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# AN INVENTORY OF TRILOBITES FROM NATIONAL PARK SERVICE AREAS

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**Abstract**—Trilobites represent an extinct group of Paleozoic marine invertebrate fossils that have great scientific interest and public appeal. Trilobites exhibit wide taxonomic diversity and are contained within nine orders of the Class Trilobita. A wealth of scientific literature exists regarding trilobites, their morphology, biostratigraphy, indicators of paleoenvironments, behavior, and other research themes. An inventory of National Park Service areas reveals that fossilized remains of trilobites are documented from within at least 33 NPS units, including Death Valley National Park, Grand Canyon National Park, Yellowstone National Park, and Yukon-Charley Rivers National Preserve. More than 120 trilobite hototype specimens are known from National Park Service areas.

## INTRODUCTION

Of the 262 National Park Service areas identified with paleontological resources, 33 of those units have documented trilobite fossils (Fig. 1). More than 120 holotype specimens of trilobites have been found within National Park Service (NPS) units. Once thriving during the Paleozoic Era (between ~520 and 250 million years ago) and becoming extinct at the end of the Permian Period, trilobites were prone to fossilization due to their hard exoskeletons and the sedimentary marine environments they inhabited. While parks such as Death Valley National Park and Yukon-Charley Rivers National Preserve have reported a great abundance of fossilized trilobites, many other national parks also contain a diverse trilobite fauna. The purpose of this report is to compile baseline data on the occurrence of trilobite fossils from NPS areas, and to support future scientific research, resource management and public education. This review collectively summarizes all currently documented occurrences of fossilized trilobites from 33 National Park Service areas in order to assess the taxonomic diversity, geologic formations which preserve trilobites, identify holotype repository information and to review known scientific literature.

## METHODS

In order to gain a better understanding of the scope, significance and distribution of trilobite fossils from National Park Service areas, a systematic inventory of existing paleontological resource data, collections and literature was undertaken.The method included comprehensive reviews of paleontolgocial resource inventory reports and publications regarding the occurrence of trilobites in each of the NPS areas. The information gathered about the trilobites included taxonomy, geologic formation, geologic age, repository data, publications, and photographs of specimens. The 33 NPS areas that have documented trilobites are grouped into physiographic regions from west to east: Alaska, Colorado Plateau, Northern Rocky Mountain, Desert Southwest, Great Plains, Great Lakes, and Appalachian Mountain Parks.

## ALASKA PARKS

### Denali National Park and Preserve, Alaska

Denali National Park and Preserve (DENA) was originally established as Mt. McKinley National Park on February 26, 1917. In 1922 and 1932, legislation expanded the park boundaries to the east and north, including lands in the Wonder Lake area. A separate proclamation on December 1, 1978, established Denali National Monument. On December 2, 1980, Mt. McKinley National Park and Denali National Monument were incorporated into and redesignated as Denali National Park and Preserve as part of the Alaska National Interest Lands Conservation Act (ANILCA). ANILCA added about 1.5 million ha (3.8 million acres) to DENA and established approximately 770,000 ha (1.9 million acres) of designated wilderness (Santucci et al., 2011).

DENA represents millions of acres of rugged geologic landscape of volcanoes, glaciers, and mountains. The geology is dominated by accreted terranes transported and shaped by plate tectonic processes largely during the Mesozoic. The geologic strata of DENA spans Ordovician through recent sediments. Paleozoic strata of DENA include strata from the earliest Ordovician through the Permian, including a

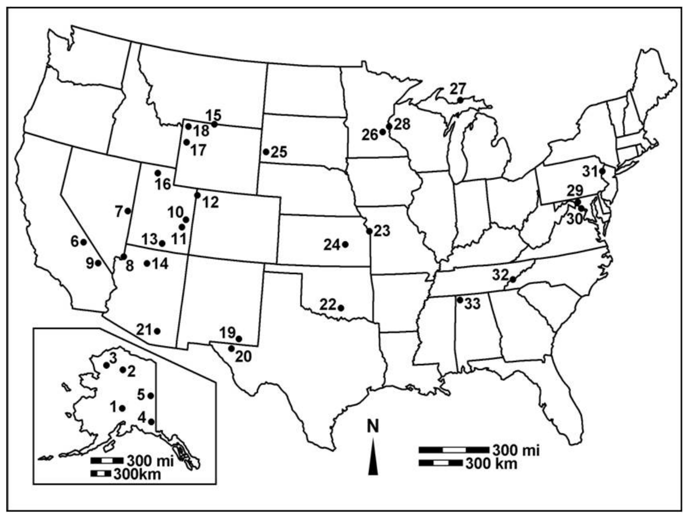


FIGURE 1. National Park Service units referenced in text. 1. Denali National Park and Preserve (DENA), Alaska; 2. Gates of the Arctic National Park and Preserve (GAAR), Alaska; 3. Noatak National Preserve (NOAT), Alaska; 4. Wrangell-St. Elias National Park and Preserve (WRST), Alaska; 5. Yukon-Charley Rivers National Preserve (YUCH), Alaska; 6. Death Valley National Park (DEVA), California–Nevada; 7. Great Basin National Park (GRBA), Nevada; 8. Lake Mead National Recreation Area (LAKE) (including NPS portions of Grand Canyon-Parashant National Monument [PARA]), Arizona–Nevada; 9. Mojave National Preserve (MOJA), California; 10. Arches National Park (ARCH), Utah; 11. Canyonlands National Park (CANY), Utah; 12. Dinosaur National Monument (DINO), Colorado–Utah; 13. Glen Canyon National Recreation Area (GLCA), Arizona-Utah; 14. Grand Canyon National Park (GRCA), Arizona; 15. Bighorn Canyon National Recreation Area (BICA), Montana–Utah ; 16. Golden Spike National Historic Site (GOSP), Utah; 17. Grand Teton National Park (GRTE), Wyoming; 18. Yellowstone National Park (YELL), Idaho–Montana–Wyoming; 19. Carlsbad Caverns National Park (CAVE), New Mexico; 20. Guadalupe Mountains National Park (GUMO), Texas; 21. Saguaro National Park (SAGU), Arizona; 22. Chickasaw National Recreation Area (CHIC), Oklahoma; 23. Santa Fe National Historic Trail (SAFE), multiple states; 24. Tallgrass Prairie National Preserve (TAPR), Kansas; 25.Wind Cave National Park (WICA), South Dakota; 26. Mississippi National River and Recreation Area (MISS), Minnesota; 27. Pictured Rocks National Lakeshore (PIRO), Michigan; 28. Saint Croix National Scenic Riverway (SACN), Minnesota–Wisconsin; 29. Antietam National Battlefield (ANTI), Maryland; 30. Chesapeake and Ohio Canal National Historical Park (CHOH), multiple states; 31. Delaware Water Gap National Recreation Area (DEWA), New Jersey–Pennsylvania; 32. Great Smoky Mountains National Park (GRSM), North Carolina–Tennessee; 33. Natchez Trace Parkway (NATR), multiple states.

number of fossiliferous marine units. Limited paleontological work has been conducted in DENA given the remote nature of the geologic setting, the challenges of access in the rugged terrain, and the fact that nearly 2 million acres of the park is designated wilderness. The record for trilobite fossils from DENA is derived largely from USGS E & R (Examine and Report on Referred Fossils) reports or publications compiled in the Alaska Paleontological Database (R. Blodgett, personal commun., 2015).

There are just a few reports of trilobites from DENA. Fragmentary remains of trilobites, identified as cf. dalmanitid, were reported by Yochelson and Dutro (1976) from an unnamed unit within the Healy B-5 Quadrangle of DENA. A precise age or stratigraphic unit was not indicated for the trilobite remains, but the specimen was believed to occur from sequences that are possibly Late Ordovician to Devonian in age.

An E&R report by Dutro (1976) stated that an indeterminate trilobite pygidium was recovered from a Devonian-aged slaty-shale unit within the Talkeetna C-5 Quadrangle of DENA. Two late Early Devonian trilobite taxa, *Weberopeltis* sp. and *Dechenella*? sp., were also reported on the north side of Shellabarger Pass, Talkeetna C-6 Quadrangle by Dutro (1976) and Reed and Nelson (1980). From the Talkeetna C-6 locality, R.B. Blodgett was subsequently able to revisit and made a large collection, including dechenellid and cheirurid trilobites (Fig. 2A), as well as the genera *Otarion* and *Leonaspis* (R. Blodgett, personal commun., 2015).

## Gates of the Arctic National Park and Preserve, Alaska

Gates of the Arctic National Park and Preserve (GAAR) was established in 1980 when Gates of the Arctic National Monument (established 1978) was combined with Gates of the Arctic Preserve. It is the nation's second largest national park, covering 3,428,702 ha (8,472,506 acres). The entire park lies north of the Arctic Circle, primarily in the Endicott Mountains of the central Brooks Range (Elder et al., 2009). The geologic history of the park begins in the Late Cambrian, but the principle geologic units span from the Late Silurian through the Cretaceous (Santucci et al., 2011).

There is a limited record of trilobites in GAAR. Dutro et al. (1984) reported the following trilobite taxa from the park: *Kootenia* cf. *K. anabarensis*, cf. "*Parehmania*" *lata*, and *Pagetia* sp. These early Middle Cambrian specimens were documented from within the park in the Wiseman C-3 quadrangle. The trilobite specimens were collected from a high ridge about 4 miles east of the junction of Wolf Creek and the Tinayguk River. The trilobites were preserved in the sandy carbonate beds occurring above the limestone units (Dutro et al., 1984).

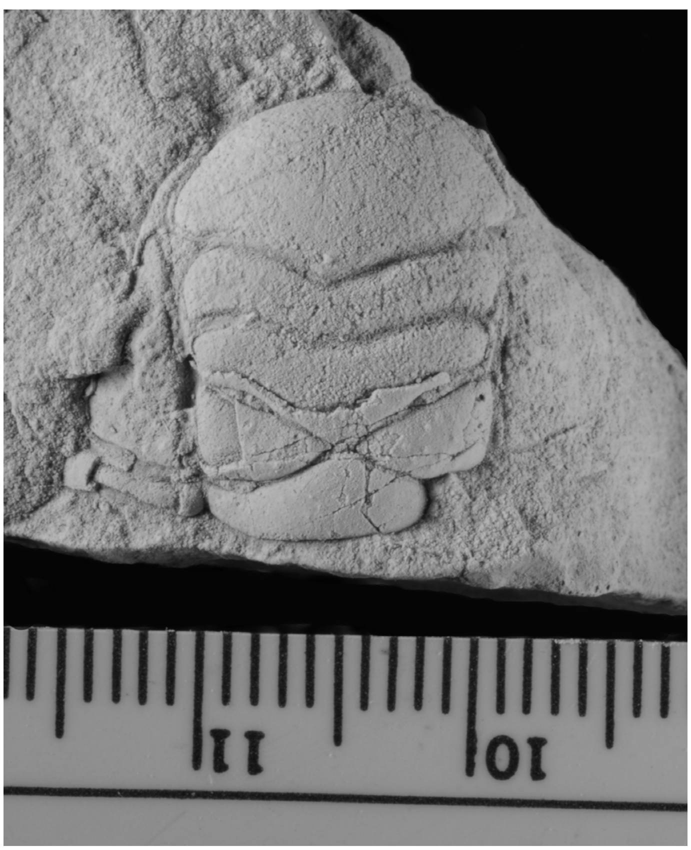


FIGURE 2. Confirmed cheirurid trilobite found within Denali National Park: (Robert Blodgett photo).

## Noatak National Preserve, Alaska

Noatak National Preserve (NOAT) was established in 1980 from land originally designated as the Noatak National Monument (established 1978). It covers 2,660,598 ha (6,574,481 acres), lies north of the Arctic Circle and is bordered on the east by Gates of the Arctic National Park and Preserve, on the south by Kobuk Valley National Park and on the north by the National Petroleum Reserve (Elder et al., 2009).

There are only a few references to trilobites in NOAT, but further paleontological field work would likely yield additional trilobite specimens. Trilobite fossils have been reported from two stratigraphic units in the Micheguk Mountain A-4 quadrangle within NOAT (Dutro, 1955). These include the genus *Dechenella* sp. from the Middle to Late Devonian Kugururok Formation (Baird Group). The trilobite genus *Griffithides* has been reported in the Early Mississippian through Early Permian Lisburne Group in the B-4 quadrangle of NOAT (Gordon, 1957).

## Wrangell-Saint Elias National Park and Preserve, Alaska

Wrangell-Saint Elias National Park and Preserve (WRST) was originally proclaimed as a national monument on December 1, 1978. Two years later, on December 2, 1980, the monument was established as a national park and preserve, and a large portion of this expansive park was designated as wilderness. Wrangell-Saint Elias National Park and Preserve represents the largest area of the National Park System and encompasses 5,332,106 ha (13,175,901 acres), larger than nine states and more than twice the land area of Maryland. The park includes 3,368,263 ha (8,323,148 acres), and the preserve includes 1,963,842 ha (4,852,753 acres).

Due to the park's rugged and vast land, paleontological investigations have been few, but trilobites have been reported within WRST.

From an unpublished report in the Alaska Paleontological Database, trilobite fragments were found in the McCarthy C-3 Quadrangle of WRST. The formation in which the trilobites were located is most likely the Early Permian Hansen Creek Formation, which was measured on the northwest side of Flood Creek, approx. elev. 1280 m (4200 ft) (Dutro, 1973).

## Yukon-Charley Rivers National Preserve, Alaska

Yukon-Charley Rivers National Preserve (YUCH) was originally proclaimed a national monument on December 1, 1978. It was soon redesignated a national preserve on December 2, 1980. The preserve is located along the Canadian border in east-central Alaska where it protects 185 km (115 mi) of the 2897 km (1800 mi) Yukon River. The entire Charley River basin is within the park, consisting of 142 km (88 mi) of one of the most spectacular wild rivers in Alaska (Santucci et al., 2011).

YUCH preserves a great assemblage of geologic and paleontological resources that stretch back to the Precambrian. The geologic features exposed within this area reveal an almost continuous geologic record. Some of the oldest fossil-bearing rocks exposed in YUCH include a large assemblage of trilobite fauna. YUCH claims the most holotype specimens of trilobites described within an NPS area, so far. Northeast of the Tintina fault is where the fossiliferous rocks of YUCH are found. The Jones Ridge, Adams, and Hillard formations are among the Cambrian strata primarily exposed along the rivers of YUCH.

The Jones Ridge Formation is exposed north of the Tatonduk River and east of a major northwest-trending fault. Kobayashi (1935) and Palmer (1968) reported on Cambrian trilobites from this area, and named a number of new species. Kobayashi described *Briscoia mertiei, Briscoia robusta* (Fig.3A)*, Briscoia septentrionalis, Chuangiella intermedia, Hungaia pacifica, Parabriscoia elegans, Parabriscoia stenorachis, Parabriscoia tripunctata, Pseudagnostus (Plethagnostus) clarki,* and *Tatonaspis alaskensis.* Palmer described *Cernuolimbus longifrons, Cheilocephalus expansus, Dunderbergia seducta, Elburgia disgranosa, Hardyoides aspinosa, Homagnostus alaskensis, Iddingsia relativa, Pterocephalia constricta, Quebecaspis aspinosa,*

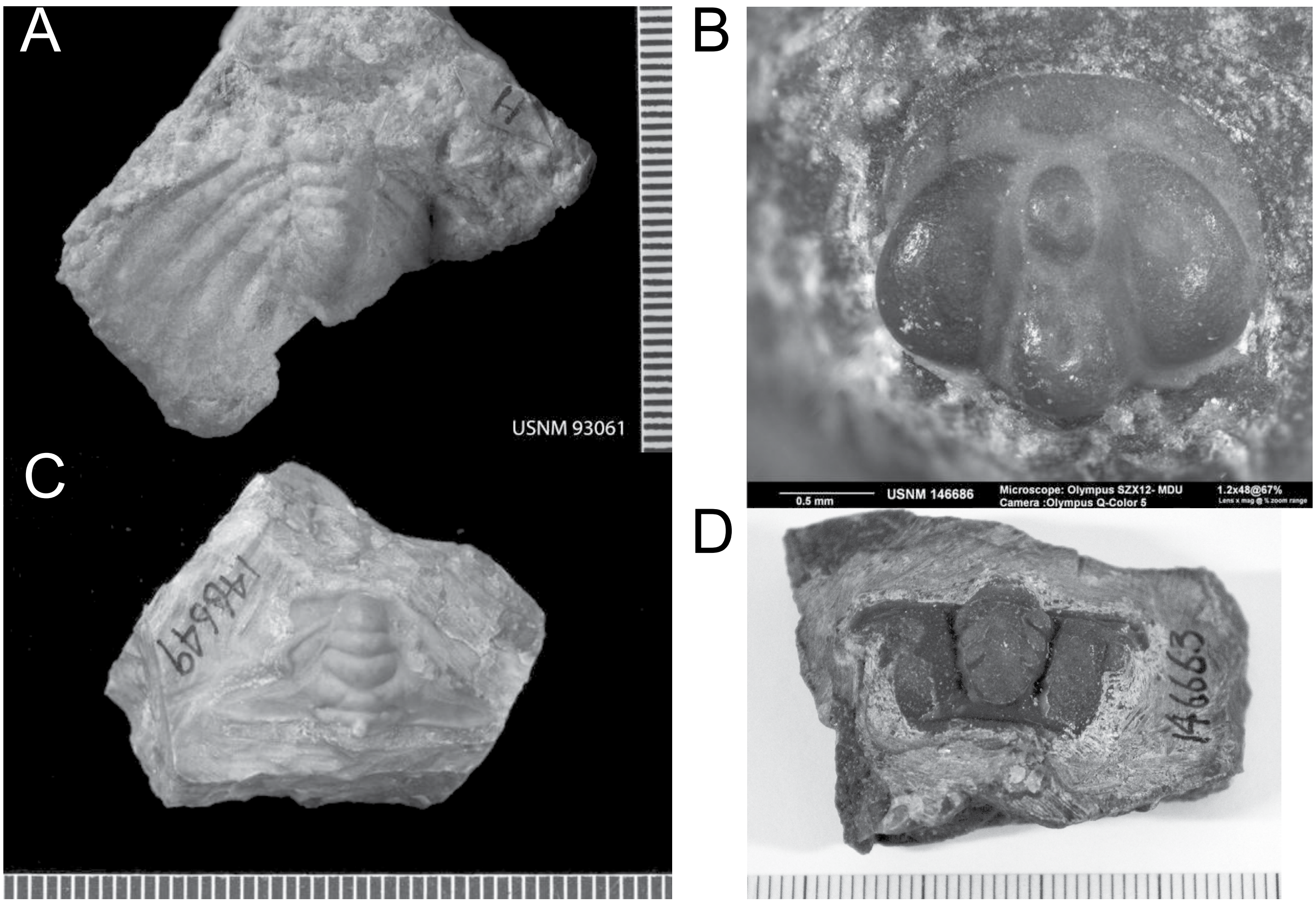


FIGURE 3. Trilobites described from Yukon-Charley Rivers National Preserve: **A**, *Briscoia robusta* Kobayashi 1935, USNM 93061 (holotype), Jones Ridge Formation, YUCH (USNM photo creator Suzanne McIntire); **B**, *Calodiscus nanus* Palmer 1968, USNM 146686 (holotype), Adams Formation, YUCH (USNM photo creator Suzanne McIntire); **C**, *Churkinia yukonensis* Palmer 1968, USNM 146649 (holotype), Adams Formation, YUCH (USNM photo creator Suzanne McIntire); and **D**, *Gelasene acanthinos* Palmer 1968, USNM 146663 (holotype), Adams Formation, YUCH.

*Richardsonella nuchastria, Sigmocheilus? compressus, Tholifrons advena,* and *Tholifrons minutus* . Kobayashi's specimens were collected from the north side of Hard Luck Creek near the international boundary, and Palmer's specimens were collected from Jones Ridge and ridges in the vicinity.

Exposed west of the northwest-trending fault and east of the Yukon River is the argillaceous Adams Formation. Palmer (1968) named a number of Cambrian trilobite species from specimens collected from this formation in YUCH: *Calodiscus nanus* (Fig. 3B), *Churkinia yukonensis* (Fig. 3C), *Dinesus arcticus, Gelasene acanthinos* (Fig. 3D), *Pagetides granulosus, Polliaxis inflata,* and *Yukonia intermedia*. These species were found near Adams Peak.

Overlying the Adams Argillite is the Late Cambrian Hillard Limestone. This exposed limestone has also produced a variety of type Cambrian trilobite specimens within YUCH. Palmer (1968) described the following: "*Antagmus*" *laminatus, Aldonaia alaskensis, Asiocephalus indigator, Athabaskiella ardis, Bathyuriscus punctatus, Bonnia tatondukensis, Brabbia pustulomarginata, Cernuolimbus arcticus, Comanchia burlingi, Elrathia alaskensis, Gerangnostus intermedius, Hungaia burlingi, Kootenia granulospinosa, Liostracinoides*? *yukonensis, Loganellus*? *arcus, Modocia compressa, Modocia transversa, Neocobboldia spinosa, Ogygopsis antiqua, Onchocephalites*? *versilis, Onchocephalus profectus, Onchonotopsis occidentalis, Onchonotus antiqus, Onchonotus brevifrons, Pagetia stenoloma, Pagetides appolinis, Pagetides occidentalis, Pareuloma spinosa, Peratagnostus hillardensis, Prohedinia brevifrons, Richardsonella quadrispinosa, Semisphaerocephalus latus, Spencella acanthine,* and *Yupingia glabra*. These trilobites came from a number of localities between the international boundary and the Yukon River.

The McCann Hill Chert of Early to Late Devonian age, specifically the *Koneprusia* locality 6492-SD, is found along the Yukon River in YUCH (Churkin and Brabb, 1967). Trilobites identified in the lower limestone and shale member of the McCann Hill Chert by Ormiston (1969, 1975) include *Dechenellurus* sp., *Astycoryphe* cf. A. *senckenberiana*, *Leonaspis* sp., *Koneprusia* aff. K. *fuscina*, *Acanthopyge* cf. A. *branikensi* (Barrande), *Harpes* aff. H. *reticulatus*, scutellid (gen. and sp. indet), and *Weberopeltis* sp. Trilobites have also been collected from the Tatonduk-Nation Rivers area in YUCH (Churkin and Brabb, 1965).

The species named by Kobayashi (1935) and Palmer (1968) are based on holotypes and syntypes reposited in the United States National Museum (USNM) in Washington D.C. and the Geological Survey of Canada (GSC) in Ottawa, Ontario. Refer to Appendix 1 for the full list of type trilobites collected within YUCH.

### Basin and Range Parks
### Death Valley National Park, California-Nevada

Death Valley National Park (DEVA) was originally established as a national monument in 1933. The boundaries expanded and the unit was redesignated a national park in 1994. DEVA is the largest unit of the National Park Service in the lower 48 states.

It preserves an extensive fossil record ranging from the Proterozoic to the Holocene. Death Valley's geologic record includes more than four dozen fossiliferous stratigraphic units exposed within the park. Death Valley strata preserve fossil plants, invertebrates, vertebrates and trace fossils. An extensive paleontological survey of DEVA was conducted by Nyborg and Santucci in 1999. Once the location of a shallow marine environment, DEVA is well known for preserving fossilized trilobites. Numerous species have been described from trilobites found within the park (Nyborg and Santucci, 1999).

The first reports of trilobites found in DEVA's current boundaries were made by Walcott (1895, 1908), who explored the Saline Valley region of Death Valley, and designated a section of strata of the White-Inyo facies as the Lower Cambrian Waucoban Series. The trilobite specimens within the Waucoban series, as well as other Cambrian units in DEVA, document important depositional settings (Nyborg and Santucci, 1999).

### Formations Exposed Within the Northwest Section of DEVA (White-Inyo Facies)

The White-Inyo Facies are exposed in the northwest section of Death Valley (Diehl, 1979). Trilobites produced within the northwest region of DEVA were found in the following Cambrian strata: Campito, Poleta, Harkless, Saline Valley, Mule Spring, and Monola Formations.

The Early Cambrian Campito Formation consists of two members: Andrews Mountain Member and Montenegro Member. The Andrews Mountain Member produced olenellid trilobites (*Fallotaspis*) (Seiple, 1984). The Montenegro Member has produced a diverse assemblage of trilobites, including the taxa *Daguinaspis, Fallotaspis, Holmia, Holmiella,* "*Juomia,*" *Laudoni*, and *Nevadia*, which were collected from the Waucoba Springs area (McKee and Gangloff, 1969; Nelson, 1976).

Overlying the Campito Formation is the Poleta Formation of Early Cambrian age. This unit is divided into three members: a lower limestone member, followed by a green-gray shale, and finally an upper limestone member. Trilobites have been documented within the middle member shale, and include *Nevadella*, *Holmia*, *Fremontia*, *Laudonia, and "Judomia*" (McKee and Gangloff 1969; Firby and Durham, 1974). The Poleta Formation has produced the type specimen of *Nevadia fritzi* (Lieberman, 2001). The overlying Harkless Formation (Early Cambrian) has produced *Paedeumias* within the upper section of the formation, along with *Bonnia* (Firby and Durham, 1974; Seiple, 1984).

The Saline Valley Formation (Early Cambrian) was deposited next and consists of consecutive layers of limestone, quartzite and shale. Trilobite genera commonly observed within the uppermost three meters of this formation include *Paedeumias, Bonnia, Bristolia, Fremontella, Ogygopsis, Olenellus, Olenoides*, and *Zacanthopsis* (Firby and Durham, 1974; Seiple, 1984).

The Cucumungo Canyon located in the northwest region of DEVA exposes the Lower Cambrian Mule Spring Limestone, which has produced trilobite genera *Bristolia* and *Peachella* (Palmer and Nelson, 1981). Nelson (1976) reported diverse and abundant trilobite fossils within the Middle Cambrian Monola Formation.

### Formations Exposed Within the Southeast Section of DEVA (Death Valley Facies)

Formations exposed within the south-east section of DEVA are referred to as the Death Valley Facies. Trilobites found in the south-east section of the park were produced from the Wood Canyon and Carrara Formations. The Wood Canyon Formation spans the Precambrian–Cambrian boundary. It has abundant Early Cambrian olenellid trilobites, which are common in the upper member. Exposures yielding trilobites are Titanothere Canyon and the Daylight Pass area (McAllister, 1974).

Overlying the Wood Canyon Formation is the Carrara Formation, which is subdivided into nine members. Each member has produced trilobites. The Carrara Formation records the most stratigraphically complete representation of late Early Cambrian to early Middle Cambrian trilobite faunal assemblages in North America (Nyborg and Santucci, 1999; Palmer and Halley, 1979). *Bristolia anteros*, *Bristolia fragilis*, *Mexicaspis radiatus*, *Mexicella grandoculus*, *Olenellus arcuatus*, *Olenellus cylindricus*, *Olenellus multinodus*, *Ptarmiganoides hexacantha*, *Syspacephalus obscurus,* and *Volocephalina contracta* are all based on specimens found in DEVA in the Carrara Formation (Palmer and Halley, 1979).

### Rock Formations Exposed Throughout the Entirety of DEVA

Younger formations exposed throughout DEVA include the Bonanza King Formation, Nopah Formation, and the Pogonip Group. The Middle Cambrian Bonanza King Formation consists of three members: the Papoose Lake Member, an informal middle member, and Branded Mountain Member. The trilobite *Glossopleura* was found in the Papoose Lake Member and an informal middle member (Hall, 1971; Hunt, 1975). Denny and Drewes (1965) documented the trilobite genera *Alokistocare* and *Ehmania* within the middle limestone beds at Ash Meadow.

Overlying the Bonanza King Formation is the Upper Cambrian Nopah Formation, which is extensively exposed throughout DEVA and consists of the Dunderberg, Halfpint, and Smoky Members. *Morosa brevispina* and *Strigambitus blepharina* (Fig. 4A) were named from specimens found in the Nopah Formation of DEVA (Palmer, 1965). Seventeen genera and 36 species of trilobites have been identified by Cooper et al. (1982) from the Dunderberg and Halfpint Members of the Nopah Formation. Constituents of the Agnostidae and Pseudagnostidale families with three nonagnostid subfamilies of Elviniiae, Aphelaspidinae, and Pterocephaliine are the dominant forms in those two members (Cooper et al., 1982).

The Ordovician Pogonip Group is upsection from the Nopah Formation. It was divided by Nolan et al. (1956) into the Goodwin, Ninemile, and Antelope Valley Limestones. Trilobites *Protopliomerops* and *Kirkella* have been noted within the lower section of the Pogonip Group (Hunt, 1975). Trilobites named from fossils found in these formations in DEVA are as follows: Antelope Valley Formation, *Ampyx compactus* (Fig. 4B) and *Carolinites angustagena*. Goodwin Formation, *Clelandia bispina* (Fig.4C), *Goniotelina hesperia*, *Illaenus auriculatus, Nileus hesperaffinis, Protocalymene mcallisteria*, *Raymondapsis vespertinus*, and *Clelandia aspina* (Fig. 4D) (Ross and Barnes, 1967).

Cambrian and Ordovician trilobite type specimens collected from DEVA are reposited at either the United States National Museum (USNM) in Washington D.C. or the Los Angeles County Museum Invertebrate Paleontology (LACMIP) collection in California. Refer to Appendix 1 for the full list of cataloged type trilobite specimens found within DEVA.

## Great Basin National Park, Nevada

In 1922, Lehman Caves National Monument was established to preserve the network of caves in east-central Nevada. The monument was incorporated into Great Basin National Park (GRBA) in 1986; along with a remnant icefield on the 3982 meter (13,063 feet) Wheeler Peak and an ancient bristlecone forest (Santucci et al., 2004). GRBA preserves numerous cave networks, rock shelters, ancient forests, mountains, desert landscapes, and significant paleontological resources (Santucci et al., 2001). Geologic formations within GRBA range in age from Precambrian to recent Quaternary deposits. Cambrian-aged strata are the oldest identified fossiliferous rocks exposed within the park (Santucci et al., 2004). Even though many of the formations exposed in GRBA are fossiliferous, few paleontological investigations have been conducted. Most of the descriptions of the fossiliferous units are taken from areas just outside of park boundaries, but exposures of these units occur within the park and likely contain similar assemblages (Santucci et al., 2001). Trilobite taxa cited from GRBA Paleontological Locality Forms (G. Bell, unpubl. locality reports, 2010-2014) and Drewes and Palmer (1957) have been documented within park boundaries.

Trilobites are among the diverse assemblage of fossils identified within GRBA rocks.

In the Cambrian Pole Canyon Limestone, which is the predominant limestone of the Lehman Caves, trilobites have been found within this fossiliferous limestone within GRBA. Drews and Palmer (1957) reported that the basal part of Member E (the most fossiliferous unit of the Pole Canyon Limestone) has fossil fragments and the upper part has bioclastic beds with trilobites. The stratigraphic section segments A and C in Drewes and Palmer (1957) appear to be wholly or almost wholly within GRBA. Several collections on Segment C, specifically Member E, which is between Lincoln Canyon and Lincoln Peak, have included trilobites.

The Middle Cambrian Lincoln Peak Formation of GRBA has produced numerous trilobite specimens. Two of Drewes and Palmer (1957)'s section segments within GRBA include collections of Lincoln Peak Formation trilobites. Segment C near the park boundary between Lincoln Canyon and Lincoln Peak yielded collections (USGS 1207-CO; 1208-CO) with *Tricrepicephalus* and *Cedaria* sp., as well as collection (USGS 1974-CO), which included *Peronopsis* sp. and *Clavagnostus* cf. C. *sulcatus*. On the northeast side of Lincoln Peak, Drewes and Palmers (1957)'s Segment D yielded (USGS 1204-CO; 1975-CO), which included trilobites *Ptychagnostus* (*Triplagnostus*) sp. and *Ptychagnostus* (*Ptychagnostus*) *richmondensis*. Unpublished locality reports from GRBA (G. Bell, unpubl. locality reports, 2010-2014) also reported *Cedaria minor*, *Peronopsis* sp., *Tricrepicephalus texanus, Coosia albertensis, Coosella, Weeksina unispina,* and *Lonchocephalus plena?* to be found in the Lincoln Peak Formation. Just outside of GRBA, Segment B near the head of Johns Wash, unidentified trilobites were also collected from within the Lincoln Peak Formation. Palmer (1960) reported trilobites from a locality (USGS 1436-CO) in eastern

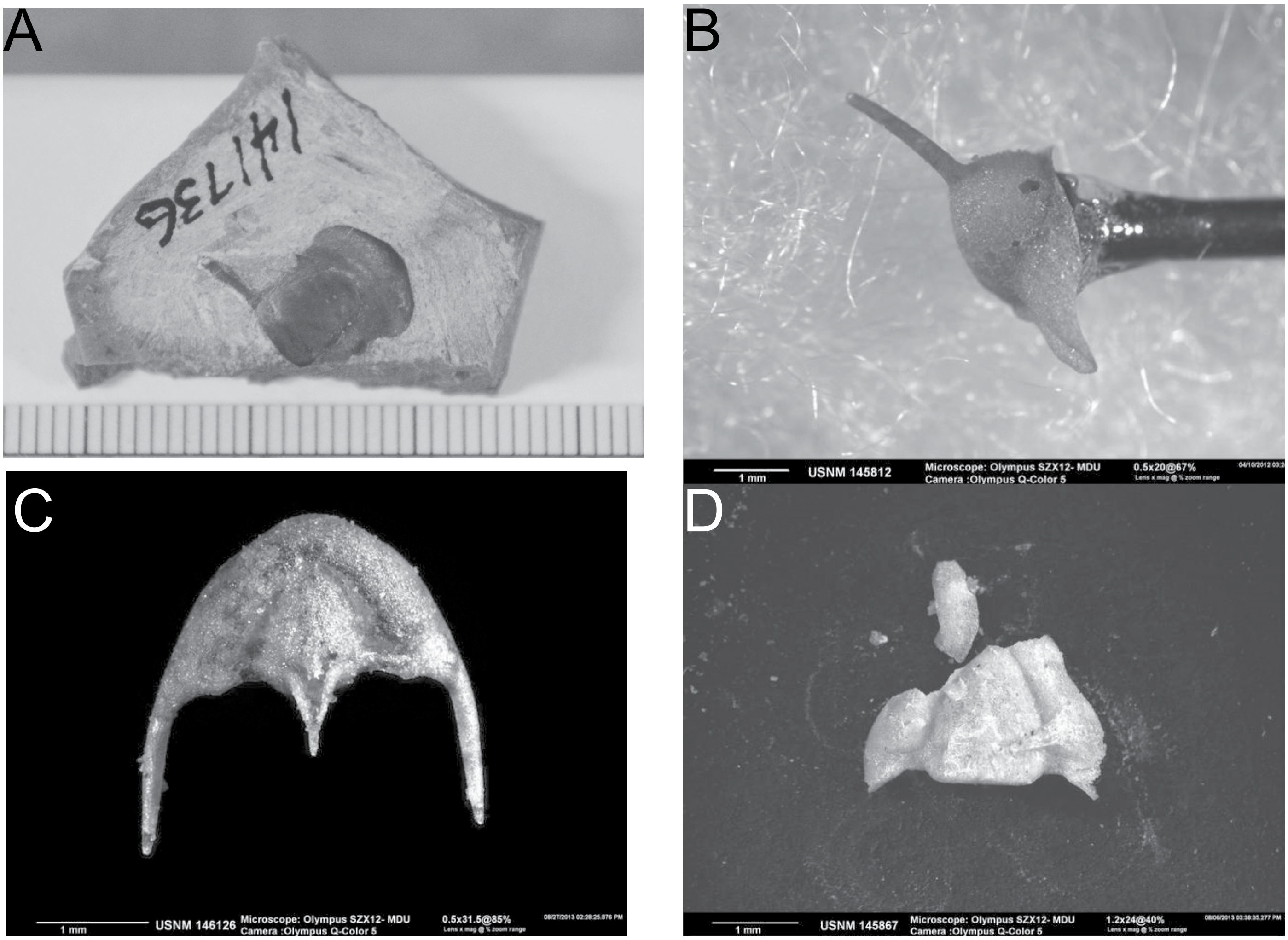


FIGURE 4. Holotypes of trilobites described from Death Valley National Park: **A**, *Strigambitus blepharina* Palmer 1966, USNM 141736 (holotype), Nopah Formation, DEVA; **B,** *Ampyx compactus* Ross and Barnes 1967, USNM 145812 (holotype) Antelope Valley Formation, DEVA (USNM photo creator Suzanne McIntire); **C**, *Clelandia bispina* Ross and Barnes 1967, USNM 146126 (holotype), Antelope Valley Formation, DEVA (USNM photo creator Suzanne McIntire); and **D**, *Clelandia aspina* Ross and Barnes 1967, USNM 145867 (holotype), Goodwin Formation, DEVA (USNM photo creator Suzanne McIntire).

GRBA, and from several localities just outside of GRBA in the area of Segment B. Trilobites from USGS 1436-CO were illustrated in Palmer (1965), where Palmer (personal commun. to D. H. Whitebread, 1959) identified trilobites from five collections (USGS 3116-CO, 3117-CO, 3118-CO, 3119-CO, and 3120-CO) obtained from sites east and north of Lincoln Peak. He then identified additional trilobites from sites now in southeastern GRBA (USGS 3804-CO, 3805-CO; D. H. Whitebread personal commun. 1962).

The overlying Johns Wash Limestone has also produced trilobites within GRBA; Palmer (personal commun. to D. H. Whitebread, 1959) identified trilobites from a collection (USGS 3115-CO) that was made in the Johns Wash Limestone east of Lincoln Peak in GRBA. From the Late Cambrian Corset Spring Shale within GRBA, trilobites have been identified by Palmer (personal commun. to D. H. Whitebread,1959) from six collections (USGS 3104-CO to 3114-CO) east of Lincoln Peak. Trilobites from USGS 3109-CO, 3110-CO, and 3114-CO were later mentioned in Palmer (1965). Whitebread (1969) mentioned the presence of trilobites and echinoderm fragments in the formation east of Lincoln Peak as well. Finally, trilobites have been found in the Late Cambrian Notch Peak Limestone. Palmer (personal commun. to D. H. Whitebread, 1961) reported that well-defined trilobite fragments were present in the "uppermost Cambrian limestone" west of Mustang Spring in GRBA.

The Ordovician Pogonip Group at GRBA consists of six formations, from oldest to youngest the House Limestone, Fillmore Limestone, Wahwah Limestone, Juab Limestone, Kanosh Shale, and Lehman Formation (Santucci et al., 2004). Bell (2014) reported trilobites, among many other invertebrates, within the six formations of the Pogonip Group.The House Limestone of GRBA has produced specimens of the trilobites *Euptychaspis lawsonensis, Notchpeakia,* and *Bowmani,* and *Pseudokainella?* (G. Bell, unpubl. locality reports, 2010-2014). Palmer (personal commun. to D. H. Whitebread, 1959) reported on trilobites attributed to the House Limestone from a locality northwest of Mustang Spring and southeast of Lincoln Peak.

Overlying the House Limestone is the Lower Ordovician Fillmore Limestone. Trilobites produced in GRBA include: Pliomeridae (pygidium), *Protopliomerops contracta*?, *Illanenus*?, *Pseudocybele lemurei*?, *Trigonocercella acuta*?, *Trigonocerca typica,* and *Pseudocybele altinasuta*? (G. Bell, unpubl. locality reports, 2010-2014). The Middle Ordovician Wahwah Limestone of GRBA has produced the trilobites: *Psephosthenaspis, Konoishia, Konoshia reticulate,* Ichnites, Cheiruridae?, *Trigonocerca typica* , *Pseudomera,* and *Pseudocybele nasuta* (G. Bell, unpubl. locality reports, 2010-2014). Deposited above the Wahwah Limestone is the Juab Limestone. Trilobite taxa found in the Juab Limestone of GRBA include *Pseudomera arachnopyge*? and *Pseudocybele nasuta* (G. Bell, unpubl. locality reports, 2010-2014).

Trilobites present in both the Juab Limestone and overlying Kanosh Shale of GRBA include *Kawina wilsoni, Madaraspis*?, *Ptyocephalus*?, *Psephosthenaspis glabrior*?, *Punka* cf.*P. nitida, Psephosthenaspis pseudobathyurus, Pseudomera, Kanoshia kanoshensis,* and *Kanoshia reticulata* (G. Bell, unpubl. locality reports, 2010-2014). GRBA trilobites documented in the Kanosh Limestone are *Isotelus?illanenus* and *Cybelopsis* (G. Bell, unpubl. locality reports, 2010-2014). Ross also identified trilobites from the Kanosh Shale for D. H. Whitebread. He identified trilobites from a locality at the crest of a ridge southwest of Granite Peak (personal commun. to D. H. Whitebread, 1959), and identified trilobites from two localities from a ridge northwest of Granite Peak (personal commun. to D. H. Whitebread, 1961).

GRBA trilobites observed in both the Kanosh Shale and overlying Lehman Formation include: *Kanoshia, Pseudoolenoides acicaudus, Cybelopsis* (pygidium), *Kanoshia reticulata, Goniotelus*? *ludificatus,* and *Kanoshia kanoshensis*? (G. Bell, unpubl. locality reports, 2010-2014). Fossils just identified in the Lehman Formation within GRBA include trilobites. Ross (personal commun. to D. H. Whitebread,1961) identified trilobites from several collections which all come from a ridge northwest of Granite Peak. Ross (1964) reported additional fossils, which included trilobites from the highest part of the Lehman Formation on Granite Peak (collections USGS D378-CO and D379-CO).

### Lake Mead National Recreation Area and Grand Canyon-Parashant National Monument, Nevada-Arizona

Lake Mead National Recreation Area (LAKE) was the first national recreation area established by an act of Congress. It was originally designated as Boulder Dam National Recreation Area on October 13, 1936. It was administered through a cooperative agreement between the National Park Service and the Bureau of Reclamation. On August 11, 1947, the site was renamed Lake Mead NRA. The recreation area includes both Lake Mead (above Hoover Dam) and Lake Mohave (below Hoover Dam), both formed by the construction of Davis Dam. There total park acreage consists of 1.5 million acres of desert and mountains, of which the lakes account for 186,700 acres. Parashant National Monument (PARA) was established in 2000 to preserve the plateaus, valleys, and canyons situated on the northern edge of the Grand Canyon. The Monument is jointly administered by the Bureau of Land Management and the National Park Service. The NPS-administered portions of the Monument are sections of LAKE that are north of the Colorado River within Arizona. Paleontological resources are specifically mentioned in the enabling legislation. Nomenclature of geologic formations varies with geographic location in and around Lake Mead National Recreation Area. LAKE and the NPS part of PARA overlap (Santucci et al., 2004).

Fossiliferous rocks are common in LAKE and the oldest sedimentary rocks are Cambrian in age. Trilobites have been produced within various geologic formations within LAKE. The oldest formation documenting trilobites is the marine mudstone known as Bright Angel Shale (Middleton and Elliot, 1990). The Bright Angel Shale is also identified within the Grand Canyon east of LAKE.

Species *Elrathiella decora* (Fig. 5A) was described by Resser (1945) from a specimen found as float on the south side of Iceberg Canyon by McKee and R. B. Wheeler in 1937. This specimen may have come from the Bright Angel Shale (Sundberg, 1994). Working on the north side of Lake Mead about a kilometer (half mile) east of Iceberg Canyon, Edward Schenk in the 1930s recovered a Pennsylvanian trilobite pygidium and cranidium, as identified in an E&R report (1963) by Richard E. Grant to LAKE.

McKee (1982) reported unidentified trilobite material from the Pennsylvanian Watahomigi Formation at Iceberg Canyon, and fossils identifiable to *Paladin* sp. in Parashant Canyon and Whitmore Wash, which appear to be within the detached parcel of LAKE (also within PARA). Gordon (1982) also identified pygidia of *Paladin* sp. from McKee's Watahomigi localities on Whitmore Wash and Parashant Canyon.

The Permian Kaibab Formation has produced trilobites within the BLM part of PARA. Longwell (1928) found trilobites from the top of a Kaibab Formation cliff, southeast of the Bronze-L Mine in PARA-BLM. Schleh (1966) also reported a number of fossils from four stratigraphic sections in northern Parashant Canyon, in PARA-BLM. The Fossil Mountain Member ("Kaibab Beta") also yielded many fossils including trilobites.

The United States National Museum holds LAKE type specimen *Elrathiella decora* (USNM 108615a). Refer to Appendix 1 for a full list of type trilobites collected within NPS vicinities.

### Mojave National Preserve, California

Mojave National Preserve (MOJA) was established on October 31, 1994, through the California Desert Protection Act, to protect the fragile habitat of the desert tortoise, vast open spaces, and historic mining operations in the Mojave Desert. MOJA encompasses 1.6 million acres of arid desert and mountains in southern California (Santucci et al., 2004).

MOJA shows evidence of a complex geologic history; its situated in portions of the Mojave Desert and Basin and Range Provinces. Strata exposed within the preserve's boundaries date back to the Precambrian (Santucci et al., 2004). A limited amount of paleontological research has been conducted in the Mojave National Preserve, but fossils have been reported in passing. Paleozoic strata are well exposed within MOJA and are evident of a shallow marine environment. Hewett (1956) reported on an abundance of Paleozoic invertebrate specimens within stratigraphic units that are now included in MOJA boundaries.

Numerous Lower Cambrian formations in the Mojave National Preserve are fossil-bearing. Fossils have been reported in the Wood Canyon Formation of MOJA. Hagadorn et al. (2000) published on a site in MOJA that has produced trilobites.

Other paleontologically rich sites within MOJA, which include fossilized trilobites, are the Latham Shale and Chambless Limestone, located in the Providence Mountains (Santucci et al., 2004). Olenellid trilobites have been found within the Latham Shale (Briggs and Mount 1982; Sundberg, 1983; Gaines, 1999), including *Paedeumias mohavensis*, *P. clarki, Mesonacis* sp., and *M. insolens* Hazzard (1933, 1954). Collection records from University of California–Riverside (UCR) regarding locality UCR 7002 show that UCR 7002/4, trilobite *Olenellus clarki*, and UCR 7002/6, trilobite *Olenellus mohavensis,* which were illustrated in Lieberman (1999), were collected in MOJA. Describing the Latham Shale in the Providence Mountains, Gaines and Droser (2002) observed five beds of trilobite fragments, four or more beds of shell lags, and tens of shell pavements, with shells of brachiopods, hyoliths, and trilobites represented. Even though localities were not specified, it can be assumed that these shell accumulations are likely a common feature in the mountains. In Hazzard's 1954 report, trilobites *Olenellus bristolensis* and *O. fremonti* were found in the Chambless Limestone (Lower Cambrian). Hazzard (1933, 1954) documented Middle Cambrian trilobites *Alokistocare* sp. and *Agnostus* sp. from the Cambrian Cornfield Spring Formation.

The Cambrian Cadiz Formation was also studied by Hazzard and Mason (1936); they identified the trilobite taxon: *Alokistocare* sp., *Clavaspidella* sp., and *Bathyuriscus* sp. Mason et al. (1937) reported Cambrian fossils from the Providence Mountains; these fossils include Lower Cambrian trilobite taxa *Olenellus*, *Paedumias*, and *Paterina* and Middle Cambrian trilobites include *Ehmania*, *Glossopleura*, *Clavaspidella*, *Zacanthoides*, *Alokistocare*, *Syspacephalus*, *Kochaspis*,

FIGURE 5. Confirmed holotype of *Elrathiella decora* Resser 1945 (USNM 108615a) found as float within Lake Mead National Recreation Area.

and possibly *Albertella*.

The Upper Cambrian Nopah Formation has also produced trilobites within MOJA. Hazzard (1954) found trilobites in the basal sandy dolomite and shale at several localities. The Anchor Limestone Member of the Mississippian Monte Cristo Limestone has yielded trilobites in the preserve (Hewett, 1956). Finally, the Pennsylvanian–Permian Bird Spring Formation, which is abundantly fossiliferous in and around MOJA, has produced Pennsylvanian trilobites within the preserve (Hazzard, 1954).

Trilobites identified in exposed strata of the Marble and Providence Mountains were used by Mount (1974, 1976, 1980a, 1980b) to identify a detailed biostratigraphic zonation of Lower and Middle Cambrian units. From oldest to youngest, the zones are divided Lower Cambrian *Bonnia-Olenellus*, and Middle Cambrian *Plagiura-Poliella*, *Albertella*, and *Glossopleura*.

## COLORADO PLATEAU PARKS

### Arches National Park, Utah

Arches National Park (ARCH), Utah, was proclaimed a national monument on April 12, 1929 and was redesignated a national park November 12, 1971. The boundaries of ARCH changed November 25, 1938; July 22, 1960; January 20, 1969; and October 30, 1998. It currently encompasses 30,966.13 ha (76,518.98 acres), all but 67.17 ha (165.97 acres) of which are under federal administration (Tweet et al., 2012). Arches National Park preserves a scientifically significant fossil record ranging from the Pennsylvanian to the late Neogene (Swanson et al., 2005). A paleontological survey was conducted in ARCH and was completed by Swanson and others in 2005.

The Paradox (Middle Pennsylvanian) and Honaker Trail (Middle to Upper Pennsylvanian) Formations have produced trilobites in ARCH. Swanson et al. (2005) reported trilobites from an exposure of the Paradox Formation that was created by blasting for drainage. From the Middle to Upper Pennsylvanian Honaker Trail Formation, Melton (1972) recovered two pygidia of the trilobite *Ditomopyge*, from an exposure of the formation along the park's southern boundary, near the Visitor Center. Although a majority of the exposure was just outside of ARCH, it is likely that trilobites can be found in the Honaker Trail Formation in ARCH, if they are present this close to park boundaries.

### Canyonlands National Park, Utah

Canyonlands National Park (CANY), Utah, was established September 12, 1964. It protects a canyon-cut landscape of rock, with spires and mesas between the gorges and valleys. The boundaries of CANY changed November 12, 1971. It currently encompasses 136,620.99 ha (337,597.83 acres), all but 11.09 ha (27.40 acres) of which are under federal administration. CANY consists of two units, a main unit and the small detached Horseshoe Canyon unit, roughly 11 km (7 miles) west of the main unit (Tweet et al., 2012).

The canyons and other geologic structures that make this national park significant are records of the rich geologic processes that have taken place over millions of years. Today, CANY is not only important for its geologic formations, but also for its paleontological resources. Among the fossils produced within CANY are fossilized trilobites that date back to the Pennsylvanian Period.

The complex Elephant Canyon Formation/Halgaito Formation/lower Cutler interval (Upper Pennsylvanian to Lower Permian) as well as the Honaker Trail Formation (Middle to lower Upper Pennsylvanian), have produced trilobites. The Honaker Trail Formation of Canyonlands National Park is a very fossiliferous limestone, with an abundance of marine invertebrate fossils. However, of those invertebrate fossils, only a few trilobites have been observed (Baars, 1993, 2010; Santucci and Kirkland, 2010).

Baars (1993) reported that the rocks of the Elephant Canyon Formation contained trilobites and that northeast of CANY, rare trilobites were identified in outcrops of the Shafer Dome area. Equivalent to the Elephant Canyon/Halgaito Formation/Cutler Interval within CANY is the outdated "Rico Formation." McKnight (1940) described 14 fossiliferous sites of the "Rico Formation" within CANY. Four of those sites are from the Shafer Limestone near the top of the stratigraphic interval, and have produced trilobites.

### Dinosaur National Monument, Colorado-Utah

Dinosaur National Monument (DINO), Colorado and Utah, was established to protect Dinosaur Quarry (also known as Carnegie Quarry or Douglass Quarry), one of the richest known localities for dinosaur fossils in the world. DINO was proclaimed an national monument October 4 1915. It has had several boundary changes: July 14, 1938; September 8, 1960; February 21, 1963; October 9, 1964; and November 10, 1978. DINO currently encompasses 85,096.31 ha (210.277.55 acres), all but 1,858.32 ha (4,592.01 acres) of which are under federal administration (Tweet et al., 2012).

Best known for its Jurassic dinosaur remains, DINO is well known for its paleontological resources. Marine invertebrates have been found in Paleozoic formations in DINO. Trilobites are present in the Upper Cambrian Lodore Formation, Middle Pennsylvanian Morgan Formation, and the Lower Pennsylvanian Round Valley Formation. The Upper Cambrian Lodore Formation is sparsely fossiliferous within DINO. Trilobites have been found in an exposure of the Lodore Formation near Jones Hole in DINO (Untermann and Untermann, 1949, 1954; Herr et al., 1982). Trilobites were documented within the Morgan Formation during a paleontological project at the monument. In White's (1876) report, he mentions the trilobite *Phillipsia* from near Echo Park, in what may be the Morgan Formation. Davis (2010) reported trilobite fragments in the Round Valley Formation/Limestone at Split Mountain in DINO.

### Glen Canyon National Recreation Area, Arizona-Utah

Glen Canyon National Recreation Area (GLCA) was established October 27, 1972. The boundaries of GLCA were changed January 3, 1975 and July 1, 2003. It currently encompasses 507,649.45 ha (1,235,429.12 acres), all but 5858.11 ha (14,475.71 acres) of which are under federal administration (Tweet et al., 2009).

The bedrock exposed within GLCA dates back to the Pennsylvanian. After millions of years, many unique geologic structures including mesas, canyons, buttes, and cliffs were created from this bedrock. The many geologic formations within GLCA have abundant and diverse fossils, primarily Mesozoic in age. Late Paleozoic trilobites have also been documented. Unspecified trilobite remains were reported by Loope and Kuntz (1987) in the Honaker Trail Formation (also known as the upper member of the Hermosa Formation). These remains came from an area along Cataract Canyon between Dark Canyon and Gypsum Canyon, as well as the lower part of Dark Canyon.

### Grand Canyon National Park, Arizona

Federal protection of the Grand Canyon of the Colorado River began February 20, 1893 with the proclamation of Grand Canyon Forest Reserve. It went through several designations before its establishment as a national park, being proclaimed Grand Canyon Game Reserve November 28, 1906, then Grand Canyon National Monument January 11, 1908, and finally its current designation as Grand Canyon National Park (GRCA) on February 26, 1919. GRCA today encompasses 492,665.64 ha (1,217,403.32 acres), 477,878.21 ha (1,180,862.78 acres) of which are under federal administration (Tweet et al., 2009).

GRCA preserves 277 river miles of the Colorado River that cuts through the Grand Canyon, creating an extensive display of geologic formations. Some of the most prominent layered rocks exposed in the canyon date back to the Paleozoic. Trilobites have been produced from a majority of those Paleozoic strata. Numerous type trilobites have been described from specimens identified within GRCA vicinities.

The Lower to Middle Cambrian Tonto Group is one of numerous Paleozoic layered rock units that are exposed within GRCA. The Tonto Group is split into three formations, from oldest to youngest the Tapeats Sandstone, Bright Angel Shale, and Muav Limestone (McKee and Resser, 1945). The Lower Cambrian Tapeats Sandstone is the oldest stratigraphic unit within GRCA boundaries to have produced trilobites. Resser (1945) reported the trilobite *Olenellus* sp. from the 212-mile point of the Colorado River, a half-mile below Fall Canyon. The site is in the transition beds of the formation. The Lower Cambrian Bright Angel Shale (Tonto Member) is exposed along the canyon wall (Santucci et al., 2004). Species named from fossils found in these rocks in GRCA include from Resser (1945) *Acrocephalops? arizonaensis* (Fig. 6A), *Albertella schenki*, *Ehmaniella arizonaensis, Elrathia nitens, Glossopleuar mckeei, Glyphaspis vulsa*, *Kootenia simplex*, *Pachyaspis fonticola*, *Parehmania tontoensis*, and *Spencia tontoensis*. Walcott identified *Alokistocare althea* (Fig. 6B) (1916a) and *Dolichometopus tontoensis* (Fig. 6C) (1916b).

Overlying the Bright Angel Shale is the Middle Cambrian Muav Limestone. The type specimens of the trilobite species *Bolaspis aemula*, *Glyphaspis tecta,* and *Kootenia schenki* (Fig. 6) were collected from the Muav Limestone within GRCA (Resser, 1945). Trilobites named from specimens found in undifferentiated Bright Angel Shale/

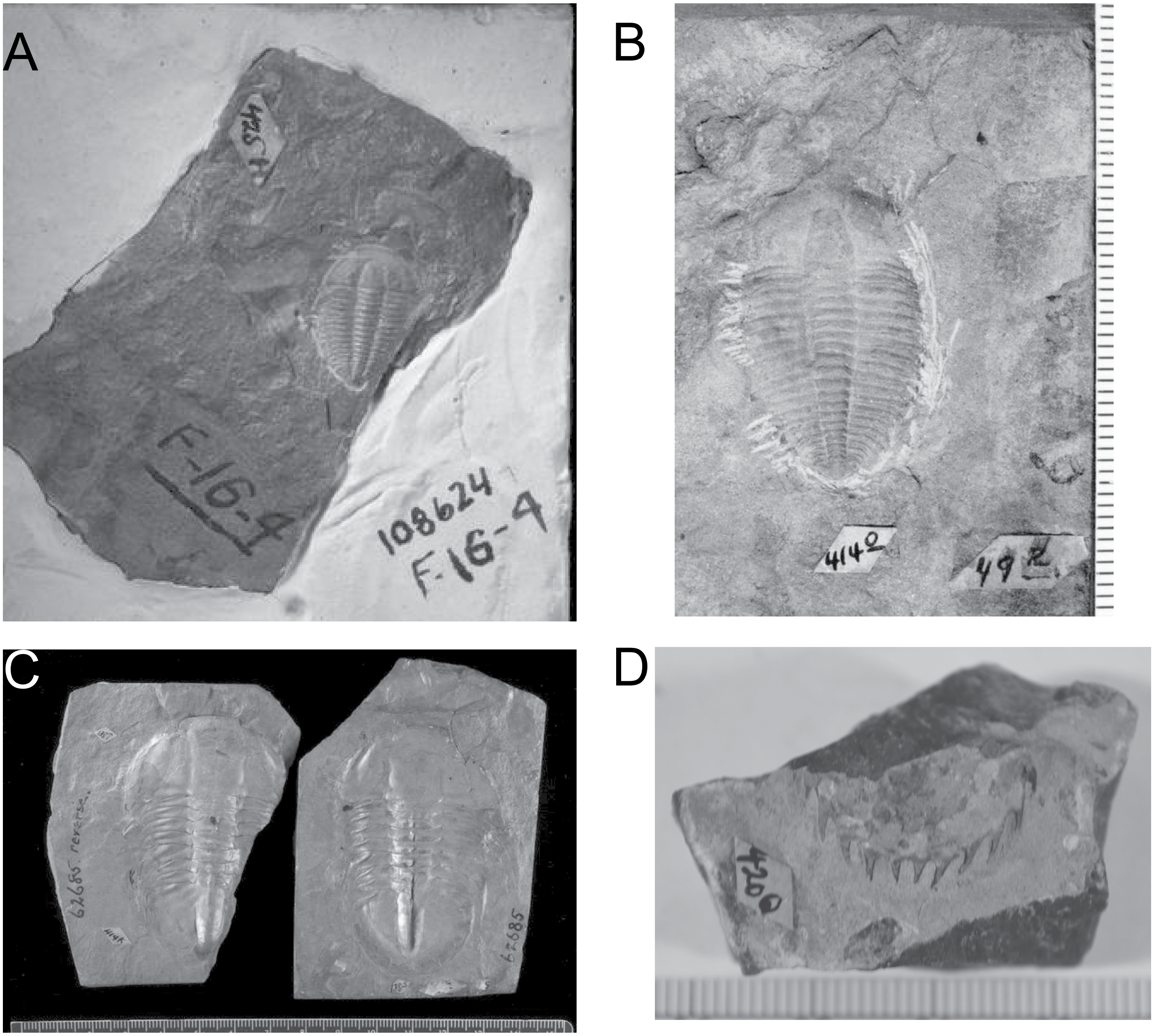


FIGURE 6. Trilobites from Grand Canyon National Park (GRCA): **A**, *Acrocephalops? arizonaensis* Resser 1945, USNM 108624 (holotype), Bright Angel Formation, (USNM photo creator Suzanne McIntire); **B**, *Alokistocare althea* Walcott 1916a, USNM 61574 (lectotype), Bright Angel Formation, (USNM photo creators Suzanne McIntire and Michael Brett-Surman); **C**, *Dolichometopus tontoensis* Walcott 1916b, USNM 62685 (lectotype), Bright Angel Formation, (USNM photo creator Suzanne McIntire); and **D**, *Kootenia schenki* Resser 1945, USNM 108586a (holotype), Muav Formation.

Muav Limestone rocks in GRCA include *Clavaspidella kanabensis*, *Kochina? angustata, Kootenia mckeei*, and *Solenopleurella diligens* (Resser, 1945). Additionally, Resser (1945) named *Ehmaniella hebes*, *Elrathiella insueta*, *Glyphaspsis kwanguntensis*, *Parehmania kwaguntensis*, *Parehmania nitida*, and *Trachycheilus typicale* (Resser, 1945) from undetermined rocks possibly in the Bright Angel Shale or Muav Limestone. Resser (1945) also named trilobites *Kootenia havasuensis* and *Pachyaspis moorei* from possibly the Muav Limestone "13 miles below Havasu Creek." It is unclear if the locality is within or outside GRCA vicinities.

The Redwall Formation, a Mississippian limestone unit, is an important part of the canyon walls. McKee and Gutschick (1969) reported the trilobite *Phillipsia sampsoni* from the Thunder Springs Member on the Bright Angel Trail of GRCA. The Upper Mississippian Surprise Canyon Formation is made up of a lower fluvial strata followed by middle and upper marine units. Trilobites identified as *Paladin* sp. have been reported from sites outside of GRCA on the south side of the Colorado River, but have not been noted from within the park (Billingsley and McKee, 1982). Above the Surprise Canyon valley fill is the Pennsylvanian Supai Group.From sites outside of GRCA, the lowest part of the Supai Group, the Watahomigi Formation, has yielded *Paladin* at Twin Springs Canyon (McKee, 1982) with an abundance of other fossilized marine invertebrates (Santucci et al., 2001). The Lower Permian Kaibab Formation has produced the type specimen of *Delaria macclintocki* (Cisne, 1971).

The trilobite type specimens collected from GRCA are held at two repositories in the United States: the United States National Museum (USNM) and Grand Canyon National Park Museum (GCNPM). A list of type trilobites found within GRCA along with their catalog numbers can be found in Appendix 1. The types of trilobites *Kootenia havasuensis* and *Pachyaspis moorei*, which Resser (1945) collected within or just outside of GRCA, are also reposited within the USNM. Refer to Appendix 2 for the full list of type trilobites that have insufficient locations and may have been collected within NPS areas.

## NORTHERN ROCKY MOUNTAIN PARKS

### Bighorn Canyon National Recreation Area, Montana-Wyoming

Bighorn Canyon National Recreation Area (BICA) was established October 15, 1966 to protect Bighorn Lake Reservoir and the associated canyons along the Bighorn River. It encompasses 48,682.15 ha (120,296.22 acres), 27,717.27 ha (68,490.87 acres) of which are under Federal administration. The geologic formations that are exposed within BICA range from the Archean to the Holocene (Tweet et al., 2013).

Similar to strata in YELL and GRTE, Cambrian BICA rock units are most often mapped as one undivided group. Due to the division of BICA between two states, Montana and Wyoming, terminology of strata has been a problem over the years, causing at times a lack of nomenclatural resolution (Tweet et al., 2013). The Cambrian sections exposed within the recreation area are not formally divided when mapped by the NPS, but are believed to be equivalent to or the same as formations from other localities in Montana and Wyoming. Montana equivalents include the following formations, oldest to youngest: Flathead, Wolsey, Meagher, Park, and Pilgrim. Wyoming equivalents include: Flathead, Gros Ventre, and Gallatin. These Cambrian units are exposed along the Bighorn Canyon, upstream of Yellowtail Dam, as well as along the western border of the Montana side of BICA (Tweet et al., 2013). Hanson (1962) reported trilobites within undivided Cambrian rocks near the mouth of Big Elk Creek, above the floor of Bighorn Canyon. Darton (1904, 1906) also examined trilobites in the Bighorn Mountains, especially near the mouth of Tepee Creek.

### Golden Spike National Historic Site, Utah

Golden Spike National Historic Site (GOSP), Utah, was established to commemorate the completion of the first transcontinental railroad in the United States, an event that took place May 10, 1869, at Promontory, Utah. GOSP was designated as a historic site April 2, 1957, and authorized as a unit of the National Park Service July 30, 1965. GOSP encompasses 1,106.93 ha (2,735.28 acres), 891.60 ha (2,203.20 acres) of which are under federal administration (Tweet et al., 2012).

Paleontological investigations have been few within GOSP, but trilobites have been documented within the historic sites boundaries. During an inventory at Golden Spike National Historic Site in 2007-2008, fragmentary trilobite remains were reported at two sites in the lower limestone of the Pennsylvanian Oquirrh Formation (Aase, unpubl., 2007-2008).

### Grand Teton National Park, Wyoming

Grand Teton National Park (GRTE) is renowned for the rugged peaks of the Teton Range, the youngest range of the Rocky Mountain system. GRTE also includes large Jackson Lake and many smaller lakes, small glaciers and a variety of glacial features, and much of Jackson Hole. The park was established February 26, 1929. GRTE's boundaries have changed once, on September 14, 1950, when most of the former Jackson Hole National Monument was added to it. GRTE presently encompasses 125,470.50 ha (310,044.36 acres); all but 930.63 ha (2,299.63 acres) are federal (Tweet et al., 2013). Twenty-eight known stratigraphic formations are exposed within the park; including 13 of which are fossiliferous (Tracy et al., 2002). Taxonomy for most trilobites within GRTE boundaries is unknown, due to them being generally reported in passing.

The oldest strata in GRTE containing fossilized trilobites is the Middle to Late Cambrian Gros Ventre Formation. The Gros Ventre Formation is exposed in northern and southwestern Wyoming and consists of three members: Wolsey Shale, Death Canyon Limestone, and Park Shale. The Wolsey Shale is normally mapped with the underlying Flathead Sandstone, while the Park Shale is mapped with the overlying Gallatin Limestone. The Death Canyon Limestone is mapped separately (Tweet et al., 2013). Trilobites that can definitely be ascribed to GRTE come from the Death Canyon Limestone Member. The blue to dark gray Death Canyon Limestone that is exposed along the Granite Canyon Trail of GRTE is reported to contain an abundance of trilobites (Love and Reed, 1968; Tracy et al., 2002). Miller (1936a) reported trilobites from the Death Canyon Limestone south of Buck Mountain, probably within GRTE.

The overlying Upper Cambrian Gallatin Limestone is primarily exposed within the northwestern and southwestern sections of the park. Exposures outside of the park boundaries may be divisible into members, but this has not been formally done within GRTE (Tweet et al., 2013). Trilobites are among the fossil assemblage reported within the Gallatin Formation of GRTE. Miller (1936a) reported trilobites from the Buck Mountain section mentioned above; Fenton and Fenton (1939) reported them from the head of Death Canyon (Pilgrim Limestone), and Saltzman (1999) reported trilobites from a part of the Gallatin Formation identified as the "Open Door Formation" of the Death Canyon area of GRTE.

The Early to Middle Mississippian Madison Limestone consists of at least four different subunits within the park and is mainly exposed in the northwestern region of GRTE (Tweet et al., 2013). Girty (1899) reported Madison Limestone trilobites on the east flank of Survey Peak in GRTE.

A small collection of fossils from GRTE have been stored in the Colter Bay Museum. During the Tracy et al. (2002) survey, trilobite specimen GRTE 4921 was collected.

### Yellowstone National Park, Wyoming-Montana-Idaho

Yellowstone National Park (YELL) is the oldest national park of the United States, the second largest in the 48 contiguous states, and in the first rank of National Park Service units in the public consciousness. It preserves a great variety of natural resources that have been shaped by glaciation and two extensive episodes of Cenozoic volcanism. YELL was established March 1, 1872. The park's boundaries have changed several times: on May 26, 1926; March 1, 1929; April 19, 1930; and October 20, 1932. Today the park encompasses 898,317.43 ha (2,219,790.71 acres), all but 0.64 ha (1.58 acres) of which is federal (Tweet et al., 2013).

YELL preserves an extensive geologic record ranging from Precambrian through the Holocene. Since 1871, when the first fossil collecting expedition was made by the Hayden Survey, abundant and diverse fossils from YELL have been described (Santucci, 1998). More than 20 fossiliferous stratigraphic formations are exposed within YELL, including a few which have documented trilobite fossils. A number of species of trilobites have been described from specimens collected in YELL (Santucci, 1998).

Yellowstone has a complex geologic history and stratigraphic nomenclature which spans three states. The northern portion of the park, within the State of Montana, uses stratigraphic nomenclature adopted by the Montana Geological Survey, whereas the southern-central portions of the park, within the State of Wyoming, use the stratigraphic nomenclature used by the Wyoming Geological Survey. This is the same stratigraphic nomenclature which is used in the Wyoming portions of Grand Teton National Park and Bighorn Canyon National Recreation Area. To date, all trilobite fossils reported from YELL come from the northern part of the park, where Montana terminology is preferred. From oldest to youngest, these are the Middle Cambrian Wolsey Shale, Meagher Limestone, and Park Shale (formerly all included in "Flathead" nomenclature), Upper Cambrian Pilgrim Limestone, Snowy Range Formation, Upper Ordovician Bighorn Dolomite, and the Lodgepole and Mission Canyon limestones of the Early to Middle Mississippian Madison Group (Tweet et al., 2013).

The oldest strata in YELL containing trilobite fossils is the Middle Cambrian Wolsey Shale . This unit is poorly exposed in the northern and northwestern sections of the Gallatin Mountains and Crowfoot Ridge regions of YELL. The Wolsey Shale is reported to contain the Middle Cambrian trilobite trace fossil *Cruziana* (Deiss, 1936).

Overlying the Wolsey Shale, the Middle Cambrian Meagher Limestone is exposed in the southern portion of the Gallatin Range and Buffalo Plateau regions of YELL. Trilobites reported from this mottled grey limestone include the type specimens of *Ehmania walcotti* (Resser, 1935), *Ehmania weedi* (Fig. 7A) (Resser, 1935), and *Zacanthoides weedi* (Resser, 1937). The trilobite genus *Agnostus bidens* was noted by Meek (1873) to have been observed in the Meagher Formation from a locality just outside of the northern border of YELL (Robison, 1982).

The Middle Cambrian Park Shale contains fragmentary remains of indeterminate trilobites from localities within YELL (Witkind, 1969). Walcott (1899) named the species *Listracus parvus* and *Ptychoparia penfieldi* (Fig. 7B) from an unspecified Middle Cambrian unit and a location within the "Flathead" formation, respectively (Tweet et al., 2013). These trilobite specimens may have been collected from what is now considered the Wolsey Shale, Meagher Limestone, or Park Shale. Similarly, fragmentary remains of *Ptychoparia wisconsensis* and *P.* (?) *diademata* were reported by Walcott (1899) near the north side of Soda Butte Creek, below the saddle on the ridge between Pebble and Soda Butte creeks in YELL, and *Ptychoparia antiquata* was found within the "Flathead" formation of the Crowfoot Ridge section of the Gallatin

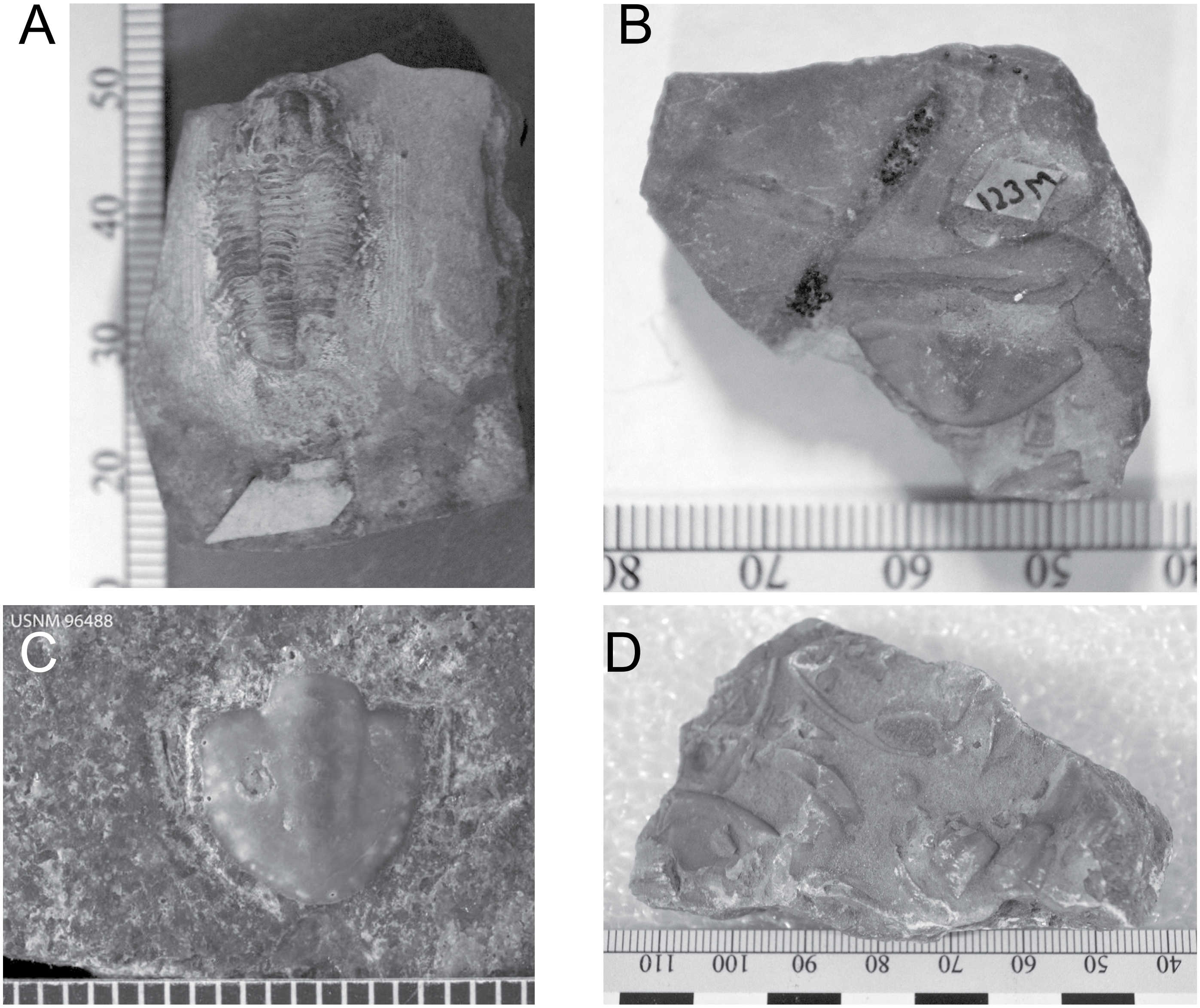


FIGURE 7. Trilobites from Yellowstone National Park (YELL): **A**, *Ehmania weedi* Resser 1935, USNM 35234 (holotype), Meagher Formation; **B**, *Ptychoparia penfieldi* Walcott 1899, USNM 35231 (holotype), "Flathead" Formation; **C,** *Blountia polita* Resser 1938, USNM 96488 (holotype), Pilgrim Formation (USNM photo creator Suzanne McIntire); and **D**, *Idahoia wyomingensis* Resser 1937, USNM 35225 (holotype), Snowy Range Formation.

Range (Hague et al., 1899).

The Upper Cambrian Pilgrim Limestone (formerly grouped under the "Gallatin" nomenclature), exposed in the northeast corner of YELL, has produced a rich trilobite fauna including the following species: *Maryvillia aequa*, *Modocia yellowstonensis* (Lochman and Duncan 1944), *Tricrepicephalus yellowstonensis* (Resser, 1937), *Blountia polita* (Fig. 7C) (Resser, 1938), *Semnocephalus minor* (Resser, 1942a), and *Solenopleura? weedi* (Walcott, 1899). Other trilobites found in this formation in northwestern YELL include: *Arapahoia* sp., *Kormagnostus* sp., *Cedarina cordillerae,* "*Homagnostus*" *lochmanae*, *Nixonnella montanensis*, *Semnocephalus centralis*, and *Syspacheilus dunoirensis* (Witkind, 1969). Walcott (1899) reported on a locality in the Crowfoot Ridge area of the Gallatin Formation which produced the trilobite species *Arionellus levis*.

The Upper Cambrian Snowy Range Formation is exposed in the northern portions of YELL within the Gallatin Range and Buffalo Plateau regions of the park. Three members of the Snowy Range Formation are mapped within park boundaries: the Dry Creek Shale, Sage Limestone, and Grove Creek members (Tweet et al., 2013). Trilobites named from the Dry Creek Shale member of the Snowy Range Formation in YELL include: *Idahoia wyomingensis* (Fig. 7D) (Resser, 1937) *Wilbernia walcotti* (Resser, 1937), *Taeinocephalus holmesi*, and *Taeinocephalus speciosus* (Resser, 1942b). The Sage Member has produced specimens of *Taenicephalus* sp., *Parabolinoides* sp., and *Eoorthis* sp. (Witkind, 1969). Unidentifiable trilobite fragments were observed in the Grove Creek Member (Ruppel, 1972). *Maustonia nasuta* and *Taenicephalus shumardi* were also identified from the undifferentiated Snowy Range Formation (Witkind, 1969). Other Cambrian Trilobitomorpha observed within YELL boundaries include: *Agnostus interstrictus, Agnostus tumidosus,* and *Crepicephalus texanus* (Santucci, 1998). William Henry Holmes (1883) reported numerous localities with trilobite remains on the lower eastern summit of Mount Holmes in YELL. All five Cambrian units (Wolsey Shale, Meagher Limestone, Park Shale, Pilgrim Limestone, and Snowy Range Formation) are exposed on Mount Holmes and the area was designated as "Trilobite Point".

Overlying the Snowy Range Formation is the Upper Ordovician Bighorn Dolomite, which is exposed in northern YELL. Ross and Barnes (1967) reported poorly preserved trilobites from Meridian Peak. In the northern portion of YELL, the fossiliferous Lodgepole Limestone and overlying Mission Canyon Limestone of the Early to Middle Mississippian Madison Group are exposed (Tweet et al., 2013). Girty (1899) reported trilobites in what was then called the Madison Limestone; Ruppel (1972) later was able to divide the Madison section, which shows that both the Lodgepole and Mission Canyon members contain trilobites in YELL. The trilobite species from the Madison Group in YELL include *Proetus loganensis* and *Proetus peroccidens*. *Proetus peroccidens* was found in both units, but *P. loganensis* was found only in Bed 31, which could be either unit because faulting repeated part of the section (Ruppel, 1972).

A small collection of trilobite fossils from YELL have been stored in various museums and repositories around the United States. The Smithsonian National Museum of Natural History (USNM) in Washington D.C. is the repository with the largest number of trilobite holotype specimens from YELL. In addition to the USNM, Montana State University Museum (MSUM) also houses a few trilobite types from YELL. Refer to Appendix 1 for the full list of type trilobites found within YELL.

## DESERT SOUTHWEST PARKS

### Carlsbad Caverns National Park, New Mexico

Carlsbad Caverns National Park (CAVE) was established October 25, 1923 to preserve "… a limestone cavern … of extraordinary proportions and of unusual beauty and variety of natural decoration … spacious chambers that have been explored, other vast chambers of unknown characters and dimensions exist…". CAVE includes 46,766 acres, of which 33,125 acres are designated wilderness. The park is best recognized for large cave a system of which, Carlsbad Cavern, contains one of the world's largest underground chambers. The park contains 113 known caves consisting of over 160 miles (257 kilometers) of passages and rooms (Santucci et al., 2007).

Carlsbad Cavern exposes and preserves a portion of one of the most famous Permian-age fossil reefs in the world, Captain Reef. A diverse assemblage of marine fossils found within CAVE are records of what built and occupied that reef during the Permian. Trilobites are among the fossils that have been found within CAVE. Permian limestones in CAVE have been exposed and have produced the remains of two species of trilobites, including a well preserved *Anisopyge perannulata* (Santucci et al., 2001).

### Guadalupe Mountains National Park, Texas

Guadalupe Mountains National Park (GUMO) was established on October 15, 1966 to preserve "an area…of outstanding geologic values...." The park contains the world's most significant fossilized limestone reef outcrops of Permian age. GUMO consists of 86,416 acres, of which 46,850 acres are designated wilderness.

The Guadalupe Mountains are a fault-block range in west Texas and southern New Mexico. A large normal fault defines the western flank of the Guadalupe Mountains, while the eastern edge is marked by the Capitan Reef escarpment. The reef escarpment essentially preserves the ancient depositional profile of the Delaware Basin margin. At GUMO the Permian Reef consists of an uplifted block forming this prominent range (Santucci et al., 2007). Today, fossilized marine fauna are preserved throughout the exposures of the Captain Reef. Trilobites are among the fossilized fauna assemblages observed within GUMO. The rock exposures of the Capitan Reef, within the Guadalupe Mountains are backreef, reef/forereef, and basin deposits. Trilobites have been reported from all three types of deposits (Brezinski, 1992).

A small number of trilobites have been documented in the Permian Artesia Group, which is part of the backreef deposit (KellerLynn, 2008). The Permian reef/forereef deposits include the Capitan Limestone, Goat Seep Dolomite, Cherry Canyon Formation, and Cutoff Formation, which all have produced trilobites (KellerLynn, 2008). From the Captain Limestone of the Guadalupe Mountains area, Shumard (1858) named the trilobite *Phillipsia perannulata* (which would later be moved to *Anisopgye*). Girty (1908) also named trilobite species *Delaria antiqua* (Fig. 8A; originally identified as *Anisopgye*? *antiqua*), from USGS locality 2967, in the Cutoff Formation (Brezinski, 1992). From the Permian basin deposits, the Bell Canyon Formation and Bone Spring Limestone have also produced trilobites (KellerLynn, 2008).

The United States National Museum (USNM) holds type *Delaria antiqua* from GUMO (syntype USNM 118169). Refer to Appendix 1 for a full list of type trilobites collected within NPS areas.

### Saguaro National Park, Arizona

Saguaro National Park (SAGU) is composed of two sections: an eastern unit in the Rincon Mountains, and a western unit in the Tucson Mountains. The two sections have significantly different geology. SAGU was proclaimed a national monument on March 1, 1933, and was transferred to the National Park Service from the U.S. Forest Service later that year, on August 10. It was redesignated as a national park on October 4, 1994. The boundaries of SAGU have changed four times, on November 15, 1961, October 21, 1976, June 19, 1991, and October 4, 1994. A wilderness area was designated within SAGU on October 20, 1976. SAGU encompasses 37,005.14 ha (91,439.71 acres). 35,421.32 ha (87,526.07 acres) of this total are under Federal administration, and the wilderness area is 28,694.86 ha (70,905 acres) (Tweet et al., 2008).

SAGU is composed of two districts: Western Tucson Mountain District and Eastern Rincon Mountain District. The Tucson Mountains are mainly composed of Permian and Cretaceous limestone, while the Rincon Mountains bedrock of granite ranges back to the Precambrian. Both mountain ranges are geologically significant and expose paleontologically diverse formations.

Drewes (1977, 1981) reported that at the head of the Rincon Valley, near the Madrona Ranger Station, trilobite-bearing rocks of the Cambrian Abrigo Formation overlie the Pennsylvanian Horquilla Limestone. This contact is possible due to a thrust fault that runs along the Abrigo Formation and Horquilla Limestone. This locality description may be describing an area immediately outside SAGU, but it is close enough to assume that the same formation exposed in adjacent areas within the park's boundaries contains trilobites.

## GREAT PLAINS PARKS

### Chickasaw National Recreation Area, Oklahoma

Chickasaw National Recreation Area (CHIC) protects an area of south-central Oklahoma surrounding the Lake of the Arbuckles. The area was first officially recognized July 1, 1902, as Sulphur Springs Reservation, set aside to preserve an area of springs in what is now the northeastern arm of CHIC. The name was changed June 29, 1906 to Platt National Park. The construction of Arbuckle Dam and subsequent filling of Lake of the Arbuckles during the 1950s and 1960s led to the creation of Arbuckle Recreation Area south and west of Platt National Park, which was authorized August 24, 1962. The two park units were merged and redesignated Chickasaw National Recreation Area on March 17, 1976. The boundaries of the units that became CHIC have changed on several occasions, but currently encompasses 4,001.87 ha (9,888.83 acres), all but 1.82 ha (4.50 acres) of which are federal (Tweet et al., 2015). CHIC exposes strata ranging from the Middle Ordovician to present day. Trilobites have been produced within the various geologic formations exposed within the recreational areas boundaries.


FIGURE 8. Trilobite described based on specimen found within Guadalupe Mountains National Park (GUMO): *Delaria antiqua* Girty 1908, USNM 118169 (syntype), Cutoff Formation.

Glaser (1965) and Alberstadt (1967, 1973) described a stratigraphic section of the Upper Ordovician Viola Group. The upper part of this section is within CHIC. Both Glaser (1965) and Alberstadt (1967, 1973) observed "abundant" trilobites in the upper part of the section, in what is now considered to be the Welling Formation. Koch and Santucci (2003) reported trilobites from the Viola Group, although it is unclear if this is a reference to CHIC or to the formation as a whole.

The Upper Silurian Henryhouse Formation has produced trilobites in CHIC (Amsden 1960; Campbell, 1967). Amsden (1960) reported trilobites from the middle and upper part of the Henryhouse Formation. Campbell's (1967) publication states that the following species were collected from the Henryhouse Formation, specifically the M10 Locality of Amsden (1960): *Calymene clavicula, Ananaspis guttulus, Dalmanites rutellum,* and *Protus foculus*.

The Lower Devonian Haragan Formation within CHIC has produced trilobites, specifically in the Goddard Youth Camp area (Stanley, 2001). Amsden (1960) and Campbell (1967) also reported trilobites within the Haragan Formation at the M10 locality. Finally Campbell (1977) and Stanley (2001) reported trilobite specimens from the Fittstown Member of the Lower Devonian Bois d'Arc Formation in the vicinity of the Goddard Youth Camp.

### Santa Fe National Historic Trail, Colorado-Kansas-Missouri-New Mexico-Oklahoma

Extending 1203 miles and passing through five states, the Santa Fe National Historic Trail (SAFE) runs from western Missouri to Santa Fe, New Mexico. SAFE was added to the National Trail System in October 1987 (Tweet et al., 2015).

The Santa Fe National Historic Trail exposes various types of bedrock along its route. Fossils have been produced within its rocks. Trilobites have been documented on land associated with the trail when it was in operation. Shumard and Swallow (1858) reported two species of trilobites from sites near or on the trail. Shumard named both *Phillipsia missouriensis*, from the Middle Coal Measures (Pennsylvanian) at Lexington, Missouri, and *Phillipsia major*, which was found in the Upper Coal Measures 12 miles south of Lecompton, Kansas on the Santa Fe road. Swallow and Hawn (1858) reported trilobite *Phillipsia* in lower Permian rocks near Council Grove, Kansas, another site on the trail.

*Philipsia major* was described based on a trilobite found probably within SAFE, but repository information is unknown. Refer to Appendix 1 for a full list of type trilobites from NPS areas.

### Tallgrass Prairie National Preserve, Kansas

Tallgrass Prairie National Preserve (TAPR), in Chase County, Kansas, was established on November 12, 1996. This 4409 ha (10,894 acres) portion of the once vast tallgrass prairie is being preserved as a critical resource for the benefit, education, and enjoyment of this and future generations (Hunt et al., 2008).

This preserve is not only culturally significant, but paleontologically important as well. Once the location of the inland Permian Sea, great assemblages of marine fauna thrived here and eventually decayed and accumulated to form the Flint Hills of the Preserve. Trilobite *Ditomopyge* sp. was documented in the Lower Permian Easly Creek Shale and Eiss Limestone Member of the Bader Limestone within TAPR (Sawin and West, 2008).

### Wind Cave National Park, South Dakota

Wind Cave National Park (WICA) was established for namesake Wind Cave, noted for its boxwork and crystal formations. WICA was established January 9, 1903. It has had several boundary changes: March 4, 1931; August 9, 1946; November 10, 1978; and September 21, 2005. Wind Cave National Game Preserve was established August 10, 1912, and was added to the park June 15, 1935. Today WICA encompasses 11,450.59 ha (28,295.03 acres), all under federal administration (Santucci et al., 2001).

Wind Cave National Park is the seventh longest cave in the world and preserves roughly 158 km (98 miles) of cave passageways (KellerLynn, 2009). As paleontological investigations were conducted, abundant Paleozoic marine invertebrates were documented in the Madison Limestone of the cave (Santucci et al., 2001). Trilobites have been documented within the parks boundaries. In Stitt's (1998) report, trilobites were found from three different sites in WICA. Two of the sites were near the Beaver Creek/Cold Spring Creek confluence and the other site was a short distance from Reeves Gulch. Christinia Lochman-Balk and students collected specimens of the trilobites *Cedarina* and *Modocia* from the basal Deadwood Formation at these sites (Stitt, 1998).

Stitt's (1998) collection of trilobite specimens from within Wind Cave National Park is reposited in the Department of Geological Sciences at the University of Missouri at Columbia.

## GREAT LAKES PARKS

### Mississippi National River and Recreation Area, Minnesota

The Mississippi National River and Recreation Area (MISS) encompasses approximately 22,000 ha (54,000 acres) along 116 km (72 miles) of the upper Mississippi River in southeastern Minnesota. The National Park Service owns only 14 ha (35 acres) within the MISS corridor boundary. All the rest is owned and managed by partner agencies (Tweet, 2014). Along the 72 scenic miles of the upper Mississippi River, geologic structures and bedrock are exposed and record the geologic processes that have taken place for millions of years. Trilobites have been documented from two geologic formations within MISS boundaries: the Platteville Formation and the Decorah Shale.

Near Coldwater Spring, the Ordovician Platteville Formation is exposed and small cephalons have been observed (Tweet, 2014). Trilobite *Nilens vigilans* (now *Anataphrus vigilans*) has been found in the lower portion of the Platteville Formation, exposed at Lock & Dam 1. Trilobite *Isotelus gigas* has been produced in both the Platteville and Decorah formations within MISS (Stauffer and Thiel, 1941; Adamson, 1993).

Overlaying the Platteville Formation is the Ordovician Decorah Shale. The following trilobites were found in the Decorah Shale at various localities. The Brickyard or Twin City Brick Company locality is the best-studied Decorah Shale locality in MISS. Adamson (1993) identified several trilobite species from this locality, including C*eraurus plattinensis*, *Dimeropyge galenensis*, *Dolichoharpes reticulata*, *Eomonorachus intermedius*, and *Isotelus gigas*. Specimens attributed to *Anataphrus*?, *Isotelus* sp., and *Lichas* sp. from this site are in the collections of the Science Museum of Minnesota and University of Minnesota, and what appears to be *Calyptaulax* sp. has also been observed from this site (J. Tweet, pers. obs. 2015). *Bumastus trentonensis* and *Calliops plattevillensis* were observed at in an exposure of the Decorah Shale near Lock & Dam 1 (Stauffer and Thiel, 1941).

Several trilobite species have been named from this region with limited locality information. It is likely that at least some of them came from sites now in MISS because of the distribution of outcrops. From the Platteville Formation, these include: *Cyrtometopus scofieldi, Pterygometopus schmidti* (Clarke, 1897), *Illaenus* (*Nileus*) *minnesotensis, Illaenus herricki* (Foerste, 1887), and *Calliops plattevillensis* (Ulrich and Delo, 1940). Two others were named from unspecified formations: *Arges wesenbergensis* var. *paulianus* and *Bathyurus schucherti* (Clarke, 1897).

Trilobite specimens from MISS are reposited at the National Museum of Natural History (USNM), Science Museum of Minnesota (SMM), and University of Minnesota Paleontology Collection (UMPC). Type specimens for species named from along the river corridor are reposited at the USNM and UMPC. Refer to Appendix 2 for the list of type specimen that may have been collected within MISS or just outside.

### Pictured Rocks National Lakeshore, Michigan

Pictured Rocks National Lakeshore (PIRO), Michigan, was established on October 15, 1966, and is located on the southern shore of Lake Superior in Michigan's Upper Peninsula, and now protects a total of 29,674 ha (73,325 acres). The "Shoreline Zone" is federally-owned and includes 13,731 ha (33,929 acres). The "Inland Buffer Zone" is a mixture of lands in State of Michigan, Forestland Group, and other private ownership and encompasses 15,907 ha (39,306 acres) (Hunt et al., 2008). The unique sedimentary structures and surfical deposits all along the shore, record the geologic processes that took place in the area. During the early Paleozoic, shallow seas covered what is now northern Michigan, which in time formed the unique sedimentary rocks within PIRO.

The Late Cambrian Munising Formation produced *Prosaukia curvicastata,* near the top of the formation. The trilobite trace fossils *Cruziana* and *Rusophycus* were also documented in the Munising Formation (Haddox and Dott 1990). Fragmentary remains of trilobites were reported by Milstein (1987) from the Miner's Castle Member. The Middle Ordovician Au Train Formation produced fragmented trilobites at the Sand Point Section (Robert Rose, pers. comm, April 2008 to GLKN inventory authors; Miller et al., 2006).

### Saint Croix National Scenic Riverway, Wisconsin-Minnesota

Saint Croix National Scenic Riverway (SACN), Minnesota and Wisconsin, preserves 406 km (252 miles) of the Namekagon and Saint Croix rivers as part of the National Wild and Scenic Rivers System. The Saint Croix National Scenic Riverway, which includes the Namekagon River, was established on October 2, 1968 as one of the original eight rivers under the National Wild and Scenic Rivers Act. The Lower Saint Croix National Scenic Riverway was added to the system on October 25, 1972. The total size for both the upper and lower riverway (including water surface, backwater and islands) is 39,486 ha (97,573 acres) (Hunt et al., 2008).

Along both the Namekagon and Lower Saint Croix Rivers banks, exposure of bedrock is common. Paleontological resources are rich in the rock along the rivers' banks and range back to the Cambrian. Numerous trilobites have been produced within SACN bedrock or the immediate vicinity. Most of the descriptive work took place in the mid-19th century, so locality information is often limited to a town or city along the SACN corridor. As with MISS, outcrops are generally close to the river corridor, so many finds probably come from sites now within SACN.

Some of these reports contain sites clearly within SACN. Shumard (1862) named the trilobite *Arionellus bipunctatus* from Cambrian sandstone at the mouth of Lawrence Creek on the Saint Croix River. Hall (1863) named *Dikelocephalus minnesotensis* var. *limbatus* from the Cambrian St. Lawrence Formation at the Osceola landing. The following trilobites were described from localities that may be within or just outside Saint Croix National Scenic Riverway boundaries. Unless specified, the formations are uncertain. Owen (1852) identified *Dikelocephalus minnesotensis* (Fig. 9A). Hall (1863) reported species *Agnostus disparilis, Conocephalites diadematus* (Fig. 9B-C)*, Conocephalites shumardi, Conocephalites*? *binodosus, Dikelocephalus osceola,* and *Illaenurus quadrates*. Resser (1937) reported trilobite *Wilbernia hudsonensis*; Walcott (1890) *Agraulos*? *thea*; *Conocephalites (Ptychaspsis?) explanatus* was documented by Whitfield (1882). The Cambrian St. Lawrence Formation produced the trilobites *Dikelocephalus gracilis, Osceolia lodensis, Osceolia lodensis var. reflexa, Osceolia praecipta* (Ulrich and Resser, 1930*)*, *Saukia leucosia,* and *Saukia pyrene* (Walcott, 1914). The Cambrian Franconia Formation (now the Tunnel City Group) produced the species *Eoptychaspis cylindricus, Parabolinoides expansa, Parabolinoides parallela, Ptychaspis arcolensis, Stigmaspis hudsonensis, Taenicephalus altus* (Nelson, 1951). The Ironton Formation (Cambrian) produced *Berkeia typica* (Resser, 1937). The Cambrian Jordan unit produced species: *Dikelocephalus halli, Dikelocephalus thwaitesi, Osceolia obsoleta, Osceolia obsoleta* var. *reversa* (Ulrich and Resser, 1930)*; Saukiella signata, Tellerina extrema,* and *Tellerina*? *leucosia* var. *parallela* (Ulrich and Resser, 1933).

Type trilobite species *Dikelocephalus minnesotensis* var. *limbatus* was collected within SACN and is reposited at the United States National Museum (USNM). Refer to Appendix 1 for a full list of type trilobites from NPS areas. Holotypes that were possibly collected within SACN vicinities, but exact location is unclear, are reposited at either the United States National Museum (USNM), American Museum of Natural History (AMNH), University of Minnesota Paleontology Collection (UMPC), Columbia University, or Wisconsin State University. Refer to Appendix 2 for the list of type trilobites with insufficient locations.

## APPALACHIAN MOUNTAINS PARKS

### Antietam National Battlefield, Maryland

Antietam National Battlefield (ANTI), Maryland, was originally established as a national battlefield by Congress on August 30, 1890 in order to preserve the bloodiest single day in American military history. The park was transferred from the War Department on August 10, 1933 and was redesignated to its current status on November 10, 1978 (Kenworthy and Santucci, 2004).

While Antietam National Battlefield is more often known for its military history, several fossiliferous geologic formations are exposed within the battlefield and represent a rich geologic past (Thornberry-Ehrlich, 2005). Mapped by the Maryland Geologic Survey, ANTI exposes four geologic formations, from oldest to youngest the Tomstown Formation, Waynesboro Formation, Elbrook Formation, and Conococheague Formation. Trilobites have been documented in the Upper Cambrian–Lower Ordovician Conococheague Formation exposed within ANTI.

The Conococheague Formation is exposed in the central region of the battlefield and is the source of type specimen *Crepichilellus antietamensis* and *Stigmacephalus? distorta*. A locality description by Wilson (1951) states that trilobite species *Crepichiellus antietamensis* was collected "in a field just across fence at west side of road leading northward from monument marking spot where General Mansfield was killed". Specimens of *Pseudosaratogia magna* along with other fragmentary trilobite remains were also produced from this unit in ANTI (Wilson, 1951).

According to Wilson (1951), the holotypes of *Crepichiellus antietamensis* and *Stigmacephalus*? *distorta* were collected within ANTI and reposited in the Yale Peabody Museum in New Haven, Connecticut. Catalog numbers are as follows: *Crepichiella antietamensis* (YPM 18596) and *Stigmacephalus? distorta* (YPM 18593). Refer to Appendix 1 for a summary of all trilobite holotypes described from NPS areas.

### Chesapeake and Ohio Canal National Historical Park, D.C., Maryland, West Virginia and Virginia

Chesapeake and Ohio Canal National Historical Park (CHOH), Maryland, follows the course of the Potomac River and the adjacent Chesapeake and Ohio Canal from Georgetown in Washington, D.C. to Cumberland, Maryland, a total of 184.5 miles (297 km). The NPS acquired the C&O Canal in 1938 and authorized portions of the canal as a national monument in 1961. Justice William O. Douglas' efforts to save the park came to fruition when CHOH was officially created on January 8, 1971(Kenworthy and Santucci, 2004). The Chesapeake and Ohio Canal National Historical Park is not only preserved for its historical and cultural remnants, but also for its significant geologic past. The canal, towpath, and associated structures provide the opportunity to observe numerous and unique geologic formations from the central Appalachian region (Thornberry-Ehrlich, 2005). Twenty-seven type localities of geologic formations are exposed along the Potomac River (Southworth et al., 2008). No formal paleontological inventories have been conducted for CHOH, but fossils are known from the canal, especially in the western Maryland section of CHOH (Clites and Santucci, 2010). Fossilized trilobites are common throughout the Valley and Ridge Province, which the C&O Canal traverses.

The Great Valley section of the Valley and Ridge Province has produced trilobites from the Elbrook Formation, Conococheague Limestone, Stonehenge Limestone, Rockdale Run Formation, and the Martinsburg Formation. The Middle Cambrian Elbrook Formation is exposed along the canal in the Valley and Ridge province. The following trilobite specimens were documented: *Glossopleura* sp., *Elrathina* sp., *Modocia* sp., *Genevievella* sp., and *Crepicephalus* sp. (Brezinski, 1996; Southworth et al., 2008).

Overlying the Elbrook Formation is the Conococheague Limestone, a unit of late Cambrian or early Ordovician. The Conocheague Limestone has produced Upper Cambrian trilobites; *Ptychaspis* sp., *Calvinella* sp., and *Pseudosaratogia* sp. (Southworth et al., 2008). Clites and Santucci (2010) observed trilobites within exposures of both the Elbrook and Conococheague Formations from mile marker 109.2 to 110 within CHOH. Deposited above the Conococheague Formation is the Lower Ordovician Stonehenge Limestone. This limestone has produced specimens of trilobites *Bellefontia* sp. and *Homagnostus* sp. (Southworth et al., 2008; Sando, 1957; Brezinski et al., 1999).

The Early Ordovician Rockdale Run Formation has produced trilobites. Sando (1957) reported that due to a great abundance of fossils produced within the Rockdale Run Formation, he divided the formation into four faunal zones. His section 1, which is both within and near CHOH, has produced trilobites. The Late Ordovician Martinsburg Formation has produced a sparse amount of trilobites, especially the trilobite *Cryptolithus* (Southworth et al., 2001). West of the North Mountain Fault section of the Valley and Ridge Province, the Late Devonian Brallier Formation and overlying Scherr Formation are exposed. Trilobites were reported between mile marker 151 and 152 from these formations (Clites and Santucci, 2010).

### Delaware Water Gap National Recreation Area, Pennsylvania and New Jersey

Delaware Water Gap National Recreation Area (DEWA), Pennsylvania and New Jersey, was established in 1965 to preserve relatively unspoiled scenic and historic land along the uppermost section of the Delaware River. The river forms the political boundary between northwestern New Jersey and northeastern Pennsylvania. As

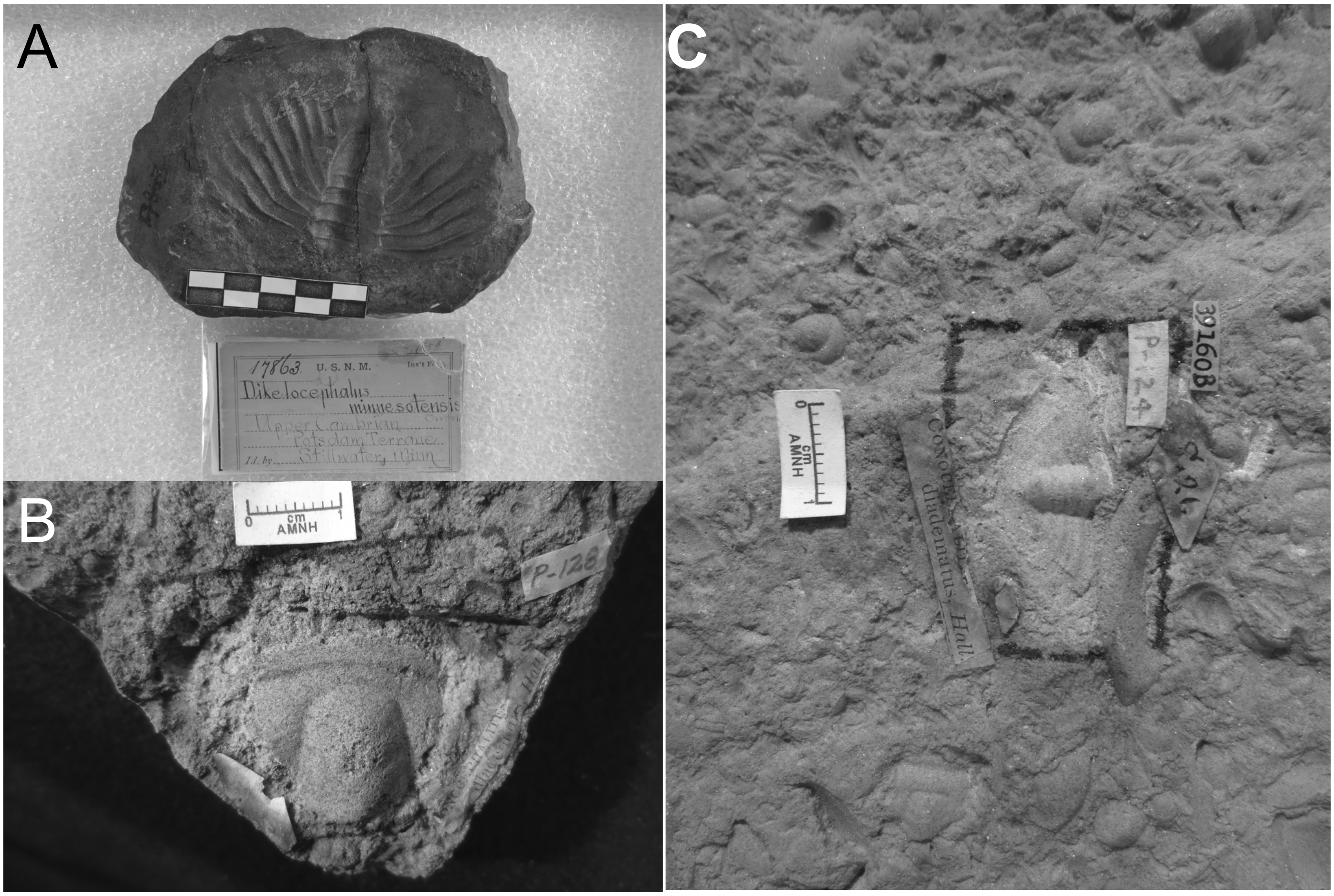


FIGURE 9. Trilobite holotype specimens possibly from Saint Croix National Scenic River (SACN). However insufficient locality information limits confirmation that the specimens were collected from within the SACN: **A**, *Dikelocephalus minnesotensis* Owen 1852, USNM 17863; and **B-C**, *Conocephalites diadematus* Hall 1863, AMNH-FI-39160B and AMNH-FI-39164 (Justin Tweet photos).

the park name implies, the park preserves the segment of river that flows through the famous gap in the Appalachian Mountains (Koch and Santucci, 2004). Fossil bearing rocks are commonly exposed along the mountains that are cut by the Delaware River (Epstein, 2006). Albright (1987) compiled faunal lists of the New Jersey's Silurian and Devonian Formations within the DEWA. The trilobites produced in units within DEWA boundaries are Silurian and Devonian age.

Albright (1987) listed the following formations as having produced trilobites in DEWA: Decker Formation (Decker Ferry), Coeymans Formation (Peters Valley, Shawnee Island, and Stormville Members), Kalkberg Formation, New Scotland Formation, Minisink Formation, Port Ewen Formation, Oriskany Formation, and the Buttermilk Falls Formation (Onondaga) (Albright, 1987). The Decker Formation produced trilobites *Calymene camerata, Proetus pachydermatus*, *Proteus* cf. *P. depressus*, *Proteus* cf. *spinosus*, and *Dalmanites aspinosa*. The Coeymans Formation produced trilobites *Proetus protuberans*, *Odontochile micrurus*, and *Phacops* sp. The New Scotland Formation produced trilobites *Odontochile micrurus* and *Phacops logani*. The Minisink Formation produced trilobites *Odontochile micrurus*, *Phacops logani*, *Trimerus vanuxemi*, and *Lichas pustulosus*. The Port Ewen Formation produced trilobites *Dalmanites* sp., *Odontochile micrurus,* and *Synphoria whiteavesi*. The Oriskany Formation produced trilobites *Trimerus vanuxemi* and *Corycephalus dentatus*. The Buttermilk Falls Formation (Onondaga) produced trilobites *Phacops rana*, *Phacops bufo*, *Phacops cristata* var. *pipo*, *Trimerus dekayi*, *Trypaulites* cf. *erinus*, *Odontocephalus selenurus*, and *Odontocephalus aegeria* (Albright, 1987).

### Great Smoky Mountains National Park, Tennessee-North Carolina

Great Smoky Mountains National Park (GRSM) spans the Tennessee and North Carolina border in the heart of the southern Appalachian Mountains. The approximately 2110 sq km (815 sq mile) area of the Great Smoky Mountains was established as a park in 1934, five years before the last lumber company ended operations (Santucci et al., 2008). A majority of the rocks within the park are sedimentary and date back to the Proterozoic. Nearly all of the rocks in GRSM are barren of fossils, with the exception of a few geologic formations.

Exposed in the western part of GRSM is the Cades Cove bedrock, which is assigned to the Jonesboro Limestone of the Knox Group (Upper Cambrian and Lower Ordovician). An assemblage of lower Paleozoic marine fauna have been described from these carbonate rocks (Repetski, 1997). Neuman (1947) identified trilobite *Hystricurus*(?) sp. in the Cades Cove bedrock. Unrug and Unrug (1990) described Paleozoic fossils including trilobite fragments from the Wilhite Formation on the Foothills Parkway. These are notable because the Wilhite Formation has usually been described as Neoproterozoic. The fossils indicate that it had been misdated or the rocks were misidentified as the Wilhite Formation.

### Natchez Trace Parkway, Alabama, Mississippi, Tennessee

The Natchez Trace Parkway (NATR), Alabama, Mississippi and Tennessee, commemorates the Natchez Trace, a historic trail that connected southern portions of the Mississippi River to the salt licks in what is now central Tennessee. Today the parkway stretches 715 km (444 miles) from Natchez, Mississippi to near Nashville, Tennessee and interprets a rich cultural history. The parkway was completed in 2005 and is a National Scenic Byway and All-American Road.

The Natchez Trace passes through 350 million years of geologic time, Mississippian to Holocene. Of the few paleontological investigations that have been conducted along the trace, trilobites have been reported in passing. Patzkowsky and Holland (1999) reported that above and below fossilized sponges in roadcuts in Catheys and Leipers, along Natchez Trace Parkway (mile 427-428), trilobites, and other marine invertebrates were identified. Black (unpubl. 1961, 1962) reported that trilobites were produced in a limestone outcrop at the junction of NATR and Tennessee Highway 99. Colvin and Marcher (1964) mapped that area as Leipers or Fernvale Formations. According to Colvin and Marcher (1964), since both the Leipers and Fernvale Formations preserve marine invertebrates, the limestone outcrop that Black (unpubl. 1961, 1962) reported could have come from either formation.

## CONCLUSIONS

Trilobites are among one of the more numerous groups of paleontological resources in National Park Service areas, they have public appeal and possess scientific and educational values. This inventory of trilobites from National Park Service areas has confirmed that as of today 33 NPS areas have documented trilobites. From this inventory, 137 confirmed trilobite holotypes from NPS areas have been documented; photographs of trilobite specimens that have been reposited at the USNM have been obtained; and scientific papers associated with NPS trilobites (including holotypes) have been compiled. A list of holotypes potentially from Grand Canyon National Park, Mississippi National River and Recreation Area, Saint Croix National Scenic Riverway, and Santa Fe National Historic Trail was assembled; in these cases, insufficient locality information prevents confirmation that the specimens were collected from within those NPS units. Future research regarding NPS trilobites will most likely add to our current knowledge of trilobite evolution and history.

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## REFERENCES

Adamson, K.F., 1993, A numerical analysis of the fauna of the upper quarter of the middle Ordovician Decorah Shale, St. Paul, Minnesota [Senior thesis]: Minneapolis, University of Minnesota.

Alberstadt, L.P., 1967, Brachiopod biostratigraphy of the Viola and "Fernvale" formations (Ordovician), Arbuckle Mountains, south-central Oklahoma [Ph.D. dissertation]: Norman, University of Oklahoma, 308 p.

Alberstadt, L.P., 1973, Articulate brachiopods of the Viola Formation (Ordovician) in the Arbuckle Mountains, Oklahoma: Oklahoma Geological Survey, Bulletin 117, 90 p.

Albright, S.S., 1987, Faunal lists of New Jersey's Silurian and Devonian formations within the Delaware Water Gap National Recreation Area: Geological Association of New Jersey, Guidebook 4, p. 1-11.

Amsden, T.W., 1960, Stratigraphy and paleontology of the Hunton Group in the Arbuckle Mountain region. Part VI, Stratigraphy: Oklahoma Geological Survey, Bulletin 84, 311 p.

Baars, D.L., 1993, Canyonlands country: Salt Lake City, University of Utah Press, 138 p.

Baars, D.L., 2010, Geology of Canyonlands National Park, Utah; *in* Sprinkel, D.A., Chidsey, T.C., Jr., and Anderson, P.B., eds., Geology of Utah's parks and monuments (3rd edition): Salt Lake City, Utah Geological Association, Publication 28, p. 61-83.

Bell, G.L., Jr., 2014, Paleontological inventory at Great Basin National Park, Nevada: Dakoterra, v. 6, p. 24-25.

Billingsley, G.H. and McKee, E.D., 1982, Pre-Supai buried valleys: U.S. Geological Survey, Professional Paper 1173, p. 137-153.

Brezinski, D.K., 1992, Permian trilobites from west Texas: Journal of Paleontology, v. 66, p. 924-943.

Brezinski, D.K., 1996, Stratigraphy of the Elbrook Formation (Middle to Upper Cambrian) in Maryland and adjacent states; *in* Brezinski, D.K. and Reger, J.P., eds., Studies in Maryland Geology–In Commemoration of the Centennial of the Maryland Geological Survey: Baltimore, Maryland Geological Survey, Special Publication 3, p. 165-186.

Brezinski, D.K., Repetski, J.E. and Taylor, J.F., 1999, Stratigraphic and paleontologic record of the Sauk III regression in the central Appalachians; *in* Santucci, V.L., and McClelland, L., eds., National Park Service Paleontological Research Volume 4: Denver, National Park Service, Technical Report NPS/NRGRD/GRDTR-99/03, p. 32-41.

Briggs, D.E.G. and Mount, J.D., 1982, The occurrence of the giant arthropod *Anomalocaris* in the Lower Cambrian of southern California, and the overall distribution of the genus: Journal of Paleontology, v. 56, p. 1112-1118.

Campbell, K.S.W., 1967, Trilobites of the Henryhouse Formation (Silurian) in Oklahoma: Oklahoma Geological Survey, Bulletin 115, 68 p.

Campbell, K.S.W., 1977, Trilobites of the Haragan, Bois d'Arc and Frisco formations (Early Devonian), Arbuckle Mountains region, Oklahoma: Oklahoma Geological Survey, Bulletin 123, 227 p.

Churkin, M., Jr. and Brabb, E.E., 1965, Ordovician, Silurian, and Devonian biostratigraphy of east-central Alaska: AAPG Bulletin, v. 49, p. 172-185.

Churkin, M., Jr. and Brabb, E.E., 1967, Devonian rocks of the Yukon-Porcupine Rivers area and their tectonic relation to other Devonian sequences in Alaska; *in* International Symposium on the Devonian System, Volume 2: Calgary, Alberta Society of Petroleum Geologists, p. 227-258.

Cisne, J.L., 1971, Paleoecology of trilobites of the Kaibab limestone (Permian) in Arizona, Utah, and Nevada: Journal of Paleontology, v. 45, p. 525-533.

Clarke, J.M., 1897, The Lower Silurian trilobites of Minnesota; *in* Winchell, N.H., Geology of Minnesota: Minneapolis, Minnesota Geological and Natural History Survey, Final Report, v. 3, p. 694-759.

Clites, E.C. and Santucci, V.L., 2010, Preliminary paleontological resource field survey—Chesapeake and Ohio Canal National Historical Park: Fort Collins, National Park Service, Natural Resource Report NPS/NRPC/NRR—2010/197.

Colvin, J.M. and Marcher, M.V., 1964, Geologic map of the Gordonsburg Quadrangle, Tennessee: Nashville, Tennessee Division of Geology, geologic map GM 50-SW, scale 1:24,000.

Cooper, J.D., Miller, R.H. and Sundberg, F.A., 1982, Environmental stratigraphy of the lower part of the Nopah Formation (Upper Cambrian), southwestern Great Basin; *in* Cooper, J.D., Troxel, B.W. and Wright, L.A., eds., Geology of Selected Areas in the San Bernardino Mountains, Western Mojave Desert and Southern Great Basin, California: Shoshone, Death Valley Publishing Company, p. 97-114.

Darton, N.H., 1904, Comparison of the stratigraphy of the Black Hills, Bighorn Mountains, and Rocky Mountain Front Range: Geological Society of America Bulletin, v. 15, p. 379-448.

Darton, N.H. 1906. Geology of the Bighorn Mountains: Washington, D.C., U.S. Geological Survey, Professional Paper 51, 129 p.

Davis, N.R., 2010, Sequence stratigraphy of the Lower Pennsylvanian (Bashkirian, Morrowan) Round Valley Limestone, Split Mountain anticline (Dinosaur National Monument) and in the eastern Uinta Mountains, Utah [M.S. thesis]: Provo, Brigham Young University, 137 p.

Deiss, C.F., 1936, Revision of type Cambrian formations and sections of Montana and Yellowstone National Park: Geological Society of America Bulletin, v. 47, p. 1257-1342.

Delo, D.M., 1940, Phacopid trilobites of North America: Boulder, Geological Society of America, Special Paper 29, 135 p.

Denny, C.S. and Drewes, H., 1965, Geology of the Ash Meadows Quadrangle, Nevada-California: U.S. Geological Survey, Bulletin 1181-L, 56 p.

Diehl P.E., 1979, The stratigraphic, depositional environments, and quantitative petrography of the Precambrian-Cambrian Wood Canyon Formation, Death Valley [Ph.D. dissertation]: University Park, Pennsylvania State University, 430 p.

Drewes, H.D., 1981, Tectonics of southeastern Arizona: U.S. Geological Survey, Professional Paper 1144, 96 p.

Drewes, H. and Palmer, A.R., 1957, Cambrian rocks of southern Snake Range, Nevada: AAPG Bulletin, v. 41, p. 104-120.

Drewes, H.D., 1977, Geologic map and sections of the Rincon Valley Quadrangle, Pima County, Arizona: U.S. Geological Survey, Miscellaneous Investigations Series Map 997, scale 1:48,000.

Dutro, J.T., Jr., 1955, Field Locality 51ASa210. Alaska Paleontological Database, E and R Reports, Report on Referred Fossils, http://www.alaskafossil.org/.

Dutro, J.T., Jr., 1973, Field Locality 72JP-1b. Alaska Paleontological Database, E and R Reports, Report on Referred Fossils, http://71.56.149.174/Paleoweb/Public/RefDetail.aspx?ref_id=569.

Dutro, J.T., Jr., 1976, Field Locality 75ANs71C and 75AR67. Alaska Paleontological Database, E and R Reports, Report on Referred Fossils, http://www.alaskafossil.org/.

Dutro, J.T., Jr., Palmer, A.R., Repetski, J. and Brosge, W.P., 1984, Middle Cambrian fossils from the Doonerak Anticlinorium, central Brooks Range, Alaska: Journal of Paleontology, v. 58, p. 1364-1371.

Elder, W.P, Santucci, V.L., Kenworthy, J.P., Blodgett, R.B. and McKenna, R.T.P., 2009, Paleontological Resource Inventory and Monitoring—-

Arctic Network: Fort Collins, National Park Service, Natural Resources Technical Report NPS/NRPC/NRTR-2009/276, TIC# D-157.

Epstein, J.B., 2006, Geology of Delaware Water Gap National Recreation Area, New Jersey–Pennsylvania; *in* Pazzaglia, F.J., ed., Excursions in geology and history: Field trips in the middle Atlantic states: Boulder, Geological Society of America, Field Guide 8, p. 47-63.

Fenton, C.L. and Fenton, M.A., 1939, Pre-Cambrian and Paleozoic algae: Geological Society of America Bulletin, v. 50, p. 89-114.

Firby, J.B. and Durham, J.W., 1974, Molluscan radula from earliest Cambrian: Journal of Paleontology, v. 48, p. 1109-1119.

Foerste, A.F., 1887, Notes on Illaeni: Minnesota Geological and Natural History Survey Annual Report, v. 15, p. 478-481.

Gaines, R.R., 1999, Ichnofabric and taphonomy of the Lower Cambrian Latham Shale, San Bernardino County, California: Clues for the decline of soft-bodied preservation: Geological Society of America, Abstracts with Programs, v. 31, no. 7, p. 363.

Gaines, R.R. and Droser, M.L., 2002, Depositional environments, ichnology, and rare soft-bodied preservation in the Lower Cambrian Latham Shale, east Mojave; *in* Corsetti, F.A., ed., Proterozoic-Cambrian of the Great Basin and beyond: Field trip guidebook and volume prepared for the annual Pacific Section SEPM fall field trip: Santa Fe Springs, Pacific Section, Society for Sedimentary Geology, Book 93, p. 153-164.

Girty, G.H., 1899, Devonian and Carboniferous fossils, *in* Geology of the Yellowstone National Park: U.S. Geological Survey, Monograph 32, p. 479-599.

Girty, G.H., 1908, The Guadalupian fauna: U.S. Geological Survey, Professional Paper 58, 651 p.

Glaser, G.C., 1965, Lithostratigraphy of carbonate petrology of the Viola group (Ordovician), Arbuckle Mountains, south-central Oklahoma [Ph.D. dissertation]: Norman, University of Oklahoma, 197 p.

Gordon, M., Jr., 1957, Mississippian cephalopods of northern and eastern Alaska: U.S. Geological Survey, Professional Paper 283, 61 p.

Gordon, M., Jr., 1982, Biostratigraphy of the Watahomigi Formation; *in* McKee, E.D., The Supai Group of Grand Canyon: U.S. Geological Survey, Professional Paper 1173, p. 113-125.

Haddox, C.A., and Dott, R.H., Jr., 1990, Cambrian shoreline deposits in northern Michigan: Journal of Sedimentary Petrology, v. 60, p. 697-716.

Hagadorn, J.W., Fedo, C.M. and Waggoner, B.M., 2000, Early Cambrian Ediacaran-type fossils from California: Journal of Paleontology, v. 74, p. 731-740.

Hague, A., Iddings, J.P., Weed, W.H., Walcott, C.D., Girty, G.H., Stanton, T.W. and Knowlton, F.H., 1899, Descriptive geology, petrology, petrography, and paleontology; *in* Part II of Geology of the Yellowstone National Park: U.S. Geological Survey, Monograph 32, p. 1-23.

Hall, J., 1863, Preliminary notice of the fauna of the Potsdam Sandstone: Sixteenth Annual Report of the Regents of the University of the State of New York on the Condition of the State Cabinet of Natural History, p. 119-226.

Hall, W.E., 1971, Geology of the Panamint Butte Quadrangle, Inyo County, California: U.S. Geological Survey, Bulletin 1229, 67 p.

Hanson, A.M., 1962, Cambrian system in the Big Horn Canyon area; *in* Campau, D.E., and Garrett, L., eds., Float trip: Big Horn River from Kane, Wyoming to Yellowtail dam site: Billings, Billings Geological Society, Guidebook 12, p. 51-57.

Hazzard, J.C., 1933, Notes on the Cambrian rocks of the eastern Mojave Desert, California with a paleontological report by Colin H. Crickmay: University of California Publications in Geological Science, v. 23, p. 57-78.

Hazzard, J.C. and Mason, J.F., 1936, Middle Cambrian formations of the Providence and Marble Mountains, California: Geological Society of America Bulletin, v. 47, p. 229-240.

Hazzard, J.C., 1954, Rocks and structures of the northern Providence Mountains, San Bernardino, California: Chapter 4 "Structural features"; *in* Geology of Southern California: Sacramento, California Division of Mines and Geology, Bulletin 170, p. 27-35.

Herr, R.G. Picard, M.D., and Evans, S.H., Jr., 1982, Age and depth of burial, Cambrian Lodore Formation, northeastern Utah and northwestern Colorado: Contributions to Geology, v. 21, p. 115-121.

Hewett, D.F., 1956, Geology and mineral resources of the Ivanpah Quadrangle, California and Nevada: U.S. Geological Survey Professional Paper 274, 172 p.

Holland, S. M. and M. E. Patzkowsky. 1999. An unusual occurrence of sponges from the upper Ordovician of the Nashville Dome, Tennessee. Geological Society of America, Abstracts with Programs v. 31, p. 21.

Holmes, W.H., 1883, Report on the geology of the Yellowstone National Park: United States Geological and Geographical Survey Annual Report, v. 12 (part 2), p. 1-57.

Hunt, C.B., 1975, Death Valley: geology, ecology, and archaeology: Berkeley, University of California Press, 234 p.

Hunt, R.K., Kenworthy, J.P. and Santucci, V.L., 2008, Paleontological resource inventory and monitoring—Great Lakes Network: Fort Collins, National Park Service, Natural Resource Technical Report NPS/NRPC/NRTR—2008/120. TIC# D-65.

KellerLynn, K., 2008, Guadalupe Mountains National Park geologic resource evaluation report: Denver, National Park Service, Natural Resource Report NPS/NRPC/GRD/NRR—2008/023, TIC# D-181.

KellerLynn, K., 2009, Wind Cave National Park geologic resources inventory report: Denver, National Park Service, Natural Resource Report NPS/NRPC/GRD/NRR—2009/087.

Kenworthy, J.P. and Santucci, V. L., 2004, Paleontological resource inventory and monitoring—National Capital Region: Denver, National Park Service, TIC# D-289.

Kobayashi, T., 1935, The Briscoia fauna of the Late Upper Cambrian in Alaska with descriptions of a few Upper Cambrian trilobites from Montana and Nevada: Japanese Journal of Geology and Geography, v. 12, p. 39-57.

Koch, A.L. and Santucci, V.L., 2004, Paleontological resource inventory and monitoring—Eastern Rivers and Mountains Network: Denver, National Park Service, TIC# D-265.

Lieberman, B.S., 1999, Systematic revision of the Olenelloidea (Trilobita, Cambrian): Bulletin of the Yale University Peabody Museum of Natural History, v. 45, 150 p.

Lieberman, B.L., 2001, Phylogenetic analysis of the Olenellina Walcott, 1890 (Trilobita, Cambrian): Journal of Paleontology, v. 75, p. 96-115.

Lochman, C.L. and Duncan, D., 1944, Early Upper Cambrian faunas of central Montana: Geological Society of America, Special Paper 54, 181 p.

Longwell, C.R., 1928, Geology of the Muddy Mountains, Nevada, with a section through the Virgin Range to the Grand Wash Cliffs, Arizona: U.S. Geological Survey Bulletin 798, 152 p.

Loope, D.B. and Kuntz, G.B., 1987, Evaporite growth within marine limestones of the upper member of the Hermosa Formation (Pennsylvanian), Cataract Canyon, southeastern Utah; *in* Campbell, J.A., ed., Geology of Cataract Canyon and vicinity: Durango, Four Corners Geological Society, Field Symposium Guidebook 10, p. 75-80.

Love, J.D. and Reed, J.C., Jr., 1968, Creation of the Teton landscape: The geologic story of Grand Teton National Park: Moose, Grand Teton Natural History Association.

Mason, J.F., Longwell, C.R. and Hazzard, J.C., 1937, Sequence of Cambrian faunas in the southern Great Basin: Proceedings of the Paleontological Society 1936, Titles and Abstracts of Papers, p. 366-367.

McAllister, J.F., 1974, Geology of the Borate Area, Death Valley, Inyo County, California; *in* Guidebook: Death Valley region, California and Nevada, prepared for the 70th annual meeting of the Cordilleran Section, the Geological Society of America, field trip number 1: Shoshone, Death Valley Publishing Co., p. 84-90.

McKee, E.D., 1982, The Supai Group of Grand Canyon: U.S. Geological Survey, Professional Paper 1173, 504 p.

McKee, E.H. and Gangloff, R.A., 1969, Stratigraphic distribution of archaeocyathids in the Silver Peak range and the White and Inyo mountains, western Nevada and eastern California: Journal of Paleontology, v. 43, p. 716-726.

McKee, E.D. and Gutschick, R.C., 1969, History of the Redwall Limestone of northern Arizona: Geological Society of America Memoir 114, 726 p.

McKee, E.D. and Resser, C.E., 1945, Cambrian history of the Grand Canyon region: Carnegie Institution of Washington, Publication 563, 232 p.

McKnight, E.T., 1940, Geology of area between Green and Colorado Rivers, Grand and San Juan counties, Utah: U.S. Geological Survey, Bulletin 908, 147 p.

Meek, F.B., 1873, Preliminary paleontological report, consisting of lists of fossils, with remarks on the ages of the rocks in which they were found: U.S. Geological Survey of the Territories, 6th Annual Report, p. 429-518.

Melton, R.A., 1972, Paleoecology and paleoenvironment of the upper Honaker Trail Formation near Moab, Utah: Brigham Young University Research Studies, Geology Series, v. 19, p. 45-88.

Middleton, L.T. and Elliot, D.K., 1990, Tonto Group; *in* Beus, S.S., and Morales, M., eds., Grand Canyon Geology: Flagstaff, Museum of Northern Arizona Press, p. 83-106.

Miller, B.M., 1936a, Cambrian stratigraphy of northwestern Wyoming: Journal of Geology, v. 44, p. 113-144.

Miller, B.M., 1936b, Cambrian trilobites from northwestern Wyoming: Journal of Paleontology, v. 10, p. 23-34.

Miller, J.F., Ethington, R.L. and Rosé, R., 2006, Stratigraphic implications of lower Ordovician conodonts from the Munising and Au Train Formations at Pictured Rocks National Lakeshore, Upper Peninsula of Michigan:

Palaios, v. 21, p. 227-237.

Milstein, R.C. 1987. Pictured Rocks National Lakeshore, northern Michigan; *in* Biggs, D.L., ed., Centennial Field Guide – North-central section: Boulder, Geological Society of America, p. 277-280.

Mississippi National River & Recreation Area, 2015, Twin Cities Geology. Retrieved 27 August 2015, from http://www.nps.gov/miss/learn/nature/twingeol.htm

Mount, J.D., 1974, Biostratigraphy of the Lower Cambrian in southeastern California: Geological Society of America, Abstracts with Programs, v. 6, no. 3,p. 224.

Mount, J.D., 1976, Early Cambrian faunas from eastern San Bernardino County, California: Bulletin of the Southern California Paleontological Survey, v. 8, p. 173-182.

Mount, J.D., 1980a., Characteristics of Early Cambrian faunas from eastern San Bernardino County, California: Southern California Paleontological Society Special Publication, no. 3, p. 52-62.

Mount, J.D., 1980b, Paleontological tour of the Mojave Desert, California-Nevada: Southern California Paleontological Society Special Publications, no. 2, p. 1-29.

Nelson, C.A., 1951, Cambrian trilobites from the St. Croix Valley: Journal of Paleontology, v. 25, p. 765-784.

Nelson, C.A., 1976, Late Precambrian-Early Cambrian stratigraphic and faunal succession of eastern California and the Precambrian-Cambrian boundary; *in* Moore, J., and Fritsche, E., eds., Depositional environments of Lower Paleozoic rocks in the White-Inyo Mountains, Inyo County, California: Los Angeles, Pacific Coast Paleontology Field Guide 1, p. 31-32.

Neuman, R.B., 1947, Notes on the Geology of Cades Cove, Great Smoky Mountains National Park, Tennessee: Journal of the Tennessee Academy of Science, v. 22, p. 167-172.

Nolan, T.B., Merriam, C.W., and Williams, J.S., 1956, The stratigraphic section in the vicinity of Eureka, Nevada: U.S. Geological Survey, Professional Paper 276, 77 p.

Nyborg, T.G., and Santucci, V.L., 1999, The Death Valley National Park paleontological survey: Fort Collins, National Park Service, Geological Resources Technical Report, NPS/NRGRD?GRDTR-99/01.

Ormiston, A.R., 1969, The trilobite Koneprusia in the Lower Devonian of Alaska: Journal of Paleontology, v. 43, p. 1210-1212.

Ormiston, A.R., 1975, Siegenian trilobite zoogeography in arctic North America: Fossils and Strata, v. 4, p. 391-398

Owen, D.D., 1852, Report of a geological survey of Wisconsin, Iowa, and Minnesota; and incidentally of a portion of Nebraska Territory: Philadelphia, Lippincott, Grambo & Co., 638 p.

Palmer, A.R., 1960, Trilobites of the Upper Cambrian Dunderberg shale, Eureka district, Nevada: U.S. Geological Survey, Professional Paper 334-C, 56 p.

Palmer, A.R., 1965, Trilobites of the Late Cambrian pterocephaliid biomere in the Great Basin, United States: U.S. Geological Survey, Professional Paper 493, 106 p.

Palmer, A.R., 1968, Cambrian trilobites of east-central Alaska: U.S. Geological Survey, Professional Paper 559-B, 115 p.

Palmer, A.R., and Halley, R.B., 1979, Physical stratigraphy and trilobite biostratigraphy of the Carrara Formation (Lower and Middle Cambrian) in the southern Great Basin: U.S. Geological Survey, Professional Paper 1047, 131 p.

Palmer, A.R. and Nelson, C.A., 1981, Lower and Middle Cambrian stratigraphy and paleontology of the southern Great Basin, California and Nevada; *in* Taylor, M.E. and Palmer, A.R., eds., Cambrian Stratigraphy and Paleontology of the Great Basin and Vicinity, Western United States: U.S. Geological Survey, Second International Symposium on the Cambrian System, Guidebook for Field trip, no. 1, p. 1-10.

Reed, B.L. and Nelson, S.W., 1980, Geologic map of the Talkeetna quadrangle, Alaska: U.S. Geological Survey, Miscellaneous Investigations Series Map I-1174, p. 1-15, scale 1:250,000.

Repetski, J., 1997, Paleozoic fossils in Cades Cove, Great Smoky Mountains National Park, Tennessee and North Carolina: U.S. Geological Survey, Open-File Report 97-747, 12 p.

Resser, C.E., 1935, Nomenclature of some Cambrian trilobites: Smithsonian Miscellaneous Collections, v. 93, no. 5.

Resser, C.E., 1937, Third contribution to nomenclature of Cambrian trilobites: Smithsonian Miscellaneous Collections, v. 95, no. 22.

Resser, C.E., 1938, Fourth contribution to nomenclature of Cambrian fossils: Smithsonian Miscellaneous Collections, v. 97, no. 10.

Resser, C.E., 1942a, Fifth contribution to nomenclature of Cambrian fossils: Smithsonian Miscellaneous Collections, v. 101, no. 15.

Resser, C.E., 1942b, New Upper Cambrian trilobites: Smithsonian Miscellaneous Collections, v. 103, no. 5.

Resser, C.E., 1945, Cambrian fossils of the Grand Canyon, *in* McKee, E.D., and Resser, C.E., Cambrian history of the Grand Canyon region: Carnegie Institution of Washington, Publication 563, p. 169-220.

Robison, R.A., 1982, Some Middle Cambrian agnostoid trilobites from western North America: Journal of Paleontology, v. 56, p. 132-160.

Ross, R.J., Jr., 1964, Middle and Lower Ordovician formations in southernmost Nevada and adjacent California: U.S. Geological Survey, Bulletin 1180-C, 101 p.

Ross, R.J., Jr., and Barnes, H., 1967, Some Middle Ordovician brachiopods and trilobites from the Basin Ranges, western United States: U.S. Geological Survey, Professional Paper 523-D, 43 p.

Ruppel, E.T., 1972, Geology of pre-Tertiary rocks in the northern part of Yellowstone National Park, Wyoming: U.S. Geological Survey, Professional Paper 729-A, 65 p.

Saltzman, M.R., 1999, Upper Cambrian carbonate platform evolution, Elvinia and Taenicephalus zones (pterocephaliid-ptychaspid biomere boundary), northwestern Wyoming: Journal of Sedimentary Research, v. 69, p. 926-938.

Sando, W.J., 1957, Beekmantown Group (Lower Ordovician) of Maryland: Boulder, Geological Society of America, Memoir 68, 161 p.

Santucci, V.L., 1998, The Yellowstone Paleontological Survey: Yellowstone National Park, Yellowstone Center for Resources, National Park Service, YCR-NR-98-1.

Santucci, V.L., Kenworthy, J. and Kerbo, R., 2001, An Inventory of Paleontological Resources Associated with National Park Service Caves: Fort Collins, National Park Service, Geologic Resources Division, Technical Report NPS/NRGRD/GRDTR-01/02.

Santucci, V.L. and Koch, A.L., 2003, Paleontological resource monitoring strategies for the National Park Service: Park Science, v. 22, p. 22-25.

Santucci, V.L., Koch, A.L. and Kenworthy, J., 2004, Paleontological resource inventory and monitoring—Mojave Desert Network: Fort Collins, National Park Service, National Park Service Report TIC#D-305.

Santucci, V.L., Kenworthy, J.P. and Visaggi, C.C., 2007, Paleontological resource inventory and monitoring—Chihuahuan Desert Network: Fort Collins, National Park Service, National Park Service Report TIC# D-500.

Santucci, V.L., McKenna, R.T.P., Kenworthy, J.P. and Connors, T., 2008, Paleontological resource inventory and monitoring—Appalachian Highlands Network: Fort Collins, National Park Service, Natural Resource Technical Report NPS/NRPC/NRTR—2008/080.

Santucci, V.L. and Kirkland, J.I., 2010, An overview of National Park Service paleontological resources from the parks and monuments in Utah; *in* Sprinkel, D.A., Chidsey, T.C., Jr., and Anderson, P.B., eds., Geology of Utah's Parks and Monuments (3rd edition): Salt Lake City, Utah Geological Association, Publication 28, p. 565-599.

Santucci, V.L., Blodgett, R., Elder, W.P. and Kenworthy, J.P., 2011, Paleontological resource inventory and monitoring—Central Alaska Network: Fort Collins, National Park Service, Natural Resource Technical Report NPS/NRPC/NRTR—2011/510.

Sawin, R.S., and West, R.R., 2008, Lithology and paleontology of the stratigraphic units cropping out at the Tallgrass Prairie National Preserve, Chase County, Kansas: Lawrence, Kansas Geological Survey, Open-file Report 2008-15, unpaginated.

Schleh, E.E., 1966, Stratigraphic section of Toroweap and Kaibab formations in Parashant Canyon, Arizona: Arizona Geological Society Digest, v. 8, p. 57–64.

Seiple, E., 1984, Fossils and formations of the Lower Cambrian type Waucoban Section: California Geology, v. 37, p. 149-153.

Shumard, B.F., 1858, Notice of new fossils from the Permian strata of Texas and New Mexico, collected by Dr. George G. Shumard, geologist of the United States Government Expedition for obtaining water by means of artisan wells along the 32d parallel, under the direction of Capt. John Pope, U. S. Corps Top. Eng.: Transactions of the Academy of Science of St. Louis, v. 1, p. 290-297.

Shumard, B.F., 1862, Notice of some new and imperfectly known fossils from the Primordial Zone (Potsdam Sand Group) of Wisconsin and Missouri: Transactions of the Academy of Science of Saint Louis, v. 2, p. 101-107.

Shumard, B.F. and Swallow, G.C., 1858, Descriptions of new fossils from the Coal Measures of Missouri and Kansas: Transactions of the Academy of Science of St. Louis Academy, v. 1, p. 198-227.

Southworth, C.S., Brezinski, D.K., Orndorff, R.C., Chirico, P.G. and Lagueux, K.M., 2001, Geology of the Chesapeake and Ohio Canal National Historical Park and Potomac River Corridor, District of Columbia, Maryland, West Virginia, and Virginia: U.S. Geological Survey, Open File Report 01-188, unpaginated.

Southworth, S., Brezinski, D.K., Orndorff, R.C., Repetski, J.E. and Denenny, D.M., 2008, Geology of the Chesapeake and Ohio Canal National Historical Park and Potomac River Corridor, District of Columbia, Maryland, West

Virginia, and Virginia: U.S. Geological Survey, Professional Paper 1691, 144 p.
Stauffer, C.R. and Thiel, G.A., 1941, The Paleozoic and related rocks of southeastern Minnesota: Minnesota Geological Survey, Bulletin 29, 261 p.
Stanley, T.M., 2001, Stratigraphy and facies relationships of the Hunton Group, northern Arbuckle Mountains and Lawrence Uplift, Oklahoma: Oklahoma Geological Survey, Guidebook 33, 73 p.
Stitt, J.H., 1998, Trilobites from the Cedarina dakotaensis zone, lowermost part of the Deadwood Formation (Marjuman Stage, Upper Cambrian), Black Hills, South Dakota: Journal of Paleontology, v. 72, p. 1030-1046.
Sundberg, F.A., 1983, Distortion Factor of Latham Shale trilobites: Southern California Paleontological Society Special Publications No. 3, p. 63-66.
Sundberg, F.A., 1994, Corynexochida and Ptychopariida (Trilobita, Arthropoda) of the Ehmaniella Biozone (Middle Cambrian), Utah and Nevada: Contributions in Science, v. 446, 137 p.
Swallow, G.C. and Hawn, F., 1858, The rocks of Kansas, with descriptions of new Permian fossils by G. C. Swallow: Transactions of the Academy of Science of St. Louis Academy, v. 1, p. 173-197.
Swanson, B.A., Santucci, V.L., Madsen, S.K., Elder, A.S. and Kenworthy, J.P., 2005, Arches National Park paleontological survey: Denver, National Park Service, National Park Service, Geologic Resources Division, Technical Report NPS/NRGRD/GRDTR—05/01.
Thornberry-Ehrlich, T., 2005, Antietam National Battlefield, Chesapeake and Ohio Canal National Historical Park, Harpers Ferry National Historical Park—Geologic resource evaluation report: Denver, National Park Service, Geologic Resources Division, Natural Resource Report NPS/NRPC/GRD/NRR 2005/006.
Tracy, K.H., Wall, W.P., Mead, A.J., and Santucci, V.L., 2002, Paleontological survey of Grand Teton National Park: University of Wyoming National Park Service Research Center Annual Report, v. 26, article 2.
Tweet, J.S., 2014, Paleontology of Mississippi National River and Recreation Area: Fort Collins, National Park Service, Natural Resource Report NPS/MISS/NRR—2014/888.
Tweet, J., Santucci, V.L. and Kenworthy, J.P., 2008, Paleontological resource inventory and monitoring—Sonoran Desert Network:Fort Collins, National Park Service, Natural Resource Technical Report NPS/NRPC/NRTR—2008/130. TIC# D-58.
Tweet, J.S., Santucci, V.L., Kenworthy, J.P. and Mims, A.L., 2009, Paleontological resource inventory and monitoring—Southern Colorado Plateau Network: Fort Collins, National Park Service, Natural Resource Technical Report NPS/NRPC/NRTR—2009/245.
Tweet, J.S., Santucci, V.L., Connors, T., and Kenworthy, J.P., 2012, Paleontological resource inventory and monitoring—Northern Colorado Plateau Network: Fort Collins, National Park Service, Natural Resource Technical Report NPS/NCPN/NRTR—2012/585.
Tweet, J.S., Santucci, V.L. and Connors, T., 2013, Paleontological resource inventory and monitoring—Greater Yellowstone Network: Fort Collins, National Park Service, Natural Resource Report NPS/GRYN/NRTR—2013/794.
Tweet, J.S., Santucci, V.L. and Connors, T., 2015, Paleontological resource inventory and monitoring—Southern Plains Network: Fort Collins, National Park Service, Natural Resource Report NPS/SOPN/NRR—2015/971.
Ulrich, E.O. and Resser, C.E., 1930, The Cambrian of the upper Mississippi Valley: Part 1, Trilobita; Dikelocephalinae and Osceolinae: Milwaukee Public Museum Bulletin, v. 12, p. 1-122.
Ulrich, E.O. and Resser, C.E., 1933, The Cambrian of the upper Mississippi Valley: Part 2, Trilobita; Saukiinae: Milwaukee Public Museum Bulletin, v. 12, p. 123-306.
Unrug, R. and Unrug, S., 1990, Paleontological evidence of Paleozoic age for the Walden Creek Group, Ocoee Supergroup, Tennessee: Geology, v. 18, p. 1041-1045.
Untermann, G.E. and Untermann, B.R., 1949, Geology of Green and Yampa River Canyons and vicinity, Dinosaur National Monument, Utah and Colorado: Bulletin of the American Association of Petroleum Geologists, v. 33, p. 683-694.
Untermann, G.E. and Untermann, B.R., 1954, Geology of Dinosaur National Monument and vicinity, Utah-Colorado: Salt Lake City, Utah Geological and Mineralogical Survey, Bulletin 42, 228 p.
Walcott, C.D., 1890, Description of new forms of Upper Cambrian fossils: Proceedings of the United States National Museum, v. 13, p. 267-279.
Walcott, C.D., 1895, Lower Cambrian rocks in eastern California: American Journal of Science, v. 49, p. 142-144.
Walcott, C.D., 1899, Cambrian fossils, *in* Geology of the Yellowstone National Park: U.S. Geological Survey, Monograph 32, p. 440-478.
Walcott, C.D., 1908, Cambrian sections of the Cordilleran area: Smithsonian Miscellaneous Collections, v. 53, p. 167-230.
Walcott, C.D., 1914, Cambrian geology and paleontology II. No. 13. *Dikelocephalus* and other genera of the Dikelocephalinae: Smithsonian Miscellaneous Collections, v. 57, p. 345-413.
Walcott, C.D., 1916a, Cambrian geology and paleontology III. Cambrian trilobites: Smithsonian Miscellaneous Collections, v. 64, p. 157-258.
Walcott, C.D., 1916b, Cambrian geology and paleontology II. Cambrian trilobites: Smithsonian Miscellaneous Collections, v. 64, p. 303-570.
White, C.A., 1876, Invertebrate paleontology of the Plateau province, together with notice of a few species from localities beyond its limits in Colorado; *in* Powell, J.W., Report on the geology of the eastern portion of the Uinta Mountains and a region of country adjacent thereto: U.S. Geological and Geographical Survey of the Territories, p 74-135.
Whitebread, D.H., 1969, Geologic map of the Wheeler Peak and Garrison quadrangles, Nevada and Utah: U.S. Geological Survey, Miscellaneous Geologic Investigations Map 578, scale 1:48,000.
Whitfield, R.P., 1882, Paleontology, *in* Geology of Wisconsin, v. 4(3): Madison, Wisconsin Geological Survey, p. 161-163.
Wilson, J.L., 1951, Franconian trilobites of the central Appalachians: Journal of Paleontology, v. 25, p. 617-654.
Witkind, I.J., 1969, Geology of the Tepee Creek Quadrangle, Montana-Wyoming: Washington, D.C., U.S. Geological Survey, Professional Paper 609, 101 p.
Yochelson, E.L. and J.T. Dutro,(1976). Field Locality 80-S-494. Alaska Paleontological Database, E and R Reports, Report on Referred Fossils, http://www.alaskafossil.org

APPENDIX 1. Confirmed trilobite holotype specimens from NPS areas. The taxon column presents the original name used; because taxonomy is subjective and under constant revision, names will vary from source to source. Repositories: Geological Survey of Canada (GSC); United States National Museum (USNM); Montana State University Museum (MSUM); Grand Canyon National Park Museum (GCNPM); Yale Peabody Museum (YPM); Los Angeles County Museum Invertebrate Paleontology (LACMIP).

| NPS SYSTEM | TAXON | Provenance (Formation, Time) | FORMATION | TIME | PUBLICATION | CATALOG NUMBER |
|---|---|---|---|---|---|---|
| ANTI | *Crepichilella antietamensis* | *CONOCOCHEAGUE, CAMBRIAN* | CONOCOCHEAGUE | CAMBRIAN | Wilson 1951 | YPM 18596 |
| ANTI | *Stigmacephalus*? *distorta* | *CONOCOCHEAGUE, CAMBRIAN* | CONOCOCHEAGUE | CAMBRIAN | Wilson 1951 | YPM 18593 |
| DEVA | *Nevadia fritzi* | *POLETA, CAMBRIAN* | POLETA | CAMBRIAN | Lieberman 2001 | LACMIP 26887 |
| DEVA | *Morosa brevispina* | *NOPAH, CAMBRIAN* | NOPAH | CAMBRIAN | Palmer 1965 | USNM 141807 |
| DEVA | *Strigambitus blepharina* | *NOPAH, CAMBRIAN* | NOPAH | CAMBRIAN | Palmer 1965 | USNM 141736 |
| DEVA | *Bristolia anteros* | *CARRARA, CAMBRIAN* | CARRARA | CAMBRIAN | Palmer 1979 | USNM 177181 |
| DEVA | *Bristolia fragilis* | *CARRARA, CAMBRIAN* | CARRARA | CAMBRIAN | Palmer 1979 | USNM 177190 |
| DEVA | *Mexicaspis radiatus* | *CARRARA, CAMBRIAN* | CARRARA | CAMBRIAN | Palmer 1979 | USNM 208141 |
| DEVA | *Mexicella grandoculus* | *CARRARA, CAMBRIAN* | CARRARA | CAMBRIAN | Palmer 1979 | USNM 208198 |
| DEVA | *Olenellus arcuatus* | *CARRARA, CAMBRIAN* | CARRARA | CAMBRIAN | Palmer 1979 | USNM 177200 |
| DEVA | *Olenellus cylindricus* | *CARRARA, CAMBRIAN* | CARRARA | CAMBRIAN | Palmer 1979 | USNM 177197 |
| DEVA | *Olenellus multinodus* | *CARRARA, CAMBRIAN* | CARRARA | CAMBRIAN | Palmer 1979 | USNM 177225 |
| DEVA | *Ptarmiganoides hexacantha* | *CARRARA, CAMBRIAN* | CARRARA | CAMBRIAN | Palmer 1979 | USNM 208156 |
| DEVA | *Syspacephalus obscurus* | *CARRARA, CAMBRIAN* | CARRARA | CAMBRIAN | Palmer 1979 | USNM 208061 |
| DEVA | *Volocephalina contracta* | *CARRARA, CAMBRIAN* | CARRARA | CAMBRIAN | Palmer 1979 | USNM 208282 |
| DEVA | *Ampyx compactus* | *ANTELOPE VALLEY, ORDOVICIAN* | ANTELOPE VALLEY | ORDOVICIAN | Ross & Barnes 1967 | USNM 145812 |
| DEVA | *Carolinites angustagena* | *ANTELOPE VALLEY, ORDOVICIAN* | ANTELOPE VALLEY | ORDOVICIAN | Ross & Barnes 1967 | USNM 145732 |
| DEVA | *Clelandia aspina* | *GOODWIN, ORDOVICIAN* | GOODWIN | ORDOVICIAN | Ross & Barnes 1967 | USNM 145867 |
| DEVA | *Clelandia bispina* | *ANTELOPE VALLEY, ORDOVICIAN* | ANTELOPE VALLEY | ORDOVICIAN | Ross & Barnes 1967 | USNM 146126 |
| DEVA | *Goniotelina hesperia* | *ANTELOPE VALLEY, ORDOVICIAN* | ANTELOPE VALLEY | ORDOVICIAN | Ross & Barnes 1967 | USNM 145794 |
| DEVA | *Illaenus auriculatus* | *ANTELOPE VALLEY, ORDOVICIAN* | ANTELOPE VALLEY | ORDOVICIAN | Ross & Barnes 1967 | USNM 145764 |
| DEVA | *Nileus hesperaffinis* | *ANTELOPE VALLEY, ORDOVICIAN* | ANTELOPE VALLEY | ORDOVICIAN | Ross & Barnes 1967 | USNM 145753 |
| DEVA | *Protocalymene mcallisteri* | *ANTELOPE VALLEY, ORDOVICIAN* | ANTELOPE VALLEY | ORDOVICIAN | Ross & Barnes 1967 | USNM 145848 |
| DEVA | *Raymondapsis vespertinus* | *ANTELOPE VALLEY, ORDOVICIAN* | ANTELOPE VALLEY | ORDOVICIAN | Ross & Barnes 1967 | USNM 145762 |
| GRCA | *Acrocephalops*? *arizonaensis* | *BRIGHT ANGEL, CAMBRIAN* | BRIGHT ANGEL | CAMBRIAN | Resser 1945 | USNM 108624 |
| GRCA | *Albertella schenki* | *BRIGHT ANGEL, CAMBRIAN* | BRIGHT ANGEL | CAMBRIAN | Resser 1945 | USNM 108583 |

| NPS SYSTEM | TAXON | Provenance (Formation, Time) | FORMATION | TIME | PUBLICATION | CATALOG NUMBER |
|---|---|---|---|---|---|---|
| GRCA | *Alokistocare althea* | *BRIGHT ANGEL, CAMBRIAN* | BRIGHT ANGEL | CAMBRIAN | Walcott 1916a | Materials including lectotype USNM 61574 |
| GRCA | *Bolaspis aemula* | *MUAV, CAMBRIAN* | MUAV | CAMBRIAN | Resser 1945 | USNM 108602a |
| GRCA | *Clavaspidella kanabensis* | *BRIGHT ANGEL / MUAV, CAMBRIAN* | BRIGHT ANGEL / MUAV | CAMBRIAN | Resser 1945 | USNM 108578a |
| GRCA | *Delaria macclintocki* | *KAIBAB, PERMIAN* | KAIBAB | PERMIAN | Cisne 1971 | GCNPM 3949 |
| GRCA | *Dolichometopus tontoensis* | *BRIGHT ANGEL, CAMBRIAN* | BRIGHT ANGEL | CAMBRIAN | Walcott 1916b | Materials including lectotype USNM 62685 |
| GRCA | *Ehmaniella arizonaensis* | *BRIGHT ANGEL, CAMBRIAN* | BRIGHT ANGEL | CAMBRIAN | Resser 1945 | USNM 108612a |
| GRCA | *Ehmaniella hebes* | *BRIGHT ANGEL OR MUAV, CAMBRIAN* | BRIGHT ANGEL OR MUAV | CAMBRIAN | Resser 1945 | USNM 108612a |
| GRCA | *Elrathia nitens* | *BRIGHT ANGEL, CAMBRIAN* | BRIGHT ANGEL | CAMBRIAN | Resser 1945 | USNM 108625 |
| GRCA | *Elrathiella? Insueta* | *BRIGHT ANGEL OR MUAV, CAMBRIAN* | BRIGHT ANGEL OR MUAV | CAMBRIAN | Resser 1945 | USNM 108621a |
| GRCA | *Glossopleura mckeei* | *BRIGHT ANGEL, CAMBRIAN* | BRIGHT ANGEL | CAMBRIAN | Resser 1935 | Materials including lectoypes USNM 62714 |
| GRCA | *Glyphaspis tecta* | *MUAV, CAMBRIAN* | MUAV | CAMBRIAN | Resser 1945 | USNM 108596a |
| GRCA | *Glyphaspis vulsa* | *BRIGHT ANGEL, CAMBRIAN* | BRIGHT ANGEL | CAMBRIAN | Resser 1945 | USNM 108595a |
| GRCA | *Glyphaspsis kwanguntensis* | *BRIGHT ANGEL OR MUAV, CAMBRIAN* | BRIGHT ANGEL OR MUAV | CAMBRIAN | Resser 1945 | USNM 108618a |
| GRCA | *Kochina? angustata* | *BRIGHT ANGEL / MUAV, CAMBRIAN* | BRIGHT ANGEL / MUAV | CAMBRIAN | Resser 1945 | USNM 108610 |
| GRCA | *Kootenia mckeei* | *BRIGHT ANGEL / MUAV, CAMBRIAN* | BRIGHT ANGEL / MUAV | CAMBRIAN | Resser 1945 | USNM 108588a |
| GRCA | *Kootenia schenki* | *MUAV, CAMBRIAN* | MUAV | CAMBRIAN | Resser 1945 | USNM 108586a |
| GRCA | *Kootenia simplex* | *BRIGHT ANGEL, CAMBRIAN* | BRIGHT ANGEL | CAMBRIAN | Resser 1945 | USNM 108591a |
| GRCA | *Pachyaspis fonticola* | *BRIGHT ANGEL, CAMBRIAN* | BRIGHT ANGEL | CAMBRIAN | Resser 1945 | USNM 108608 |
| GRCA | *Parehmania kwaguntensis* | *BRIGHT ANGEL OR MUAV, CAMBRIAN* | BRIGHT ANGEL OR MUAV | CAMBRIAN | Resser 1945 | USNM 108620a |
| GRCA | *Parehmania nitida* | *BRIGHT ANGEL OR MUAV, CAMBRIAN* | BRIGHT ANGEL OR MUAV | CAMBRIAN | Resser 1945 | USNM 108613a |
| GRCA | *Parehmania tontoensis* | *BRIGHT ANGEL, CAMBRIAN* | BRIGHT ANGEL | CAMBRIAN | Resser 1945 | USNM 108614 |
| GRCA | *Solenopleurella diligens* | *BRIGHT ANGEL / MUAV, CAMBRIAN* | BRIGHT ANGEL / MUAV | CAMBRIAN | Resser 1945 | USNM 108627a |
| GRCA | *Solenopleurella erosa* | *MUAV, CAMBRIAN* | MUAV | CAMBRIAN | Resser 1945 | USNM 108616a |
| GRCA | *Solenopleurella porcata* | *MUAV, CAMBRIAN* | MUAV | CAMBRIAN | Resser 1945 | USNM 108626a |
| GRCA | *Spencia tontoensis* | *BRIGHT ANGEL, CAMBRIAN* | BRIGHT ANGEL | CAMBRIAN | Resser 1945 | USNM 108611a |
| GRCA | *Trachycheilus typicale* | *BRIGHT ANGEL OR MUAV, CAMBRIAN* | BRIGHT ANGEL OR MUAV | CAMBRIAN | Resser 1945 | USNM 108619 |

| NPS SYSTEM | TAXON | Provenance (Formation, Time) | FORMATION | TIME | PUBLICATION | CATALOG NUMBER |
|---|---|---|---|---|---|---|
| GUMO | *Delaria antiqua (originally identified as Anisopyge?* antiqua*)* | *CUTOFF, PERMIAN* | CUTOFF | PERMIAN | Girty 1908 | Materials including syntype USNM 118169 |
| LAKE | *Elrathiella decora* | *FLOAT, CAMBRIAN* | FLOAT | CAMBRIAN | Resser 1945 | USNM 108615a |
| SACN | *Arionellus bipunctatus* | *UNCERTAIN, CAMBRIAN* | UNCERTAIN | CAMBRIAN | Shumard 1862 | Unknown |
| SACN | *Dikelocephalus minnesotensis* var. *limbatus* | *ST. LAWRENCE, CAMBRIAN* | ST. LAWRENCE | CAMBRIAN | Hall 1863 | USNM 58622 |
| SAFE | *Phillipsia major* | *TBD, PENNSYLVANIAN* | TBD | PENNSYLVANIAN | Shumard 1858 | Unknown |
| YELL | *Maryvillia aequa* | *PILGRIM, CAMBRIAN* | PILGRIM | CAMBRIAN | Duncan 1944 | MSUM T1549 |
| YELL | *Modocia yellowstonensis* | *PILGRIM, CAMBRIAN* | PILGRIM | CAMBRIAN | Duncan 1945 | MSUM T1560 |
| YELL | *Ehmania walcotti* | *MEAGHER, CAMBRIAN* | MEAGHER | CAMBRIAN | Resser 1935 | USNM 90667 |
| YELL | *Ehmania weedi* | *MEAGHER, CAMBRIAN* | MEAGHER | CAMBRIAN | Resser 1935 | USNM 35234 |
| YELL | *Idahoia wyomingensis* | *SNOWY RANGE, CAMBRIAN* | SNOWY RANGE | CAMBRIAN | Resser 1937 | USNM 35225 |
| YELL | *Tricrepicephalus yellowstonensis* | *PILGRIM, CAMBRIAN* | PILGRIM | CAMBRIAN | Resser 1937 | USNM 61523 |
| YELL | *Wilbernia walcotti* | *SNOWY RANGE, CAMBRIAN* | SNOWY RANGE | CAMBRIAN | Resser 1937 | USNM 35227 |
| YELL | *Zacanthoides weedi* | *MEAGHER, CAMBRIAN* | MEAGHER | CAMBRIAN | Resser 1937 | USNM 94345 |
| YELL | *Blountia polita* | *PILGRIM, CAMBRIAN* | PILGRIM | CAMBRIAN | Resser 1938 | USNM 96488 |
| YELL | *Semnocephalus minor* | *PILGRIM, CAMBRIAN* | PILGRIM | CAMBRIAN | Resser 1942a | USNM 102322 |
| YELL | *Taeinocephalus holmesi* | *SNOWY RANGE, CAMBRIAN* | SNOWY RANGE | CAMBRIAN | Resser 1942b | USNM 9595 |
| YELL | *Taeinocephalus speciosus* | *SNOWY RANGE, CAMBRIAN* | SNOWY RANGE | CAMBRIAN | Resser 1942b | USNM 108831a |
| YELL | *Arionellus levis* | *"GALLATIN", CAMBRIAN* | "GALLATIN" | CAMBRIAN | Walcott 1899 | USNM 35230 |
| YELL | *Liostracus parvus* | *UNSPECIFIED, CAMBRIAN* | UNSPECIFIED | CAMBRIAN | Walcott 1899 | USNM 35233 |
| YELL | *Ptychoparia penfieldi* | *"FLATHEAD", CAMBRIAN* | "FLATHEAD" | CAMBRIAN | Walcott 1899 | USNM 35231 |
| YELL | *Solenopleura? weedi* | *PILGRIM, CAMBRIAN* | PILGRIM | CAMBRIAN | Walcott 1899 | USNM 35236 |
| YUCH | *Briscoia mertiei* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Kobayashi 1935 | USNM 93057A |
| YUCH | *Briscoia robusta* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Kobayashi 1935 | USNM 93061 |
| YUCH | *Briscoia septentrionalis* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Kobayashi 1935 | USNM 93060A |
| YUCH | *Chuangiella intermedia* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Kobayashi 1935 | USNM 93054 |
| YUCH | *Hungaia(?) pacifica* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Kobayashi 1935 | Material including syntypes USNM 93066A and B |

| NPS SYSTEM | TAXON | Provenance (Formation, Time) | FORMATION | TIME | PUBLICATION | CATALOG NUMBER |
|---|---|---|---|---|---|---|
| YUCH | *Parabriscoia elegans* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Kobayashi 1935 | Material including syntypes USNM 93058A, B. and C |
| YUCH | *Parabriscoia stenorachis* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Kobayashi 1935 | USNM 93059 |
| YUCH | *Parabriscoia*(?) *tripunctata* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Kobayashi 1935 | USNM 93056 |
| YUCH | *Pseudagnostus* (*Plethagnostus*) *clarki* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Kobayashi 1935 | USNM 93062 |
| YUCH | *Tatonaspis alaskensis* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Kobayashi 1935 | USNM 93065A |
| YUCH | "*Antagmus*" *laminatus* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146704 |
| YUCH | *Aldonaia alaskensis* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146703 |
| YUCH | *Asiocephalus indigator* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | GSC 20314 |
| YUCH | *Athabaskiella ardis* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146742 |
| YUCH | *Bathyuriscus punctatus* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146737 |
| YUCH | *Bonnia tatondukensis* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146693 |
| YUCH | *Brabbia pustulomarginata* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146838 |
| YUCH | *Calodiscus nanus* | *ADAMS, CAMBRIAN* | ADAMS | CAMBRIAN | Palmer 1968 | USNM 146686 |
| YUCH | *Cernuolimbus arcticus* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146800 |
| YUCH | *Cernuolimbus longifrons* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Palmer 1968 | USNM 146793 |
| YUCH | *Cheilocephalus expansus* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Palmer 1968 | USNM 146809 |
| YUCH | *Churkinia yukonensis* | *ADAMS, CAMBRIAN* | ADAMS | CAMBRIAN | Palmer 1968 | USNM 146649 |
| YUCH | *Comanchia burlingi* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | GSC 20274 |
| YUCH | *Dinesus arcticus* | *ADAMS, CAMBRIAN* | ADAMS | CAMBRIAN | Palmer 1968 | USNM 146643 |
| YUCH | *Dunderbergia seducta* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Palmer 1968 | USNM 146775 |
| YUCH | *Elburgia disgranosa* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Palmer 1968 | USNM 146770 |
| YUCH | *Elrathia alaskensis* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146629 |
| YUCH | *Gelasene acanthinos* | *ADAMS, CAMBRIAN* | ADAMS | CAMBRIAN | Palmer 1968 | USNM 146663 |
| YUCH | *Geragnostus intermedius* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146842 |
| YUCH | *Hardyoides aspinosa* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Palmer 1968 | USNM 146780 |
| YUCH | *Homagnostus alaskensis* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Palmer 1968 | USNM 146761 |
| YUCH | *Hungaia burlingi* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | GSC 20301 |

| NPS SYSTEM | TAXON | Provenance (Formation, Time) | FORMATION | TIME | PUBLICATION | CATALOG NUMBER |
|---|---|---|---|---|---|---|
| YUCH | *Iddingsia relativa* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Palmer 1968 | USNM 146766 |
| YUCH | *Kootenia granulospinosa* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146726 |
| YUCH | *Liostracinoides? yukonensis* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146893 |
| YUCH | *Loganellus? arcus* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146859 |
| YUCH | *Modocia compressa* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146625 |
| YUCH | *Modocia transversa* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146623 |
| YUCH | *Neocobboldia spinosa* | *ADAMS, CAMBRIAN* | ADAMS | CAMBRIAN | Palmer 1968 | USNM 146670 |
| YUCH | *Ogygopsis antiqua* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146690 |
| YUCH | *Onchocephalites? versilis* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146709 |
| YUCH | *Onchocephalus profectus* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146695 |
| YUCH | *Onchonotopsis occidentalis* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146744 |
| YUCH | *Onchonotus antiqus* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146855 |
| YUCH | *Onchonotus brevifrons* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146851 |
| YUCH | *Pagetia stenoloma* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146711 |
| YUCH | *Pagetides appolinis* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146714 |
| YUCH | *Pagetides granulosus* | *ADAMS, CAMBRIAN* | ADAMS | CAMBRIAN | Palmer 1968 | USNM 146681 |
| YUCH | *Pagetides occidentalis* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146715 |
| YUCH | *Pareuloma spinosa* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | GSC 20292 |
| YUCH | *Peratagnostus hillardensis* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | GSC 20289 |
| YUCH | *Polliaxis inflata* | *ADAMS, CAMBRIAN* | ADAMS | CAMBRIAN | Palmer 1968 | USNM 146659 |
| YUCH | *Prohedinia brevifrons* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146627 |
| YUCH | *Pterocephalia constricta* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Palmer 1968 | USNM 146789 |
| YUCH | *Quebecaspis aspinosa* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Palmer 1968 | USNM 146819 |
| YUCH | *Richardsonella nuchastria* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Palmer 1968 | USNM 146873 |
| YUCH | *Richardsonella quadrispinosa* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146865 |
| YUCH | *Semisphaerocephalus latus* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146642 |
| YUCH | *Sigmocheilus? compressus* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Palmer 1968 | USNM 146803 |

| NPS SYSTEM | TAXON | Provenance (Formation, Time) | FORMATION | TIME | PUBLICATION | CATALOG NUMBER |
|---|---|---|---|---|---|---|
| YUCH | *Spencella acanthina* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | USNM 146636 |
| YUCH | *Tholifrons advena* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Palmer 1968 | USNM 146822 |
| YUCH | *Tholifrons minutus* | *JONES RIDGE, CAMBRIAN* | JONES RIDGE | CAMBRIAN | Palmer 1968 | USNM 146829 |
| YUCH | *Yukonia intermedia* | *ADAMS, CAMBRIAN* | ADAMS | CAMBRIAN | Palmer 1968 | USNM 146674 |
| YUCH | *Yupingia glabra* | *HILLARD, CAMBRIAN* | HILLARD | CAMBRIAN | Palmer 1968 | GSC 20308 |

APPENDIX 2. Trilobite holotype specimens possibly from NPS areas, however insufficient locality information limits confirmation the specimen was collected from within a NPS unit. The taxon column presents the original name used; because taxonomy is subjective and under constant revision, names will vary from source to source. Repositories: United States National Museum (USNM); American Museum of Natural History (AMNH); University of Minnesota Paleontology Collections (UMPC); Columbia University; Wisconsin State College.

| NPS SYSTEM | TAXON | Provenance (Formation, Time) | FORMATION | TIME | PUBLICATION | CATALOG NUMBER |
|---|---|---|---|---|---|---|
| GRCA | *Kootenia havasuensis* | *MUAV, CAMBRIAN* | MUAV | CAMBRIAN | Resser 1945 | USNM 108601a |
| GRCA | *Pachyaspis moorei* | *MUAV, CAMBRIAN* | MUAV | CAMBRIAN | Resser 1945 | USNM 108606a |
| MISS | *Arges wesenbergensis* var. *paulianus* | *UNCERTAIN, ORDOVICIAN* | UNCERTAIN | ORDOVICIAN | Clarke 1897 | Material including cotypes USNM 42436 |
| MISS | *Bathyurus schucherti* | *UNCERTAIN, ORDOVICIAN* | UNCERTAIN | ORDOVICIAN | Clarke 1897 | Material including cotypes USNM 43502 |
| MISS | *Cyrtometopus scofieldi* | *PLATTEVILLE, ORDOVICIAN* | PLATTEVILLE | ORDOVICIAN | Clarke 1897 | USNM 41952 |
| MISS | *Pterygometopus schmidti* | *PLATTEVILLE, ORDOVICIAN* | PLATTEVILLE | ORDOVICIAN | Clarke 1897 | Material including syntype UMPC R5084 |
| MISS | *Illaenus* (*Nileus*) *minnesotensis* | *PLATTEVILLE, ORDOVICIAN* | PLATTEVILLE | ORDOVICIAN | Foerste 1887 | Unknown |
| MISS | *Illaenus herricki* | *PLATTEVILLE, ORDOVICIAN* | PLATTEVILLE | ORDOVICIAN | Foerste 1887 | Unknown |
| MISS | *Calliops plattevillensis* | *PLATTEVILLE, ORDOVICIAN* | PLATTEVILLE | ORDOVICIAN | Ulrich &Delo 1940 | USNM 78972 |
| SACN | *Agnostus disparilis* | *UNCERTAIN, CAMBRIAN* | UNCERTAIN | CAMBRIAN | Hall 1863 | unspecified AMNH material (AMNH FI 310A-C?) |
| SACN | *Conocephalites diadematus* | *UNCERTAIN, CAMBRIAN* | UNCERTAIN | CAMBRIAN | Hall 1863 | unspecified AMNH material (AMNH FI 39160-39162, 39164-39165?) |

| NPS SYSTEM | TAXON | Provenance (Formation, Time) | FORMATION | TIME | PUBLICATION | CATALOG NUMBER |
|---|---|---|---|---|---|---|
| SACN | *Conocephalites shumardi* | *UNCERTAIN, CAMBRIAN* | UNCERTAIN | CAMBRIAN | Hall 1863 | trilobite, based on unspecified AMNH material of Marine on St. Croix and Kickapoo, WI (not in SACN); the AMNH has AMNH FI 39129 under this species from Marine |
| SACN | *Conocephalites*? *binodosus* | *UNCERTAIN, CAMBRIAN* | UNCERTAIN | CAMBRIAN | Hall 1863 | unspecified AMNH material (AMNH FI 39144A and B?) |
| SACN | *Dikelocephalus osceola* | *UNCERTAIN, CAMBRIAN* | UNCERTAIN | CAMBRIAN | Hall 1863 | unspecified AMNH material (AMNH FI 39114 and 39115?) |
| SACN | *Illaenurus quadratus* | *UNCERTAIN, CAMBRIAN* | UNCERTAIN | CAMBRIAN | Hall 1863 | unspecified AMNH material (AMNH FI 300?) |
| SACN | *Eoptychaspis cylindricus* | *FRANCONIA, CAMBRIAN* | FRANCONIA | CAMBRIAN | Nelson 1951 | Material inclufing syntypes UMPC 6554a-e |
| SACN | *Parabolinoides expansa* | *FRANCONIA, CAMBRIAN* | FRANCONIA | CAMBRIAN | Nelson 1951 | UMPC 6553a and b |
| SACN | *Parabolinoides parallela* | *FRANCONIA, CAMBRIAN* | FRANCONIA | CAMBRIAN | Nelson 1951 | UMPC 6562a |
| SACN | *Ptychaspis arcolensis* | *FRANCONIA, CAMBRIAN* | FRANCONIA | CAMBRIAN | Nelson 1951 | UMPC 6556a |
| SACN | *Stigmaspis hudsonensis* | *FRANCONIA, CAMBRIAN* | FRANCONIA | CAMBRIAN | Nelson 1951 | UMPC 6563a |
| SACN | *Taenicephalus altus* | *FRANCONIA, CAMBRIAN* | FRANCONIA | CAMBRIAN | Nelson 1951 | UMPC 6504a-c |
| SACN | *Dikelocephalus minnesotensis* | *UNCERTAIN, CAMBRIAN* | UNCERTAIN | CAMBRIAN | Owen 1852 | Material including cotypes USNM 17863 |
| SACN | *Berkeia typica* | *IRONTON, CAMBRIAN* | IRONTON | CAMBRIAN | Resser 1937 | Columbia University 22285 |
| SACN | *Wilbernia hudsonensis* | *UNCERTAIN, CAMBRIAN* | UNCERTAIN | CAMBRIAN | Resser 1937 | USNM 35228 |
| SACN | *Dikelocephalus gracilis* | *ST. LAWRENCE, CAMBRIAN* | ST. LAWRENCE | CAMBRIAN | Ulrich & Resser 1930 | Material including cotypes USNM 58606 and 71749 |