintla age. Flathead County, Montana. Yakinikak limestone.

(Broadwater)

-- Dupuyer Creek, Pondera County, Montana. Exact locality unknown.

Madison limestone.

5. Zone 3, Spotted Bear Mt., four miles S. 75° of the junction of Spotted Bear River and South Fork of Flathead River. Fossils collected at an elevation of 7000 feet on south point of mountain in sec. 25; T. 25 N., R. 15 W. Madison limestone.


-- Roadway at diversion dam, North Fork of Sun River Canyon, Lewis and Clark County, Montana. Madison limestone, undifferentiated.


-- Danaher Creek, located on the northeast side of Fool Hen Creek, Ovando quadrangle, Powell County, Montana.

19. Welcome Creek, 8300 foot peak, situated N. 45° E., of Scapagoat Mt., Lewis and Clark Range, Coopers Lake quadrangle, Lewis and Clark
Localities

County, Montana. Madison limestone, Dean Lake chert member.

13. West side of Monitor Mt., situated east of the Continental Divide between Dearborn River and South Fork of Falls Creek, in the Coopers Lake quadrangle, Montana. Madison limestone.

17. Rattler Gulch, 5 miles west of Drummond, Granite County, Montana. Fossils collected from upper part of formation, at a point two miles from mouth of gulch. Madison limestone, Rooney chert member.

33-2. East of the head of Ruby Creek, elevation 8500 feet, lying in the SW^2 sec. 35; T. 7 S., R. 26 E., Pryor Mt. division, Custer National Forest, Carbon County, Montana. Madison limestone, middle portion.

33-3. Big Saddle, on knob at elevation of 7750 feet, northeast of large saddle separating East Pryor Mt. from its northeast spur, in the SW^1 sec. 25; T. 7 S., R. 26 E., Pryor Mt. division, Custer National Forest, Carbon County, Montana. Madison limestone, basal 50 feet.


33-11. Sage Creek Ranger Station. On ridge southeast and immediately above the Sage Creek Ranger Station site; at an elevation of 7300 feet; sec. 29; T. 7 S., R. 26 E. Pryor Mt. division, Custer National Forest,
Carbon County, Montana. Madison limestones, approximately 150 feet from base of formation.

**STRATIGRAPHIC CONCLUSIONS**

Seventy-two species whose stratigraphic ranges have been determined in relation to the type Mississippian section are represented in the Madison fauna of Montana. The names of these species and their geologic ranges are listed in the faunal chart. Thirty-six of these species are Kinderhook, nine are common to the Kinderhook and Osage, fifteen are limited to the Osage, and one species is common to the Osage and Meramec. Fifty-five species or 75 per cent of the total fauna are limited to the Kinderhook and Osage, and thus the Madison is definitely correlated with the Lower Mississippian of the Mississippi basin.

Twelve species were collected from the Yakinikak limestone. Of these, nine, or 75 per cent are Meramec and Chester and three are Kinderhook and Osage. The presence of the Kinderhook and Osage species among an assemblage that is dominantly Upper Mississippian is probably an example of a recurrent fauna. The species may have originated during Waverlyan time and persisted in some unknown region until Upper Mississippian invasions of the sea allowed them to enter northwestern Montana. The Yakinikak limestone cannot be correlated with the Madison, but may possibly be correlated with the Brazer. Weller considered the Yakinikak lime-

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stone equivalent in age to the St. Louis limestone. Evidence obtained from the fossils studied by the writer substantiates Weller's conclusion.

In addition to the Upper Mississippian species collected from the Yakinikak limestone the fauna studied also contains nine other species that occur in the Upper Mississippian. These nine species were collected from widely separated localities, and occur in association with Kinderhook and Osage forms. There are two explanations suggested for their occurrence: 1; These species may be varieties of those to which they are considered equivalent but because of the rather poorly preserved material, the varietal characters could not be observed; 2; These forms may have had their inception in the Pacific seas, entered the cordilleran region in the Lower Mississippian but did not reach the Mississippi basin until the Upper Mississippian. The latter suggestion seems most plausible.

Correlation between localities throughout the State is possible by means of interpolation. No single species occurs in all localities; but enough species are common to several localities to make correlation between them possible.

The Pryor Mountain localities, when considered as a unit, show the following relation to localities in northwestern Montana. Exclusive of new species described in this paper, 26 are from the Pryor Mountains. Four of these are common to Rattler Gulch, six to Monitor Mt., two to the Sun River Canyon locality, one each to zones 2 and 3 Basin Butte, and Yakinikak Creek.
The Monitor Mt. fossils were not placed in zones, but were collected from a portion of the measured section thought by Deiss to represent the Dean Lake and Rooney chert members of the Madison limestone. In the Basin Butte section, Locality 21, Deiss considers zone 2 equivalent of the Dean Lake chert member, and zone 3 the equivalent of the Rooney chert. The Rattler Gulch section has not been measured but is relatively well known because it has been mapped on several occasions by the field classes of the State University. Deiss considers the upper part of the formation as exposed in the vicinity of Drummond, Montana the equivalent of the Rooney chert member of the Madison limestone. The following correlation was obtained between these three localities, i.e., Monitor Mt., Basin Butte and Rattler Gulch.

Twenty-two species were recorded from Monitor Mt., twenty-two from zones 2 and 3, Basin Butte, and twenty from Rattler Gulch. Five species are common to Monitor Mt. and Rattler Gulch; three to Basin Butte and Rattler Gulch; four to Basin Butte and Monitor Mt.; and two to all three localities.

This is the first attempt at zonal correlation that has been made in the Madison of Montana. The correlation is not conclusive. The lack of more common species may have resulted from incomplete collections from the respective localities, rather than from nonequivalence of the strata.


24. F. Deiss, personal communication.
BIBLIOGRAPHY


Statement of lithology, thickness, with complete faunal list.


Description of two new species, and discussion of geologic range of genus.

Bevan, Arthur, see Clapp, C. H., 1921.

Billingsley, Paul, see Kemp, J. F., 1920.


Faunal list for limestones that are probably Upper Mississippian.


Madison represented in undifferentiated Carboniferous limestones.

No descriptions of fossils.

Chang, M. S., see Ehlers, G. M.; 1926.


Statement of general lithology, and extent of formation.

Madison limestone does not outcrop in this area.

Formation mentioned in generalized section for eastern Montana.


Table of formations with generalized sections.


General statement of the extent of the Madison.


Brief mention of the unconformity of Madison; occasional capping by beds bearing pebbles of Madison limestone; and relation to Jurassic baseleveling.

Cooper, G. Arthur, see Schuchert, Charles, 1932.


Measured sections; complete description of lithology, and faunal lists. Only small portion of area lies in Montana.


Strata are Carboniferous and Permian ? in age. Described two new species of Rhynchonella, from Pennsylvanian.
Deiss, C. F., "Paleozoic formations of northwestern Montana:"
State Bureau Mines and Geology, Mem. 6, 1933.
Definitions, descriptions, and correlation of members of Madison limestone.
Douglass, Earl, "Some notes on the geology of southwestern Montana:"
Faunal lists and general discussion of Madison limestone.
Ehlers, G. M., and Cheng, M. S., "New brachiopods from the Warsaw formation of Wayne County, Kentucky:"
Describes two new species, Spiriferina praetransversa, and Spirifer casei.
Emmons, Ebenezer, "Geological sketch of the Rocky Mountain region:"
Generalized discussion of rocks in state and their economic importance. Devoted chiefly to igneous rocks.
Emmons, W. H., "Gold deposits of the Little Rocky Mountains, Montana:"
Mentions general character of geologic section, but gives no detailed measurements.
(and Calkins, F. C.) "Geology and ore deposits of the Phillipsburg quadrangle, Montana:"
Complete measured section of Madison and faunal list.
Very general section of Madison.

Etheridge, R., "Paleontology of the coasts of the Arctic lands visited by the late British expedition under Capt. Sir George Nares:"

Five genera of brachiopods reported, which appear to represent mingling of Mississippian and Pennsylvanian forms. No new species described.


Most significant contribution yet made to the paleontology of the Madison limestone.


Historical review; recapitulation of Paleozoic geologic history; correlation of formations; discussion of fauna; with adequate figures of many Carboniferous species.


Original description of genus Schuchertella


Brief mention of typical fossils, no descriptions. Lithology; areal extent; but no measured sections of Mississippian strata.

Statement of some problems of Carboniferous stratigraphy in United States.


Fauna essentially of pelecypods, gastropods, and cephalopods, with few brachiopods. Describes one new variety of brachiopod Chonetes planumbonus var. choctawensis.


Original description of the genus Moorefieldsella. Describes 12 new species and varieties of brachiopods.


Descriptions and figures of five new species of brachiopods, and one plate showing representative Carboniferous fauna.


Beds up to and including Warsaw. Describes two new species of brachiopods, Camarophoria simulans, and Shumardella missouriensis.
"Fauna of the so called Boone chert near Batesville, Arkansas:"
Discusses fauna formerly included in Boone limestone, and describes four new species of brachiopods.

"The fauna of the Batesville sandstone of northern Arkansas;"
Upper Mississippian, correlation of formation; 128 species discussed. Two new varieties of brachiopods described.

Girty, G. H., see, Roundy, P. V.

"Descriptions of new species of Carboniferous and Triassic fossils from southeastern Idaho;"
Excellent discussion of age relation of Madison and Brazer limestones. Describes and figures eight new species of brachiopods.

"The fauna of the middle Boone near Batesville, Arkansas;"
Nine new species and varieties of brachiopods described and figured. Excellent description of extent of Lower Mississippian limestones in United States.

Goldman, M. L., see Roundy, P. V.,

Good general reference. Not comprehensive enough for detailed work.

Greger, D. K., "On the genus Rhynchopora, King, with notice of a new species;"
"North American species of the brachiopod Etheridgina:"

Hall, James, "Paleontology of Iowa:" Iowa Geol. Survey vol. 1, pt. 2,
pp. 473-724, pls. 1-29, 1858.
Descriptions of large number of Mississippian forms. Valuable
for original descriptions though most species have been redescribed
by Weller.

"Notes and observations upon fossils of the Goniatite lime-
Descriptions worthless.

"Descriptions and figures of the fossil Brachiopods of the
upper Helderberg, Hamilton, Portage, and Chemung groups:" Paleon-
Description of several species that occur both in the Devonian
and Mississippian.

Hall, James, (and Whitfield, R. P.,) "Paleontology:" U. S. Geol. Explor.
Vital reference for work on the Madison limestone.

Hall, James, (and Clarke, J. M.;) "An introduction to the study of the
genera of Paleozoic Brachiopoda:" New York Geol. Survey, Paleontology,
vol. 8, pts. 1 and 2, 1893-94.
Most outstanding contribution to the knowledge of brachiopods
made in America.

Hart, Lyman, see Tanaley, Wilfred, 1933.

Haynes, W. P. "New facts bearing on the Paleozoic stratigraphy of the

No mention of Madison; discussion of Devonian.


Faunal lists for Renault, Okaw, and Paint Creek limestones; correlation between Indiana and Illinois; no detailed sections.


Carboniferous section, not measured in detail; has Kinderhook facies; Spirifer centronatus Winchell and Spirifer centronatus var. albapinensis lacking from fauna.

Iddings, J. F., see Weed, W. H., 1895.


Brief mention of Madison.


List and synonymy of forms found in Missouri localities; without descriptions. Plates poor.

King, Ralph, "Neospirifer dumbari, nom. nov." Jour. of Paleontology, vol. 7, No. 4, 1933.

Synonymy of species formerly known as Spirifer triplicata and as Spirifer camerata.
Koinck, de L., "Recherches sur les animaux fossiles," Premier partie. 
Monographie des genres Productus et Chonetes. pp. 246, pl. 1-20, 1847.

Classification and grouping of genera Chonetes and Productus, 
with descriptions and figures of species.

Knappen, R. S., (and Moulton, Gail F.,) "Geology and mineral resources of parts of Carbon, Big Horn, Yellowstone, and Stillwater counties, Montana:" U. S. Geol. Survey Bull. 822A, pp. 1-70, pl. 1-5, 1930.

Measured section of the Madison, and discussion of Madison-Amsden unconformity.

Lambert, G. S., see Clapp, O. H., 1921.

Laudon, L. R., "Stratigraphy of the Kinderhook series in Iowa:

Detailed sections with faunal zones of each. Describes new unconformity, and introduces term Hampton for uppermost beds of Kinderhook. No description of species.

LeVene, Clara M., see Schuchert, Charles, 1929.


Fossils appear to have come from upper Carboniferous rocks.


Descriptions of forms from Shasta County. Figures good.

---------- "Preliminary paleontological report, consisting of lists and descriptions of fossils, with remarks on the ages of the rocks in which they are found:" U. S. Geol. Survey Terr. Sixth Annual Report,
Full discussion of this reference given in "Historical Review" in this paper. Described *Spirifer agelains* and *S. mysticensis*. 


Lists few species; describes none, and considers fauna equivalent of the Spergen.


Vital to any work on western Mississippian formations.


Seven new species of brachiopods described.

Moulton, G. F.; see Knappen, R. S.


Detailed work, well measured sections; illustrations of typical fossils; and descriptions of two new species of Lower Carboniferous brachiopods.


Contains descriptions of number of Mississippian species not found elsewhere.


Brief mention of Madison, and statement of general lithology.

Condensed statement of lithology and approximate thickness of Madison.


Section and lists of fossils as identified by Walcott.

Original use of formations name Madison. Discussion of general relation of fauna; no descriptions of new species.

Pirsson, L. V., see Weed, W. H., 1896.


Few species listed from Gibson dam site, North Fork of Sun River.

No sections.

Roundy, P. V. (and Girty, G. H., and Goldman, M. I.,) "Mississippian formations of San Saba County, Texas:" U. S. Geol. Survey Prof. Paper 146, 63 pp., 33 pls.; 1926.

Two Mississippian formations recognized. Eleven new species described and figured.


General statement of lithology; thickness; and faunal lists.

Unreliable as far as checked.

Rutherford, R. L., see Allan, J. A., 1932.

Schafer, Paul A., see Tansey, Wilfred, 1923.


Invaluable for checking synonymy.


Most valuable bibliographic tool yet presented to paleontologist interested in brachiopods.


Excellent description of genera, and check lists of valid species of genera listed. Glossary, and proposed terms for describing brachiopod morphology are good.

Shimer, H. W., see Grabaue, A., 1909.

Lithology and thickness of Banff shale and limestone. No measured section given. Faunal list with discussion of assemblage of forms.

Stebinger, Eugene, "Oil and gas geology of the Birch Creek-Sun River area, northwestern Montana," U. S. Geol. Survey Bull. 691, pp. 149, 184, 1918.

General statement of the Madison and Brazer lithology.


Mentions occurrence and thickness of Madison.


Brief mention of the Madison limestone and its general lithology.


Descriptions but no figures. Descriptions largely found in Weller.


Descriptions poor; no figures. Varieties given of Spirifer lineatus, cameratus, kentuckiensis, leyi, increbescens, and keokuk.


Very brief mention of the Madison limestone.

Gives general discussion of Madison, and unconformity separating it from Amsden.


Bibliography, index of systematic names, one plate of new Recent species, one plate showing orientation of valves during life. Should be consulted for anatomy by anyone working on Brachiopoda.


Fossils lists, diagramatic sections given for the localities where the sections were measured. Madison divided into members lithologically. Weak point is fact that sections are separated from one another by too great distances.


Figures and describes large number of previously known forms, and also some new species of brachiopods.


Faunal list; fauna compares closely to that from Liard river localities, and from Madison limestone of Montana and Wyoming.

---------- "Banff Area, Alberta;" Canadian Geol. Survey Mem. 153, pp. 94, pls. 7, map, 1927.
Measured sections of Mississippian limestones; discussion of its relation to Madison limestone; and description and figures of two new species; *Spirifer cascadensis* and *roundlensis*.


Generalized section of the Rundle, and discussion of its fauna as compared to that of Madison limestone. Description of several new species of brachiopods from Devonian.


Described superficially some Carboniferous beds, with fossils listed.


No Madison discussed.


Gives measured section of Madison.


Mentions Madison, and gives short faunal list.

"Geology and Mineral resources of
the Judith Mountains, Montana:” U. S. Geol. Survey 18th Ann. Rep.,

Good measured section, faunal list and discussion of the fauna.

Weller, Stewart, "A bibliographic index of the North American carbonifer-

Vital to any work on Mississippian brachiopods.

---------- "Kinderhook faunal studies; IV, the fauna of the Glen Park
limestone:" Trans. St. Louis Acad. Sci., vol. 16, pp. 435-471,
illus., 1906.

Faunal lists, and discussion of relation of forms listed to those
in other localities.

---------- "Kinderhook faunal studies; V, the fauna of the Farglen
formation:" Geol. Soc. America, Bull., vol. 20, pp. 365-332, illus.,
1909.

Faunal lists and discussion.

---------- "Genera of Mississippian loop-bearing Brachiopoda:" Jour.

Redefinition of the following new genera, Girtyella, Dielasmoides,
Hamburgia, Dielasmella, and Rowleyella.

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I, 2 vols., text, and Plates, 1914.

Greatest contribution to knowledge of Mississippian thus far made
in the English language.

---------- "Faunal zones in the standard Mississippian section:"
Jour. of Geology, vol. 4, no. 4, pp. 320-335, 1926.
Divides Mississippian into lower portion Iowan and upper Chesterian.

Whitfield, R. P., see Hall, James.

Willis, Bailey, "Stratigraphy and structure, Lewis and Livingston ranges:"

Yakinikak limestone defined, no measured section, considered same age as St. Louis limestone. Quartzite cited as base of formation probably Kintla.

Winchell, A., "Descriptions of fossils from the yellow sandstones lying beneath the 'Burlington limestone' at Burlington, Iowa:"

Describes new genus, Syringothyris, and several new species of brachiopods.

---------- "Descriptions of new species from the Marshall Group of Michigan:"

Described several new species of brachiopods, descriptions of which appear in no other place.


Excellent general reference.
EXPLANATION OF PLATE I

Fig. 1. *Atrypa sp. undet* .................................................. 42

View of brachial valve showing general outline of shell; rounded plicae; and small nodes developed on plicae in anterior portion of fold. Natural size.

Locality 21, zone 2.

Fig. 2. *Atrypa sp. undet.*

Lateral view of specimen shown in fig. 1, showing relative convexity of valves. Natural size.

Fig. 3. *Atrypa sp. undet.*

Posterior view of same specimen shown in fig. 1, showing relative convexity of valves; short hinge line; and small size of beaks. Natural size.

Fig. 4. *Brachytheris n. sp. 1* ............................................ 43

View of pedicle valve showing rounded cardinal extremities; and fine median plica in sinus. Natural size.

Locality 7, zone 2. (Broadwater)

Fig. 5. *Brachytheris n. sp. 1*

Lateral view of specimen shown in fig. 4, showing relative convexity of valve. Natural size.

Fig. 6. *Brachytheris n. sp. 2* ............................................ 45

View of pedicle valve showing outline of shell and character of plicae in sinus. Magnified 2 diameters.

Locality 7, zone 2. (Broadwater)
Fig. 7. *Brachythyris n* sp. 2

View of specimen shown in fig. 6, showing deltothyrium. Magnified 2 diameters.

Fig. 8. *Brachythyris n* sp. 3 ........................................ 46

View of pedicle valve showing prominent umbonal region, and nonbifurcating median plica in sinus. Natural size.

Locality 17.

Fig. 9. *Brachythyris n* sp. 3

Lateral view of pedicle valve shown in fig. 8, showing angle of cardinal area; and convexity of valve. Natural size.

Fig. 10. *Camarotoechia n* sp. 1 .............................. 47

View of pedicle valve of nearly complete specimen; beak broken. Strong character of plications in anterior portion shown. Magnified 2 diameters.

Locality 33-3.

Fig. 11. *Camarotoechia n* sp. 1

View of brachial valve of specimen shown in fig. 10, showing character of fold. Magnified 2 diameters.

Fig. 12. *Camarotoechia n* sp. 1

Anterior view of specimen shown in fig. 10, showing character of fold and sinus at anterior margin. Magnified 2 diameters.
Fig. 13. Camarotoechia n. sp. 1

Posterior view of specimen shown in fig. 10, showing beak of brachial valve; beak of pedicle valve removed. Magnified 2 diameters.

Fig. 14. Camarotoechia n. sp. 1

Posterior view of another individual slightly larger, showing relation of beaks; and variation in convexity of valves. Magnified 2 diameters.

Fig. 15. Camarotoechia n. sp. 2

View of pedicle valve showing umbal ridge; and slightly flattened mesial portion of valve. Magnified 2 diameters.

Locality 33-3.

Fig. 16. Camarotoechia n. sp. 2

Lateral view of pedicle valve shown in fig. 15, showing umbal "cap". Magnified 2 diameters.

Fig. 17. Camarotoechia n. sp. 2

View of brachial valve of another individual, showing four plications on flattened fold. Magnified 2 diameters.

Fig. 18. Camarotoechia n. sp. 3

View of pedicle valve, showing plicae in sinus. Rostral angle not clearly shown due to orientation of specimen. Magnified 2 diameters.

Locality 33-3.
Fig. 19. **Camarotoechia n. sp. 3**

Lateral view of pedicle valve shown in fig. 13.

Magnified 2 diameters.

Fig. 20. **Composita n. sp. 1** ........................................... 51

View of pedicle valve showing outline of shell.

Sinus absent but appears to be present due to lighting. Magnified 2 diameters.

Locality 33-3.

Fig. 21. **Composita n. sp. 1**

View of specimen shown in fig. 20, showing foramen and delthyrium. Magnified 2 diameters.

Fig. 22. **Composita n. sp. 1**

Lateral view of specimen shown in fig. 20, showing general convexity of valve. Magnified 2 diameters.

Fig. 23. **Composita n. sp. 1**

View of pedicle valve of another individual.

Magnified 2 diameters.

Locality 33-3.

Fig. 24. **Composita n. sp. 1**

Lateral view of specimen shown in fig. 23, showing convexity of valve. Magnified 2 diameters.

Fig. 25. **Composita n. sp. 2** ........................................... 53

View of pedicle valve showing wide rostral angle; and small auricular expansions of valve. Magnified 2 diameters.
Locality 33-3.

Fig. 26. **Composite n. sp. 2**

Lateral view of valve shown in fig. 25, showing tumid character of pedicle valve. Magnified 2 diameters.

Fig. 27. **Composite n. sp. 3**

View of pedicle valve showing general outline. Magnified 2 diameters.

Locality 33-3.

Fig. 28. **Composite n. sp. 3**

Oblique view of specimen shown in fig. 27, showing curvature of umbonal region; pedicle foramen; and nature of cardinal area. Magnified 2 diameters.

Fig. 29. **Composite n. sp. 3**

Lateral view of specimen shown in fig. 27. Magnified 2 diameters.

Fig. 30. **Composite n. sp. 4**

View of pedicle valve showing extended umbonal region. Magnified 2 diameters.

Locality 33-3.

Fig. 31. **Composite n. sp. 4**

Lateral view of specimen shown in fig. 30, showing convexity of valve. Magnified 2 diameters.
Fig. 32. *Composta n. sp. 4*

View of cardinal area of specimen shown in fig. 30.

Magnified 2 diameters.
Fig. 1.  *Dielasma n. sp. 1* ................................................ 55

View of pedicle valve showing pentagonal outline of valve. Natural size.

Locality 33-6.

Fig. 2.  *Dielasma n. sp. 1*

Lateral view of specimen shown in fig. 1, showing curvature of valve. Natural size.

Fig. 3.  *Echinoconchus n. sp. 1* ....................................... 57

View of specimen showing concentric banding; radial ribbing; and widely extended circular expansions. Latter feature best shown on right of specimen. Natural size.

Locality 21, zone 2.

Fig. 4.  *Echinoconchus n. sp. 2* ...................................... 58

Lateral view showing convexity of pedicle valve. Natural size.

Locality, Sun River Canyon.

Fig. 5.  *Echinoconchus n. sp. 2*

View of pedicle valve shown in fig. 4, showing tumidity of valve; and fine radial ornamentation. Natural size.

Fig. 6.  *Girtyella n. sp. 1* ........................................... 59

View of pedicle valve, showing slight mesial sinus.

Magnified 2 diameters.
Locality 7, zone 2. (Broadwater)

Fig. 7. *Girtyella n. sp. 1*

View of brachial valve of specimen shown in fig. 6, showing sinus and bordering folds. Magnified 2 diameters.

Fig. 8. *Girtyella n. sp. 1*

Lateral view of specimen shown in fig. 6, showing relative convexity of two valves. Magnified 2 diameters.

Fig. 9. *Girtyella n. sp. 1*

Posterior view of specimen shown in fig. 6, showing beaks; and tumidity of valves. Magnified 2 diameters.

Fig. 10. *Girtyella n. sp. 1*

Posterior view of specimen shown in fig. 6, showing deflections of commissure. Magnified 2 diameters.

Fig. 11. *Spirifer calvini n. var. 1*

View of pedicle valve showing nonbifurcated median plica in sinus; rounded plicae; and concentric growth lines. Natural size.

Locality 13.

Fig. 12. *Spirifer calvini n. var. 1* .............................. 60

Lateral view of specimen shown in fig. 11, showing wide cardinal area; and thick shell material. Natural size.
Locality 33-2.

Fig. 13. *Spirifer calvini* n. var. 2 ........................................... 61

View of pedicle valve, showing broad rounded plicae. Natural size.

Locality 33-2.

Fig. 14. *Spirifer calvini* n. var. 2

Lateral view of specimen shown in fig. 13, showing wide cardinal area. Natural size.

Fig. 15. *Spirifer calvini* n. var. 2

Oblique view of cardinal area of specimen shown in fig. 13, showing nature of delthyrium. Natural size.

Fig. 16. *Spirifer increbescens* n. var. 1 ........................................... 63

View of pedicle valve. Natural size.

Locality 13.

Fig. 17. *Spirifer increbescens* n. var. 1

Lateral view of specimen shown in fig. 16, showing convexity of valve. Natural size.

Fig. 18. *Spirifer increbescens* n. var. 1

View of cardinal area of specimen shown in fig. 16, showing vertically striated cardinal area; and delthyrium. Natural size.
EXPLANATION OF PLATE III

All figures natural size.

Fig. 1. *Spirifer centronatus* Winchell ........................................ 62
Large brachial valve.
Locality 21. - loose.

Fig. 2. *Spirifer centronatus* Winchell
Large brachial valve, showing greater number of plicae than average specimen.
Locality 33-6.

Fig. 3. *Spirifer n. sp. 13* ...................................................... 60
View of pedicle valve showing wide flat sinus;
rounded plicae; and low umbonal region.
Locality 17.

Fig. 4. *Spirifer n. sp. 13*  
View of another pedicle valve with shell material
broken away to expose dental lamellae.
Locality 17.

Fig. 5. *Spirifer n. sp. 13*  
View of a third pedicle valve, slightly distorted.
Locality 5.

Fig. 6. *Spirifer n. sp. 14* ...................................................... 81
View of pedicle valve showing poorly defined sinus;
and fasciculate character of plicae.
Locality 5.
fig. 7. *Spirifer missouriensis* Swallow ........................................ 64

View of pedicle valve.
Locality, on Dupuyer Creek.

fig. 8. *Spirifer forbesi* n. var. 1 ........................................ 63

View of pedicle valve showing well defined plicae;
shallow sinus; and low umbonal region.
Locality 13.

fig. 9. *Spirifer forbesi* n. var. 2 ........................................ 63

View of pedicle valve showing high umbonal region;
well plicae; and shallow sinus.
Locality 32-2.
EXPLANATION OF PLATE IV

All figures natural size.

Fig. 1.  *Spirifer n. sp. 1* .................................................. 65

View of pedicle valve showing general shape of valve.

Locality 17.

Fig. 2.  *Spirifer n. sp. 1*

Lateral view of specimen shown in fig. 1, showing orthocline cardinal area.

Fig. 3.  *Spirifer n. sp. 1*

View of cardinal area of specimen shown in fig. 1, showing delthyrium.

Fig. 4.  *Spirifer n. sp. 2* .................................................. 66

View of pedicle valve showing outline; and angular nature of plicae.

Locality 17.

Fig. 5.  *Spirifer n. sp. 2*

Lateral view of specimen shown in fig. 4, showing convexity of valve; and narrow cardinal area.

Fig. 6.  *Spirifer n. sp. 3* .................................................. 67

View of pedicle valve showing general shape.

Locality 17.

Fig. 7.  *Spirifer n. sp. 3*

Lateral view of specimen shown in fig. 6, showing convexity of valve.
Fig. 8. *Spirifer n. sp. 4* ................................................. 63
  View of pedicle valve showing shallow sinus.
  Locality 17.

Fig. 9. *Spirifer n. sp. 4*  
  View of cardinal area of specimen shown in fig. 8.

Fig. 10. *Spirifer n. sp. 5* ................................................. 70
  View of pedicle valve showing general contour of shell; and rounded plicae.
  Locality 13.

Fig. 11. *Spirifer n. sp. 5*  
  Lateral view of specimen shown in fig. 10, showing convexity of valve.

Fig. 12. *Spirifer n. sp. 7* ................................................. 72
  View of pedicle valve showing weak plicae in sinus.
  Locality 33-6.

Fig. 13. *Spirifer n. sp. 7*  
  View of cardinal area of specimen shown in fig. 12, showing delthyrium.

Fig. 14. *Spirifer n. sp. 7*  
  Lateral view of specimen shown in fig. 12, showing wide cardinal area.

Fig. 15. *Spirifer n. sp. 8* ................................................. 73
  View of pedicle valve showing rounded plicae; non-complicated sinus; and submicronate cardinal extremities.
Locality 21, zone 2.

Fig. 16. **Spirifer n. sp. 8**

Lateral view of specimen shown in fig. 15, showing relative convexity of valves.

Fig. 17. **Spirifer n. sp. 8**

Posterior view of specimen shown in fig. 15, showing narrow cardinal area; and relation of beaks.

Fig. 18. **Spirifer n. sp. 8**

View of another pedicle valve of slightly larger size.

Locality 21, zone 2.
EXPLANATION OF PLATE V

All figures natural size

Fig. 1. **Spirifer n. sp. 6** .............................................. 71

View of pedicle valve showing nonplicate sinus;
broad flattened plicae; and high umbonal region.

Locality 8.

Fig. 2. **Spirifer n. sp. 6**

View of brachial valve of specimen shown in fig. 1,
showing rounded fold; and relative height of beaks.

Fig. 3. **Spirifer n. sp. 6**

View of posterior of specimen shown in fig. 1,
showing wide cardinal area; crushed condition of beak
of brachial valve which causes it to fill base of delthyrium of pedicle valve; and relative convexity of valves.
EXPLANATION OF PLATE VI

Fig. 1. **Spirifer n. sp. 10** ........................................... 76

View of pedicle valve showing high umbonal region; broad shallow sinus; faint plicae on lateral slopes; and acuminate cardinal extremities. Magnified 2/3 diameters.

Locality 21, zone 3.

Fig. 2. **Spirifer n. sp. 9** ........................................... 74

View of pedicle valve showing nonplicated sinus; rounded plicae; and uniform slope of valve from beak to cardinal extremities. Natural size.

Locality 33-3.

Fig. 3. **Spirifer n. sp. 9**

View of cardinal area of specimen shown in fig. 2, showing delthyrium. Natural size.

Fig. 4. **Spirifer n. sp. 10**

View of cardinal area of specimen shown in fig. 1, showing orthoclinc cardinal area; sinus extending to beak; and wide, large delthyrium. Magnified 2/3 diameters.

Fig. 5. **Spirifer n. sp. 11** ........................................... 77

View of pedicle valve showing shallow, illy defined sinus; bifurcated median plica in sinus; and concentric growth lines. Natural size.

Locality 21, zone 3.
EXPLANATION OF PLATE VII

All figures natural size.

Fig. 1. **Spirifer n. sp. 12**

View of pedicle valve, bearing catalogue number, 5074, Museum of Paleontology, State University.

Figure shows shallow sinus; acuminate cardinal extremities; and strong growth lines in anterior portion of valve.

Locality on Dupuyer Creek.

Fig. 2. **Syringothyris n. sp. 1**

Lateral view of specimen showing wide cardinal area of pedicle valve.

Locality 13.

Fig. 3. **Syringothyris n. sp. 1**

View of cardinal area of specimen shown in fig. 2, showing large delthyrium; delthyrial plate perforated by syrinx; and slight median septum of brachial valve.

Fig. 4. **Spirifer n. sp. 12**

View of another pedicle valve.

Location 8.

Fig. 5. **Syringothyris n. sp. 1**

View of pedicle valve of specimen shown in fig. 2, showing outline of valve.