PALEONTOLOGICAL TOUR OF THE MOJAVE DESERT, CALIFORNIA-NEVADA
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# CHARACTERISTICS OF EARLY CAMBRIAN FAUNAS FROM EASTERN SAN BERNARDINO COUNTY, CALIFORNIA

by Jack D. Mount[1]



## Introduction

Moderately to highly fossiliferous lower Cambrian clastic and carbonate rocks crop out at localities scattered throughout much of the Mojave Desert in eastern San Bernardino County, California. This relatively thin succession of strata is representative of the Craton facies of the Cordilleran geocline and rests on crystalline basement rocks of Early Precambrian age. The original discovery of fossiliferous lower Cambrian rocks was made more than 70 years ago in the southern end of the Marble Mountains about 3.3 kilometers northeast of the railroad siding of Cadiz. Similar sections have since been located in the Providence, Kelso, New York and Mesquite Mountains, the Mescal Range, and the Silurian and Salt Spring Hills, all in eastern San Bernardino County. The present report, which is seventh in a series of preliminary notes making known the results of my research on the faunas from these rocks, lists 35 Early Cambrian fossils, which is four times the number of taxa known prior to the initiation of my studies.

## Previous Studies

More than 40 formal and informal papers, notes and abstracts have been published dealing with aspects of the paleontology and stratigraphy of the study area; however, only the more useful references are discussed here:

Darton (1907, 1915) first described the lower Cambrian section in the southern Marble Mountains (he called them the Iron Mountains) as part of his study of the geology along the route of the Santa Fe Railroad. Clark (1921) described in more detail this same section, which he referred to as Bristol Mountain, and listed four trilobite taxa. Using Clark's original collection from the classical locality near the old Vaughan Quarry at the southern end of the Marble Mountains, Resser (1928) prepared the first systematic report on the fossils describing 6 taxa, 3 of them new olenellid trilobites.

As the results of studies for graduate degrees at the University of California, J. C. Hazzard published a series of papers (Hazzard, 1933, 1937a, 1938, 1954; Hazzard and Mason, 1936) describing in some detail the Cambrian stratigraphy and formalizing the nomenclature for the previously unnamed rock units in the area. Crickmay (1933) briefly described the fossils and included the description of a new species of olenellid trilobite.

Riccio (1949, 1952) studied the ontogeny and morphology of the olenellid trilobites from the Marble Mountains but made no new additions to the lower Cambrian faunal list for the area.

Five preliminary notes were published by Mount (1973, 1974a, 1974b, 1974c, 1976) outlining the progress of his current study of the systematics and biostratigraphy of the Early Cambrian faunas. Mount (in press) has described one of the oldest articulate brachiopods.

The systematic description of a finely preserved eocrinoid from the Marble Mountains was presented by Durham (1978).

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## Lithostratigraphy

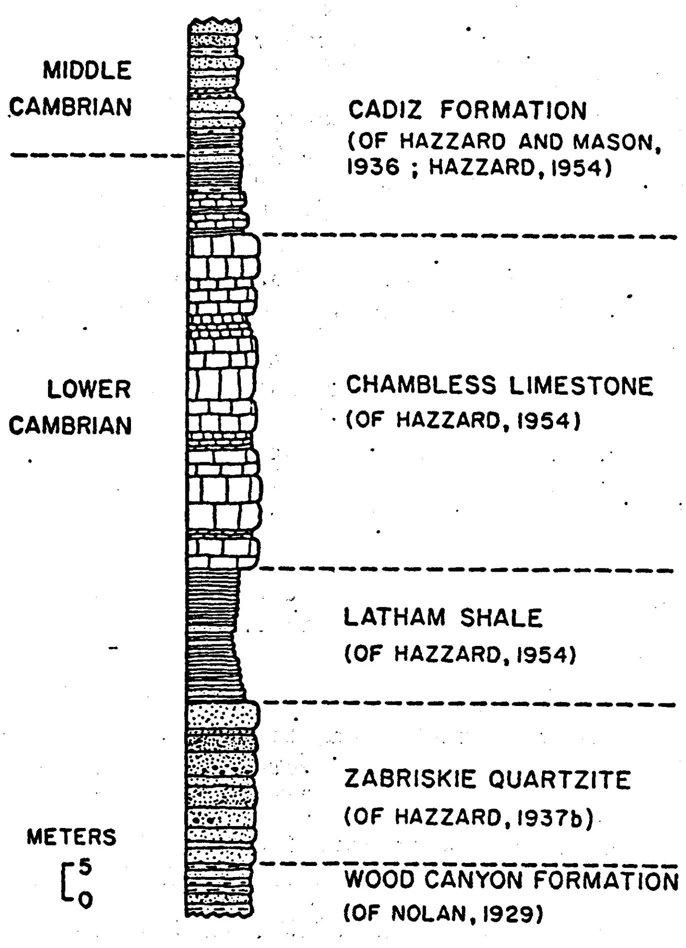
Hazzard (1954) and Stewart (1970) have described the lower Cambrian sections in detail and have divided the lower Cambrian into 5 formations (see text-fig. A). The lower Cambrian rocks consist of a conformable sequence of shallow marine, clastic and carbonate sediments which overlies cratonic Precambrian plutonic or metamorphic rocks to the south and Precambrian marine sediments to the north. The youngest Precambrian basement rock, a porphyritic, coarse-grained granite, in the Marble Mountains area has been dated at 1.4 billion years (Lanphere, 1964).

The lowest sedimentary unit in the area, the Wood Canyon Formation of Nolan (1929), consists of from 125 to over 400 meters of a varied assemblage of rocks ranging from shale to sandstone, quartzite and conglomerate. No fossils have been found in it in the study area. Hazzard (1937b) and Cloud (1973) report trilobites from the Wood Canyon Formation in the Nopah Range. Nelson (1976) has shown that the Wood Canyon Formation is entirely of Early Cambrian age and that the *Fallotaspis*, *Nevadella* and *Bonnia-Olenellus* Zones fall with in it.

Massive, poorly fossiliferous, pink to white ortho- and protoquartzite overlie the Wood Canyon Formation. This is the Zabriskie Quartzite of Hazzard (1937b) and it ranges in thickness from less than 5 meters in the Marble Mountains to over 75 meters in the Salt Spring Hills (Stewart, 1970). In some sections these two formations have been lumped together in earlier reports as the Prospect Mountains Quartzite (Hazzard, 1954; Hewett, 1956); the Tapeats Sandstone (Hewett, 1956; Stewart, 1970) or unnamed quartzite (Fritz, 1975). A single specimen of *Olenellus* sp. indet. and the trace fossil *Skolithos* sp. are the only fossils noted in this formation in the study area.

**Text-fig. A**

LOWER CAMBRIAN SECTION IN THE MARBLE AND PROVIDENCE MOUNTAINS, SAN BERNARDINO COUNTY, CALIFORNIA




The sandstone and quartzite is conformably overlain by the highly fossiliferous Latham Shale of Hazzard (1954), 15 to 45 meters of gray-green shale, platy micaceous siltstone, sandstone and a minor amount of limestone. The shale weathers to red, paper-thin fragments and contains a diverse assemblage of Early Cambrian fossils with abundant olenellid trilobites.

Above the shale is the Chambless Limestone of Hazzard (1954) which ranges from 36 to 66 meters in thickness. It is characterized by the massive beds of algal oncolites of the genus *Girvanella* (Hazzard, 1937a). Platy limestone with trilobite fragments, brachiopods and primitive mollusks and a minor amount of shale occur as interbeds.

The highest lower Cambrian unit is the Cadiz Formation of Hazzard and Mason (1936). Hazzard (1954) redefined the formation by lowering the lower contact to include the 33+ meters of lower Cambrian rocks excluded in the original definition. The formation consists of a heterogeneous assemblage of rocks including sandstone, shale, siltstone and limestone. Only about the lower one tenth of the formation is Early Cambrian in age. The Cadiz Formation is overlain by the middle

Cambrian Bonanza King Formation of Hazzard and Mason (1936).

## Fauna

The fossils thus far recovered from the lower Cambrian rocks total 35 taxa; they are listed in Table 1. Of the 33 taxa identifiable to the species level, 3 are new genera and 12 are new species.

The Latham Shale is dominated by a large quantity and a great diversity of olenellid trilobites of the genera *Olenellus*, *Bristolia* and *Peachella*. *Olenellus* n. sp. A is characterized by the greatly advanced genal spines and the more acute metagenal angle. The genus *Bristolia*, which was first recognized from the Latham Shale, is characterized by having very advanced genal spines and an hour-glass-shaped glabella that reaches anteriorly to the rim. *Bristolia* n. sp. has the least advanced genal spines of any species in the genus, a strongly semicircular shaped cephalon and wider palpabral lobes. *Onchocephalus* n. sp. is represented by 6 known specimens which are the largest and most complete known in the genus. This is the second known occurrence for the inarticulate brachiopod *Mickwitzia* which was previously known from the lower part of the *Bonnia-Olenellus* Zone in the Harkless Formation of Esmeralda Co., Nevada. *Nisusia "fulleri"* Mount, mss, is one of the earliest described species of the genus (Mount, 1974c and in press). The presence of the soft-bodied animals *Anomalocaris canadensis* and the new annelid (see fig. 20) is particularly interesting and is reminescent of the Burgess Shale fauna. This is the most southwesterly known occurrence of *Anomalocaris*. Briggs (1979) has interpreted this genus as an appendage of a large as yet unknown arthropod.

Trilobites in the Chambless Limestone are rare and generally poorly preserved. This is the first record of *Olenellus puertoblancoensis* from the area between its type locality in Sonora,Mexico, and an occurrence in northwestern Canada (Fritz, 1972). *Olenellus* n. sp. B has a large cephalon with advanced genal spines, a large inflated anterior glabellar lobe and long palpabral lobes extending to the posterior margin. The hyolithoid mollusk *Novitatus* has previously been known only from eastern Asia. It is interesting to note here that because specimens of some species of trilobites occur in both the Latham Shale and the Chambless Limestone it is possible to compare specimens which may have original relief with those crushed in the shale and Sundberg (1974) has shown that some dimensions of the cephalon may have been increased differentially by as much as 15% through compression.

Fossils are moderately abundant in two shale beds near the base of the Cadiz Formation but are not as diverse as in the Latham Shale. The fauna from these highest beds of the lower Cambrian in western North America has been poorly known; recently, Palmer and Halley (1979) have described a small assemblage of trilobites from this stratigraphic position in the Carrara Formation. The new olenellid genus (see fig. 32), which appears to be thus far known only from the Cadiz Formation in the Marble Mountains, has mixed characteristics of the genera *Bristolia*, *Peachella* and *Olenellus*.

## Biostratigraphy

The stratigraphic ranges of the trilobite taxa suggest that this sequence of rocks belongs to the upper part of the *Bonnia-Olenellus* Zone of Rasetti (1951), the youngest of the three Early Cambrian zones (Fritz, 1972). The base of this zone is considered to extend to at least 15 meters below the base of the Latham Shale where a single specimen of *Olenellus* sp. indet. was collected. The Early Cambrian fossils from eastern San Bernardino County are sufficiently abundant and evenly distributed through the section and can be grouped into three faunules (see fig. 33) demonstrating the need for three subdivisions of the upper part of the *Bonnia-Olenellus* Zone in this area.

Table 1. Early Cambrian fossils from eastern San Bernardino Co.

| TAXA | FORMATIONS | Zabriskie Quartzite | Latham Shale | Chambless Limestone | Cadiz Formation |
|---|---|---|---|---|---|
| Phylum Coelenterata | | | | | |
| Class Anthozoa | | | | | |
| Order Actinaria | | | | | |
| *Bergaueria radiata* Alpert, 1973 | [fig. 1] | | X | | |
| Phylum Brachiopoda | | | | | |
| Class Inarticulata | | | | | |
| Order Acrotretida | | | | | |
| Family Acrotretidae | | | | | |
| *Hadrotreta primaea* (Walcott, 1902) | [fig. 28] | | | | X |
| Family Acrothelidae | | | | | |
| *Eothele spurri* (Walcott, 1908) | [fig. 22] | | | X | |
| Order Paterinida | | | | | |
| Family Paterinidae | | | | | |
| *Paterina prospectensis* (Walcott, 1884) | [fig. 2] | | X | X | |
| *Dictyonina pannula* (White, 1874) | [fig. 29] | | | | X |
| *Mickwitzia occidens* Walcott, 1908 | [fig. 3] | | X | | |
| Class Articulata | | | | | |
| Order Orthida | | | | | |
| Family Nisusiidae | | | | | |
| *Nisusia "fulleri"* Mount, mss | [fig. 4] | | X | | |
| Family Eoorthidae | | | | | |
| *Wimanella highlandensis* (Walcott, 1886) | [fig. 30] | | | | X |
| Phylum Mollusca | | | | | |
| Class Calyptoptomatida | | | | | |
| Order Hyolithida | | | | | |
| Family Hyolithidae | | | | | |
| *Hyolithes whitei* Resser, 1938 | [fig. 5] | | X | | |
| Order Orthothecida | | | | | |
| *Novitatus* new species | [fig. 23] | | | X | |
| Phylum Annelida | | | | | |
| Annelid-new genus and species | [fig. 20] | | X | | |
| Phylum Arthropoda | | | | | |
| Class Trilobita | | | | | |
| Order Redlichiida | | | | | |
| Family Olenellidae | | | | | |
| *Olenellus clarki* (Resser, 1928) | [fig. 6] | | X | X | X |
| *Olenellus fremonti* Walcott, 1910 | [fig. 7] | | X | X | |
| *Olenellus gilberti* Meek *in* White, 1874 | [fig. 8] | | X | X | X |
| *Olenellus mohavensis* (Crickmay, 1933) | [fig. 9] | | X | | |
| *Olenellus nevadensis* (Walcott, 1910) | [fig. 10] | | X | | |
| *Olenellus puertoblancoensis* (Lochman, 1952) | [fig. 24] | | | X | X |
| *Olenellus* new species A | [fig. 11] | | X | | |
| *Olenellus* new species B | [fig. 25] | | | X | |
| *Olenellus* new species C | [fig. 31] | | | | X |
| *Olenellus* species indeterminate | | X | | | |
| *Bristolia anteros* Palmer, 1979 | [fig. 15] | | X | | |
| *Bristolia bristolensis* (Resser, 1928) | [figs. 12, 13] | | X | X | |
| *Bristolia insolens* (Resser, 1928) | [fig. 14] | | X | | |
| *Bristolia* new species | [fig. 16] | | X | | |
| *Peachella iddingsi* (Walcott, 1884) | [fig. 17] | | X | | |
| Olenellid-new genus and species | [fig. 32] | | | | X |
| Order Ptychopariida | | | | | |
| Family Ptychopariidae | | | | | |
| *Onchocephalus* new species | [fig. 18] | | X | | |
| Ptychopariid-new genus and species | [fig. 26] | | | X | |
| Class, Order, and Family uncertain | | | | | |
| *Anomalocaris canadensis* Whiteaves, 1892 | [fig. 19] | | X | | |
| Phylum Echinodermata | | | | | |
| Class Eocrinoidea | | | | | |
| Family Eocrinidae | | | | | |
| *Gogia ojenai* Durham, 1978 | [fig. 21] | | X | | |
| ?*Gogia* species indeterminate | [fig. 27] | | | X | |
| Ichnofossils | | | | | |
| *Skolithos* species | | X | | | |
| Plants-Algae | | | | | |
| *Girvanella* new species | | | | X | |
| *Morania* new species | | | X | | |

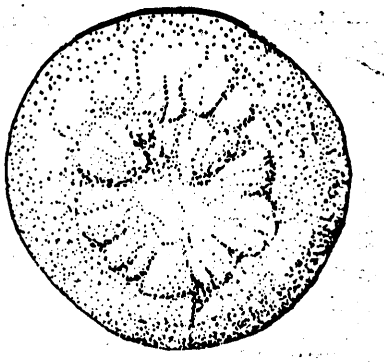


Fig. 1 (x1.7)
*Bergaueria radiata* Alpert
Holotype, LACMIP 1233, basal view
[specimen from near Goldfield, Nevada; after Alpert (1973)]

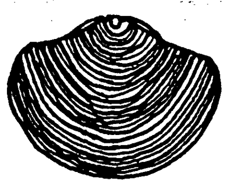


Fig. 2 (x3.0)
*Paterina prospectensis* (Walcott)
Hypotype, UCR 10/2006
pedicle valve exterior

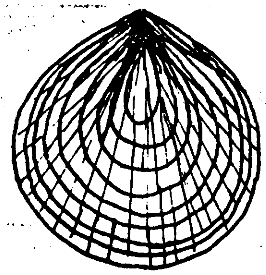


Fig. 3 (x1.4)
*Mickwitzia occidens* Walcott
Hypotype, UCR 10-8/1
brachial valve exterior

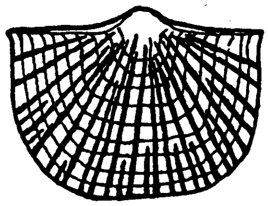


Fig. 4 (x2.0)
*Nisusia "fulleri"* Mount
Hypotype, UCR 10/2019
pedicle valve exterior

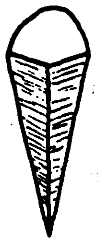


Fig. 5 (x2.4)
*Hyolithes whitei* Resser
Hypotype, UCR 10/2018
side view

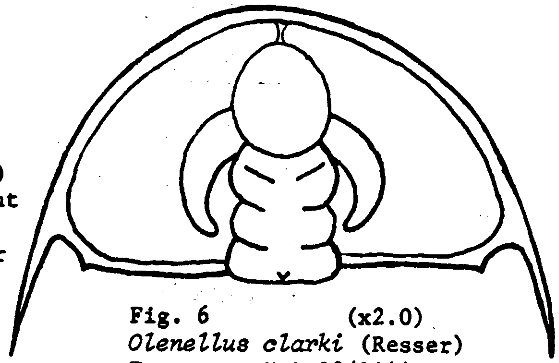


Fig. 6 (x2.0)
*Olenellus clarki* (Resser)
Topotype, UCR 10/1144
complete cephalon

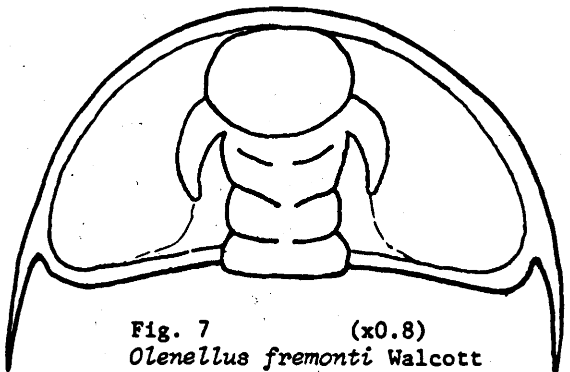


Fig. 7 (x0.8)
*Olenellus fremonti* Walcott
Hypotype, UCR 10/2004
complete cephalon

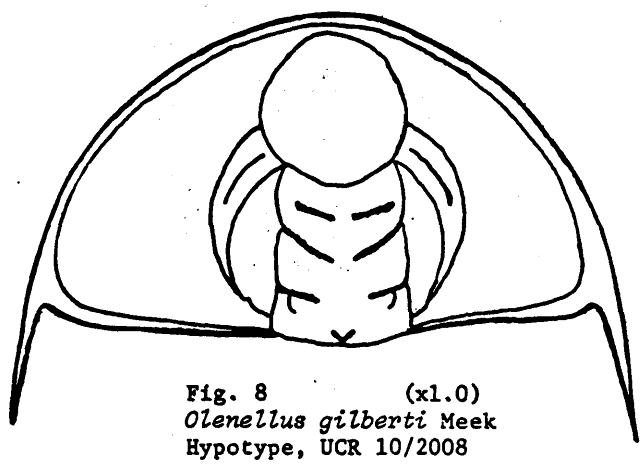


Fig. 8 (x1.0)
*Olenellus gilberti* Meek
Hypotype, UCR 10/2008
complete cephalon

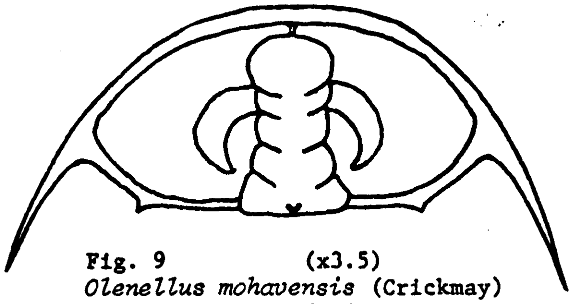


Fig. 9 (x3.5)
*Olenellus mohavensis* (Crickmay)
Topotype, UCR 10/316
complete cephalon

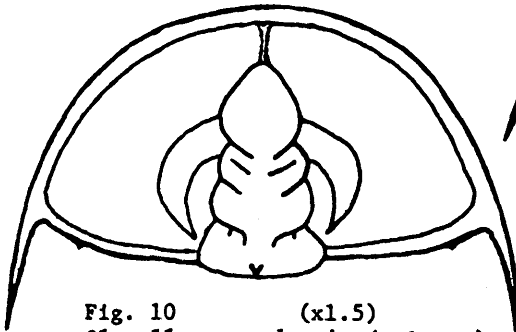


Fig. 10 (x1.5)
*Olenellus nevadensis* (Walcott)
Hypotype, UCR 10/2005
complete cephalon

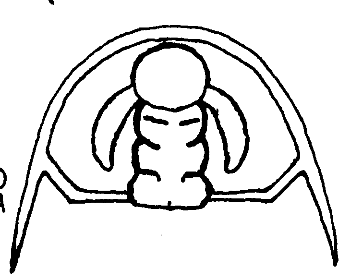


Fig. 11 (x1.5)
*Olenellus* new species A
Hypotype, UCR 7897/1
complete cephalon

# EARLY CAMBRIAN FOSSILS FROM THE LATHAM SHALE [cont.]

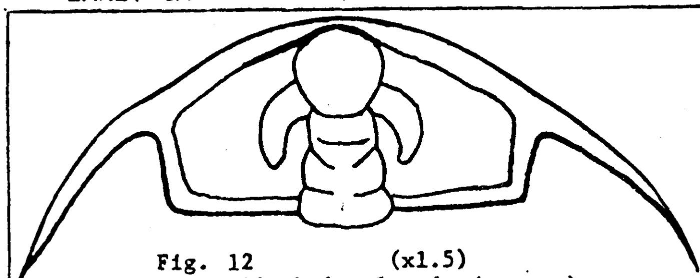


Fig. 12 (x1.5)
*Bristolia bristolensis* (Resser)
Topotype, UCR 10/10
complete cephalon

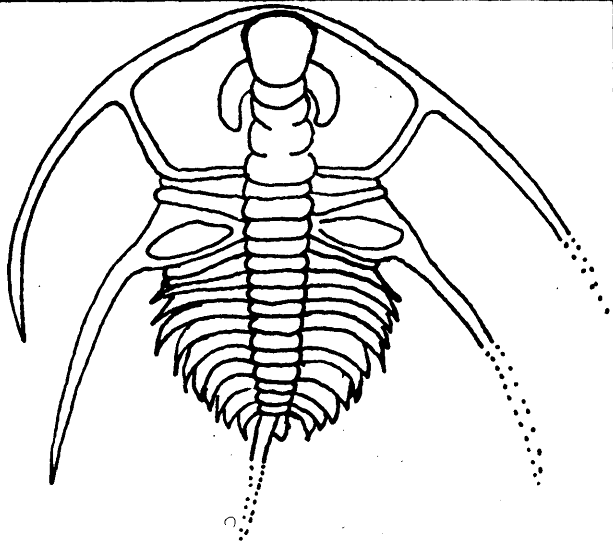


Fig. 13 (x1.5)
*Bristolia bristolensis* (Resser)
Topotype, UCR 10/7
complete exoskeleton

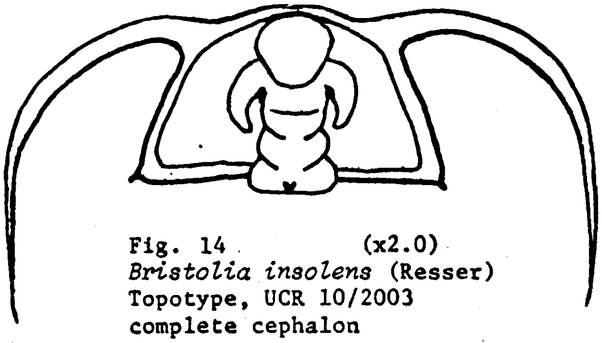


Fig. 14 (x2.0)
*Bristolia insolens* (Resser)
Topotype, UCR 10/2003
complete cephalon

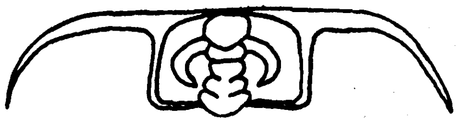


Fig. 15 (x3.0)
*Bristolia anteros* Palmer
Hypotype, UCR 10-3/1
complete cephalon

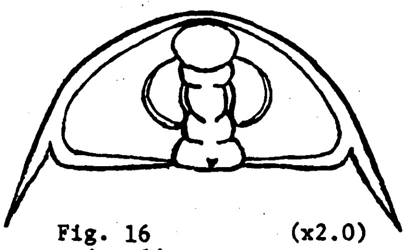


Fig. 16 (x2.0)
*Bristolia* new species
Hypotype, UCR 7271/7
complete cephalon

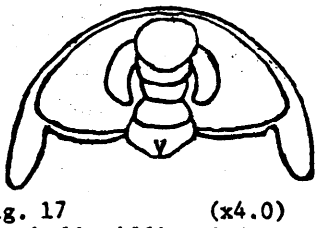


Fig. 17 (x4.0)
*Peachella iddingsi* (Walcott)
Hypotype, UCR 10-1/14
complete cephalon

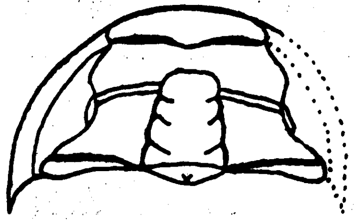


Fig. 18 (x3.0)
*Onchocephalus* new species
Hypotype, UCR 10/2012
nearly complete cephalon

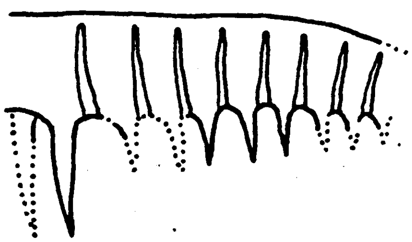


Fig. 19 (x0.5)
*Anomalocaris canadensis* Whiteaves
Hypotype, UCR 7002/1
part of appendage

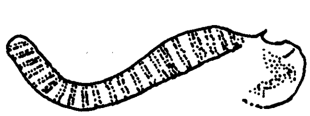


Fig. 20 (x1.0)
Annelid-new genus and species
Hypotype, UCR 7003/1
part of body

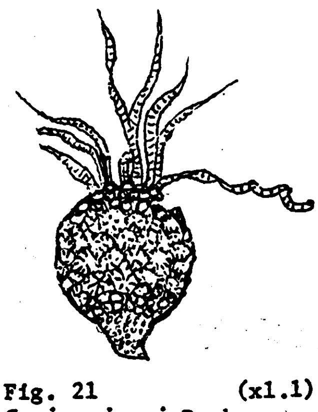


Fig. 21 (x1.1)
*Gogia ojenai* Durham
Holotype, UCMP 14526
nearly complete skeleton

## EARLY CAMBRIAN FOSSILS FROM THE CHAMBLESS LIMESTONE

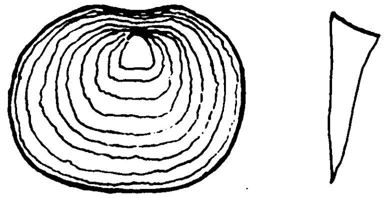


Fig. 22 (x5.5)
*Eothele spurri* (Walcott)
Hypotype, UCR 7311/3
pedicle valve exterior

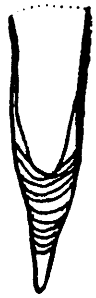


Fig. 23 (x2.3)
*Novitatus* new species
Hypotype, UCR 2332/1
longitudinal section

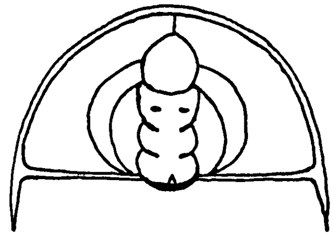


Fig. 24 (x3.2)
*Olenellus puertoblancoensis* (Lochman)
Hypotype, UCR 7311/2
complete cephalon

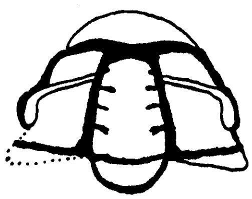


Fig. 26 (x2.2)
Ptychopariid-new genus and species
Hypotype, UCR 7306/1
nearly complete cranidium

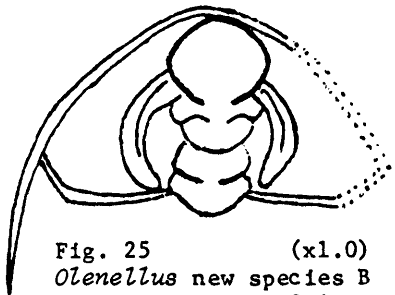


Fig. 25 (x1.0)
*Olenellus* new species B
Hypotype, UCLA 10814
nearly complete cephalon

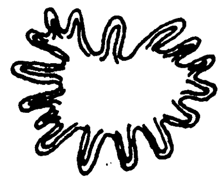


Fig. 27 (x7.4)
?*Gogia* sp.
Hypotype, UCR 7311/1
single thecal plate

## EARLY CAMBRIAN FOSSILS FROM THE CADIZ FORMATION

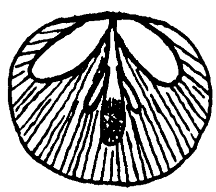


Fig. 28 (x4.5)
*Hadrotreta primaaea* (Walcott)
Hypotype, UCR 7312/1
brachial valve interior

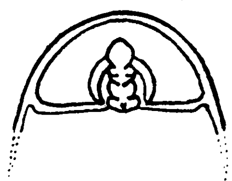


Fig. 31 (x2.0)
*Olenellus* new species C
Hypotype, UCR 7307/15
complete cephalon

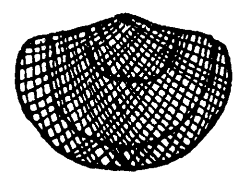


Fig. 29 (x3.7)
*Dictyonina pannula* (White)
Hypotype, UCR 7307/1
brachial valve exterior

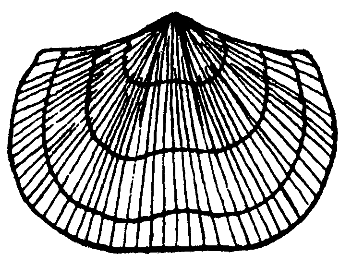


Fig. 30 (x2.2)
*Wimanella highlandensis* (Walcott)
Hypotype, UCR 7307/12
brachial valve exterior

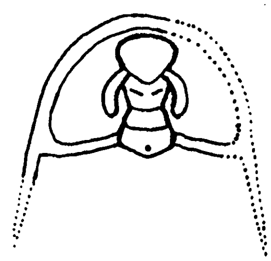


Fig. 32 (x1.5)
Olenellid-new genus and species
Hypotype, UCR 7896/1
partially complete cephalon

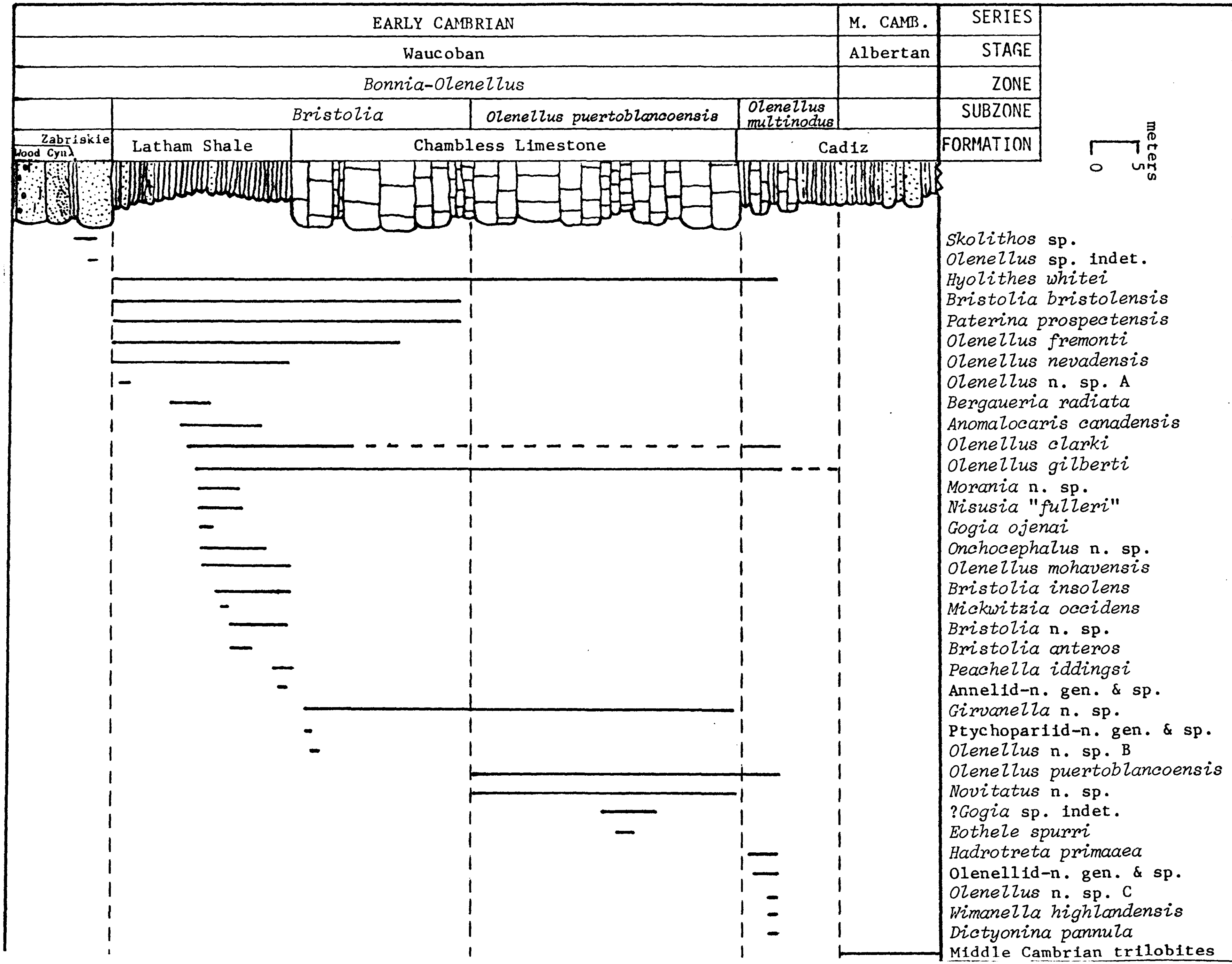



Fig. 33. Stratigraphic distribution of Early Cambrian fossils from eastern San Bernardino Co.

The oldest of the three subzones, the *Bristolia* Subzone of Mount (1974a, 1974b), is based on an assemblage of olenellid trilobites dominated by the genera *Olenellus* and *Bristolia* and the base of the subzone is placed at the first appearance of *Bristolia bristolensis*. The ranges of *B. insolens*, *B. anteros*, *B.* n. sp., *Olenellus mohavensis*, *O. nevadensis*, *O.* n. sp. A, *Peachella iddingsi*, *Onchocephalus* n. sp., and the new ptychopariid are apparently restricted to this subzone. The longer ranging *Olenellus clarki* and *O. gilberti* appear to have their first occurrences within the subzone. The *Bristolia* Subzone ranges from the base of the Latham Shale to about 15 to 30 meters above the base of the Chambless Limestone.

The next subzone is the *Olenellus puertoblancoensis* Subzone of Mount (1976). The base of this unit is defined by the first occurrence of *O. puertoblancoensis*. The upper boundary of this subzone approximates the Chambless Limestone-Cadiz Formation contact.

The youngest subzone of the Early Cambrian is the *Olenellus multinodus* Subzone. It is defined by the first occurrence of *O. multinodus* Palmer which is found immediately above the base of the Cadiz Formation. Palmer and Halley (1979) first recognized this unit as their *O. multinodus* Zonule. They reported the occurrence of this distinctive trilobite from the base of the Cadiz Formation at the type locality of the Chambless Limestone in the central Marble Mountains. It has not been collected during the present study. In the Marble Mountains the ranges of *Olenellus* n. sp. C and the new olenellid (see fig. 32) are restricted to this subzone. In the east-central California and Nevada area the assemblages from this subzone are charcterized by several species of *Olenellus* and the ptychopariid trilobites *Crassifimbra*, *Zacanthopsis* and *Antagmus* (Palmer, 1971; Palmer and Halley, 1979).

The three subzones are particularly well developed at the southern end of the Marble Mountains and on the west slope of the Providence Mountains just south of Summit Springs and these localities should serve as valuable reference sections for the subzones. Assemblages characteristic of these units have wide distribution in the southern Great Basin.

The middle Cambrian portion of the Cadiz Formation contains faunas from the Middle Cambrian *Plagiura-Poliella* (Hazzard, 1954), *Albertella* (Takeo Susuki, personal communication), and *Glossopleura* (Mason, 1935; Hazzard and Mason, 1936; Hazzard, 1954; Stoyanow and Susuki, 1955; Stoyanow, 1956; Fuller, 1980) Zones; however, they have not received critical biostratigraphical study.

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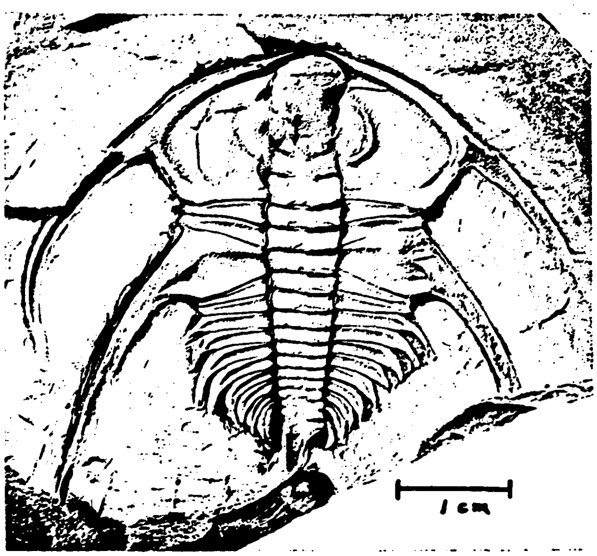


*Bristolia bristolensis* (Resser)
Topotype, UCR 10/7