6-1950

Fauna and Stratigraphy of the Meagher Formation at Three Localities in Southwestern Montana

William J. Van Matre

FAUNA AND STRATIGRAPHY OF THE MEAGHER FORMATION AT THREE LOCALITIES IN SOUTHWESTERN MONTANA

by
William J. Van Matre

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
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FAUNA AND STRATIGRAPHY OF THE MEAGHER FORMATION

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INTRODUCTION

In the past 75 years, the scenic area about the headwaters of the great Missouri River has attracted the attention of many leading stratigraphers and paleontologists; for in this area bountiful outcrops of Paleozoic fossil horizons are available for study and correlation.

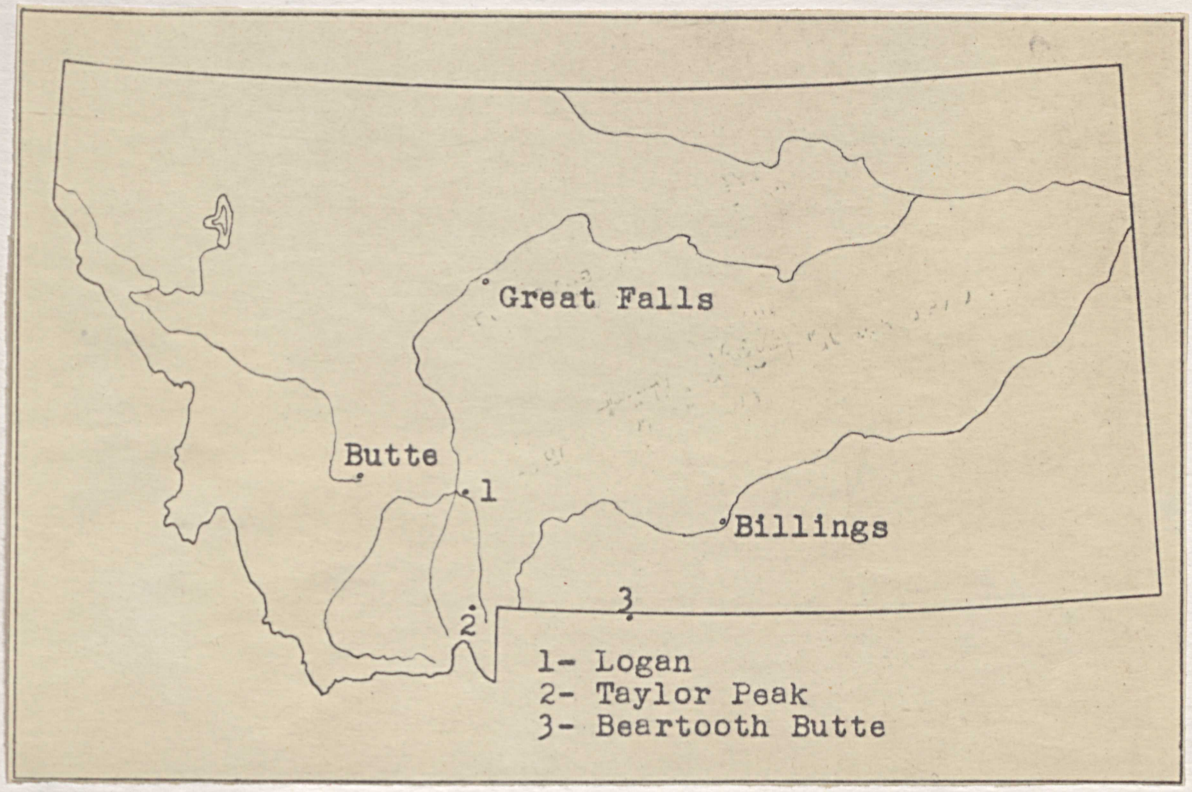

Fig. 1. Location of Sections

This paper presents the results of a laboratory study of specimens collected from the Middle Cambrian Meagher

formation at localities near Logan and Taylor Peaks, Montana and Beartooth Butte, Wyoming. These fossils have been identified, classified, and grouped into faunal zones.

Studies of these strata have been made by Meek (1873), Hayden (1873 and 1888), Peale (1890, 1893, and 1896), Walcott (1891, 1908, and 1916), Weed (1896, 1899, and 1900) Tansley and Schafer (1933), Deiss (1933, 1936, 1938 and 1939), and Bell (1941); and papers published by these writers contributed much to the knowledge of Montana stratigraphy and paleontology concerning the Meagher formation.

Rock samples containing the fossil specimens described herein, and the included stratigraphic descriptions were secured by Dr. Alvin M. Hanson of the Montana School of Mines Geology Department during the summer of 1949. Acknowledgment is given to Dr. Hanson for the use of his specimens and field notes and for his advice and cooperation on many subjects with which this paper is concerned. The author is grateful for the helpful suggestions given him by Dr. Eugene S. Perry of the Montana School of Mines Geology Department. Thanks are also given to Mrs. Loretta Peck for her assistance in locating references and to John T. Eastlick for his assistance in the photographic work.

STRATIGRAPHY

DEFINITION OF MEAGHER FORMATION

The Meagher formation was originally defined by Weed (1900 p. 285) as the thinly and irregularly bedded limestone that capped the summits of Belt Park buttes. He des-

cribed these rocks as consisting of pure, gray limestone mottled with patches of buff-colored, arenaceous, clayey matter. Deiss (1936 p. 1277) showed that the summits of these buttes are actually Pilgrim limestone; therefore, the original definition must be modified. Because the name Meagher has been used repeatedly in the literature to denote the limestones that lie between the Wolsey and the Park shales, Deiss favors retention of the name and offers the following definition of the formation (1936 p. 1331): "The Meagher limestone rests conformably upon the upper beds of the Wolsey shale, and is overlain by the Park shale everywhere in the area. The most diagnostic characteristics of the Meagher formation are the thick- and thin-bedded gray and tan limestones, which contain buff clay flakes and nodules irregularly disseminated throughout most of the lower beds, and weather buff to pale-gray; the green-gray, fissile shales interbedded with the limestones; and the absence of intraformational conglomerates. The Meagher is usually recognizable throughout central Montana by means of buff-weathered cliffs or, in their absence, limestone soil between the Wolsey and Park shales."

The Meagher formation ranges in lithology from a massive dolomite in the western portion of the state (see Fig. 2) to an intermixture of massive and thin-bedded limestones and green-gray micaceous shales in the central portion of the state. The massive beds commonly are characterized by drab-gray oolitic zones. Thin-bedded limestones

near the bottom and top of the formation contain tan and gray mottling, and these zones weather to a buff and gray color. The Meagher formation stands out in the field because it generally forms cliffs above the Wolsey shale, and it is characterized by a notable percentage of shale, either as shaly partings in limestones or as actual beds of shale.

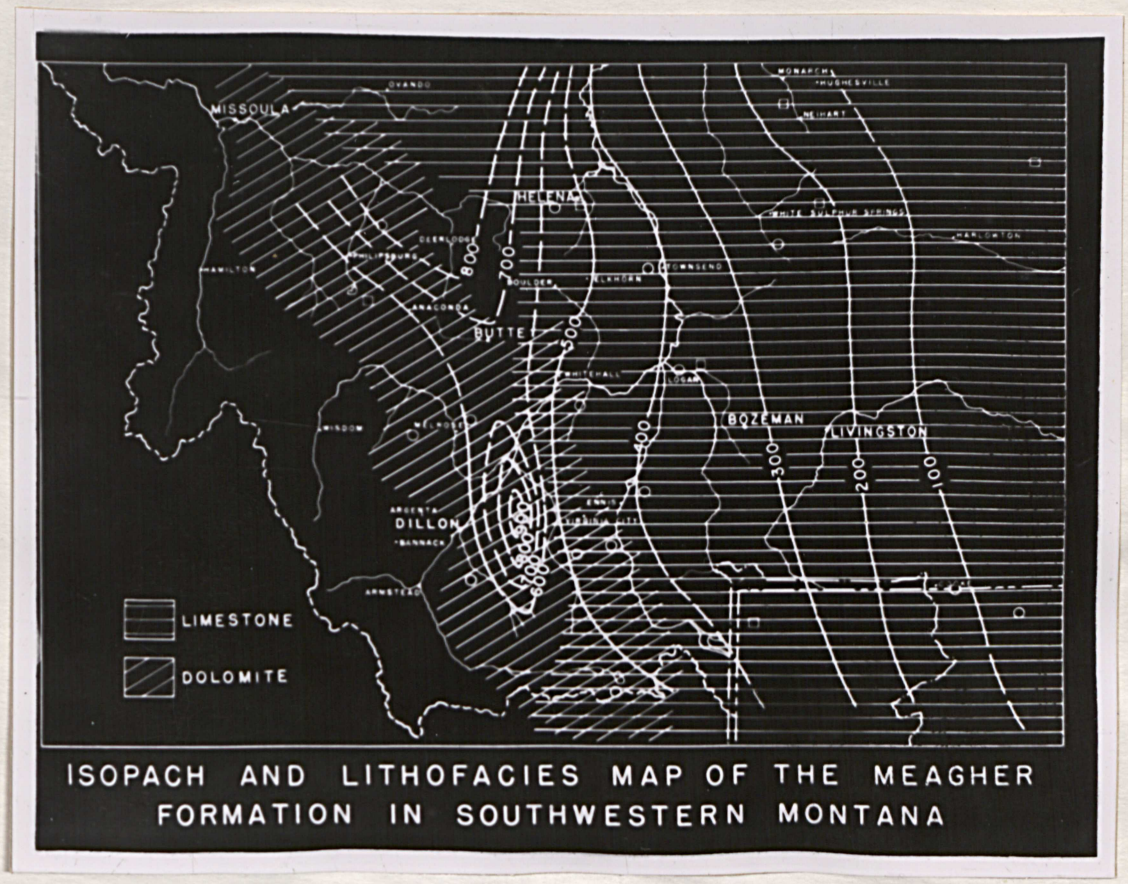

Fig. 2.

Where the Meagher has much shale in its lower members, it may be difficult to determine the boundary between the Meagher and the Wolsey, because the Wolsey commonly contains limy members in its upper horizons.

Fossils are generally more abundant in zones near the

top and bottom of the formation, but at several occurrences they are found throughout the formation. The fossils collected from the Meagher belong to the following species:

Brachiopods--
Micromitra? *sculptilis*

Agnostids--
Agnostus sp. "a"
Agnostus sp. "b"

Trilobites--
Bathyuriscus sp. "a"
Ehmania? sp. "a"
Ehmania sp. "b"
Ehmania sp. "c"
Glyphaspis calenus?
Glyphaspis camma?
Solenopleurella? sp. "a"

THICKNESS AND DISTRIBUTION

The Meagher formation varies in thickness more than any other Cambrian formation in the area. It thickens westward from 50 feet at Beartooth Butte, Wyoming to over 900 feet in the Ruby River valley. Outcrops are numerous and are spread throughout the area; although, they are more common in mountainous regions where the strata has been folded and faulted. Fig. 3 shows locations where the Meagher may be expected to crop out.

According to the Cambrian correlation subcommittee (1944 p. 1003), the Meagher is approximately the equivalent of the Stephen formation in Alberta and British Columbia, the Gros Ventre member of the Depass formation in Wind River Canyon, Wyoming, the Blacksmith formation in the Bear River Range, Utah, and the Pentagon shale of northwestern Montana.

Fig. 3.

DETAILED STRATIGRAPHIC SECTIONS

LOGAN SECTION

The Logan section was measured by Dr. Hanson along the north side of the Gallatin River near Logan, Montana. Because of its abnormal thickness, it is quite possible that the lower 184 feet that were measured are part of the Wolsey shale. Members are listed from top to bottom.

Park shale.

Meagher formation.

(15) Limestone: thin-bedded; similar to (14) .. 24 ft.

(14) Limestone: massive, finely crystalline, dark-gray to dark-brownish-gray; shows tendency to be thin-bedded where highly weathered.....190 ft.

(13) Covered interval: shaly, thin-bedded limestone..... 65 ft.

(12) Limestone: mostly thin-bedded, dark-brownish-gray, shaly partings; some beds in lower 10 ft. medium to thick-bedded, mottly and fossiliferous; fossil zone L-1C12a in lowest 10 ft. of unit..... 57 ft.

(11) Shale: greenish-gray, micaceous, with intercalated brown sandstone; shale:sandstone about 3:1..... 20 ft.

(10) Covered..... 47 ft.

(9) Shale: greenish-gray, drab and purple-drab, micaceous, fissile; intercalated sandstone, thin-bedded with worm trails on surface; one bed of brownish-gray limestone similar to (7); fossil zone L-1C9a 25 ft. above base..... 49 ft.

(8) Limestone: medium- to thick-bedded, dark gray, finely crystalline..... 6 ft.

(7) Limestone: thin-bedded, dark-gray, finely crystalline; thin, shaly partings..... 25 ft.

(6) Limestone: thin-bedded, mottly, gray, drab shale partings; shale:limestone about 1:2..... 7 ft.

(5) Limestone: thin-bedded, mottly, gray, drab shale partings; shale:limestone about 3:1..... 9 ft.

(4) Limestone: thin-bedded, mottly, gray, drab shale partings; shale:limestone about 1:2..... 11 ft.

(3) Limestone: thin- to medium-bedded, medium-gray, fossiliferous; one ft. of drab shale containing limestone lenses near middle..... 4 ft.

(2) Shale: drab, fissile, with thin beds and lenses of medium-gray, fossiliferous limestone; fossil zone L-1C2a..... 4 ft.

(1) Limestone: thin- to thick-bedded, medium-brownish-gray, fossiliferous..... 2 ft.

Wolsey shale.

Total Meagher.....520 ft.

TAYLOR PEAK SECTION

This section was measured by Dr. Hanson in the Taylor Peak area between the head of Tumbledown Creek and Taylor Fork in the west one-half of section 23, T-9S, R-2E, Madison County, Montana. Members are listed from top to bottom.

Park shale.

Meagher formation.

(5) Covered: mottled oolitic limestone in talus..... 50 ft.

(4) Limestone: massive, brownish-gray, finely crystalline, mottled with tan; an occasional thin-bedded zone; upper portion contains pisolitic zone and thin glauconitic zones; estimated thickness...308 ft.

(3) Limestone: brownish-gray, finely crystalline, with intercalated brown shale..... 6 ft.

(2) Limestone: thin-bedded, fine-grained, brownish-gray with tan mottling; bedding planes not distinct; forms a massive ledge; fossil zone X-1B2a in upper two feet..... 33 ft.

(1) Limestone: similar to (2), but more distinctly bedded; weathers down into small ledges and slopes.....75 ft.

Wolsey shale.

Total Meagher.....472 ft.

BEARTOOTH BUTTE SECTION

The Beartooth Butte section was measured by Dr. Hanson in section 31, T-58N, R-105W, Park County, Wyoming. Members are listed from top to bottom.

Park shale.

Meagher formation.

(4) Limestone: thin-bedded, brownish-gray, mottled with tan, finely crystalline; light gray micaceous shale partings in lower two feet..... 20 ft.

(3) Limestone: thin-bedded, similar to (4), mottled, partially covered, interbedded with gray micaceous shale and sandy shale..... 16 ft.

(2) Limestone: thin-bedded, brownish-gray; contains flat pebbles with haphazard orientation; some shaly partings; some beds are glauconitic; three-inch bed at base fine-grained and compact with vertical worm borings..... 15 ft.

(1) Limestone: contains disc-shaped pisolites; four-inch bed of argillaceous fine-grained sandstone four inches above base; four-inch fossil zone B-2Cla at base..... 2 ft.

Wolsey shale. Total Meagher..... 53 ft.

LABORATORY PROCEDURE

Fig. 4. Laboratory Equipment

Before the fossils could be studied and compared for identification and classification, they had to be freed from the surrounding rock matrix and photographed. They

were freed from the rock with the aid of a small hammer and chisel. Before they were photographed, they were thinly coated with magnesium oxide by burning a strip of magnesium metal beneath the overturned fossil. They were then photographed in stereographic pairs in order to obtain relief when the pair of photographs was viewed through a stereoscope. The apparatus shown in Fig. 4 was used to accomplish this, and it was done in the following manner: First, the fossil was photographed from directly above; next, the arm supporting the camera was moved horizontally seven degrees, and the fossil was again photographed.

P A L E O N T O L O G Y

GENERAL DISCUSSION

The fossils studied were mainly trilobites; however, a few agnostids and one brachiopod were observed. Of these, the trilobites are the most diagnostic. The lower fossil zones characteristically contain Ehmania, but a few specimens of Bathyuriscus were also observed. At Logan, Montana, the next higher zone, which may be in the Wolsey shale, contains only Glyphaspis. The top zone, which is definitely in the Meagher formation, contains mostly Bathyuriscus, but Ehmania and Solenopleurella? were also observed.

The fossils of this area have been studied by many noted paleontologists, such as Walcott, Resser, Howell, Lochman, Duncan, Dorf, and Deiss; however little has been published on the fossils of the Meagher formation. Therefore, it was not always possible to identify and classify

a particular species. A question mark will appear behind those classifications which are doubtful.

REGISTER OF FOSSIL LOCALITIES

Logan, Montana.

Zone L-1C2a-- This zone lies two feet above the base of the measured section; however, it is highly probable that the zone may be in the Wolsey shale instead of the Meagher.

Ehmania sp. "b"
Agnostus sp. "a"

Zone L-1C9a-- This zone lies 93 feet above the base of the measured section, and it also may be in the Wolsey shale.

Glyphaspis calenus?
Glyphaspis camma?

Zone L-1C12a-- This zone lies 184 feet above the base of the measured section. It is definitely in the Meagher formation.

Ehmania sp. "b"
Bathyuriscus sp. "a"
Solenopleurella? sp. "a"
Micromitra? *sculptilis*

Taylor Peak, Montana.

Zone X-1B2a-- This zone lies 106 feet above the base of the Meagher.

Ehmania sp. "b"
Bathyuriscus sp. "a"
Agnostus sp. "b"

Beartooth Butte, Wyoming.

Zone B-2C1a-- This zone lies at the base of the Meagher.

Ehmania? sp. "a"
Ehmania sp. "c"
Bathyuriscus sp. "a"

SYSTEMATIC DESCRIPTIONS

PHYLUM BRACHIOPODA

Order Atremata

Genus Micromitra Meek

Micromitra Meek, 1873, 6th Ann. Rept., U.S. Geol. Surv. Terr., p. 479.

Micromitra? sculptilis Meek

(Plate I, figure 1)

One dorsal valve was observed.

Bell (1941 p. 205) gives the following description of this species:

> Outline transversely subelliptical except for truncated posterior margin with elevated ventral apex projecting slightly beyond it; line of valve junction slightly shorter than greatest width of shell; surface ornamentation basically a rectangular pattern formed by junction of fila and radiating ribs or ridges, often greatly modified in younger portions of shell; shell calcareocorneous, composed of a single homogeneous layer, usually thin.

REMARKS: This specimen so closely matches pictures and the description of "M" sculptilis that it is either "M" sculptilis or a species very similar to it.

OCCURRENCE: Meagher formation near Logan, Montana (L-1Cl2a).

PHYLUM ARTHROPODA

Subclass Agnostia

Genus Agnostus Brongniart

Agnostus Brongniart, 1822.

Agnostus sp. "a"

(Plate I, figures 3-5)

Species known from several cephalons and pygidia.

Cephalon subcircular in outline; relatively smooth; moderately convex. Dorsal, transverse, and marginal furrows clearly defined; medial furrow present, but poorly defined. Longitudinal width of anterior lobe two-thirds transverse width. Basal lobe has two pairs of very poorly defined furrows and a very weak, conical tubercle at its mid-point. Anterior lobe is one-third length of glabella.

Pygidium subcircular in outline; moderately convex; relatively smooth. Dorsal and marginal furrows clear; medial and transverse furrows indistinct. Axial lobe relatively large; bluntly pointed at rear; more convex than remainder of shield; has tubercle slightly forward of mid-point.

OCCURRENCE: Meagher formation near Logan, Montana (L-1C2a).

Agnostus sp. "b"

(Plate I, figures 6-9)

Species known from several cephalons and pygidia.

Cephalon subcircular in outline; moderately convex; relatively smooth. Dorsal, transverse, and marginal furrows clearly defined; medial furrow present, but poorly defined. Width of anterior lobe equals its length. Anterior lobe is two-fifths length of glabella. Basal lobe has a very weak, conical tubercle at its mid-point.

Pygidium subcirclar in outline; moderately convex;

relatively smooth. Dorsal and marginal furrows clear; medial furrow poorly defined; transverse furrow absent. Axial lobe pointed at rear; slightly more convex than remainder of shield; has large tubercle slightly forward of mid-point.

REMARKS: Agnostus sp. "b" differs from Agnostus sp. "a" in that it has a larger, anterior, glabellar lobe, no furrows on its basal, anterior lobe, a small and more pointed axial lobe on its pygidium, and greater definition of medial furrows.

OCCURRENCE: Meagher formation near Taylor Peaks, Montana (X-1B2a).

Subclass Trilobita

Genus Bathyuriscus Meek

Bathyuriscus Meek, 1873, 6th Ann. Rept., U.S. Geol. Surv. Terr., p. 282-284.

Bathyuriscus Walcott, 1886, U.S. Geol. Surv., Bull. 30, vol. 64, p. 330.

Bathyuriscus Resser, 1935, Smithson. Misc. Coll., vol. 93, no. 5, p. 13.

Walcott (1916b p. 330) gives the following generic description of Bathyuriscus:

> General form elongate oval. Axial and pleural lobes strongly defined. Cephalon transversely semi-circular with genal angles extended backward in spines of medium length. Marginal border narrow in front, widening towards the genal angles where it merges into the genal spines; posterior margin and occipital ring usually defined by a well-marked furrow. The facial sutures cut the anterior margin a short distance each side of the line of the greatest expansion of the glabella and curve obliquely inward to the anterior base of the eye lobes; encircling the latter, they continue obliquely outward

and cut the posterior margin a short distance inside the base of the genal spine. Glabella elongate, usually expanding towards the broadly rounding front and narrowing slightly midway; marked by three or four pairs of short lateral furrows, the posterior two pairs of which are extended obliquely inward and backward, and the anterior more or less obliquely forward. Occipital segment well-defined and in some species rising at the center to form a base for a small sharp spine that extends obliquely upward and backward. Fixed cheeks moderately convex, with strong postero-lateral limbs, narrow center section, and small antero-lateral limbs; a well-defined palpebral ridge curves around the eye and extends obliquely forward across the dorsal cheek to the dorsal furrow beside the glabella; palpebral lobes narrow and varying in length from one-fourth to more than one-half the length of the cephalon. Free cheeks of medium width and terminating posteriorly in a sharp genal spine; visual surface of eye narrow and elongate.

Thorax with 8 to 9 segments. (The genotype has nine.) Each segment has a node or spine on the median axis and a very distinct, rather broad pleural furrow that extends nearly to the outer termination of the segment. In the type species, a narrow, elongate triangular ridge extends from the axis out into the pleural furrow; this this character is now found in all the species now referred to the genus. The pleural lobes of the segments curve slightly backward and terminate in a short falcate point.

Pygidium semicircular in outline. Median axis nearly as long as the pygidium, convex and marked by several transverse furrows that outline transverse segments; both furrows and segments extend across the pleural lobe to a narrow border.

Bathyuriscus sp. "a"

(Plate III, figures 3-7)

Species known from many cranidia and two pygidia.

No specimens were observed with free cheeks attached to cranidium. Glabella elongate; expanding forward and narrowing slightly midway; marked by four pairs of furrows: posterior pair deep, well-defined, and extending sharply backward; medial pair transverse, very short, and well-defined; anterior pairs less distinct and extending slightly forward. Occipital ring has a small, sharp spine extend-

ing slightly upward and backward. Occipital furrow well-defined. Anterior border very narrow. Fixed cheeks slightly convex, characterized by well-developed palpebral lobes and posterior limbs. Palpebral lobe crescentiform in shape. Occular ridges meet dorsal furrow between first and second glabellar furrows. Facial sutures extend directly back from border to anterior ends of palpebral lobes, follow back around palpebral lobes, then are directed transversely outward to lateral ends of posterior limbs. Hypostoma convex; subtriangular in outline.

Pygidium semielliptical in outline; anterior margin slightly rounded; length two-thirds of width. Width of axial lobe one-third that of pygidium. Axial lobe subquadrate in outline; rounded; composed of three segments and one terminal section, the terminal section being about twice the width of other segments and gently rounded on posterior end. Pleural lobes slightly convex transversely with poorly defined grooves extending to border. Border thickened and even.

REMARKS: This species compares favorably with Bathyuriscus powersi Walcott, and is found near the same locality where "B" powersi is known to occur.

OCCURRENCE: Meagher formation near Logan, Montana (L-1C12a), near Taylor Peaks, Montana (X-1B2a), and near Beartooth Butte, Wyoming (B-2C1a).

Genus Ehmania Resser

Ehmania Resser, 1935, Smithson. Misc. Coll., vol. 93, no. 5, p. 24-25.

Resser (1935 p. 24) gives the following generic description of Ehmania:

> Cranidium of a very common type. Glabella tapered, rounded in form, distinctly demarcated by dorsal furrow; glabellar furrows usually very faint. Brim variable in width, with a convex pre-glabellar area and a flat, upturned rim. Eyes moderate in size, not much bowed, situated about the middle of the cranidium. Fixed cheeks about half as wide as the glabella. Free cheeks show suture intramarginal for some distance and have a stout, short genal spine.
>
> Thorax has 12 to 14 segments in the specimens observed.
>
> Pygidium wide; axis well-defined except at rear; up to six or more axial rings are marked out. Pleural lobes very distinctive because both the pleural furrows and grooves are distinctly impressed to the very margin.

Ehmania? sp. "a"

(Plate II, figures 1-7)

Species known from many cranidia and a portion of a thorax. Several pygidia were also observed.

Glabella typical of Ehmania. Glabellar furrows very weak. Small node present on each side of glabella between anterior pairs of furrows. Occipital furrow moderate. Occipital ring equal in width to anterior border. Brim flatly convex; approximately one-half width of anterior border. Anterior border much longer than in other species of Ehmania. Fixed cheeks flatly convex; very broad, their width being approximately equal to length of cranidium. Palpebral lobes moderate; curved slightly inward; located opposite mid-length of glabella; curved slightly inward;

connected to front quarter of glabella by strong, oblique, occular ridges. Posterior limbs long, flared and curved slightly backward. Facial sutures go inward from anterior border to palpebral lobes, then turn sharply outward to lateral ends of posterior limbs.

Axial lobe of thorax rounded; nearly one-third width of thorax; has well-developed articulating furrows. Pleural lobes flat. Front pleuron about one-half width of back pleuron. End portions of pleurons curved sharply downward and slightly backward.

Pygidium subtriangular in outline. Axial lobe narrow, tapered and rounded; composed of five or six segments, with strongly articulating furrows. Terminal section sharply rounded; extends nearly to posterior edge of pygidium. Pleural lobes flattened. Interpleural grooves and pleural furrows extend out and slightly back from axial lobe, near the lateral edge they curve sharply backward and downward to posterior edge of pygidium.

REMARKS: These cranidia are similar in many ways to Elrathiella Poulsen and Rowia Deiss; however, because of the pygidia with which they were associated, the author deems it wise to temporarily class them under the genus Ehmania. This species differs from previously described species in that it has a wider cranidium and a more triangular pygidium. Ehmania weedi Resser is somewhat similar to this species.

OCCURRENCE: Meagher formation near Beartooth Butte,

Wyoming (B-2C1a).

Ehmania sp. "b"

(Plate II, figures 8-10)
(Plate III, figures 1-2)

Species known from many cranidia and associated pygidia.

Glabella typical of Ehmania; elevated with faint furrows and small nodes similar to Ehmania? sp. "a". Occipital ring and furrow moderate. Brim flatly convex; width one-half that of anterior border. Transverse length of anterior border equal to length of glabella; less than width of free cheeks. Brim slightly upturned. Fixed cheeks moderately convex. Palpebral lobes small and connected to glabella by poorly defined occular ridges. Posterior limbs long, flared, and curved slightly backward. Facial sutures go outward from border to palpebral lobes, follow around palpebral lobes, then curve sharply outward to lateral ends of posterior limbs.

Pygidium semielliptical in outline. Axial lobe short, rounded, and tapered; composed of four or five segments with a bluntly rounded terminal section. Pleural lobes flattened. Pleural grooves and furrows typical of Ehmania.

REMARKS: This species is very similar to Ehmania gallatinensis Meek. It differs from Ehmania? sp. "a" in that it has narrower fixed cheeks and a semiellipical instead of a subtriangular outlined pygidium.

OCCURRENCE: Meagher formation near Logan, Montana

(L-1C2a and L-1C12a) and near Taylor Peaks, Montana (X-1B2a).

Ehmania sp. "c"

(Plate I, figure 10)

Species known from one cranidium.

Cranidium proportions essentially the same as those of Ehmania sp. "b" except that its glabella is much shorter and more tapered.

OCCURRENCE: Meagher formation near Beartooth Butte, Wyoming (B-2C1a).

Genus Glyphaspis Resser

Asaphiscus Meek, 1873, 6th Ann. Rept., U.S. Geol. Surv. Terr., p. 485.

Glyphaspis Poulsen, 1927, Meddels. om Gronland, vol. 70, p. 273.

Glyphaspis Resser, 1935, Smithson. Misc. Coll., vol. 93, no. 5, p. 34.

Walcott (1916b p. 381) gives the following generic description of Asaphiscus (Glyphaspis).

> Dorsal shield subelliptical, moderately convex, distinctly trilobed. Cephalon semicircular in outline with genal angles rounded or prolonged into spines of moderate length; border rounded, strong and clearly defined all about the cephalon; glabella subconical in outline, rounded convex and with only slight traces of a pair of oblique posterior lateral furrows and two pairs of short, faint anterior furrows; occipital furrow shallow and only faintly separating the glabella and occipital ring; fixed cheeks about one-half the width of the glabella, posteriorly they merge into a rather large postero-lateral limb and anteriorly into the broad frontal limb; palpebral lobe of medium size and located just back of the cranidium. Very slight traces of palpebral ridges crossing the fixed cheeks. The facial sutures cut the posterior margin within the genal angles and extend obliquely inward to the posterior end of the eye lobe, in

front of the latter they extend gently outward and incurve across the frontal border. Free cheeks about one-fourth the width of the cephalon; they rise rather rapidly to the base of the narrow eye lobe and may or may not terminate in a genal spine.

Thorax with from 7 to 11 segments; pleurae with stron longitudinal furrow, and usually short falcate ends. The axial portion of the segment may be smooth or have a central node or small spine.

Pygidium relatively large and with a strong convex axial lobe that is divided into several transverse rings by narrow furrows that are slightly indicated on the pleural lobes by shallow furrows; border usually broad and slightly flattened.

Surface smooth or marked by shallow pits, and rarely is it granulated.

Specimens from horizon (L-1C9a) near Logan, Montana are very poorly preserved; however, they so closely resemble pictures and descriptions of specimens Walcott collected from this area in 1916, that the author believes them to be of the same species.

Glyphaspis calenus? Walcott

(Plate III, figures 8-10)

Several pygidia and one cranidium were observed.

Glabella narrow; sharply tapered on anterior end. Brim one-half as wide as rear of glabella. Anterior border narrow and raised. Palpebral lobes large; well-defined; extend from near middle of posterior limb forward and curve into front one-third of glabella.

Pygidium elliptical in outline. Axial lobe narrow; sharply tapered; includes seven segments and a terminal section. Pleural lobes flat; nearly smooth except for four or five pairs of indistinct furrows that terminate at the wide, posterior border.

OCCURRENCE: Fossil zone (L-1C9a) near Logan, Montana.

Glyphaspis camma? Walcott

(Plate IV, figures 1-4)

Two pygidia and two cranidia were observed.

Glabella subtrapezoidal, tapering forward; two pairs of glabellar furrows extend inward and slightly backward. Occipital ring wide; separated from glabella by well-defined occipital ring. Brim wide; terminated by a thin, raised, anterior border. Palpebral lobes large; extending upward from near middle of posterior limb and curving into front one-third of glabella.

Pygidium elliptical in outline. Axial lobe fairly thin; slightly tapered; includes seven segments and a terminal section. Pleural lobes flat; nearly smooth except for four or five pairs of furrows which terminate in the wide, posterior border.

REMARKS: "G" camma? differs from "G" calenus? in that it has a subtrapezoidal shaped glabella, a wider axial lobe, and longer pleural furrows in its pygidium.

OCCURRENCE: Fossil zone (L-1C9a) near Logan, Montana.

Genus Solenopleurella Poulsen

Solenopleurella Poulsen, 1927, Meddels om Gronland, vol. 70, p. 269.

Solenopleurella sp. "a"

(Plate I, figure 2)

Species known from a single cranidium.

Glabella long and smooth; convex; slightly tapered;

rounded in front. Occipital furrow deep and well-defined. Large node present on back of occipital ring. Brim about one-third width of anterior border. Anterior border convex; separated from brim by a well-defined, marginal furrow. Fixed cheeks broad and convex; about two-thirds width of glabella. Palpebral lobes small and well-defined; situated along transverse middle of cranidium. Facial sutures directed backward and slightly outward from anterior border to palpebral lobes. Small occular ridges connect palpebral lobes to dorsal furrow near front of glabella.

REMARKS: This species is similar to Solenopleurella diligens Resser, but differs in that it has a definite node or neck spine.

OCCURRENCE: Meagher formation near Logan, Montana (L-1C12a).

B I B L I O G R A P H Y

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EXPLANATION OF PLATE I

Fig.

Micromitra? sculptilis

1. Dorsal valve (X2½); Meagher formation (L-1C12a), Logan, Montana.

Solenopleurella? sp. "a"

2. Cranidium (X3); Meagher formation (L-1C12a), Logan, Montana.

Agnostus sp. "a"

3. Pygidium (X3); Meagher formation? (L-1C2a), Logan, Montana.
4. Cranidium (X3); Meagher formation? (L-1C2a), Logan, Montana.
5. Cranidium (X3); Meagher formation? (L-1C2a), Logan, Montana.

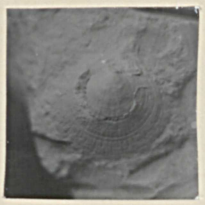
Agnostus sp. "b"

6. Cranidium (X3); Meagher formation (X-1B2a), Taylor Peak, Montana.
7. Cranidium (X3); Meagher formation (X-1B2a), Taylor Peak, Montana.
8. Pygidium (X3); Meagher formation (X-1B2a), Taylor Peak, Montana.
9. Pygidium (X3); Meagher formation (X-1B2a), Taylor Peak, Montana.

Ehmania sp. "c"

10. Cranidium (X3); Meagher formation (B-2C1a), Beartooth Butte, Wyoming.

Plate I



1

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4a

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6a

7

7a

8

8a

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9a

10

10a

MEAGHER FOSSILS

EXPLANATION OF PLATE II

Fig.

Ehmania? sp. "a"

1. Cranidium (X3); Meagher formation (B-2C1a), Beartooth Butte, Wyoming.
2. Cranidium (X3); Meagher formation (B-2C1a), Beartooth Butte, Wyoming.
3. Cranidium (X3); Meagher formation (B-2C1a), Beartooth Butte, Wyoming.
4. Thorax (X3); Meagher formation (B-2C1a), Beartooth Butte, Wyoming.
5. Pygidium (X3); Meagher formation (B-2C1a), Beartooth Butte, Wyoming.
6. Pygidium (X3); Meagher formation (B-2C1a), Beartooth Butte, Wyoming.
7. Pygidium (X3); Meagher formation (B-2C1a), Beartooth Butte, Wyoming.

Ehmania sp. "b"

8. Pygidium (X2); Meagher formation (L-1C12a), Logan, Montana.
9. Pygidium (X2); Meagher formation? (L-1C2a), Logan, Montana.
10. Cranidium (X1½); Meagher formation? (L-1C2a), Logan, Montana.

Plate II

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1a

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7a

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8a

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9a

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10a

MEAGHER FOSSILS

EXPLANATION OF PLATE III

Fig.

Ehmania sp. "b"

1. Cranidium (X2½); Meagher formation (X-1B2a), Taylor Peak, Montana.
2. Pygidium (X2½); Meagher formation (X-1B2a), Taylor Peak, Montana.

Bathyuriscus sp. "a"

3. Pygidium (X2½); Meagher formation (L-1C12a), Logan, Montana.
4. Cranidium (X2); Meagher formation (L-1C12a), Logan, Montana.
5. Pygidium (X2½); Meagher formation (L-1C12a), Logan, Montana.
6. Cranidium (X2); Meagher formation (X-1B2a), Taylor Peak, Montana.
7. Cranidium (X3); Meagher formation (B-2C1a), Beartooth Butte, Wyoming.

Glyphaspis calenus?

8. Cranidium (X2); Meagher formation? (L-1C9a), Logan, Montana.
9. Pygidium (X2); Meagher formation? (L-1C9a), Logan, Montana.
10. Pygidium (X2); Meagher formation? (L-1C9a), Logan, Montana.

Plate III

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1a

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7a

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10a

MEAGHER FOSSILS

EXPLANATION OF PLATE IV

Fig.

Glyphaspis camma?

1. Cranidium (X2); Meagher formation? (L-1C9a), Logan, Montana.
2. Cranidium (X2); Meagher formation? (L-1C9a), Logan, Montana.
3. Pygidium (X2); Meagher formation? (L-1C9a), Logan, Montana.
4. Pygidium (X2); Meagher formation? (L-1C9a), Logan, Montana.

1

1a

2

2a

3

3a

4

4a

MEAGHER FOSSILS