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SOME DRESBACHIAN AND FRANCONIAN TRILOBITES OF WESTERN UTAH

by

Richard A. Robison

BRIGHAM YOUNG UNIVERSITY

DEPARTMENT OF GEOLOGY

PROVO, UTAH

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by

Richard A. Robison

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ABSTRACT

The purpose of this paper is to systematically describe the Dresbachian and Franconian trilobite fauna of western Utah and to extend previously defined Upper Cambrian faunal zones into this region. Fossils were collected from ten measured sections in western Utah, from the Deep Creek Range near the Nevada line on the west to Provo Rock Canyon in central Utah on the east, and north-south from the Silver Island Range to the Wah Wah Mountains.

In the vicinity of the House Range, where the thickest section is found, the Upper Cambrian is comprised of the Weeks, Orr, Dunderberg, and Notch Peak formations. Upper Cambrian rocks of central Utah have been subdivided into three units known as the Opex, Dunderberg, and Ajax formations.

Representatives of six of the seven standard Upper Cambrian trilobite zones have been recognized. They are, from oldest to youngest: Cedaria, Crepicephalus, Aphelaspis, Elvinia, Ptychaspis-Prosaukia, and Saukia. The Cedaria, Crepicephalus, and Elvinia zones are the most prolific in numbers of trilobite species preserved, but the Aphelaspis zone is by far the most abundantly fossiliferous zone encountered. Fifty-two trilobite species have been identified and most of them are described.

Faunal evidence indicates that the Weeks and Orr formations are equivalent to the Lamb and Hicks formations in western Utah, and to the Opex dolomite in central Utah. The name, Dunderberg shale, has been extended from central Nevada into western Utah for the widespread shale unit which marks the base of the Franconian. The Notch Peak limestone of western Utah is equivalent to the Ajax limestone of central Utah.

INTRODUCTION

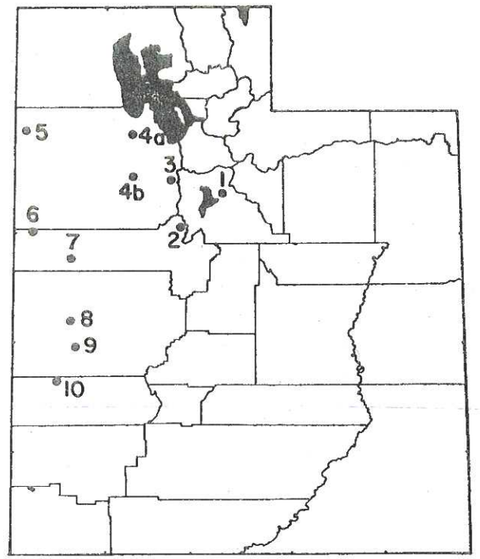
The thickest known section of Upper Cambrian miogeosynclinal rocks in the United States occurs in western Utah. Several workers have measured sections and described parts of the faunas in this area. Walcott in 1908a (p. 9-10) defined the Weeks, Orr, and Notch Peak formations of the House Range and in 1935, Nolan (p. 12-16) defined the Lamb, Hicks, and Chokecherry formations of the Gold Hill district in the Deep Creek Range. Upper Cambrian rocks of the Tintic mining district in central Utah have been assigned to the Opex and Ajax formations by Lindgren and Loughlin (1919, p. 29-32). Most of the previous faunal work consists of sporadic descriptions by Walcott and Resser, appearing in several publications dating from about 1908 to 1942.

No regional correlation of the Upper Cambrian in the Great Basin, based on field work, has previously been completed. Consequently, because lithologic similarities were not readily apparent, there has been much confusion concerning boundaries and nomenclature of stratigraphic units in this region.

The task of correlating the Croixian stratigraphy in central and western Utah has been jointly undertaken by Craig B. Bentley and myself in partial fulfillment of the requirements for Master's of Science degrees from Brigham Young University. Bentley's contribution (1958) contains a detailed lithologic description of the stratigraphic units encountered in ten measured sections (Text-fig. 1). The purpose of my work is to systematically describe the Dresbachian and Franconian trilobite faunas of these sections and to extend previously defined Uppper Cambrian faunal zones into western Utah. Because of the lack of information concerning the regional correlation of Upper Cambrian units in western Utah, it seemed desirable to collect representative samples from as many sections as available time and funds would allow, rather than to conduct an extensive study of faunal relationships in one locality. It is hoped that this work will now serve as a "stepping stone" for more extensive and detailed studies of individual zones or sections.

Expenses for this study have been partially defrayed by a graduate assistantship granted by Brigham Young University. Appreciation is expressed to Drs. J. Keith Rigby and Lehi F. Hintze for their helpful suggestions and guidance throughout this project.

I wish to thank Dr. A. R. Palmer for critically reviewing the manuscript and for several helpful suggestions. The aid and pleasant companionship of Craig B. Bentley in completing the field work for this project were invaluable. Kenneth F. Bick and Fred E. Schaeffer are also acknowledged for their help in pointing out suitable sections for measurement in the Deep Creek and Silver Island Ranges respectively.



INDEX MAP

FIG. 1--Index map. Numbers indicate the following measured sections or fossil localities:

1. Provo Rock Canyon (10913)
2. Tintic District (10917)
3. Ophir District (10912)
4. Stansbury Mountains
   a. north end of range (10915)
   b. south end of range (10916)
5. Silver Island Range (10914)
6. Deep Creek Range (10909)
7. Fish Springs Range (10910)
8. House Range (10911)
9. Yersin Ridge (10919)
10. Wah Wah Mountains (10918)

STRATIGRAPHY

Upper Cambrian rocks in central and western Utah consist mostly of carbonates. The only major exception is a widespread shale unit that marks the base of the Franconian stage. A general decrease in dolomite is noted as the sections are traced from east to west. Central Utah formations consist almost entirely of dolomite, while units of the House Range section in western Utah consist entirely of limestone and minor shales.

Much compositional variation is encountered in each individual section, but gross similarities can be recognized in all areas. Dresbachian units, such as the Orr, Lamb, Hicks, and Opex formations, are generally characterized by calcarenites, much bioclastic "hash," and calcareous oolites, pisolites, and algal balls. To the extreme south in the Wah Wah Mountains, the Dresbachian rocks show a marked increase in size of clastic material. Calcirudites in the form of intraformational conglomerates are common in the lower part of the exposed section. The Weeks limestone of the House Range is a facies variant. It consists largely of thin- to medium-bedded argillaceous limestone that weathers to a characteristic buff color.

Distinct thinning of Dresbachian rocks occurs from south to north (Text-fig. 2). In the House Range, where the thickest section occurs, 2,687 feet of beds are exposed. A uniform decrease can be traced from there to the Silver Island Range where rocks with a thickness of only 180 feet are encountered. Isopachous maps of Upper Cambrian rocks in Utah (Bentley, 1958, p. 20, fig. 4) support the suggestion of Lochman (1956, p. 575) that the Uinta positive element formed a prominent peninsula on the western cratonic coastline. The element was apparently active during Dresbachian time with a resultant thinning of sedimentary units up its flanks. Following this there seems to have been a period of stability in which sediments of Franconian and Trempealeauian age were deposited over the crest of the formerly active area in thicknesses similar to those shown in sections to the south (Text-fig. 2).

A prominent shale unit is encountered in all sections beneath the equivalent Notch Peak and Ajax formations. It generally consists of green to brownish-gray fissile shale which is commonly interbedded

with thin platy limestones. Bentley (1958, p. 21) proposed that the name, Dunderberg shale, be extended from central Nevada into western Utah for this distinctive lithologic unit.

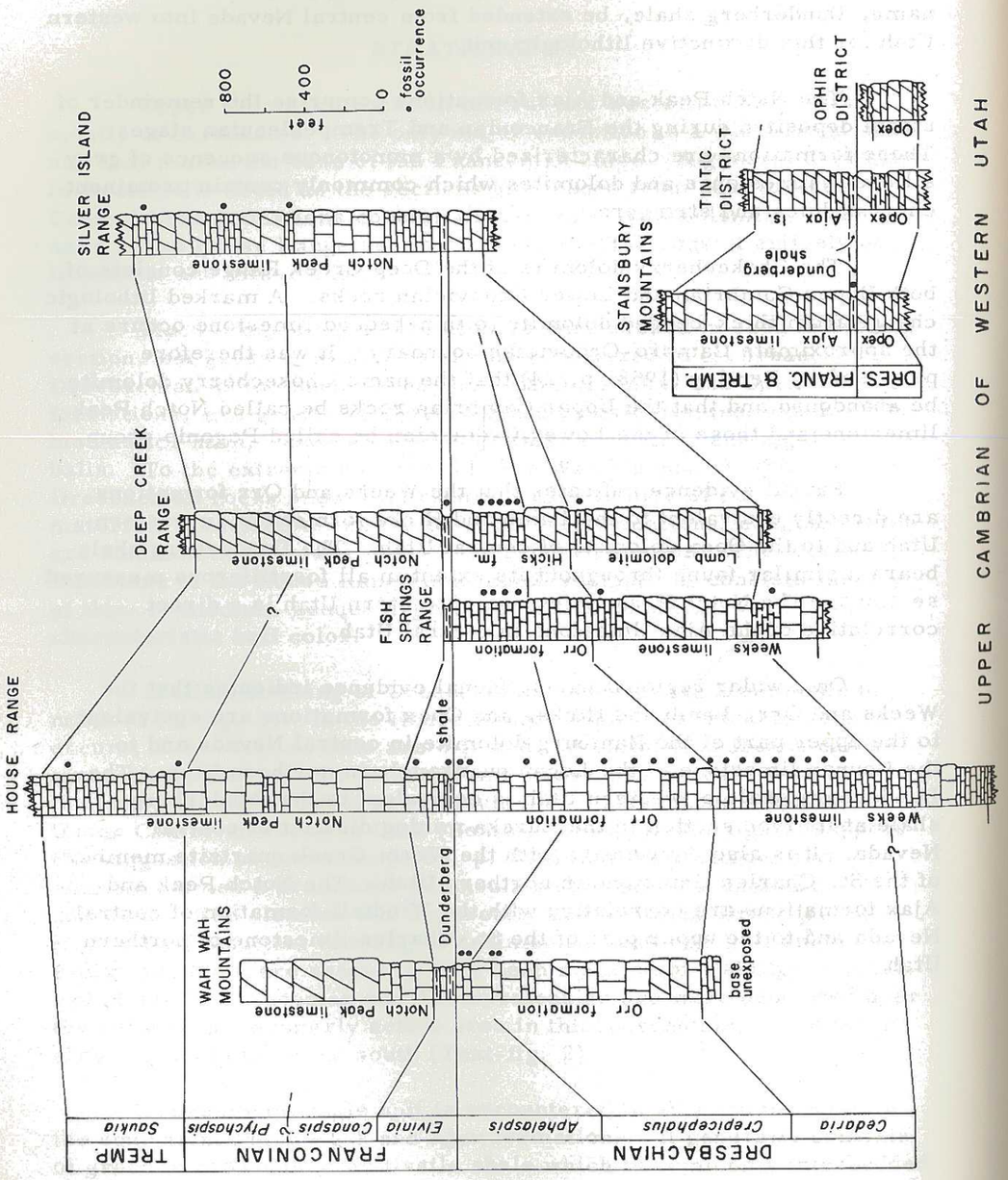
The Notch Peak and Ajax formations comprise the remainder of strata deposited during the Franconian and Trempealeauian stages. These formations are characterized by a monotonous sequence of gray siliceous limestones and dolomites which commonly contain prominent chert nodules and stringers.

The Chokecherry dolomite of the Deep Creek Range consists of both Upper Cambrian and Lower Ordovician rocks. A marked lithologic change from thick-bedded dolomite to thin-bedded limestone occurs at the approximate Cambro-Ordovician boundary. It was therefore proposed by Bentley (1958, p. 24) that the name Chokecherry dolomite be abandoned and that the Upper Cambrian rocks be called Notch Peak limestone and those of the Lower Ordovician be called Pogonip group.

Faunal evidence indicates that the Weeks and Orr formations are directly equivalent to the Lamb and Hicks formations in western Utah and to the Opex dolomite of central Utah. The Dunderberg shale bears a similar fauna throughout its extent in all fossiliferous measured sections. The Notch Peak limestone of western Utah is a direct correlative of the Ajax limestone in central Utah.

On a wider regional basis, faunal evidence indicates that the Weeks and Orr, Lamb and Hicks, and Opex formations are equivalent to the upper part of the Hamburg dolomite in central Nevada and to the Nounan limestone of the Logan quadrangle in northern Utah. The Dunderberg shale of western Utah is equivalent to the Dunderberg shale at its type section in the Eureka mining district of central Nevada. It is also correlative with the Worm Creek quartzite member of the St. Charles limestone in northern Utah. The Notch Peak and Ajax formations are correlative with the Windfall formation of central Nevada and to the upper part of the St. Charles limestone of northern Utah.

FIG. 2--Faunal and lithologic relationships of the Upper Cambrian of western Utah.



FAUNAL ZONES

Six of the seven standard Upper Cambrian trilobite zones have been recognized in western Utah. These zones are, from oldest to youngest: Cedaria, Crepicephalus, Aphelaspis, Elvinia, Ptychaspis-Prosaukia, and Saukia. The only standard trilobite zone that has not been recognized is the Conaspis zone. Absence of representatives of this zone is apparently due to lack of fossil preservation rather than to a hiatus in the stratigraphic record.

Western Utah sections have proven to be fossiliferous at many horizons. This is in marked contrast to sections in central Utah which are generally barren. Lack of Upper Cambrian fossils in central Utah seems to be due either to a lack of original preservation or to destruction of organic material by secondary dolomitization.

Cedaria zone. - The Weeks limestone of the House Range has yielded almost all of the Cedaria fauna collected. The only other specimens obtained from this zone came from a seventy-eight foot argillaceous limestone unit which marks the top of the Lamb dolomite in the Deep Creek Range.

Fossil preservation in the upper part of the Weeks limestone is commonly restricted to the argillaceous parting surfaces of thin platy limestones. At least two diverse conclusions can logically be drawn regarding this mode of preservation. It may either indicate that these forms thrived in relatively clear water, but were unable to withstand the cyclic influxes of argillaceous material which are repeated through several hundred feet of stratigraphic thickness, or it may indicate that they were mud loving forms which thrived only when argillaceous material was abundant.

Fauna of the Cedaria zone is characterized by species of Cedaria, Deiracephalus, Holcacephalus, and Tricrepicephalus. The following species have been identified:

Cedaria minor (Walcott)
Deiracephalus multisegmentus (Walcott)
Densonella semele (Walcott)
Geragnostus tumidosus (Hall & Whitfield)
Holcacephalus tenerus (Walcott)

Kormagnostus simplex Resser
Lonchocephalus plena Walcott
Maryvillia arion Walcott
Menomonia calymenoides (Whitfield)
Oedorhachis typicalis Resser
Oedorhachis? ulrichi Resser
Pseudagnostus? nordicus (Lochman)
Syspacheilus camurus Lochman
Tricrepicephalus coria (Walcott)
Weeksina sp.

Crepicephalus zone. - The boundary between the Cedaria and Crepicephalus zones occurs in a gradational interval that is confined to beds approximately one hundred feet thick. A similar gradational contact between the two zones was found in Montana by Lochman and Duncan (1944, p. 33-34) and in Texas by Palmer (1954, p. 712).

Members of the Crepicephalus zone commonly occur in a rock matrix of oolites, pisolites, and bioclastic calcarenites. Depth of water during the time of deposition of these sediments was apparently shallow with active oscillating current or wave action. Species most characteristic of the zone are Crepicephalus sp., Kingstonia walcotti, and a variety of Tricrepicephalus coria that had developed a shortened brim. Species collected from the Crepicephalus zone are:

Coosella sp.
Coosina ariston (Walcott)
Crepicephalus sp.
Genevievella campbellina Tasch
Kingstonia walcotti Resser
Kormagnostus simplex Resser
Llanoaspis undulata Lochman
Maryvillia arion Walcott
Syspacheilus camurus Lochman
Terranovella dorsalis (Hall)
Tricrepicephalus coria (Walcott)
Unassigned pygidium A

Aphelaspis zone. - The pronounced faunal break between the Crepicephalus and Aphelaspis zones, that has been noted by many other Upper Cambrian workers, can also be documented in western Utah. Only the agnostids, Geragnostus tumidosus, Kormagnostus simplex, and Pseudagnostus? nordicus, are known to bridge the boundary in this region.

Agnostids are commonly found throughout most sections whenever the limestones increase significantly in percentage of argillaceous material, or when a stagnant reducing environment is indicated by black fetid limestone. This fact along with the long range of some species indicates that the agnostids were hardy mud-loving organisms capable of withstanding rigorous ecological changes.

The Aphelaspis zone contains the following species:

Aphelaspis? sp.
Dunderbergia? granulosa (Hall & Whitfield)
Dunderbergia nitida (Hall & Whitfield)
Dunderbergia? sp.
Dytremacephalus sp.
Labiostria conveximarginata? Palmer
Labiostria sp. A
Pseudagnostus communis (Hall & Whitfield)
Pseudagnostus? nordicus (Lochman)
Pterocephalia sanctisabae Roemer
Unassigned pygidium B

Lochman-Balk and Wilson (1958, p. 333) have proposed a new Dunderbergia zone for the upper part of the Cordilleran miogeosynclinal fauna that occurs between the Crepicephalus and Elvinia zones. Ranges of species collected from western Utah fail to substantiate this proposal (Table I). It is believed that more detailed documentation of this sequence of rocks in the Great Basin is needed before the proposal can be accepted or rejected.

Elvinia zone. - A rather sharp faunal break is present between the Aphelaspis and Elvinia zones This may partially be due to the presence of an unfossiliferous unit of limestone or dolomite that commonly separates faunas of the two zones. The most common trilobite species encountered in the Elvinia zone are Elvinia roemeri and Kindbladia affinis. Following is a list of the fauna collected:

Cliffia lataegenae (Wilson)
Deadwoodia duris (Walcott)
Elvinia roemeri (Shumard)
Geragnostus tumidosus (Hall & Whitfield)
Housia varro (Walcott)
Iddingsia robusta (Walcott)
Iddingsia similis (Walcott)
Irvingella major Ulrich & Resser
Kindbladia affinis (Walcott)

Kormagnostus simplex Resser
Labiostria sp. B
Pseudagnostus prolongus (Hall & Whitfield)
Pterocephalia sp.

Ptychaspis-Prosaukia and Saukia zones. - The siliceous limestones of the Notch Peak limestone have generally proved to be only sparsely fossiliferous. A few poorly preserved specimens of the Ptychaspis-Prosaukia and Saukia zones have been found. They have not been described or illustrated because of their poor state of preservation. The following species have been collected:

Ptychaspis-Prosaukia zone:
Illaenurus sp.
Pseudagnostus josepha (Hall)
Ptychaspis? sp.

Saukia zone:
Eurekia sp.
Saukiella sp.

A notable exception to the commonly unfossiliferous Trempealeuian rocks is a large fauna of silicified trilobites that has been collected from Yersin Ridge by Dr. Lehi F. Hintze. The collection was obtained about two hundred feet below the Cambro-Ordovician boundary. It contains several genera including Euptychaspis and Stenopilus.

SYSTEMATIC PALEONTOLOGY

All specimens described in this paper are deposited in the Brigham Young University paleontological repository. The terminology proposed by Howell et al. (1947, p. 72-76) is used with the exception of the term, axon, which is used in this paper for the axial part of either a thoracic or pygidial segment.

Because of the confusion that exists concerning higher taxonomic categories of Trilobita, most genera discussed in this paper are tentatively assigned to the families used by Lochman-Balk and Wilson (1958, p. 312-350) until the volume on trilobites of the Treatise on Invertebrate Paleontology is published.

Class TRILOBITA
Family AGNOSTIDAE
Genus GERAGNOSTUS Howell, 1935
GERAGNOSTUS TUMIDOSUS (Hall & Whitfield)
Pl. 1, fig. 3

Agnostus tumidosus HALL & WHITFIELD, 1877, p. 231, pl. 1, fig. 32.

Geragnostus cf. G. tumidosus PALMER, 1954, p. 719, pl. 76, figs. 4, 6.

Diagnosis. - Cephalon subcircular to subquadrate in outline. Glabella bilobed, anterior lobe narrower than posterior lobe. No median preglabellar furrow is present. Pygidium unknown from western Utah. For a detailed description of this species see Palmer (1955, p. 88-91).

Remarks. - Specimens from the Elvinia zone are identical with specimens described from Eureka, Nevada, by Palmer, except that the cephalon is only four-fifths as long as it is wide whereas the Nevada specimens generally have a width and length which are about equal. One cephalon was collected from the top of the Cedaria zone whose cephalic length and width are equal but the dorsal features are not as sharply defined as on specimens occurring higher in the section. Further collecting may prove this form to be a new species, but for the present, it is tentatively assigned to G. tumidosus.

Occurrence. - Rare in the upper Cedaria zone at locality 10909-L 910 and in the Elvinia zone at 10909-D 14 and 10919.

Genus KORMAGNOSTUS Resser, 1938
KORMAGNOSTUS SIMPLEX Resser
Pl. 1, figs. 6, 11

Kormagnostus simplex RESSER, 1938a, p. 49, pl. 9, figs. 11-13. RASETTI, 1946, p. 444, pl. 69, figs. 32-34. PALMER, 1954, p. 718-719, pl. 76, figs. 8-12.

Kormagnostus harlanensis RESSER, 1938a, p. 49, pl. 10, figs. 11, 12.

Kormagnostus esterius LOCHMAN, 1940, p. 24, pl. 2, figs. 32-35. LOCHMAN and DUNCAN, 1944, p. 77, pl. 5, figs. 15, 16. LOCHMAN, 1950, p. 348, pl. 51, figs. 6-9.

Kormagnostus splendens LOCHMAN, 1940, p. 25, pl. 2, figs. 23-31.

Remarks.-Cephalon slightly expanded anteriorly. Glabella characterized by a well defined posterior lobe and faintly outlined anterior lobe. A broad shallow marginal furrow is present on both cephalon and pygidium.

Pygidium slightly expanded posteriorly. Broad axial lobe bears a prominent median node on the second segment. A near perfect pygidium exhibits a small terminal node on the posterior part of the axial lobe just above the dorsal furrow. For a more complete description and synonomy see Palmer (1954, p. 718-719).

Occurrence.-Fairly common in argillaceous limestones. Specimens have been collected from the upper Cedaria zone at 10909-L 910, from the lower Crepicephalus zone at 10911-O 85, and the Elvinia zone at 10909-D 15.

Genus OEDORHACHIS Resser, 1938
OEDORHACHIS TYPICALIS Resser
Pl. 1, figs. 7, 8

Oedorhachis typicalis RESSER, 1938a, p. 50, pl. 10, figs. 16, 22, 28.

Supplementary description.-Cephalon with slightly greater width than length, strongly rounded anteriorly. Glabella well defined by moderately deep dorsal furrow. Length about two-thirds that of the cephalon. Unequally divided into two segments by a distinct transverse furrow. Anterior segment slightly wider than anterior part of posterior segment. Posterior segment expands posteriorly and is highest behind its midpoint. Basal glabellar lobes triangular and well defined. Cheeks

undivided and slightly greater in width than glabella on midline of cephalon. Border narrowest at posteriolateral margin and widest at anterior margin.

The two thoracic segments show no specific characteristics.

Pygidium slightly wider than it is long and rounded posteriorly. Axial lobe broad, well define, and extended to posterior marginal furrow. It is unequally divided into three segments by two very faint pairs of furrows. The middle segment bears a low medial node and the posterior segment is expanded to a bulbous outline. Border is well defined and bears two short posteriolateral spines which occur on a transverse line through the intersection of the axial lobe with the posterior marginal furrow and in a distinct distance from the widest extent of the pygidium. Surface of carapace smooth.

Remarks.-Utah specimens are almost identical to Resser's figured holotype. The only noticeable difference is a greater posterior expansion of the posterior glabellar lobe.

Occurrence.-Common in the upper part of the Cedaria zone. The figured specimens were collected by Mr. E. W. John from an unknown locality in the upper part of the Weeks limestone in the House Range. Specimens have been collected from a measured section at locality 10911-W 783-1388.

OEDORHACHIS? ULRICHI Resser, 1938
Pl. 1, fig. 9

Oedorhachis ulrichi RESSER, 1938a, p. 50, pl. 10, fig. 29.

Diagnosis.-Pygidium subquadrate in outline. Axial lobe terminates in a short medial spine. Other features are similar to those of O. typicalis.

Remarks.-Only the pygidium is known of this species. It is associated with O. typicalis but is easily differentiated by its subquadrate outline and the presence of three short spines on the posterior margin.

Occurrence.-Upper part of the Cedaria zone. All specimens studied were collected by Mr. E. W. John from an unknown locality in the upper part of the Weeks limestone in the House Range.

Genus PSEUDAGNOSTUS Jaekel, 1909
PSEUDAGNOSTUS COMMUNIS (Hall & Whitfield)
Pl. 1, figs. 2, 5

Agnostus communis HALL & WHITFIELD, 1877, p. 228, pl. 1, figs. 28, 29.

Agnostus neon HALL & WHITFIELD, 1877, p. 229, pl. 1, figs. 26, 27.

Pseudagnostus communis KOBAYASHI, 1939, p. 157. PALMER 1954, p. 720-721, pl. 76, figs. 1-3. PALMER, 1955, p. 94-96, pl. 19, figs. 16, 19-21; pl. 20, figs. 4-11, 14.

Diagnosis. -Cephalon with only moderately defined dorsal furrow and preglabellar median furrow. Pygidium characterized by posteriorly expanded axial lobe and moderately defined furrows. For a detailed description and discussion of this species, see Palmer, 1955, p. 94-96.

Occurrence. -Common in the Aphelaspis zone at locality 10911-O 975.

PSEUDAGNOSTUS? NORDICUS (Lochman)
Pl. 1, figs. 1, 4

"Agnostus" nordicus LOCHMAN, 1940, p. 23, pl. 2, figs. 20-22.

"Agnostus" valentinus LOCHMAN, 1944, p. 78, pl. 5, fig. 14.

Pseudagnostus? nordicus PALMER, 1954, p. 721, pl. 76, figs. 5, 7.

Diagnosis. -Cephalon characterized by an elongate triangular glabella. A preglabellar median furrow is present, and the cheeks are surrounded by a narrow border. Only the anterior one-third of the axial lobe is defined on the pygidium. A prominent axial node is present, but transverse furrows are absent. Specimens from western Utah add little to Palmer's (1954a, p. 721) discussion of the species.

Occurrence. -Rare in the upper part of the Cedaria zone and the lower part of the Aphelaspis zone. Specimens were collected at localities 10909-L 905 and 10909-H 290.

Family ASAPHISCIDAE
Genus KINGSTONIA Walcott, 1924
KINGSTONIA WALCOTTI Resser
Pl. 1, figs. 14, 17, 18

Kingstonia walcotti RESSER, 1938a, p. 83, pl. 12, figs. 3, 4. LOCHMAN, 1940, p. 35, pl. 4, figs. 13-16. LOCHMAN & DUNCAN, 1944, p. 113-114, pl. 14, figs. 21-26. RASETTI, 1946, p. 455, p. 69, figs. 23, 24.

Diagnosis. -Minute representatives of this species are characterized by nearly featureless cranidia and pygidia. Specimens from western Utah differ little from previously described forms except that they have a less faintly impressed dorsal furrow on the inner surface of exfoliated cranidia. Also the interpleural grooves of exfoliated pygidia may or may not be visible.

Remarks. -Two subgenera of Kingstonia have been proposed by Shaw (1952, p. 471-472) and defended by Palmer (1954, p. 725). They are based upon the shape of the posterior limbs of the cranidium, depending on whether they are long and sharp-pointed or stubby and rounded. Tasch (1952, p. 859) and Lochman (1953, p. 886-887) have challenged this proposal and have pointed out that cranidia from large suites of kingstonid trilobites bear both types of posterior limbs and are intergradational. They therefore consider the variation to be no more than a specific difference. Large numbers of kingstonids in my collection also exhibit an intergradation between stubby and long posterior limbs although those with long posterior limbs are rare. On the basis of this gradation, I concur with Tasch and Lochman that the shape of the posterior limb is no more than a specific character.

Occurrence. -Common in bioclastic units of the Crepicephalus zone. Specimens have been collected at localities 10911-O 295, 10918-O 753-798, and 10920.

Genus MARYVILLIA Walcott, 1916
MARYVILLIA ARION Walcott
Pl. 1, figs. 20, 21

Maryvillia arion WALCOTT, 1916b, p. 400, pl. 64, figs. 4, 4a-c. RASETTI, 1956, p. 1267 (for synonomy to date).

Diagnosis. -Cranidium characterized by shallow furrows and smooth surface. Frontal limb steeply downsloping and laterally bounded

by facial sutures that are nearly parallel. Specimens lower in the section are generally smaller (about 5 to 8 mm.), have a slightly more elevated glabella, and have a less steeply downsloping frontal limb. Pygidium subtriangular and characterized by a long narrow axis and faint furrows.

Remarks. -Rasetti (1956, p. 1267) has presented a detailed description and discussion of synonomy for this species. Specimens from western Utah essentially agree with Rasetti's description. The only exception noted is that the border may be either flat or convex.

Occurrence. -Common in the uppper part of the Cedaria zone and the lower part of the Crepicephalus zone. Specimens have been collected at localities 10909-L 910, 10910-W 1100-1157, 10911-O 85, 10918-O 858, and 10920.

Family CATILLICEPHALIDAE
Genus LONCHOCEPHALUS Owen, 1852
LONCHOCEPHALUS PLENA Walcott
Pl. 1, fig. 13

Lonchocephalus plena WALCOTT, 1916a, p. 194-195, pl. 34, figs. 2, 2a.

Lonchocephalus plenus RASETTI, 1954, p. 601.

Diagnosis. -Cranidium of small size. Glabella convex, only slightly tapered, but strongly rounded anteriorly. A shallow occipital furrow anteriorly delimits an occipital ring which is narrow laterally but extends posteriorly into a long, sharp, medial spine. Dorsal furrow narrow and deep. Frontal limb characterized by lack of brim and narrow upturned border which may partially owe its relief to mode of preservation in argillaceous limestone. Fixed cheecks less than one-half width of glabella on medial line. Ocular ridges distinct and only slightly reflexed posteriorly.

Remarks. -The holotype figured by Walcott has a glabella whose width is almost equal to its length. All the specimens in my collection exhibit glabellas which normally have a width about three-fourths that of their length, thus giving them a distinctly elongate appearance.

Rasetti (1954, p. 601) points out that Lonchocephalus plena is a gradational species between Lonchocephalus and Welleraspis. However, on the basis of its slightly tapered and anteriorly rounded glabella, it is assigned to the genus Lonchocephalus.

Occurrence. -Moderately common in the upper part of the Cedaria zone. Specimens were collected at locality 10911-W 1060-1388.

Genus TERRANOVELLA Lochman, 1938
TERRANOVELLA DORSALIS (Hall)
Pl. 1, fig. 10

Conocephalites? (Arionellus?) dorsalis HALL, 1863, p. 222.

Ptychoparia dorsalis VOGDES, 1890, p. 141. TELLER, 1911, p. 267.

Lonchocephalus sospita WALCOTT, 1916a, p. 195, pl. 36, figs. 1, 1a.

Terranovella dorsalis RAASCH & LOCHMAN, 1943, p. 234, pl. 35, figs. 3-10, 17. NELSON, 1951, p. 773, pl. 106, fig. 9.

Remarks. -Although members of this species have been collected and described by several authors, their external surfaces have been unknown until now. Well preserved specimens from the Wah Wah Mountains exhibit a peculiar anastomosing pattern of raised lines on the border, fixed cheeks, and posterior limbs. The external surface of the glabella is smooth except for the glabellar furrows.

Prior descriptions of Terranovella dorsalis indicate that it lacks a border; however, Walcott (1916a, p. 195) mentions a "very narrow thread-like frontal rim" on a trilobite from Minnesota that he named Lonchocephalus sospita. This species has since been placed in synonomy with T. dorsalis (Nelson, 1951, p. 773). Specimens in my collection display a narrow border that is defined better by a change in surface ornamentation than by a marginal furrow because the marginal furrow is conspicuous only at its lateral limits. The border has a longitudinal length of about one-fifth that of the brim and its surface is marked by a number of parallel raised lines. It has been debated whether or not to place these specimens in a new species, but since the external surface of T. dorsalis is unknown to date, and because all other important morphologic features coincide, it is felt that the Utah specimens should be assigned to T. dorsalis.

Occurrence. -Rare in the upper part of the Crepicephalus zone. Specimens were collected at 10918-O 1012-1063.

Genus WEEKSINA Resser, 1935
WEEKSINA sp.
Pl. 1, fig. 23

Description. -Carapace ovate. Cephalon semi-circular with short genal spines. Glabella tapered, bluntly rounded anteriorly. Dorsal furrow narrow but well defined. A moderately wide occipital furrow, that is deepest near the dorsal furrow, separates a wide occipital ring that bears a low median node. Longitudinal length of frontal limb slightly greater than one-third that of glabella. A wide shallow marginal furrow separates the brim and border that have a length ratio of 2:1. Fixed cheecks narrow. Facial sutures diverge anterior to anteriolateral corners of glabella and cut across border to their intersection with the marginal furrow thus causing the anterior angles of the cranidium to be strongly rounded.

Thorax composed of twelve segments. Each axon bears a low median node.

Pygidium small, less than one-half length of cephalon. Axis tapers slightly, extends almost to border, and bears four axons and a terminal section.

Remarks. -This new species is represented in my collections by three carapaces that are nearly complete but somewhat weathered. All general morphologic features are similar to those of Weeksina unispina except that Weeksina sp. has twelve instead of ten thoracic segments, each of which bears a low median node. No axial spines are present. W. unispina bears a long medial spine on the eighth thoracic axon and lacks nodes on the remaining axons.

Occurrence. -Rare in the middle part of the Cedaria zone. Specimens were collected in a talus slope at 10911-W 760.

Family CEDARIIDAE
Genus CEDARIA Walcott, 1924
CEDARIA MINOR (Walcott)
Pl. 1, fig. 16

Asaphiscus minor WALCOTT, 1916b, p. 388, pl. 61, figs. 3, 3a-b.

Cedaria minor RESSER, 1935, p. 19-20.

Diagnosis. -Carapace elongate elliptical. Glabella slightly tapered, rounded anteriorly. Frontal area one-half length of cranidium.

Marginal furrow well defined. Thorax consists of seven thoracic segments. Axial lobe well defined by deep dorsal furrow. Semicircular pygidium bears four segments and a terminal section on the axial lobe.

Occurrence. -Common in the upper part of the Cedaria zone. Many specimens were collected from 10911-W 670-1388. In addition, several nearly complete specimens were available for study that were collected from an unknown locality in the Weeks limestone by Mr. E. W. John.

Family CREPICEPHALIDAE
Genus COOSELLA Lochman, 1936
COOSELLA sp.
Pl. 2, fig. 11

Discussion. -One fragmentary pygidium of this genus was found in the argillaceous limestone unit that marks the top of the Lamb dolomite in the Deep Creek Range. It is almost identical with an unnamed species of Coosella collected by Palmer (1954, p. 730, pl. 79, fig. 1) from the Riley formation in central Texas. The Utah specimen is characterized by a short axial lobe with twin nodes on the posterior axon. The border is wide and exhibits a slight posterior median indentation.

Occurrence. -Rare in the upper part of the Cedaria zone. One specimen was collected at locality 10909-L 915.

Genus COOSINA Rasetti, 1956
COOSINA ARISTON (Walcott)
Pl. 2, figs. 13, 16

Maryvillia ariston WALCOTT, 1916b, p. 401, pl. 64, figs. 5, 5' (not fig. 5a).

Coosina ariston RASETTI, 1956, p. 1267-1268 (for synonomy to date).

Remarks. -Specimens from Utah add little to the detailed description of Rasetti (1956, p. 1267-1268). All of the cranidia and pygidia collected are larger than most specimens that have been illustrated by other workers.

Occurrence. -Moderately rare in the upper part of the Crepicephalus zone at locality 10918-O 1012-1063.

Genus CREPICEPHALUS Owen, 1852
CREPICEPHALUS sp.
Pl. 2, figs. 9, 10, 12, 15

Description. Cranidium minus posterior limbs nearly quadrate, width between palpebral lobes about equal to axial length. Glabella broad, slightly tapered, strongly rounded anteriorly. Occipital ring widest at midpoint. Axial length of border commonly twice that of brim. A range of growth forms exhibits a shallow median depression on the brims of younger forms but the depression disappears on mature individuals. The border is gently rounded and bears minute raised lateral lines on its surface. Fixed cheeks one-half the width of glabella on transverse line between palpebral lobes.

Pygidium subrectangular in outline. Its axial length is one-half to three-fourths less than its width. The axial lobe is narrow, contains five axons, and tapers almost to the posterior margin. Anterior pleural furrow well impressed, others faint and distally diminishing. No marginal furrow is present. A pair of short posteriolateral spines extend posteriorly. The spines range in length from about one-third the length of the axial lobe in young forms to about two-thirds the axial length in mature forms. A large assemblage of specimens also shows a gradation in shape of the posterior margin between the posteriolateral spines from nearly straight to moderately curved, however the nearly straight margined forms are by far the most abundant in my collection.

Remarks. -Utah specimens are similar to Crepicephalus australis except that the brim to border ratio is 1:2 rather than 1:1 and the posterior margin of the pygidium between the posteriolateral spines is straighter. It is also similar to C. buttsi montanensis but possesses wider fixed cheeks, five instead of three pygidial segments, and has shorter posteriolateral spines on the pygidium. Some of the smaller pygidia are similar to C. brevispinus but they differ in having five instead of three segments on the pygidium and external surfaces are smooth instead of minutely granulated.

The specimen illustrated on Plate 2, figure 10, is of interest because it shows a pygidium that had its right posteriolateral spine broken off and the irregular edge healed over while the animal was still alive. Lochman (1941, p. 324-325) has noted a similar healed injury on a species of Tricrepicephalus and has discussed its significance.

Occurrence. -Common in the Crepicephalus zone at localities 10911-O 5-295, 10911-O 689, and 10918-O 1012-1065.

Genus SYSPACHEILUS Resser, 1938
SYSPACHEILUS CAMURUS Lochman
Pl. 2, fig. 7

Syspacheilus camurus LOCHMAN, 1940, p. 42, pl. 3, figs. 21-25.

Remarks. -Cranidium characterized by an anterior margin rounded at the sides but nearly straight across the front. Its surface may or may not bear minute granules. A short tapered glabella has a length slightly less than its posterior width. The dorsal furrow is narrow but distinctly shown. All specimens have a border whose surface is marked by transverse raised lines.

In the original description of this species, Lochman states that the border bears "a prominent backward bulge on the median line of the cranidium." Specimens in my collections display a medial widening of the marginal furrow at the expense of the brim rather than a backward bulge of the border. Utah specimens agree with the original description in all other important features.

Occurrence. -Rare in the upper part of the Cedaria zone and the lower part of the Crepicephalus zone. Specimens were obtained at localities 10909-L 910 and 10911-O 85.

Family DOKIMOCEPHALIDAE
Genus IDDINGSIA Walcott, 1924
IDDINGSIA ROBUSTA (Walcott)
Pl. 1, fig. 12

Ptychoparia similis robustus WALCOTT, 1884, p. 53, pl. 1, figs. 9, 9a.

Iddingsia robusta WALCOTT, 1925, p. 97, pl. 16, figs. 10, 11.

Remarks. -This species is similar to Iddingsia similis but differs chiefly in the shape of the glabella. The glabella of I. robusta is slightly rounded laterally and moderately tapered, whereas the glabella of I. similis is nearly straight sided and broadly rounded anteriorly. The nonexfoliated surface of I. robusta is thickly granulated.

Occurrence. -Rare in the lower part of the Elvinia zone. One specimen was collected at 10909-D 15.

IDDINGSIA SIMILIS (Walcott)
Pl. 1, figs. 19, 22

Ptychoparia similis WALCOTT, 1884, p. 52-53, pl. 10, fig. 10.

Iddingsia similis WALCOTT, 1924, p. 58, pl. 12, fig. 6. WALCOTT, 1925, p. 97, pl. 16, figs. 8, 9. BELL, FENIAK, & KURTZ, 1952, p. 184, pl. 30, figs. 4a-c; pl. 31, fig. 2.

Diagnosis. - Glabella convex, nearly straight sided, and broadly rounded anteriorly. Three pairs of glabellar furrows are present. The anterior pair is very faint, the middle pair is somewhat stronger, and the posterior pair is well impressed. A moderately wide occipital furrow is nearly straight medially but is reflexed forward and becomes deeper at its lateral ends. Occipital ring widest at its center and bears a small medial node. A broad frontal limb is one-fourth the length of the cranidium. The brim is one-half the length of the border. Narrow fixed cheeks upslope sharply from a narrow dorsal furrow. Posterior limbs are thin.

Remarks. - Four fairly well silicified cranidia and several fragments have been leached from calcareous rocks collected from the base of the Notch Peak limestone in the Ibex area of western Utah.

Occurrence. - Moderately common in the upper part of the Elvinia zone at locality 10919.

Genus KINDBLADIA Frederickson, 1948
KINDBLADIA AFFINIS (Walcott)
Pl. 1, fig. 15

Ptychoparia (Euloma?) affinis WALCOTT, 1884, p. 54, pl. 10, fig. 12.

Euloma affinis WALCOTT, 1914, p. 362.

Iddingsia affinis RESSER, 1937, p. 14.

Berkeia affinis RESSER, 1942a, p. 7.

Supplementary description. - Cranidium appears to be elongate but actually it is normally less than one-fifth greater in length than its width through the palpebral lobes. Specimens have a cranidial length that varies from 4.3 to 8.4 millimeters. Glabella convex, slightly tapered, strongly rounded anteriorly, and well defined by a wide deep dorsal furrow. Three pairs of glabellar furrows are present but only

the posterior two are well impressed and arcuate. Occipital furrow wide and deep except for a minor constriction near its intersection with the dorsal furrow. Occipital ring moderately wide, convex, and bears a medial node. Brim steeply downsloping. A wide marginal furrow contains three faint pits which are almost absent on exfoliated specimens. Border slightly upturned and equal with the brim in width. Fixed cheecks narrow and upsloping. Posterior limbs thin, tapered distally, and equal to the glabella in width. The facial suture is marginal across the front to a point anterior to the intersection of the dorsal furrow and middle glabellar furrow. From that point it cuts obliquely back across the border until it intersects the marginal furrow and then cuts almost straight back, curves around the palpebral lobes, and then diverges across the front margin of the posterior limbs at an angle of forty-five degrees.

Remarks. - This species belongs to the genus Kindbladia, established by Frederickson in 1948 (p. 802), because of its narrow upsloping fixed cheeks, convex glabella, and pitted marginal furrow anterior to the glabella. It is similar to K. wichitahensis (Resser) and Berkeia nevadensis Resser but bears a glabella which is more convexly elevated above the fixed cheeks. B. nevadensis also belongs to the genus Kindbladia and comparison of holotypes may indicate that it is conspecific with K. wichitahensis.

Occurrence. - Common in the Elvinia zone. Several specimens have been collected at 10909-D 1-30 and a few moderately silicified specimens have been leached from rocks collected at locality 10919.

Family DORYPYGIDAE
Genus OLENOIDES Meek, 1877
OLENOIDES sp.
Pl. 2, fig. 14

Description. - Dorsal carapace large, elongate elliptical in outline. One nearly complete carapace, if restored, would measure approximately six inches in length and nearly four inches in width through the anterior part of its thoracic region.

Cephalon semicircular in outline. Glabella expands anteriorly to a broadly rounded front, slightly arched both laterally and longitudinally, surface smooth except for three pairs of glabellar furrows. Two anterior pairs faintly impressed in contrast to prominent sigmoidally trending posterior pair. Glabella delimited by moderately impressed dorsal and occipital furrows. Occipital ring slightly convex. Fixed cheeks, posterior limbs, and free cheeks coarsely granulate.

Thorax consists of seven segments. Axial lobe slightly convex and equal in width to pleural lobes exclusive of pleural spines. Posterior margin of axon bows forward from dorsal furrow, characteristically exposing the underlying half ring for one-half the axial length of the axon. Pleural lobes nearly flat except for a minor arch on the lateral extremities, surface granulate. Pleurons bear strong oblique pleural grooves. Length of pleural spines about one-third that of the pleural lobe.

Pygidium large and semicircular in outline, length about two-thirds that of its width. Axial lobe consists of five axons and a terminal section. Pleural platform composed of five anchylosed segments which terminate in reflexed marginal spines. Interpleural grooves and pleural furrows become progressively more reflexed until they almost parallel the axial lobe on posterior part of pleural platform. Ventral surface of pleural lobes marked by fine pits connected by minute grooves. These are expressed on the dorsal surface as coarse granules with a pattern of minute interconnecting lines.

Remarks. - Three specimens of this species occur in my collections. They consist of one nearly complete carapace, one cranidium, and a fragmentary pygidium. Both cranidia were partially crushed by compaction of the enclosing thin-bedded shaly limestone during diagenesis.

Olenoides sp. differs from O. inflatus in that it has five rather than ten axons on the pygidium and a less bulbous glabella. It also has less axons than O. superbus and in addition has a more anteriorly expanded glabella. Also the granules are better developed on the external surface of O. sp. than on most other species of the genus.

The occurrence of Olenoides in the upper Weeks limestone is the second known occurrence of the genus above the Middle Cambrian. Rasetti (1946, p. 459-560) recorded the occurrence of two pygidia that he discovered on the western Gaspe peninsula of Quebec. He tentatively assigned them to the genus Olenoides and noted that this genus possesses the unique distinction among Cambrian trilobites of ranging from the late Lower Cambrian to the early Upper Cambrian.

Occurrence. - Rare in the upper part of the Cedaria zone. Specimens were collected at locality 10911-W 1230 and on a talus slope of Weeks limestone at an unmeasured horizon in a canyon southwest of the west face of Notch Peak in the House Range.

Family HOUSIIDAE
Genus HOUSIA Walcott, 1924
HOUSIA VARRO (Walcott)
Pl. 2, fig. 1

Dolichometopus (Housia) varro WALCOTT, 1916b, p. 374-375, pl. 65, figs. 1, 1a-e.

Housia varro WALCOTT, 1924, p. 57, pl. 12, fig. 4. WALCOTT, 1925, p. 95-96, pl. 18, figs. 4-8. BELL, FENIAK, & KURTZ, 1952, p. 183, pl. 30, figs. 3a-d.

Diagnosis. - Free cheeks are wide, lack genal spines, and possess a doublure that is about one-third the width of the free cheek. Pygidium semicircular with one partially anchylosed anterior segment. A slightly tapered axial lobe has a length two-thirds that of the pygidium.

Occurrence. - Rare in the Elvinia zone. Two pygidia and three free cheeks were collected at locality 10921 and about twenty specimens were collected by Dr. J. Keith Rigby from the Dunderberg shale in the northern Stansbury Mountains at locality 11006.

Family LLANOASPIDAE
Genus GENEVIEVELLA Lochman, 1938
GENEVIEVELLA CAMPBELLINA Tasch
Pl. 2, fig. 8

Bienella problematica LOCHMAN (part), 1944, p. 65, pl. 4, figs. 13, 15.

Genevievella campbellina TASCH, 1951, p. 292-293, pl. 46, figs. 17, 18; pl. 47, fig. 1.

Diagnosis. - Cranidium subquadrate, characterized by lack of a brim. Glabella broad, bluntly rounded anteriorly. A border of moderate width is marked by several narrow, raised, transverse lines. Tasch's description is adequate for this species.

Remarks. - Specimens from western Utah are almost identical with Tasch's species from the Warrior formation. A small cranidium which was tentatively assigned by Lochman (1944, p. 65) to Bienella problematica, is also considered to be conspecific with this species because of its close similarities. The genus and species, Bienella problematica, were erected for some unusual pygidia rather than for the one small associated cranidium.

Occurrence. -Rare in the lower part of the Crepicephalus zone at localities 10911-O 8 and 10911-O 83.

Genus LLANOASPIS Lochman, 1938
LLANOASPIS UNDULATA Lochman
Pl. 2, fig. 6

Llanoaspis undulata LOCHMAN, 1938a, p. 81, pl. 17, figs. 24-26. PALMER, 1954, p. 738, pl. 82, figs. 6, 7.

Genevievella rogersvillensis RESSER, 1938a, p. 78, pl. 15, figs. 16-18.

Llanoaspis montanensis LOCHMAN, 1944, p. 67, pl. 7, figs. 14, 15.

Remarks. -One fragmentary cranidium of this species was collected from the Orr limestone in the Wah Wah mountains. Its undulating border and straight marginal furrow are characteristic.

Occurrence. -Rare in the upper part of the Crepicephalus zone at locality 10918-O 1018.

Family MENOMONIIDAE
Genus DENSONELLA Shaw, 1952
DENSONELLA SEMELE (Walcott)
Pl. 2, fig. 4

Millardia semele WALCOTT, 1916a, p. 166, pl. 28, figs. 3, 3a-c. LOCHMAN, 1940, p. 9-10.

Menomonia semele RESSER, 1938b, p. 35. LOCHMAN, 1944, p. 135-136, pl. 14, figs. 10-13. RASETTI, 1946, p. 458, pl. 70, fig. 15.

Densonella semele SHAW, 1952, p. 477.

Diagnosis. -This species is represented in my collections by one nearly complete, well preserved specimen. Carapace elongate elliptical, tapering slightly posteriorly. Surface spotted with granules, regularly placed except on posterior limbs and free cheeks. Cephalon slightly more than twice as wide as it is long. Glabella highly convex, roughly triangular with anterior half tapering most abruptly. Palpebral lobes occur on prominent stalks opposite anterior end of glabella. Thorax characterized by well differentiated segments of which only eighteen are preserved. Axis and pleural lobes strongly convex.

Occurrence. -Rare in the Cedaria zone at locality 10911-W 540-1380.

Genus MENOMONIA Walcott, 1916
MENOMONIA CALYMENOIDES (Whitfield)
Pl. 2, fig. 5

Conocephalites calymenoides WHITFIELD, 1878, p. 52. WHITFIELD, 1882, p. 179, pl. 3, figs. 2-5.

Menomonia calymenoides WALCOTT, 1916a, p. 162-163, pl. 26, figs. 4, 4a-d. LOCHMAN, 1940, p. 43, pl. 4, figs. 34-38. TASCH, 1951, p. 300-301, pl. 47, fig. 7.

Remarks. -One fairly well preserved cranidium with an axial length of 4.25 millimeters was collected from the Deep Creek Range. It is characterized by a deep dorsal furrow; smooth, slightly concave brim; and granular frontal border, fixed cheeks, and posterior limbs. The glabellar surface ispunctate on its crest and marked by an orderly arrangement of granules on its lateral and anterior sides. Two prominent pustules occur on the brim near the anterio-lateral corners of the glabella. Previous descriptions of this species are adequate for remaining morphologic features.

Occurrence. -Rare in the upper part of the Cedaria zone at locality 10909-L 910.

Family NORWOODIIDAE
Genus HOLCACEPHALUS Resser, 1938
HOLCACEPHALUS TENERUS (Walcott)
Pl. 2, fig. 2

Norwoodia tenera WALCOTT, 1916a, p. 172, pl. 28, figs. 2, 2a-g. LOCHMAN, 1938a, p. 83-84, pl. 18, figs. 11-13.

Holcacephalus granulatus RESSER, 1938a, p. 81, pl. 9, figs. 15-17.

Norwoodina tenera LOCHMAN, 1940, p. 50, pl. 5, figs. 12-14.

Holcacephalus tenerus LOCHMAN & DUNCAN, 1944, p. 137, pl. 13, figs. 15-17.

Remarks. -This species can be easily distinguished by its subrectangular glabella, well defined dorsal furrow, and granular surface. Previous descriptions are adequate.

Specimens from the House Range occur in thin, platy, siliceous limestone beds one-fourth to one-half inch thick with argillaceous parting planes. H. tenerus is commonly associated with Deiracephalus multisegmentus and Cedaria minor. Preservation of these forms is normally restricted to argillaceous parting planes.

Occurrence. -Abundant in the upper part of the Cedaria zone and rare in the lowermost Crepicephalus zone. Specimens have been collected from localities 10911-W 783-1388 and 10911-O 8.

Family PTEROCEPHALIIDAE
Genus APHELASPIS Resser, 1935
APHELASPIS? sp.
Pl. 3, figs. 1, 6, 8, 12

Description. -Cranidium minus posterior limbs rectangular with moderate relief. Surface coarsely granular on non-exfoliated specimens, generally smooth on exfoliated surfaces. Granules are most conspicuous on juvenile forms and tend to become less noticeable on gerontic individuals.

Glabella straight sided, tapered, generally rounded at anterior margin. Dorsal furrow well defined on lateral sides of glabella but becomes shallow near center of anterior margin. Four pairs of glabellar furrows are faintly to moderately impressed. The anterior pair is reflexed slightly forward. The second pair is nearly straight, while the posterior two pairs are reflexed posteriorly. Occipital furrow shallow at midpoint, becoming much deeper at contact with dorsal furrow. The occipital ring is widest at its midpoint and commonly bears a small medial node. Border broadly arcuate in anterior outline and is separated from the brim by a distinct change in slope which makes a wide shallow depression. No definite marginal furrow is present. Surface of the brim is marked by an anastomosing pattern of minute raised lines that is present on both exfoliated and non-exfoliated specimens. Axial length of border and brim about equal in juvenile forms but in mature specimens the border normally has a length varying from four-fifths to nine-tenths that of the brim. Fixed cheeks approximately one-half width of glabella on medial line through palpebral lobes. Shallow palpebral furrows delimit wide, slightly upturned palpebral lobes. Posterior limbs narrow, about equal to occipital ring in width.

Free cheeks slender, downsloping from ocular region. A wide shallow marginal furrow separates the smooth border from a granulose

ocular platform. The extension of the marginal furrow from the posterior limb is more deeply impressed than is the marginal furrow around the outer part of the cephalon. The border extends posteriorly into a long sharp genal spine.

Pygidium elliptical with a lateral elongation. The axial lobe is tapered posteriorly, elevated above pleural lobes, and divided into four axons. Pleural furrows are wide and shallow, decreasing in prominence posteriorly. The pygidial surface lacks granules and is nearly smooth except for an inosculating system of raised lines around the outer part of the pleural platform. A marginal furrow and border are absent on the pygidium.

Remarks. - This species differs from all known species of Aphelaspis in that it bears abundant granules on its cephalon. It also differs in having four pairs of commonly well impressed glabellar furrows that are absent or only faintly exhibited by other specific members of Aphelaspis.

Aphelaspis? sp. bears some resemblance to Pterocephalina utahensis but differs by having four instead of three glabellar furrows, a shorter frontal limb, and the pygidia are markedly different. This species cannot definitely be assigned to any presently defined genus; therefore, on the basis of close similarities of both cranidia and pygidia to members of Aphelaspis, it is questionably assigned to that genus until a more comprehensive study is made of the group of trilobites to which this species belongs.

Occurrence. -Common in the Aphelaspis zone at localities 10909-H 230-470, 10911-O 1193-1257, and 10918-O 1149-1222.

Genus DYTREMACEPHALUS Palmer, 1954
DYTREMACEPHALUS sp.
Pl. 4, figs. 5, 8

Description. -Cranidium subquadrate in outline. Anterior margin wide and only slightly rounded. Axial length averages nine millimeters. Glabella slightly tapered, truncate anteriorly. Three pairs of arcuate glabellar furrows are present. The anterior pair is faint and often obliterated on poorly preserved specimens. Dorsal furrow wide and fairly deep at lateral sides of glabella, shallower across front. Two pits prominently occur in the dorsal furrow at the anteriolateral corners of the glabella. Occipital furrow wide and shallow. Occipital ring widest at midpoint and sometimes bears a

small medial node. The characteristically wide brim and border are both slightly convex and moderately downsloping. They are separated by a shallow marginal furrow. The axial length of the border averages one-half that of the brim. Fixed cheeks nearly flat or slightly upsloping, width one-half that of glabella on midline through palpebral lobes. Oblique ocular ridges are prominent. Posterior limbs narrow and equal to occipital ring in width. Well preserved non-exfoliated specimens have a glabellar surface which is faintly granulated while the frontal limb and fixed cheeks are finely punctate.

Remarks. -This is a new species that is easily differentiated from the other two known species of Dytremacephalus because of its wide (lateral) frontal limb, nearly straight anterior margin, and surface markings.

Occurrence. -Common in the Aphelaspis zone. Many specimens have been collected at localities in 10909-H 230-470 and 10910-O 354-406.

Genus LABIOSTRIA Palmer, 1954
LABIOSTRIA CONVEXIMARGINATA? Palmer
Pl. 3, fig. 10

Labiostria convexiimarginata PALMER, 1954, p. 751, pl. 86, figs. 1-4.

Remarks. -The two cranidia of this species in my collections are marked by a convex border, straight-sided glabella, and minutely punctate surface. The marginal furrow exhibits a characteristic medial posterior sag and the occipital ring bears a small node. The specimens are questionably assigned to L. convexiimarginata because they lack associated pygidia that Palmer (1958, personal communication) believes is necessary for specific identification.

Occurrence. -Rare in the lower part of the Aphelaspis zone at locality 10910-O 354-406.

LABIOSTRIA sp. A
Pl. 3, figs. 2, 7

Diagnosis. -Glabella straight-sided, slightly tapered, and truncated anteriorly. Three arcuate glabellar furrows are faintly shown on exfoliated specimens. Occipital ring expanded medially at the expense of a shallow occipital furrow. A small occipital node

is present. The species is characterized by a long, convex down-sloping brim that is separated from a relatively short border by a shallow marginal furrow.

Occurrence. -Rare in the upper part of the Aphelaspis zone. Three cranidia were collected at 10918-O 1208.

LABIOSTRIA sp. B
Pl. 3, fig. 14

Diagnosis. -One fragmentary cranidium was collected which has an axial length of 6.6 millimeters. Glabella is rectangular, bears two pairs of short glabellar furrows, and is depressed between steeply upsloping fixed cheeks. Occipital furrow is deepest near the dorsal furrow. Brim and border are of nearly equal length and are separated by a marginal furrow that has a slight posterior medial bend. The border is distinctly concave. Palpebral lobes are extremely large. Surface of cranidium is abundantly punctate.

Remarks. -The specimen is definitely a new species. It differs from any presently known species of Labiostria because of its concave border, steeply upsloping fixed cheeks, and large palpebral lobes.

Occurrence. -Rare in the lower part of the Elvinia zone at locality 10909-D 15.

Genus PTEROCEPHALIA Roemer, 1849
PTEROCEPHALIA SANCTISABAE Roemer
Pl. 3, figs. 4, 5, 9

Pterocephalia sanctisabae ROEMER, 1849, p. 421. ROEMER, 1852, p. 92, pl. 11, figs. 1a-d. BRIDGE & GIRTY, 1937, p. 246-251, pl. 67, figs. 1a-d; pl. 68, figs. 7-43. WILSON, 1949, p. 42, pl. 10, figs. 1-3. FREDERICKSON, 1949, p. 355-356, pl. 69, figs. 1-4.

For a more complete synonomy see BRIDGE & GIRTY, 1937, p. 246, and FREDERICKSON, 1949, p. 355.

Diagnosis. -Cranidial length averages eleven millimeters. Glabella tapered and truncate anteriorly. Dorsal furrow deep at lateral sides of glabella and shallow across front. Frontal limb long, broad, and concave. Pygidium subovate in outline. Posterior margin with slight medial indentation. Axis tapered, length one-half that of pygidium. Pleural platform broad and concave.

Remarks. -The cranidia collected in western Utah are smaller than average. The frontal limbs have a length slightly less than one-half that of the cranidia, while on specimens from other localities, the frontal limbs normally are equal to or greater than one-half the cranidial length. This ratio difference can apparently be attributed to position of the specimens in a growth series. When measurements of thirty-six specimens of P. sanctisabae (Bridge & Girty, 1937, table facing p. 248) from various localities in the United States are plotted graphically, the Utah specimens fit well into the linear trends. Pygidia collected are of normal size. Possible explanations for the smaller cranidia may be that they were selectively sorted by current or wave action or the larger cranidia may have been more fragile and thus less susceptible to preservation.

Occurrence. -Rare in the lower part of the Aphelaspis zone at locality 10909-H 230-280.

PTEROCEPHALIA sp.

Remarks. -A fragmentary cranidium was found among the silicified trilobite fauna collected at Yersin Ridge. It is assigned to the genus Pterocephalia because of its long, broad, concave frontal limb.

Occurrence. -Rare in the upper part of the Elvinia zone at locality 10919.

Family SOLENOPLEURIDAE
Genus CLIFFIA Wilson, 1951
CLIFFIA LATAEGENAE (Wilson)
Pl. 2, fig. 3

Acrocephalites lataegenae WILSON, 1949, p. 31-32, pl. 10, fig. 14.

Cliffia lataegenae WILSON, 1951, p. 633, pl. 90, figs. 18-24.
BELL, FENIAK, & KURTZ, 1952, p. 182, pl. 29, fig. 6.
DELAND & SHAW, 1956, p. 551, pl. 65, figs. 11, 12.

Diagnosis. -Cranidium small, axial length ranging from one to three millimeters. Glabella moderately convex, tapered, and depressed between fixed cheeks which slope steeply up to the palpebral lobes. Three pairs of glabellar furrows are present. The posterior two pairs are characteristically short, broad, and oblique.

Remarks. -Wilson (1949, p. 31; 1951, p. 633) has described this species in great detail. Specimens from western Utah agree with the original description except that they lack a central swelling on the brim anterior to the glabella. They are also generally smaller in size but this is probably due to selective silicification.

All specimens that have been collected are silicified forms that were leached free from their carbonate matrix with HCl. One rock sample that had a volume of about ten cubic inches yielded approximately fifty cranidia and three pygidia.

Occurrence. -Common in the upper part of the Elvinia zone at localities 10911-NP 10-84 and 10919.

Family TRICREPICEPHALIDAE
Genus TRICREPICEPHALUS Kobayashi, 1935
TRICREPICEPHALUS CORIA (Walcott)
Pl. 3, figs. 3, 15-18

Crepicephalus coria WALCOTT, 1916a, p. 206, pl. 33, figs. 3, 3a-g.

Tricrepicephalus coria PALMER, 1954, p. 755, pl. 81, figs. 1-4, 6.
For synonomy to date and a more complete discussion see PALMER, 1954, p. 754-757.

Diagnosis. -Entire surface of cranidium granulate. Glabella tapered, rounded anteriorly, and slightly keeled. Some specimens have an occipital node but none have a true occipital spine. Marginal furrow bears three distinct pits. Two spines extend posteriorly from the posteriolateral surface of the pygidium.

Remarks. -Tricrepicephalus coria is a common long ranging species. Nearly one hundred specimens have been collected at many horizons ranging from near the base of the Cedaria zone to the top of the Crepicephalus zone. This collection from western Utah substantiates Palmer's (1954, p. 755) conclusions that there is much variation in surface granulation, longitudinal profile, and relative width of the brim and border on individual specimens of T. coria. Specimens collected from low in the Cedaria zone have a brim to border length ratio of approximately 1:1. A constant relative increase in the width of the border can be traced through superjacent beds until, high in the Crepicephalus zone, the brim to border ratio is approximately 1:3.

Occurrence. -Common in the Cedaria and Crepicephalus zones. Specimens have been collected at localities 10909-L 865-943; 10910-W 1100-1157; 10911-W 210-1117; 10911-O 1-740; and 10918-Hb (base unexposed) 1014-1065.

Position Unknown
Genus DEADWOODIA Resser, 1938
DEADWOODIA DURIS (Walcott)
Pl. 3, fig. 11

Asaphiscus? duris WALCOTT, 1916b, p. 392, pl. 63, figs. 8, 8a.

Dunderbergia? declivita MILLER, 1936, p. 30, pl. 8, figs. 37-38.

Deadwoodia duris WILSON, 1948, p. 33, pl. 8, figs. 9-17. WILSON, 1951, p. 633, pl. 92, figs. 1-5. BELL, FENIAK, & KURTZ, 1952, p. 183, pl. 29, figs. 3a, b. DELAND & SHAW, 1956, p. 551, pl. 65, figs. 7-10.

Remarks. -A cranidium from the Deep Creek Range has an axial length of 6.5 millimeters. It is similar in all respects to Wilson's descriptions of the species except that the brim and at least the front part of the glabella are minutely punctate in addition to the faint granules that cover the glabella.

Occurrence. -Rare in the Elvinia zone at locality 10909-D 14.

Genus DEIRACEPHALUS Resser, 1935
DEIRACEPHALUS MULTISEGMENTUS (Walcott)
Pl. 3, fig. 13

Acrocephalites multisegmentus WALCOTT, 1916a, p. 180, pl. 24, figs. 5, 5a.

Deiracephalus multisegmentus RESSER, 1935, p. 22.

Diagnosis. -Glabella is tapered, conical, and slightly more than one-half the length of the cranidium minus the occipital spine. The occipital ring is extended posteriorly into a long, sharp, granulated spine. This distinctive species bears an elevated median ridge on the brim which joins a strongly elevated frontal border to form a characteristic "T" shaped structure on the frontal limb. The longitudinal length of the brim is normally about twice that of the border. Slightly elevated ocular ridges are generally reflexed posteriorly at an angle of about fifteen degrees.

Occurrence. -Common in the upper part of the Cedaria zone at locality 10911-W 770-1388.

Genus DUNDERBERGIA Walcott, 1924
DUNDERBERGIA? GRANULOSA (Hall & Whitfield)
Pl. 4, figs. 1, 4, 7, 11

Crepicephalus (Loganellus) granulosa HALL & WHITFIELD, 1877, p. 214-215, pl. 2, figs. 2, 3.

Ptychoparia granulosa WALCOTT, 1884, p. 57.

Inouyia granulosa WALCOTT, 1916a, p. 204.

Dunderbergia granulosa RESSER, 1935, p. 24.

Supplementary description. -Cranidia of this species have an axial length that averages twelve millimeters but specimens ranging up to twenty-two millimeters in length have been collected. Glabella moderately tapered and bluntly truncated anteriorly. It is often slightly elevated above the fixed cheeks, but sometimes is depressed to an equal elevation with the fixed cheeks. Three pairs of arcuate glabellar furrows are present. They become progressively deeper and longer toward the posterior and the third pair is faintly connected across the glabella on well preserved specimens. The dorsal furrow is wide and deep and many small specimens bear distinct pits at the anteriolateral corners of the glabella. These pits are not present on gerontic individuals. Occipital furrow is wide, deep, and prominent. It delimits a flat occipital ring which is constricted at its lateral ends. A wide shallow marginal furrow separates a commonly steep downsloping brim from a narrow convex border which diminishes distally. Fixed cheecks are gently upsloping and have a width one-half that of the glabella on a midline through the palpebral lobes. Posterior limbs bear prominent wide marginal furrows. The facial sutures cut almost directly forward from the palpebral lobes to an intersection with the border and then obliquely across the border.

Pygidia tentatively assigned to this species are semicircular in outline. A wide axial lobe extends almost to the rear border. It bears four axons which are separated by extremely wide and deep furrows. Pleural lobes are slightly convex and show only faint evidence of anchylosed segmentation. A narrow upturned border marks the periphery.

Remarks. - This species is probably the most abundantly preserved and most widespread form encountered in the Upper Cambrian of western Utah. It has been assigned to the genus Dunderbergia by Resser (1935, p. 24), but differs from that genus chiefly because of the course of its facial suture, prominence of glabellar furrows, and wider dorsal furrow. Palmer (1957, written communication) has indicated that he is proposing a new generic name for this species in a forthcoming paper on the fauna of the Dunderberg shale of Nevada. The species is therefore still tentatively assigned to the genus Dunderbergia until that work is published.

Occurrence. - Abundant in the Aphelaspis zone. Specimens have been collected at localities 10909-H 230-470; 10910-O 301-505; 10911-O 740-1257; 10918-O 1149-1222, and 10921.

DUNDERBERGIA NITIDA (Hall & Whitfield)
Pl. 4, figs. 9, 10, 13, 16

Crepicephalus (Loganellus) nitidus HALL & WHITFIELD, 1877, p. 212-214, pl. 2, fig. 8 (not 9, 10).

Crepicephalus (Loganellus) simulator HALL & WHITFIELD, 1877, p. 218, pl. 2, figs. 16-18.

Ptychoparia nitidus WALCOTT, 1884, p. 57-58.

Dunderbergia nitidus WALCOTT, 1924, p. 56, pl. 11, fig. 2 (part).

Dunderbergia simulator RESSER, 1935, p. 24.

Dunderbergia nitida SHIMER & SHROCK, 1944, p. 625, pl. 264, fig. 29 (not 30).

Diagnosis. - Cranidium subquadrate and strongly arched longitudinally. Axial length averages eleven millimeters. Glabella strongly convex, slightly tapered, and moderately rounded to bluntly truncated anteriorly. Three pairs of faint glabellar furrows are sometimes present with the anterior pair being almost indistinguishable. Occipital ring widest at midpoint and occasionally bears a minute medial node. A steeply downsloping brim is separated from an upturned border by a wide marginal furrow that characteristically comes to a blunt point on the axial line. Axial length of border is one-half that of the brim. Fixed cheeks slightly convex, width one-half that of the glabella on midline through palpebral lobes.

Remarks. - Much variation in glabellar shape is exhibited among the one hundred specimens of this species that are available for study. Two extremes exist. One is a somewhat globose glabella, similar to the genotype, that has a basal width slightly greater than its axial length. The other is an elongate glabella with a length slightly greater than its basal width. Both types are common and gradational forms exist between both end members. No stratigraphic significance is apparent for either type of glabella and graphical plotting of various cranidial measurements of many specimens has failed to produce any definite specific differences. It is therefore felt that all of the forms should be assigned to one species.

It has been pointed out by Palmer (1954, p. 761) that the pygidium, illustrated by Hall and Whitfield and by subsequent authors for Dunderbergia nitida, belongs to a species of Housia.

Walcott (1884, p. 57-58), in studying a large series of specimens of D. nitida, found that the cranidia and supposed pygidia varied in size, and that there were no differences between the larger cranidia and the type of Crepicephalus (L.) simulator and he placed the latter species in subjective synonomy. In disregard for this information, Resser (1935, p. 24) resurrected the species, Dunderbergia simulator, but gave no reason or explanation for so doing. It is felt that the large collection of D. nitida from western Utah more than justifies Walcott's conclusions and the species, D. simulator, should again be placed in synonomy with D. nitida.

Occurrence. - Abundant in the Aphelaspis zone at locality 10909-H 230-470 and common at locality 10911-O 1193-1257.

DUNDERBERGIA? sp.
Pl. 4, figs. 3, 14, 15

Description. - Cranidium, minus posterior limbs, elongate subquadrate in outline. The largest cranidium found has an axial length of twenty-eight millimeters and is forty-four millimeters wide through the posterior limbs. It is moderately arched both longitudinally and laterally. Glabella elongate, tapered, and squarely truncated anteriorly. Four pairs of arcuate glabellar furrows become progressively longer and more deeply impressed posteriorly. The fourth pair has completely isolated the posterior glabellar lobes. Dorsal furrow is deep and moderately wide. The occipital furrow is present only at the central margin of the glabellar base, thus causing the occipital ring and basal glabellar lobes to be united. Axial length of border is one-half that of the brim. Border is broadly triangular. Fixed cheeks

are moderately convex and slightly upsloping. Width is one-third that of glabella on midline through palpebral lobes. Palpebral lobes are delimited by well defined arcuate furrows and are equal to the brim in length. Ocular ridges are prominent. Posterior limbs have a length slightly less than base of glabella and bear wide marginal furrows. The facial sutures diverge at an angle of about twenty degrees in front of the palpebral lobes. Entire external surface of cranidium is minutely granulate.

Remarks. -Dunderbergia? sp. is similar to D.? granulosa but it has four instead of three glabellar furrows, the facial sutures are more divergent, and it has narrower fixed cheeks. It will be assigned to the same genus as D.? granulosa (Palmer, 1958, personal cummunication) because of deep glabellar furrows and tendency toward a bluntly pointed anterior margin. The species is now tentatively assigned to Dunderbergia until a new generic name is formally proposed in Palmer's forthcoming paper on the Dunderberg shale fauna of Nevada.

Dunderbergia? sp. closely resembles species of Elvinia in general outline of many features and appears to be closely related to that genus. The major difference is that the characteristic posterior pair of connected glabellar furrows is situated farther back, intersecting the occipital furrow. D.? sp. also bears four pairs of glabellar furrows rather than three and the fixed cheeks are narrower.

Occurrence. -Rare in the lower part of the Aphelaspis zone. Two well preserved specimens were collected at locality 10909-H 245.

Genus ELVINIA Walcott, 1924
ELVINIA ROEMERI (Shumard)
Pl. 4, fig. 12

Dikelocephalus roemeri SHUMARD, 1861, p. 220-221.

Elvinia roemeri WALCOTT, 1924, p. 56, pl. 11, fig. 3. BRIDGE & GIRTY, 1937, p. 251-255, pl. 67, figs. 2a, b, 3a, b; pl. 69, figs. 1-22. FREDERICKSON, 1949, p. 352, pl. 69, figs. 19-21. LOCHMAN, 1950, p. 333, pl. 47, figs. 21-23. NELSON, 1951, p. 775, pl. 107, fig. 8. BELL, FENIAK & KURTZ, 1952, p. 183, pl. 30, figs. 1a-d.

Elvinia utahensis RESSER, 1942b, not RESSER, 1938b, p. 95, pl. 18, figs. 5, 6.

For a more complete synonomy see BRIDGE & GIRTY, 1937, and FREDERICKSON, 1949, p. 352.

Remarks. -Study of specimens from western Utah adds little to previous descriptions of Elvinia roemeri. They display the same wide variability among growth forms that has already been described by many previous workers.

The trilobite described by Resser in 1942 as E. utahensis is an invalid holotype because the same name was used previously by Resser for a different trilobite (1938b, p. 32). The single specimen that was the basis for his 1942 description is a badly weathered cranidium which was apparently considered to be a new species on the basis of its shallow occipital furrow and rear pair of glabellar furrows. Weathering of the specimen seems to more logically account for the shallow features than does a difference in morphology. Remaining morphologic features indicate that the specimen is probably E. roemeri.

Occurrence. -Common in the Elvinia zone at localities 10909-D 1-30 and 10911-D 5-120. One fragmentary specimen was found at locality 10920.

Unassigned pygidium A
Pl. 4, fig. 6

Remarks. -Two distinctive fragmentary pygidia have been found that cannot be assigned to any present genus. The most complete specimen has an axial length of 11.7 millimeters. Pygidium is semicircular in outline and bears a moderately wide rectangular axial lobe which extends slightly more than two-thirds the length of pygidium. An exfoliated specimen shows four to five faint segments on the axial lobe. Pleural platform is slightly downsloping. No border is present. A characteristic wide shallow furrow extends across the anterior margin of the pygidium.

Occurrence. -Rare in the Crepicephalus zone at locality 10918-O 839.

Unassigned pygidium B
Pl. 4, fig. 2

Diagnosis. -An oval shaped pygidium with a convex tapered axial lobe that extends almost to the posterior margin. Five axons and a terminal section are present. The pleural lobes are nearly flat anteriorly but slope rather steeply to the posterior. Interpleural grooves are wide and deep giving the surface an effect of bearing elevated reflexed ridges.

Remarks. - This pygidium is similar to one assigned to Labiostria conveximarginata by Palmer (1954, pl. 86, fig. 1) but has a more tapered axis and lacks a slight posterior marginal indentation. It is commonly associated with Dytremacephalus sp. but cannot definitely be assigned to that species.

Occurrence. - Common in the upper part of the Aphelaspis zone at locality 10909-H 400-470.

LOCALITY INDEX

Geographic distribution of measured sections in central and western Utah is shown by Text-fig. 1. The numbering system used in this paper consists of a Brigham Young University locality number for each measured section, followed by a hyphen and an abbreviation of the formation name and the stratigraphic thickness above the base of the formation. Thus, a specimen bearing the number, 10909-H 245, would indicate that it was collected from the Deep Creek Range, 245 feet above the base of the Hicks formation. The following formation names and abbreviations are used in this paper: Ajax limestone (A), Hicks formation (H), Lamb dolomite (L), Notch Peak limestone (NP), Opex formation (Op), Orr formation (O), and Weeks limestone (W). Sections were measured at the following localities:

10909 - Deep Creek Range. - The section was measured eight miles west-northwest of Callao, Juab County, Utah, on the north side of Goshute Canyon, commencing one-half mile up the canyon from a prominent windfall. The line of traverse extended northwest from the base of the Lamb dolomite to the top of the Dunderberg shale, and then west to the top of the Notch Peak limestone near the crest of the range. The traverse extended through Secs. 26, 27, and 34, T 10 S, R 18 W (unsurveyed) as shown on the 1908 U. S. Geological Survey Fish Springs Quadrangle map. A section was measured in this area rather than at the type area, eighteen miles to the north in the Gold Hill district, because the rocks are less affected by intrusive dolomitization and the fossils are much better preserved.

10910 - Fish Springs Range. - The measured section is located about five miles north of Sand Pass on the eastern most salient of the Fish Springs Range, Juab County, Utah, in Secs. 10, 14, and 15, T 13 S, R 14 W (unsurveyed) as shown on the Fish Springs Quadrangle map. The traverse commenced about 1800 feet up the east face of the salient and included the Lamb, Hicks, and Dunderberg formations. The Notch Peak limestone was not measured because of inaccessability.

10911 - House Range. - This is a composite section measured in four parts. The Weeks limestone was measured at Weeks Canyon in a north-south traverse that began at the base of a massive cliff

two and one-fourth miles southwest of Marjum Pass and extended to the massive brown limestone ledges on the south side of Weeks Canyon. The Orr and Dunderberg formations were measured in a north-south traverse that began on the eastern nose of Orr Ridge and extended to the base of the massive medium gray cliffs that mark the base of the Notch Peak limestone. A measured section containing the lower part of the Notch Peak limestone was begun at the head of an unnamed canyon just south of Granite Canyon and continued in a southwest direction up Notch Peak until it was necessary to offset and continue the section in a northwest direction to the crest of Notch Peak. The remaining upper part of the Notch Peak limestone was measured in a southwest traverse about five miles northeast of Skull Rock Pass in T 20 S, R 13 W.

10912 - Ophir District. - The partial section of Upper Cambrian present in Ophir Canyon lies on the west side of the Oquirrh Mountains. It was measured one-half mile west of Ophir, Tooele County, Utah, on the north side of Lion Hill in Sec. 23, T 5 S, R 4 W.

10913 - Provo Rock Canyon. - The Lynch dolomite of this area was measured in the $NW\frac{1}{4}$ $SW\frac{1}{4}$ Sec. 28, T 6 S, R 3 E, about one and one-half miles northeast of Provo, Utah County, Utah. The formation has been assigned an Upper Cambrian age by previous workers, but on the basis of the occurrence of lower Middle Cambrian trilobites in the upper part of the underlying Maxfield limestone, it is now thought to be Middle Cambrian in age.

10914 - Silver Island Range. - A broken section was measured on a line south-southwest of East Peninsula Peak, about ten miles northeast of Wendover, Tooele County, Utah, in T 1 N, R 18 W.

10915 - Stansbury Mountains (north). - This section was measured in Sec. 18, T 1 S, R 7 W, about one and three tenths miles southeast of Timpe, Tooele County, Utah, near the northern most promintory of the Stansbury Mountains. The traverse extended in a southwest direction to the crest of the range and then east-west along the crest.

10916 - Stansbury Mountains (south). - An incomplete Upper Cambrian section was measured in Secs. 15 and 16, T 5 S, R 7 W, about five miles east of the Skull Valley Indian Reservation, Tooele County, Utah.

10917 - Tintic District. - A section was measured along the ridge west of Eureka Peak between the mining towns of Eureka and Mammoth in Juab County, Utah. It is located in Sec. 24, T 10 S, R 3 W.

10918 - Wah Wah Mountains. - The base of the Upper Cambrian is unexposed in the Wah Wah Mountains and the top of the sequence has been eroded from the top of the range. An east-northeast traverse was measured up the west face of the prominent peak located about one mile north of Wah Wah Pass in Beaver County, Utah.

10919 - Yersin Ridge. - Fossils were collected in the $SW\frac{1}{4}$ $NW\frac{1}{4}$ Sec. 19, T 23 S, R 13 W, in the lower part of the Notch Peak limestone on the north side of Steamboat Pass. A section was not measured in this area because the middle part of the Upper Cambrian section is unexposed.

10920 - Yersin Ridge. - Fossils were collected in Sec. 21, T 23 S, R 13 W, in the Orr formation. No section was measured.

10921 - Granite Canyon. - Fossils were collected from the Dunderberg shale, east of the New Klondike mine camp in Granite Canyon, House Range, Utah, in T 19 S, R 13 W. No section was measured.

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Table I. - The observed stratigraphic ranges of trilobites identified from western Utah.

	ZONES					
	Cedaria	Crepicephalus	Aphelaspis	Elvinia	Ptychaspis-Prosaukia	Saukia
Aphelaspis? sp.			xxxxxx			
Cedaria minor (Walcott)	xxx					
Cliffia lataegenae (Wilson)				xxx		
Coosella sp.	x					
Coosina ariston (Walcott)		xx				
Crepicephalus sp.		xxxxxx				
Deadwoodia duris (Walcott)				x		
Deiracephalus multisegmentus (Walcott)	xxx					
Densonella semele (Walcott)	xxxx					
Dunderbergia? granulosa (Hall & Whitfield)			xxxxxx			
Dunderbergia nitida (Hall & Whitfield)			xxxxxx			
Dunderbergia? sp.			x			
Dytremacephalus sp.			xxxxxx			

Elvinia roemeri (Shumard)	xxxxxx
Euptychaspis sp.	x
Eurekia sp.	x
Genevievella campbellina Tasch	xx
Geragnostus tumidosus (Hall & Whitfield)	x.....xxxx
Holcacephalus tenerus (Walcott)	xxxx
Housia varro (Walcott)	xx
Iddingsia robusta (Walcott)	xx
Iddingsia similis (Walcott)	xx
Illaenurus sp.	x
Irvingella major Ulrich & Resser	xx
Kindbladia affinis (Walcott)	xxxxxx
Kingstonia walcotti Resser	xxx
Kormagnostus simplex Resser	xxxxxxxxxxxxxx
Labiostria conveximarginata? Palmer	xx
Labiostria sp. A	xx
Labiostria sp. B	xx
Llanoaspis undulata Lochman	xx
Lonchocephalus plena Walcott	xxx
Maryvillia arion Walcott	xxxx
Menomonia calymenoides (Whitfield)	x

Oedorhachis typicalis Resser	xxxx
Oedorhachis? ulrichi Resser	xx
Olenoides sp.	xx
Pseudagnostus communis (Hall & Whitfield)	xx
Pseudagnostus josepha (Hall)	xx
Pseudagnostus? nordicus (Lochman)	x.....x
Pseudagnostus prolongus (Hall & Whitfield)	xx
Pterocephalia sanctisabae Roemer	xxx
Pterocephalia sp.	xx
Ptychaspis? sp.	x
Saukiella sp.	x
Stenopilus sp.	x
Syspacheilus camurus Lochman	xx
Terranovella dorsalis (Hall)	x
Tricrepicephalus coria (Walcott)	xxxxxxxxxx
Weeksina sp.	xx
Unassigned pygidium A	x
Unassigned pygidium B	xx

EXPLANATION OF PLATE 1

FIG. 1, 4--Pseudagnostus? nordicus (Lochman), X7½. 1, Small cephalon, 10909-H 290a; Aphelaspis zone. 4, Pygidium, 10909-L 905a; Cedaria zone.

2, 5--Pseudagnostus communis (Hall & Whitfield), X5. 2, Cephalon, 10911-O 975a; 5, pygidium, 10911-O 975b; Aphelaspis zone.

3--Geragnostus tumidosus (Hall & Whitfield), X7½. Cephalon, 10919-D 14a; Elvinia zone.

6, 11--Kormagnostus simplex Resser, X7½. 6, Cephalon, 10909-L 910a; Cedaria zone. 11, Pygidium, 10911-O 85a; Crepicephalus zone.

7, 8--Oedorhachis typicalis Resser, X7½. Two nearly complete carapaces from an unknown locality in the upper part of the Weeks limestone, 10911; Cedaria zone.

9--Oedorhachis? ulrichi Resser, X7½. Pygidium, collected from an unknown locality in the upper part of the Weeks limestone, 10911; Cedaria zone.

10--Terranovella dorsalis (Hall), X7½. Cranidium, 10918-O 1020a; Crepicephalus zone.

12--Iddingsia robusta (Walcott), X2. Fragmentary exfoliated cranidium, 10909-D 15a; Elvinia zone.

13--Lonchocephalus plena Walcott, X7½. Weathered cranidium, 10911-W 1210a; Cedaria zone.

14, 17, 18--Kingstonia walcotti Resser, X5. 14, Partially exfoliated cranidium, 10918-O 765a; 17, Nonexfoliated pygidium, 10918-O 765b; 18, Exfoliated pygidium, 10918-O 765c; Crepicephalus zone.

15--Kindbladia affinis (Walcott), X5. Cranidium, 10909-D 15b; Elvinia zone.

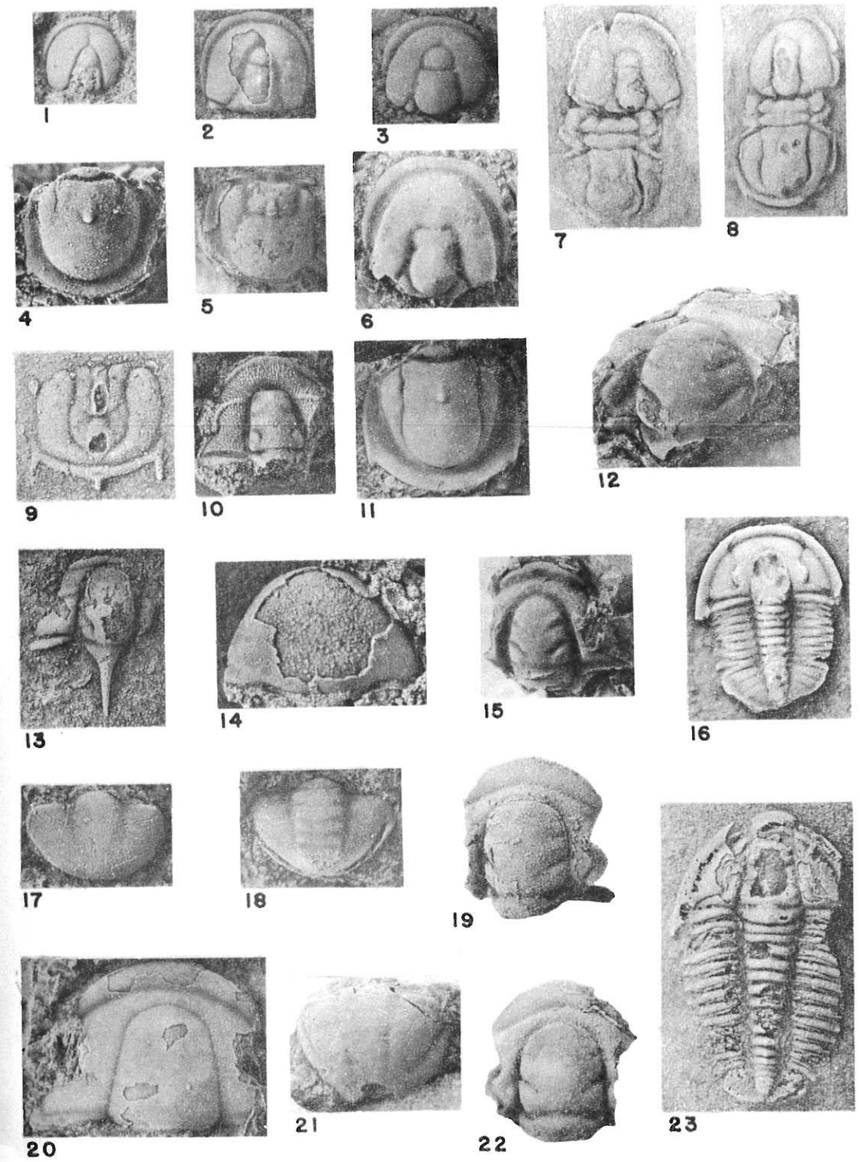
16--Cedaria minor (Walcott), X5. Nearly complete carapace collected from an unknown locality in the upper part of the Weeks limestone, 10911; Cedaria zone.

19, 22--Iddingsia similis (Walcott), X3. Two silicified cranidia, 10919; Elvinia zone.

20, 21--Maryvillia arion Walcott. 20, Partially exfoliated cranidium, 10911-O 85b, X5; 21, Fragmentary pygidium, 10918-O 858a, X2½. Crepicephalus zone.

23--Weeksina sp., X5. Nearly complete carapace, 10911-W 761a (talus); Cedaria zone.

Plate I.



Upper Cambrian trilobites

EXPLANATION OF PLATE 2

FIG. 1--Housia varro (Walcott), X1. Ventral mold of pygidium preserved in shale, 10921; Elvinia zone.

2--Holcacephalus tenerus (Walcott), X7½. Cranidium, 10911-W 1250a; Cedaria zone.

3--Cliffia lataegenae (Wilson), X7½. Silicified cranidium, 10911-NP 84a; Elvinia zone.

4--Densonella semele (Walcott), X5. A nearly complete carapace, 10911-W 541a; Cedaria zone.

5--Menomonia calymenoides (Whitfield), X5. Fragmentary cranidium, 10909-L 910b; Cedaria zone.

6--Llanoaspis undulata Lochman, X5. Fragmentary cranidium, 10918-O 1018a; Crepicephalus zone.

7--Syspacheilus camurus Lochman, X5. Cranidium, 10911-O 85c; Crepicephalus zone.

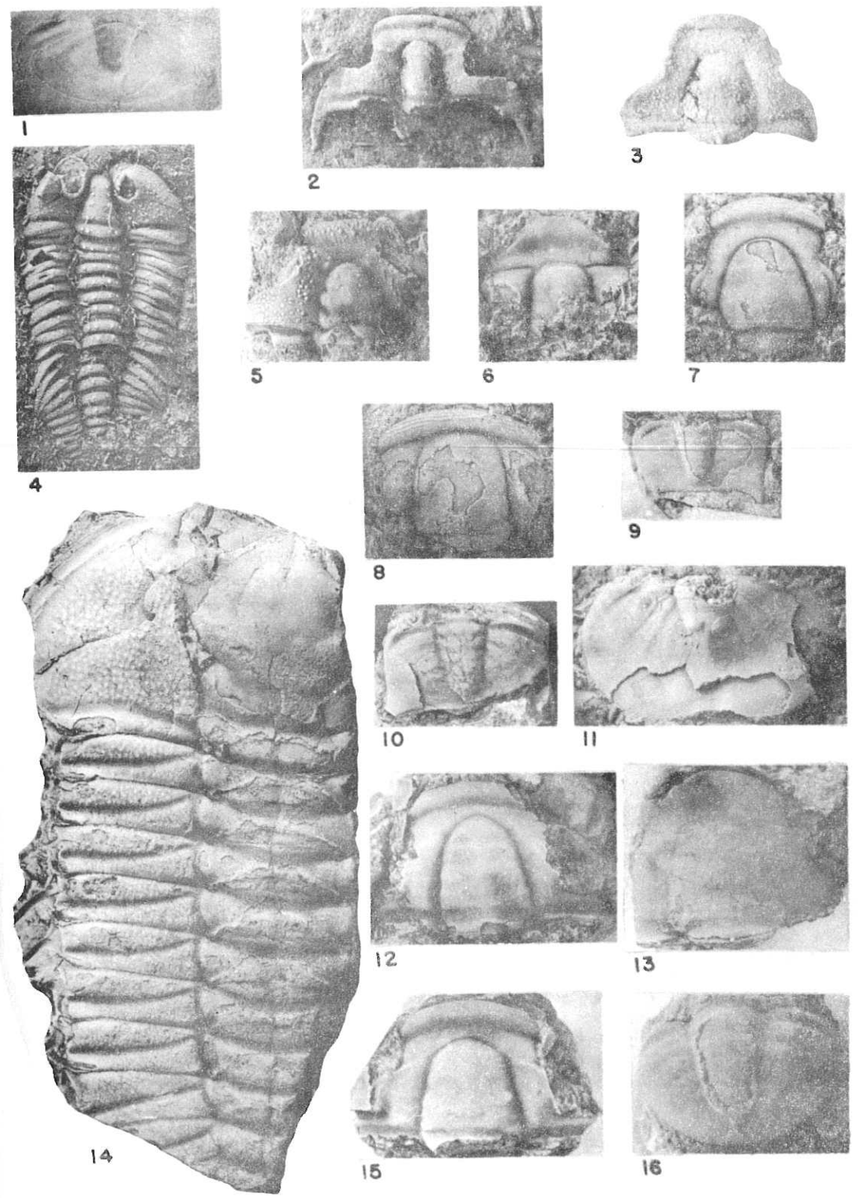
8--Genevievella campbellina Tasch, X5. Partially exfoliated cranidium, 10911-O 83a; Crepicephalus zone.

9, 10, 12, 15--Crepicephalus sp. 9, Partially exfoliated pygidium, 10918-O 1020b, X2; 10, A pathologic pygidium that exhibits a healed injury, 10918-O 1020c, X1; 12, Cranidium, 10918-O 1020d, X1½; 15, Cranidium, 10918-O 1020e, X1½; Crepicephalus zone.

11--Coosella sp., X2. Fragmentary pygidium; 10909-L 915a; Cedaria zone.

13, 16--Coosina ariston (Walcott). 13, Cranidium, 10918-O 1020f, X1½; 16, Pygidium, 10918-O 1020g, X2; Crepicephalus zone.

14--Olenoides sp., X1. Large fragmentary carapace, collected from a talus slope of upper Weeks limestone southwest of Notch Peak in the House Range; Cedaria zone.



Upper Cambrian trilobites

EXPLANATION OF PLATE 3

FIG. 1, 6, 8, 12--Aphelaspis? sp. 1, Immature cranidium, 10909-H 290b, X5; 6, Pygidium, 10918-O 1210a, X2; 8, Immature cranidium, 10909-H 240, X5; 12, Cranidium, 10918-O 1210b, X2; Aphelaspis zone.

2, 7--Labiostria sp. A, X2. 2, Exfoliated cranidium, 10918-O 1208a; 7, Fragmentary cranidium, 10918-O 1208b; Aphelaspis zone.

3, 15-18--Tricrepicephalus coria (Walcott). 3, Cranidium, 10918-O 1020h, X1; Crepicephalus zone. 15, Cranidium, 10909-L 910c, X2; Cedaria zone. 16, Cranidium, 10909-L 910d, X2; Cedaria zone. 17, Pygidium, 10918-O 1020i, X2; Crepicephalus zone. 18, Pygidium, 10911-W 1176a, X2; Cedaria zone.

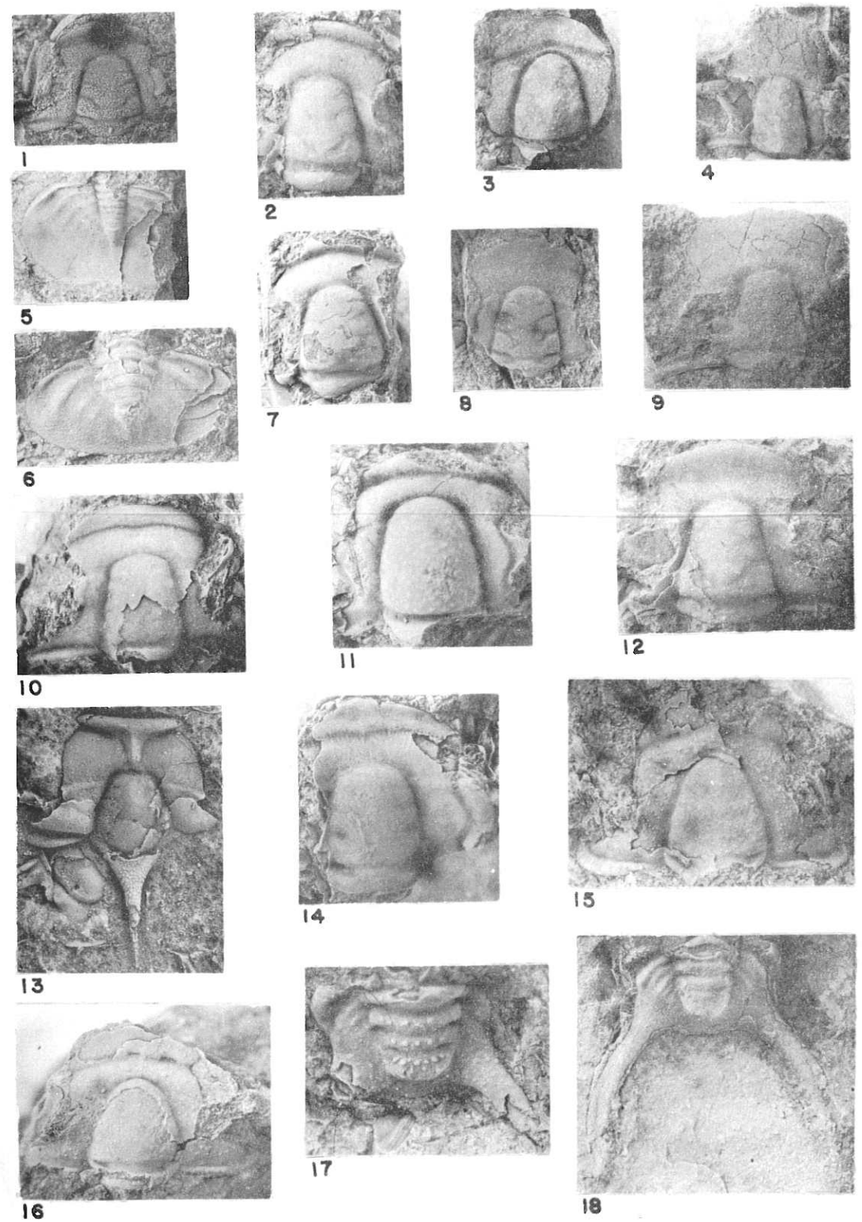
4, 5, 9--Pterocephalia sanctisabae Roemer. 4, Fragmentary exfoliated cranidium, 10909-H 250a, X2; 5, Pygidium, 10909-H 250b, X1; 9, Fragmentary exfoliated cranidium, 10909-H 250c, X2; Aphelaspis zone.

10--Labiostria conveximarginata? Palmer, X2. Partially exfoliated cranidium, 10910-O 370a; Aphelaspis zone.

11--Deadwoodia duris (Walcott), X5. Cranidium, 10909-D 14b; Elvinia zone.

13--Deiracephalus multisegmentus (Walcott), X5. Partially crushed cranidium, collected from an unknown locality in the upper part of the Weeks limestone, 10911; Cedaria zone.

14--Labiostria sp. B, X5. Fragmentary cranidium, 10909-D 15c; Elvinia zone.



Upper Cambrian trilobites

EXPLANATION OF PLATE 4

FIG. 1, 4, 7, 11--Dunderbergia? granulosa (Hall & Whitfield). 1, Pygidium, 10909-H 290c, X2; 4, 7, Side and dorsal views of a well preserved cranidium, 10918-O 1210c, X2; 11, Large fragmentary cranidium, 10909-H 410b, X1½; Aphelaspis zone.

2--Unassigned pygidium B, X3. Small exfoliated pygidium, 10909-H 410d; Aphelaspis zone.

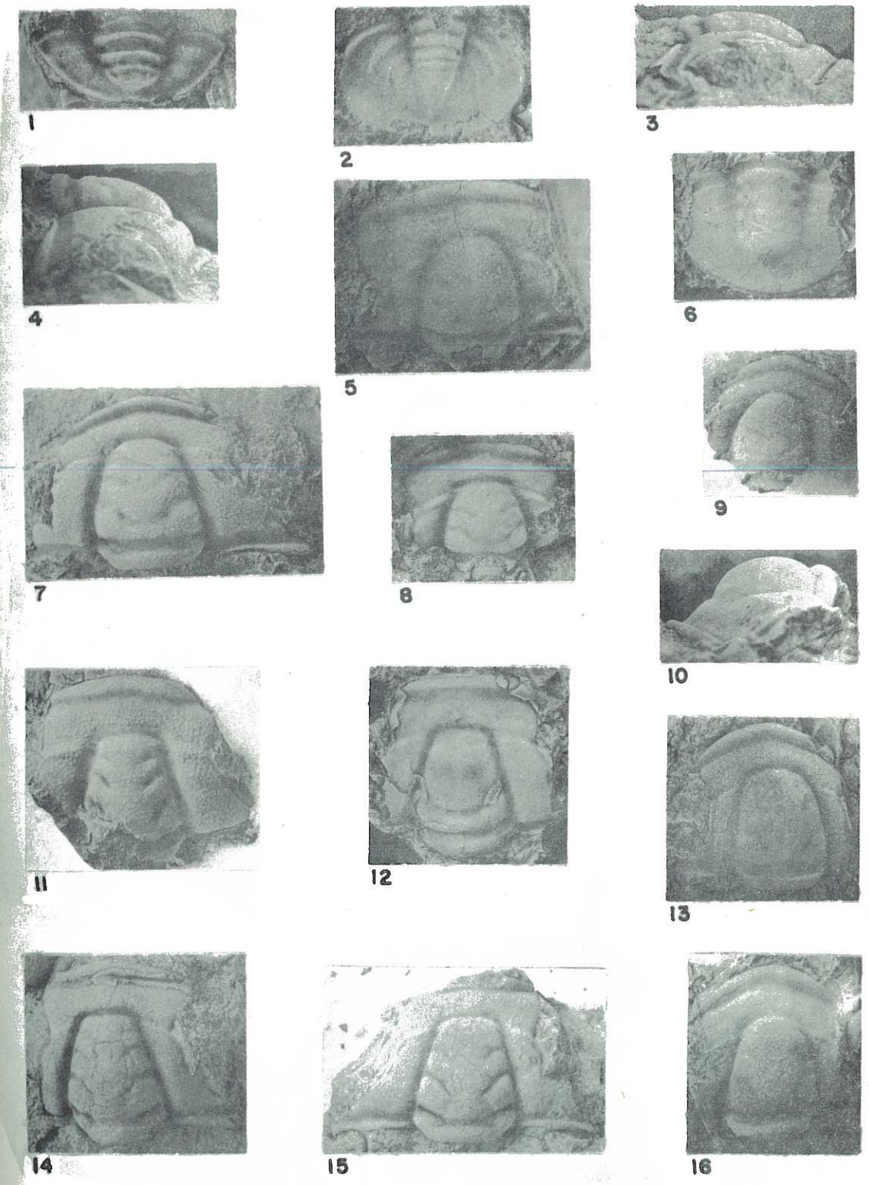
3, 14, 15--Dunderbergia? sp. 3, 14, Side and dorsal views of exfoliated cranidium, 10909-H 245a, X2; 15, Large cranidium, 10909-H 245b, X1; Aphelaspis zone.

5, 8--Dytremacephalus sp., X3. 5, Cranidium, 10909-H 410a; 8, Cranidium, 10909-H 410c; Aphelaspis zone.

6--Unassigned pygidium A, X2. 10918-O 839a; Crepicephalus zone.

9, 10, 13, 16--Dunderbergia nitida (Hall & Whitfield), X2. 9, Fragmentary cranidium with shortened glabella, 10909-H 415a; 10, 16, Side and dorsal views of cranidium with elongate glabella, 10909-H 415b; 13, Cranidium, 10909-H 415c; Aphelaspis zone.

12--Elvinia roemeri (Shumard), X1. Large exfoliated cranidium, 10909-D 15d; Elvinia zone.



Upper Cambrian trilobites