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A New Dorypterid Fish from Central Montana

A new fossil fish fauna has been found in a limestone quarry on the south flank of the Little Snowy Mountains near the abandoned town of Becket, Montana. The fossils occur in the Bear Gulch limestone formation which is early Pennsylvanian or possibly late Mississippian in age.

At least six different kinds of fish can be recognized. Five of them belong to the order Paleonisciformes and one specimen is a coelocanth. The most easily recognized of the Paleoniscid fish is a dorypterid, here named *Allenypterus montanus.* There are four families in the sub-order Platysomoidei which include two rather generalized and two very specialized deep bodied families of fishes. The family Dorypteridae is the most specialized family. Until now, the Dorypteridae have been restricted to one genus Dorypterus, known only from rocks of Permian age in Europe. The family is listed as a separate sub-order by Lehman in the *Traite de Paleontolgie.* However, Gill and Westoll both consider that these fish are derived from a Platysomid ancestor, so Romer's 1966 classification is followed here.

The most distinctive characteristics of the family Dorypteridae are the presence of the post abdominal bone, the high dorsal fin, the additional fin fringe from the base of the dorsal fin to the tail, and the perculiar reduction in the bones of the skull. Westol (1941) discusses the characteristics and probable ecology of such fish in detail, and concludes that *Dorypterus* could only have been derived from a Platysomid ancestor.

The Bear Gulch formation, in which these fish are found, is a relatively thin bedded limestone unit with a thickness of over 200′. The beds range from almost paper thin laminations to about two feet or more in thickness. The lime is dense, siliceous, and very fine grained. The jointing, which is nearly vertical to the bedding, occurs at irregular intervals. Fossils are preserved with a lithographic detail. Marine or at least estuarine invertebrates are found with the fish. The area has been mapped by L. S. Gardiner in USGS Oil and Gas Investigations Preliminary Report 106, but he does not differentiate the Bear Gulch formation from the lower Amsden equivalent which is called Pennsylvanian and Mississippian.

Willis (1959) and Mundt and Foster (1956) describe the formation especially in the sub-surface and mention the marine invertebrate fauna. They regard it as a tongue or lentil in the Tyler formation, and consider it to be of Pennsylvanian age although it may be as early as the latest Chester of Upper Mississippian age (see Fig. 2).

Invertebrates were found in association with the fish, and a good invertebrate fauna locality was found about 15 feet lower in the section downstream from the fish bearing quarry. The eurypterid or scorpion, shrimp, conularid, and marine worms collected by a University of Montana field party, have been examined by Dr. E. P. Stumm of the Museum of Paleontology at the University of Michigan. The conularid may be closely related to the one found in the Phosphoria and Kaibab formations of Permian age.

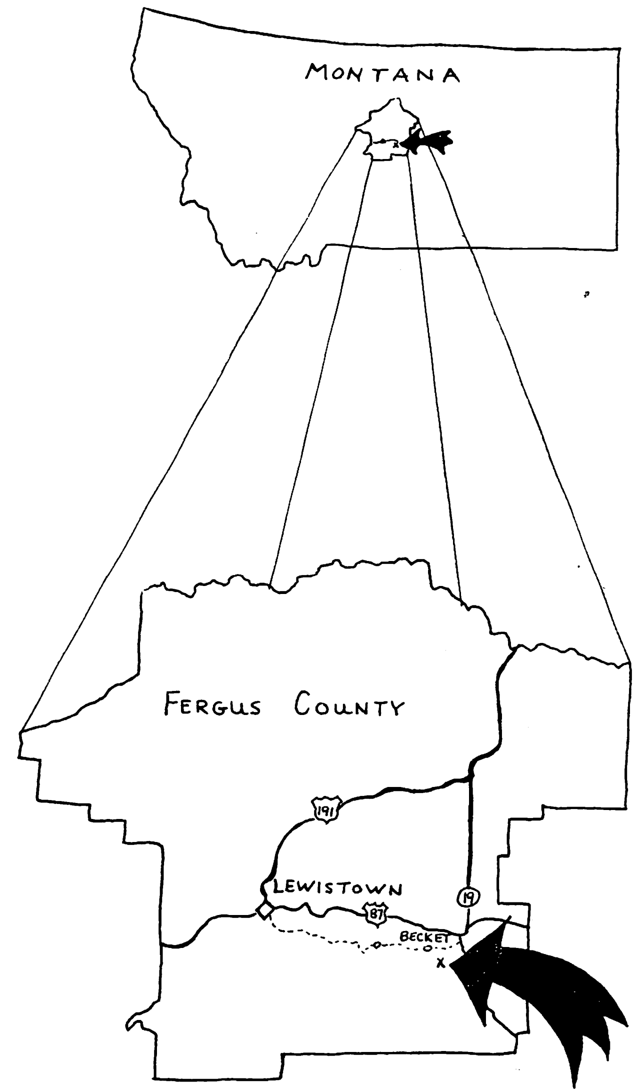

Figure 1. Map showing fossil locality and general geographic relationship of Fergus County in Montana.

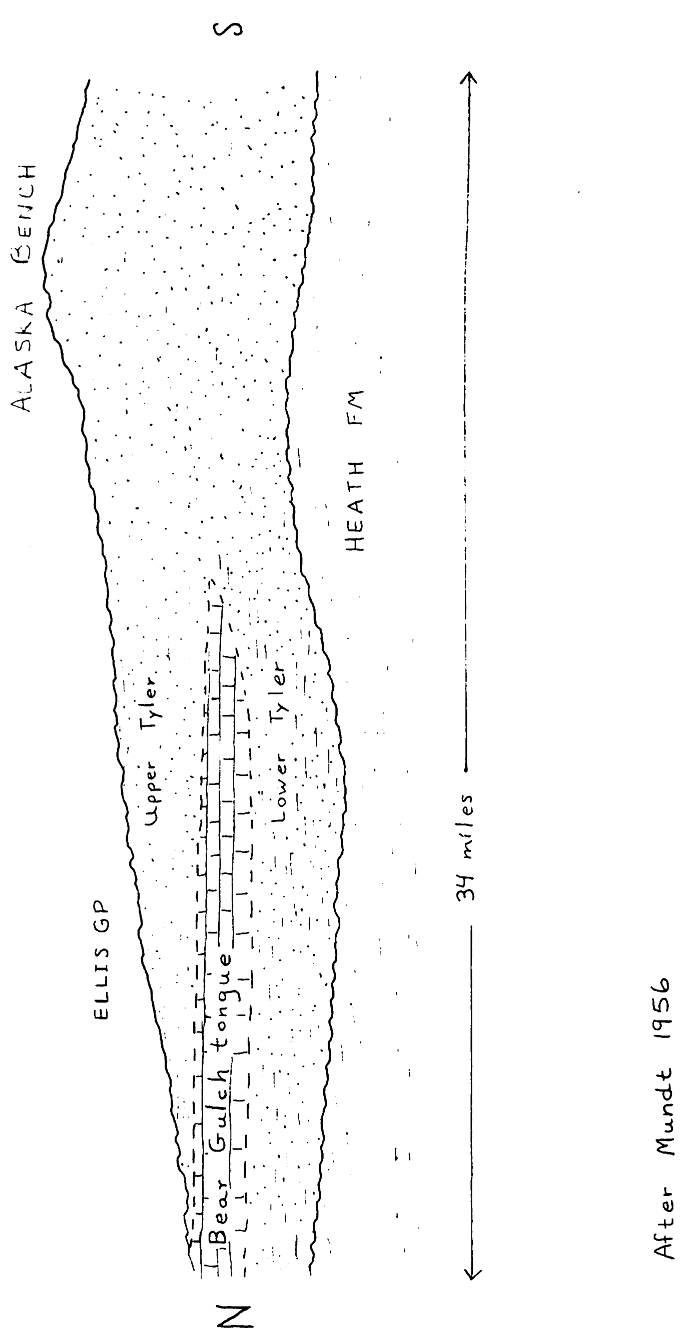

Figure 2. Generalized startigraphy after Mundt.

At the quarry site, the formation is directly overlain by the Alaska Bench formation. To the northeast, the formation is overlain by the Sands of the Tyler formation of Pennsylvanian age. In one locality, where I saw the base of the formation, Bear Gulch overlies a black shale which may be either the Tyler formation or possibly the Heath formation of Mississippian age. The fish locality occurs about 35 to 45 feet below the top of the formation or about five to 15 feet above the base of the limestone bluff. Dating of the Bear Gulch will have to await a more thorough study of the invertebrate fauna.

Doctor Ernest Gilmore of Central Washington College at Cheney, Washington spent a day with me in September, establishing some stratigraphic relationships for the quarry site. We started from a section several miles to the west, which he measured while working on his doctoral dissertation. We then circled around the Potter Creek dome to Forest Grove and Becket and to the vicinity of the fish quarry. Later I measured a section above the fish quarry.

The fish were immersed in acetone, as Moy-Thomas suggested, in order to make a detailed study under a microscope at 7 X to 30 X.

Description

Order Paleonisciformes
Sub-Order Platysomoidei
Family Dorypteridae
Allenypterus montanus—new genus and species. Type UMV 25,55 A and B.

Allenypterus montanus is a deep bodied fish although the general proportions are not as deep bodied as *Dorypterus* (see Figs. 3, 7, and 8). The dorsal pectoral fin is a broad flat fin and is about as large as the body cavity. The ventral pectoral fins are shorter and narrower. On the right slab (Fig. 7), the fin is compressed against the body and covers the large anteroventral scales. The lateral extremity of the ventral pectoral fins are absent on the left side. This is probably due to the way the rock was split at the quarry. The pelvic fins have a triangular bone support which may articulate with the ventral extremity of the post abdominal bone. The pelvic fin is short and has only a few short rays which do not branch. The anal fin has a long, flat, and triangular bony support which is longer and larger than the bony support of the pelvic fin. The body of the fish is covered by small scales behind the anal fin. The dorsal fin has a large triangular shaped support at the posterior end. Four of the dorsal ribs either support this bone or are covered by it. The dorsal ribs divide below the anterior edge of the dorsal fin. There is a posterior extension, or fringe, from four ribs behind the dorsal fin to the tail. Each of the ribs bifurcates behind the dorsal fin, except the first four, and extends upward a short distance. As in *Dorypterus,* a post abdominal bone is present and the bones of the skull are greatly reduced in number. Seven large anteroventral plates or scales are present, but no large dorsal plates are present, and no large posteroventral plates or scales are present. The ribs do not flatten towards their extremity.

The pelvic fins are greatly reduced or absent in the Permian specimens. A ventral pectoral fin is present only on the right side of *Allenypterus.* The total length of the body is about 134 millimeters in length, and 52 millimeters in height. The height was measured across the body directly above the plate of the dorsal fin to the ventral side of the plate of the pelvic fin.

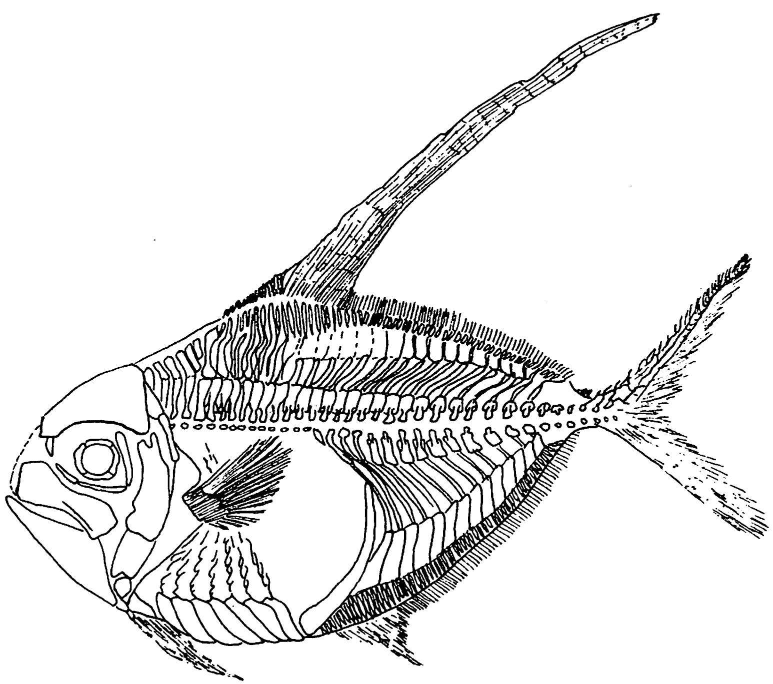

Figure 3. Drawing of *Dorypterus hoffmani* after Westoll.

The entire right side is covered by scales from the head to the tail although scales are missing in some areas on the left side. The scales are cycloid, overlapping, and ornamented with fine ridges (see Fig. 6).

The ribs do not have the sigmoidal curve that was noted by Westoll and Gill and, in addition, the ribs do not expand distally. The post abdominal bone is thinner and flattens and widens ventrally. It appears to be composed of five bones extending downward from one vertebra. There is a broad, flat impression of the distal end of the anterior post abdominal bone, indicating a possible fusion of some of these bones. The position is such that it could form support for the pelvic fins and the anal fin.

The outline of the skull is very clear in both slabs, although some of the bone was broken and lost when the rock was split. Figures 4 and 5 detail of bones on both sides are not the same. More bones are exposed on the right side behind the opercula, and the operculas are tilted at different angles. The orbit is large and surrounded by at least three or more sclerotic bones. It first appeared that there was space between the orbit and the skull roof in which no bones occurred. When the fish is immersed in acetone, however, even what appear to be the sensory canals can be seen and the outline of the bones is more distinct. The skull roof appears to be composed of more than one bone, a frontal, parietal, and post-temporal. The maxilla is broken anteriorally on the left side and the exact relationship to the lower jaw is not clearly defined until the specimen is placed in acetone. An opercula is present behind a preopercula. There is a little rod-like sub-orbital which may be

the same bone that Westoll called the ceratohyal. This rod is broken on the left side and therefore appears somewhat smaller than the rod on the right side. In the enlargements of the skull (Figs. 4 and 5), the suborbital or ceratohyal, and quadrate can be seen, and either a sub-opercular or a bone that could be the symplectic can be seen. Both cleithra occur behind the opercular with a sub-cleithra and two short triangular 'clavicles' seem to originate from two short fins. These ventral pectoral

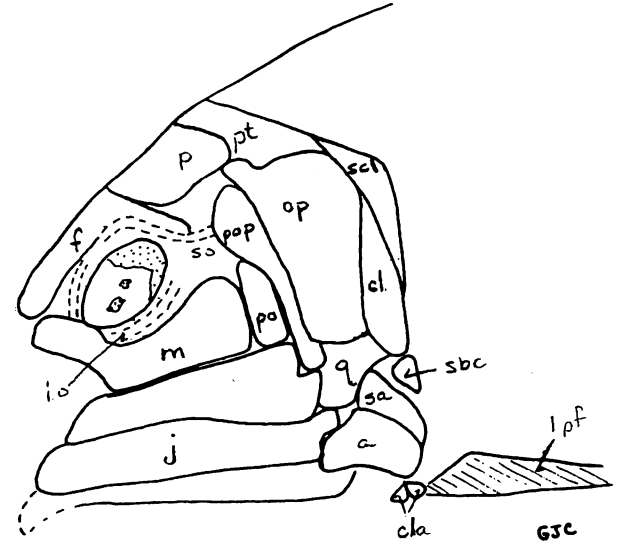

Figure 4. Skull of *Allenypterus,* right side.

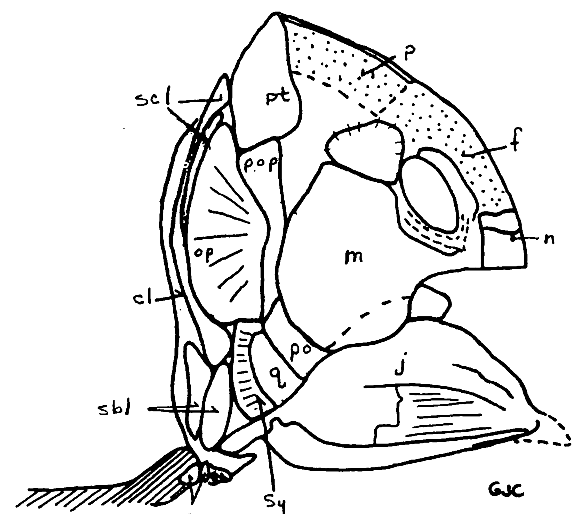

Figure 5. Skull of *Allenypterus,* left side.

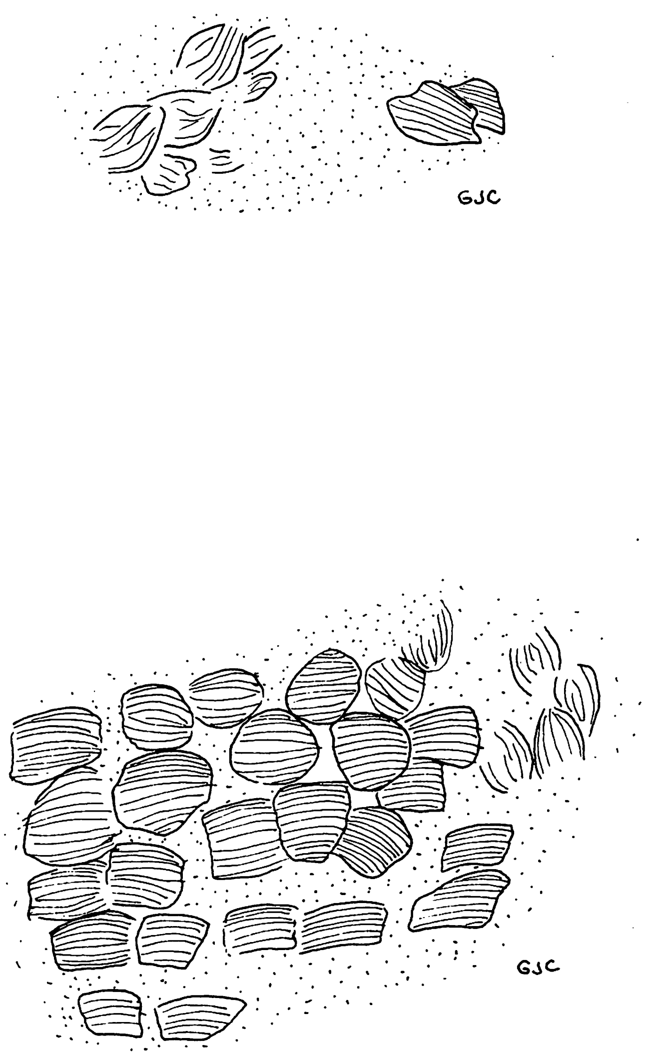

Figure 6. Drawing of scales of *Allenypterus* on right side, showing ornamentation.

fins must have been very close together. Branching rays for the support of fins occur on the left side (Fig. 7), but no fin is apparent. The lower pectoral fin covering the anteroventral scales can be seen on the right side when it is immersed in acetone. More bones can be seen on the left side at the back of the head including the two cleithra, two sub-cleithra, and two short clavicles, with four or five short rays extending from each side. The preopercula is shoved back on the left side and the opercula is at a different angle than on the right side. An impression indicating the presence of a post orbital bone is also present on the left side. Superimposing a drawing of the right side over the post orbital would indicate that the lower part of the impression may be a part of the broken left maxilla. The impression on both sides indicates a short nasal was present. The specimen is named for Mr. Charles Allen of Grass Range, Montana, in appreciation of his interest in these fish and their donation to the University of Montana Geology Museum.

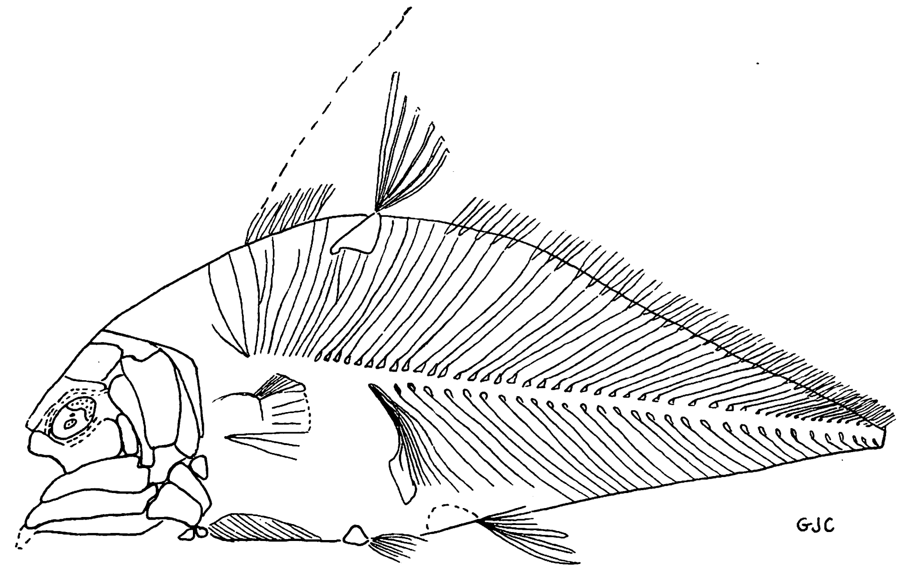

Figure 7. Drawing of *Allenypterus montanas*, right side.

The family Dorypteridae was named for the genus *Dorypterus hoffmani* described by E. F. German in 1842. E. S. Gill, in 1925, and T. S. Westoll, in 1941, carefully studied this peculiar fish and other specimens of the same species. The Dorypteridae are deep bodied fish with a very high, rather short based dorsal·fin (Fig. 3). The tail is strongly heterocercal, narrow, and nearly equilobate. The most striking features are the post-abdominal bone structure at the back of the body cavity. A rather broad lobate pectoral fin is located only slightly below the vertebral column. *Dorypterus* had only seven large anteroventral scales. The skull roof is very simplified in *Dorypterus* and contains a single dorsal bone according to Westoll.

Allenypterus montanus is very similar in shape to the genus *Dorypterus*. Both have the post abdominal bone and are deep bodied with a triangular shaped lower

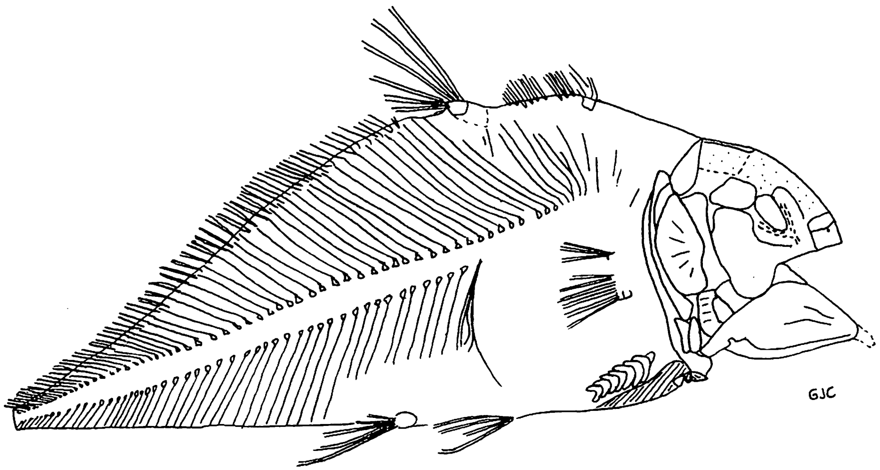

Figure 8. Drawing of *Allenypterus montanas,* left side.

jaw. There is a peculiar arrangement of the neural spines just below the dorsal fin. The tail and dorsal fin unfortunately are absent on *Allenypterus.*

Allenypterus differs from *Dorypterus* in the more slender and less curved ribs, the absence of the large posterior dorsal and ventral plates, the absence of the posterior fringe, and the presence of more bones in the skull structure. *Allenypterus* is completely covered with scales.

The occurrence of this fish in rocks of probably earliest Pennsylvanian age is not surprising, although it does not appear to be the form ancestral to *Dorypterus,* but is more closely related to *Dorypterus* than any other deep bodied fish that I have been able to find described in the literature. The family Bobastranidae has a more complex skull and lacks the post abdominal bone and the scales are rhomboidal in shape. The other two Platysomid families are much more generalized.

The skull of *Allenypterus* is much more complicated than *Dorypterus,* and is certainly closer to some platysomid ancestor. The presence of the body covered by scales would also indicate a more primitive fish than *Dorypterus.* However, the complete absence of the ventral fin fold, or fringe, the shape of the ribs, and the more flattened belly would seem to indicate a different sort of specialization and habitat than *Dorypterus.*

The varied invertebrate fauna has not yet been studied. Its age could be older than Pennsylvanian, but, because of the stratigraphic position, the fish in this fauna are certainly no younger than that.

Acknowledgements

I wish to express my deep appreciation to Mr. Charles Allen and Mr. Ralph Hartin who donated the specimens to the Geology Museum of the University of Montana. I would like to thank Dr. Ernest Gilmour for the time spent in the field examining outcrops, and for his very helpful comments on the possible age of the invertebrate fauna; and Dr. E. C. Stumm, who examined some of the invertebrates. I also wish to thank Larry and Gary Eichorn, for furnishing information and the maps of the area; Mr. and Mrs. J. W. Rodgers, for their hospitality; and George W. Wolfe and Douglas Wolfe, for their assistance and donations of fossils to the Geology Museum. Drawings were made by Glenda Clay. Support for preliminary field work has been furnished by the Geology Department of the University of Montana.

It is hoped that further work in the area will provide more specimens that will add to the present information on this fish as well as other fish now known from the fauna. At present, the details of the stratigraphy are not well known. The invertebrate fauna is abundant, but not easily seen. Neither the age nor the ecology have been studied in detail. There are more genera of Paleoniscid fish of this age from this quarry than have been previously described from North America.

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Abbreviations Used in Figures

a—angular
af—anal fin
cl—cleithrum
cla—clavicle
df—dorsal fin
fr—frontal
inf—infraorbital
j—lower jaw
lpw—lower pectoral fin
op—opercular
pa—parietal
pf—pelvic fin
po—post orbital
pop—preopercular
pt—posttemporal
q—quadrate
sa—surangular
sbcl—subcleithrum
scl—supracleithrum
sbo—suborbital
upf—upper pectoral fin
UMV—University of Montana Geology Museum, vertebrate collection

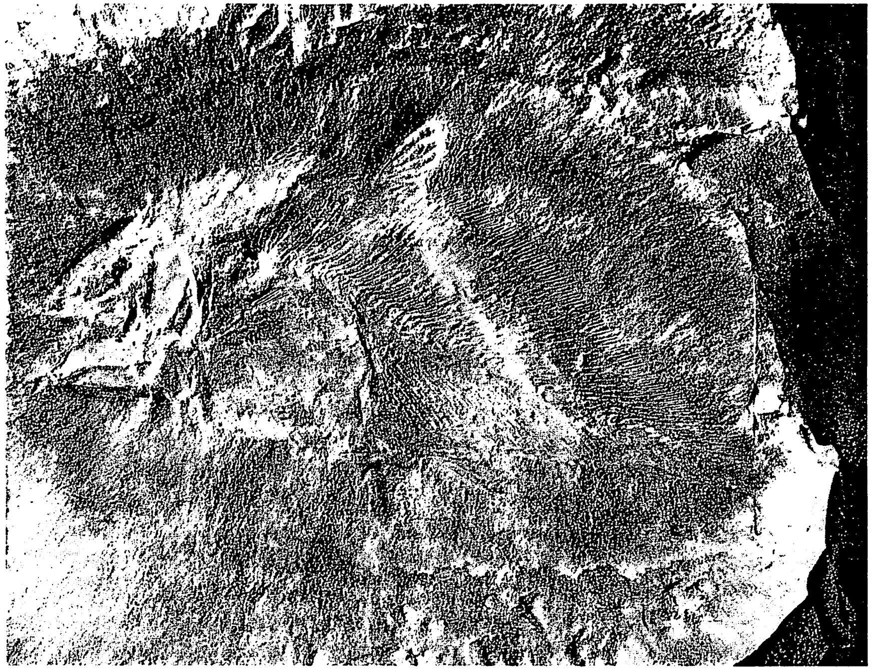

PLATE I. Photograph of *Allenypterus:* a right side.

PLATE II. Photograph of *Allenypterus:* left side.

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Trophic Relationships of Hydromedusae in Yaquina Bay, Oregon[2]

Hydromedusae are quite varied in their size and appearance. Generally they are bell-shaped, with a hollow tube (manubrium) hanging down from the interior roof of the bell. The manubrium contains the stomach and opens downward by means of a mouth. The interior of the manubrium is continuous with (usually) four radial canals which lead from the top of the manubrium outward and downward to meet a ring canal which encircles the bell near the rim. Tentacles are found around the rim and bear stinging cells (nematocysts).

According to Hyman (1940), the phylum Cnidaria is strictly carnivorous. Animals coming in contact with the tentacles are "held and paralyzed by the nematocysts aided by adhesive secretions." The food is moved toward the mouth by the tentacles, and sometimes the mouth moves toward the food also. The food is grasped by the mouth rim and engulfed by ciliary and/or muscular action, "aided by mucous secretion from the pharynx or from the gastrodermis of the manubrium." Their bodies are quite distensible and relatively large objects can be swallowed. Coelenterates exhibit some selectivity in their choice of food and will generally reject non-nutritive objects unless soaked in flesh juices. "When satiated with food, coelenterates generally fail to react to additional food or drop it after capture and often remain in a contracted state until digestion is completed" (Hyman, 1940, pp. 392-393).

The digestion is both extracellular and intracellular.

> . . . the fleshy parts of prey may be broken down in a few hours and the resulting broth completely engulfed by the gastrodermis in 8 to 12 hours. Undigested parts are then ejected through the mouth (Hyman, 1940, p. 393).

Intracellular digestion usually takes a few days. "Excess food is stored in the gastrodermis chiefly as fat; glycogen may be stored without change" (Hyman, 1940, p. 393).

Notes on the feeding of medusae have been made by Lebour (1922, 1923), Hyman (1940), Mikhailov (1962), and Roosen-Runge (1967).

Marshall and Orr (1955) mentioned that the copepod *Calanus* is sometimes eaten by medusae.

Lebour (1922, 1923) reported that in the laboratory *Aurelia* ate fish, amphipods, crab zoeae, other crustacea, and the hydromedusa *Sarsia tubulosa. Phialidium* was seen to eat a variety of fishes, including very young herring and sprat eggs. One *Sarsia tubulosa* ate copepods (*Pseudocalanus elongatus, Acartia clausii, Calanus fin-*

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[2] This report includes part of the author's Ph.D. thesis presented at Oregon State University.