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An Early Cambrian Trilobite Faunule from Utah

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ABSTRACT.—Representatives of four genera of trilobites are described from the Pioche Formation of late Early Cambrian age in the House Range of western Millard County. They are the oldest metazoan fossils known from Utah, and include *Olenellus apsis,* n. sp., *Wanneria humilis,* n. sp., and undetermined species of *Bonnia* and *Onchocephalus.* Faunal evidence indicates that the Pioche Formation of the House Range is temporally equivalent to only the lower part of the Pioche Shale at the type locality near Pioche, Nevada.

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INTRODUCTION

The oldest metazoan fossils known from Utah have been collected from the Pioche Formation of Early Cambrian age in the House Range of western Millard County. They consist of a small faunule of trilobite body fossils in association with a variety of trace fossils. The trilobites are not well preserved, but they are significant because they include guide fossils that enable rather precise age determination; they can be used in correlation with faunas from other areas; and they add to an understanding of the succession of Cambrian life and environments in the region that is now Utah.

Other fossils from Utah have been erroneously reported to be of Early Cambrian age. In 1886 Walcott (p. 173) reported that *Olenellus gilberti* had been collected from beds 50 to 300 feet above the basal Cambrian quartzite (=Tintic Quartzite) in Ophir Canyon of the Oquirrh Mountains and in Big Cottonwood Canyon of the Wasatch Range. This report was repeated in subsequent publications, but in 1912 Walcott (p. 189) noted and corrected the original and later errors. Apparently, however, Walcott's correction was overlooked, and unfortunately the error has been continued by some later writers. Positive documentation of the error has recently been provided by M. D. Crittenden, Jr. (1971, oral communication), who a few years ago in company with A. R. Palmer discovered early Middle Cambrian fossils, which are undescribed, in beds transitional between the Tintic Quartzite and the Ophir Shale in Big Cottonwood Canyon. Additional fossils have since been collected from the same beds by R. A. Robison, and are in collections at the University of Utah. With the correction of the erroneous reports of Early Cambrian fossils in the Oquirrh Mountains and the Wasatch Range, the House Range becomes the only Utah locality presently known to have fossils of Early Cambrian age.

Considering the appreciable thickness of the Tintic Quartzite and the occurrence of early Middle Cambrian fossils in beds transitional between the Tintic and the overlying Ophir Shale, it is likely that at least the lower part of the Tintic Quartzite is of Early Cambrian age. However, paleontologic evidence to prove this possibility is yet to be found.

Deiss (1938, p. 1139, 1143) was the first to report the discovery of an Early Cambrian fossil from the Pioche Formation of the House Range. It was a single cephalon identified as *Olenellus*, but it was not described or illustrated. Several more trilobites were collected from the formation in 1957 by L. F. Hintze and students of the Brigham Young University geology field course. Over the years additional specimens were added to the collection by Hintze and his students, and that entire BYU collection forms the basis for this paper.

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STRATIGRAPHY AND FAUNAS

The Pioche Formation consists mostly of detrital sediment that accumulated in marine environments. In the House Range the formation is approximately 350 feet thick and is composed of interbedded phyllitic quartzite and shale that is characteristically dark brown. The quartzite is predominantly fine- to medium-grained, is thick- to medium-bedded in the lower part of the formation, and becomes medium- to thin-bedded in the upper part. The formation is well exposed along the west face of the range in ledges and block-strewn slopes.

Walcott (1908a, b) was the first to apply the name Pioche Formation to rocks in the House Range, and use of the name has been continued by Deiss (1938), Wheeler (1948), Wheeler and Steele (1951), and Hintze (in press). Lithologically the formation is much more arenaceous in the House Range than at the type locality near Pioche, Nevada. This probably is because of a more shoreward position for the House Range section, which appears to represent a variety of littoral and shoreface lithotopes.

The trilobite faunule from the Pioche Formation of the House Range was collected from an interval 80 to 140 feet beneath the top of the formation at a locality in the NW¼ NW¼ sec. 15, T. 18 S., R. 14 W., on the north side of Marjum Canyon near its mouth (for geologic map see Hintze, in press). The faunule contains:

Olenellus apsis, n. sp.
Wanneria humilis, n. sp.
Bonnia sp. undet.
Onchocephalus sp. undet.

This generic assemblage is typical of the late Early Cambrian. Faunas of this age generally are sparse and poorly preserved. Consequently, pertinent biostratigraphic terminology has been a subject for continual modification. Rasetti

(1951, p. 81-87) has ably discussed the major problems, and has tentatively used the name *Bonnia-Olenellus* Zone to include faunas of this age from the Canadian Rockies. All four trilobite genera from the House Range faunule occur in the *Bonnia-Olenellus* Zone of the Canadian Rockies, and there is no evidence to suggest that the age of the two faunas is appreciably different.

Associated with the trilobites in the Pioche Formation is a great variety of fucoidal trace fossils (Pl. 3, fig. 3) that may represent annelid activity. Most of the trace fossils are simple, irregular tubular structures that range from at least 1 to 25 mm in diameter, and are generally oriented parallel to bedding surfaces. The fucoidal fossils are particularly abundant in the upper and more shaly part of the formation. Some quartzite beds, commonly those with trilobites and without fucoidal fossils on the surfaces, contain *Skolithus,* which are vertical nonbranched tubes, usually about 2 to 3 mm in diameter, that probably were made by an annelid or phoronid. *Cruziana* and *Rusophycus,* which have been interpreted as the feeding and resting traces made by trilobites (*e.g.* Seilacher, 1970), are rare in the formation and are usually poorly preserved.

The type Pioche Shale in Nevada is known to contain late Early Cambrian fossils in the lower part of the formation and early Middle Cambrian fossils in the upper part (Palmer, *in* Merriam, 1964, p. 25-27). In the House Range the Pioche Formation is overlain conformably by the Tatow Formation, which contains an undescribed fauna of early Middle Cambrian age. Therefore, the Pioche Formation of the House Range correlates temporally with only the lower part of the type Pioche Shale, and the Tatow Formation of the House Range approximately correlates with the upper part of the type Pioche.

SYSTEMATIC PALEONTOLOGY

Preservation.—All specimens are disarticulated. Most exoskeletal material has been removed by solution, and the specimens are preserved as internal or external molds in quartzite. None of the molds retain vestiges of possible exoskeletal ornamentation.

Terminology.—The term "advanced genal spines" is used in this paper to designate subanterior cephalic spines as described by Harrington (1956). Following the usage of Clarkson (1966, p. 27) and Eldredge (1970, p. 9-15), the term "anterior arch" is used to designate an upward arcuate bend of the anterior cephalic margin. With these exceptions, morphological terms used here are the same as those defined in Part O of the *Treatise on Invertebrate Paleontology* (Harrington and others, 1959, p. 117-126).

Repository.—All specimens illustrated in this paper are deposited at the U. S. National Museum in Washington, D. C. Other specimens are with the paleontological collections of Brigham Young University.

Family OLENELLIDAE Vogdes, 1893

Genus *OLENELLUS* Hall, 1862

Remarks.—Because of lack of agreement concerning the taxonomic importance of certain morphologic features, the concept of *Olenellus* has been, and continues to be, a controversial subject. Symptomatic of that controversy is the fact that the Synonomy File of Cambrian Fossils, which is an unpublished card index maintained by the U. S. Geological Survey, lists more than 65 citations for the genus *Olenellus*. Some of the features that are subjects of dispute are length of eyes or palpebral lobes, position of genal spines, hypostomal dentition, and nature of thoracic segmentation. Several new genera have been defined by the use of various combinations of these and other features. It is beyond the scope of this paper to thoroughly review the complexities of olenellid taxonomy, but a few remarks concerning the concepts of *Olenellus* and *Fremontia* are pertinent to the generic assignment of one olenellid species from the House Range.

In 1936, Raw discussed the generic classification of the mesonacids (=olenellids) and suggested the name *Fremontia* (p. 243) with the following brief comment:

> ". . . we can make a distinction between a long-eyed genus *Olenellus*, which would include *O. thompsoni* and *O. gilberti*, and a short-eyed genus which, after the first described species, might be named '*Fremontia*'."

In a subsequent discussion, Harrington (1956) reviewed the classification of olenellids that have advanced genal spines, a feature to which he attached prime importance, and redefined *Fremontia* as an olenellid genus characterized by moderately advanced genal spines. Some specimens from the House Range have moderately advanced genal spines and long palpebral lobes that extend posteriorly to a point opposite the middle of the occipital ring. Thus, if the criterion of eye length is stressed, as by Raw (1936), the species should be assigned to

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EXPLANATION OF PLATE 1

OLENELLUS, BONNIA, and ONCHOCEPHALUS of the Pioche Formation

FIGS. 1-4.—*Olenellus apsis* n. sp., all internal molds and all X1.6. *1a* Stereogram of holotype cephalon, USNM 180630. *1b*. Anterior view of holotype. *2-4*. Paratype cephala, USNM 180631-180633.

FIG. 5.—*Bonnia* sp. undetermined, internal mold of pygidium, USNM 180639, X5.

FIG. 6.—*Onchocephalus* sp. undetermined, latex cast of cranidium USNM 180640, X4.

EXPLANATION OF PLATE 2

WANNERIA of the Pioche Formation

FIGS. 1-3.—Wanneria humilis n. sp., all latex casts and all X0.9. *1a, b*. Dorsal and anterior views of holotype cephalon, USNM 180634. 2. Left side of fragmentary paratype cephalon that has well-preserved palpebral lobe, USNM 180635. *3*. Right side of fragmentary paratype cephalon that has well preserved posterior border and genal spine, USNM 180636.

EXPLANATION OF PLATE 3

WANNERIA and fucoidal trace fossils of the Pioche Formation

FIGS. 1, 2.—*Wanneria humilis* n. sp., both latex casts and both X1.0.
1. Fragmentary cephalon with relatively wide glabella, USNM 180637.
2. Fragmentary cephalon with relatively narrow glabella and moderately well-defined anterior glabellar lobe, USNM 180638.

FIG. 3.—Fucoidal trace fossils of moderate size, USNM 180641, X1.0.

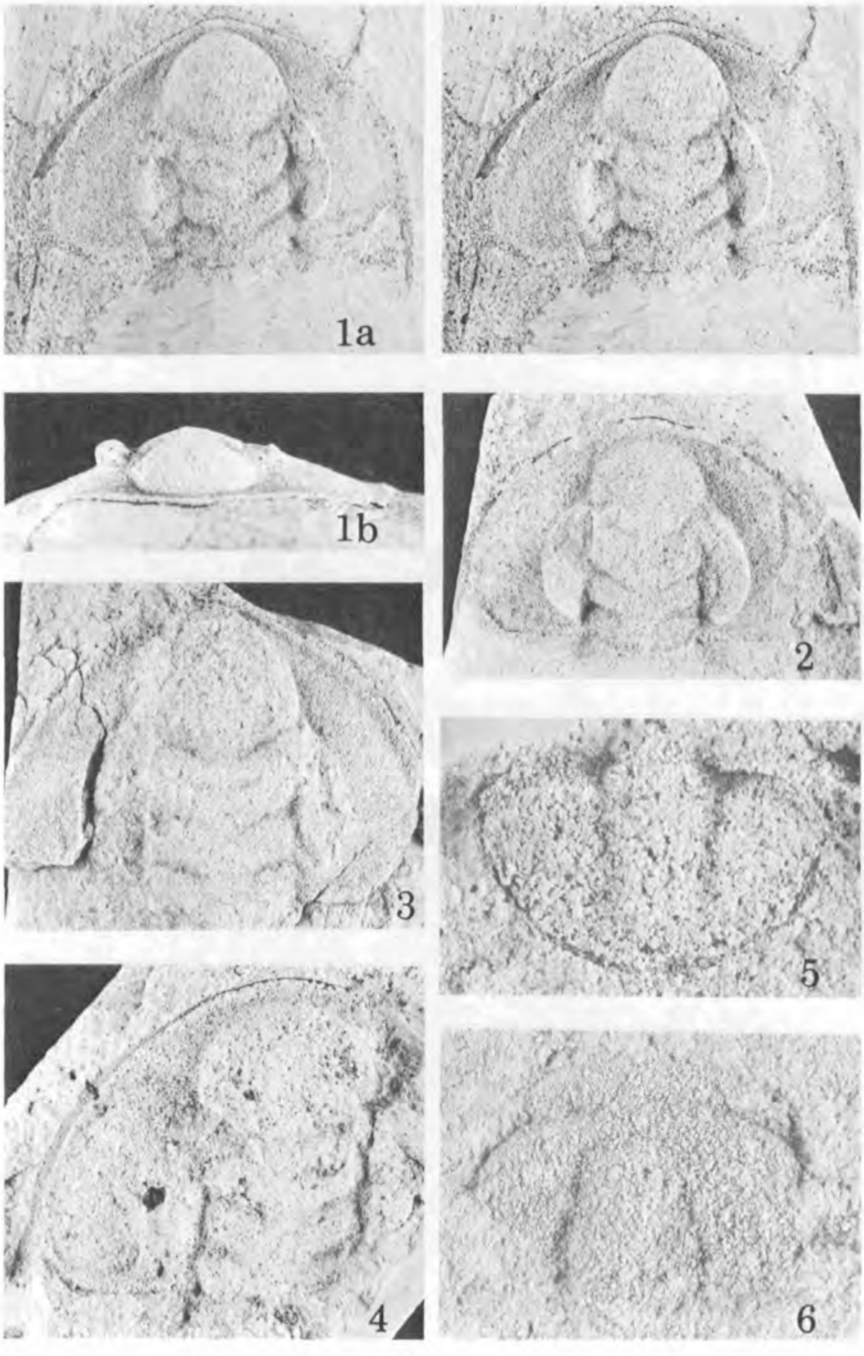

PLATE 1

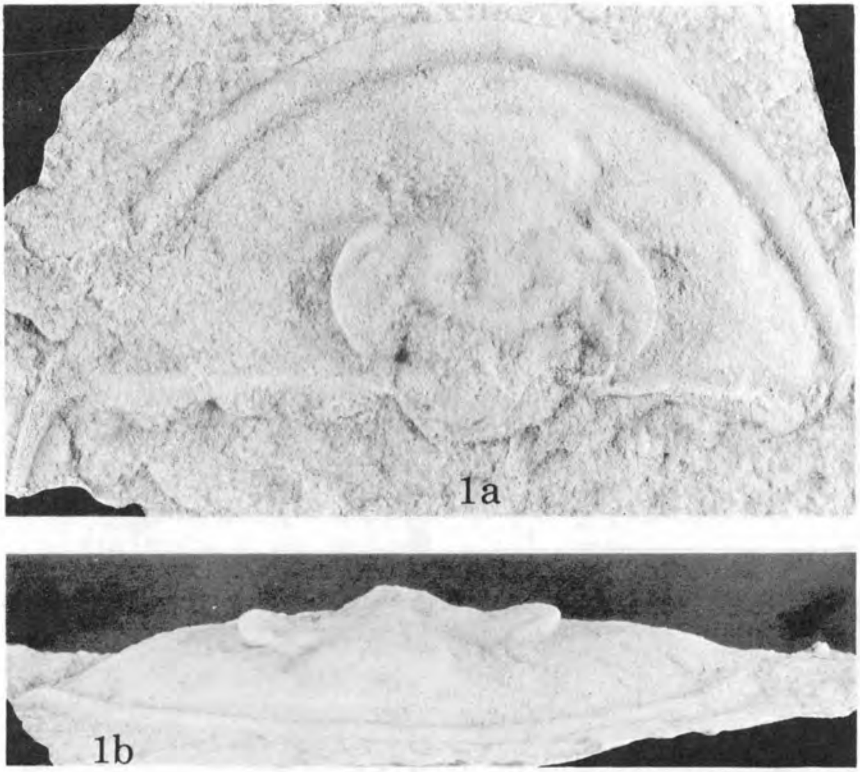

PLATE 2

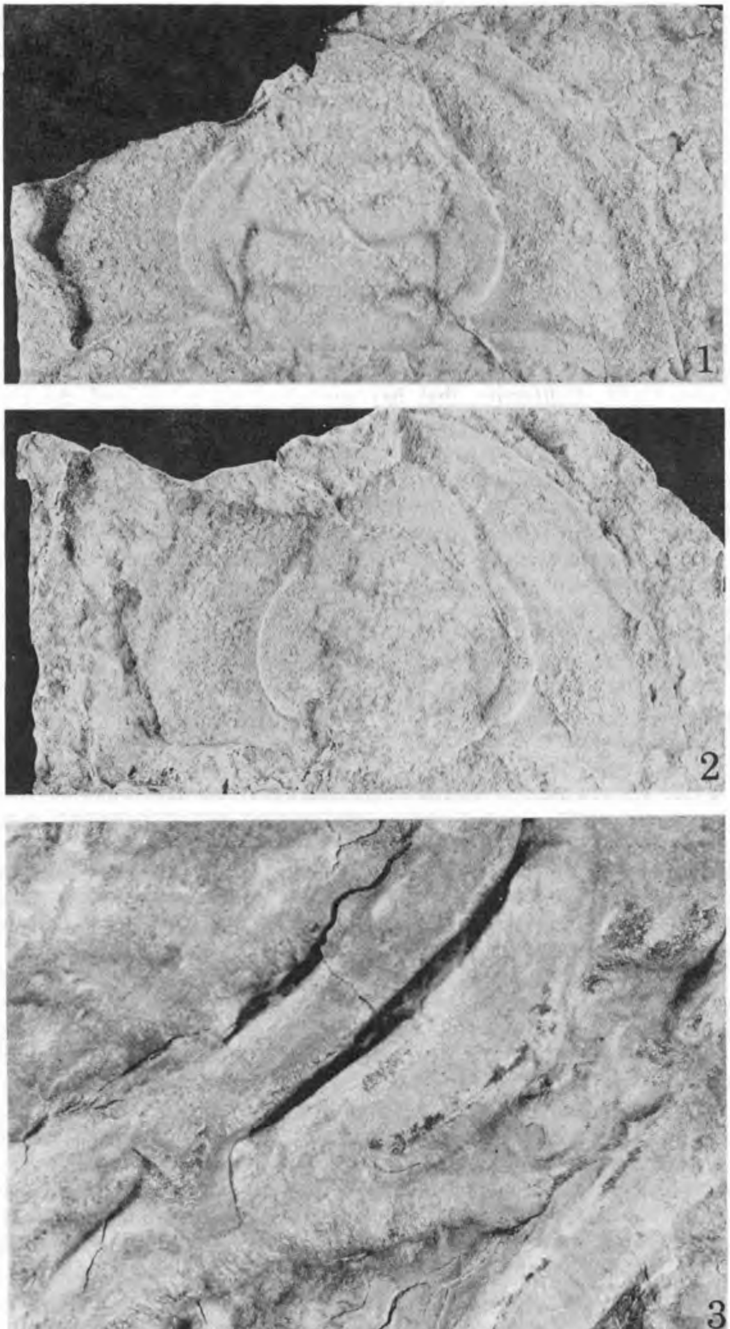

PLATE 3

Olenellus. On the other hand, if the position of the genal spines is emphasized, as by Harrington (1956), the species should be assigned to *Fremontia.*

Another alternative is the erection of a new olenellid genus characterized by long eyes and advanced genal spines, which would include the House Range specimens. That alternative is rejected at this time for the following reasons: Among the numerous olenellids illustrated by Walcott (1910) and Resser and Howell (1938) are all gradational stages from short- to long-eyed forms. A review of described olenellids also shows a gradational range of considerable variation in the position of genal spines. For example, Best (1952), who was not referred to by Harrington (1956), illustrated three species of *Olenellus* that exhibit a complete gradation from cephala (*i.e.* Pl. 1, fig. 2) with essentially normal genal spines to some (*i.e.* Pl. 1, fig. 12) with genal spines even more advanced than those Harrington assigned to *Fremontia.* To further complicate matters, we have in hand a cast of a complete olenellid from near Cadiz, California, that has normal genal spines and short eyes. If a new genus were erected for long-eyed olenellids with advanced genal spines, another new genus logically would be required to accommodate the short-eyed forms with normal genal spines. Because variation in eye length and position of genal spines appears to be common among olenellid trilobites, we see no meaningful way by which objective definitions can be based on those two features only. Therefore, until more is learned concerning the functional and evolutionary significance of olenellid morphology, we prefer to follow a conservative taxonomic approach. We accept the rather loose concept of *Olenellus* presented by Resser and Howell (1938, p. 217-218), which is based on several morphologic features, and we assign the House Range specimens to that genus. Also, we tentatively recommend that *Fremontia* be suppressed as a subjective junior synonym of *Olenellus.*

Olenellus apsis, n. sp.

Pl. 1, figs. 1-4

Description.—Cephalon subsemicircular to broadly ogival in outline; convexity moderate transversely and sagittally; anterior arch moderate; length approximately two-thirds width. Glabella extends to, and may forwardly deflect, anterior border furrow; frontal lobe tumid and slightly wider (trans.) than other lobes. Transverse glabellar and occipital furrows are reflexed obliquely backward at angles of about 60 degrees from axial furrows; all are shallow across axial line; and all are well defined abaxially except middle pair of transverse glabellar furrows, which are deepest in midcourse and do not extend to axial furrow. Occipital ring is approximately 0.3 cephalic width, and apparently lacks medial tubercle. Palpebral lobes are robust, crescentic, and extend posteriorly to points opposite middle of occipital ring. Anterior border narrows medially and widens posterolaterally; at genal angles width is approximately double that at anterior midline; curvature of anterior and lateral margins is not uniform. Genal spines are slender and moderately advanced. Metagenal angles are approximately 130-140 degrees and metagenal spines appear to be absent. Doublure is almost absent at anterior midline, but gradually widens posterolaterally; opposite occipital furrow, width is about one-half that of basal genal spine.

Thorax and pygidium are unknown.

Discussion.—*O. apsis* is characterized by long palpebral lobes, moderately advanced genal spines, a broadly ogival anterior margin, a border of increasing width from anterior to posterior, a tumid anterior glabellar lobe that usually deflects the anterior border furrow, and a moderate anterior arch. The combination of these characters distinguishes *O. apsis* from all described species of *Olenellus*. It somewhat resembles a specimen of *O. canadenis* (Walcott, 1910, Pl. 38, fig. 1) that has advanced genal spines and a border that widens from anterior to posterior, but *O. apsis* differs by having longer palpebral lobes and a less restricted posterior glabella and occipital ring.

Occurrence.—The species is known from about 30, mostly fragmentary, cephala that are preserved in pale to dark yellowish brown, fine-to medium-grained quartzite. It is commonly associated with *Skolithus*.

Holotype.—Cephalon illustrated on Pl. 1, fig. 1; USNM 180630.

Genus *Wanneria* Walcott, 1910

The generic diagnosis of Palmer (1964, p. F3-4) is followed here.

Wanneria humilis, n. sp.

Pl. 2, figs. 1-3; Pl. 3, figs. 1, 2

Description.—Cephalon is subsemicircular in outline; convexity is low transversely and moderate sagittally; anterior arch is very low; length is approximately one-half width. Glabella is poorly defined anteriorly on largest specimens, but may be moderately well defined on smaller specimens. Frontal lobe is slightly expanded transversely. Occipital furrow and posterior pair of lateral glabellar furrows are reflexed obliquely backward at angles of about 70 to 75 degrees from axial furrow, moderately deep abaxially, and shallow across axial line; other lateral glabellar furrows are poorly defined. Occipital ring ranges from 0.2 to 0.3 cephalic width, and has weak medial tubercle. Palpebral lobes are prominent, crescentric, and extend posteriorly to points opposite middle of occipital ring. Shallow curved longitudinal groove divides anterior part of each palpebral lobe, but disappears posteriorly. Anterior and lateral borders are well defined, relatively wide (approximately 0.1 cephalic length), evenly curved, and of nearly uniform width. Genal spines are slender, and not advanced. Posterior borders are widest about one-third the distance inward from genal angles, are narrowest adaxially, and have weak metagenal angles just inward from genal spines.

Thorax and pygidium are unknown.

Discussion.—*W. humilis* is characterized by a wide anterior cephalic border of uniform width, poorly defined anterior glabellar lobe on larger specimens, long palpebral lobes, and a low anterior arch. Holaspids are also large in size. The holotype, which is a nearly complete cephalon, is 59 mm long and 123 mm wide. Dimensions of some fragments show that the cephalon of other individuals was even larger.

Several species have been assigned to *Wanneria*, but after taxonomic revision by various authors, only four previously described species from North America remain in the genus. They are *W. buelnaensis* Lochman, *W. logani*

(Walcott), *W. occidens* Walcott, and *W. walcottana* (Wanner). *W. humilis* differs from all four of these species by usually having a less well defined anterior glabellar lobe, and the anterior two pairs of transverse glabellar furrows are fainter. It further differs from *W. walcottana,* the type species, by having longer palpebral lobes. Compared with *W. logani,* the glabella is less clavate and the cephalic width is greater relative to the cephalic length. It differs from *W. occidens* by having longer palpebral lobes and by lacking metagenal and occipital spines. *W. buelnaensis,* which was referred to as *Fremontia* by Harrington (1956, p. 57), but reassigned to *Wanneria* by Palmer (1964, p. F4), differs obviously from *W. humilis* because of its advanced genal spines, presence of short metagenal spines, and narrower cephalic border. We currently are uncertain as to the generic assignment of *W. buelnaensis* of Lochman.

Specimens of *W. humilis* have a cephalic length to width ratio of approximately 1:2, whereas associated specimens of *Olenellus apsis* have a ratio of approximately 2:3. *W. humilis* further differs from *O. apsis* by having a wider anterior border of uniform width, a less tumid and more poorly defined anterior glabellar lobe, a weak occipital tubercle, genal spines that are not advanced, and a much lower anterior arch. Eldredge (1970, p. 9-15) has shown that the anterior arch probably is functionally related to burrowing activity. Therefore, differences in curvature of the arch in these two species probably indicate differences in burrowing behavior. Whether the differences are related to rates, frequency, and efficiency of burrowing is yet to be determined.

Occurrence.—The species is known from 11 fragmentary cephala that are preserved in grayish brown to dusky yellowish brown, fine- to medium-grained quartzite.

Holotype.—Cephalon illustrated on Pl. 2, fig. 1; USNM 180634.

Family DORYPYGIDAE Kobayashi, 1935
Bonnia, species undetermined

Pl. 1, fig. 5

A poorly preserved internal mold of one pygidium exhibits a form typical of *Bonnia.* It is nearly semicircular in outline, the axis is cylindrical and extends to the posterior border, the pleural fields are approximately the same width as the axis, and a single pair of short spines extend from the anterolateral margins. Other features, which are necessary for species identification, are not preserved.

Occurrence.—Approximately 100 feet below the top of the Pioche Formation in grayish brown, fine- to medium-grained quartzite.

Family PTYCHOPARIIDAE Matthew, 1887
Onchocephalus, species undetermined

Pl. 1, fig. 6

Although poorly preserved, an external mold of a single cranidium retains enough detail to allow its assignment to *Onchocephalus.* Its glabella is slightly tapered, truncated in front, and slopes from posterior to anterior. The preglabellar field is slightly shorter (sag.) than the convex anterior border, and the deep anterior border furrow has a slight median inbend. Palpebral areas of the fixigenae are slightly convex and nearly horizontal. Eye ridges curve slightly toward the posterior. These features agree well with the generic concepts of *Onchocephalus* as described by Lochman (1947, p. 63) and Rasetti (1955, p. 16-17). Other features of the cranidium are considered to be inadequate for species identification.

Occurrence.—Approximately 100 feet below the top of the Pioche Formation in grayish brown, fine- to medium-grained quartzite.

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