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Upper Mississippian Faunas of Western Montana

James King

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UPPER MISSISSIPPIAN FAUNAS OF WESTERN MONTANA

by

JAMES KING

A Thesis
Submitted to the Department of Geology
in Partial Fulfillment of the
Requirements for the Degree of
Bachelor of Science in Geological Engineering

MONTANA SCHOOL OF MINES
BUTTE, MONTANA
May 2, 1942
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## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>The Amsden problem</td>
<td>2</td>
</tr>
<tr>
<td>The Yakinikak problem</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory technique</td>
<td>3</td>
</tr>
<tr>
<td>Stratigraphy</td>
<td>4</td>
</tr>
<tr>
<td>Big Snowy Group</td>
<td>4</td>
</tr>
<tr>
<td>Amsden formation</td>
<td>5</td>
</tr>
<tr>
<td>Yakinikak formation</td>
<td>5</td>
</tr>
<tr>
<td>Conclusions</td>
<td>7</td>
</tr>
<tr>
<td>Description of species</td>
<td>8</td>
</tr>
<tr>
<td>Productus inflatus (McChesney)</td>
<td>9</td>
</tr>
<tr>
<td>Productus ovatus (Hall)</td>
<td>10</td>
</tr>
<tr>
<td>Productus sp.</td>
<td>11</td>
</tr>
<tr>
<td>Girtyella indianensis (Girty)</td>
<td>12</td>
</tr>
<tr>
<td>Dielasmella compressa (Weller)</td>
<td>13</td>
</tr>
<tr>
<td>Dielasma sp. (King)</td>
<td>14</td>
</tr>
<tr>
<td>Composita subquadra (Hall)</td>
<td>16</td>
</tr>
<tr>
<td>Composita trinuclea (Hall)</td>
<td>17</td>
</tr>
<tr>
<td>Clithyridina sp. (Buckman)</td>
<td>19</td>
</tr>
<tr>
<td>Spiriferina spinosa (Norwood and Pratten)</td>
<td>20</td>
</tr>
<tr>
<td>Spiriferina transversa</td>
<td>22</td>
</tr>
<tr>
<td>Spirifer sp.</td>
<td>24</td>
</tr>
<tr>
<td>Spirifer increbescens (Hall)</td>
<td>25</td>
</tr>
<tr>
<td>Spirifer welleri (Branson)</td>
<td>26</td>
</tr>
<tr>
<td>Spirifer pellaensis (Weller)</td>
<td>27</td>
</tr>
<tr>
<td>Camarotoechia mutata (Hall)</td>
<td>29</td>
</tr>
<tr>
<td>Zaphrentis amsdenensis (Branson)</td>
<td>30</td>
</tr>
<tr>
<td>Menophyllum princetonensis</td>
<td>30</td>
</tr>
<tr>
<td>Caninia sp.</td>
<td>30</td>
</tr>
<tr>
<td>Bibliography</td>
<td>32</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>35</td>
</tr>
<tr>
<td>Plates 1-4</td>
<td>35</td>
</tr>
<tr>
<td>Plate 5 (Map of Montana, areas studied)</td>
<td>3</td>
</tr>
<tr>
<td>Plate 6 (Faunal chart)</td>
<td>7</td>
</tr>
</tbody>
</table>
UPPER MISSISSIPPIAN FAUNAS OF WESTERN MONTANA.

INTRODUCTION

In central and western Montana a series of beds is present between the Madison limestone of Middle Mississippian time and the Ellis formation of Jurassic time which previous to 1934 had been correlated with the Quadrant formation of southern Montana and Wyoming. In 1934, however, Dr. H.W. Scott of the Department of Geology of the Montana School of Mines headed a field party which made a study of the so-called Quadrant beds.

After completing the field work, Scott decided that the name "Quadrant" could not be applied to those beds of central Montana because they are lithogically and faunally dissimilar to the beds of the true Quadrant as defined by Darton. (5)

As Scott divided the group it consists of four formations in some localities and five in others. Following is his division of the Upper Mississippian in central and western Montana:

5. Quadrant formation.
4. Amsden formation.
3. Heath formation.)
2. Otter formation.) Big Snowy Group.
1. Kibbey formation.)

The author has made a study of an assemblage of fossils from the Blacktail Range near Dillon Montana with the purpose in view of attempting a correlation of that group with the fauna of the Big Snowy Group. Fossils have also been obtained from a limestone formation in northwestern Montana and from four diff-
different areas in the Amsden formation in central and western Montana. This paper represents the work done by the author and his conclusions.

The Amsden Problem.

The Amsden formation was described by Darton (5) in 1904 from its outcrops along the Amsden River on the east slope of the Big Horn Mountains in northern Wyoming. Since then it has been described and mapped along the Wind River Mountains of Wyoming and in southern and western Montana. Darton has called the upper Amsden Pennsylvanian, on the basis of fossils collected from the Big Horn Mountain area. Branson (3) however, has made a study of a fossil assemblage from out of the Amsden in the Wind River Mountains and has found that the fauna from this area are identical in character with the fauna in the Ste. Genevieve formation of the Mississippi valley which is Upper Mississippian in age. G.R.Powe (18) has found that the Amsden of central Montana contains a good Chester fauna.

In order to differentiate the upper part of the Amsden which is Pennsylvanian in age from the lower part which carries a distinct Upper Mississippian fauna, Branson gave the name Sacajawea to the lower part and continues to call the upper part Amsden. It is evident therefore that the Amsden includes strata representing two periods and that a separation can be made only on the basis of a change in fauna.

The Yakinikak Problem.

In northwestern Montana, T.37 N., R.22W. there occurs a late Paleozoic limestone known as the Yakinikak limestone, named after Yakinikak Creek which is a tributary of the North Fork of the Flathead River.
head River. The limestone rests conformably, according to Willis, (25) in a horizontal position on the Kintla quartzite of pre-Cambrian age, which in turn lies unconformably on other Beltian strata of the region.

The presence of this formation has been known for many years, but because the region is heavily timbered and somewhat remote, it has never been mapped in detail. Some work has been done with the fauna of the formation by Stuart Weller (23) in 1902. According to him the faunal facies of the Yakinikak is identical in lithologic character and faunal content with the fauna of the St. Louis horizon in the Mississippi valley. D. L. Blackstone JR. (2) identified twelve species from the Yakinikak. He found that nine of these were Meramac and three were Kinderhook and Osage in age.

In order to more completely determine the age of the Yakinikak the author decided to study and describe an assemblage of fossils from that formation in conjunction with his other work on Mississippian faunas.

Laboratory Technique.

Field collections of fossils were made by Dr. L. L. Sloss and Mr. Wilmer Peterson. The specimens from all localities were enclosed in limestone. To free the specimens the author used a small hammer and several small chisels. A stiff brush was used to clean the surfaces more thoroughly and bring out details. A thin film of oil placed on the specimen helped in clarifying minute characteristics. Many of the identifications were made with the aid of a binocular microscope.
PLATE 5 Showing areas from which fossils were obtained.
STRATIGRAPHY

Big Snowy Group

\begin{itemize}
  \item Heath formation.
  \item Otter formation.
  \item Kibbey formation.
\end{itemize}

The formations comprising the Black tail Range have been tentatively correlated with the Big Snowy Group which lie immediately to the east.

The name "Big Snowy Group" has been given by Scott (21) to a series of sediments of upper Mississippian age. This series is well exposed in the Big Snowy Mountains of central Montana between the Amsden and Madison formations.

Perry (17) states that in the type locality "the group consists of an upper 450 feet of black petroliferous shale with sandstone lenses (Heath formation); a middle 600 feet of gray to vivid green shale with some anhydite and gypsum and beds of limestone and sandstone (Otter Formation); and a basal 130 feet of red to brown shaly or calcareous fine-grained sandstone (Kibbey formation). The group of sediments thin gradually southward and disappear near Three Forks". The formation has been heavily eroded in northern Montana and is not known to be present in the extreme north section of the state. The group is also missing in the Big Horn Mountains of Wyoming and Montana and in the Black Hills of South Dakota and Wyoming.
Amsden Formation

In the type section, the Amsden formation consists of a basal member of red to purple and yellow sandy shale and an upper member of limestone. In the south-central Montana area, the Amsden formation consists of approximately 200 feet of fine-grained buff-colored limestone which is underlain by 10 to 20 feet of purple, red, and buff-colored calcareous sandy shale. In the Whitehall area, the shale zone has decreased in amount until the horizon consists of about five feet of bright red, shaly limestone. These Amsden "redbeds" are conspicuous markers in that area and often impart a characteristic red color to the alluvium in the vicinity.

In southern Montana, the Amsden rests disconformably upon Madison limestone of lower Mississippian age and is overlain by the Quadrant quartzite of Pennsylvanian age. To the northward, the Big Snowy Group is introduced and in the vicinity of the Little Belt Mountains, this series reaches a thickness of over 1200 feet. In that locality, the Amsden rests conformably on the Heath (upper member of the Big Snowy Group) and is overlain disconformably by the Ellis formation of Jurassic age.

YAKINIKAK FORMATION

The description of the Yakinikak presented here is that given by Bailey Willis. (25) "The rock is light grey, and dark blue, limestone about 100 feet thick, distinctly bedded, commonly crystalline, occasionally oolitic. Some fractures have a black speckled appearance due to dark cleavage faces on calcite crystals. It is without upper stratigraphic limit, but rests conformably on a quartzite, which is unconformable on Algonkian
strata. The quartzite is about 25 feet thick, and it and the limestone lie in a nearly horizontal position. The name Yakinikak is here applied to the limestone, exclusive of the quartzite which may elsewhere develop independent importance."

The hand samples of the limestone in the author's possession display the same color, crystallinity, and oolitic characteristics cited by Willis. None of the samples, however, exhibit the black speckled feature which has been described.

Willis states that the presence of the Yakinikak formation lying at a comparatively low level among mountains composed of Algonkian argillites may be due to down-faulting of the high, rugged, limestone mountains, known as the Wigwams, which form the divide between the Wigwam and Flathead rivers. "Its presence in this locality taken in connection with other occurrences north and south, may be evidence of the former extension of upper Mississippian limestone over this entire area. The absence of earlier Mississippian strata in the area may be indicative of an unusual overlap."
CONCLUSIONS

As a result of his study of Upper Mississippian faunas of western Montana, the author has reached the following conclusions:

(1) The fauna from the Blacktail Range is distinctly Chester (Upper Mississippian) in age and contains several species represented in the fauna of the Big Snowy Group.

(2) The Blacktail Range itself is a unit of the Big Snowy Mountains.

(3) The Amsden formation in central and western Montana is Upper Mississippian in age.

(4) None of the areas of Amsden deposition studied contained any lower Pennsylvanian faunas.

(5) The Yakinikak formation of northwestern Montana contains a good Upper Mississippian fauna.

(6) The presence of the Yakinikak limestone in an area of pre-Cambrian strata is due to down faulting of the limestone mountains known as the Wigwam Mountains which lie to the north of Yakinikak Creek.
<table>
<thead>
<tr>
<th>GENUS AND SPECIES</th>
<th>LOCATION</th>
<th>AGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spirifer incrassatus</td>
<td>Amsden, North Boulder</td>
<td>Chester</td>
</tr>
<tr>
<td></td>
<td>Amsden, South Boulder</td>
<td>Ste. Genevieve</td>
</tr>
<tr>
<td></td>
<td>Amsden, Sappington</td>
<td>Sacajawea</td>
</tr>
<tr>
<td></td>
<td>Amsden, Haymaker Creek</td>
<td>Kinderhook</td>
</tr>
<tr>
<td></td>
<td>Big Snowy, Blacktail Range</td>
<td></td>
</tr>
</tbody>
</table>
DESCRIPTION OF SPECIES

CLASS BRACHIOPODA

Genus PRODUCTUS Sowerby

Weller's description (23):--"Shells varying from small to very large, deeply concave-convex in form, usually produced anteriorly, the hinge line straight and usually equaling the greatest width of the shell, commonly auriculate at the cardinal extremities. Pedicle valve without cardinal area or hinge teeth, the two valves held together at the cardinal margin by the strongly incurved beak of the pedicle valve. Brachial valve more or less concave, or nearly flat in the visceral region, becoming more strongly curved towards the anterior and lateral margins; cardinal area, dental sockets or socket plates absent or very rudimentary, the cardinal process large and strong, extending far beyond the hinge-line into the umbral cavity of the opposite valve. Surface of both valves marked by distinct, subequal, regular or flexuose, and usually continuous radiating costae, and by concentric undulations or wrinkles which are commonly restricted to the posterior portion of the valves or to the region towards the cardinal extremities. More or less elongate, hollow spines are present in various situations upon the shell surface, usually most conspicuously developed in the region of the cardinal extremities."

Remarks:--Several species of this genus are present in the author's collection. They are especially numerous in the limestones of the Big Snowy Group, being practically the only types present in a sufficiently well preserved state to make
identification possible. The genus is easily recognized and can be used in many instances for correlational purposes.

**PRODUCTUS INFLATUS** MoChesney

Plate 1 Figs. 1-2


Description:—Shell of medium size, longer than wide, the greatest width at the hinge line. The dimensions of a pedicle valve are: length 41 m.m., width 29.4 m.m., convexity 18 m.m.

Pedicle valve gibbous, the umbonal region protuberant beyond the hinge line, the beak strongly incurved, the surface curving abruptly to the cardinal margin and more gently to the lateral and anterior margins, lateral slopes steep in the posterior half of the shell but flattened abruptly at the cardinal extremities into distinct auriculations. Surface of valve marked by rounded, radiating costa which increase by bifurcation on the posterior slope of the valve, usually continuing across the anterior slope without division. Concentric wrinkle-like markings cross the plications and are especially visible on the posterior part of the shell. A few spine sockets are interspersed across the valve especially around the auriculations.

Brachial valve gently concave, the greatest concavity posterior to the middle, the surface curvature regular to the margins. Plications are similar to those of the opposite valve, and well-developed growth lines cross the anterior part of the shell.

Remarks:—This species is abundant in both the Amsden formation and in the Big Snowy Group but it is very difficult to find a well preserved specimen except on weathered surface. The au-
thor was unable to secure a suitable complete specimen showing both valves.

The species is abundant in a limestone bed of the Blacktail Range which is probably the equivalent of the limestone unit at the top of the Otter formation.

PRODUCTUS OVATUS
Plate 1 Figs. 3


Weller's description:—"Shell thin and delicate, variable in size but usually of medium size or larger, longer than wide, the hinge-line shorter than the greatest width, the cardinal extremities angular. The dimensions of a nearly complete pedicle valve are: length from hinge-line to front margin 27.5 m.m., length from umbonal region to front margin 34 m.m., greatest width 27 m.m., length of hinge-line 23.5 m.m., convexity 22.5 m.m."

Pedicle valve gibbous, the greatest convexity posterior to middle. Surface of valve marked by five, rounded, flexuose costae; about three costae occupy the space of 1 m.m. Concentric wrinkle-like markings are present on the posterior portion of the valve. A few slender spine bases are scattered irregularly over the surface of the shell.

Remarks:—Specimens of P. ovatus are reputed to be numerous in the fauna of the Big Snowy Group. The writer has obtained only one specimen, however, and that one is a very imperfectly preserved specimen.

Horizon:—Big Snowy Group
PRODUCTUS SP.

Plate 1 Figs. 4-5-6

Two specimens of Productus have been found in the Big Snowy assemblage that are not found in Weller's Monograph on Mississippian Brochiopoda. The species bear some resemblance to *P. inflatus* but are larger and longer than that animal. There is also a lack of radiating costae on the posterior slope of the pedicle valve which is characteristic of *P. inflatus*.

An attempt has been made by the writer to correlate this species with Lower Pennsylvanian types, but no species which agrees with the type was found.

Horizon: - Big Snowy Group

Family TEREBRATULIDAE

Genus GIRTYELLA Weller

Weller's description: - "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 socket retreat from the margins of the valve anteriorly beyond the point of auriculation 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:—Genus Girtyella is well represented in two formations studied by the author. The Yakinikak limestone yielded several good specimens of the species G. indianensis. This species is also present in the assemblage from the Big Snowy Group.

**GITYELLA INDIANENSIS (Girty)**

Plate I  Figs. 7-8-9


Description:—Shell small, subovate or subpentagonal in outline, the greatest width a little in front of the middle. The dimensions of two specimens are: length 12 m.m., 10.2 width m.m., thickness 8 m.m.

Pedicle valve most convex posterior to the middle, the surface curving abruptly to the cardinal margin and gently to the lateral and anterior margins; mesial sinus obsolete in the umbo- nal region, rarely originating posterior to the middle most often being confined to the anterior third of the valve; shallow, rather narrow and rounded in the bottom; the beak prominent and projecting well beyond that of the opposite valve.

Brachial valve a little less convex than pedicle, the greatest convexity at or near the middle, the surface arched with more abrupt curvature anteriorly, the lateral slopes regularly convex; mesial fold obsolete; beak small and incurved beneath that of opposite valve.

Surface of both valves marked by fine, concentric lines. Shell surface in most specimens is finely punctate.
Remarks---This species is found perfectly preserved in the Yakinikak limestone and is also found in the Big Snowy Group especially on weathered surfaces. It is often confused with *G. brevilobata* but may be distinguished from that species because of its sinus developed in the anterior part of the pedicle valve and by the absence of fold on the brachial valve which is so characteristic of *G. brevilobata*.

Genus *DIELASMELLA* Weller

Weller's Description:—"Shell terebratuliform, compressed. Pedicle valve with well developed dental lamellae of moderate length. Brachial valve without medium septum or true hinge plate—Shell structure finely punctate."

**DIELASMELLA COMPRESSA** Weller

Plate 1  Figs. 10-11


Weller's Description:—Shell very small, lenticular, compressed subovate in outline usually longer than wide, the greatest width near the mid-length of the shell. The dimensions of a specimen are: length 5.9 mm, width 5 mm, thickness 2.5 mm.

Pedicle depressed convex, the greatest convexity posterior to the middle, the surface usually very gently convex towards the lateral margins———-the surface is abruptly inflected to the cardinal extremities; the median portion of the valve differentiated
From the lateral slopes as a narrow, somewhat ill-defined flattened region which is sometimes slightly depressed medially in a faint sinus; the beak pointed and nearly erect.

Brachial valve equally convex with pedicle, the greatest convexity posterior to the middle;——the median portion of the valve, differentiated as a rather narrow, flattened region similar to the opposite valve.

Surface of both valves nearly smooth, marked only by fine concentric lines of growth. Shell structure finely punctate.

Remarks.—The author at first identified this genus as small forms of *Girtyella* *indianensis* but later decided that the specimens lacked certain characteristics of *G* *indianensis* such as the incurved beak and greater convexity of the shells.

Horizon: Yakinikak limestone.

Genus *DIELASMA* King

Plate 1 Figs. 12


Weller's Description:—"Shell terebratuliform. Pedicle valve with or without median sinus——. Brachial valve usually without mesial fold; internally the crural plates are separate from the dental socket plates, they diverge from the apex of the valve with an elongate attachment to the inner surface of the valve, the free portion of the brachidium is short with diverging descending lamellae."

"Shell of medium size, subovate or subpentagonal in outline, the greatest width near the middle, the anterior margin rounded."
Remarks:--Only one member of the genus was found in the collection from the Blacktail Range and this was so badly crushed and distorted as to make identification of the species impossible.

Horizon:--Big Snowy Group.

Genus COMPOSITA Brown

Weller's description:--"Shells small or of medium size, sub-ovate, subquadrangular to subpentagonal in outline, the valves bi-convex, 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 the 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 the 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 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."

Remarks:--This genus is fairly well represented in the fauna of the Big Snowy Group and in the Amsden limestone. Two species are present in the collection.

Powe's Description, (18):—"Shell of medium size, subovate or subquadrate in outline, usually wider than long, the greatest width near and anterior to the middle, the hinge-line much shorter than the greatest width. The dimensions of three specimens are: length 27 mm., 26 mm., and 23.5 mm.; width 28.5 mm., 26 mm., and 24 mm., thickness 18 mm., 18.5 mm., and 16.5 mm.

Pedicle valve strongly convex, the greatest convexity posterior to the middle, the surface curvature less abrupt toward the anterior margin than toward the posterior margin, the lateral slopes passing with gradual convex curvature to the lateral margins; mesial sinus originating in the umbonal region and becoming broader and deeper anteriorly; beak rather large, incurved and pierced by a large, subcircular foramen which encroaches upon the umbonal region; cardinal area obsolete.

Brachial valve more convex than the pedicle, the greatest convexity posterior to the middle, the surface curvature regularly convex to the anterior and posterior margins, the lateral slopes regularly convex; mesial fold originates in the anterior half of the shell becoming higher toward the anterior margin; beak closely incurved beneath that of the opposite valve.

Surface of both valves marked only by concentric growth lines which are most numerous and most conspicuous near the anterior margin."
Remarks:—Two well-preserved specimens of the above species were present in the collection from the Amsden limestone and one from out of the Big Snowy Group. This species may be used as an index fossil and is easily recognizable.

COMPOSITA TRINUCLEA (Hall)
Plate 2 Figs. 4-5-6


Powers's Description:—"Shell small, subovate or subquadrate in outline, the length usually greater than the width, the greatest anterior to the middle, the hinge-line shorter than the greatest width. The dimensions of three specimens are: length 15 mm., 13 mm., and 12 mm., width 13.5 mm., 13 mm., and 12 mm., thickness 6.5 mm., 6.5 mm., and 6 mm.

Pedicle valve convex, the greatest convexity posterior to the middle, the surface curving abruptly to the cardinal margin and gently to the anterior margin, the lateral slopes convex; mesial sinus originating in the umbonal region, becoming, wider and deeper anteriorly; beak small, incurved and pierced by a large, subcircular foramen; cardinal area obsolete.

Brachial valve convex, the greatest convexity near the middle, mesial fold extending from the cardinal margin to the anterior margin, becoming higher and more sharply defined anteriorly, lateral ridges are present on each side of the fold separated from it by distinct furrows which give to the valve a trilobate appearance; lateral slopes regularly convex from the ridges to the lateral margins; beak small and closely incurved beneath that of the opposite valve.
Surface of both valves marked only by concentric growth lines which are most numerous and most conspicuous near the anterior margin.

Remarks:--C. trinuclea is well represented in the Yakini-kak limestone, but it is difficult to secure good specimens. Some fragments of the species were also present in the Amsden formation.

Horizon:--Yakinikak limestone, Amsden formation.

Family ATHYRIDAE
Genus CLIOTHYRIDINA Buckman

Weller's description:--"Shells small, of medium size or large, from subcircular to transversely subelliptical in outline, mesial sinus of the pedicle valve and fold of the brachial valve well developed or obsolete, the surface of the valves marked by broad, thin, lamellar extensions, which are divided nearly or quite to their bases into long, flat spines. The beak of the pedicle valve usually incurved so as to conceal the foramen and delthyrium in the mature shells, the dental lamellae and muscular scars as in Athyris. In the brachial valve the hinge-plate and brachidium are similar to the same structures in Athyris."

Remarks:--Two specimens which correspond to this genus were found in the collection, one from the Yakinikak and one from the Big Snowy. The specimens, however, were not complete enough to identify the species.

The species examined consisted of two deformed pedicle valves. The shells were 12.5 m.m. long and 10.2 m.m. wide and possessed certain characteristics of C. sublamellosa but the author did not feel justified in assigning them to this species because of lack of complete details.

Family SPIRIFERIDAE
Genus SPIRIFERINA d'Orbigny

Weller's description:—"Shells usually small, spiriferoid in form, transverse, the greatest width usually along the hinge-line and the cardinal extremities acutely angular; mesial fold and sinus well developed, either non-plicate or covered with simple plications, and the whole shell marked by sublamellose, concentric lines of growth. Pedicle valve with a moderately high, arched cardinal area having an open delthyrium; internally the dental plates are well developed and continue to the inner surface of the valve along the lateral margins of the muscular scar, between them a well developed median septum is present which extends further anteriorly than the dental lamellae and may reach beyond the center of the valve. In the brachial valve the spiral cones are directed laterally as in Spirifer, the primary lamellae being joined by a simple transverse or subacute jugum. Shell structure strongly punctate throughout."
SPIRIFERINA SPINOSA (Norwood and Pratten)

Plate 2  Fig. 9


Weller's Description:- "Shell below medium size, broader than long, the greatest width along the hinge-line or a little anterior to it, the cardinal extremities angular or a little rounded. The dimensions of two perfect specimens are: length of pedicle valve 14.2 m.m. and 12.5 m.m., width 18.7 m.m. and 20.4 m.m., and thickness 12.5 and 9.8 m.m."

Pedicle valve most convex posterior to the middle, the umbo prominent, the surface curving abruptly to the cardinal margin and more gently to the anterior margin, often a little compressed towards the cardinal extremities; the mesial sinus sharply defined, originating at the beak, of moderate width and rather deep, subangular in the bottom; the beak rather small, pointed and incurved; cardinal area of moderate height, concave with the curvature increasing towards the beak, the lower and flatter portion lying at nearly a right angle to the plane of the valve, the lateral margins well defined but rounding rather abruptly to the lateral slopes of the valve; delthyrium about as wide as high; each lateral slope marked by five or six rounded or subangular, simple plications, which originate along the cardinal margin, those bounding the mesial sinus are the strongest, the others becoming successively smaller to the cardinal extremities. Internally a strong median septum reaches from the beak to more than one-third the length of the valve,
the hinge-teeth are supported by dental plates which diverge anteriorly and extend about one-third as far as the median septum.

Brachial valve nearly or quite as convex as the pedicle, the greatest depth near the middle or towards the front of the mesial fold; the surface convex on each side of the fold, usually becoming a little compressed towards the cardinal extremities; mesial fold rounded or subangular, sharply defined, moderately or rather highly elevated in front; the beak small and incurved; the cardinal area very narrow, lying in nearly the plane of the valve; the plications on the lateral slopes are similar to those of the opposite valve and alternate with them.

Surface of both valves, when well preserved, marked by crowded tubercles which are the bases of spinules which are scattered in position or sometimes are arranged in rather irregular radiating rows. One or more rather strong lines of growth are sometimes present towards the anterior margin of the valves. Shell substance punctate."

Remarks:—One specimen from out of the Yakinikak was identified as S. spinosa. This specimen consisted of a fragment of a brachial valve and possessed the prominent characteristics described by Weller. It is a common Chester type and can be recognized by the surface markings.
SPIRIFERINA TRANSVERSA (McChesney)

Plate 2 Figs. 10-11


Description:—Shell small, broader than long, the greatest width along the hinge-line, the length about equal to the thickness. The dimensions of one individual is; length 9 m.m., width 17 m.m., thickness 9 m.m.

Pedicle valve convex, the greatest convexity posterior to the middle, the umbo prominent, the surface curvature gradual to the anterior margin and abrupt to the cardinal margin; the mesial sinus sharply defined, originating at the beak, moderate in width and rather deep, subangular in the bottom; the beak small and slightly incurved; each lateral slope of the valve marked by six to nine subangular plications.

Brachial valve about equally convex with the pedicle, the greatest convexity posterior to the middle; mesial fold rounded or subangular, sharply defined, moderately or rather highly elevated in front; the beak small and incurved; median fold originating at the beak, becoming more strongly elevated anteriorly and marked by a median groove which originates near the middle of the shell.

The surface of both valves marked by six to nine subangular plications on each lateral slope, the plications of the two valves alternating at the anterior margins. Surface also marked by fine sublamellose lines. Shell structure finely punctate.

Remarks:—Several specimens which are probably of the above species are present in the Yakunikak limestone, but they are
badly broken and fragmentary and make actual identification impossible. The species is often confused with *S. solidrostris* but *S. transversa* has somewhat finer plications and a narrower umbonal region.

Horizon: Yakinikak limestone.

**Genus SPIRIFER Sowerby.**

Weller's 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 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 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 at the cardinal margin 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 form 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 shell layers bear a series of vertical canals at whose extremities along the hinge-line the shell thins to one
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 obcordate 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 cones 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:-- Genus Spirifer is well represented in the author's collection. Many complete and well preserved specimens were gathered from the Amsden formation. The Yakinikak limestone also contained several fine specimens.

SPIRIFER SP.

Plate 2-Fig. 12

Description:-- Two large Spirifer were obtained from two different areas in the Amsden formations. Both specimens were crushed pedicle valves and were found on the weathered surface of the limestone. The dimensions of the pedicle valve of one
specimen is length 42 m.m., width 40.2 m.m., and thickness about 12 m.m. The valve is marked by about 17 rounded plications. The mesial sinus is shallow and poorly defined. The features of the pedicle valve coincide with those of *S. shoshonenses* (Branson) but the author did not have a complete enough specimen to make an accurate comparison.

Horizon: - Amsden formation.

**SPIRIFER INCREBESCENS** Hall
Plate 2 Figs. 13-14-15
Plate 3 Figs. 1-2-3


Weller's Description: - "Shell of medium size, wider than long, greatest width along the hinge-line, the valves subequally convex. The dimensions of two individuals are; length 31 m.m. and 28 m.m., width 40 and 44 m.m. and thickness 23 m.m. and 19 m.m.

Pedicle valve with it's greatest convexity posterior to the middle, the surface sloping abruptly from the more or less gibbous umbonal region to the cardinal margin and more gently to the antero-latereal margins. Beak pointed and incurved; cardinal area concave becoming more curved towards the beak.

Brachial valve with its greatest convexity near the middle, the surface sloping more abruptly towards the cardinal margin, usually somewhat compressed towards the cardinal extremities; mesial fold sharply defined at the beak but scarcely elevated above the general surface of the valve. It is marked by a median furrow corresponding with the median plication of the sinus and usually with two plications on each side.
The surface of both valves are marked by exceedingly fine concentric and longitudinal lines which give it a finely reticulate appearance under a lens, and by coarser lines of growth which are sometimes crowded towards the anterior margins."

Remarks: This species is most like *S. pellaensis* but is always larger in its adult condition with a greater number of plications and greater uniformity in its general outline. It is very abundant in the Amsden formation of the North Boulder area.

**SPIRIFER WELLERI** (Branson)

Plate 3 Figs. 4-5-6


Branson's Description: "Shell below medium size; length and breadth subequal; greatest breadth in front of the hinge line; cardinal extremities rounded. The average size of eight full-grown specimens is: Length, 16 mm.; breadth, 17.6 mm.; thickness, 10.4 mm.

Pedicle valve strongly convex, with greatest convexity opposite the hinge line; beak strongly incurved; cardinal area high, short, height and breadth as 1 to 3. Cardinal area not sharply defined, but with the shell rounding to meet the area; lateral slopes of the valve convex, marked by 9 to 11 subangular to rounded plications. The mesial sinus is broad and shallow and originates at the beak; a median plication starts at the umbone and increases in size backward; two plications come into the sinus by bifurcation of the marginal plications, and these may remain small or become subequal to the median plication.

Brachial valve much less convex than the pedicle. The mesial fold which originates at the beak is set off from the rest of the
shell by grooves that are deeper and wider than those between the plications. Near the beak the fold is not elevated above the rest of the shell, but anteriorly it becomes prominent. A median furrow originates at or near the beak, and two shallower, lateral furrows originate about the middle of the fold.

Remarks:—This species is very much like *S. pellaensis* but according to Branson "it has been given species rank on account of the constantly short hinge line and high narrow area. It is the most abundant Spirifer in the Amsden."

**SPIRIFER PELLAENSIS** Weller

*Plate 3* Figs. 7-9-9


Powe's Description:—"Shell below medium size, wider than long, the greatest width at the hinge-line, the cardinal extremities angular or slightly acuminate, the valves subequally convex. The dimensions of two specimens are: length 27 and 23.5 mm., width 37 and 28 mm., thickness 20 mm. and 18 mm.

Pedicle valve most convex posterior to the middle, the beak pointed and closely incurved, the cardinal area concave, its height 3 to 4 mm. Lateral slopes of the valve convex, becoming slightly compressed toward the cardinal extremities, the surface curving much more abruptly to the posterior margin than toward the anterior or lateral margins, each lateral slope bearing 10 or 11 angular or slightly rounded plications which grow gradually smaller toward the cardinal extremities; the second plication on each side originates near the beak from the outer side of the first, and the third plication originates near the middle of the shell from
the inner side of the fourth, the remaining ones usually extend to the anterior margin without division; the mesial sinus originates at the beak where it is angular and sharply defined, becoming wider but still well defined anteriorly. An angular median plication originates near the beak becoming larger toward the anterior margin. Each of the lateral bounding plications gives rise to a plication which continues to the anterior margin without division. These lateral plications within the sinus are smaller than the median plication and occasionally they are nearly obsolete.

Brachial valve about equally convex with the pedicle, its greatest convexity near the middle, the surface curving a little more abruptly to the cardinal margin becoming slightly compressed toward the cardinal extremities; a mesial fold originates becoming higher and wider anteriorly and bearing a median furrow; on each lateral slope of the fold is a single plication which is sometimes very weak; lateral slopes marked by plications similar in size and number to those of the opposite valve."

Remarks:—This is a very common type in the Amsden formation. Specimens were secured from North Boulder, South Boulder, and Sappington. Most specimens are well preserved.

Family RHYNCHONEILLIDAE

Genus CAMAROTOECHIA Hall and Clarke

Weller's description:—"Shell rhynchonelliform, small or below medium size, subovate, subpentagonal or subtriangular in outline. The mesial fold and sinus well developed, the surface of both valves marked by angular or subangular plications which extend to the beak, the plications not medially grooved in front. In the pedicle valve the hinge-teeth are rather small and are supported by slender, vertical, dental lamellae. In the brachial
valve a well-defined median septum is present in the rostral portion of the valve which is divided internally to form a V-shaped crural cavity, the hinge-plate is divided, the inner margin of each lateral portion being supported by one of the lateral walls of the crural cavity; no cardinal process is present and the crura are formed by the anterior extension of the inner margins of the two divisions of the hinge-plate."

CAMAROTOECHIA MUTATA (Hall)
Plate 4 Figs. 1-2

Weller's description:—"Shell subovate triangular in outline, wider than long, the greatest width in the posterior portion of the shell immediately in front of the hinge-line. The dimensions of an individual are: Length 9.7 mm., width 10.6 mm., and thickness 7 mm.

Pedicle valve convex in the umbonal region, usually flattened in the middle and towards the antero-lateral margins, the surface curves more abruptly to the antero-lateral margins and is arched from the beak to the front; the beak is pointed, only slightly incurved and is produced posteriorly beyond that of the brachial valve; plications are simple, slightly angular, becoming faint close to the beak; fourteen plications extend from medial sinus to lateral-extremities.

Brachial valve more strongly convex than the pedicle, greatest convexity anterior to the middle; medial portion of valve somewhat flattened transversely; mesial fold weakly defined except upon the abrupt anterior slope of the valve; the beak strongly incurved beneath the opposite valve. Plications similar in form and number
to those on opposite valve."

Remarks:—One specimen was found in the Yakinikak limestone. No representative of the genus could be found in either the Amsden formation or the Big Snowy Group.

CORALS

Three different species of corals were found in the Yakinikak formation and one each from out of the Amsden and Big Snowy Group. Due to the lack of available literature the author was unable to make positive identifications on any of these.

One species found in the Yakinikak has been tentatively identified as Menophyllum princetonensis and that from the Amsden as Zaphrentis Amsdenensis. The single specimen from the Big Snowy is a large member of the genus Caninia.

ZAPHRENTIS AMSDENENSIS (Branson)

Plate 3  Fig. 10


Branson's description:—"Corallum horn-shaped, circular in cross-section, slightly curved, sides diverging at an angle of about 30 degrees. Surface marked by inconspicuous wrinkles, unequally spaced. Calyx shallow; fossula indistinct on the shorter, concave side of the corallum; septae averagin 36, approaching the center in pairs, but leaving a small central area clear.

Dimensions of largest specimen collected: Length, 51 mm.; diameter, 24 mm.; average specimens, length, 35 mm.; diameter, 15 mm.; smallest specimens, length, 14 mm.; diameter, 8 mm.
*Z. amsdenensis* differs from *Z. pellaensis*, probably the most closely related species, in the absence of spines, smaller angle of divergence of the sides, and less conspicuous fossula. From *Z. daeli* Milne Edwards and Haime, another closely related species, it differs in the absence of spines and the less conspicuous fossula."

Remarks:—The specimens in the author’s collection agree in size and external characteristics with those described by Branson.
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Explanation of Plate 1

Figures 1-2. *Productus inflatus* (McChesney) ................................................. 9
   Pedicle views of two specimens.

Figure 3. *Productus ovatus* (Hall) ................................................................. 10
   View of a single pedicle valve.

Figures 4-6. *Productus* sp................................................................. 11
   Pedicle and lateral views of a specimen.

Figures 7-9. *Girtyella indianensis* (Girty) ................................................. 12
   Brachial, lateral, and pedicle views of a specimen.

Figures 10-11. *Dielasma compressa* ..................................................... 13
   Pedicle and brachial views of two specimens. x3.

Figure 12. *Dielasma* sp. (King) ................................................................. 14
**Explanation of Plate 2**

| Figures 1-3. | Composita subquadrata (Hall) | Pedicle, brachial, and lateral views of a specimen from the Blacktail Range. | 16 |
| Figures 4-6. | Composita trinuclea | Pedicle, brachial, and lateral views. | 17 |
| Figures 7-8. | Cliothyridina sp. | Views of two imperfect pedicle valves. | 19 |
| Figure 9. | Spiriferina spinosa (Norwood and Pratten) | View of a fragmentary pedicle valve. | 20 |
| Figures 10-11. | Spiriferina transversa (McChesney) | Views of two pedicle valve fragments. | 22 |
| Figure 12. | Spirifer sp. | View of a pedicle valve. | 24 |
| Figures 13-15. | Spirifer increbescens (Hall) | Pedicle, brachial, and lateral views of a small specimen. | 25 |
Explanation of Plate 3


Figures 4-6. Spirifer welleri (Branson). Pedicle, brachial, and lateral views. Page 26


Figure 10. Zaphrentis amadenensis (Branson) Page 30

Figures 11-12. Menophyllum princetonensis Page 30
**Explanation of Plate 4**

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figures 1-2.</td>
<td>Camarotoechia mutata (Hall)</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Views of two specimens.</td>
<td></td>
</tr>
<tr>
<td>Figure 3.</td>
<td>Caninia sp. x 1/8</td>
<td>30</td>
</tr>
</tbody>
</table>