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Some Middle Cambrian Fossils of Utah

LLOYD F. GUNTHER AND VAL G. GUNTHER



*Front cover: Wheeler Shale trilobites Elrathia kingi, Drum Mountains.*  
*Inside front cover: Mass mortality of Wheeler Shale trilobites Asaphiscus wheeleri, House Range.*  
*Inside back cover: A multiple slab of the agnostid trilobite Peronopsis interstricta from the Wheeler Shale.*

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#### REPOSITORIES OF ILLUSTRATED SPECIMENS

BUR	Burnside Collection, Salt Lake City, Utah.	KU	The University of Kansas, Lawrence, Kansas.
BYU	Brigham Young University, Provo, Utah.	RF	Robert Fife Collection, Eureka, Utah.
EF	Ed Fowler Collection, Los Angeles, California.	SC	Scott Chesley Collection, Delta, Utah.
GL	Gary Locker Collection, North Hollywood, California.	UCLA	University of California at Los Angeles, Los Angeles, California.
GM	George Melloy Collection, Bethlehem, Pennsylvania.	USNM	United States National Museum of Natural History, Washington, D.C.
GUN	Gunther Collection, Brigham City, Utah.	UU	University of Utah, Salt Lake City, Utah.
HAR	Harris Collection, Delta, Utah.	WR	William Ratcliffe Collection, Orem, Utah.

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We are greatly indebted to Metta Gunther, who accompanied and aided us in most of our collecting trips and found some of the specimens illustrated.

## INTRODUCTION

Articles written about fossils found in Utah are many, but most are of a strictly technical nature and are scattered in various professional journals, monographs, and other publications spanning many decades. From Middle Cambrian strata alone, probably no less than 500 species of trilobites have been described.

We have put together this paper with the intent that it would be understood by and helpful to nonprofessional and professional alike. It is not meant to be anything approaching a complete account of the Middle Cambrian life forms of Utah; it deals with only a small fraction of the species found here, many that others are also likely to find.

This paper, in part, seeks to remedy the problem of most who study fossils: not knowing what the complete organism looked like. So many fossil descriptions are based largely on fragmented material that the reader is left wondering what the animal or plant was really like. Our illustrations consist of drawings, photographs, and brief descriptions. We hope they will provide a useful reference for identifying and studying in more detail some of these life forms.

During the past 15 years we have made collections from some of the fossiliferous Middle Cambrian rock outcrops of the state and have recovered numerous complete, articulated specimens. Many such finds are unique, especially where past descriptions have relied largely on disarticulated parts and fragments. We were therefore prompted and encouraged by others to prepare illustrations of some of the best specimens we have

discovered. To supplement our own finds, we have secured some photographs of specimens that others have collected from these same formations. We did so in order to bring together as much variety as possible from this specific time period. Specimens collected and/or photographed by others are so credited.

Although we are amateurs ourselves, our collecting and preparation of fossils stem from a strong desire to contribute something worthwhile to the knowledge of the earth's history and the life it supported in the distant past. Some of the illustrations are of type specimens we have found, and some are by others. Many species have yet to be found as complete specimens, and others may never be found whole or in an articulated condition because of the environmental conditions in which they lived and died. Many new genera and species remain to be discovered. Some of the specimens illustrated are new but are not given species names as several of them are in the process of being formally described by other authors. It is our hope that the information provided may whet the interest and enthusiasm of others to further study and explore other fossil-bearing rock exposures to add further knowledge of the earth's life history. This contribution is directed to the student, the collector, the professional—and to any interested person wishing to be informed.

Our collecting efforts have been focused principally on the following Middle Cambrian locations and formations (fig. 1):

1. Spence Shale outcrops in the Wasatch and Bear River Ranges of northern Utah, especially in the Wellsville Mountains north of Brigham City, Box Elder County.
2. Wheeler and Marjum Formations of the House Range in Millard County.
3. Wheeler and Pierson Cove Formations in the Drum Mountains, Millard County.

## THE CAMBRIAN SEAS OF UTAH AND WESTERN NORTH AMERICA

The Cambrian Period in western North America was a relatively quiet time, geologically speaking, with no major tectonic disturbances evident in the sedimentary rocks. The seas were already teeming with a great variety of life forms, which included representatives of most of the present invertebrate phyla and others that have since become extinct.

A major land area, referred to as the Canadian Shield and the Transcontinental Arch, extended southwestward from the Hudson Bay region of Canada to the south central United States throughout Early and Middle Cambrian time. The Pacific Ocean washed at the margins of this easterly elevated land mass. At that time there was no Rocky Mountain chain, but only its geological forerunner—the Cordilleran Geosyncline. This great trough ran from Lower California and extended northeastward into Utah and Idaho, then back toward the Pacific through Montana, Alberta, and Alaska.

The initial marine deposits were chiefly terrigenous quartz sands washed in from the continental interior, later to become metamorphosed into quartzite. Carbonates at this time appeared only in the westernmost areas. With the passage of time, subsidence of the land, and the transgressions of the sea

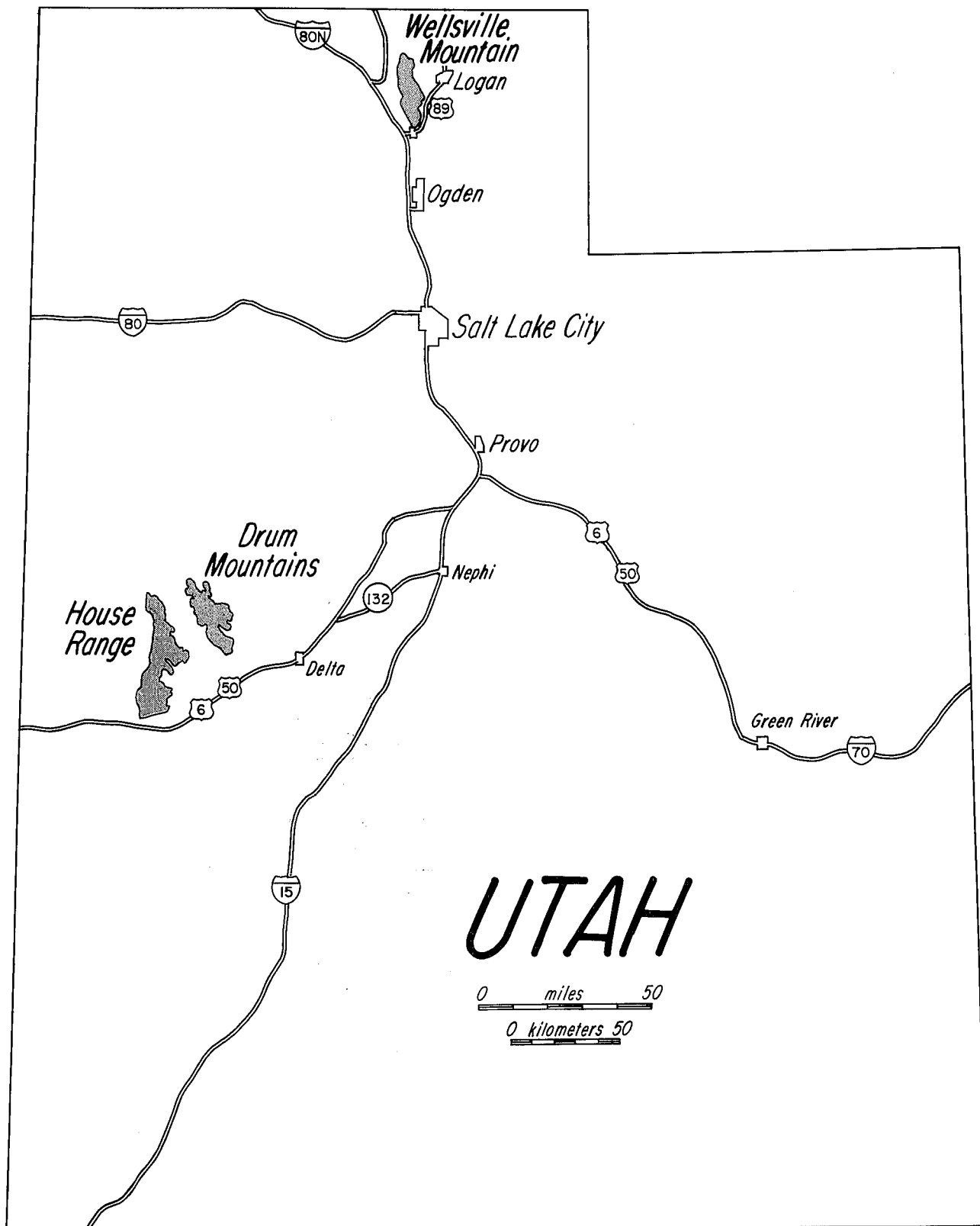


FIGURE 1.—Index map showing collection localities.

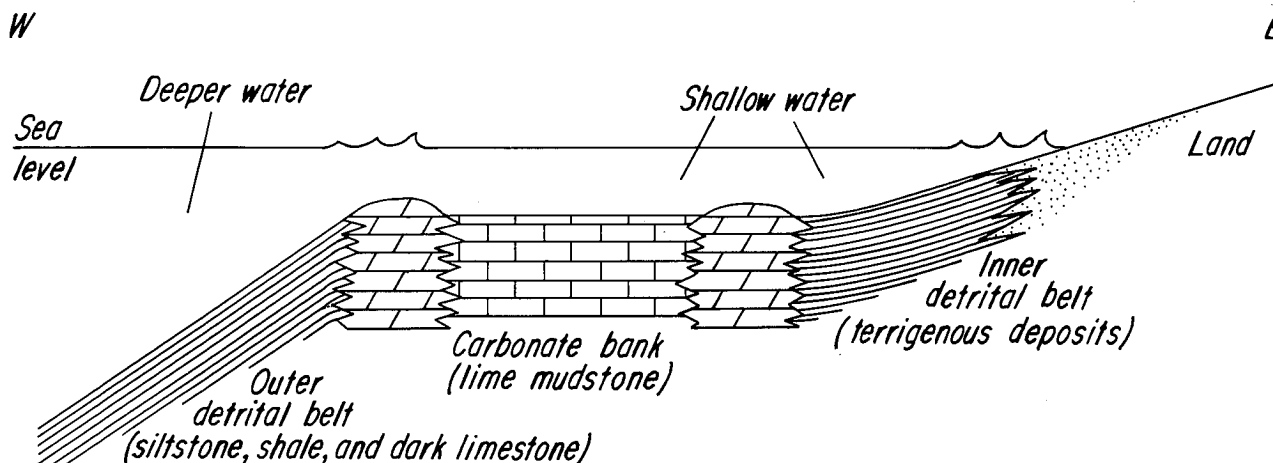


FIGURE 2.—Paleogeographic model of Cambrian depositional environments along an east-west cross section of western Utah, showing inner and outer detrital belts separated by middle carbonate bank. Not drawn to scale.

eastward, the sediments became finer and more calcareous. The land area to the east was gradually submerged during the Late Cambrian, and by the beginning of the Ordovician Period most of the United States was submerged beneath a shallow sea.

In Utah, during Middle and Late Cambrian time, a wide belt of carbonate sediments was deposited. The presence of cross-bedded oolites, algal oncoliths, stromatolites, and massive limestone and dolomites free of terrigenous material is strong evidence of rather shallow-water conditions.

According to Palmer (1960), this carbonate belt separated an inner region of shallow-water, light colored terrigenous sediments (inner detrital belt) from an outer region of deeper-water, dark-gray or black, silty and shaly sediments commonly associated with dark, thin-bedded limestone (outer detrital belt). The carbonate banks served as an effective barrier separating two major faunal regions: an inner region, including the inner bank margins and the inner detrital belt; and an outer region, including the outer bank margin and the outer detrital belt (fig. 2). These "belts" were parallel to the ancient Cambrian coastline.

Although Cambrian deposits once covered nearly all of Utah, they accumulated to a much greater thickness in the western part of the state. Water depths were probably never great as the deposition of limy muds and other sediments kept pace with subsidence. The shoreline gradually migrated eastward from Nevada all across Utah.

Utah, in Cambrian times, presented a scene vastly different from what it is today. No mountains of any significance were present. The equator is believed to have run northward near or through Utah. Seas covering the state were warm and shallow.

As a result of such favorable habitat and depositional environments, the Cambrian rock exposures of Utah do reflect a rich and diverse fauna. As might be expected, trilobites are by far the largest and most diverse group of marine organisms. Numerous species have been described, others are in the process of being described, and new ones continue to be found. Other arthropods present include a variety of phyllocarids (leaf shrimp) and merostomes. Sponges occur, sometimes in articulated form, in a variety of facies of Cambrian rocks. Brachiopods are represented by both inarticulate and articulate forms. Echinoderms, especially eocrinoids, were abundant at certain sites, where literally "gardens" of them are found in articulated condition. Other echinoderm classes are represented at several

localities. Hyolithids, possibly members of the phylum Mollusca, are common and in places are preserved with appendages (helens) attached. Even such soft-bodied organisms as annelid worms and jellyfish occur in the shales at several localities. Algal "seaweed" (green and bluegreen) is also common.

#### COLLECTING

The Earth is a vast cemetery where the rocks are the tombstones on which the buried dead have written their own epitaphs. —Louis Agassiz.

Thousands of people collect fossils and for many different reasons. Aside from professional collectors, there are those who collect out of curiosity; because of the great antiquity of fossils; or for use of them as ornaments, curios, or merely conversation pieces. Some use them for jewelry, and some even collect impulsively for no apparent reason.

Many fossils are dug up only to be buried again in kegs, sacks, and boxes often to be forgotten in sheds, garages, or other storage places. Many are later discarded or lost when the novelty of collecting or possessing has worn off. Usually such collections are stored unlabeled, and the important vital data regarding them are unknown to those who may later rediscover or possess them. From a scientific viewpoint this can be a tragedy—a loss of information that might have added to a better understanding of the earth's life forms of the long-distant past.

Of equal importance to collecting a fossil is the careful recording of as much vital information concerning it as possible: when and by whom it was found, where it was collected: the precise location, the formation and its stratigraphic position, its orientation, and any other data that might be important. With such labeling information attached to the specimen, amateur collectors can make a real and significant contribution to science. Identification and names can be applied later.

Even with proper collecting and recording of data, it is most important that the specimens be evaluated by the scientific community. Amateur collectors can share their finds and information with professionals at the various universities and other educational institutions. This cooperation can lead to important discoveries and thereby contribute a wealth of information. In Utah, collectors are encouraged to share their discovery information with the state paleontologist. Collecting on state lands in Utah by anyone requires a permit issued by the Paleontology Branch, Antiquities Section, Division of State History, Salt Lake City, Utah 84102. Similarly, many federal



FIGURE 3.—Long crowbar is effective in prying apart shale and limestone slabs in the Marjum Formation.

agencies require permits or other permission to collect on lands in their custody. The responsible collector knows the rules and applies them to his or her hobby.

The professional collector or knowledgeable amateur is always aware of the need to assemble and preserve every scrap of information related to a fossil, from its acquisition to its storage or exhibit. A suggested procedure follows:

1. Using an appropriate map or air photo, note the exact geographic position of the fossil locality and the distance logged from the nearest town, intersection, or prominent physiographic feature.
2. Prepare photos, sketches, and/or notes to record the exact stratigraphic position of the fossil occurrence.



FIGURE 4.—Tools used in quarrying trilobites and phyllocarids in interbedded shale and limestone layers of the Marjum Formation.

3. Employ appropriate tools and collecting procedures to prevent damage to the specimens (figs. 3,4). **Never attempt the preparation of any fossil specimens in the field.**
4. Carefully wrap each specimen or provide protection to prevent damage during transportation from the field.
5. Before leaving the field, number each specimen or slab consecutively and enter all relevant information for each number in a notebook or journal, e.g., (a) collector's name(s), (b) date, (c) locality, (d) legal description from map if possible, (e) photo and map reference, and (f) number and brief description of the fossil.
6. Using conventional techniques for cleaning and preparing paleontological specimens, generally process as soon as time permits. If there is reason to believe the specimen has special scientific significance, however, delay preparation until it can be evaluated by a specialist. Important features may be damaged or destroyed by improper or premature preparation.
7. Once prepared, each specimen should have a unique number assigned to it and permanently entered on an unobtrusive area of the fossil or matrix where it will be protected from damage.
8. Finally, a separate card or label should be prepared to accompany each specimen.



FIGURE 5.—Vibrating tool being used to remove the matrix from trilobite, *Hemirhodon amplipyge*.

#### PREPARATION OF SPECIMENS

Many choice fossils have been ruined in the field by collectors, ourselves included, when they have attempted to remove too much of the matrix. Rather than risk damaging a specimen, it is far safer to take a large rock containing the fossil to a place where it can be sawed or safely trimmed to the desired dimensions.



If a fossil is broken, it can usually be repaired if all the pieces are carefully wrapped in the field. We have found a roll of aluminum foil in the collecting bag to be excellent material for this purpose. Wrapping the pieces individually in the foil serves to prevent damage in transport and to keep all the related pieces together for later assembly. Newspaper or tissue can be substituted for foil where there is less likelihood of damage or the specimen is less fragile.

Different preparation techniques are required for the various types of fossil preservation and matrix. Where much matrix has to be removed to uncover the fossil, power tools can often be used efficiently. They include tools for grinding and chipping. Vibrating tools with sharp needles are excellent for this purpose (fig. 5). For exposing and cleaning many types of fossils, the airbrasive is an excellent device. Various types of abrasive powders are available for use with this equipment. An economical miniature sandblaster or airbrasive unit (air eraser, fig. 6) is available for those who cannot afford the more expensive sophisticated models. We have used one and adapted the nozzle to accommodate hypodermic needles (fig. 7) with great success. This device is portable and can be used outdoors by the operator wearing a filter mask or respirator (Gunther, Gunther, and Rigby 1979).

Some fossils are preserved as natural molds or in a non-calcareous matrix suitable for making artificial molds by acid (HCl) etching. In such cases latex or silicone rubber casting

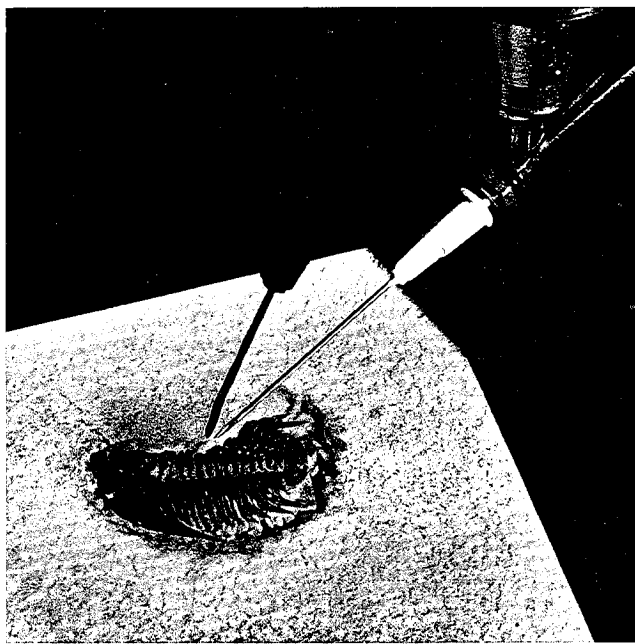


FIGURE 6.—Trilobite, *Modocia typicalis* being uncovered with miniature sandblaster.

can be used to replicate the original surface in minute detail. Many delicate parts and appendages can be shown in better detail for study by this method. Various pigments can be used in the liquid rubber to obtain the color or shade desired.

Another technique we have used for rubber molding or casting where enlargements are desired is explained in Gunther, Guillot, and Rigby (1979).

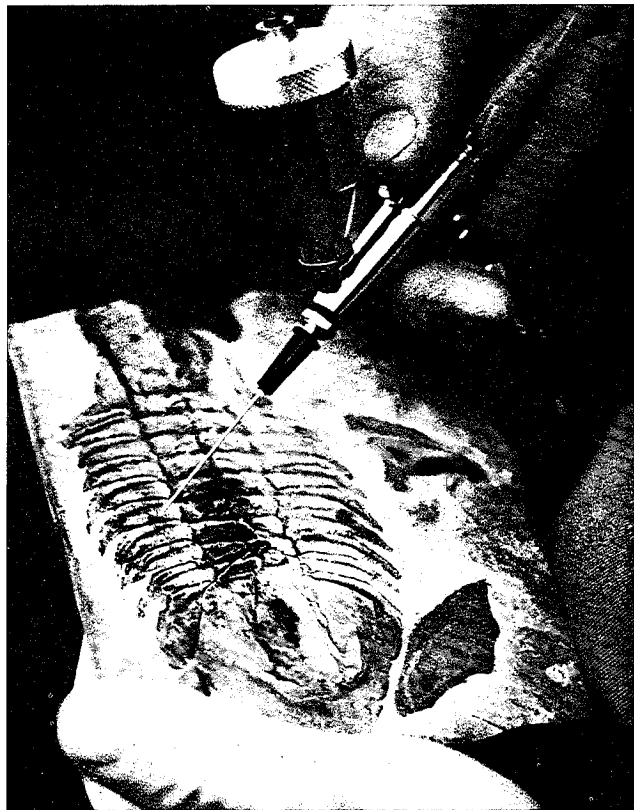


FIGURE 7.—Simple, inexpensive miniature sandblaster being used to prepare trilobite, *Glossopleura gigantea*. Unit fitted with hypodermic needle for fine work.

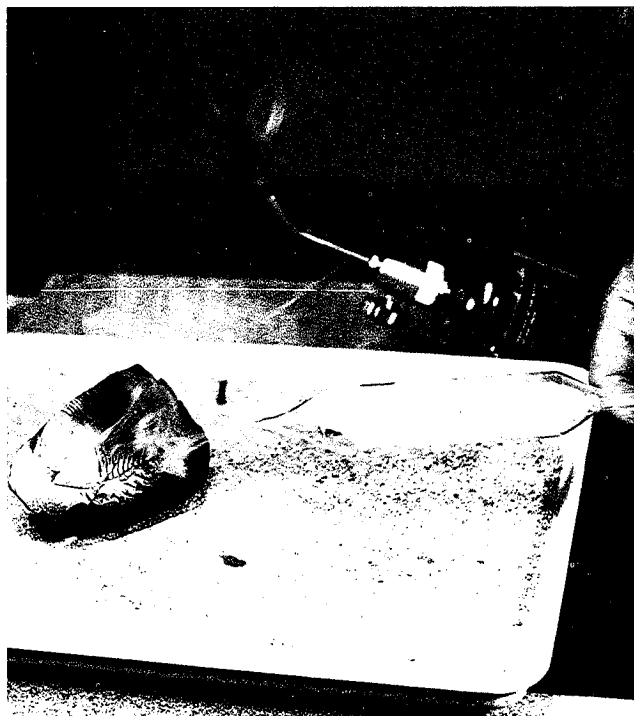


FIGURE 8.—Butane torch used to heat ammonium chloride in a glass tube to blow white smoke onto a trilobite in preparation for photographing it.

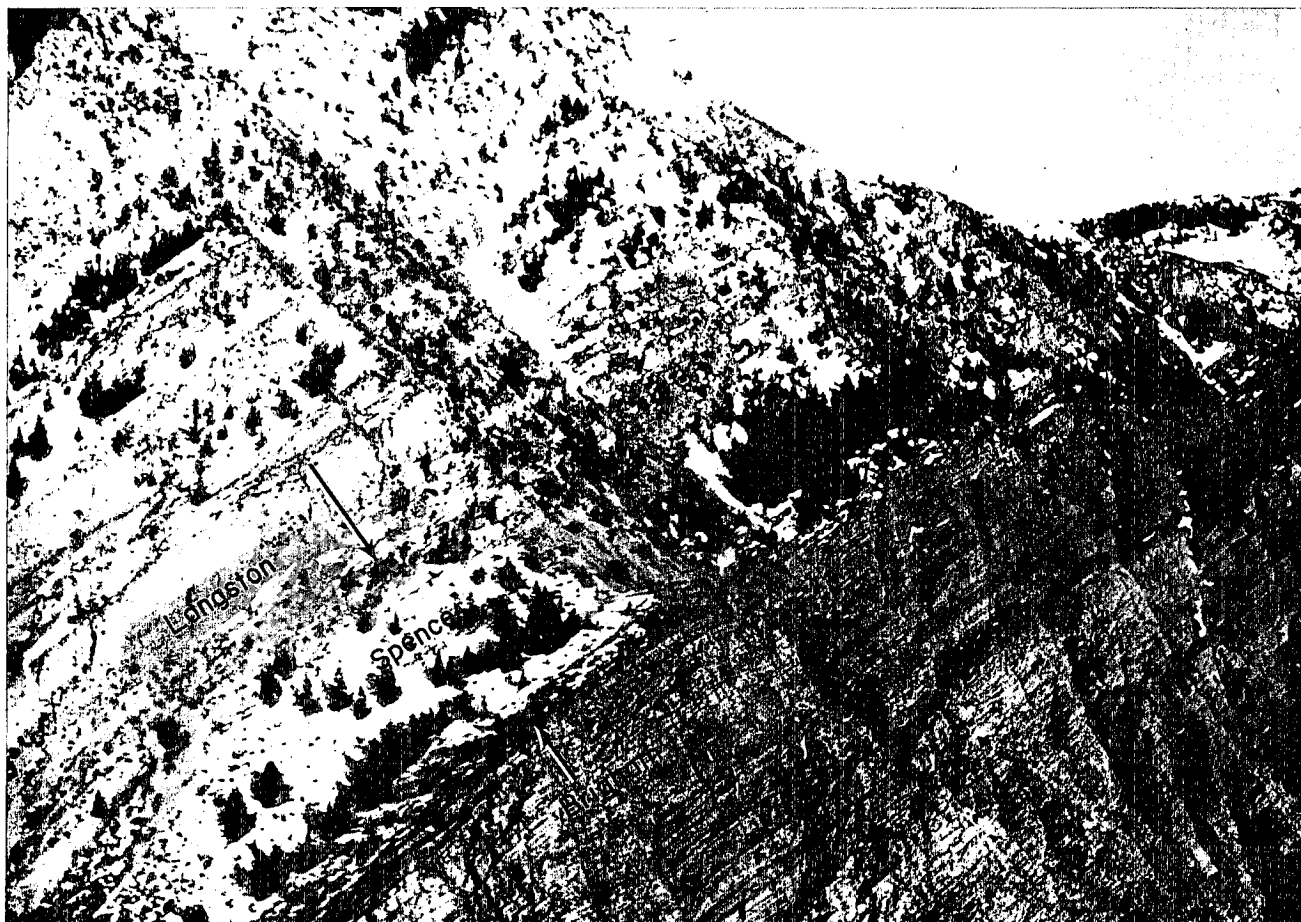


FIGURE 9.—Approximately 60 m (200 ft) of Spence Shale sandwiched between Langston Dolomite ledge above and massive Brigham Quartzite cliffs below.

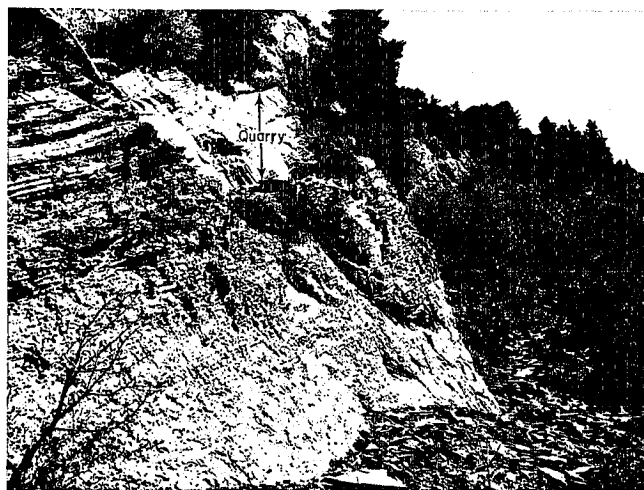


FIGURE 10.—Fossil quarry in ledge outcrop of Spence Shale, Wellsville Mountain. Upper 4.6 m (15 ft) at this site are richly fossiliferous.

To prepare specimens for photography, a “smoking” technique can be used to show more detail. It is accomplished by first coating the specimen with a black water-soluble ink. After the ink has dried, apply smoke by heating ammonium chloride in a glass tube with a rubber bulb attached to provide the air to blow white smoke out the opposite end (fig. 8). Magnesium ribbon can also be burned and the smoke channeled through a funnel to the specimen to be treated. With the latter technique suitable protective goggles should be worn to prevent eye damage from the intensely bright flame. “Smoking” does not harm the specimen, and it can be returned to its original condition by washing in water. (Note: Ammonium chloride, if left on calcareous specimens in a humid climate, converts to HCl and can cause damage.)

#### SOME MIDDLE CAMBRIAN FOSSILIFEROUS FORMATIONS

##### Spence Shale

The Spence Shale was named by Walcott (1980a) as a member of the Ute Formation and described as argillaceous shales, and he later added the words *and sandy shales*. It was named in honor of Robert S. Spence of Garden City, Utah,



FIGURE 11.—Closeup of tilted beds of Spence Shale, Wellsville Mountain, north of Brigham City.

who in 1896 and subsequent years sent some interesting and well-preserved fossils to Dr. Charles D. Walcott at the U.S. National Museum. His doing so led to Dr. Walcott's studies and collections at Spence's discovery site and other localities in southern Idaho and northern Utah.

Williams and Maxey (1941) later recognized that the Spence Shale was actually a member of the Langston Formation, separated from the Brigham Quartzite by only a few feet of crystalline limestone (fig. 9). More recent authors have used the name *Spence* to refer to the Spence Tongue of the Lead Bell Shale, the preferred usage today.

The lower part of the Spence, containing agnostid trilobites, consists of dark silty micrite and gray to gray black laminated shales considered to represent outer detrital-belt environments (fig. 10). The upper part of the Spence lacks agnostids and has some thin-bedded sparry limestone. Below the Spence Shale is the Naomi Peak Limestone, which represents the middle carbonate bank, and the massive Brigham Quartzite below it represents the inner detrital belt.

Spence Shale of variable thickness crops out at several localities (fig. 11) in the Wasatch Mountains north of Brigham City (fig. 12) and in its eastern spur, the Bear River Range, extending into southern Idaho.

#### Wheeler Shale

The Wheeler Shale was also named by Walcott (1908a) and briefly described as "alternating bands of thin shaly limestone and calcareous shale."

The Wheeler Shale, at the type locality in the Wheeler Amphitheater (fig. 13), consists of a heterogeneous succession of highly calcareous shale, shaly limestone, mudstone, and thin flaggy limestone. A more homogeneous component of highly calcareous shale and shaly limestone occurs in the northern part of the House Range. In the central part of the House Range the upper and lower boundaries of the Wheeler Shale are marked by fairly sharp lithologic changes from limestone to shale (lower) and shale to limestone (upper) (Robison 1964). The Wheeler Shale is also representative of the outer detrital belt. In the Drum Mountains the Wheeler is much thicker and is dominated by limestone rather than by shale.

The Wheeler, Marjum, and lower Weeks Formations of western Utah contain from 490 to 610 m (1,600 to 2,000 ft) of limestone and shale in one of the thickest, best exposed, and most fossiliferous succession of upper Middle Cambrian rocks in North America (Robison 1964).

#### Marjum Formation

The Marjum Formation was also named by Walcott (1908a) and briefly described as "gray to dark, more or less thin-bedded, arenaceous limestone." The type locality was designated as "the cliffs on the south side of Marjum Pass, House Range, Utah."

Robison (1964) further described the Marjum Formation at the type locality as consisting of 60 percent thin-bedded, fine-grained, silty limestone, and about 38 percent shale and mudstone. A few beds of intraformational flat-pebble conglomerate, thin algal biostromes, and other miscellaneous rock types from less than 2 percent of the formation. The unit is expressed geo-



FIGURE 12.—Large trilobite, *Glossopleura gigantea*, uncovered in place, Spence Shale, Hansen Canyon, Wellsville Mountain.

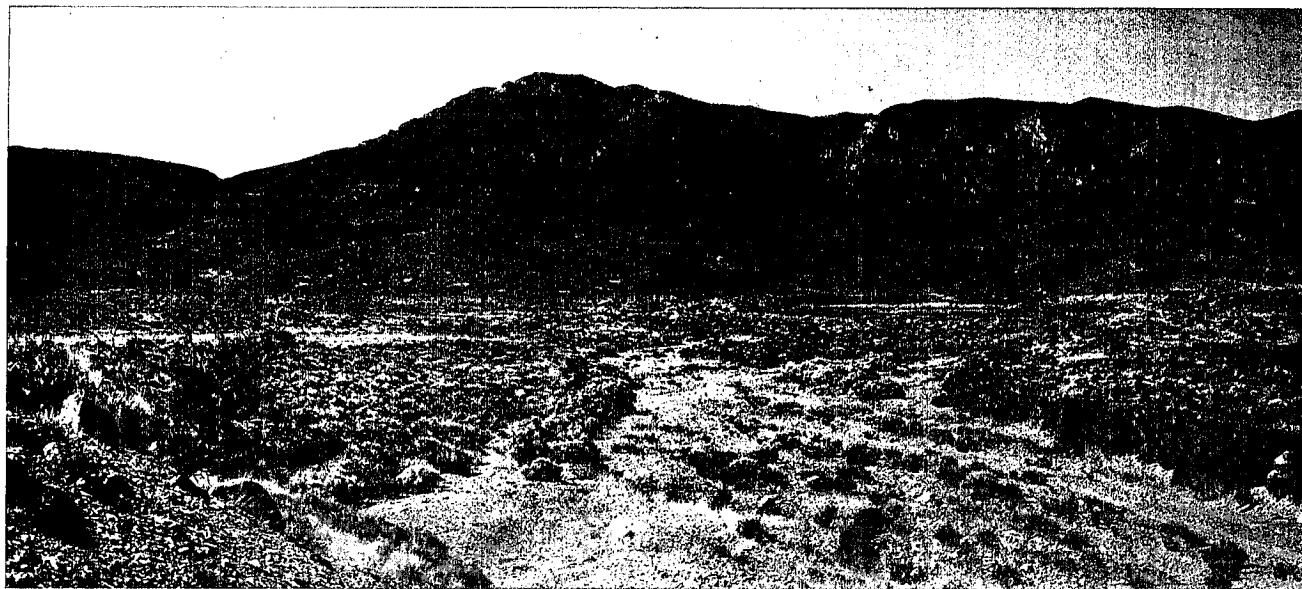


FIGURE 13.—Distant view looking northeast at Wheeler Amphitheater, House Range. Highest mountain is Swasey Peak.

morphically as a series of slopes, ledges, and cliffs (figs. 14, 15, 16, 17).

In the vicinity of the Wheeler Amphitheater, 14.5 km (9 mi) north of Marjum Pass, individual beds of shale and mudstone decrease to less than 5 percent of the formation. As the unit is traced from south to north, it changes from interbedded shale and limestone (Marjum Pass area; fig. 18) to thin-bedded limestones with smooth, silty bedding surfaces (Wheeler Amphitheater area; fig. 19) to thin-bedded limestone with silty mottles and irregular bedding surfaces (Swasey Peak area; fig. 20) and, finally, to massive pure limestone (north end of the House Range).

#### Pierson Cove Formation

A stratigraphically equivalent unit of the Marjum in the Drum Mountains, the Pierson Cove Formation (fig. 21), consists mostly of thin- to medium-bedded limestone and dolomite that represent the middle carbonate lithofacies.

#### SOME REPRESENTATIVE FOSSILS

##### Trilobites (Nonagnostid)

Of all the Cambrian life forms, trilobites (fig. 22) predominate and are the best known. Trilobite remains capture the interest of most who are interested in fossils. They seem to

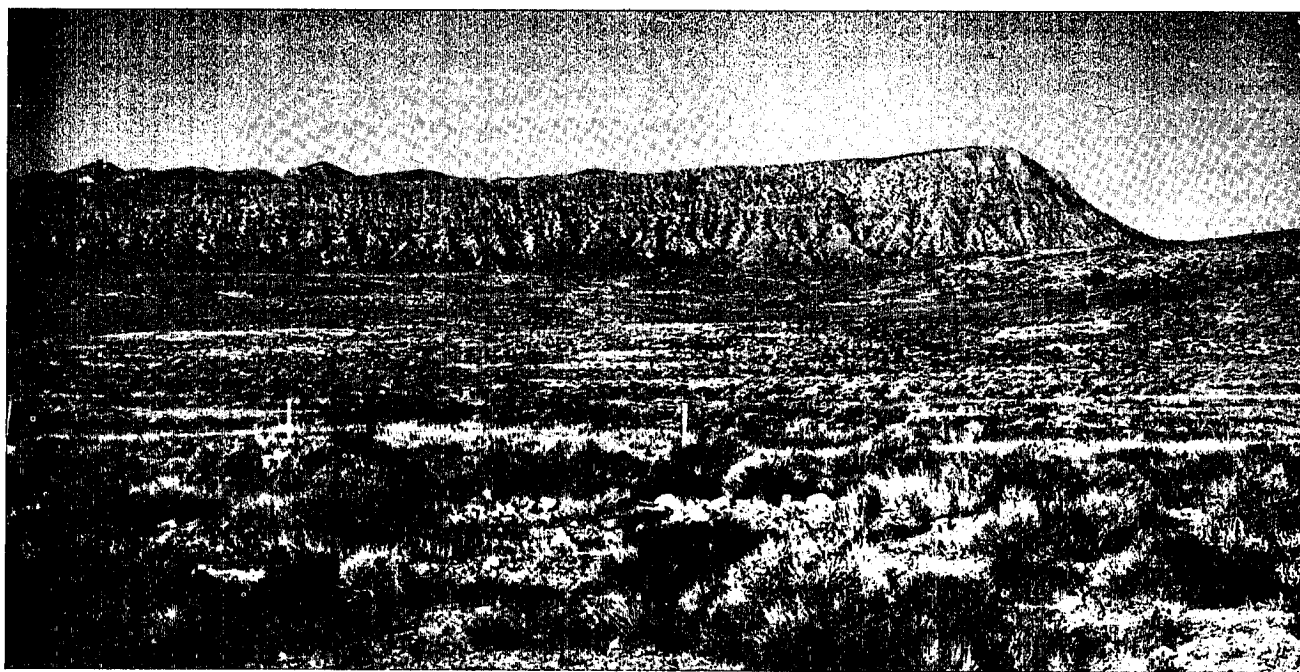


FIGURE 14.—View looking south at House Range just east of Marjum Pass. Marjum Formation is exposed, capped by Weeks Formation.



FIGURE 15.—Quarrying for fossil sponges in Marjum shale, House Range.



FIGURE 17.—View of a quarry site in the Marjum limestone and shale, House Range, Marjum Pass area.

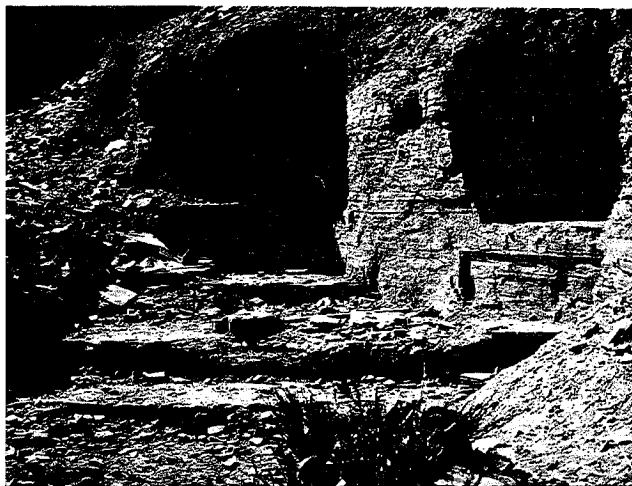


FIGURE 18.—Closeup of quarry showing interbedded layers of limestone and shale at Marjum Pass.



FIGURE 16.—Lloyd and Metta Gunther quarrying for large *Hemirhodon amplipyge* trilobites in Marjum Formation, House Range.

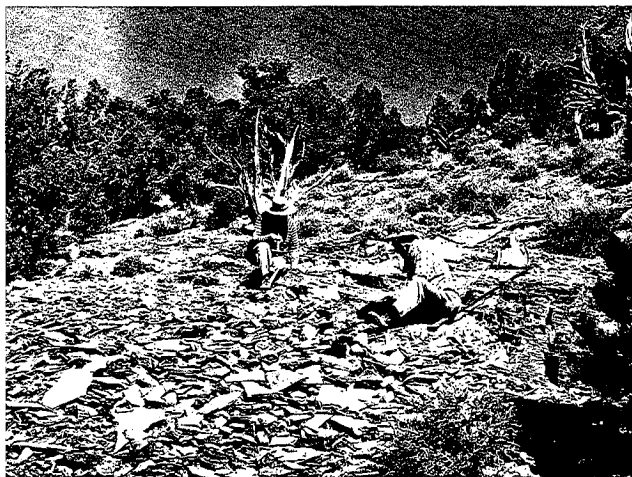


FIGURE 19.—Searching for large *Olenoides superbus* trilobites in Marjum limestone at east side of Wheeler Amphitheater, House Range.



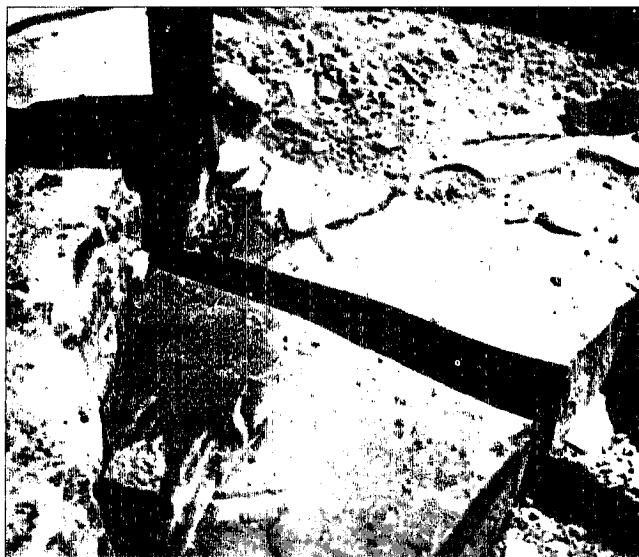


FIGURE 20.—Extracting trilobite, *Utae marjumiensis* from limestone near Swasey Peak in Marjum Formation, House Range.

have character and are fascinating and aesthetically pleasing. They appear to be the most lifelike of all the inhabitants of the ancient seas. Trilobites have great antiquity, being among the earliest animal forms to appear in great numbers and variety in the fossil record. So far as is known, trilobites were the first animals to see the world about them. Their eyes, except for those that were blind, were excellent sight organs. Some were able to see in all directions. It is little wonder they were masters of their environment for some 200 million years. They took on a great variety of sizes, shapes, and ornamentation. Some swam, some crawled on the ocean floor, and some burrowed in the bottom sediments. Some may have been carnivores, others filter feeders, but most probably fed on the organic particles from the sea floor. Not only are they interesting objects to see; they contribute a wealth of scientific data as well. Because of their worldwide distribution, they are excellent index fossils and provide valuable paleobiologic information of the Paleozoic Era.

This paper deals more with trilobites than with other organisms simply because they were the more dominant representatives of Middle Cambrian time. Other life forms associated with trilobites are also treated, and they are of no less importance to the paleontologic record even though they may seem to take a subordinate role.



FIGURE 21.—Pierson Cove Formation, Drum Mountains. Collecting fossils in shale exposure between limestone ledges.



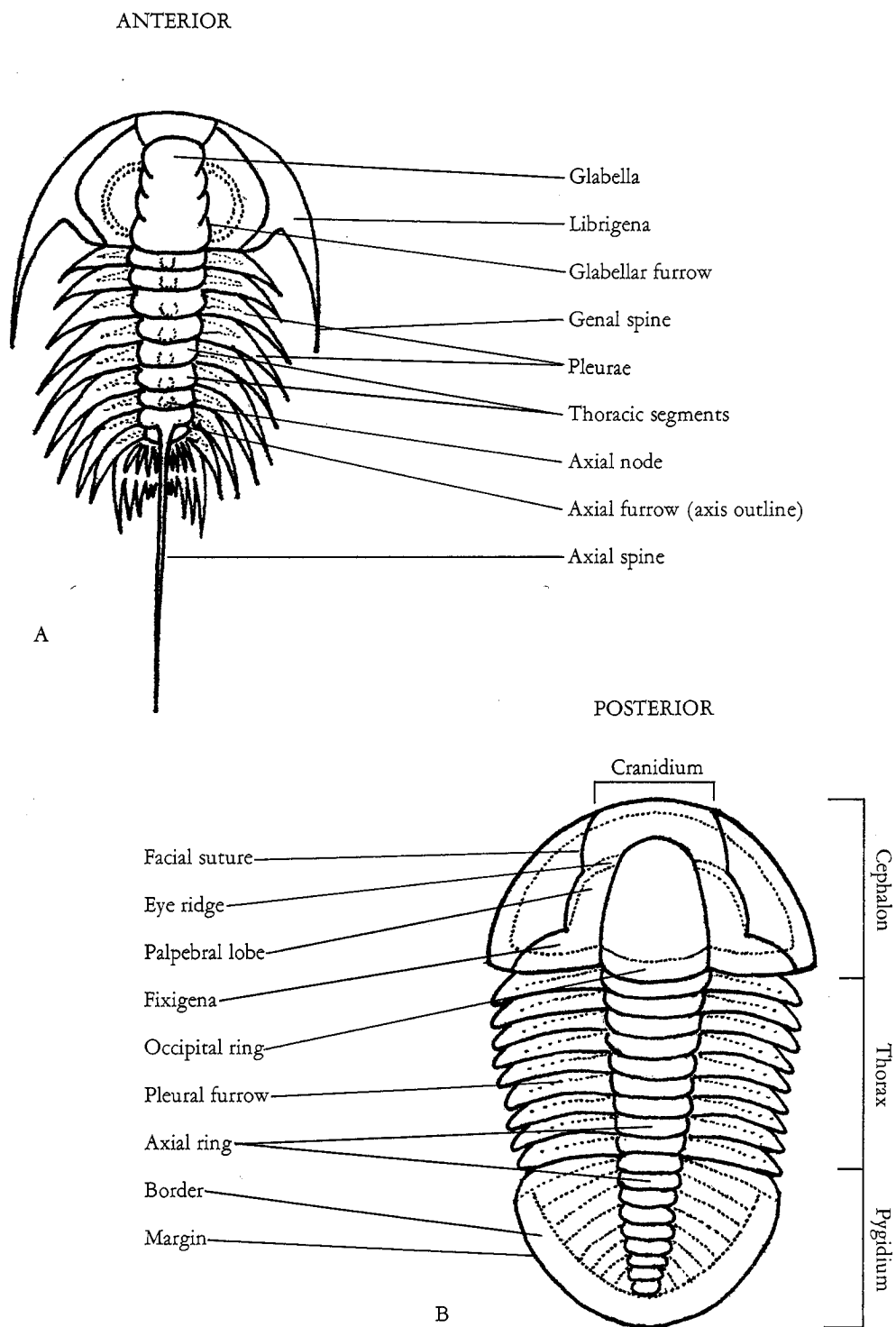


FIGURE 22.—Terms applied to trilobite dorsal exoskeleton: A.—*Zacanthoides idahoensis* Walcott; B.—*Asaphiscus wheeleri* Meek.

Trilobites have been collected in Utah for more than a century. They were discovered at Antelope Springs (Wheeler Amphitheater) by members of the King Survey during the late 1860s (Meek 1870).

Indians are believed to have collected trilobites at Antelope Springs at a much earlier period. Historical records indicate that specimens of the common trilobite *Elrathia kingi* were collected by Pahvant Ute Indians and fabricated into amulets or "good luck charms." Specimens with holes drilled through the cephalon have been found in burial sites where they are associated with other Indian artifacts (Taylor and Robison 1976).

Other collectors have also found trilobites associated with Indian artifacts, some with holes drilled through them near the posterior end of the specimen. Figure 23 shows two trilobites found by Robert Fife about 16 km (10 mi) west of Delta, Utah, which is only about 48 km (30 mi) from the Antelope Springs site where they are most abundant.

Trilobites have been quarried commercially at Antelope Springs since September 1960 by Robert Harris of Delta, Utah. He has estimated that 1.5 million specimens, mostly *Elrathia kingi*, have been mined during the twenty-year period. This operation is still in progress. Specimens taken from this state-leased land are now found in museums and collections throughout the world. Figures 24 and 25 show portions of this commercial quarry.

In popularity, Utah trilobites rank close to the great dinosaurs for which the state is well known.



FIGURE 23.—Two specimens of trilobite *Elrathia kingi* were found in association with other Indian artifacts. Each has a hole drilled through inner part of specimen just above pygidium. Collected by Robert Fife about 16 km (10 mi) west of Delta, Utah.

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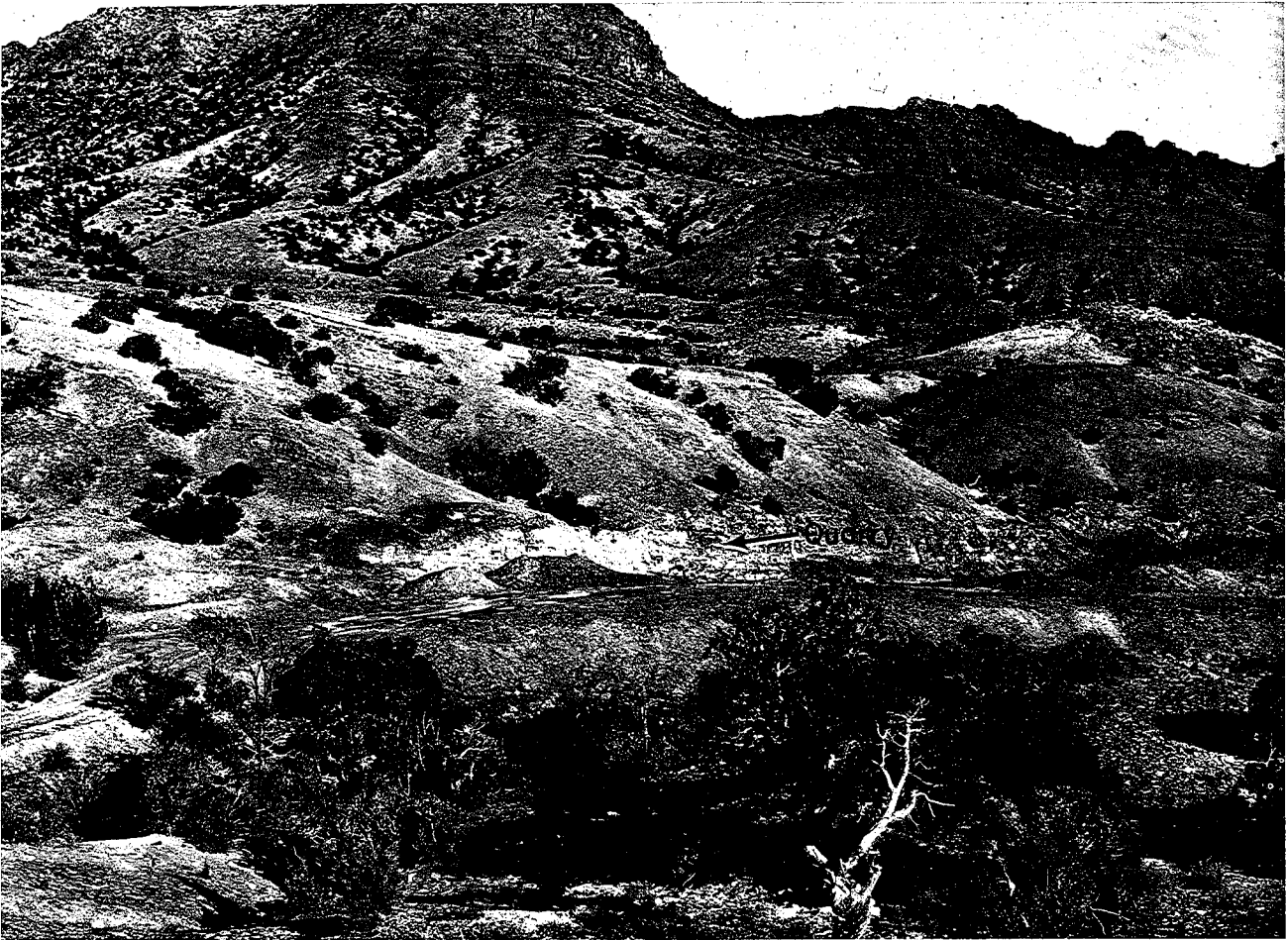


FIGURE 24.—Wheeler Shale and commercial quarry in foreground. Marjum Formation forms steep slopes in background, Wheeler Amphitheater.

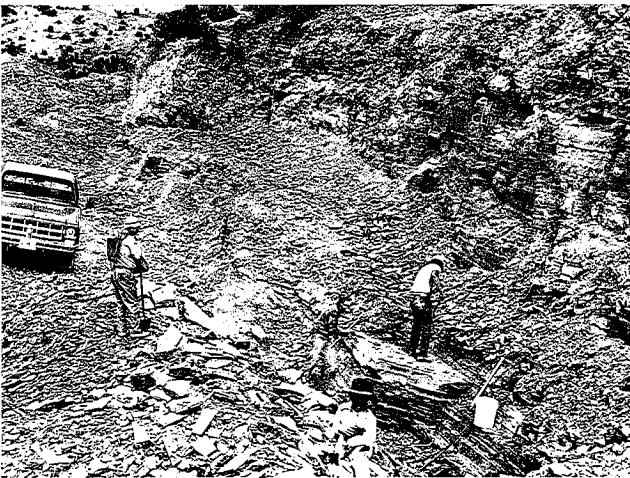
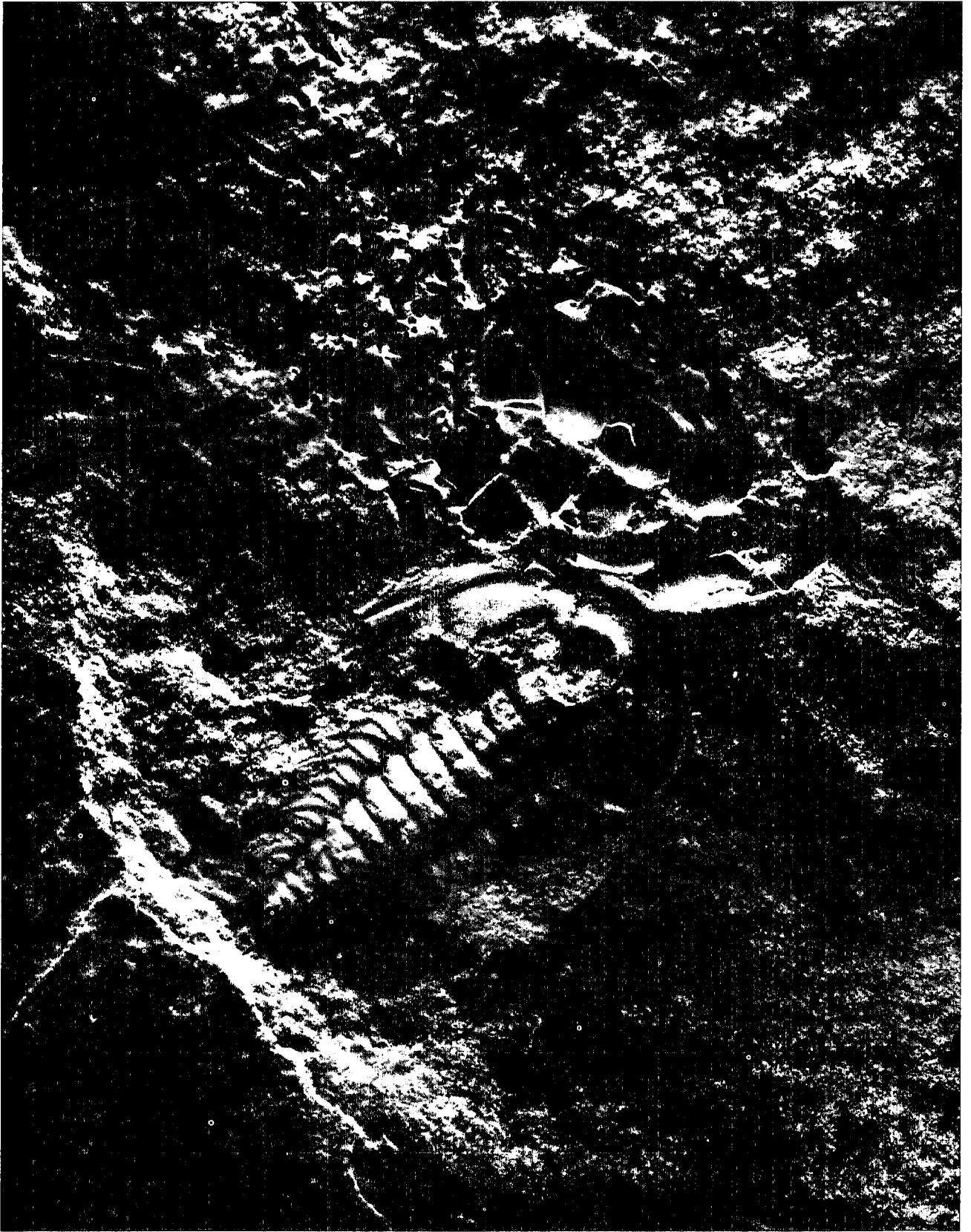


FIGURE 25.—Harris commercial quarry in Wheeler Shale, Wheeler Amphitheater. Trilobites mined here have been sold to museums, collectors, and institutions throughout the world.



*Zacanthoides* and an undescribed species of *Gogia*, showing association of trilobites with eocrinoids.

## Nonagnostid Trilobites

## Plate 1

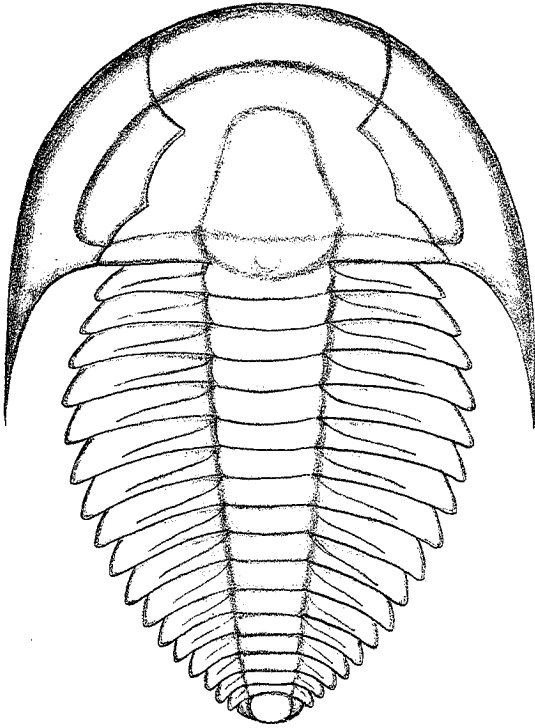
*Achlysopsis* sp.

*Description.*—A small trilobite about 11 mm in length. Glabella tapered and broadly rounded anteriorly. Frontal area gently sloping, slightly concave. Preglabellar field about or near same width as border. Fixigena narrower than glabella at eye line, slightly convex downsloping. Occipital ring widest medially and bears a faint medial node. Thorax has 17 segments. Axis widest anteriorly, narrowing gradually posteriorly. Pygidium tiny.

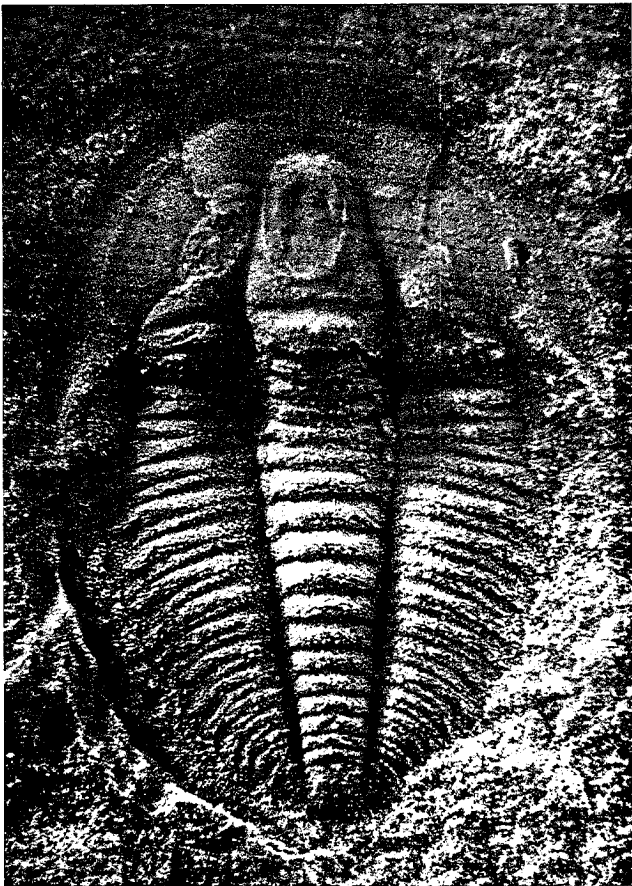
A.—Reconstruction.

B.—Specimen X10.5 (GUN) from upper Spence Shale, Antimony Canyon, Wellsville Mountain. Photographed smoked.

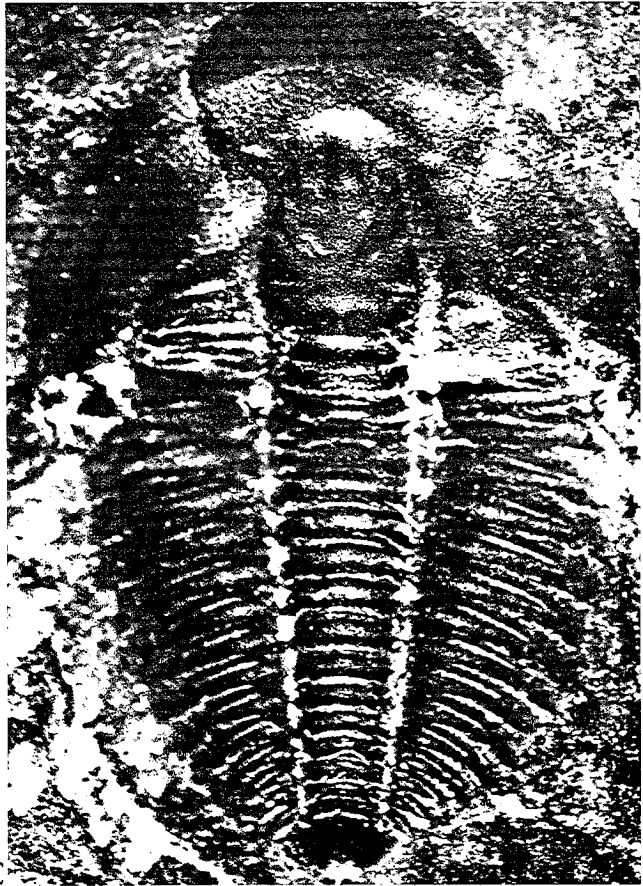
C.—Same specimen unsmoked.



A



B



C

## Plate 2

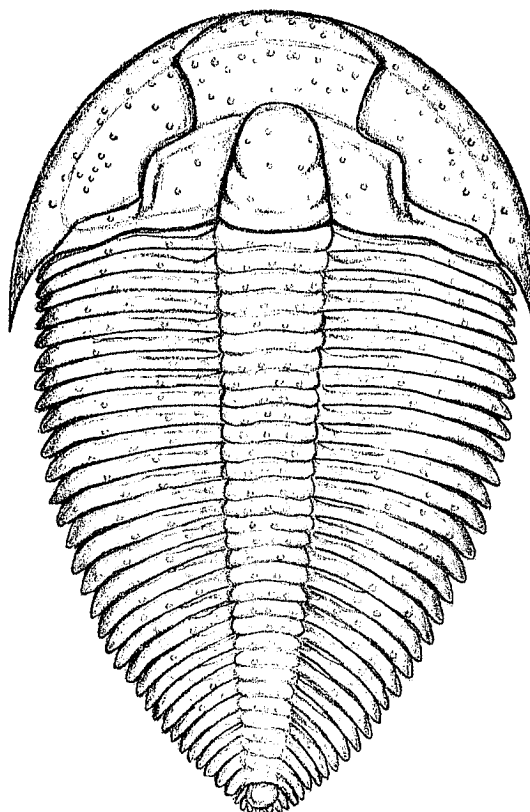
*Alokistocare harrisi* Robison

*Description.*—A medium-sized trilobite. Frontal area slightly shorter than glabella. Anterior border well developed and evenly curved. Genal spines extend to the third to fifth thoracic segments. Thorax has 32 segments. Tips of pleura vary from nonfalcate anteriorly, to moderate falcate medially, to slightly falcate posteriorly. Pygidium tiny; axis twice as wide as pleural field. Ornamentation consists of scattered coarse granules and abundant fine granules over entire dorsal exoskeleton.

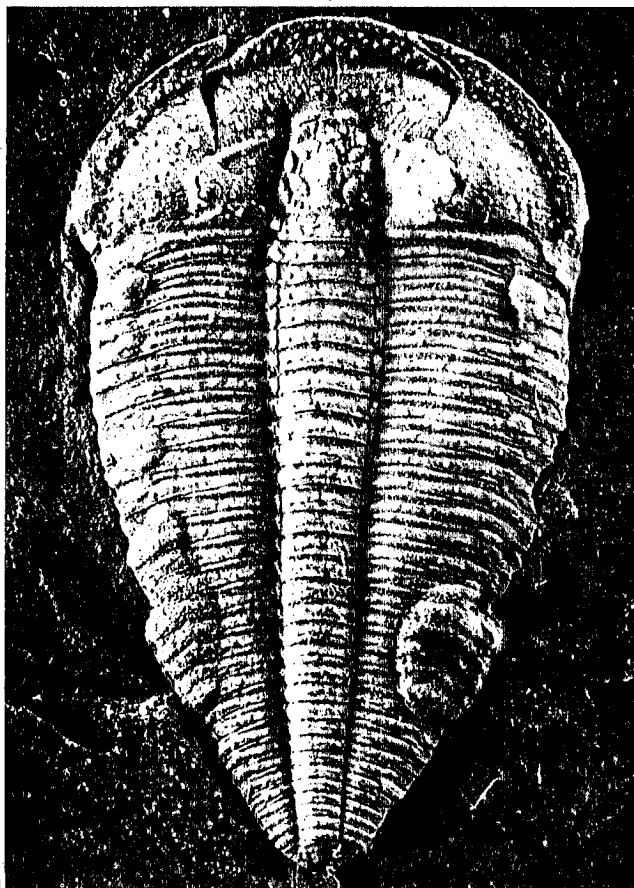
A.—Reconstruction.

B.—Specimen X2.8 (GUN) from upper Wheeler Shale, Wheeler Amphitheater.

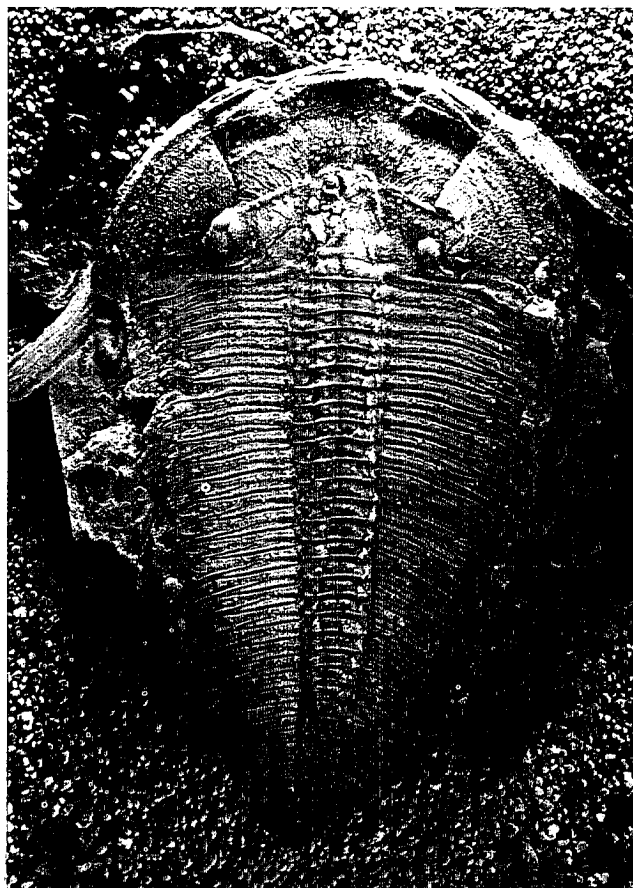
C.—Large specimen X1.9 (HAR) collected by Robert Harris, Wheeler Shale, Harris Quarry, Wheeler Amphitheater.



A



B



C



## Plate 3

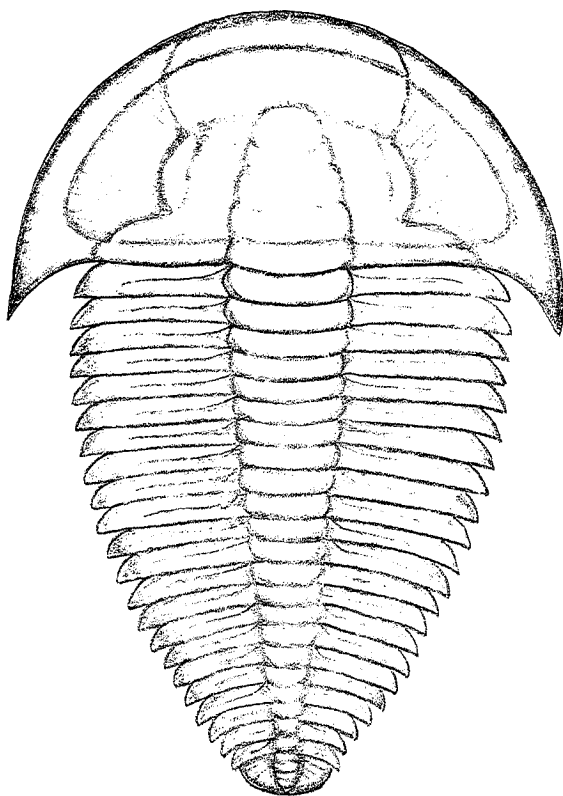
*Alokistocare idahoense* Resser

*Description.*—A medium-sized trilobite, ranging from about 30 to 50 mm long. Cephalon semicircular. Glabella prominent, tapered, and bluntly rounded anteriorly. Frontal area long, broad, and nearly equal to glabellar length. Border turned upward medially and slopes down laterally. Frontal area of cranidium covered with anastomosing lines. Eye ridges prominent. Librigena with evenly curved lateral margin with genal spines extending to third or fourth thoracic segments. Thorax has 22 to 24 segments. Pleurae of each segment with distinct pleural furrows and short falcate tips. Pygidium tiny, about twice as wide as long.

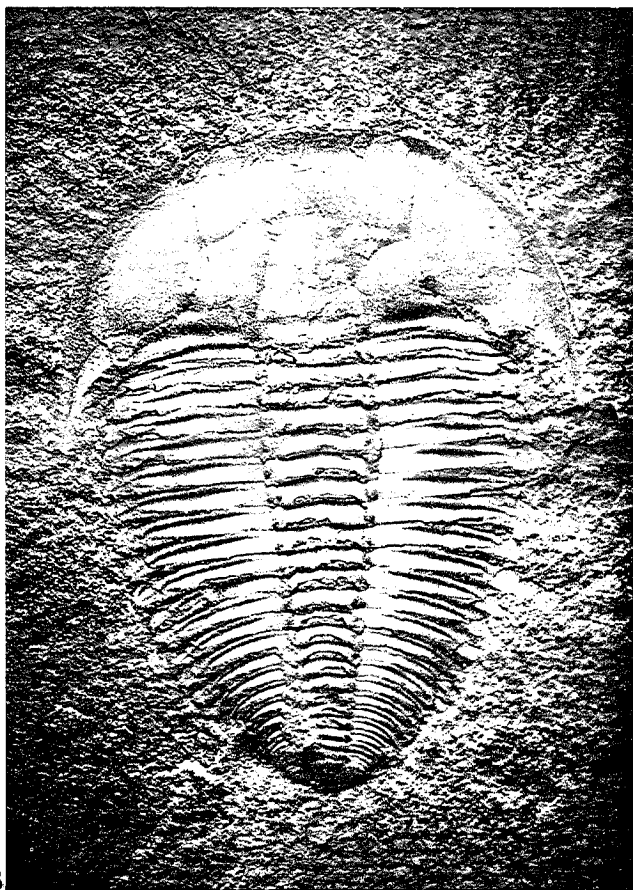
A.—Reconstruction.

B.—Specimen X2.1 (GUN) from Antimony Canyon, Wellsville Mountain.

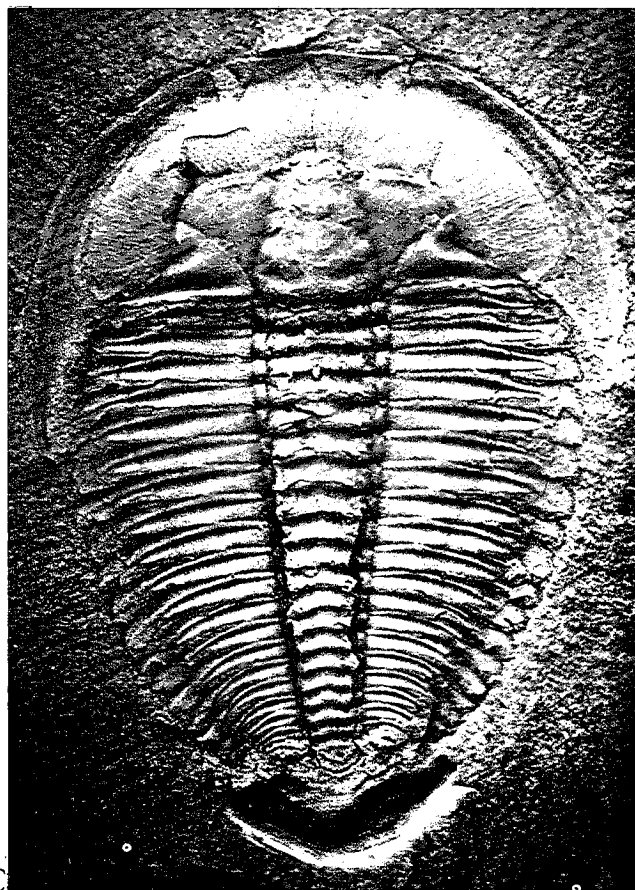
C.—Specimen X2.1 (GUN) from Spence Shale, Miners Hollow, Wellsville Mountain.



A



B



C

## Plate 4

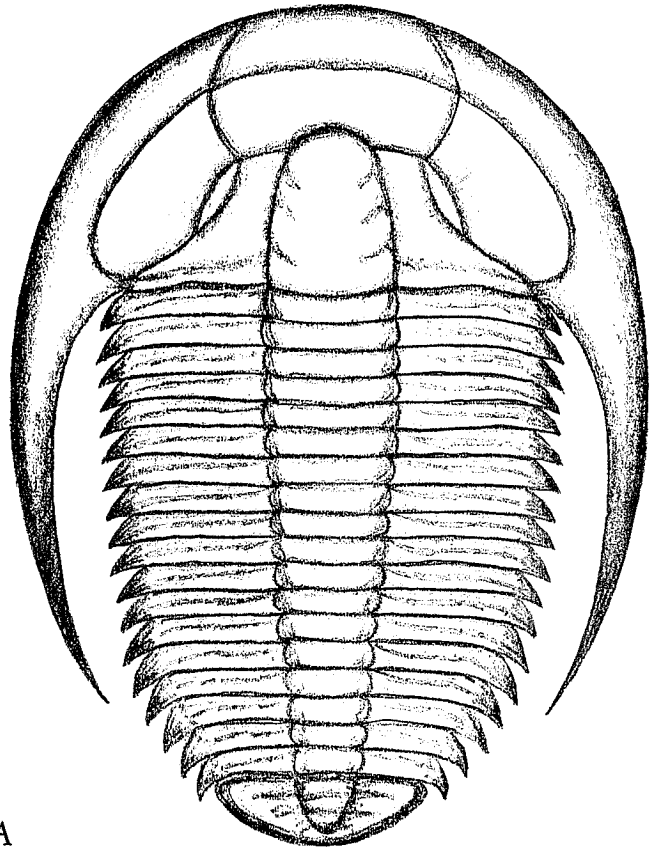
*Alokistocare laticaudum* Resser

*Description.*—A medium-sized trilobite, ranging from 20 mm to 55 mm in length on the basis of 6 specimens collected. Cephalon semielliptical with wide brim. Genal spines extremely long extending almost to pygidium. Glabella tapering and bluntly rounded anteriorly. Thorax has 17 to 18 segments. Axis narrower than pleurae and tapering slightly posteriorly. Pygidium small with distinct pleural furrows.

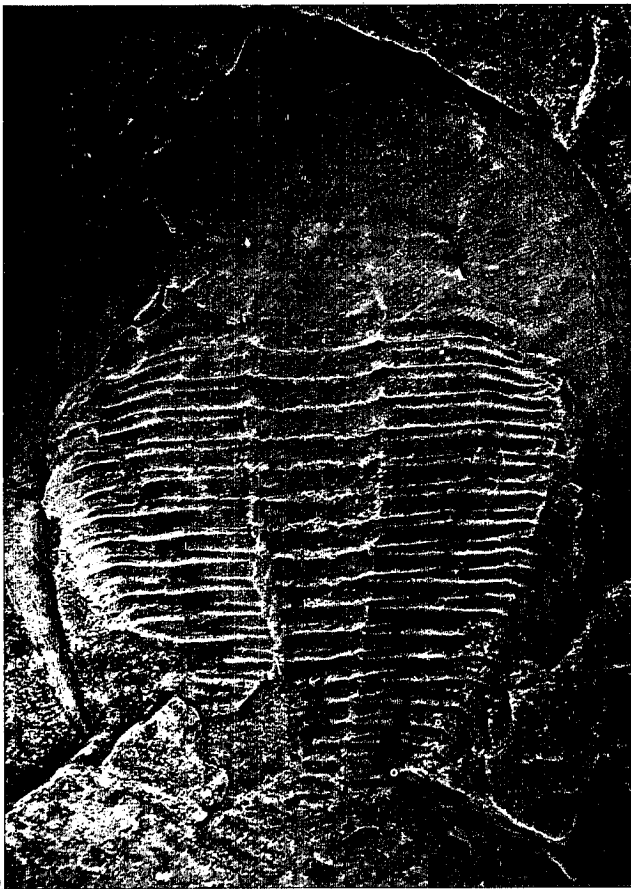
A.—Reconstruction.

B.—Partially exfoliated specimen X2.1 (GUN) from Spence Shale in Antimony Canyon, Wellsville Mountain.

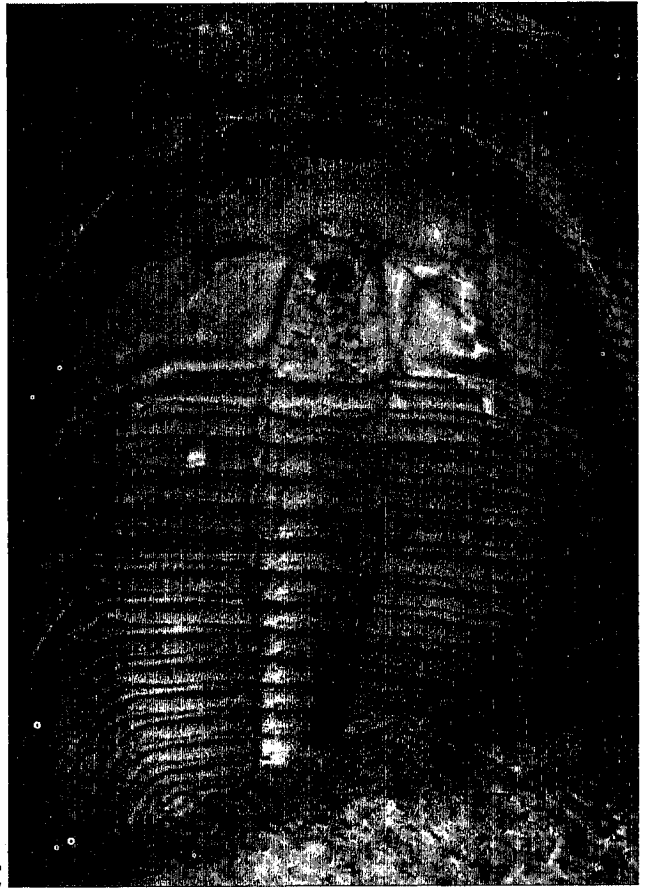
C.—Specimen X2.1 (GUN) from Spence Shale, Miners Hollow, Wellsville Mountain.



A



B



C

## Plate 5

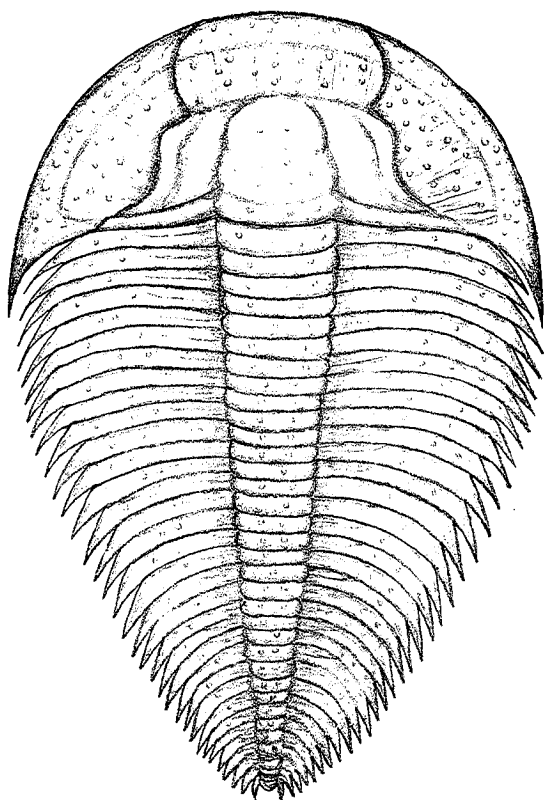
*Alokistocare* sp.

*Description.*—A medium-sized trilobite, ranging in size from 40 to 65 mm in length on the basis of about a dozen specimens collected. This undetermined species, similar in detail to *A. harrisi*, differs in having longer thoracic segments with tips that taper rather sharply backward.

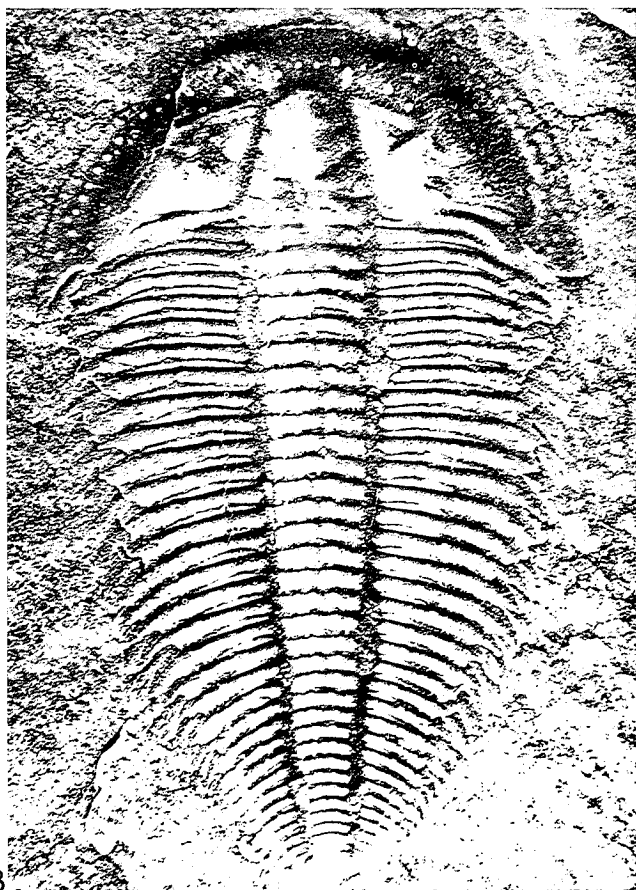
A.—Reconstruction.

B.—Specimen X3 (GUN) collected from shale beds of the Pierson Cove Formation in the Drum Mountains. This trilobite is commonly associated with *Asaphiscus wheeleri* and *Olenoides nevadensis*.

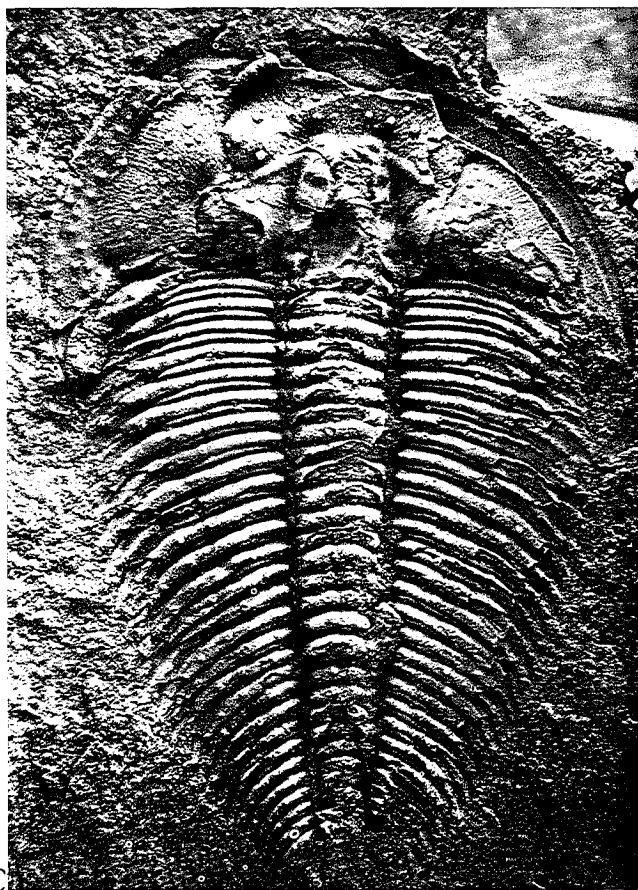
C.—Specimen X2.6 (GUN) collected from the same locality as B.



A



B



C

## Plate 6

*Asaphiscus wheeleri* Meek

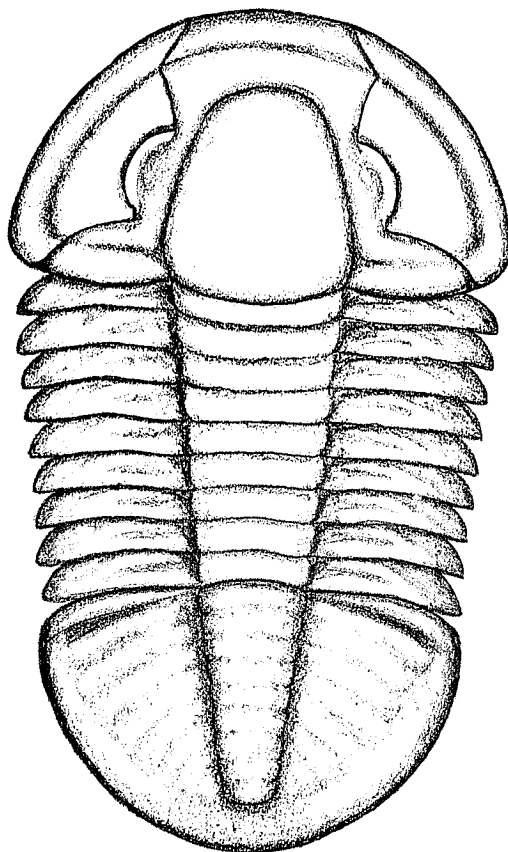
*Description.*—A medium-sized trilobite and a very common species. It is best characterized by its poorly defined glabella, moderately defined and curved anterior border furrow, the lack of genal spines, nine thoracic segments, and a relatively large pygidium with a wide posterior border.

This species occurs commonly at numerous sites of the Wheeler Formation and lower Marjum Formation in the House Range. It also occurs in the upper Wheeler and lower Pierson Cove Formation in the Drum Mountains.

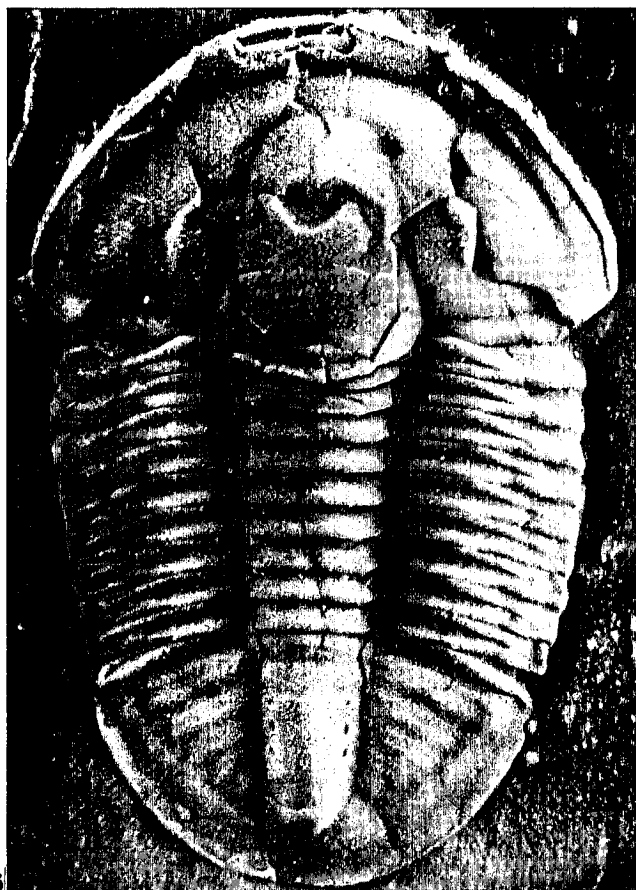
A.—Reconstruction.

B.—Specimen X3.7 (GUN) from upper Wheeler Shale, Wheeler Amphitheater.

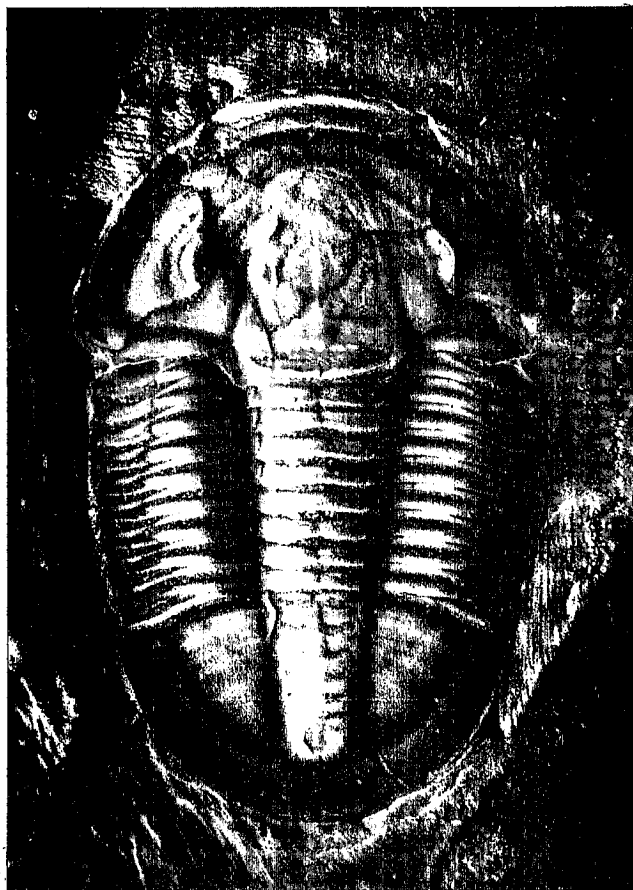
C.—Specimen X2.1 (GUN) from same locality B.



A



B



C

## Plate 7

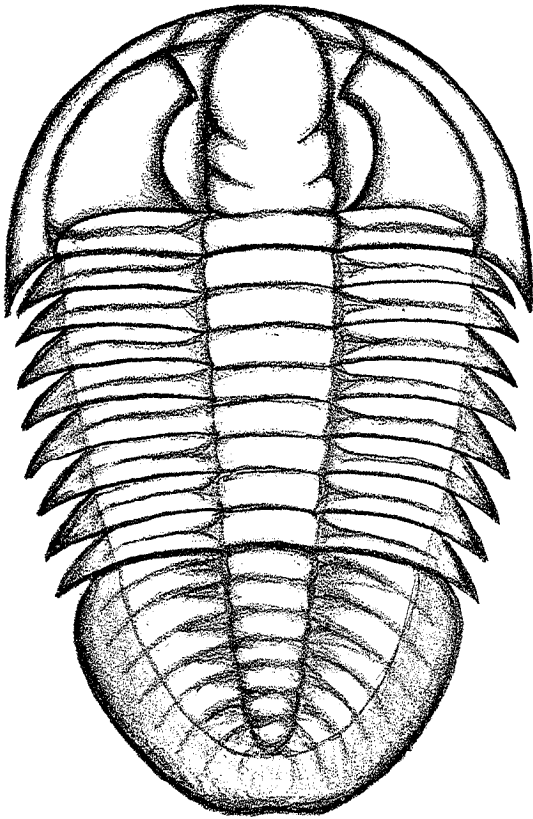
*Athabaskia bithus* (Walcott)

*Description.*—A medium to medium-large trilobite. Cephalon semicircular. Glabella extends to anterior margin and expands anteriorly. Palpebral lobes long and distinct. Genal spines extend to second thoracic segment. Thorax has eight segments. Axis narrower than pleural fields. Pygidium subelliptical. Axis slightly tapered. Border wide, concave, and smooth; anterolateral corners somewhat rounded. Posterior border has a slight medial indentation on some specimens.

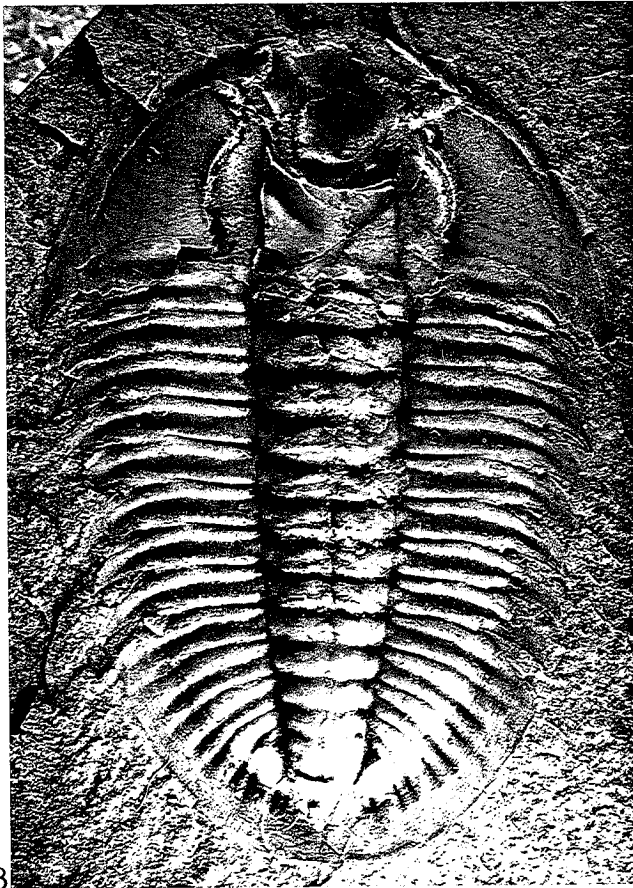
A.—Reconstruction.

B.—Specimen X2.1 (GUN) from near top of Spence Shale, Hansen Canyon, Wellsville Mountain.

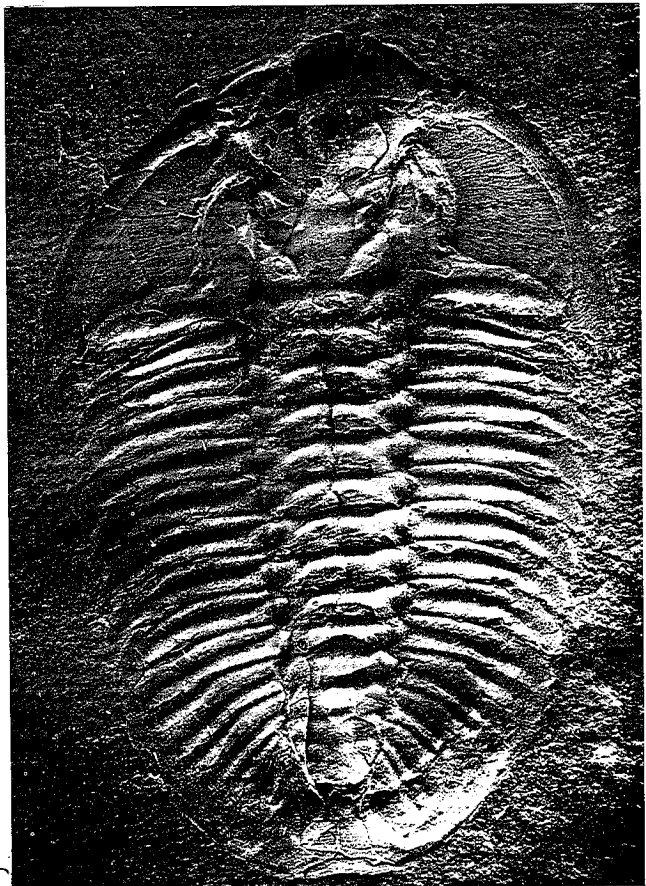
C.—Specimen X2.2 (GUN) from near top of Spence Shale, Antimony Canyon, Wellsville Mountain.



A



B



C



## Plate 8

*Athabaskia wasatchensis* (Resser)

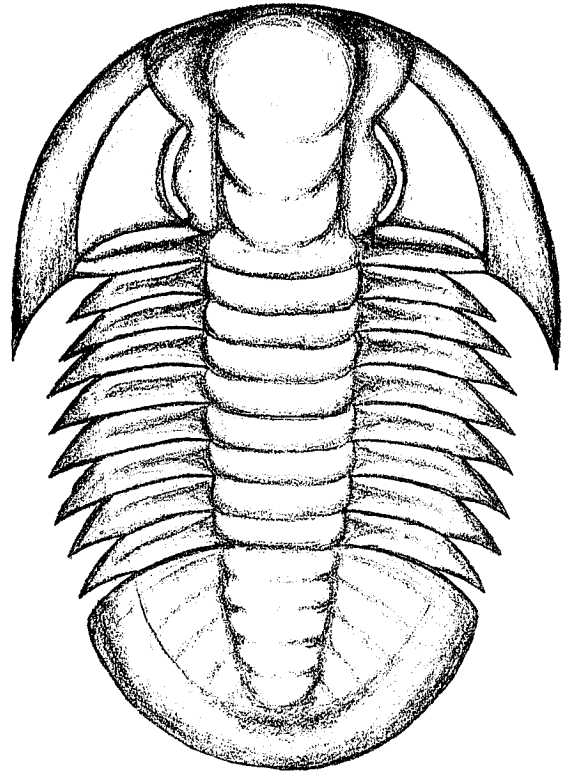
*Description.*—A medium-sized trilobite. This species is similar to *A. bithus* but differs from it in having a wider and flat, rather than a concave, border. The exoskeleton outline is shorter and broader than *A. bithus*.

This species appears to be somewhat more restricted in its occurrence than *A. bithus* but does occur at several sites in the Wellsville Mountain.

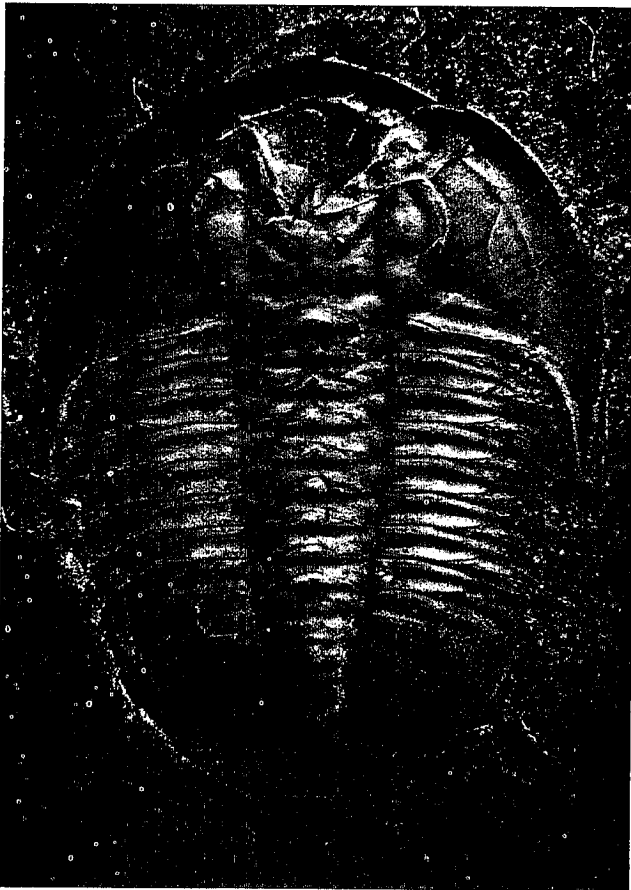
A.—Reconstruction.

B.—Nicely preserved specimen X2.4 (GUN) from near top of Spence Shale, Antimony Canyon, Wellsville Mountain.

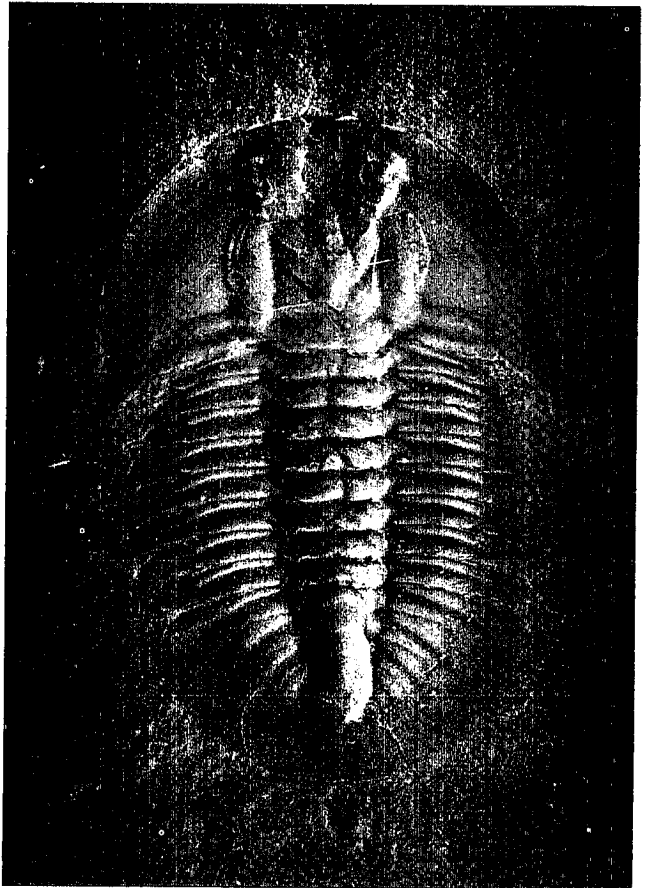
C.—A near perfect specimen X2.1 (GUN) also from near top of Spence Shale, Antimony Canyon, Wellsville Mountain.



A.



B.



C.



## Plate 9

*Bathyriscus brighamensis* Resser

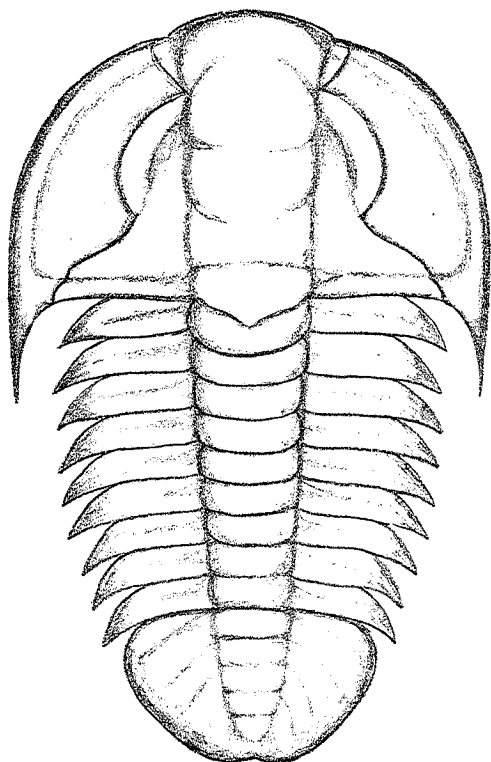
*Description.*—A small- to medium-sized trilobite. Glabella prominent, elongate, expands abruptly anteriorly and possesses four pairs of furrows. Occipital ring bears a small median node. Thorax has nine segments. Pleurae slightly wider than axis, and each pleura has a wide shallow furrow and terminates in a reflexed spine that progressively increases in length posteriorly. Pygidium has four rings and a terminal piece.

This species closely resembles *B. wasatchensis* but differs in having no anterolateral spines on the pygidium.

A.—Reconstruction.

B.—Specimen X7.9 (GUN) showing expanded glabella. From lower Spence Shale, Miners Hollow, Wellsville Mountain.

C.—Specimen X4.3 (GUN) from same locality as B.



A



B



C

## Plate 10

*Bathyriscus elegans* (Walcott)

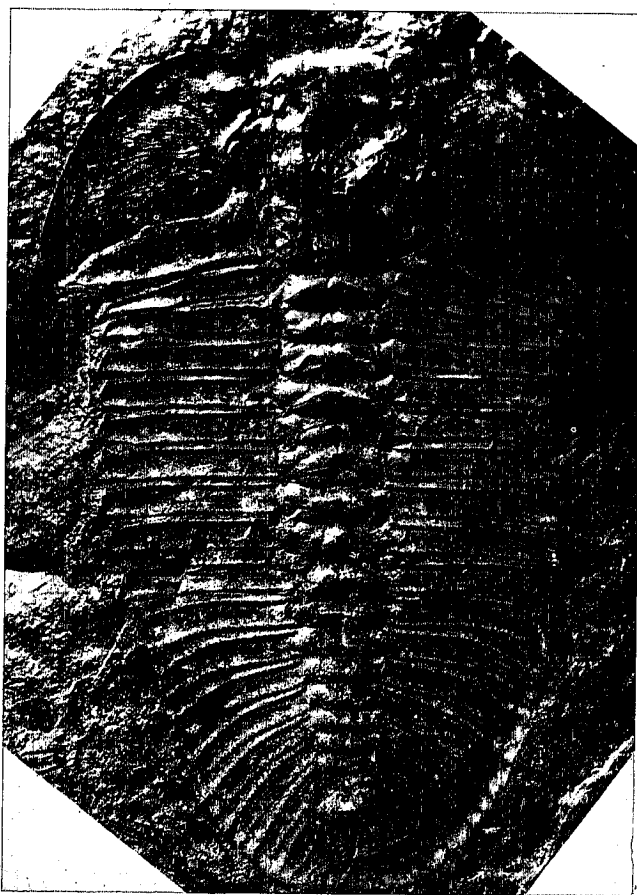
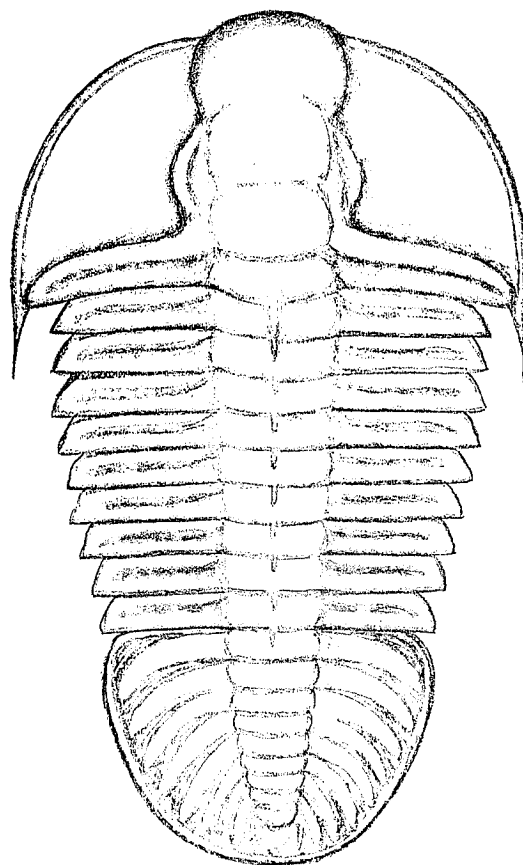
*Description.*—A medium to large trilobite, some individuals measuring more than 80 mm in length. Glabella narrow, parallel sided or slightly expanded forward, and reaching narrow anterior border.

Anterior and palpebral areas of fixigena very narrow, posterior areas very wide. Librigena has prominent irregular network of raised lines. Genal spines of moderate length. Occipital ring bears a median node or short spine. Thorax has nine segments. Pygidium large, semicircular in outline with narrow, raised border. Axis has seven or eight segments plus a terminal piece.

A.—Reconstruction.

B.—Specimen X1.5 (GL) collected by Gary Locker from Marjum Formation, Wheeler Amphitheater.

C.—Small, somewhat weathered specimen X7 (GL) collected by Gary Locker from float in Marjum Formation, Wheeler Amphitheater.



## Plate 11

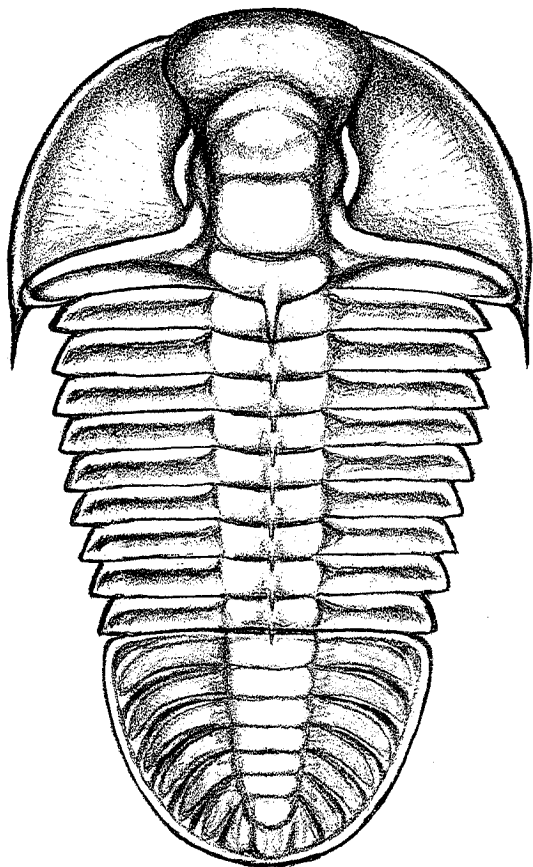
*Bathyriscus fimbriatus* Robison

*Description.*—A medium-sized trilobite. Cephalon semicircular in outline, with narrow anterior border. Glabella expanded and bluntly rounded anteriorly. Axial furrow, fossulae, and palpebral lobes are distinctly impressed. Anterior fixigena is wider than that of *B. elegans*. Thorax has nine segments. Genal spines of moderate length. Occipital ring bears a median spine. Pygidium is large and semicircular in outline with a narrow raised border. Pygidium usually contains six or seven axial rings and a terminal piece.

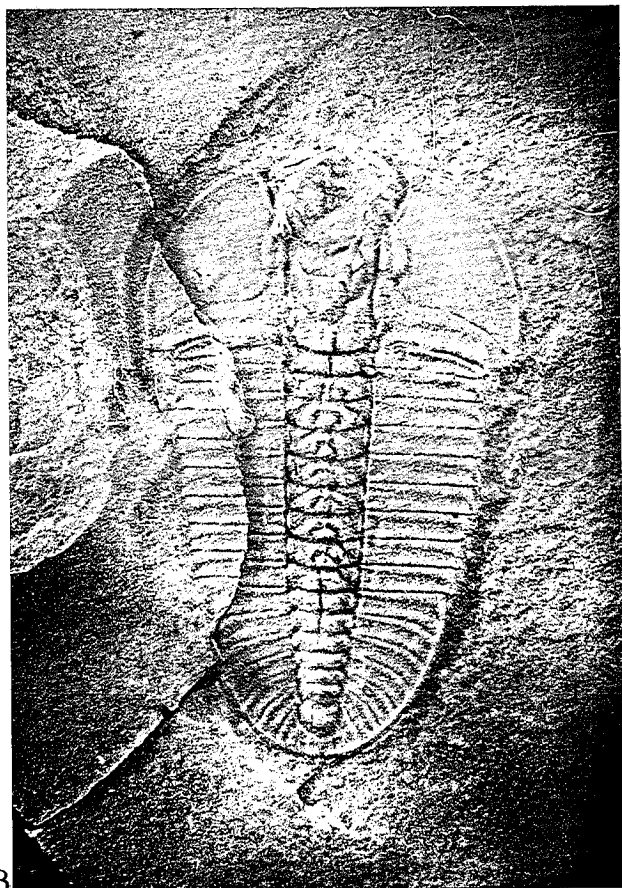
A.—Reconstruction.

B.—Specimen X3.5 (GUN) from lower Marjum Formation at a site about 5 km (3 mi) east of Marjum Pass, House Range.

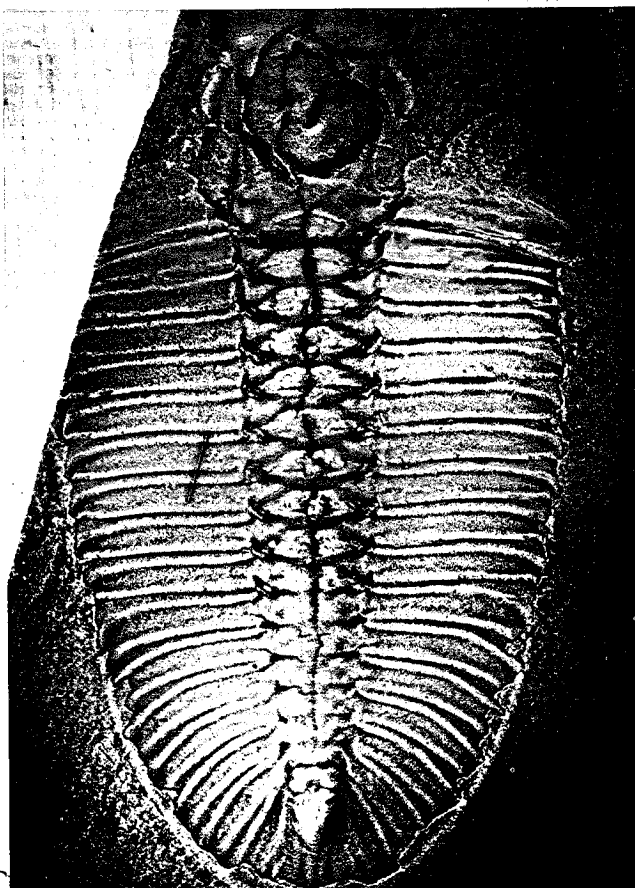
C.—Specimen X2.2 (GUN) from same site.



A



B



C

## Plate 12

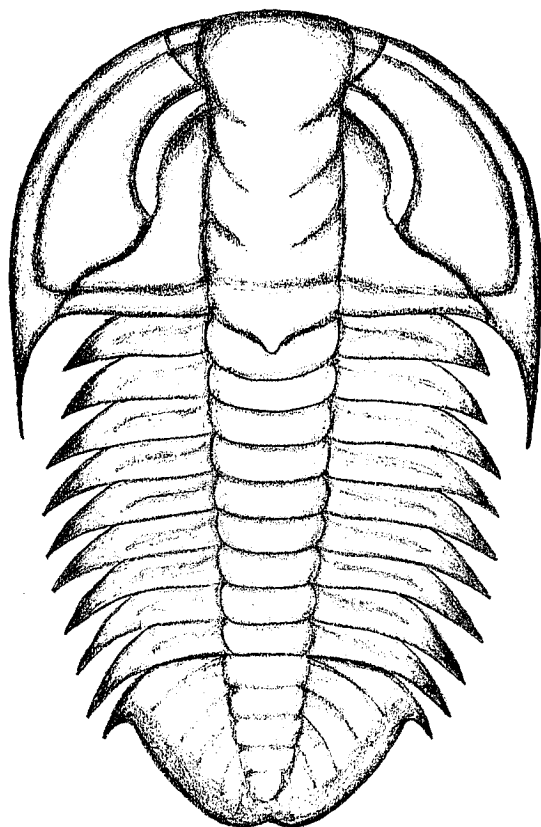
*Bathyriscus wasatchensis* (Resser)

*Description.*—A small- to medium-sized trilobite. Exoskeleton elongate oval in outline. Cephalon semicircular. Genal spines extend to fourth or fifth thoracic segments. Occipital ring bears a small median node. Thorax has nine segments. Pleurae slightly wider than axis, and each pleura has a wide shallow furrow and terminates in a reflexed spine that progressively increases in length posteriorly. Pygidium semielliptical. Axis has four rings and a terminal piece, and ridge extends to edge of border. Anterior segment of pygidium terminates in a prominent recurved spine. Posterior border has a weak median notch.

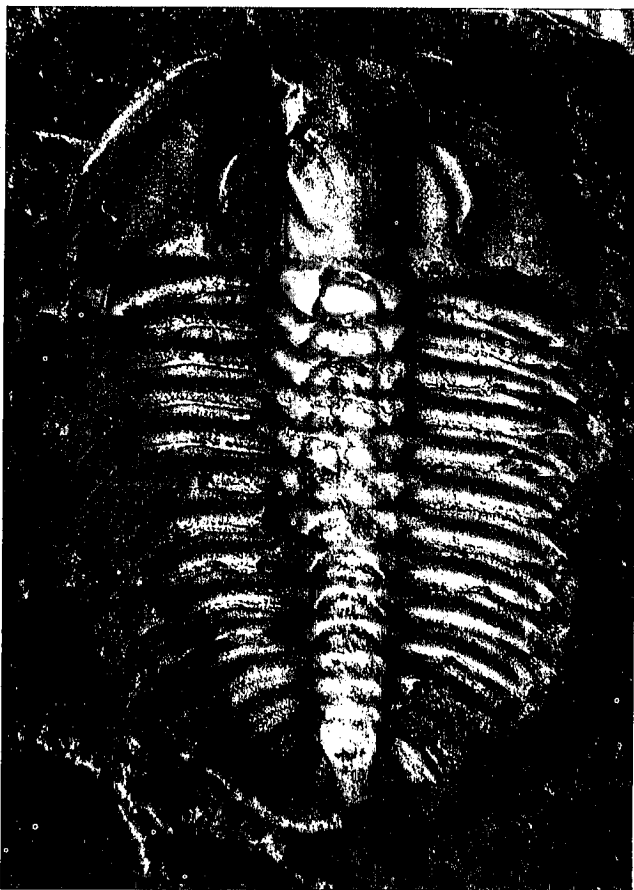
A.—Reconstruction.

B.—Specimen X5.3 (GUN) from lower Spence Shale, Miners Hollow, Wellsville Mountain.

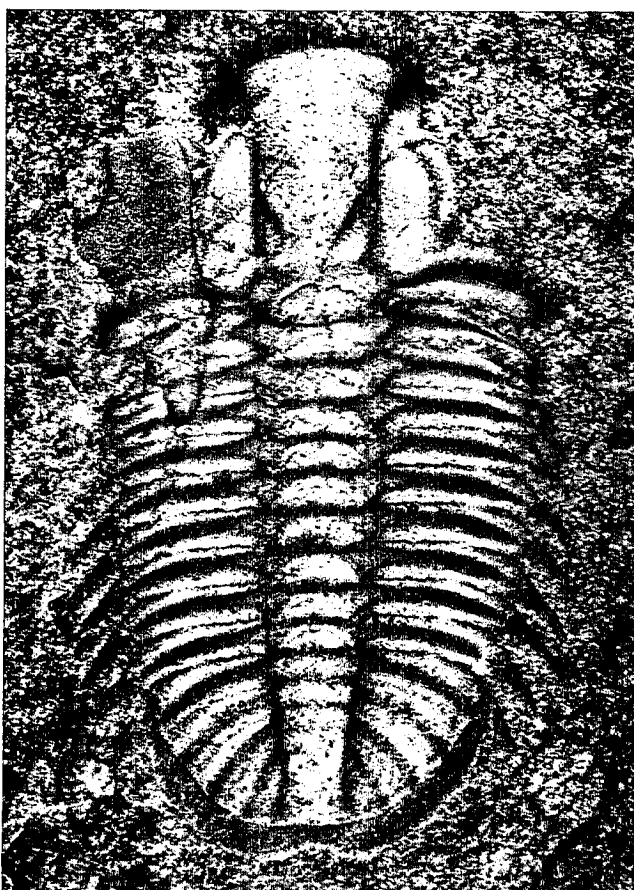
C.—Specimen X3.3 (GUN) from same locality.



A



B



C

## Plate 13

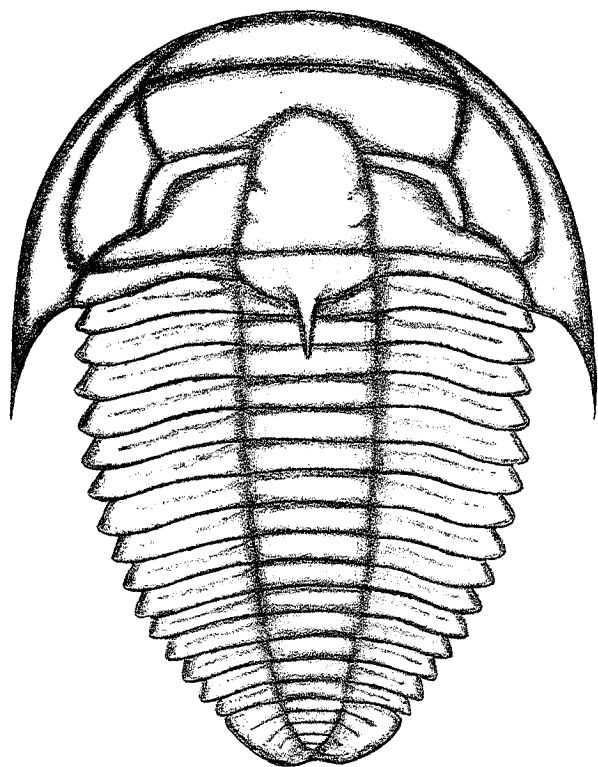
*Bolaspidella housensis* Walcott

*Description.*—A small ovate trilobite generally less than 10 mm in length. Frontal area concave with nearly straight anterior border furrow and prominent upturned convex border. Glabella subrectangular and bluntly rounded anteriorly. Occipital ring widest at center and may or may not possess a medial node or spine. Eye ridges usually visible. Thorax has 15 segments. Pygidium minute, axis contains three or four rings and a terminal piece. Pleural fields contain three or four ribs.

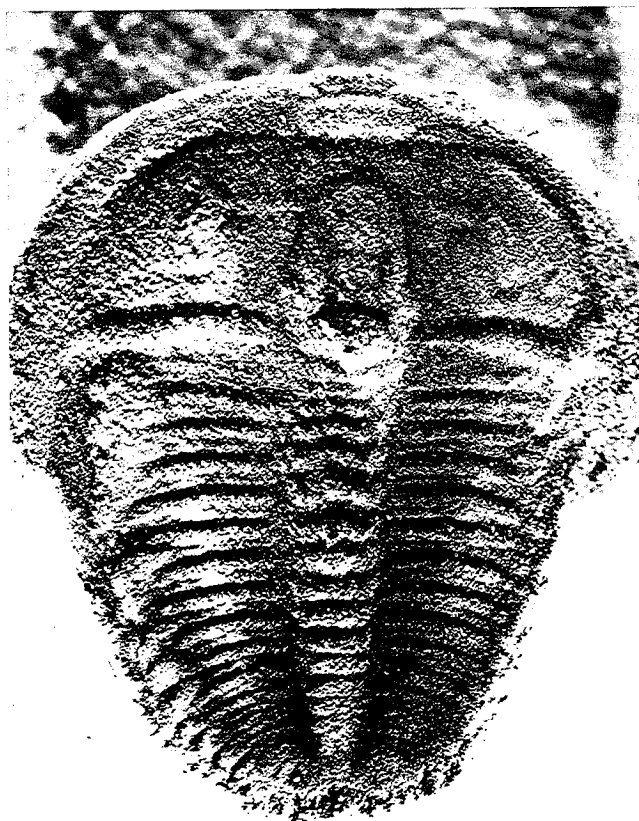
A.—Reconstruction.

B.—Specimen X15.8 (BUR) collected from Wheeler Shale at Wheeler Amphitheater by Mr. and Mrs. Hugh Burnside.

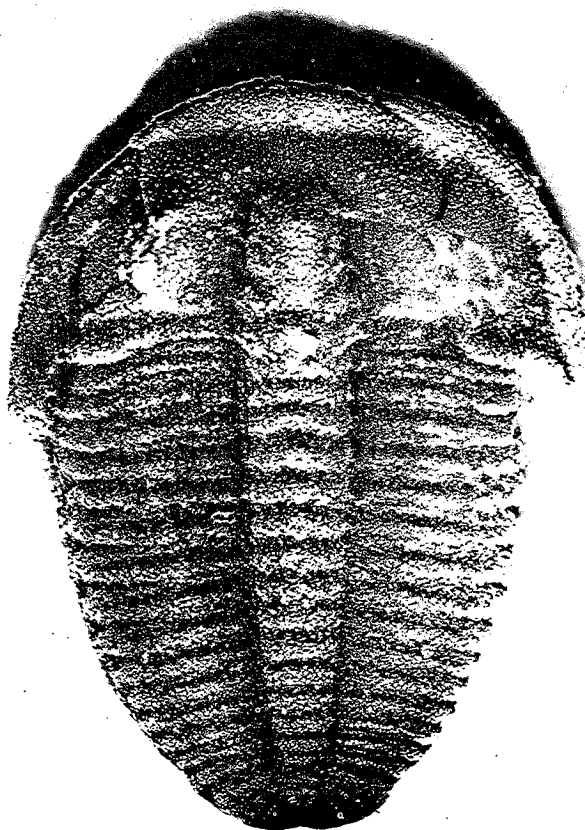
C.—Specimen X10 (BUR) taken from same locality.



A



B



C



## Plate 14

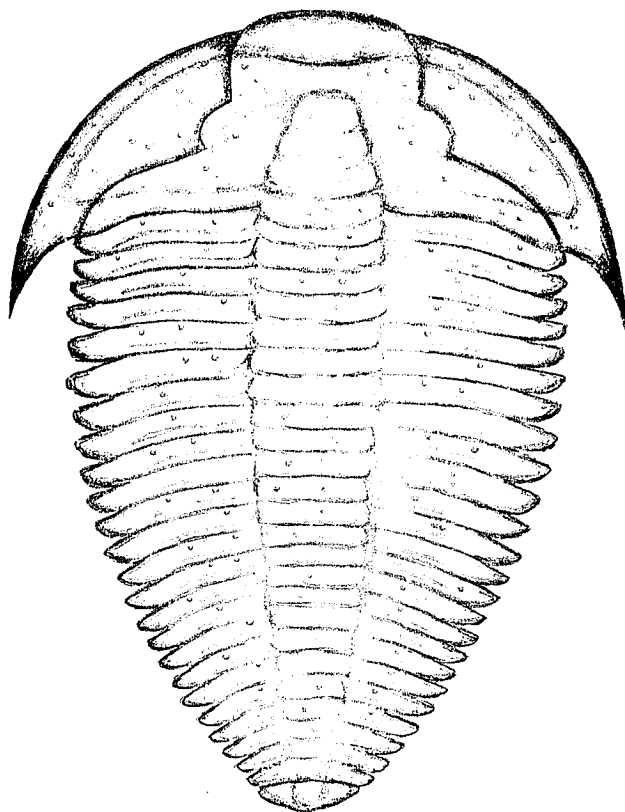
*Bolaspidella wellsvillensis* (Lockman and Denson)

*Description.*—A small trilobite ranging up to about 22 mm in length. Occipital ring bears a faint medial node. Palpebral lobes located opposite or slightly anterior to glabellar midpoint. Genal spines extend back to the third or fourth thoracic segments. Thorax has 24 segments. Pygidium tiny, width over  $2\frac{1}{2}$  times length. Axis has three rings and a terminal piece.

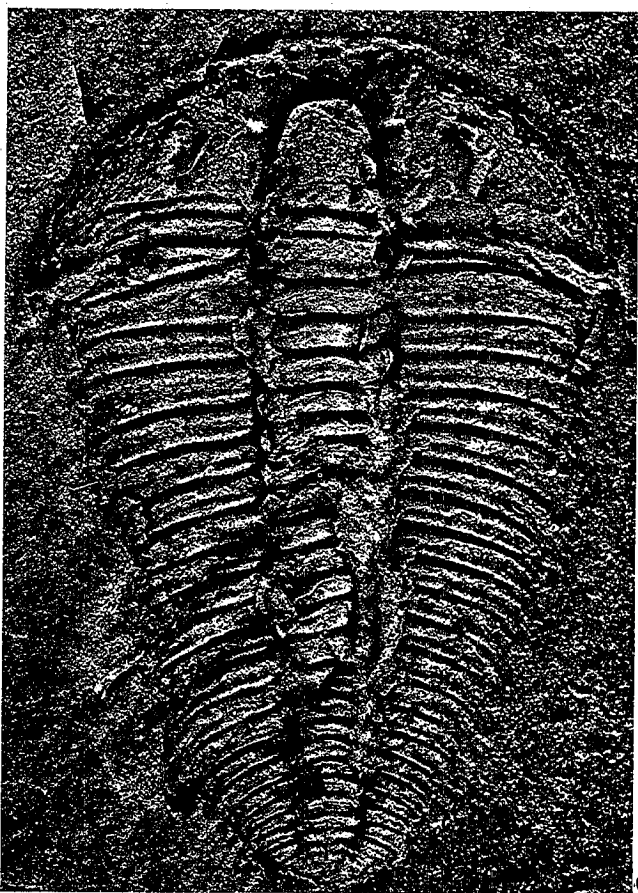
A.—Reconstruction.

B.—Specimen X9.5 (EF) collected by Ed Fowler in Marjum Shale about 5 km (3 mi) east of Marjum Pass, House Range.

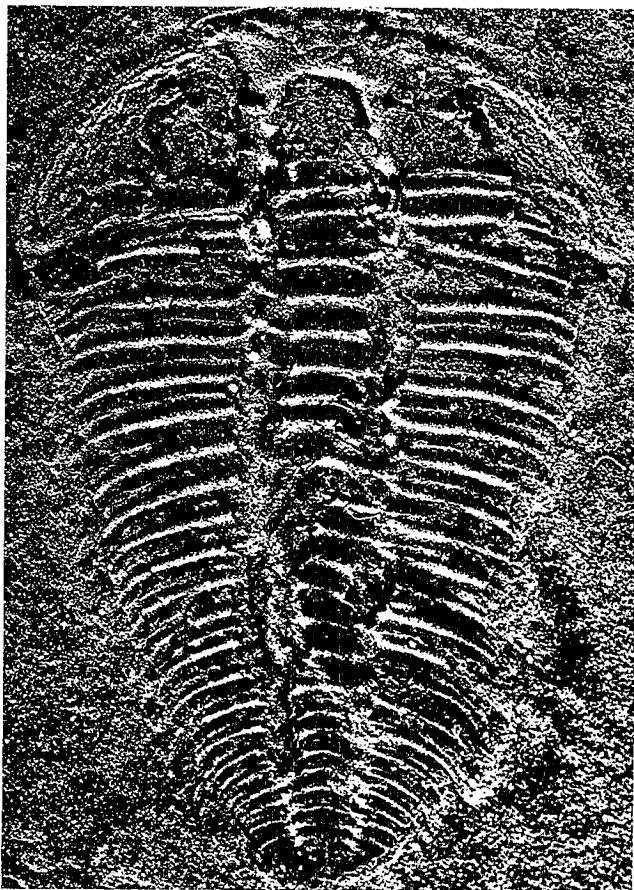
C.—Counterpart (negative) X9.5 of specimen B.



A



B



C

## Plate 15

*Bolaspidella* sp.

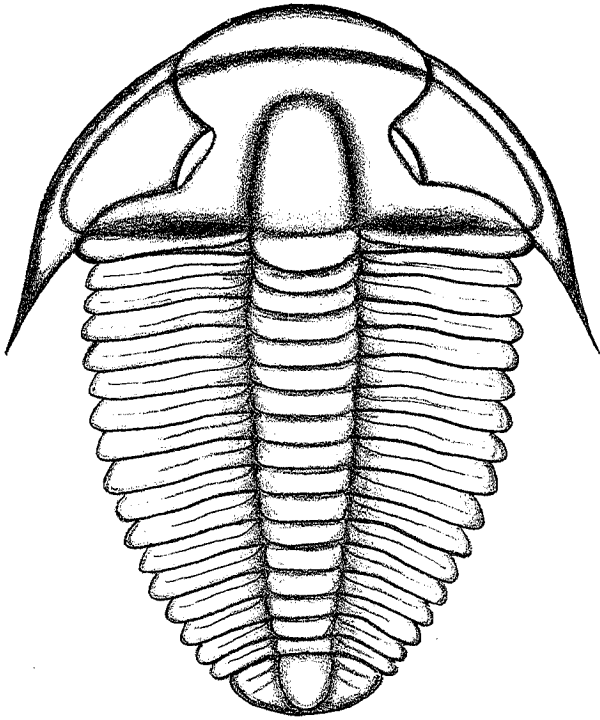
*Description.*—A small ovate trilobite seldom reaching over 20 mm in length. Glabella tapering slightly anteriorly. Frontal area concave with a slightly curved anterior border and a very prominent upturned convex border. Librigenae with genal spines reaching to second or third thoracic segments. Occipital ring without a spine. Thorax has 15 to 18 segments. Pygidium minute.

A.—Reconstruction.

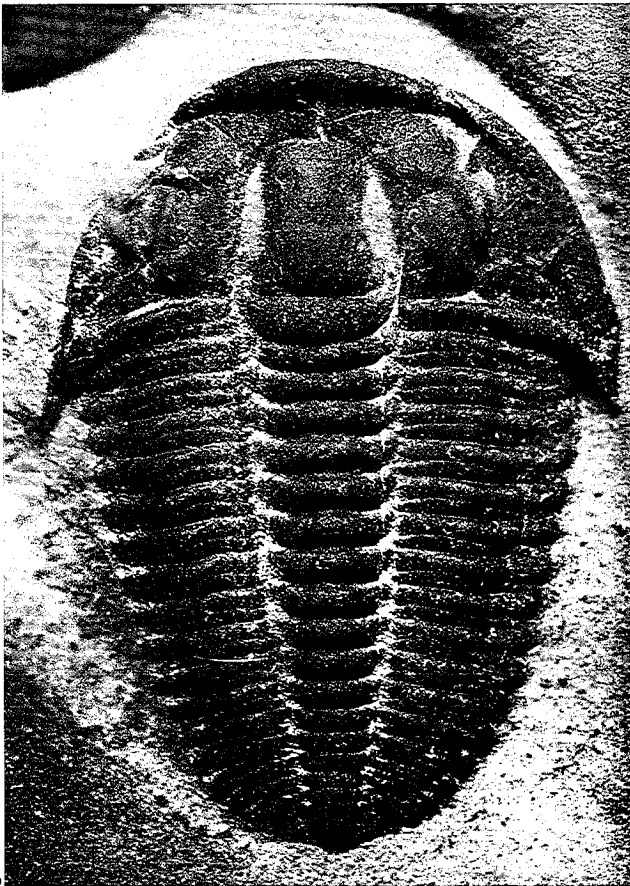
B.—Specimen X11.6 (GUN) from the Marjum Formation at a locality about 3.2 km (2 mi) southwest of Wheeler Amphitheater.

C.—Specimen X6 (GUN) from same locality.

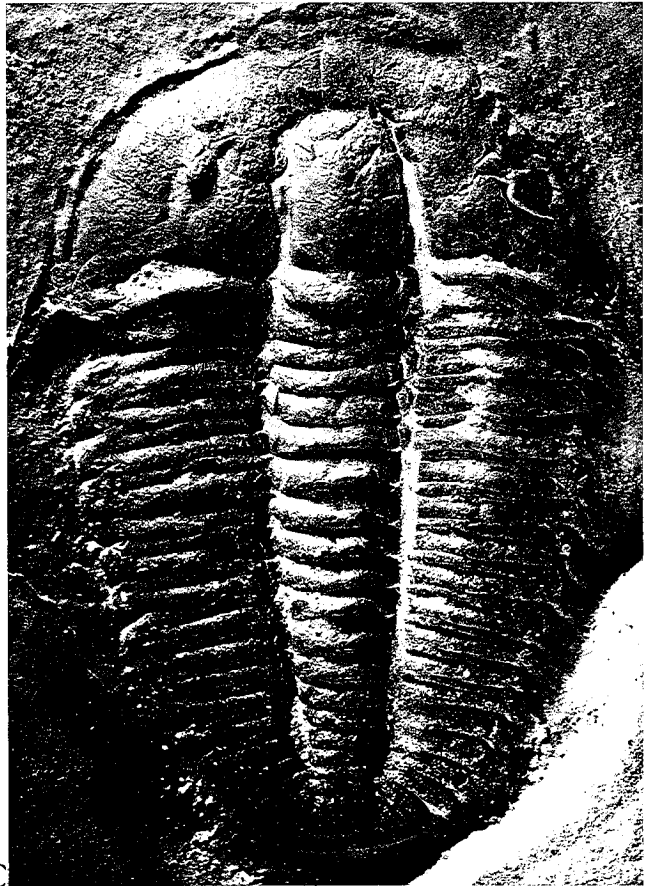
This species occurs in red to pinkish shale associated with *Modocia typicalis*.



A



B



C



## Plate 16

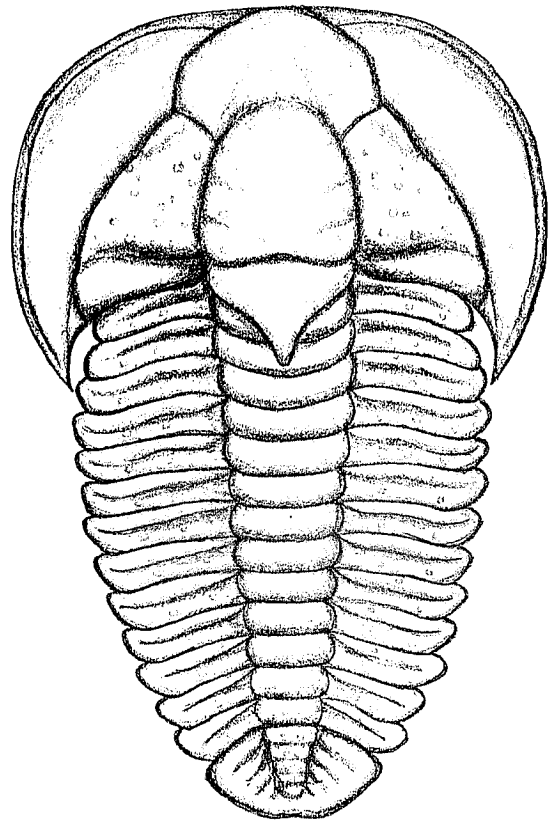
*Brachyaspidion microps* Robison

*Description.*—A small trilobite ranging in size up to 15 mm in length. Glabella tapers forward, is rounded anteriorly. Glabella displays two pairs of oblique transverse furrows on well-preserved specimens. Librigenae have broad-based genal spines extending to the third or fourth thoracic segments. Occipital ring bears a broad based stubby spine extending to or beyond the second thoracic segment. Scattered coarse granules and many fine granules are present on the cranidium and thorax. Thorax has 13 segments. Pygidium is transversely ellipsoidal with the axis bearing four to rarely six rings and a terminal piece.

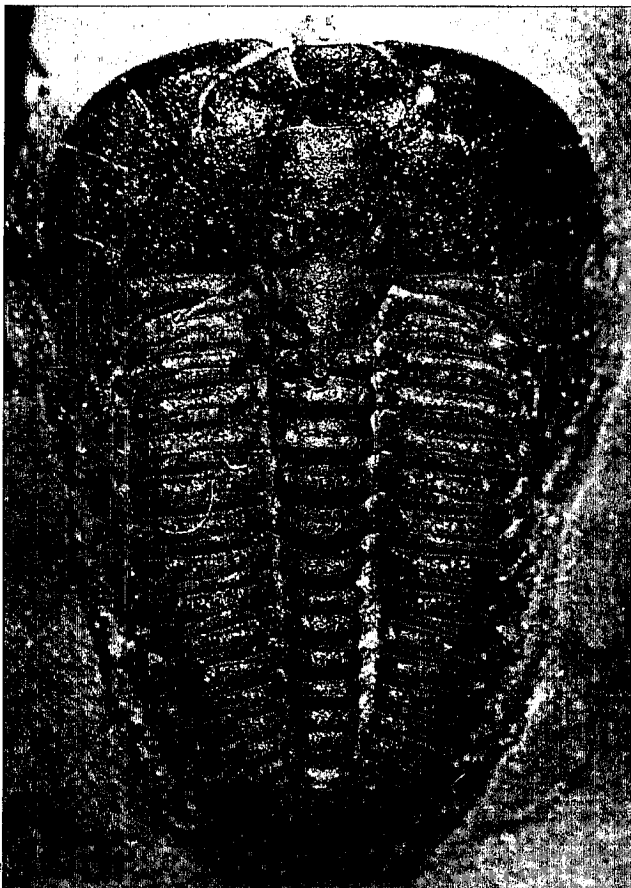
A.—Reconstruction.

B.—Specimen X8.4 (GUN) from upper Wheeler Shale in the vicinity of Swasey Spring, House Range.

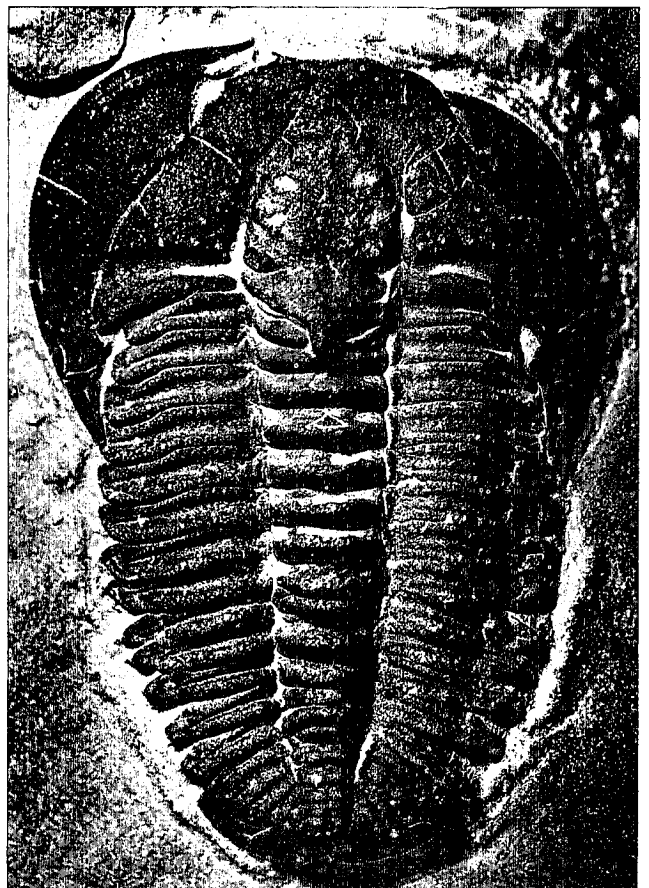
C.—Specimen X15.8 (GUN) from same locality.



A



B



C

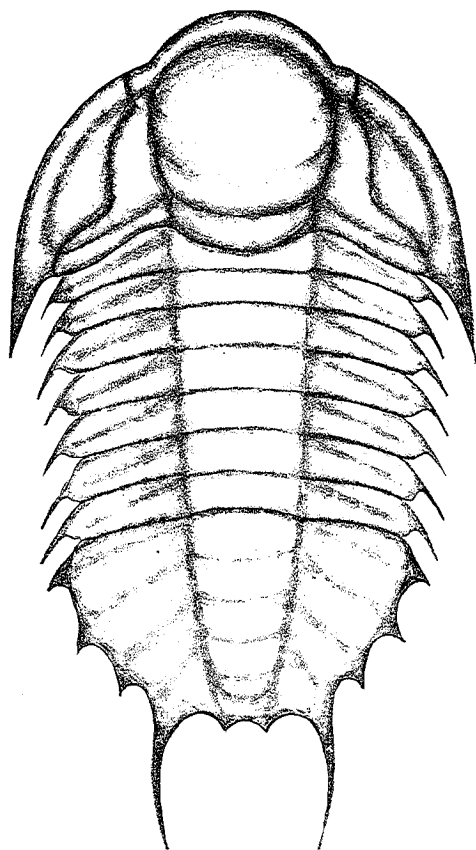
## Plate 17

*Dorypyge* sp.

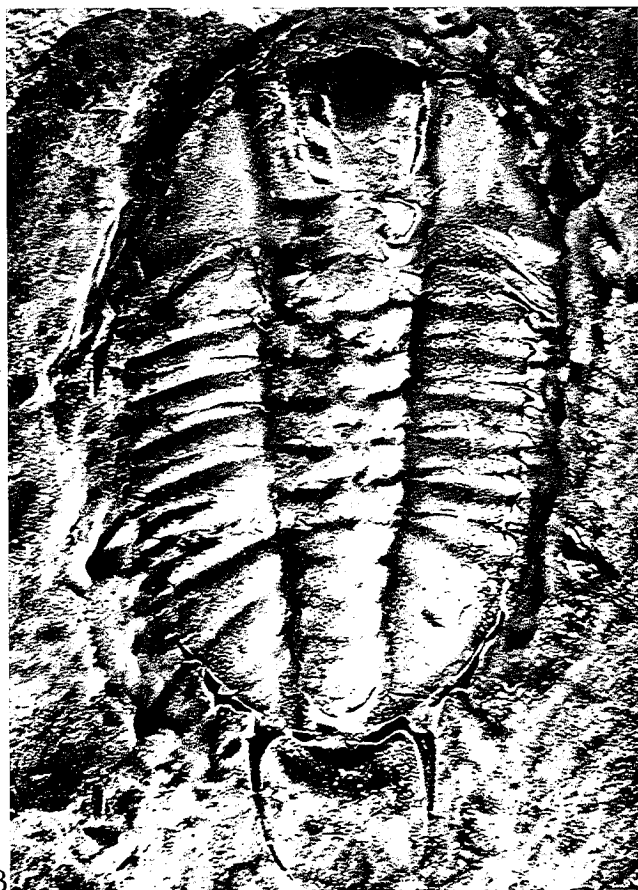
*Description.*—A medium-sized trilobite, one complete specimen measures 50 mm in length, excluding spines. Glabella slightly expanded anteriorly. Border upturned. Genal spines of moderate length extending to the second thoracic segments. Thorax has seven segments, each terminating in a prominent spine. Pygidium semielliptical, axis has four rings and a short terminal piece. Border bears five pairs of spines, three anterior pairs short, the fourth pair long and curved slightly inward. Posterior pair from small triangular spines to minute nubs.

A.—Reconstruction.

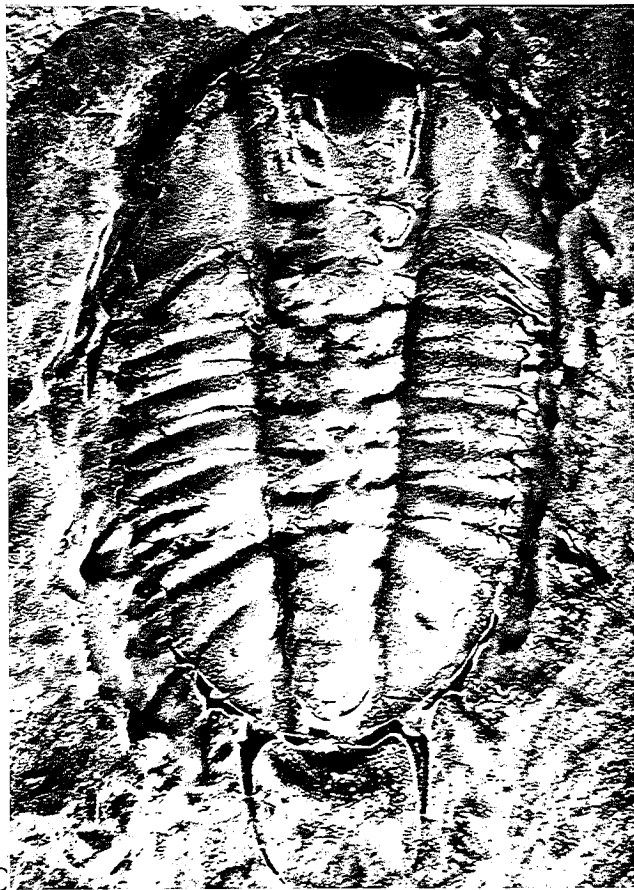
B,C.—Specimen X1.9 (GUN) from Spence Shale between Hansen Canyon and Antimony Canyon, Wellsville Mountain.



A



B



C

## Plate 18

*Elrathia kingi* (Meek)

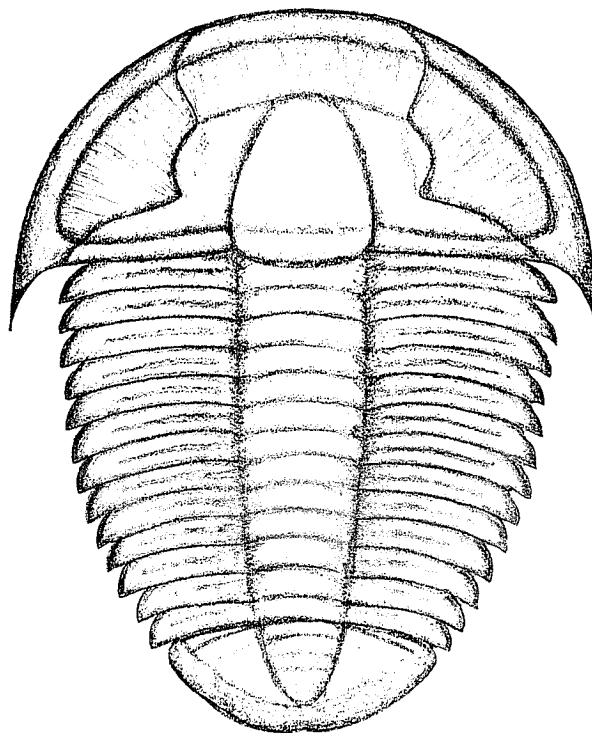
*Description.*—A medium-sized trilobite with a smooth subovate carapace that is tapered toward the posterior. Cephalon is evenly rounded anteriorly. Glabella unfurrowed, slightly tapered, and broadly rounded anteriorly. Genal spines generally extend to the second or third thoracic segments. Thorax usually has 13 segments. Pygidium has four axial rings and a long terminal piece. Posterior margin usually with a broad medial notch.

This is the most ubiquitous trilobite in the Wheeler Shale of Utah, occurring at numerous sites in the House Range and Drum Mountains.

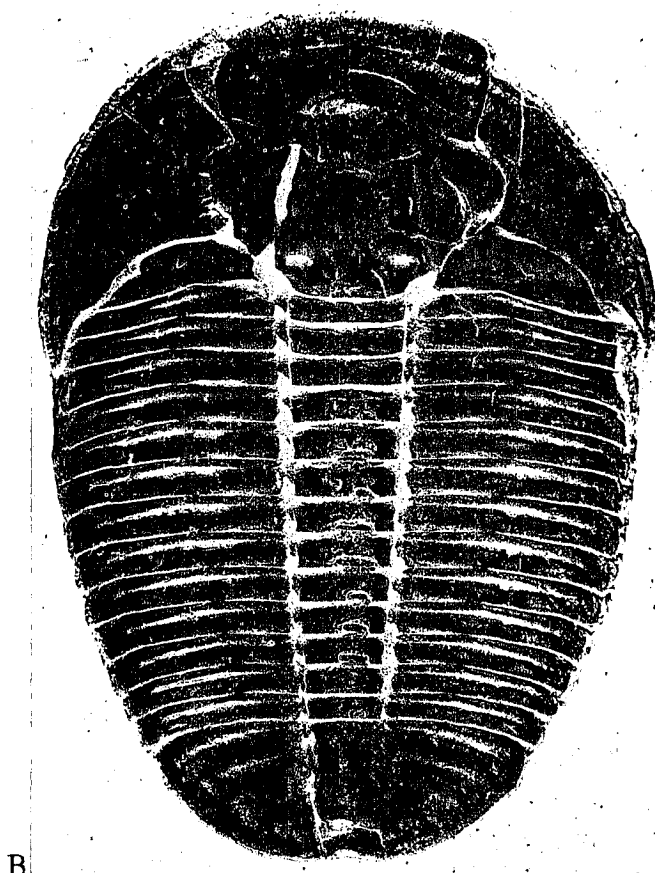
A.—Reconstruction.

B.—Specimen X2.6 (GUN) from the Wheeler Shale, Wheeler Amphitheater.

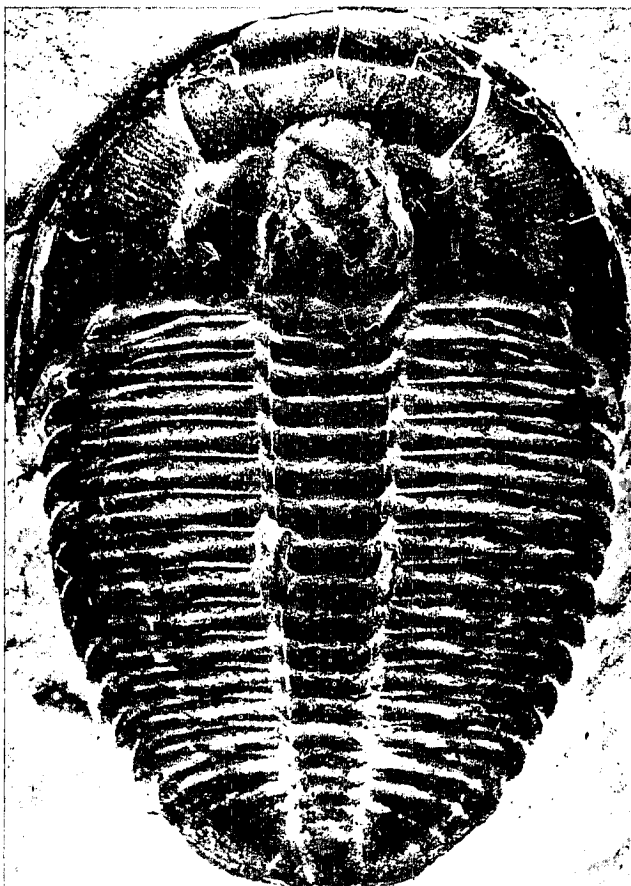
C.—Specimen X4.2 (GUN) from same locality.



A



B



C

## Plate 19

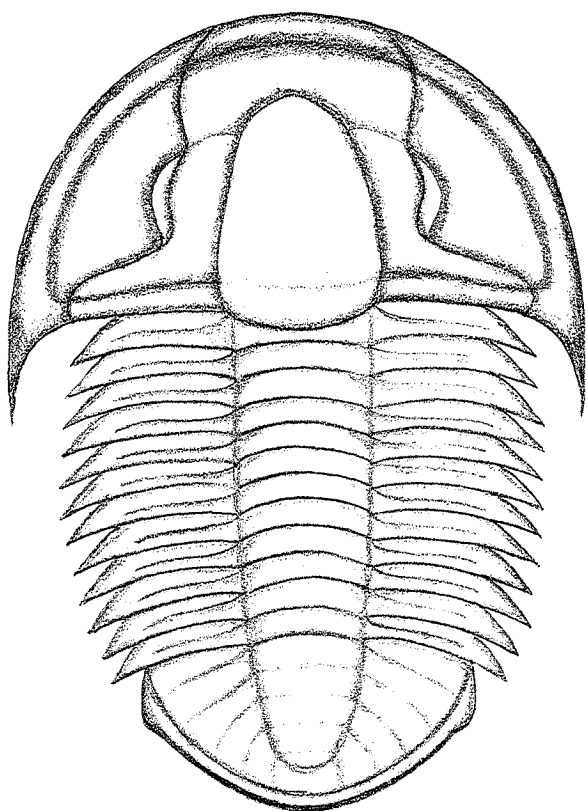
*Elrathia marjumi* Robison

*Description.*—A small- to medium-sized trilobite. Glabella large and rounded anteriorly. Anterior border of cranidium sharply upturned. Palpebral lobes about one-third glabellar length. Thorax has 12 segments as contrasted to *E. kingi* which has 13. Pygidium has axis with five rings and a terminal piece, lacks medial notch on posterior margin, and possesses incipient anterolateral spines.

A.—Reconstruction.

B.—Specimen X5.1 (GL) collected by Gary Locker from Marjum Formation, Wheeler Amphitheater. Photo by Art Marquez.

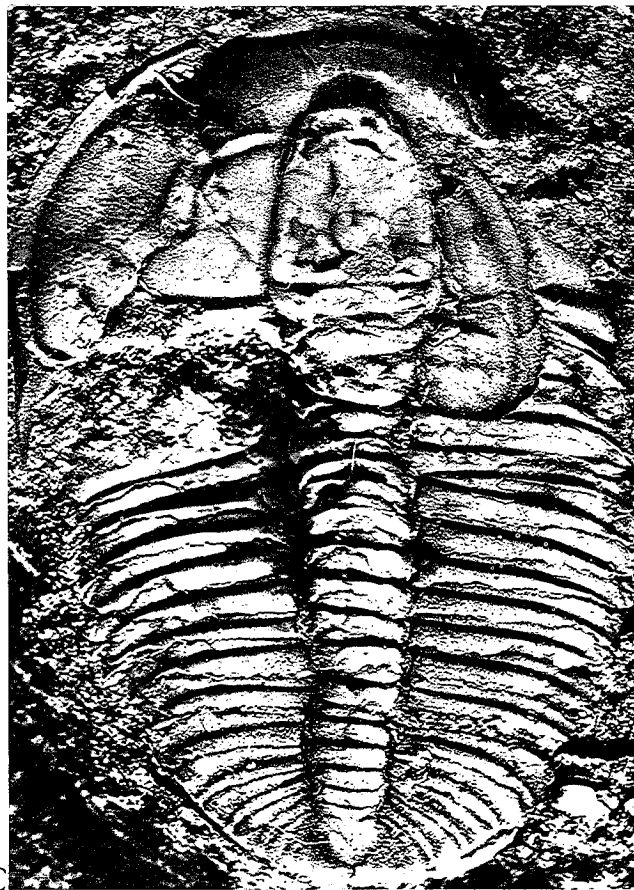
C.—Specimen X6.3 (GL) collected by Gary Locker from same locality.



A



B



C

## Plate 20

*Elrathina* sp.

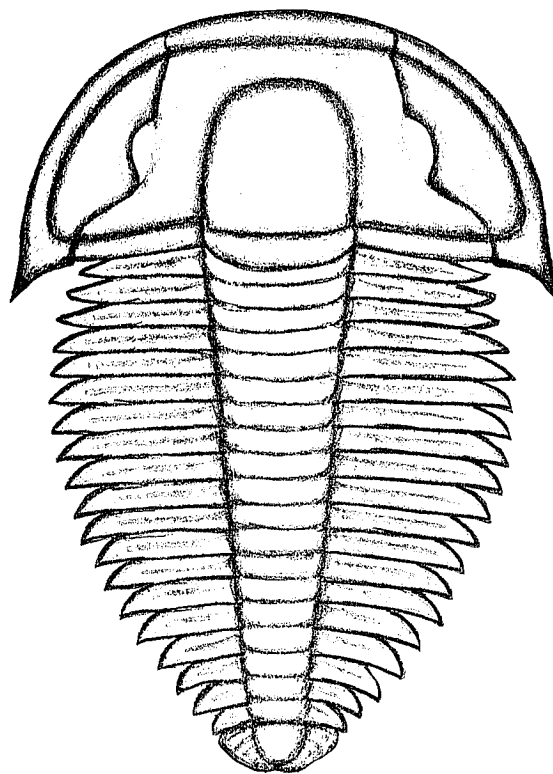
*Description.*—A medium-sized trilobite. Glabella tapered slightly forward, with distinct lateral furrows and broadly rounded anteriorly. Cephalon semielliptical in outline. Occipital ring bears a small medial node. Genal spines extend to second or third thoracic segments. Axis tapered slightly posteriorly. Pleural lobes are moderately wide anteriorly, reach a maximum width about midlength, and narrow quite abruptly anteriorly. Thorax has 19 segments. Pygidium tiny; axis wider than pleural field, and posterior margin is slightly indented.

This species is presently known from only a single site and is associated with *Elrathia kingi*.

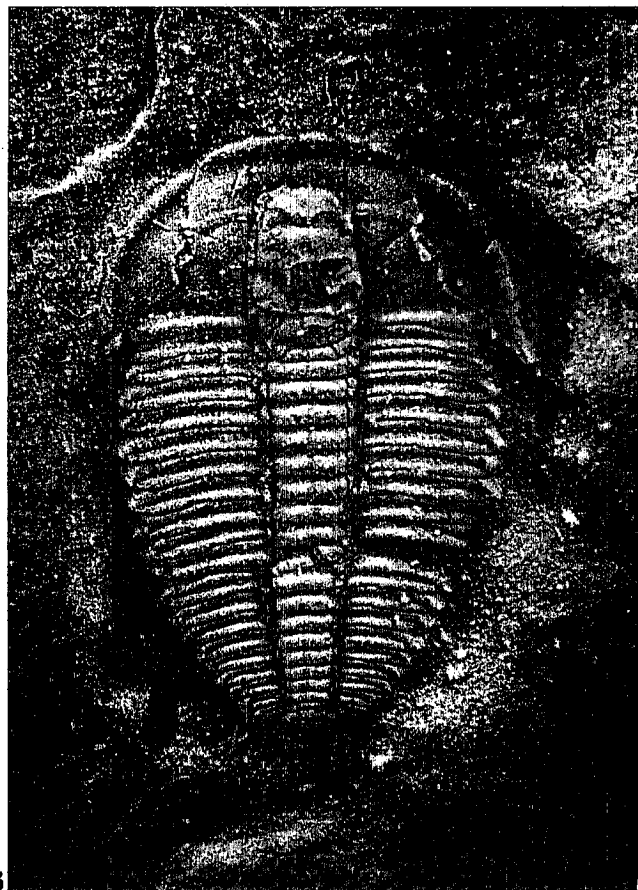
A.—Reconstruction.

B.—Specimen X5.3 (GUN) from Wheeler Shale at a site about 3.2 km (2 mi) north of east side of Marjum Pass, House Range.

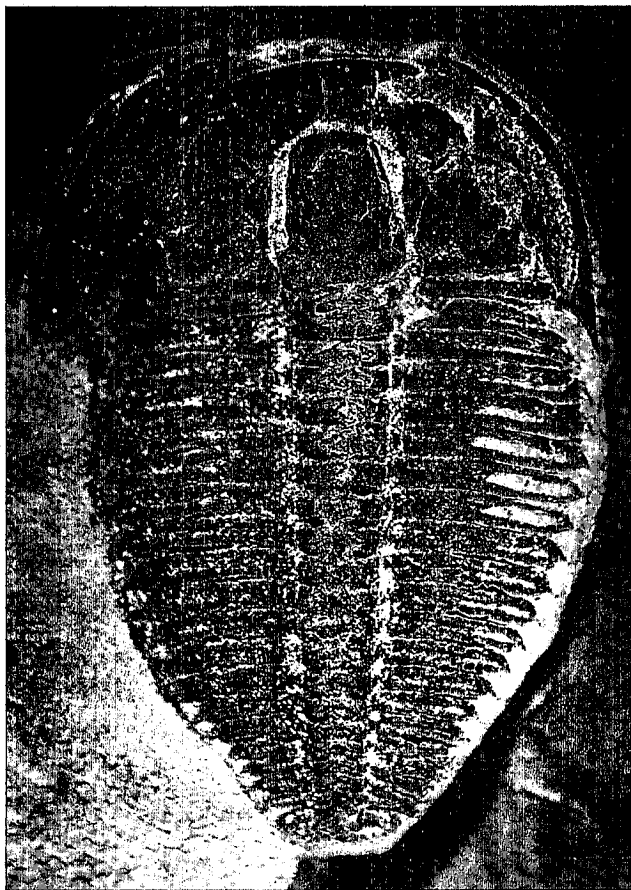
C.—Specimen X7.4 (GUN) from same locality.



A



B



C



## Plate 21

*Glossopleura bion* (Walcott)

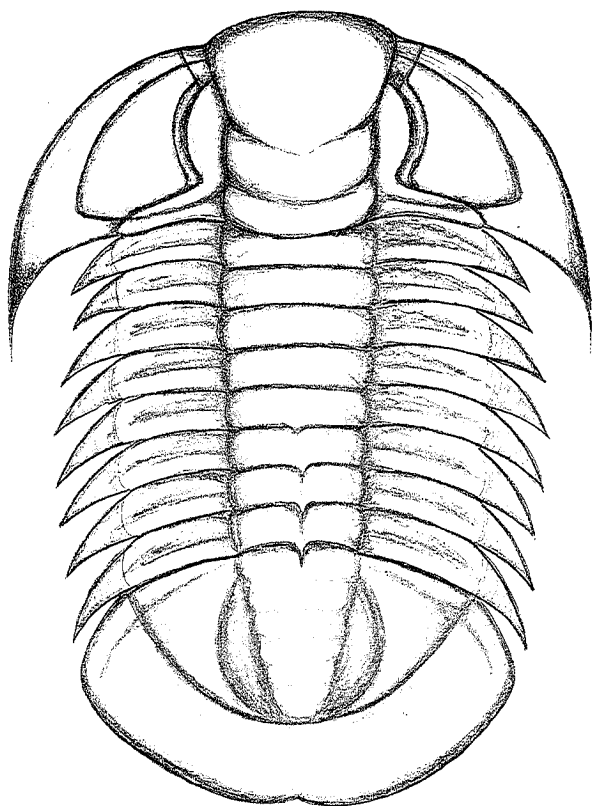
*Description.*—A fairly large trilobite with some specimens measuring over 77 mm in length. It differs from all other species of *Glossopleura* in having a frontal area. Glabella expands rather abruptly anteriorly. Thorax has seven segments. Pygidium has a short axis, and the very broad border is an outstanding characteristic of this species.

A.—Reconstruction.

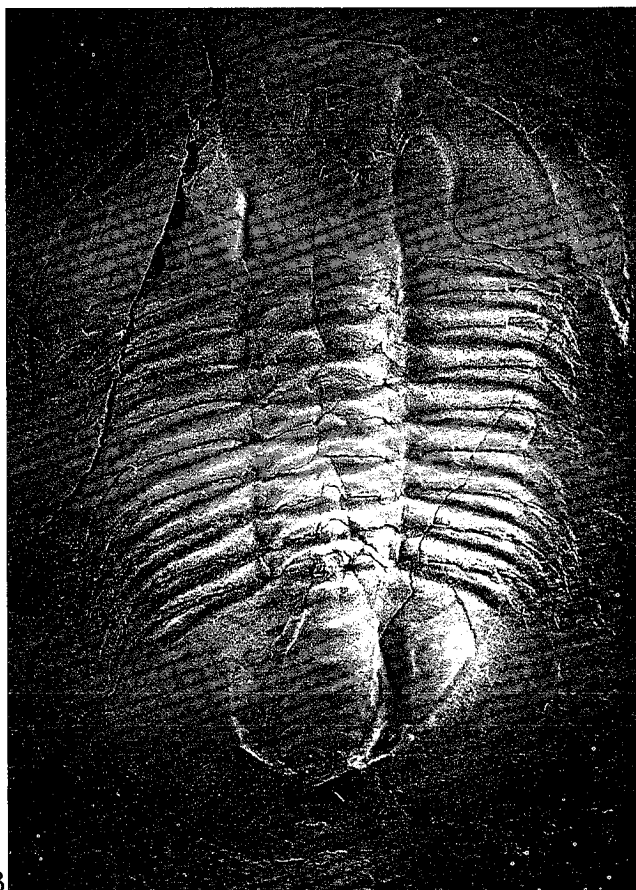
B.—Specimen X1.5 (RF) collected by Robert Fife from near middle of Spence Shale, Antimony Canyon, Wellsville Mountain.

C.—Specimen X1.5 (RF), counterpart (negative) of specimen B.

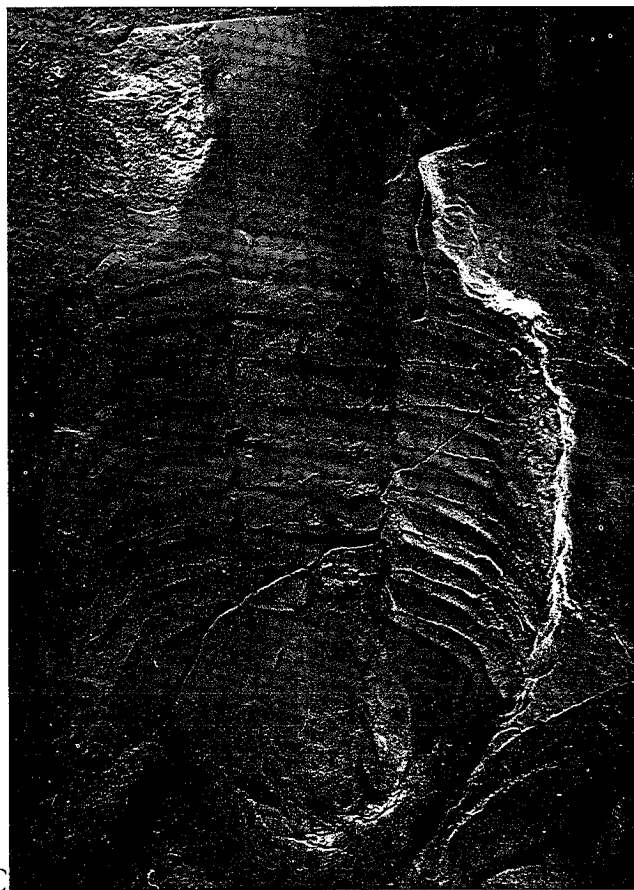
Other specimens have been found in Hansen Canyon, Wellsville Mountain.



A



B



C

## Plate 22

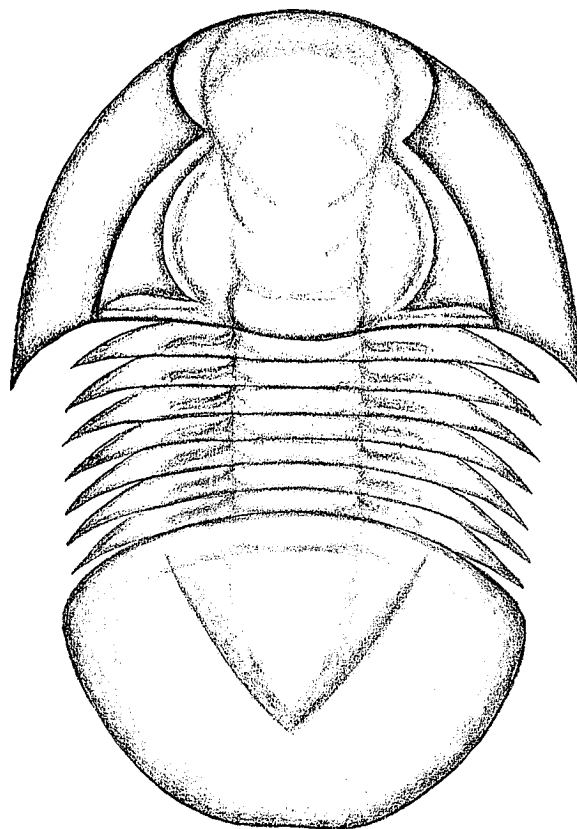
*Glossopleura gigantea* Resser

*Description.*—One of the largest Middle Cambrian trilobites of Utah. One complete specimen measures 134 mm in length. On the basis of other fragments, some would have exceeded 140 mm. Glabella large, expanding forward reaching anterior margin of cranium and bluntly rounded. Short, stout genal spines extend to the second or third thoracic segments. Thorax has eight segments. Axis is about the same width as pleura minus the spines. Pleural spines rather thick and curve backward, increasing in length posteriorly. Pygidium semicircular with a broad border that has a slight medial notch, rounded anterolateral margins, and faint terrace lines.

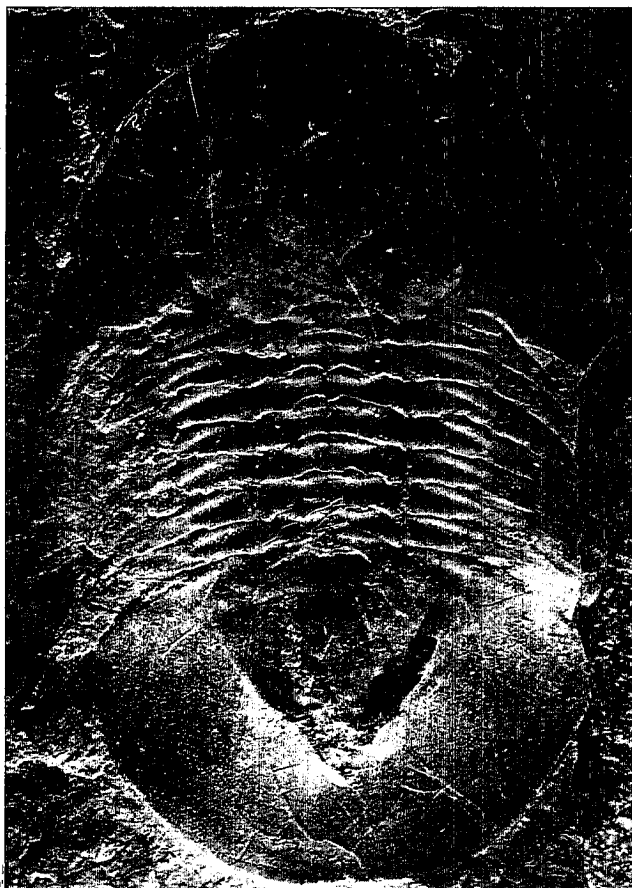
A.—Reconstruction.

B.—Specimen X0.8 (GUN) from upper Spence Shale, Hansen Canyon, Wellsville Mountain.

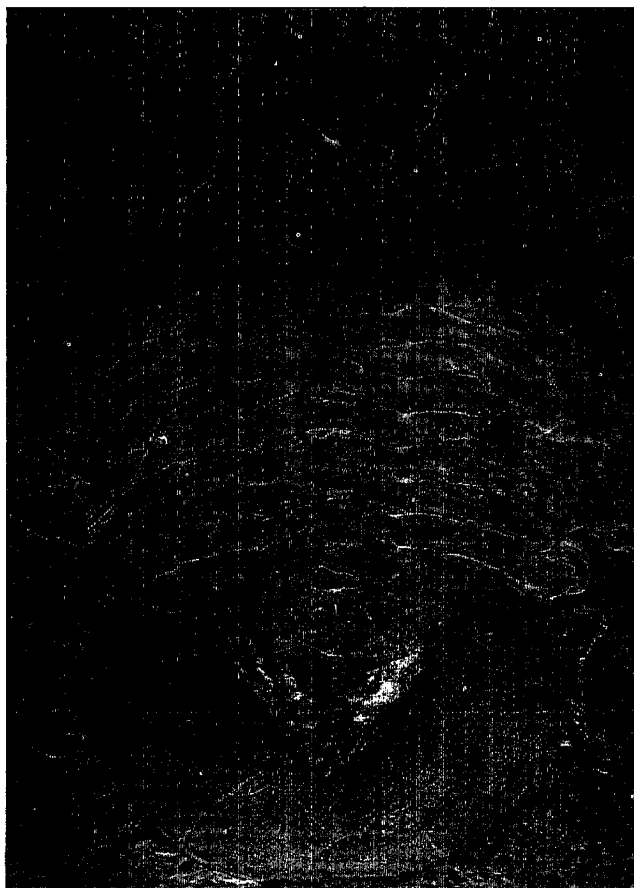
C.—Specimen X0.9 (GUN) from upper Spence Shale, first canyon north of Hansen Canyon, Wellsville Mountain.



A



B



C



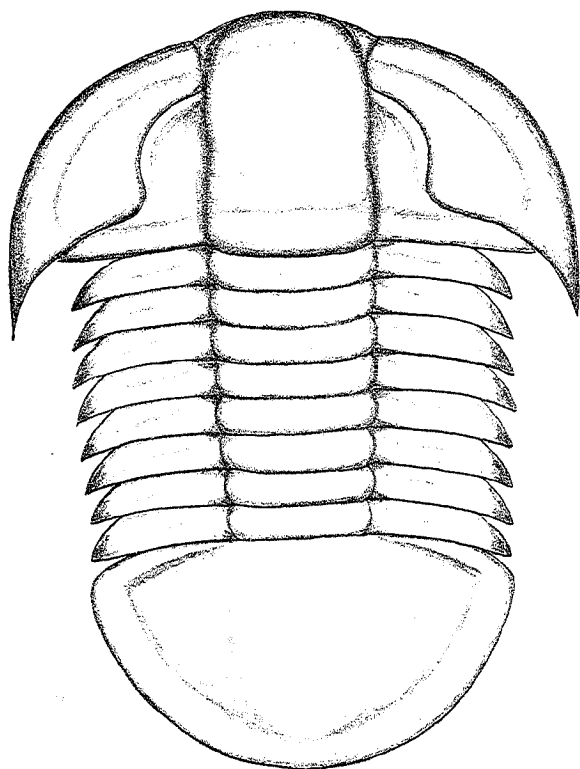
## Plate 23

*Glossopleura* sp.

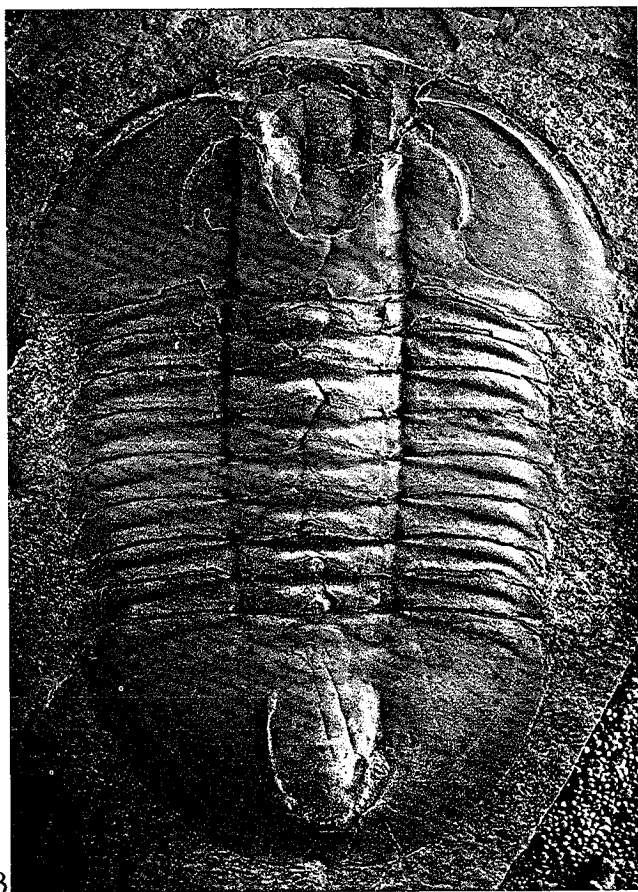
*Description.*—A medium-sized trilobite. Cephalon semicircular in outline. Glabella large, slightly expanded, and bluntly rounded, extending to border. Genal spines fairly short, extending to the second thoracic segment. Thorax has eight segments. Axis slightly wider than pleura anteriorly, tapering to about the same width posteriorly. Pleura tips falcate. Pygidium semielliptical, length about 0.60 width, a medium wide border with rounded anterolateral margins. Axis prominent, slightly tapered, reaching the inner margin of posterior border.

A.—Reconstruction.

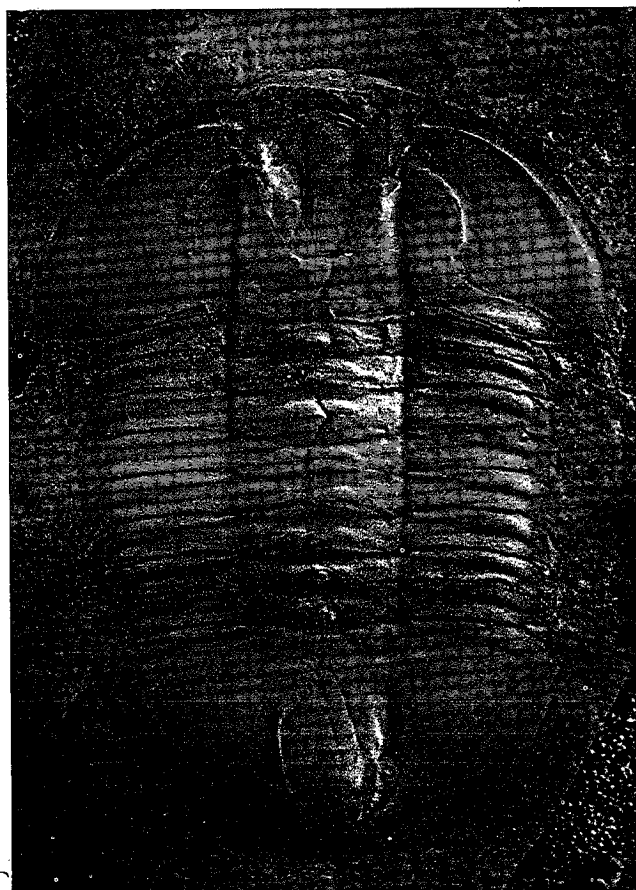
B,C.—Specimen X1.7 (GUN) from upper Spence Shale in Antimony Canyon, Wellsville Mountain.



A



B



C

## Plate 24

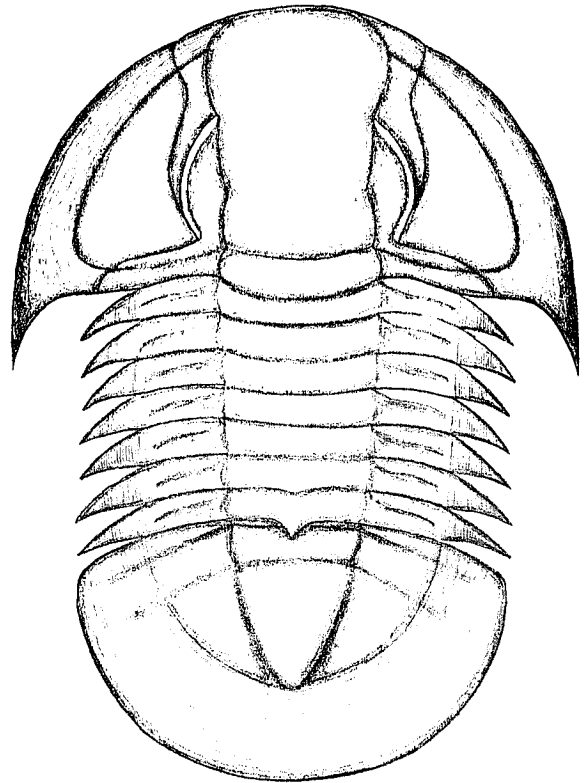
*Glossopleura* sp.

*Description.*—A medium-sized trilobite. Glabella large, extending to border and expanded moderately anteriorly. Eye ridges prominent, extending over half the glabellar length. Thorax has seven segments. The last axial segment has a short stubby medial spine. Pygidium semicircular in outline with a moderately wide border.

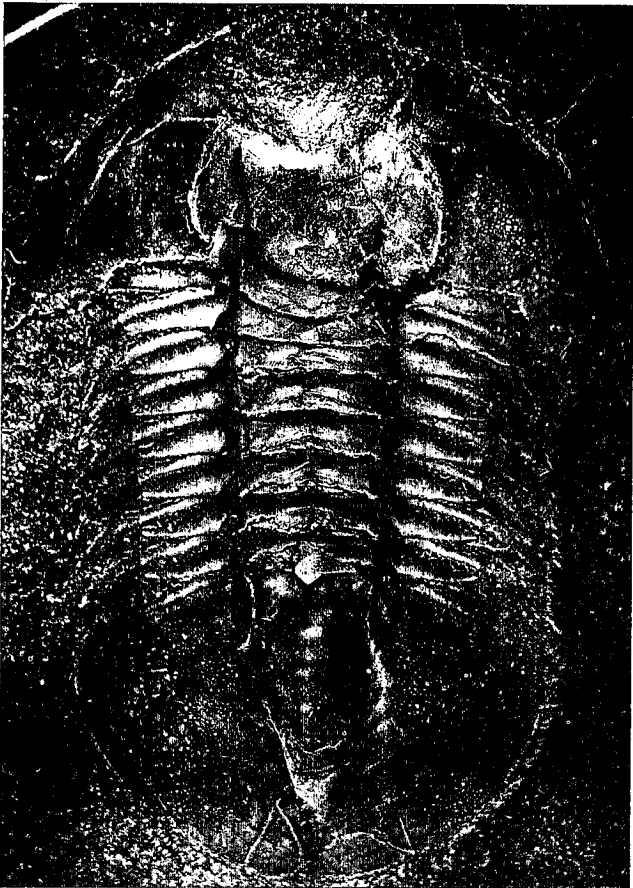
A.—Reconstruction.

B.—Specimen X1.8 (GUN) from upper Spence Shale in Antimony Canyon, Wellsville Mountain.

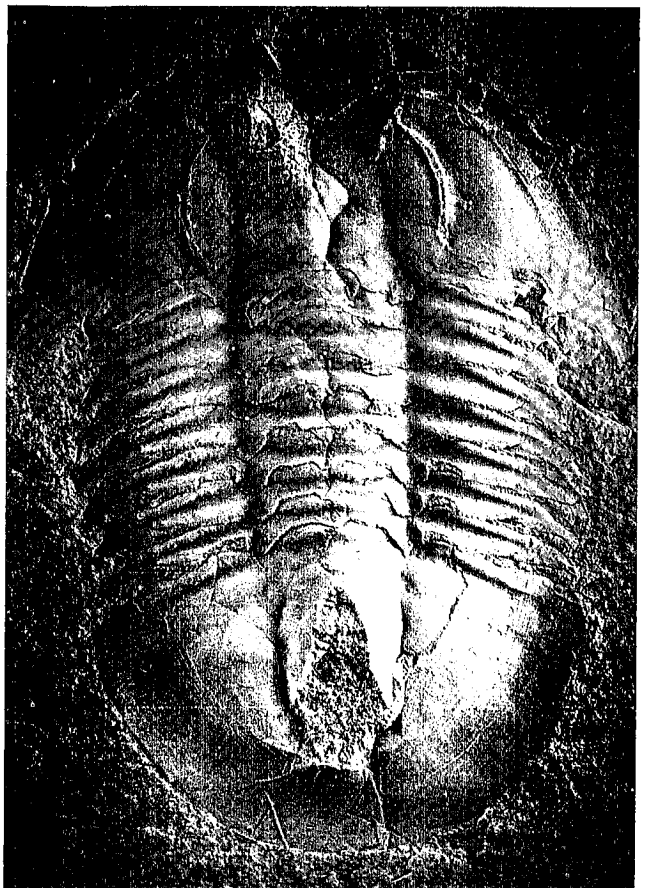
C.—Specimen X2.1 (GUN) from near top of Spence Shale, Antimony Canyon, Wellsville Mountain.



A



B



C

## Plate 25

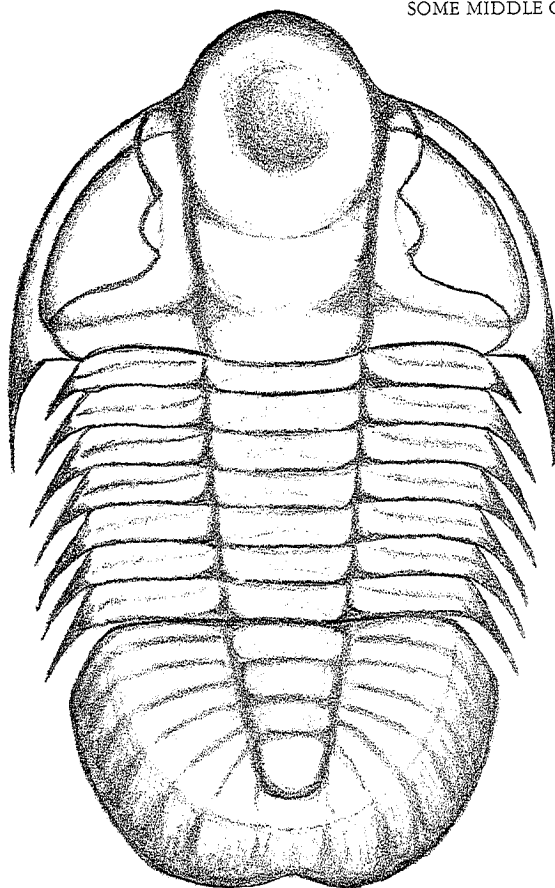
*Hemirhodon amplipyge* Robison

*Description.*—A large trilobite, some specimens measuring over 100 mm in length. Glabella expands anteriorly, extending beyond anterior margin of librigenae. Genal spines extend to the third thoracic segment. Thorax has seven segments, each terminating in narrow reflexed tips. Pygidium large, length nearly equal to that of the cephalon. It is generally semicircular in outline and nearly twice as wide as long with the posterior margin usually indented.

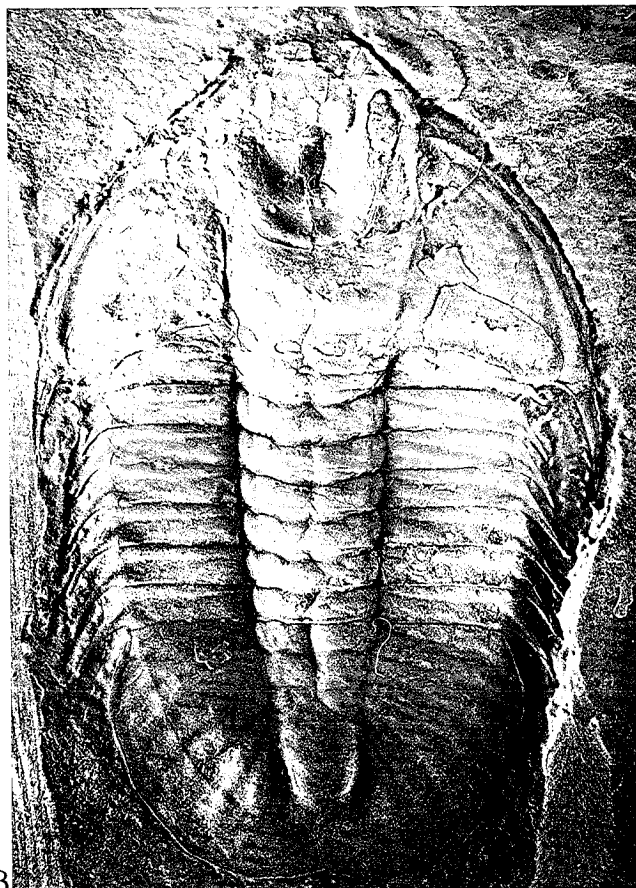
A.—Reconstruction.

B.—Specimen X1 (GUN) from near the middle of the Marjum Formation, Marjum Pass, House Range.

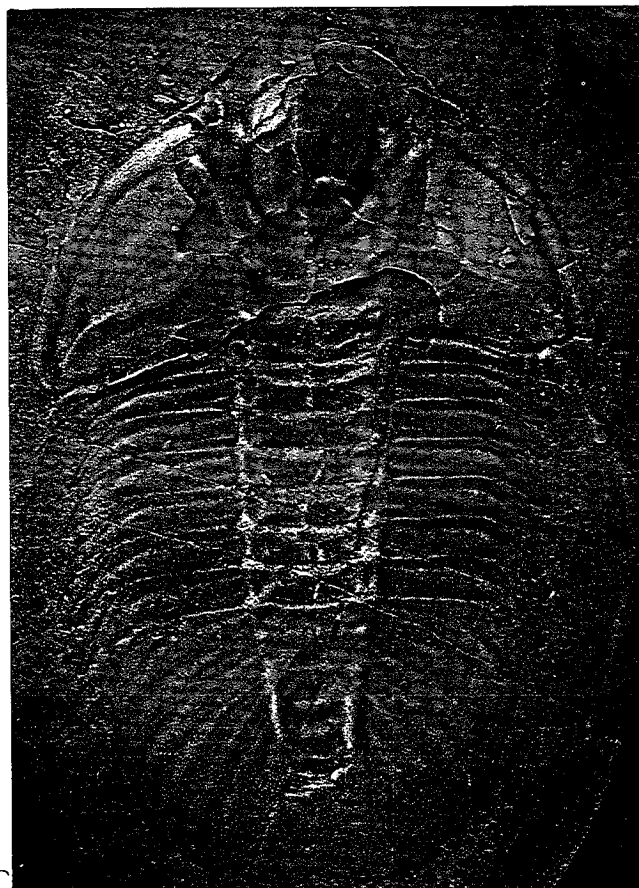
C.—Specimen X1 (GUN) from the same locality.



A



B

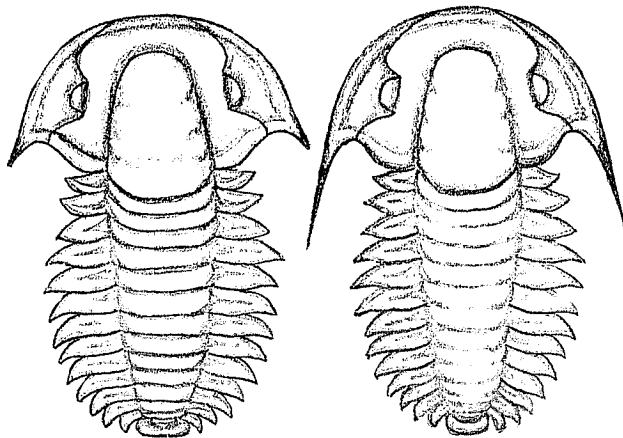


C

## Plate 26

*Jenkinsonia varia* Robison

*Description.*—This genus and only known species is characterized by its small size and imperfect hour-glass shape. It ranges up to 11 mm in length. Cephalon transversely semielliptical in outline. Glabella moderately large, subquadrate with slightly tapered sides and bluntly rounded anterior. Occipital ring unusually long. Genal spines flaring and of variable length, suggesting the possibility of sex dimorphism. Thorax has 12 to 14 segments. Pleural lobes are narrow anteriorly, reach maximum width about midlength, and narrow again posteriorly. Pleurae have sharp points that may be slightly falcate in central and posterior regions of thorax. Pygidium tiny, width two to three times length.



A.—Reconstruction.

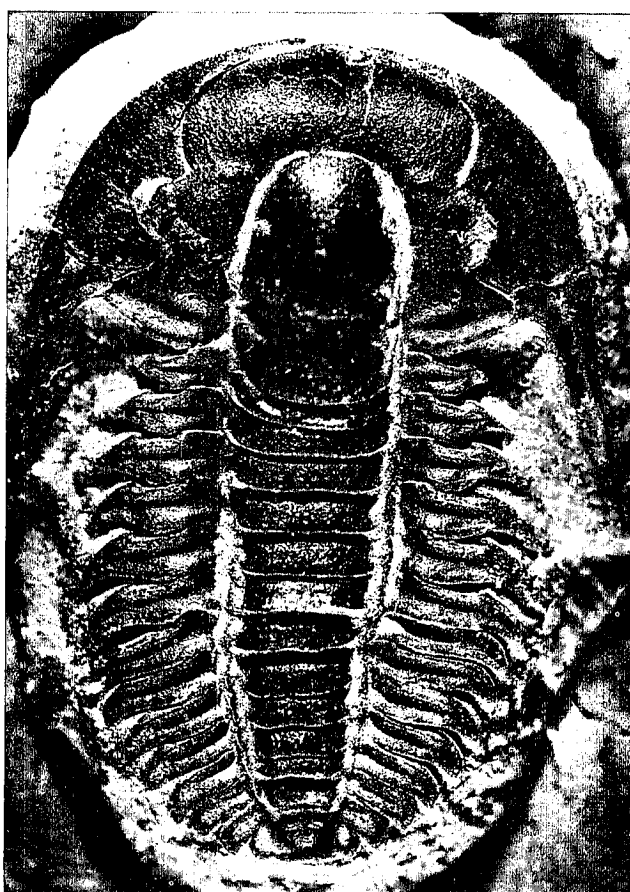
B.—Specimen X12.6 (GUN) with short genal spines from upper Wheeler Shale near Swasey Spring, House Range.

C.—Specimen X13.6 (GUN) with long genal spines from same locality.

A



B



C

## Plate 27

*Kochina vestita* Resser

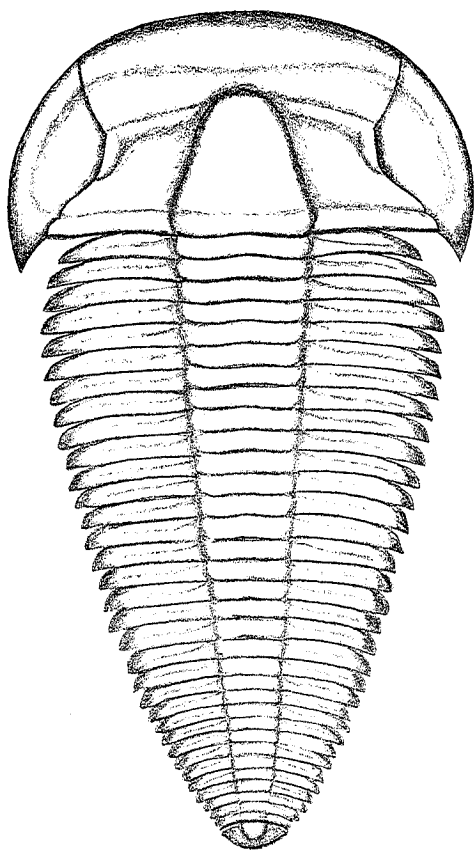
*Description.*—A long, slender trilobite averaging in four specimens we have collected about 60 mm in length. Glabella tapered and bluntly rounded anteriorly. Frontal area long and broad, nearly equal to glabellar length. Librigenae short, terminating in a broad-based stubby spine. Thorax has 33 segments. Axis nearly as wide as pleurae and tapering gradually posteriorly. Pygidium tiny.

A.—Reconstruction.

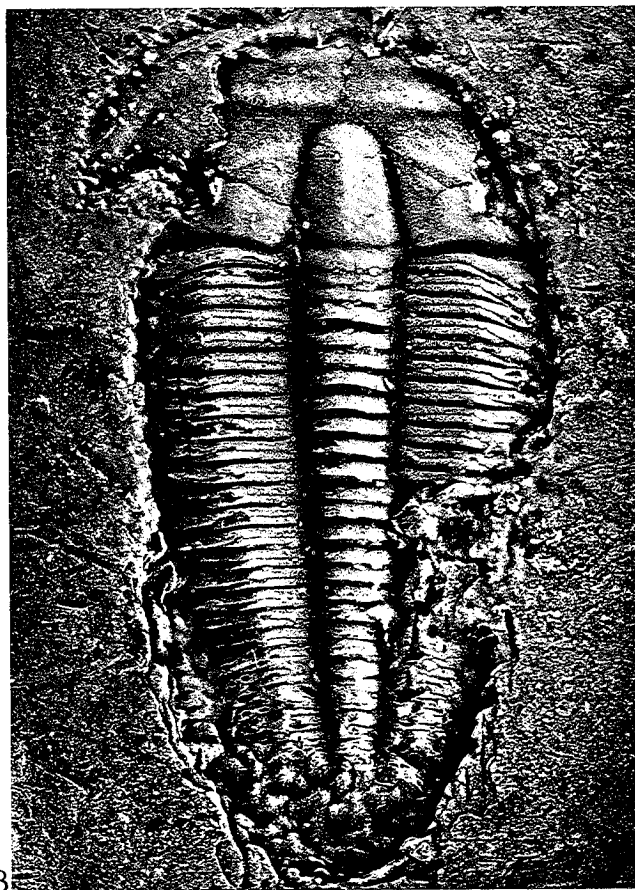
B.—Specimen X1.5 (GUN) taken about 75 feet below top of Spence Shale, Antimony Canyon, Wellsville Mountain.

C.—Specimen X1.9 (GUN) from float at Antimony Canyon, Wellsville Mountain.

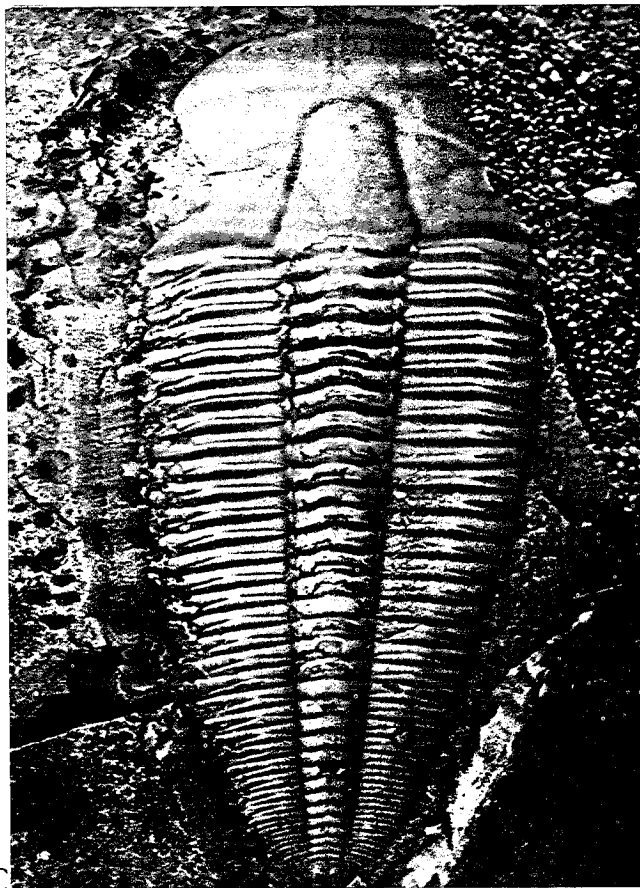
Other specimens have been found at Miners Hollow, Wellsville Mountain.



A



B



C

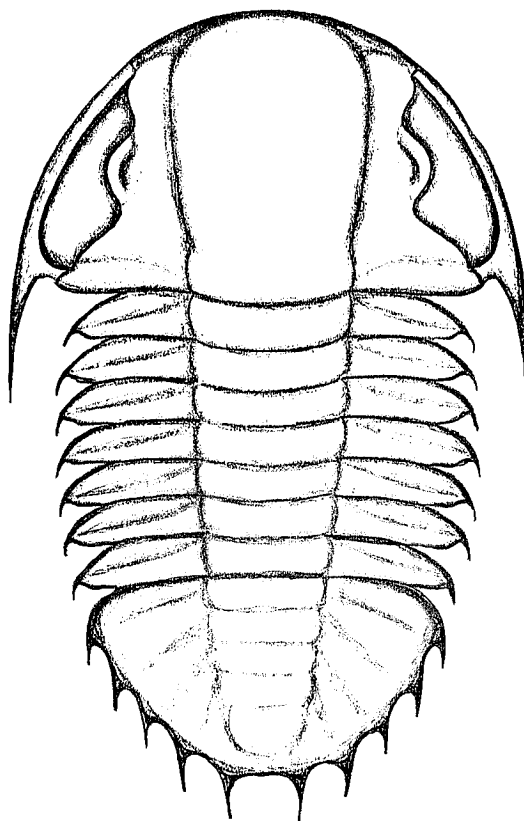
## Plate 28

*Kootenia* sp.

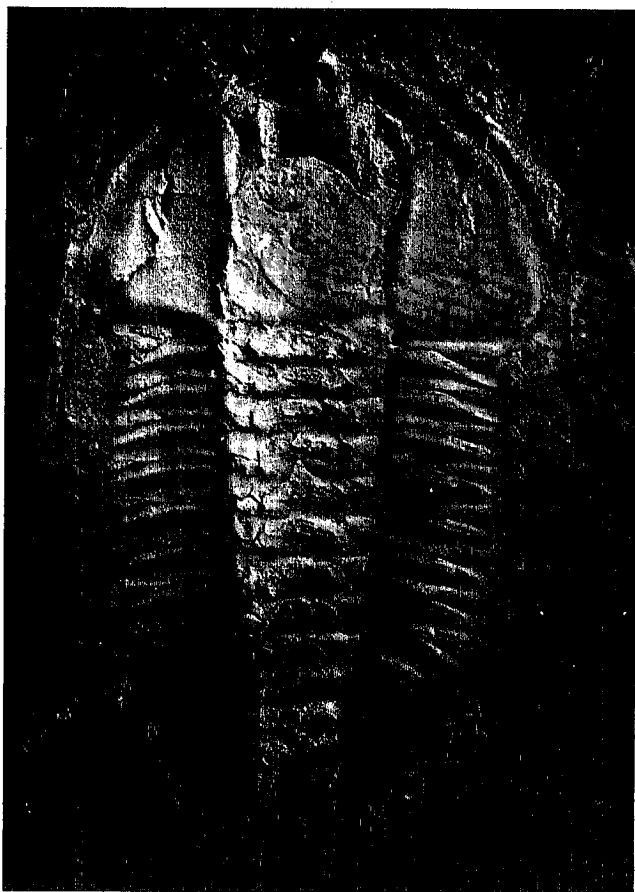
*Description.*—A medium-sized trilobite measuring 43 mm on one specimen examined. Cephalon semicircular in outline. Glabella long, extending to border, moderately broad, unfurrowed, and rounded anteriorly. Fixigena width nearly one-half glabellar width at eye line. Genal spines moderately long and slender extending to third thoracic segment. Thorax has seven segments each terminating in very short, posterolaterally directed spines. Pygidium semielliptical, distinctly wider than long. Axis has four rings and a terminal piece. Border extended into five pairs of short, stubby spines that increase in length posteriorly.

A.—Reconstruction.

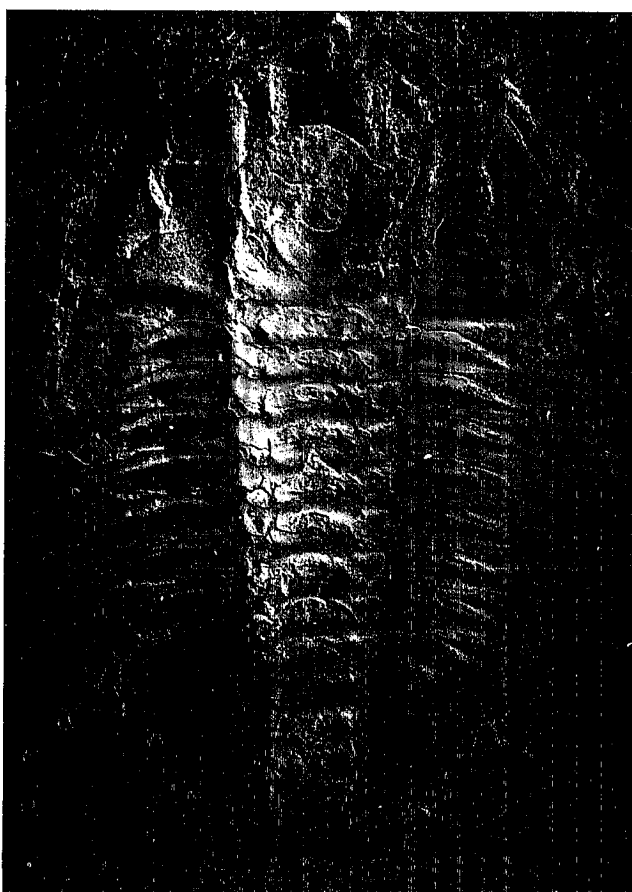
B,C.—Specimen X2.5 (GUN) from near top of Spence Shale, Antimony Canyon, Wellsville Mountain. Photographed “smoked” and “unsmoked.”



A



B



C



## Plate 29

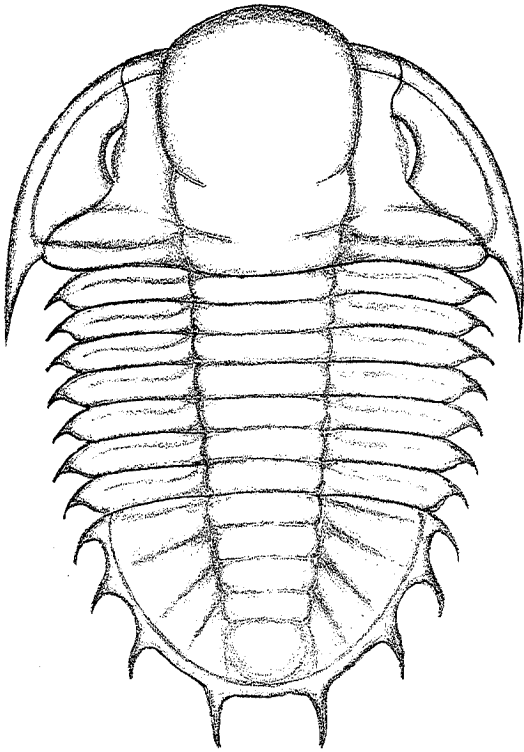
*Kootenia* sp.

*Description.*—A medium-sized trilobite averaging about 40 to 50 mm in length. Cephalon semicircular in outline. Glabella prominent, expanded, and rounded anteriorly. Genal spines extend to second or third thoracic segments. Thorax has seven segments. Pleurae terminate in short, reflexed spines. Pygidium has five axial rings and four pairs of marginal spines that increase slightly in length posteriorly. Posterior pair nearly straight, the other three pairs are more recurved.

A.—Reconstruction.

B.—Specimen X2.1 (GUN) from shale beds of the Pierson Cove Formation in the Drum Mountains.

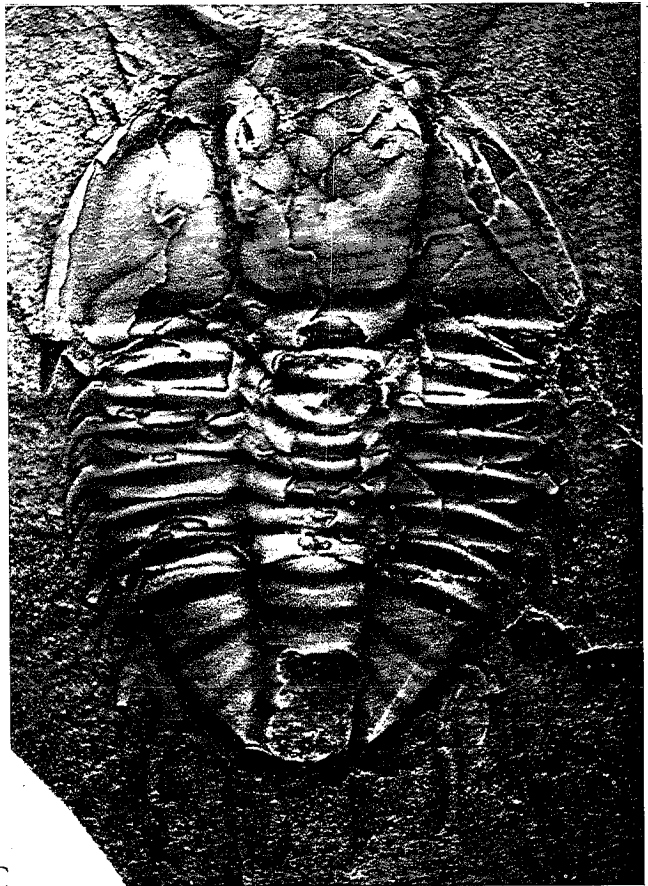
C.—Specimen X2.1 (GUN) from same locality. This species is commonly associated with *Olenoides nevadensis* and *Asaphiscus wheeleri*.



A



B



C

## Plate 30

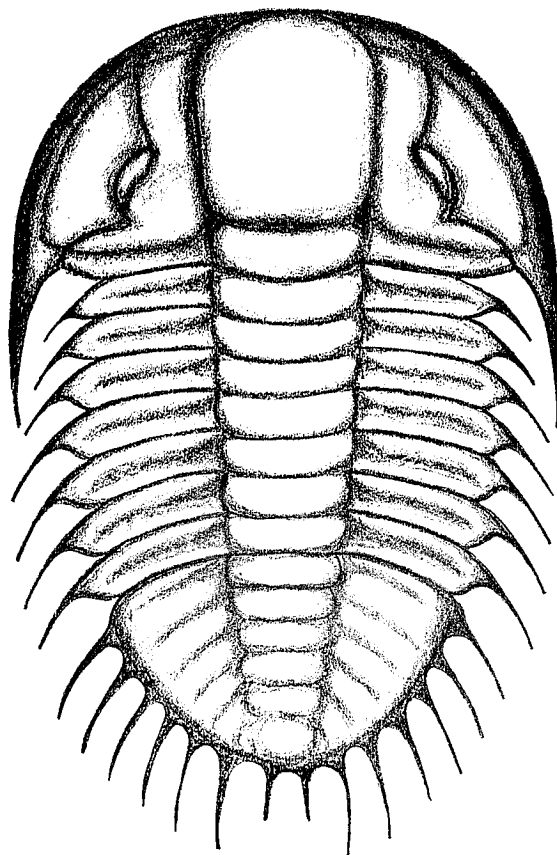
*Kootenia spencei* Resser

*Description.*—A medium-sized trilobite. Glabella prominent with slightly convex sides, rounded anteriorly. Frontal area short. Border distinct, slightly upturned, border furrow well defined. Thorax has seven segments. Axial lobe slightly narrower than pleural lobes. Pleural segments terminate in long, slender recurved spines. Pygidium semielliptical, wider than long. Axis bears five rings and a terminal piece. Border well defined and extends into seven pairs of long slender spines, the seventh pair being shorter and more slender.

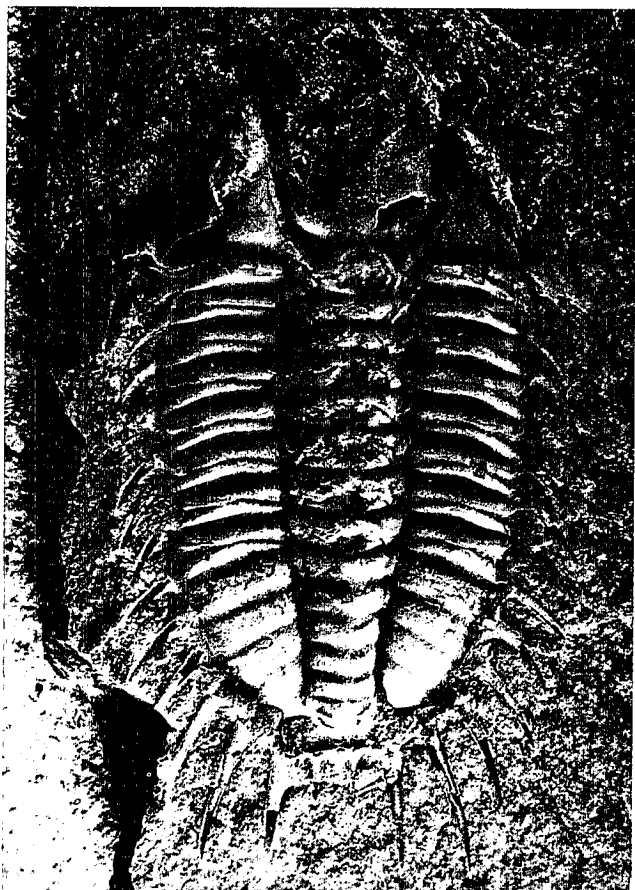
A.—Reconstruction.

B.—Specimen X2.1 (GUN) taken from near top of Spence Shale, Hansen Canyon, Wellsville Mountain.

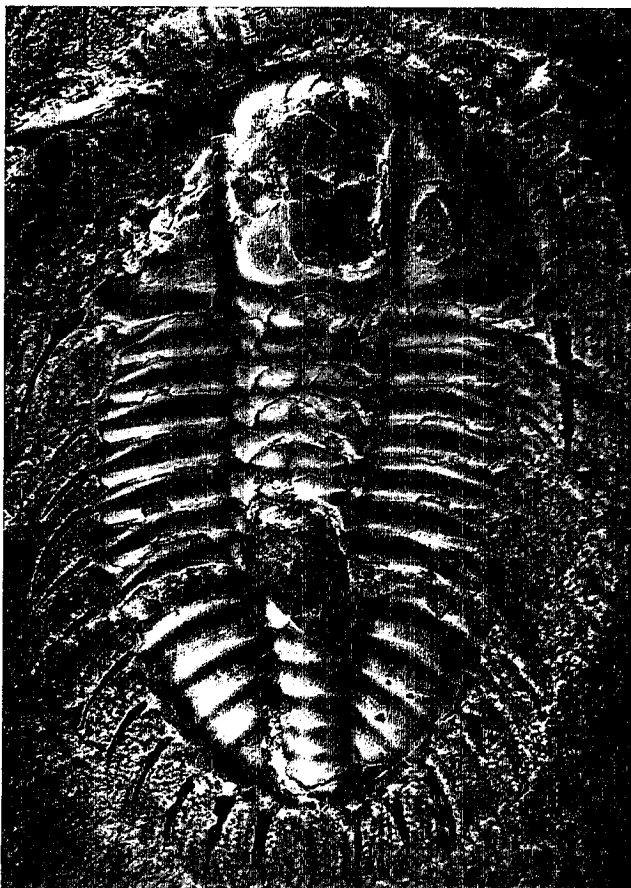
C.—Specimen X2.1 (GUN) taken from middle region of the Spence Shale, Antimony Canyon, Wellsville Mountain.



A



B



C

## Plate 31

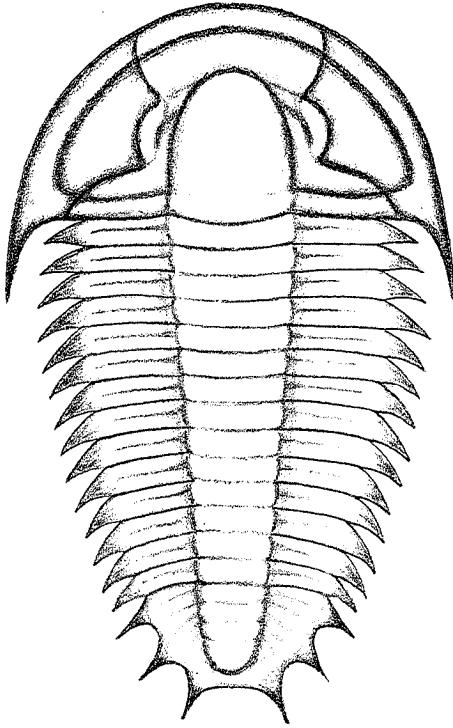
*Marjумia typa* Walcott

*Description.*—A medium to large trilobite, measuring up to 90 mm in length. Cephalon semicircular in outline. Glabella unfurrowed, moderately tapered, and rounded anteriorly. Anterior border well defined with nearly constant width except for slight narrowing at lateral ends. Occipital ring widest medially. Librigena has moderately long genal spines. Thorax has 14 segments. Axis well defined. Pleurae terminate in sharp reflexed points. Pygidium semicircular; margin possesses one to four pairs of short stubby spines.

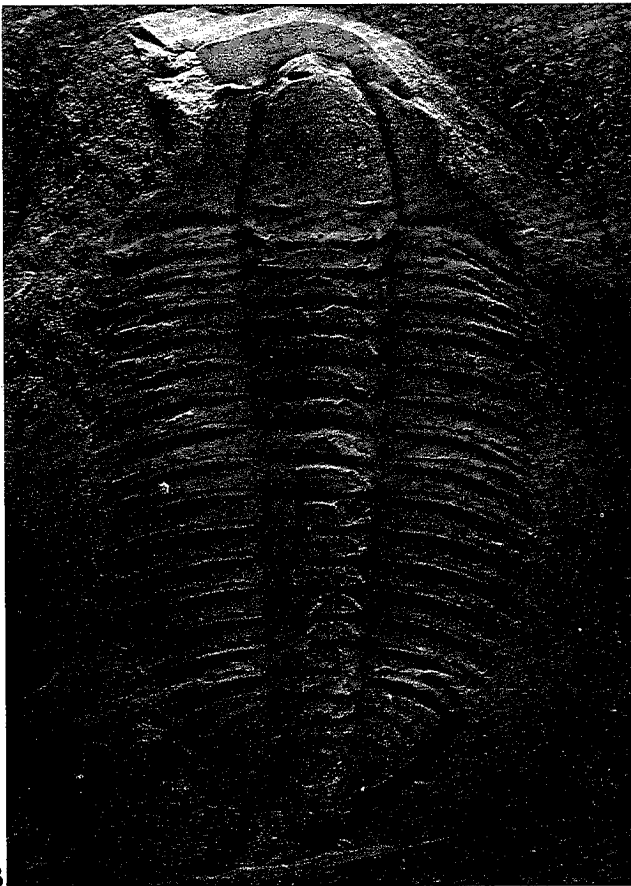
A.—Reconstruction.

B.—Specimen X1.5 (WR) collected by Bill Ratcliffe from the Marjum Formation, Wheeler Amphitheater, House Range.

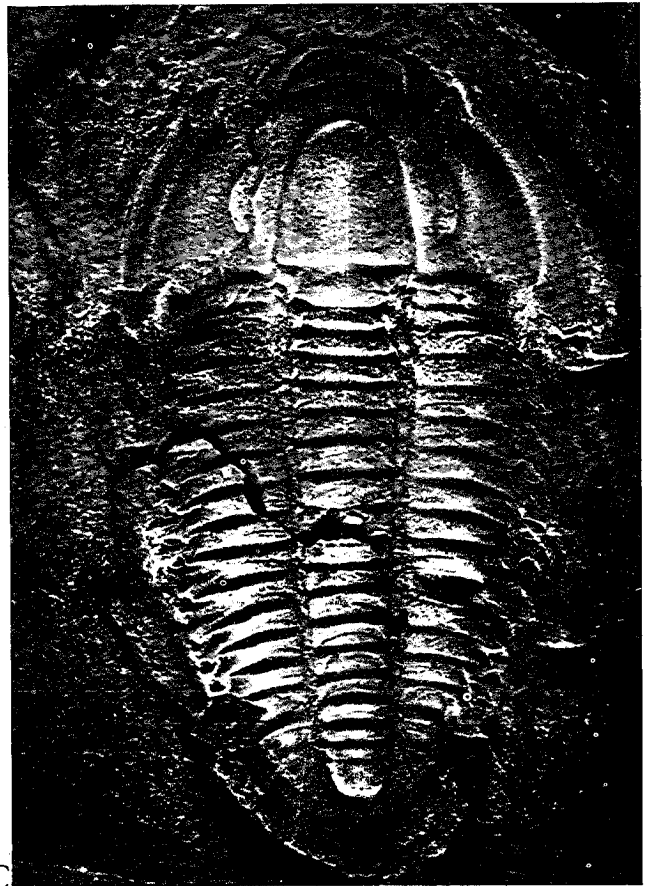
C.—Specimen X2.1 (GUN) collected by Gary Locker from the Marjum Formation, Wheeler Amphitheater, House Range.



A



B



C

## Plate 32

*Modocia brevispina* Robison

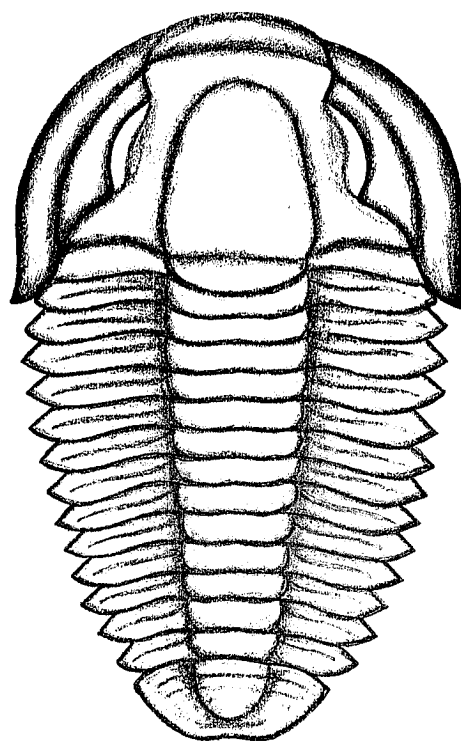
*Description.*—A small- to medium-sized trilobite averaging about 20 to 30 mm in length. Glabella moderately tapered and rounded anteriorly. Librigena has short, nubby genal spines. Thorax has 13 segments that terminate abruptly in short, sharp points. Pygidium short and wide, contains four axial rings and a short terminal piece. Pygidium and cephalon have dorsal surface covered with fine granules.

A.—Reconstruction.

B.—Specimen X3.4 (GUN) from shale beds of the Pierson Cove Formation in the Drum Mountains.

C.—Specimen X4.2 (GUN) from same site as B.

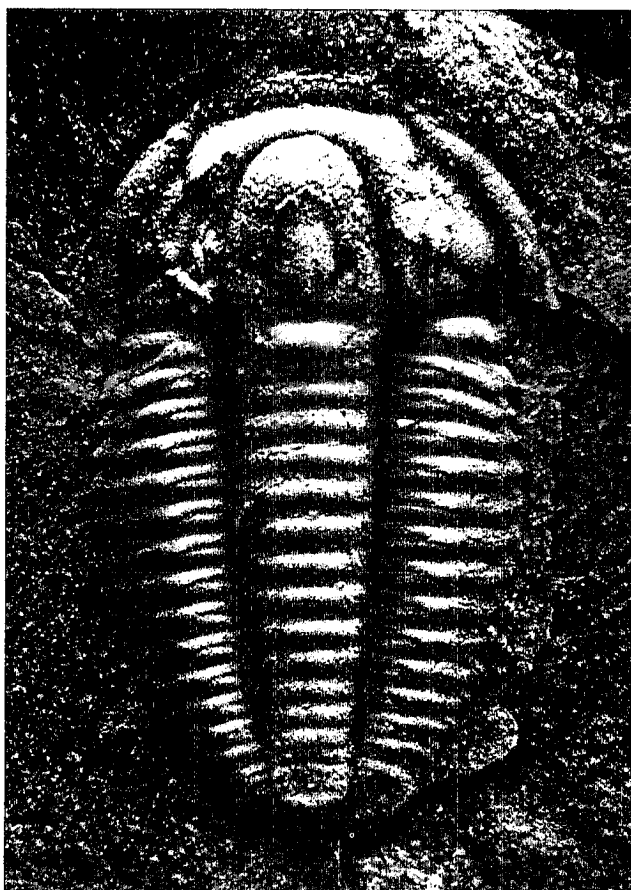
This species is also present in the lower Wheeler Shale in the House Range.



A



B



C

## Plate 33

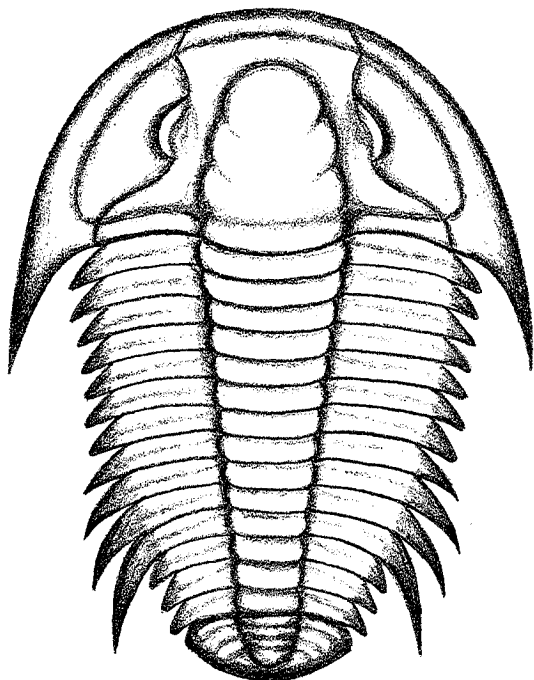
*Modocia typicalis* (Resser)

*Description.*—A medium-sized trilobite. Glabella moderately tapered and rounded anteriorly. Preglabellar field and anterior border about equal in length. Librigena has rather long genal spines extending to the third to fifth thoracic segments. Thorax has 14 segments. Pleurae become progressively longer, more posteriorly reflexed, and falcate on the first to eleventh or twelfth segments, with the posterior two or three terminating in distinctly shorter and only slightly reflexed spines. Pygidium has three or four axial rings and a short terminal piece.

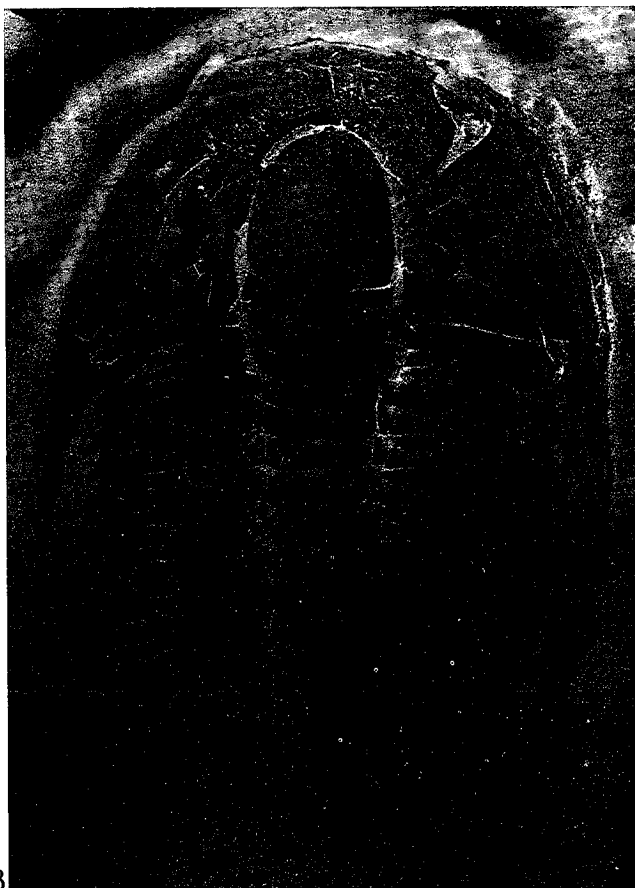
A.—Reconstruction.

B.—Specimen X6.9 (GUN) from Marjum Formation at a site about 3.2 km (2 mi) southwest of Wheeler Amphitheater.

C.—Specimen X2.1 (GUN) from same locality as B.



A



B



C

## Plate 34

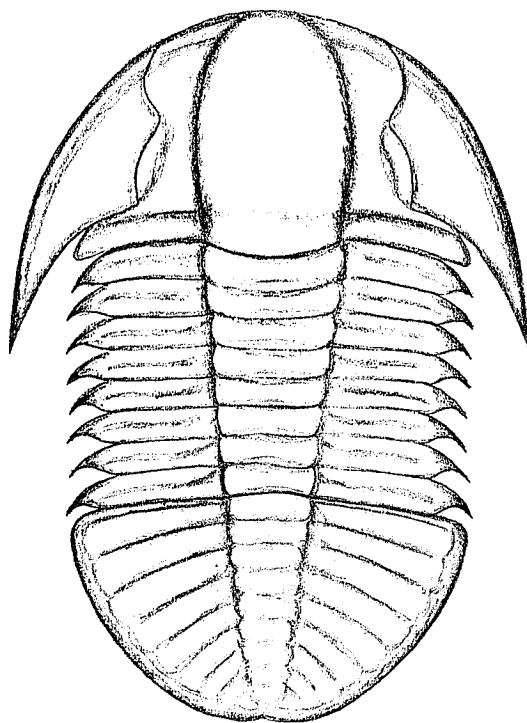
*Ogygopsis typicalis* (Resser)

*Description.*—A medium-sized trilobite. Cephalon semicircular in outline. Glabella large, long, reaching the border and rounded in front. Sides subparallel tapering slightly forward and backward. Librigena about one-third the width of glabella. Genal spines extend to the third or fourth thoracic segments. Thorax has eight segments; tips of each have short, slender, posterolaterally directed spines. Pleurae about twice the width of the axis. Pygidium large and semicircular. Axis well defined with eight to ten rings and a terminal piece. A small medial notch indents the posterior margin.

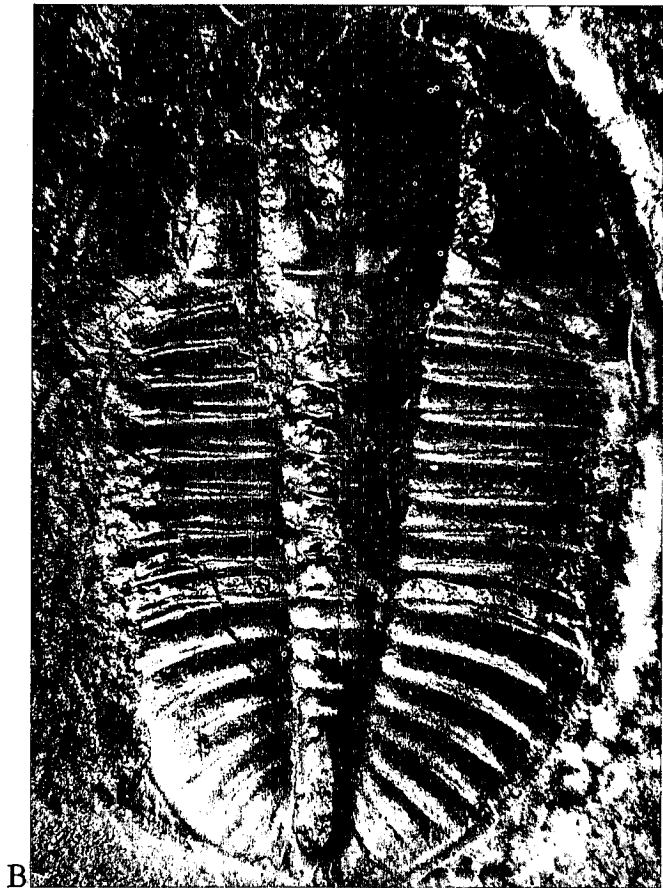
A.—Reconstruction.

B.—Specimen X2.5 (GUN) from lower Spence Shale, Miners Hollow, Wellsville Mountain.

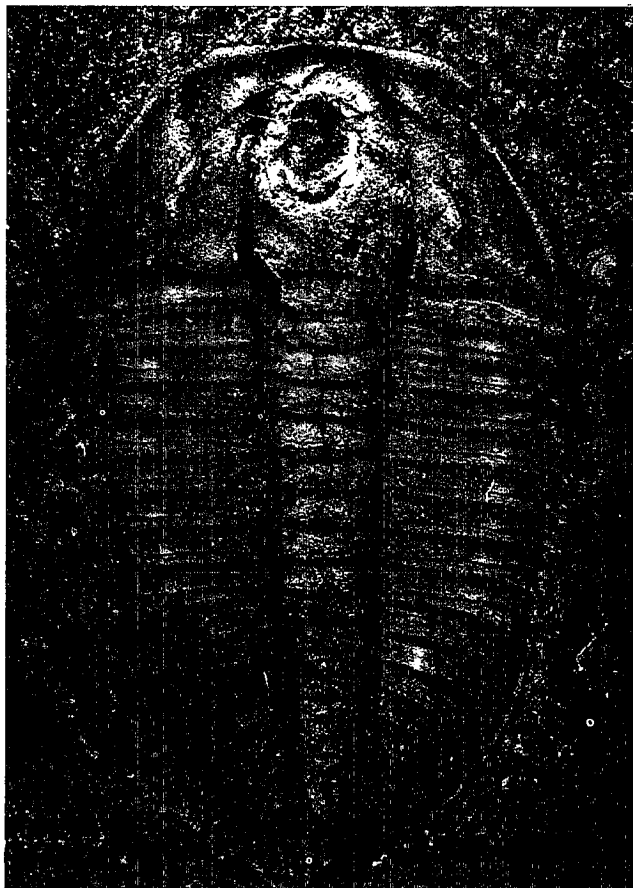
C.—Specimen X3.2 (GUN) from base of Spence Shale, Hansen Canyon, Wellsville Mountain.



A



B



C



## Plate 35

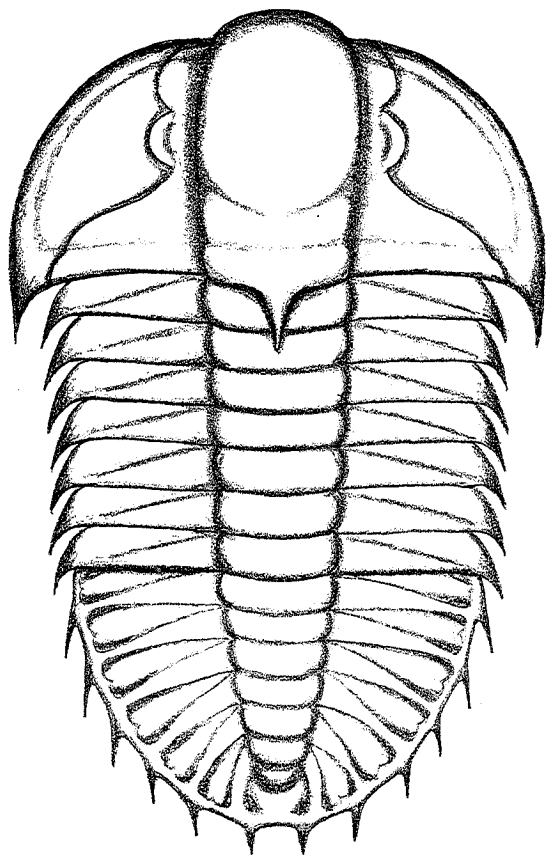
*Olenoides marjumensis* Resser

*Description.*—A large, rare trilobite. One complete specimen measures over 100 mm in length, excluding spines. It is best characterized by a pygidium with six pairs of short, stubby marginal spines all about equal in length. Axis of pygidium has six or seven rings and a terminal piece. Thorax has seven segments, each terminating in short reflexed spines.

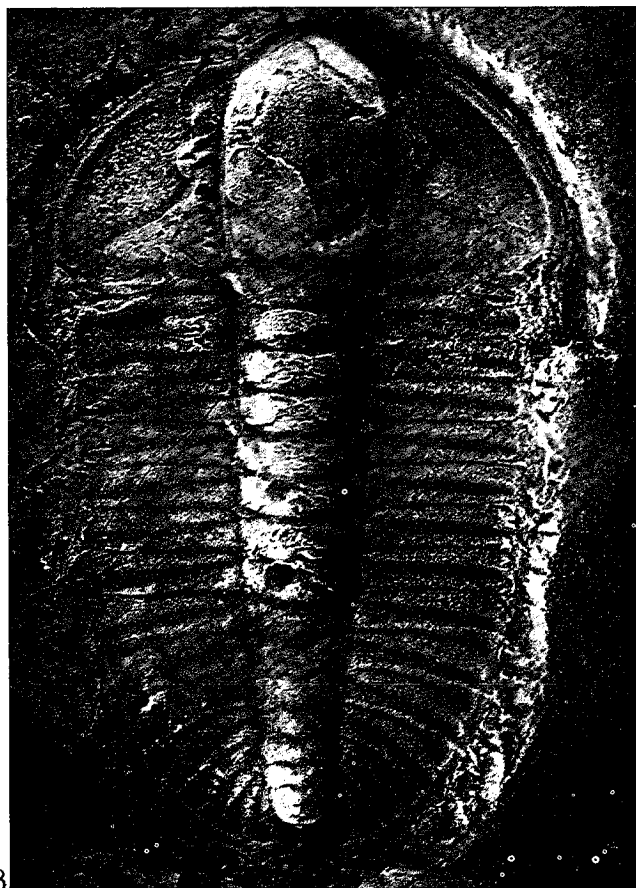
So far as is known, the illustrated specimen is the only complete one to have been collected.

A.—Reconstruction.

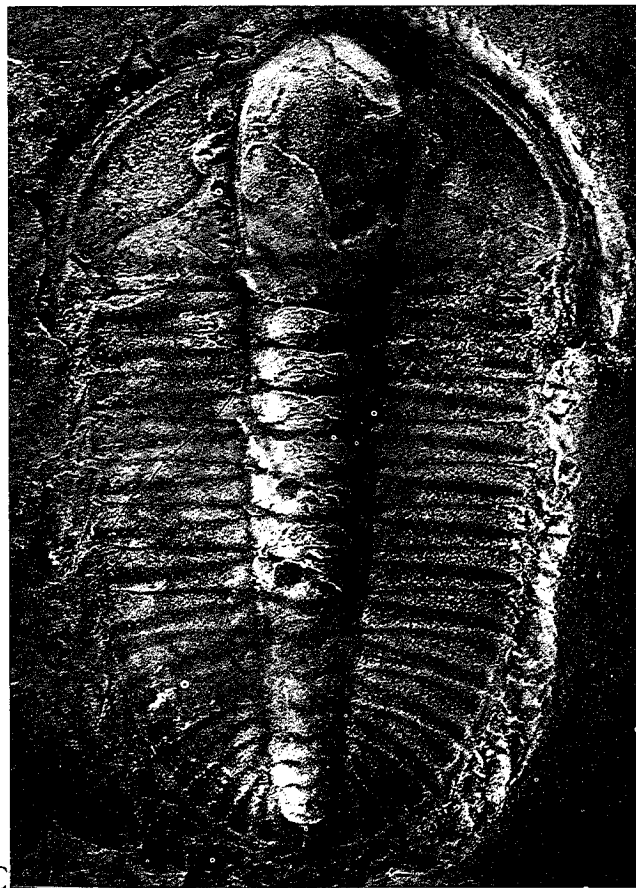
B,C.—Specimen X1 (GUN) from Marjum Formation about 0.8 km (0.5 mi) south of Wheeler Amphitheater, House Range.



A



B



C

## Plate 36

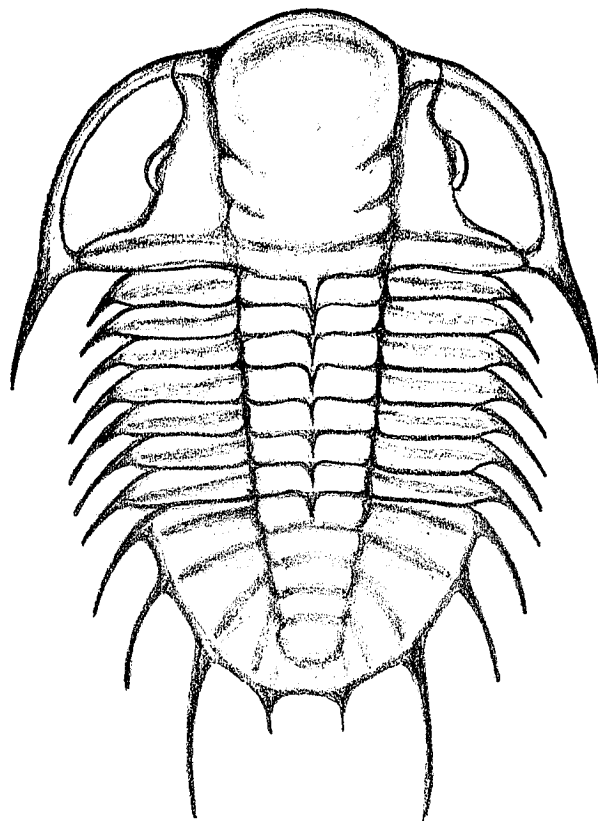
*Olenoides nevadensis* (Meek)

*Description.*—A medium to large trilobite. Glabella large and expanded anteriorly and with faint to distinct lateral furrows. Occipital ring bears a medial spine. Genal spines extend to the third thoracic segment. Thorax has seven segments, with each axial ring bearing a long slender medial spine. Pleurae terminate in reflexed spines that are progressively longer posteriorly. Pygidium has axis with four rings and a long terminal piece. Margin bears four pairs of spines, the third pair by far the longest and the posterior pair the shortest.

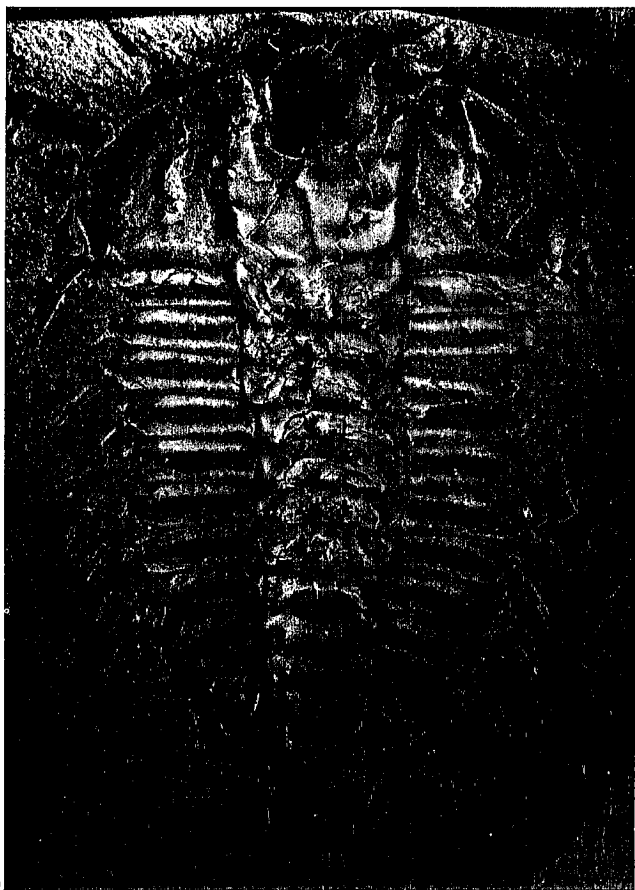
A.—Reconstruction.

B.—Specimen X1.7 (GUN) from shale beds of the Pierson Cove Formation in the Drum Mountains.

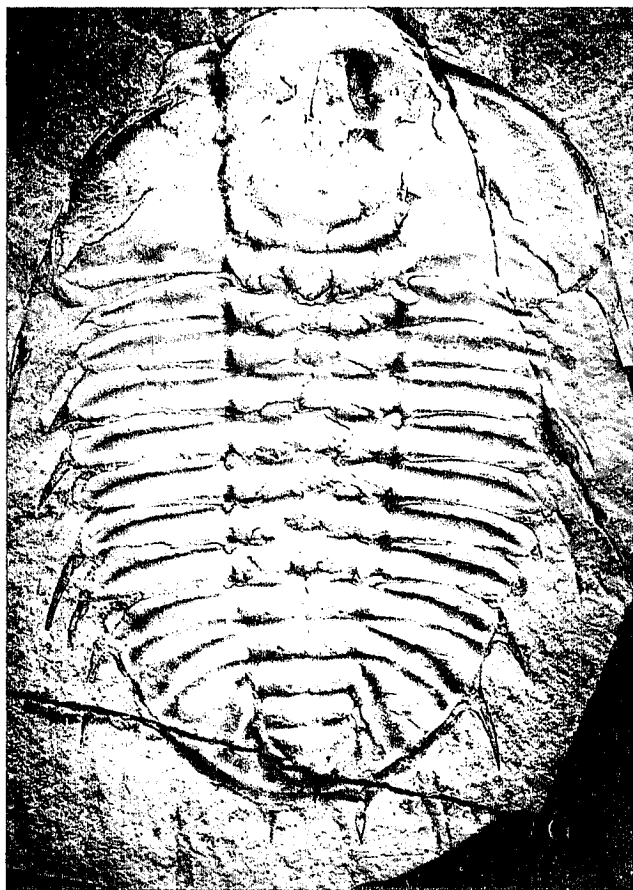
C.—Specimen X1.4 (GUN) from the same locality as B.



A



B



C

## Plate 37

*Olenoides* sp.

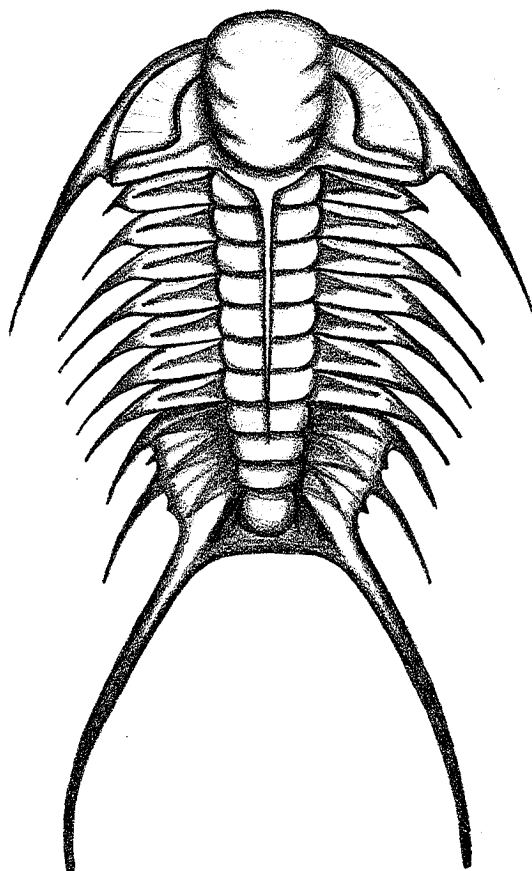
*Description.*—A very large trilobite. A complete specimen has not been found, but a single large pygidium with spines measuring 88 mm long indicated this to be one of the largest Middle Cambrian trilobites of Utah. Glabella large and slightly expanded anteriorly. Occipital ring bears a very long, slender medial spine. Genal spine is long and slender. Thorax has seven segments. Pygidium has three pairs of marginal spines that increase in length posteriorly, the posterior pair being extremely long and slightly curved.

A.—Reconstruction.

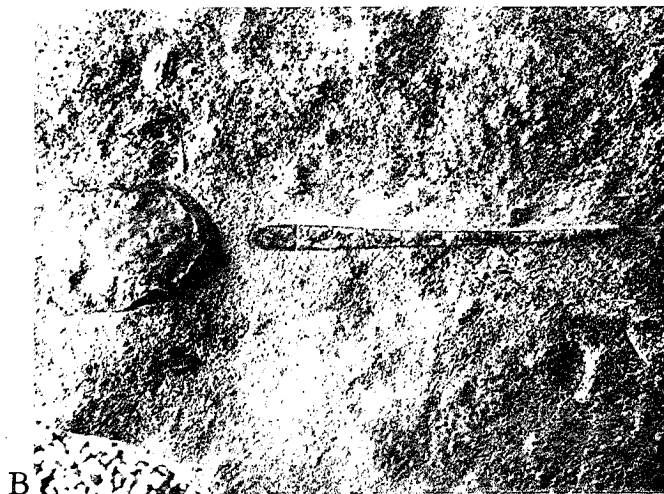
B.—Weathered specimen X3 (GUN) showing glabella and long occipital spine. From limestone beds in the Pierson Cove Formation in the Drum Mountains.

C.—A weathered librigena X4.5 (GUN) from same locality as B.

D.—A weathered pygidium X2 (GUN) also from same locality as B.



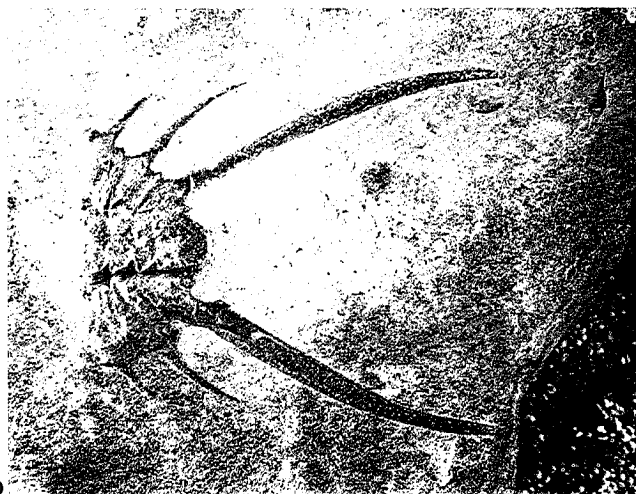
A



B



C



D

## Plate 38

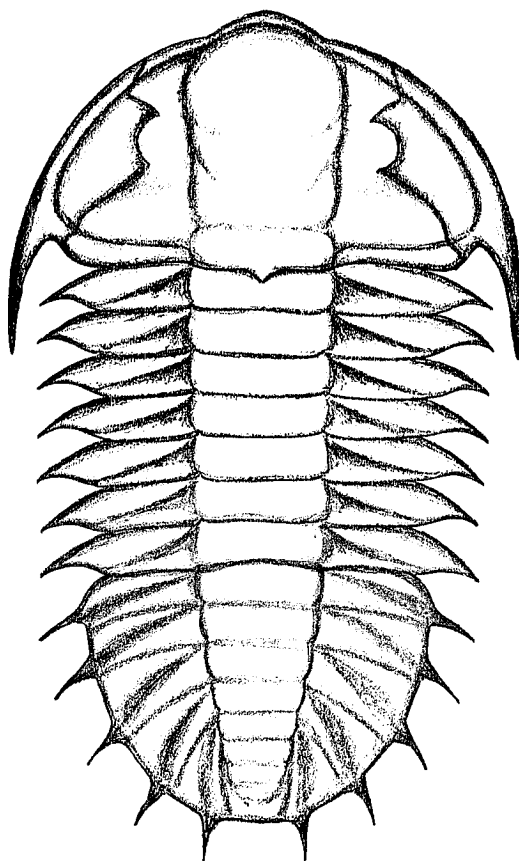
*Olenoides superbus* (Walcott)

*Description.*—A very large trilobite, some specimens measuring over 150 mm in length. Glabella nearly parallel sided to slightly expanded anteriorly. Thorax has seven segments that terminate in short spines. Pygidium has five pairs of broad-based marginal spines of near equal length. Axis has six or seven rings and a terminal piece.

A.—Reconstruction.

B.—Very large specimen X0.8 (WR) Collected by William Ratcliffe from the Marjum Formation, east side of Wheeler Amphitheater. Photo is of a cast. The original specimen is at Utah Natural History Museum, Vernal, Utah.

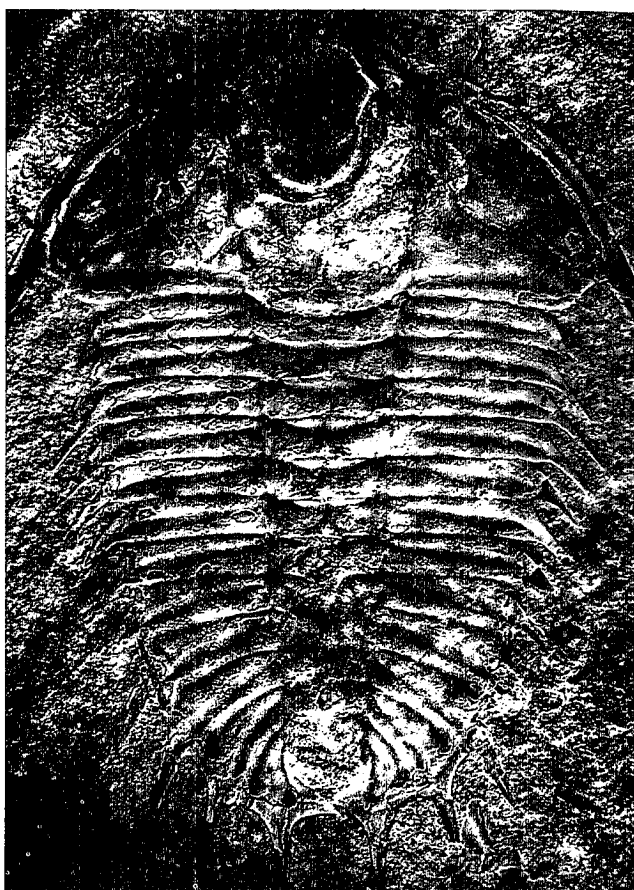
C.—Specimen X1.5 (GUN) from the Marjum Formation, east side of Wheeler Amphitheater, House Range.



A



B



C

## Plate 39

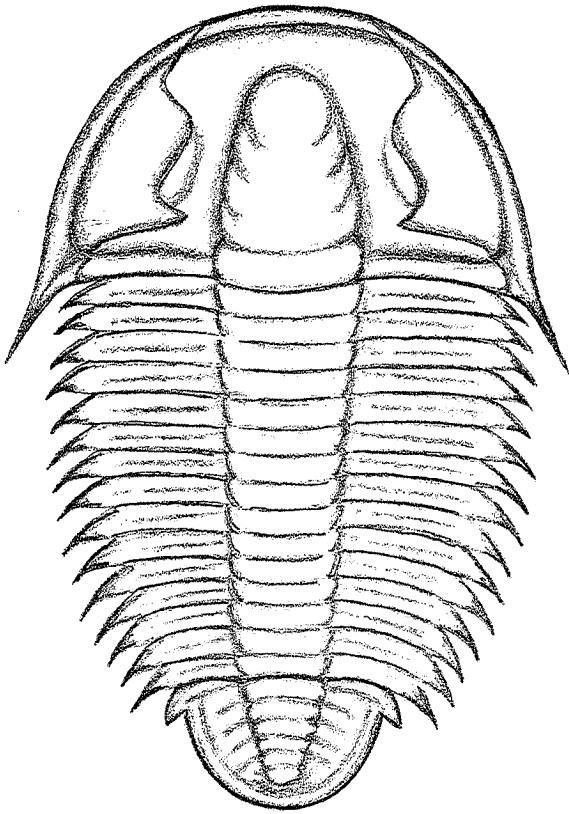
*Utaspis marjumensis* (Resser)

*Description.*—A moderately large trilobite, some specimens over 90 mm in length. Cephalon semicircular in outline. Glabella moderately tapered and rounded anteriorly. Genal spines rather short and somewhat flaring. Thorax has 15 segments. Anterior pleurae slightly wider than anterior axial ring. Pleurae terminate in moderately short reflexed spines. Axis tapers moderately posteriorly. Pygidium semicircular, much wider than long. Anterolateral corners have one pair of reflexed marginal spines. Pygidium has a narrow border of nearly constant width.

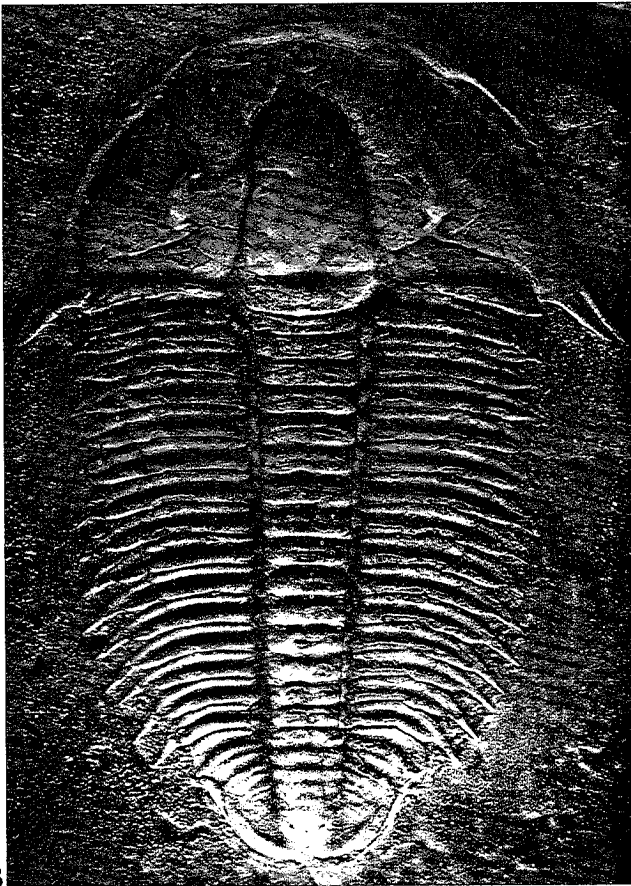
A.—Reconstruction.

B.—Specimen X1.3 (HAR) Collected by Robert Harris from the Marjum Formation about 3.2 km (2 mi) southwest of Wheeler Amphitheater.

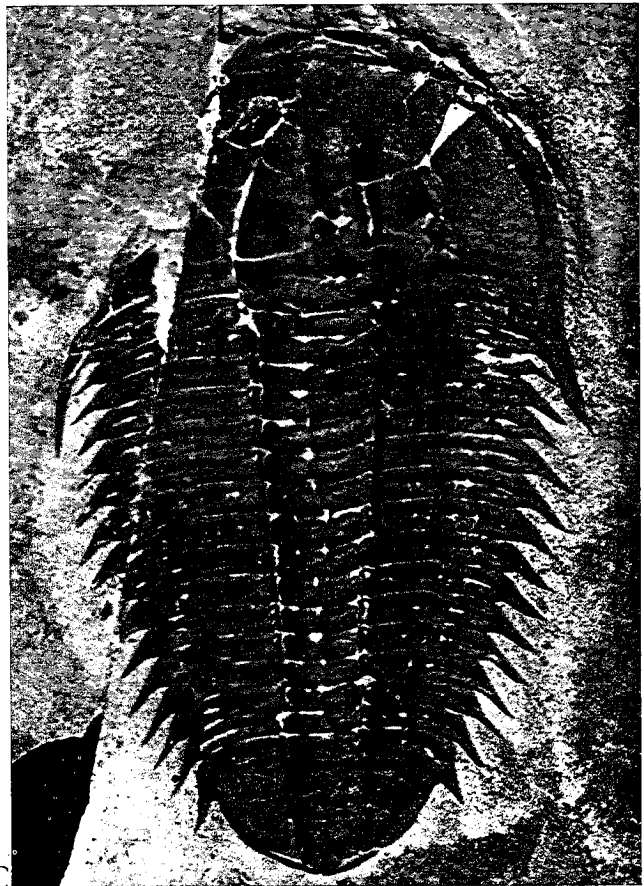
C.—Specimen X2.1 (GUN) from same locality.



A



B



C



## Plate 40

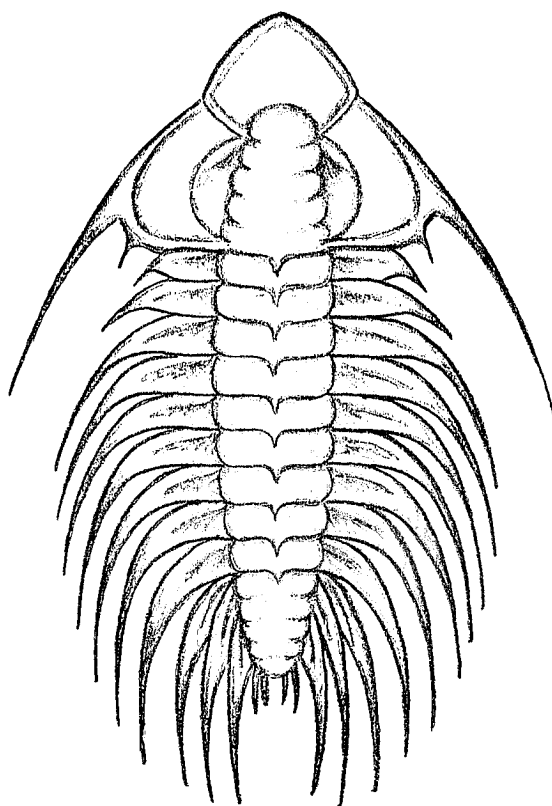
*Zacanthoides grabaui* Pack

*Description.*—A medium-sized trilobite, one larger specimen measures 54 mm in length minus spines. Cephalon triangular in outline. Glabella elongate, nearly twice as long as wide, slightly tapered and rounded anteriorly, has four pairs of furrows. Occipital ring bears a medial node. Frontal area and fixigena have faint and anastomosing lines. Librigena has long slender genal spines extending to fourth thoracic segment. A small metalibrigenal spine is also present. Thorax has nine segments with pleurae terminating in long, narrow falcate spines. Axial lobes wider than pleural lobes. Pygidium has four rings and a terminal piece, and five pairs of spines that progressively decrease in size from outer to inner pairs.

A.—Reconstruction.

B.—Specimen X1.8 (GUN) from upper Spence Shale, Hansen Canyon, Wellsville Mountain.

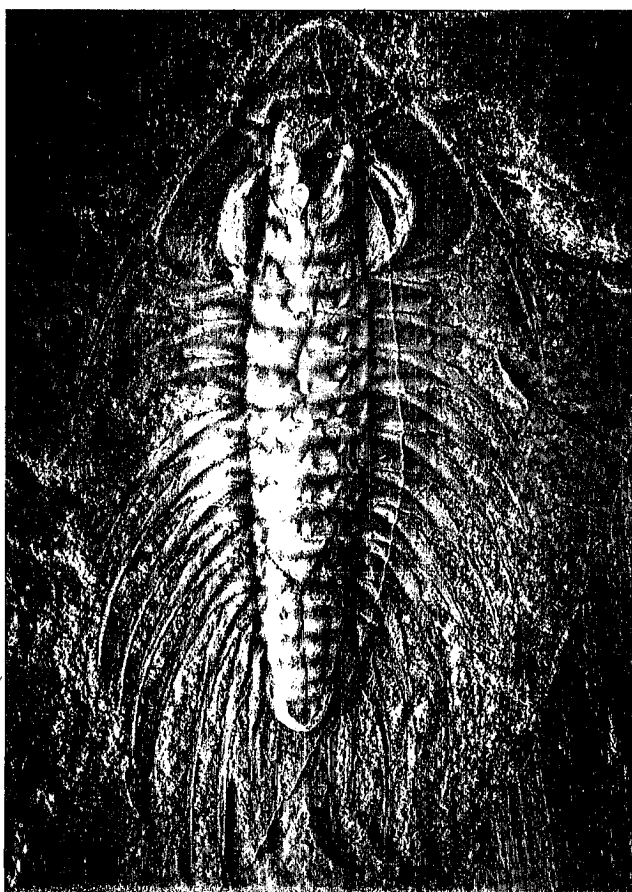
C.—Specimen X3.2 (GUN) Collected by Robert Fife in Spence Shale, Antimony Canyon, Wellsville Mountain.



A



B



C



## Plate 41

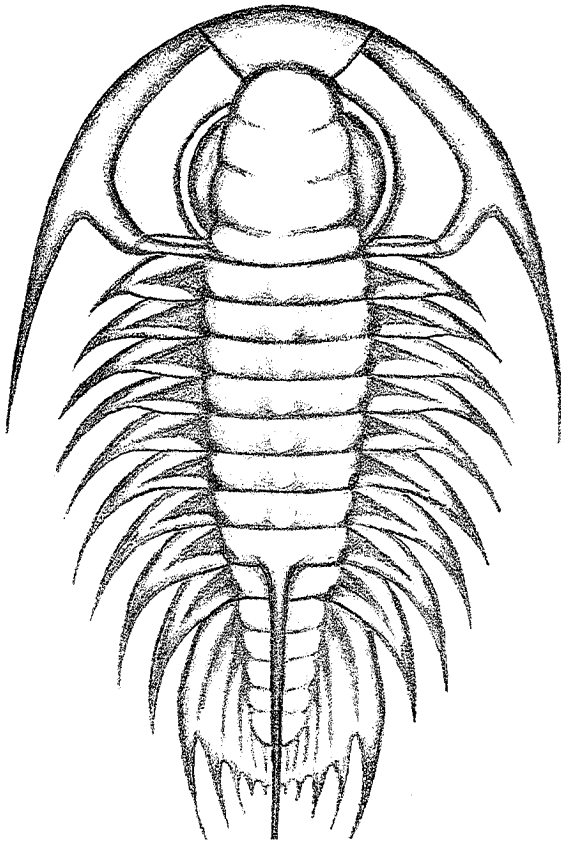
*Zacanthoides idahoensis* Walcott

*Description.*—A fairly large trilobite, with some individuals measuring up to 75 mm in length excluding spines. Glabella tapered slightly and rounded anteriorly, does not reach margin. Genal spines long and slender, in some individuals reaching nearly entire length of thorax. Thorax has nine segments with pleurae terminating in long recurved spines. A long spine originates from the second to last thoracic segment. Pygidium has five pairs of spines that decrease in size from outer to inner pairs.

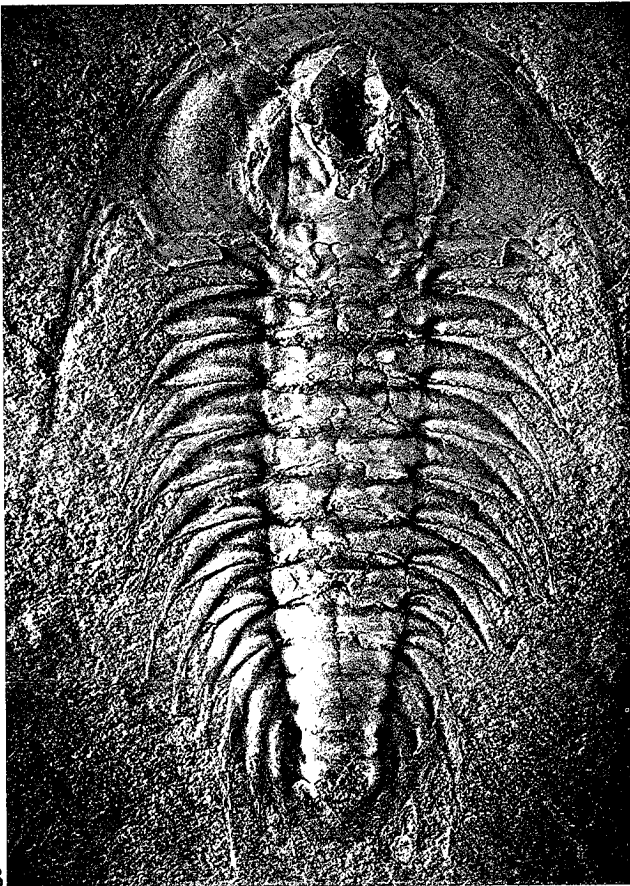
A.—Reconstruction.

B.—A large specimen X1.8 (GUN) from near top of Spence Shale, Antimony Canyon, Wellsville Mountain.

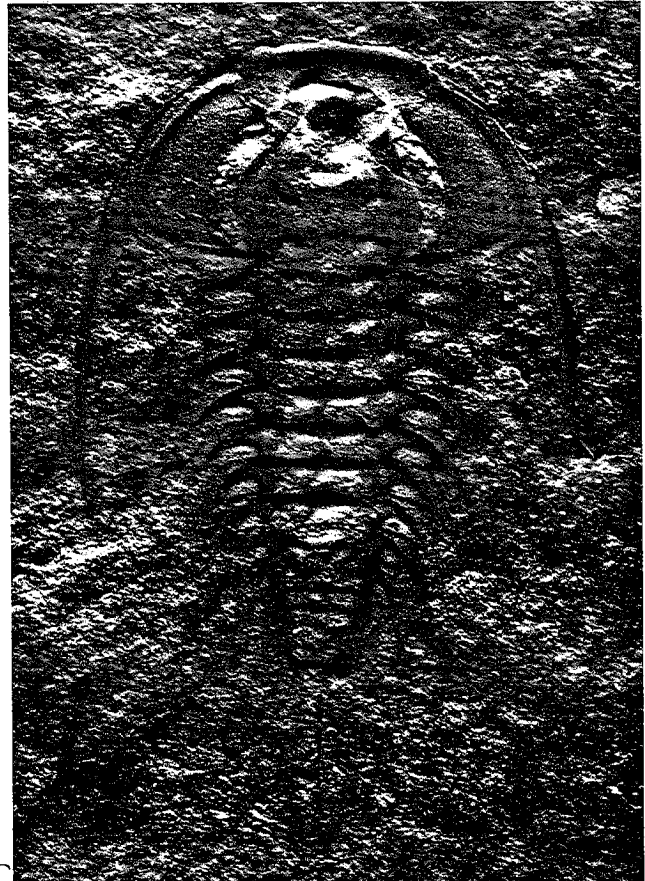
C.—Specimen X5.3 (GUN) from upper Spence Shale, Hansen Canyon, Wellsville Mountain.



A



B



C

## Plate 42

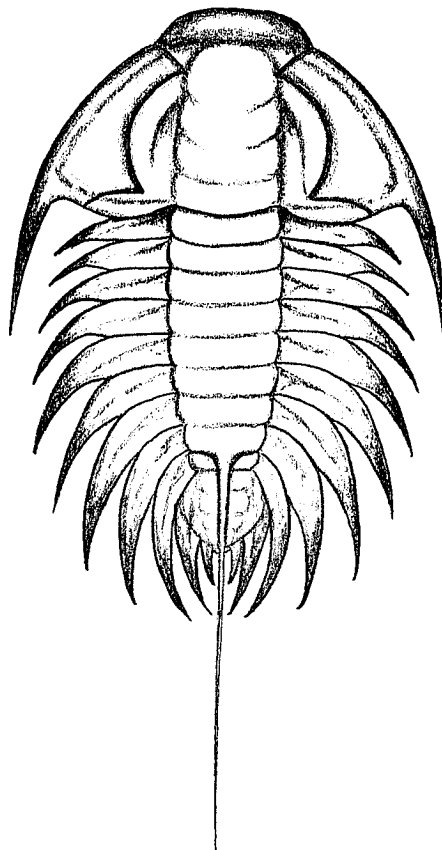
*Zacanthoides* sp.

*Description.*—A small- to medium-sized trilobite similar to *Z. idahoensis*; differs in having much wider pleural lobes and a pygidium with only two pairs of spines.

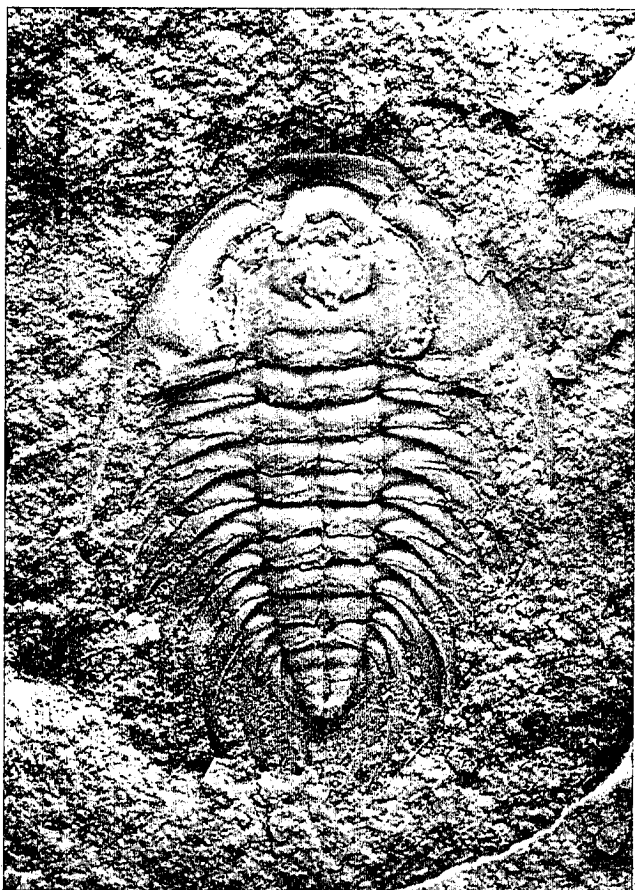
There remains the possibility that this may be just a variant form of *Z. idahoensis* since but a single individual has been found bearing these characteristics in a zone where *Z. idahoensis* is common.

A.—Reconstruction.

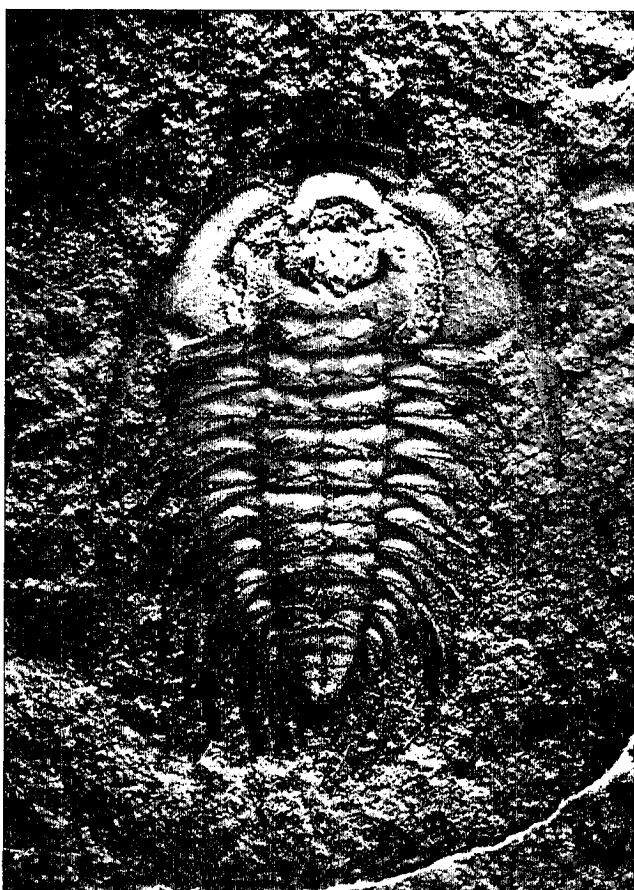
B,C.—Specimen X4.2 (GUN) from near top of Spence Shale in Hansen Canyon, Wellsville Mountain.



A



B



C

## Agnostids

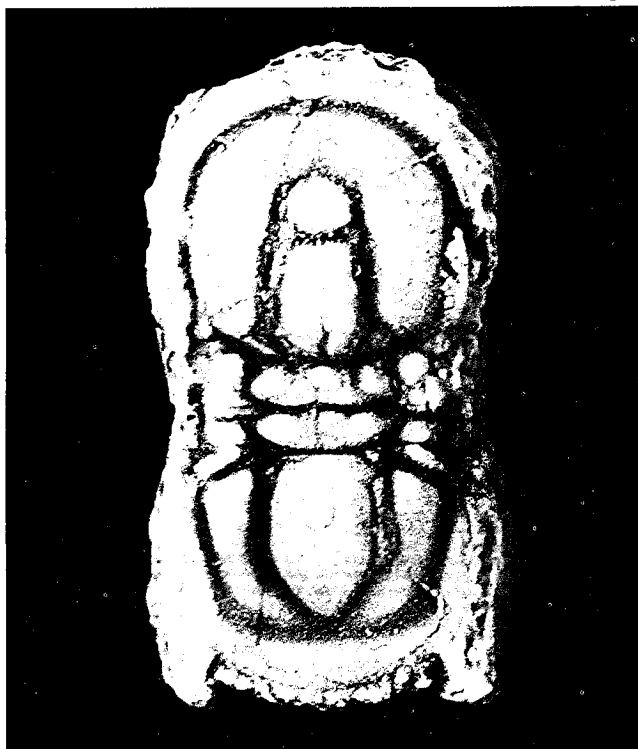
## Plate 43

Agnostids are small, blind trilobites with only two thoracic segments; the pygidium and cephalon are nearly equal in size. Common in many outcrops representing the outer detrital belt, they are believed to have lived a pelagic mode of life in the oceanic province (Robison 1972). Because of their small size they are often neglected by collectors.

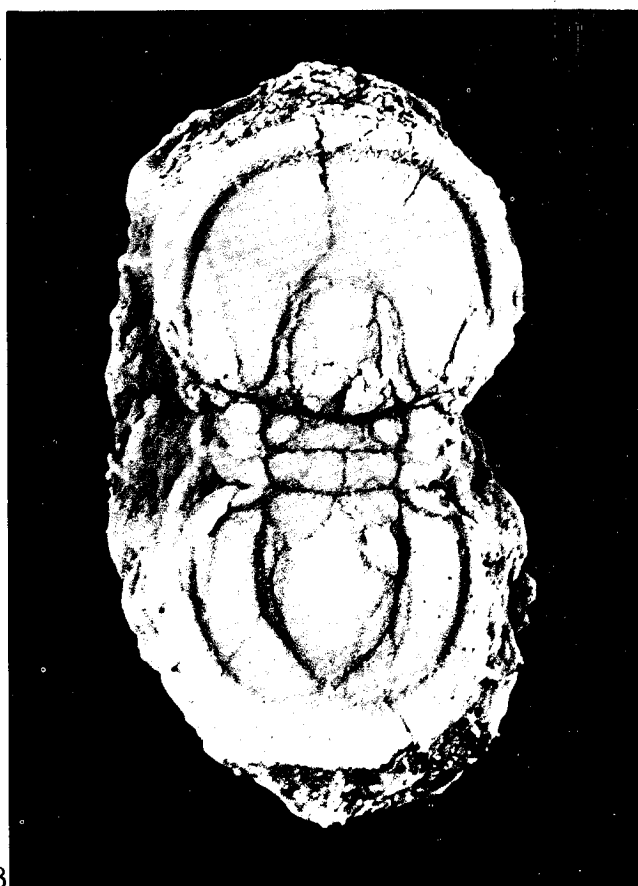
A.—*Baltagnostus eurypyx* Robison X21 (KU) from upper Wheeler Formation near Swasey Spring, House Range. Photo by R. A. Robison.

B.—*Hypagnostus parvifrons* (Linnarson) X13.7 (KU) from upper Wheeler Formation near Swasey Spring, House Range. Photo by R. A. Robison.

C.—*Linguagnostus perplexus* Robison X18.9 (GL) collected by Gary Locker in the Marjum Formation, Wheeler Amphitheater.



A



B



C

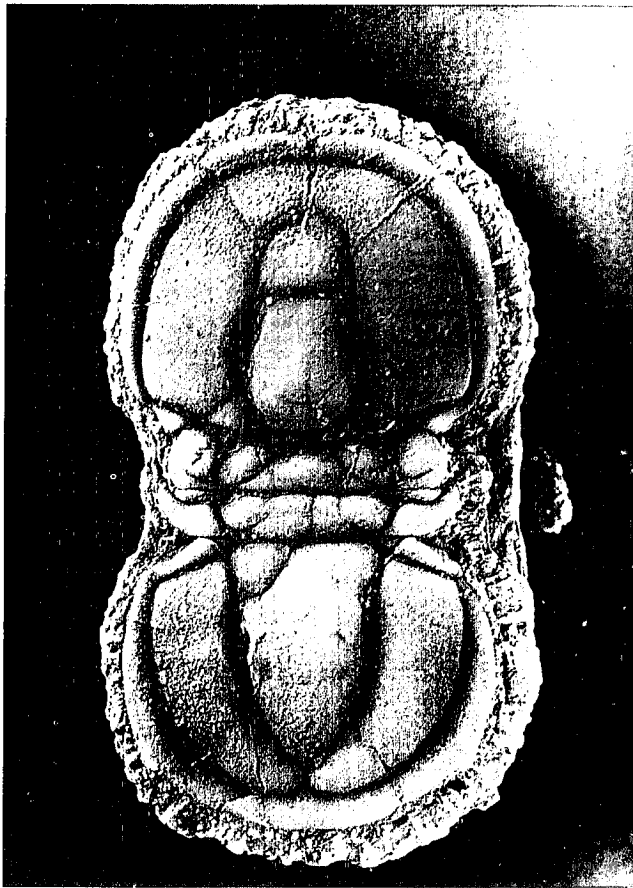
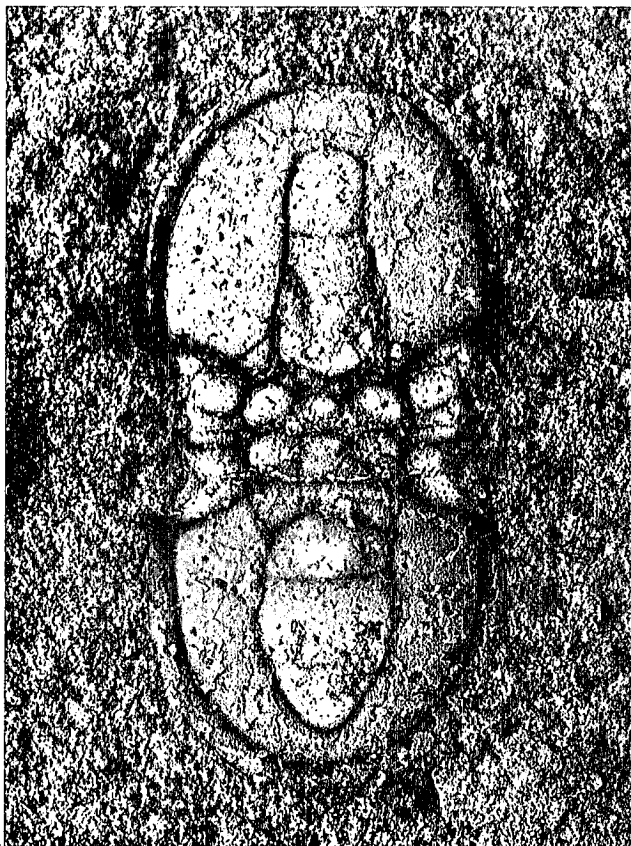
## Plate 44

## Agnostids

A.—*Peronopsis brighamensis* (Resser) X12.6 (UU)  
collected by D. P. Campbell at Antimony Canyon,  
Wellsville Mountain. Photo by D. P. Campbell.

B.—*Peronopsis interstricta* (White) X12.5 (KU) from  
upper Wheeler Formation near Wheeler  
Amphitheater, House Range.

C.—*Prychagnostus akanthodes* (Robison) X16.8 (KU)  
from middle Marjum Formation near Wheeler  
Amphitheater. Photo by R. A. Robison.



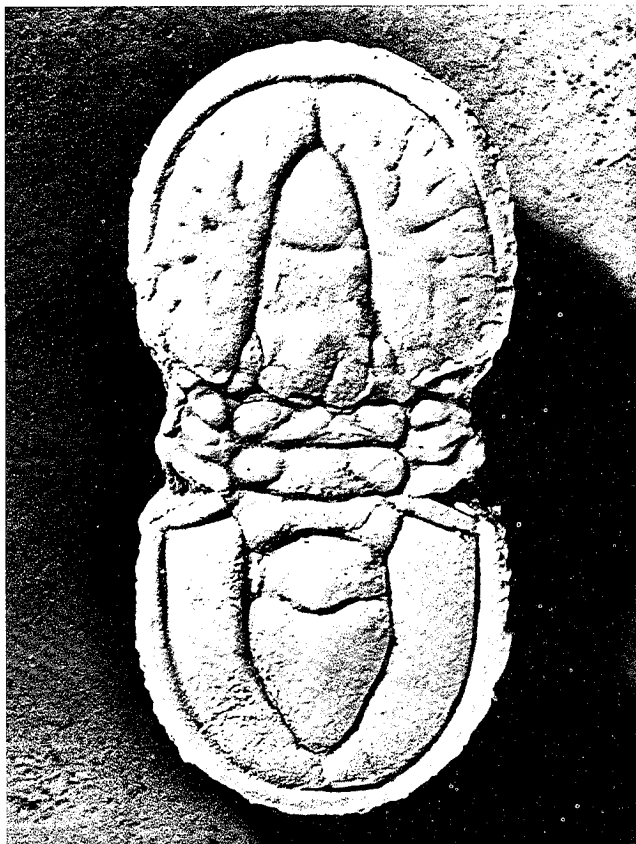
## Plate 45

## Agnostids

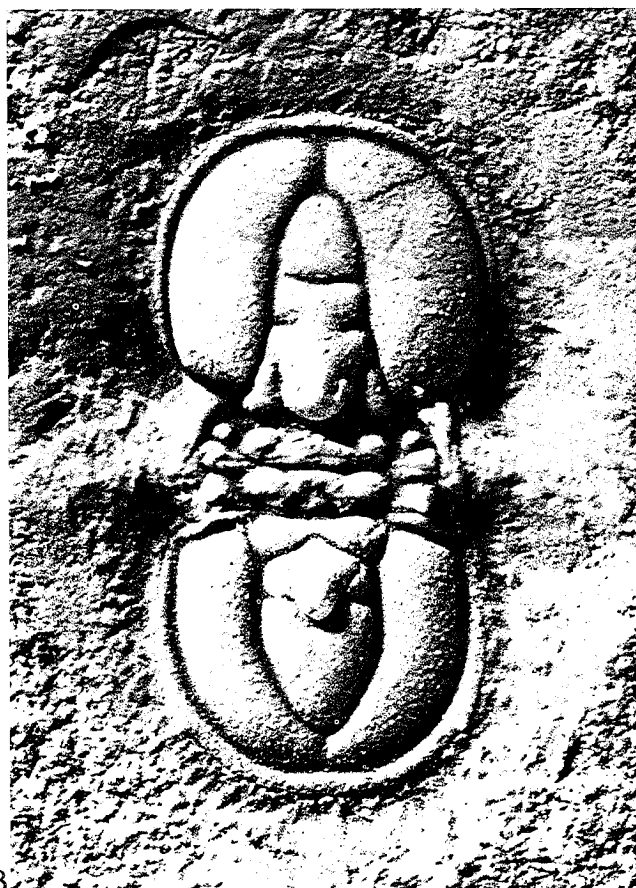
A.—*Ptychagnostus atavus* (Tullberg) X12.6 (KU) from upper Wheeler Formation near Swasey Spring, House Range. Photo by R. A. Robison.

B.—*Ptychagnostus gibbus* (Linnarson) (KU) from lower Wheeler Formation, south slope of Swasey Peak, House Range. Photo by R. A. Robison.

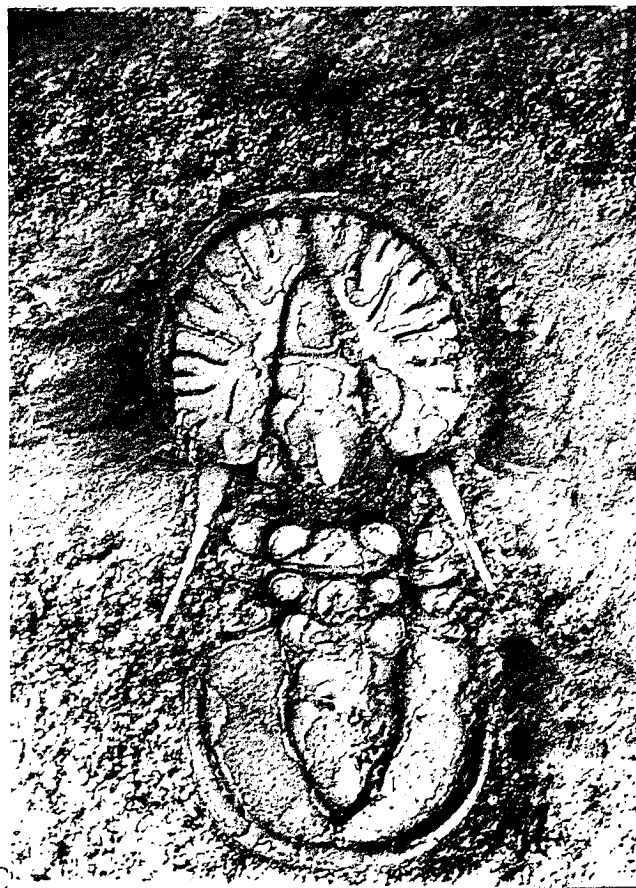
C.—*Ptychagnostus richmondensis* (Walcott) X12.6 (KU) from lower Marjum Formation near Marjum Pass, House Range. Photo by R. A. Robison.



A



B



C



## Phyllocarids and Other Arthropods

## Plate 46

Phyllocarids are among the lesser known crustaceans. They are distinguished by the rather large carapace which sheltered the anterior part of the body. This structure, resembling a bivalve, is hinged along the dorsal edge, as in the ostracods, and is the only part generally preserved. Phyllocarids are fairly common in outcrops in Utah and are usually associated with trilobites. Several species occur in the state, some of which are shown in the following photographs.

A.—*Pseudoarctolepis sharpi* Brooks and Caster X1.1 (UK). A large specimen from the Pierson Cove Formation in the Drum Mountains.

B.—*Pseudoarctolepis sharpi* X1 (UU). Specimen belonging to William L. Stokes taken from the Wheeler Formation, House Range. Photo by R. A. Robison.

C.—*Pseudoarctolepis sharpi* X2.1 (UK) from upper Wheeler Formation in the Drum Mountains. Photo by R. A. Robison.



A



B



C



## Plate 47

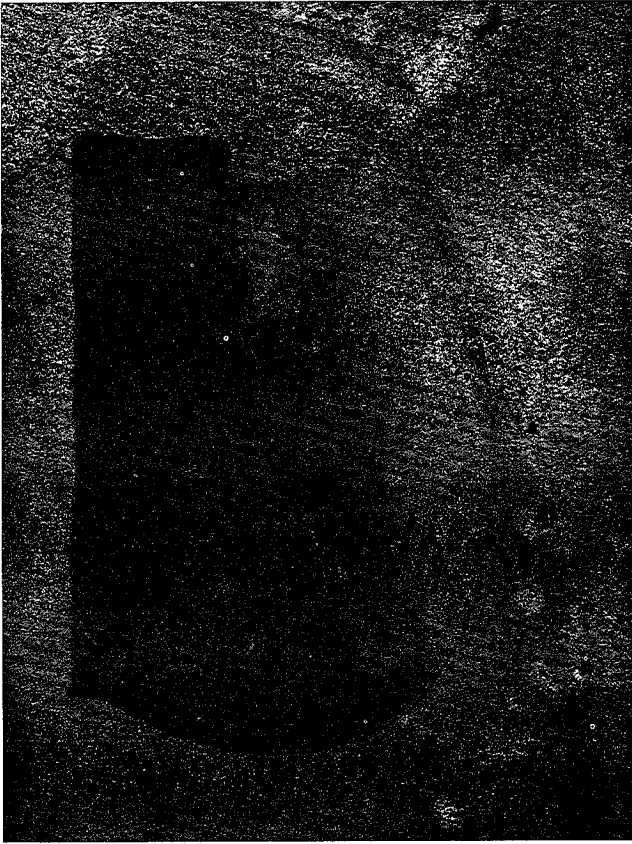
## Phyllocarids and Other Arthropods

A.—*Branchiocaris* ? sp. X2.6 (KU) from upper Wheeler Formation in the Drum Mountains.

B.—*Perspica* ? sp. X1.6 (KU) from Marjum Formation about 3.2 km (2 mi) southwest of Wheeler Amphitheater. Photo by R. A. Robison.

C.—*Tuzoia* sp. X1 (KU) from Marjum Formation about 3.2 km (2 mi) southwest of Wheeler Amphitheater. Photo by R. A. Robison.

Briggs (1976, 1977, 1978) has shown that quite different arthropods possess superficially similar carapaces. Identification cannot be made with certainty without soft parts. Some of the above genera are therefore followed with question marks.



A



B



C

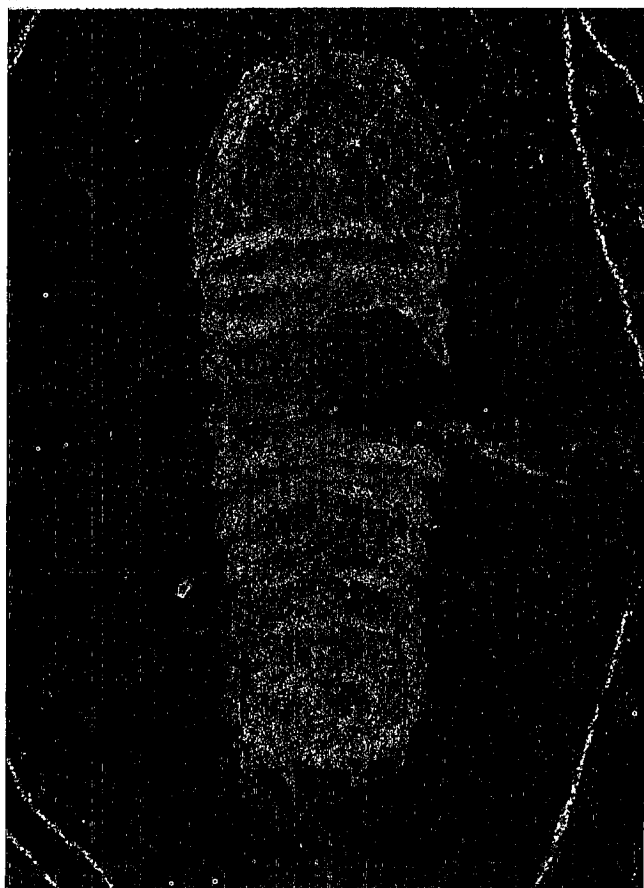
## Plate 48

## Other Arthropods

A.—A *Mollisonia*-like arthropod X3.7 (KU) collected by Lehi F. Hintze from the Wheeler Shale, Wheeler Amphitheater, House Range. Photo by R. A. Robison.

B.—A poorly preserved *Molania*-like trilobitomorph X0.89 (KU) collected by George Melloy in the Wheeler Shale at a locality about 8 km (5 mi) southwest of the Wheeler Amphitheater, House Range. It was associated with the trilobite *Elrathia kingi*.

A



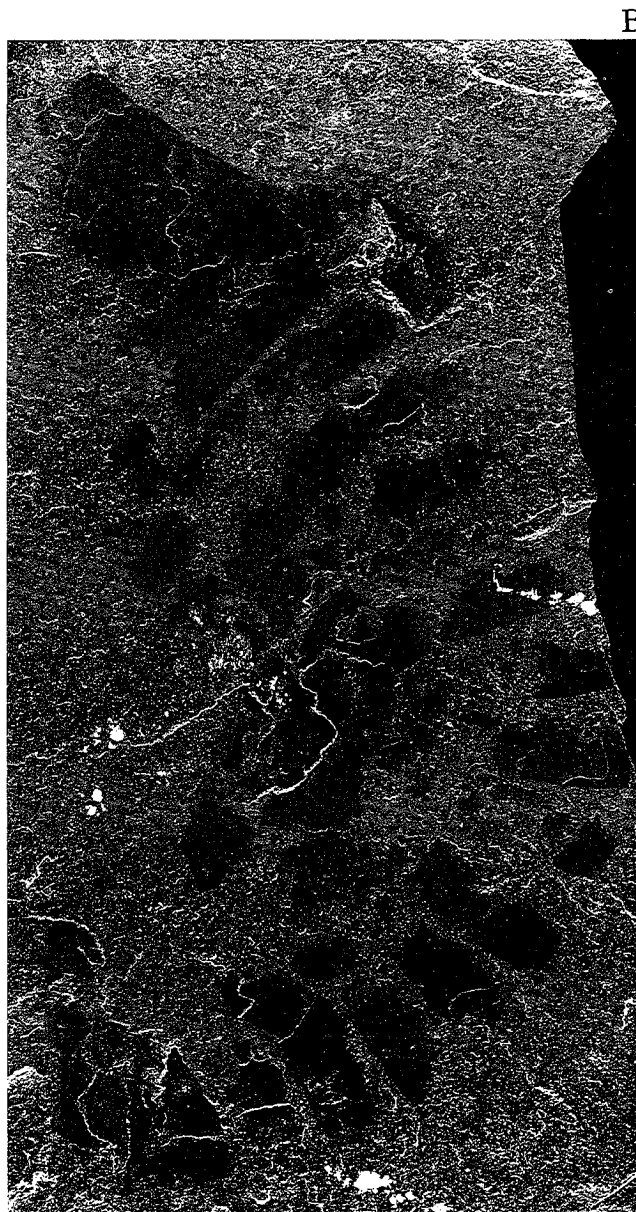
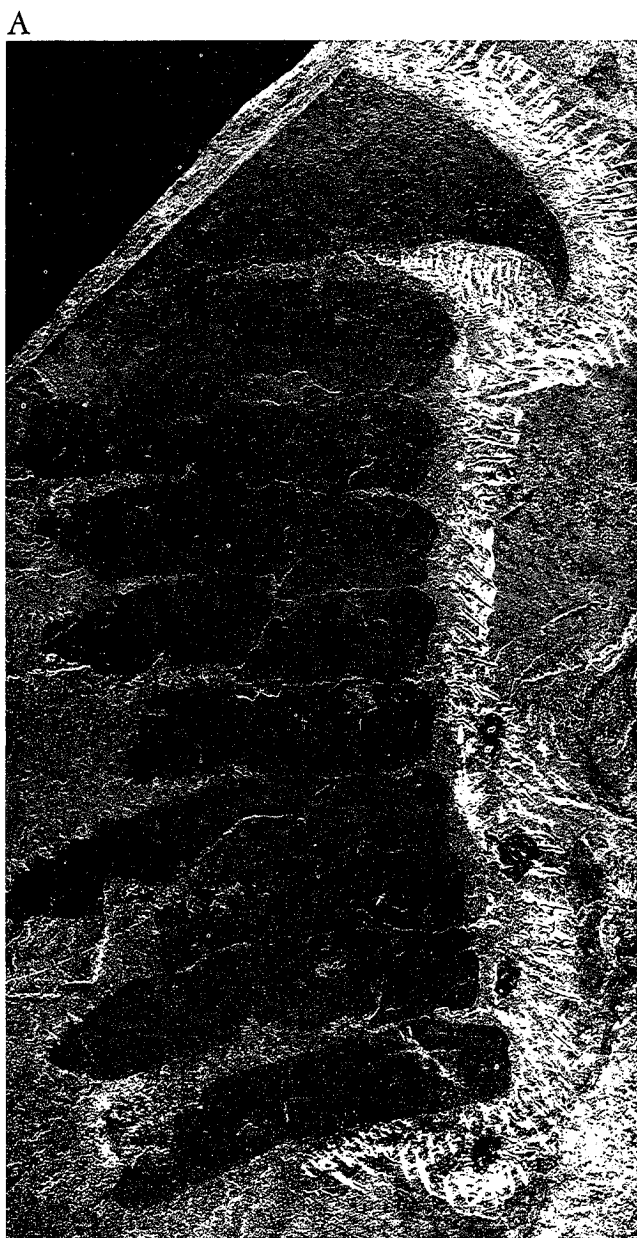
B



## Plate 49

## Arthropod (Undetermined genus)

A,B.—A meristomelike arthropod was collected from near the top of the Spence Shale in Antimony Canyon, Wellsville Mountain. Photos by R. A. Robison. Both X1.8.



## Plate 50

## Sponges

Well-preserved Cambrian sponges are best known from the Burgess Shale in Canada; however, an increasing number are being discovered in the Middle Cambrian rocks of Utah. As a consequence, the known sponge fauna of Utah is next to the Burgess Shale in diversity. Cambrian sponges apparently had skeletal nets that were weakly united and required generally quiet water for their preservation (Rigby 1975).

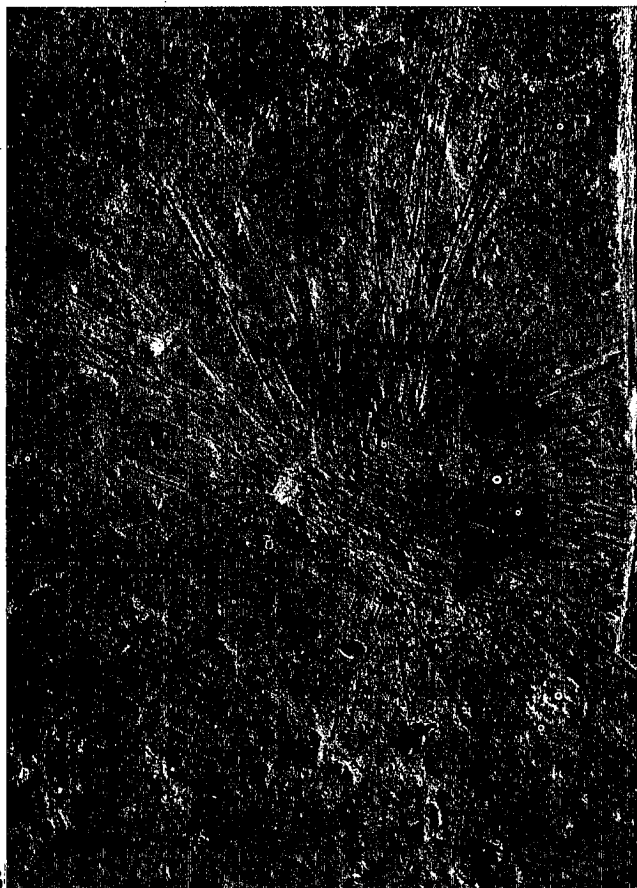
A.—*Choia carteri* Walcott X2 (KU 107224) showing the dense central disk and size of the radiating prostalia. From the Wheeler Shale, Wheeler Amphitheater. Photo by J. K. Rigby.

B.—*Choia utabensis* Walcott X2 (KU 107229), showing the coarse radiating prostalia and the dense central disk of this conical sponge. From Wheeler Shale, Wheeler Amphitheater. Photo by J. K. Rigby.

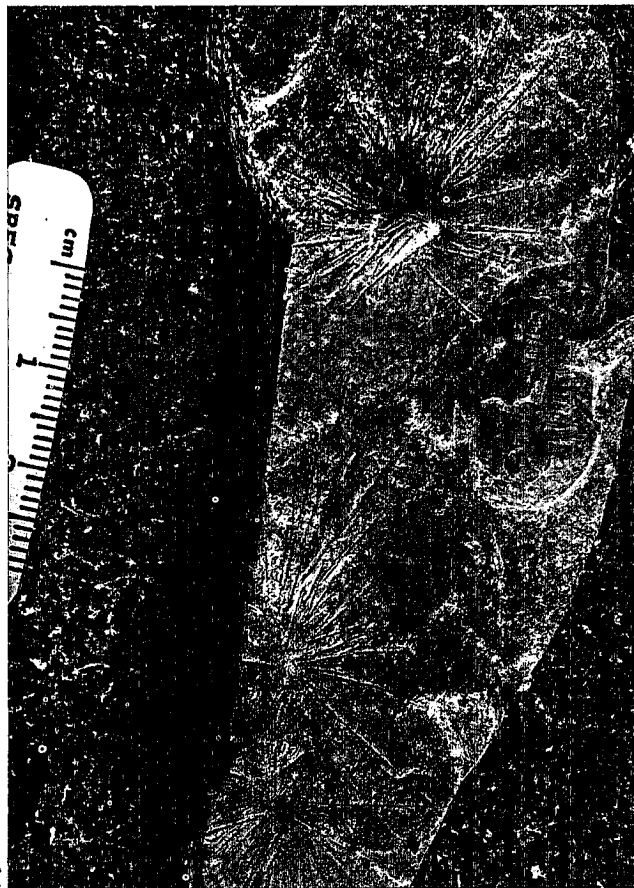
C.—*Choia utabensis* Walcott (BYU). A group of three individuals from the Wheeler Shale, Wheeler Amphitheater. Photo by J. K. Rigby.



A



B



C

## Plate 51

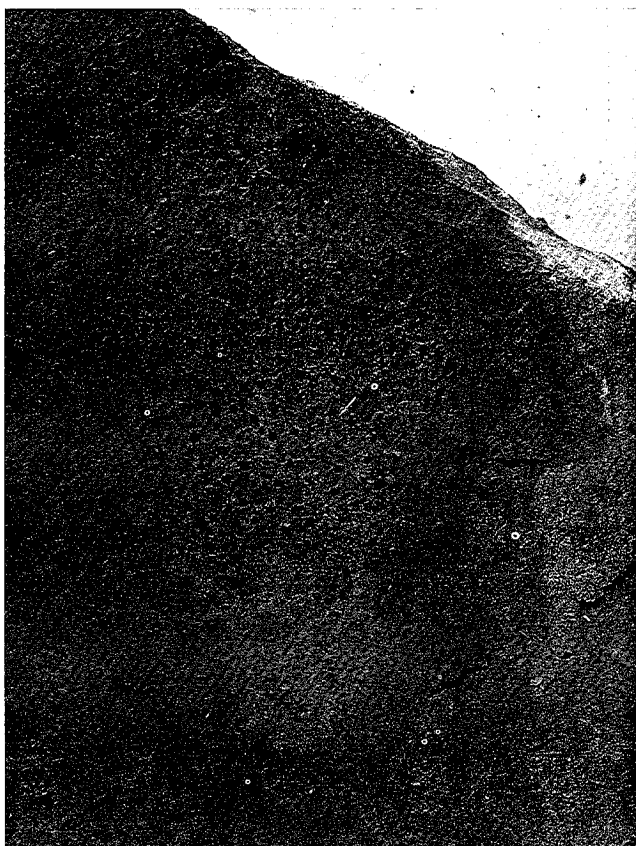
## Sponges

Sponges of the genus *Chancelloria* are thin walled tubular to conical-cylindrical, having four- to six-rayed spicules. They are known from several Wheeler Shale localities in the House Range.

A.—*Chancelloria pentacta* Rigby X2.1 (BYU 925), holotype specimen from Harris Quarry, Wheeler Amphitheater, showing five-rayed spicules. Photo by J. K. Rigby.

B.—*Chancelloria pentacta* Rigby X1.3 (GM). Collected by George Melloy from upper Wheeler Shale at a locality about 3.2 km (2 mi) north of east end of Marjum Pass, House Range.

C.—*Chancelloria pentacta* Rigby X5 (UCLA 38952), paratype, showing dominantly five-rayed spicules typical of the species.



A



B



C



**Plate 52****Sponges**

Two specimens of a new species of an unbranched conical-cylindrical sponge were collected from the Spence Shale in northern Utah. This documents the first reported occurrence of this genus in the United States (Rigby 1980).

A.—*Vauxia magna* Rigby (KU 111763) X2.1, holotype specimen from Miners Hollow, Wellsville Mountain. Specimen photographed under water by J. K. Rigby.

B.—Enlarged view X10.5 of holotype showing hexagonally-arranged skeletal net. Photo by J. K. Rigby.

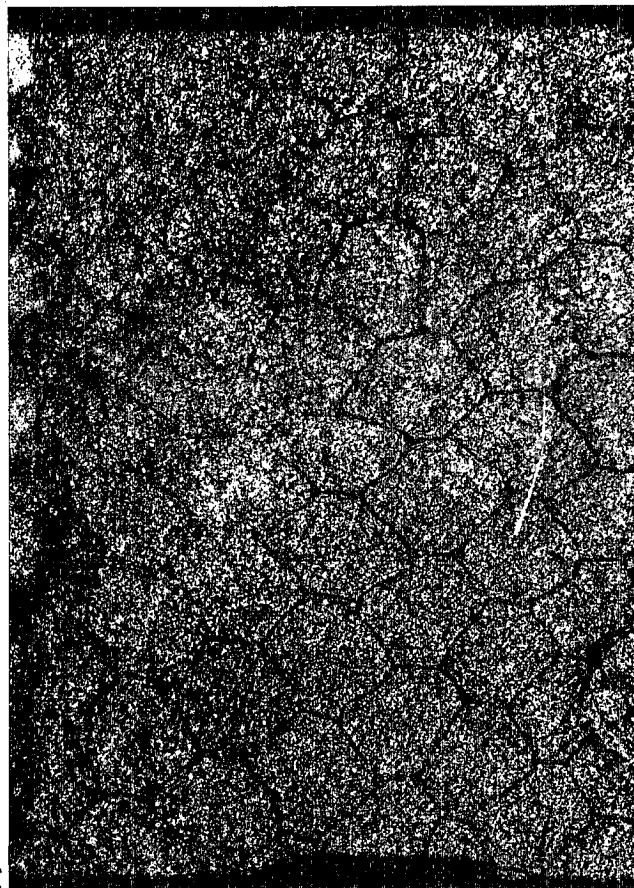
C.—Photomicrograph of the upper right part of the holotype specimen.



A



B



C



## Plate 53

## Sponges

Another Utah sponge previously recorded only from the Burgess Shale of Canada.

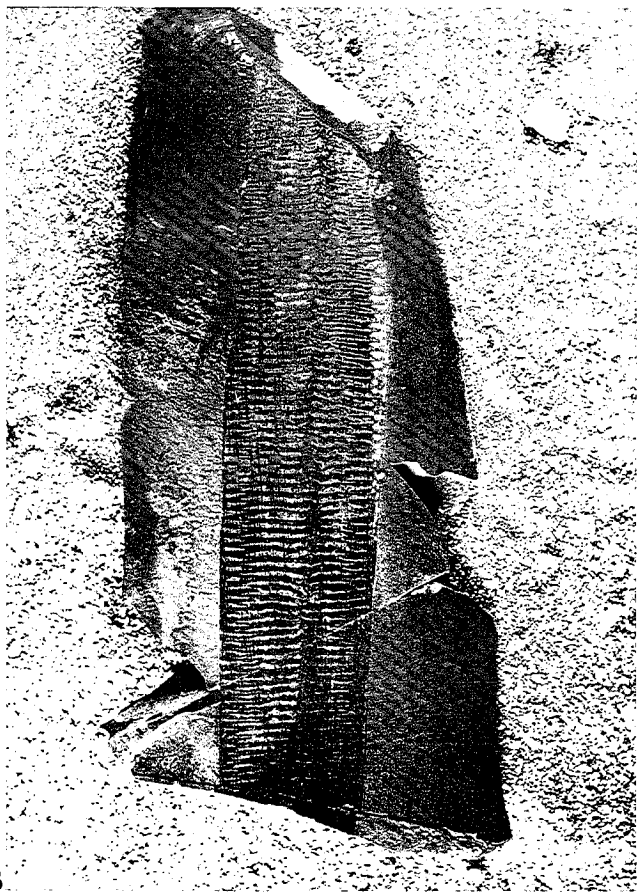
A.—*Leptomitrus bellilineata* Walcott X0.8 (BYU) from the Marjum Formation at a locality about 3.2 km (2 mi) southwest of Wheeler Amphitheater, House Range.

B.—*Leptomitrus bellilineata* Walcott X0.8 (GUN), counterpart of specimen A.

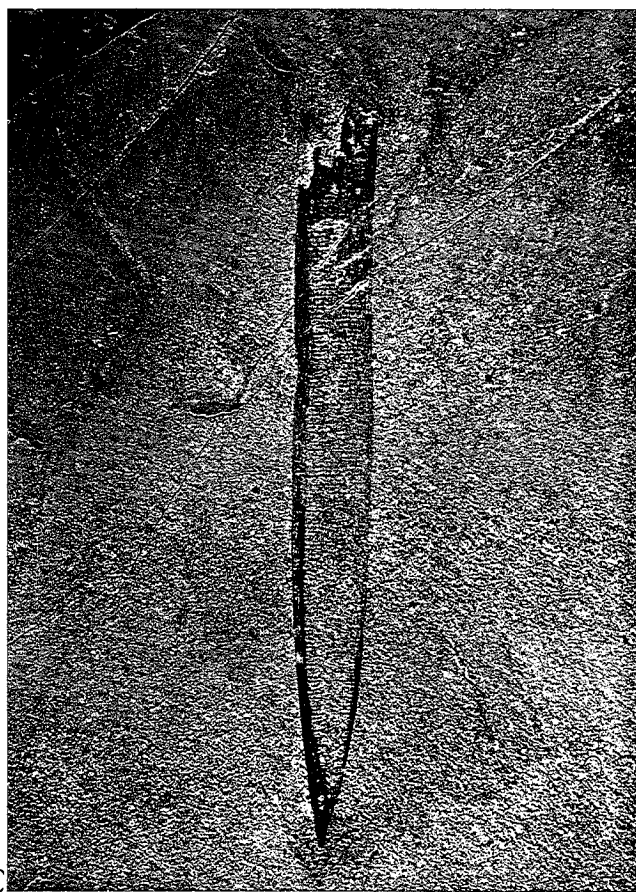
C.—*Leptomitrus bellilineata* Walcott X1.4 (BYU). Basal section of sponge from the same locality as A.



A



B



C

## Plate 54

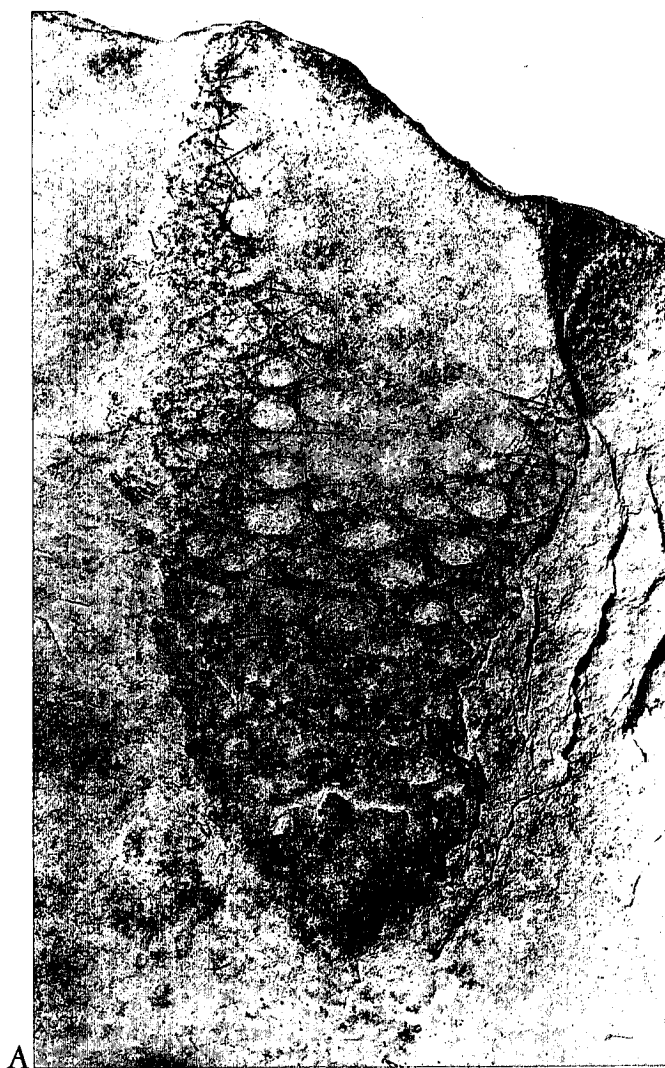
## Sponges

A sponge that has been recorded only from western Utah.

A.—*Ratcliffespongia perforata* Rigby X1.6 (BYU 1482), holotype specimen. Collected by William Ratcliffe from the Marjum Formation at Marjum Pass, House Range. Photo by J. K. Rigby.

B.—Enlarged section X5.8 of lower part of same specimen, showing the general arrangement of spicules and parietal gaps. Photo by J. K. Rigby.

C.—Enlarged section X5 of upper wall, showing confused part of skeletal net with possible prosthelia near center overlying normal skeletal material. Photo by J. K. Rigby.



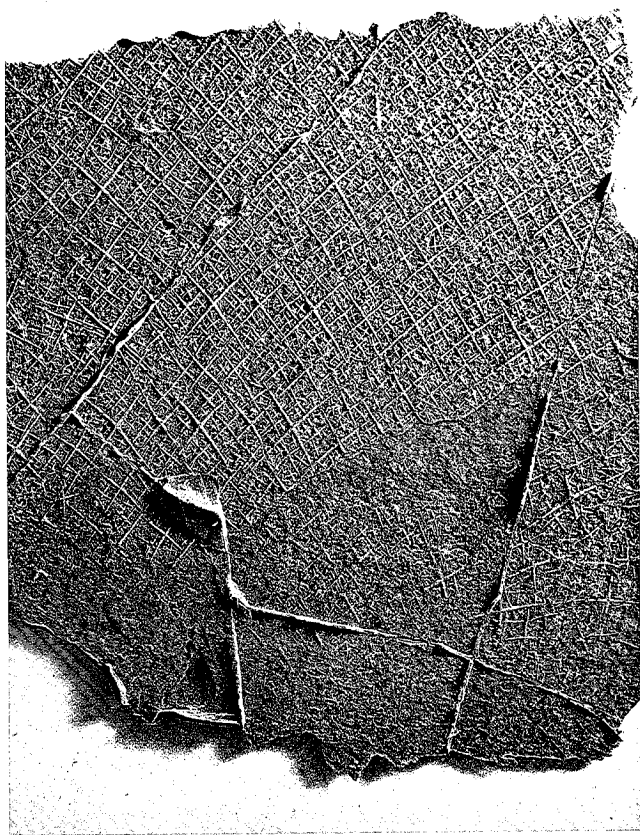
## Plate 55

## Sponges

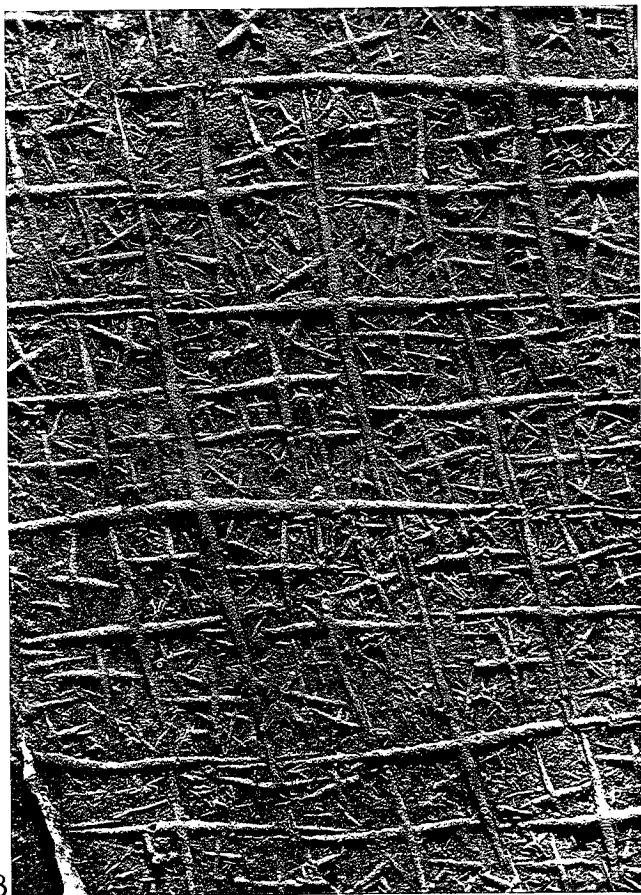
A.—*Protospongia hicksi* Hinde X1 (USNM 145295) (BYU 1070). Probably the largest and most nearly perfect preserved fragment known. Collected by A. R. Palmer from the Marjum Formation on the south side of Painter Springs Canyon in the House Range. Silicone rubber cast of original specimen. Photo by J. K. Rigby.

B.—Enlarged view of A, showing five ranks of spicules. Photo by J. K. Rigby.

C.—*Protospongia hicksi* Hinde X2.1 (GUN) from the Spence Shale at Two Mile Canyon, Malad, Idaho.



A



B



C

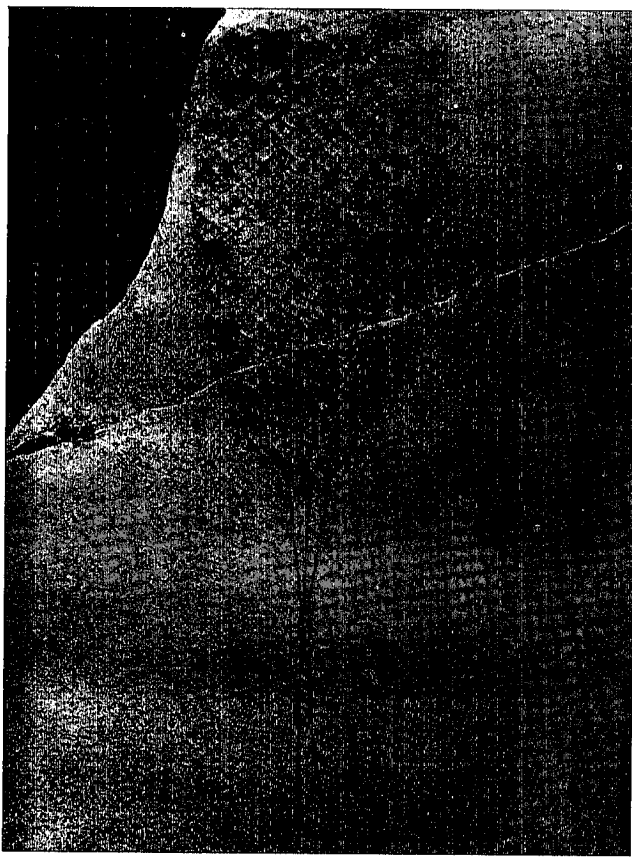
## Plate 56

## Sponges

A.—*Diagonella* sp. X2.2 (BYU) collected by R. A. Robison in the upper Wheeler Shale near Marjum Pass, House Range. Photo by J. K. Rigby.

B.—*Diagonella* sp. X1 (BYU). A large colony of articulated sponges from the Marjum Formation at a locality about 3.2 km (2 mi) southwest of Wheeler Amphitheater, House Range. Photo by J. K. Rigby.

C.—*Diagonella* sp. X2.1. An enlarged view of several of the individuals in B. Photo by J. K. Rigby.



A



B



C



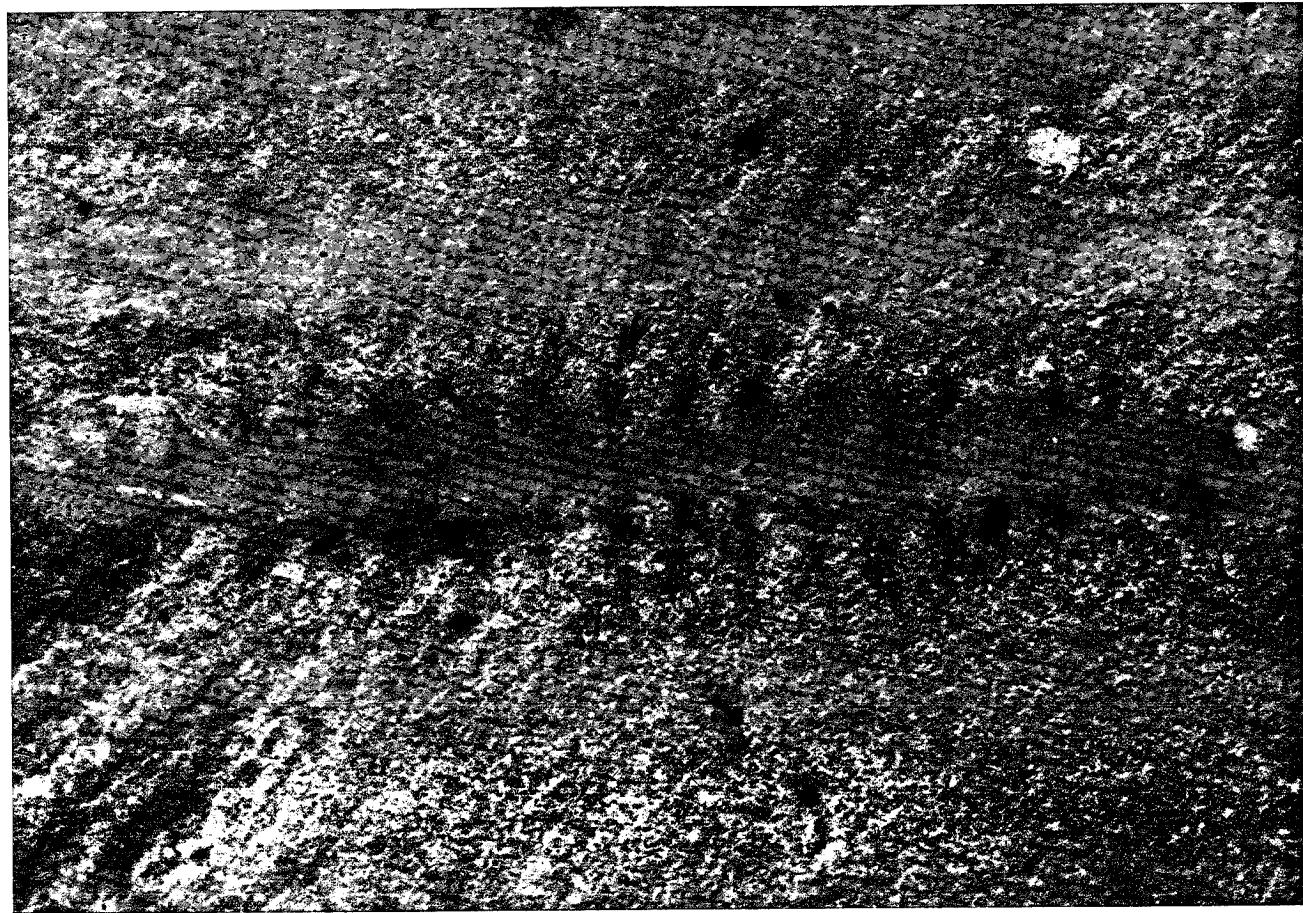
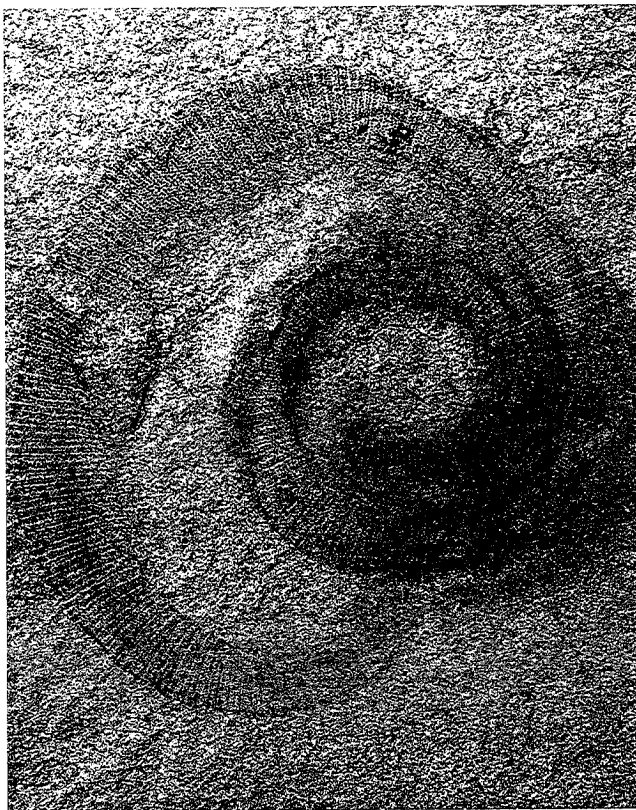
## Plate 57

## Annelid Worms

Annelidlike trails or trace fossils are common in Middle Cambrian rocks of Utah; however, fossilized body remains are extremely rare. Two examples are shown here.

A.—*Palaeoscolex ratcliffei* Robison X2.7 (UU 1020). Holotype specimen collected by William Ratcliffe from the Spence Shale, Miners Hollow, Wellsville Mountain. Photo by R. A. Robison. This represents a genus previously reported only from the Shineton and Breadstone Shales of England.

B.—*Canadia* sp. A rather poorly preserved specimen X7.7 (UU 1021) from the lower Spence Shale, Miners Hollow, Wellsville Mountain. Photo by R. A. Robison. The large chaetose parapodia and general body outline are distinctive enough to warrant assignment of this specimen to the genus *Canadia*.



## Plate 58

## Jellyfish

Lacking skeletal structures or hard parts, medusoids are rarely preserved as fossils. Imprints of three types of medusoids have been found in Middle Cambrian rocks of Utah. One possible *Brooksella* and a *Peytoia*-like specimen have recently been found in the Spence Shale, and a *Cambromedusa* and another *Peytoia*-like specimen have also been found in the Wheeler Shale. They represent the first known occurrences from the Cambrian in the Great Basin area and add a little more variety to the known Middle Cambrian fauna.

A.—*Brooksella* ? sp. X1. (BYU 1545) holotype, from the Spence Shale in Dry Canyon, Wellsville Mountain.

B.—An undetermined *Peytoia*-like medusoid (KU) from the Spence Shale, Miners Hollow, Wellsville Mountain.

C.—Another *Peytoia*-like medusoid (KU) from the upper Wheeler Shale near Swasey Spring, House Range.



A



B



C



## Plate 59

## Ctenocystoids

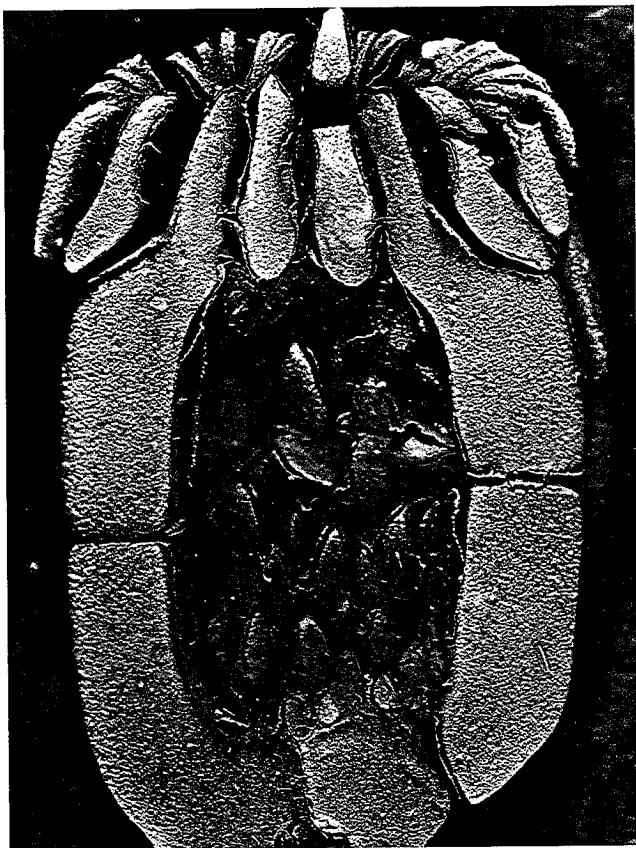
The oldest known "carpoid" of the echinoderm subphylum Homalozoa. These tiny free-living animals are known only from the Spence Shale in northern Utah.

A.—*Ctenocystis utahensis* Robison and Sprinkle X13.5 (GUN), showing inferior surface of a topotype specimen from the Spence Shale, Antimony Canyon, Wellsville Mountain.

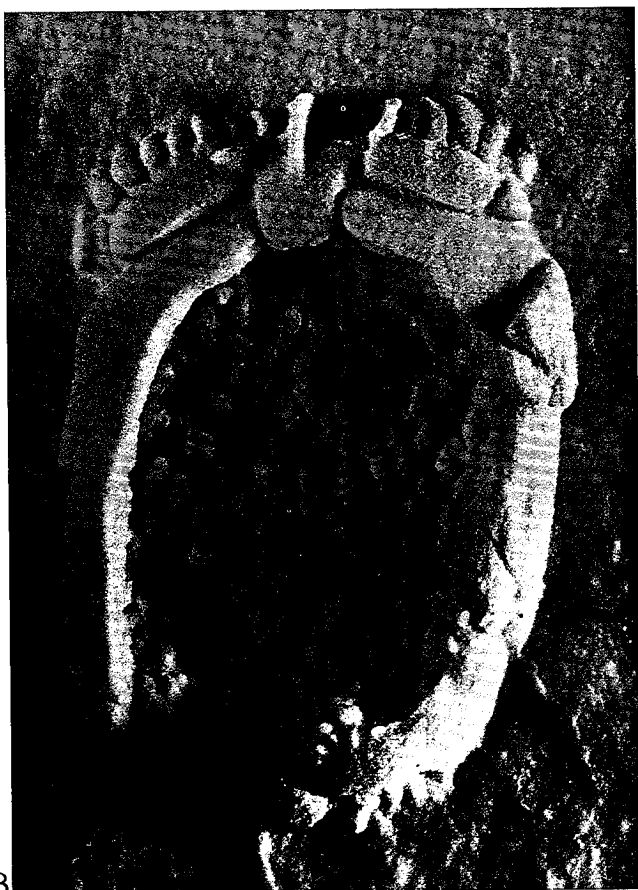
B.—Superior surface of a topotype specimen X21 (GUN) from same locality.

C.—A group of three individuals X7.4 (GUN) also from same locality.

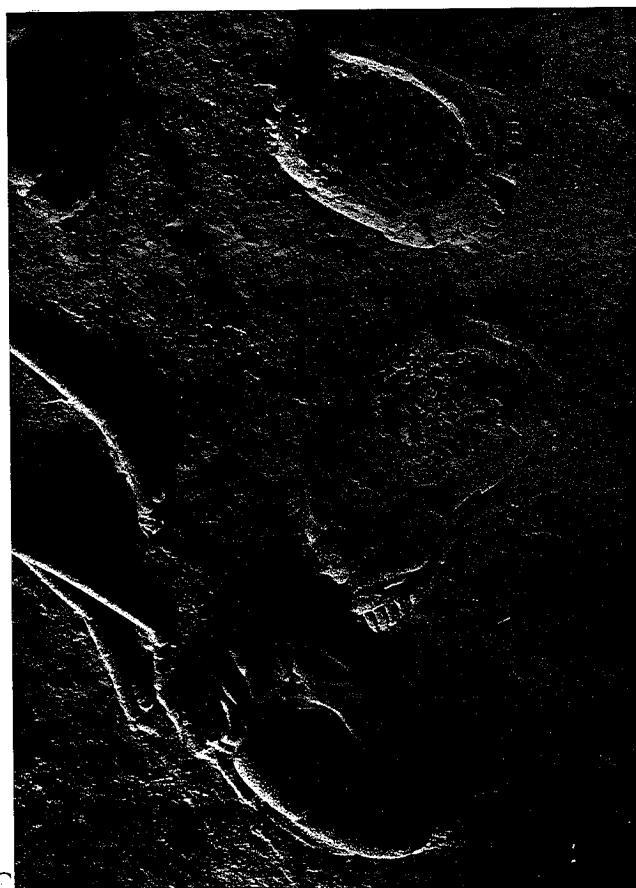
Photos were taken from silicone rubber casts smoked with ammonium chloride.



A



B



C

## Plate 60

## Eocrinoids

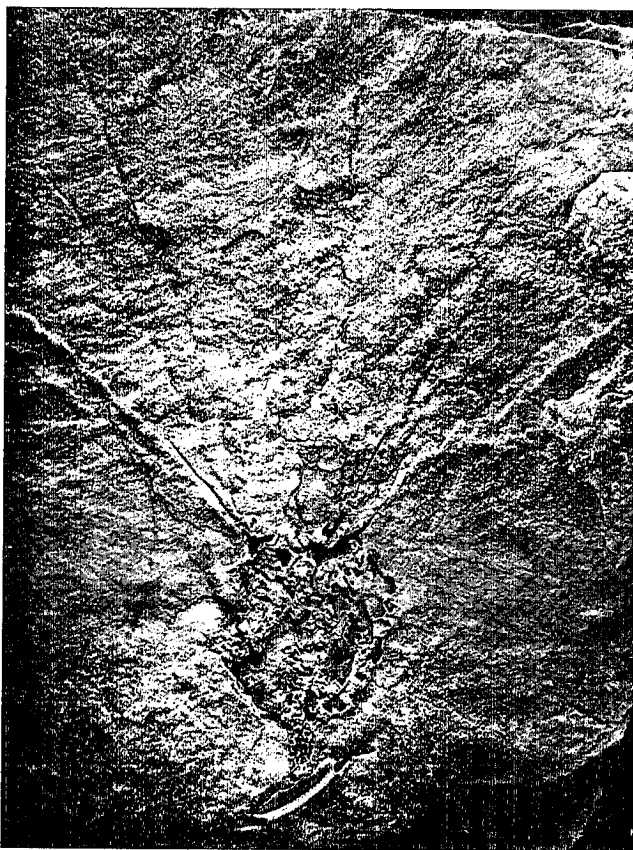
*Gogia granulosa* Robison

This eocrinoid is characterized by its globular calyx, strongly spiralled brachioles, and small, cylindrical holdfast.

A.—Specimen X2.8 (GUN), showing its holdfast attachment to a trilobite fragment. From near middle of Spence Shale, Miners Hollow, Wellsville Mountain.

B.—Specimen X2.8 (GUN), showing spiralled brachioles and calyx plates. From near middle of Spence Shale, Cataract Canyon, Wellsville Mountain.

C.—A group of three individuals X1.5 (GUN), all oriented in same direction. From Miners Hollow, Wellsville Mountain.



A



B



C

## Plate 61

## Eocrinoids

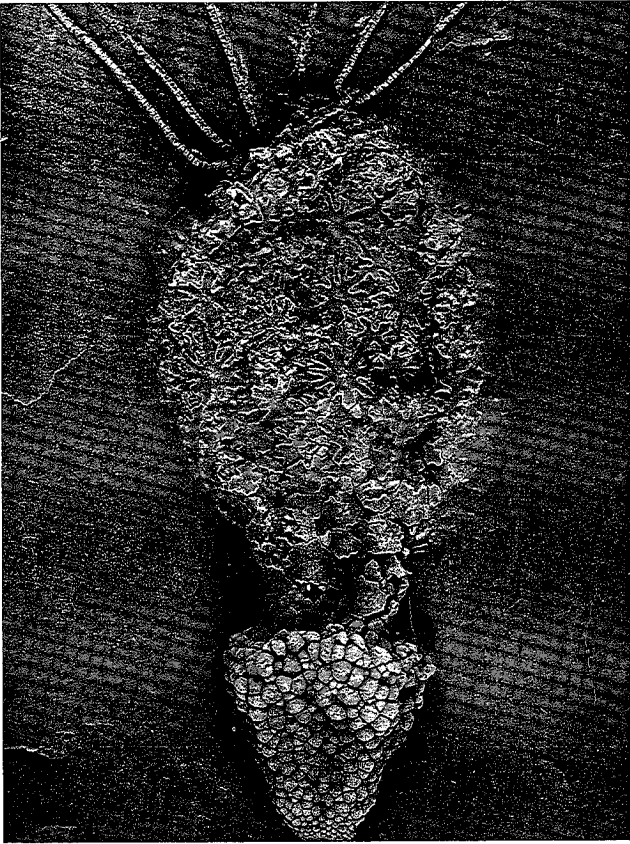
*Gogia guntheri* Sprinkle

This eocrinoid is characterized by its partially spiralled brachioles and its strongly inflated holdfast. It is found near the base of the Spence Shale and does not overlap with other species of eocrinoids that also occur in the Spence Shale.

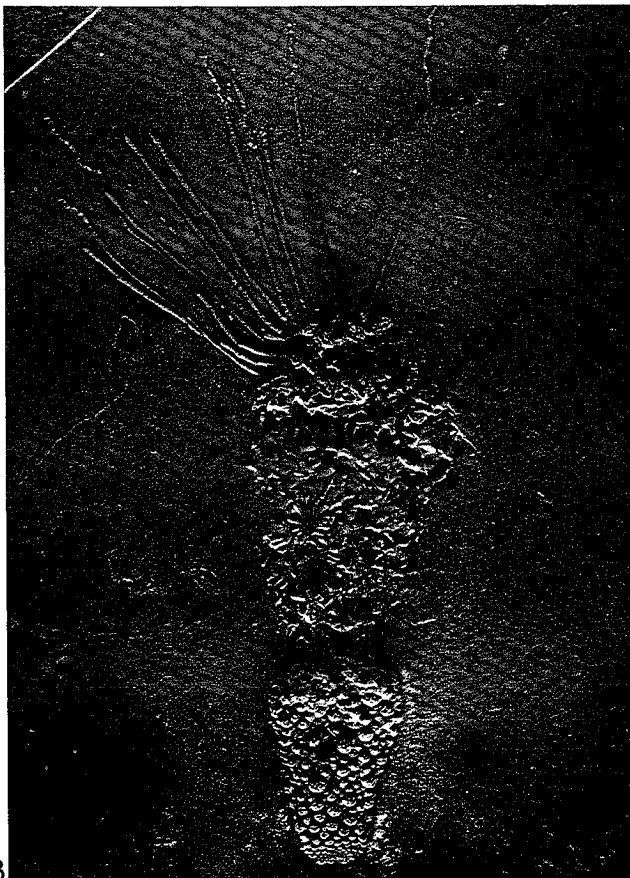
A.—Holotype specimen X2.6 (UU 1010a), showing ellipsoidal calyx and conical inflated holdfast. From Miners Hollow, Wellsville Mountain. Photo by R. A. Robison.

B.—Topotype specimen X1.5 (GUN) also from Miners Hollow, Wellsville Mountain.

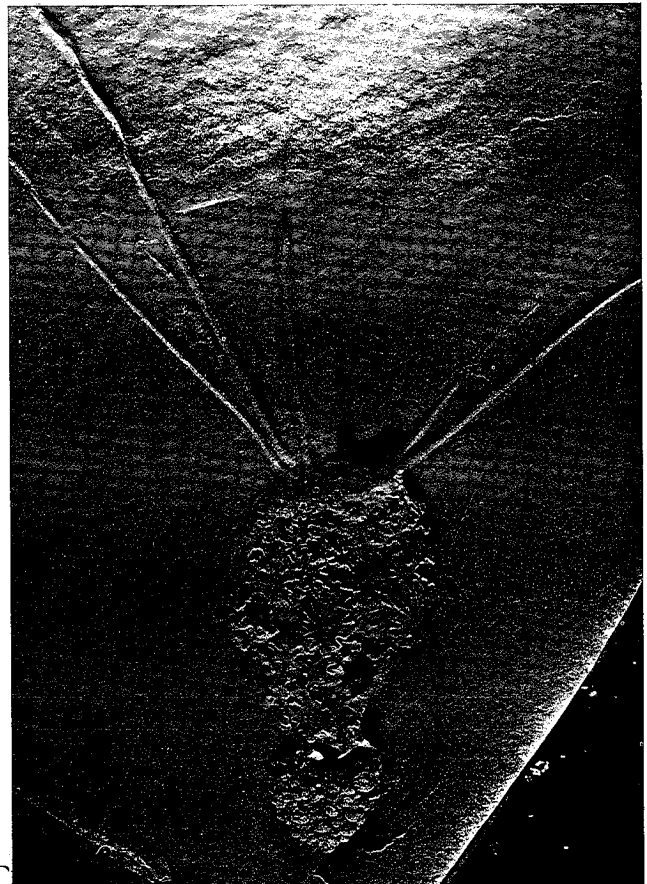
C.—Another topotype specimen X2.1 (GUN) from same locality.



A



B



C

## Plate 62

## Eocrinoids

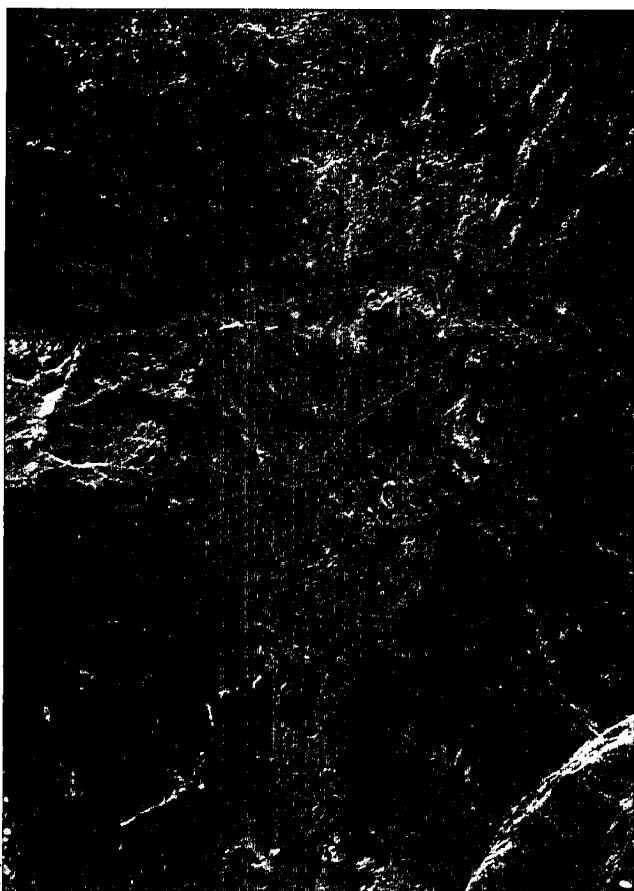
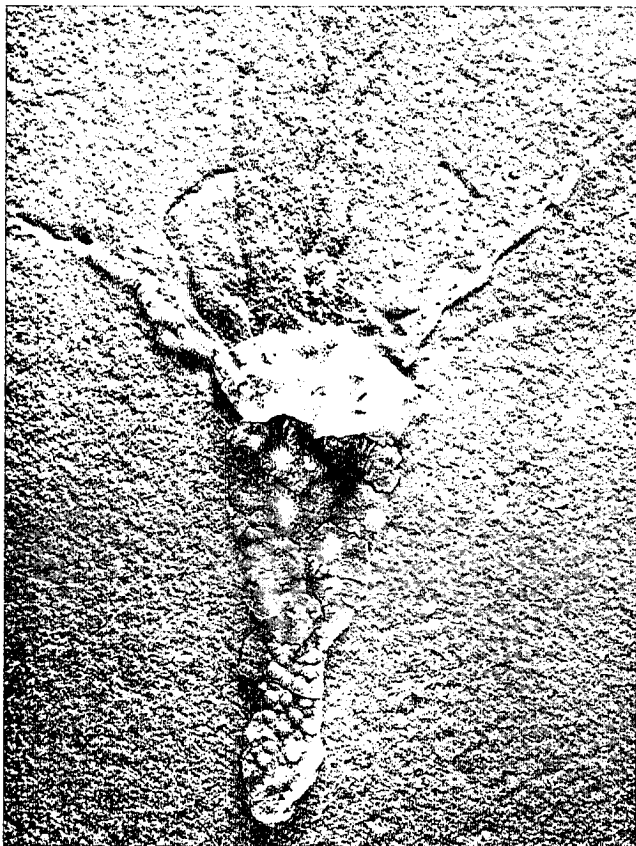
*Gogia spiralis* Robison

This is one of three known species with spiralled brachioles and the only one with a holdfast ranging from medium length cylindrical to slightly inflated. It differs from most other species in having a smaller number of plates per side, no plate ornamentation, a cylindrical or slightly inflated holdfast, and an abrupt holdfast-calyx transition.

A.—Specimen X2.75 (GUN) from base of Marjum Formation at Marjum Pass, House Range.

B.—Specimen X2.1 (GUN) from near top of Wheeler Shale just north of the Wheeler Amphitheater, House Range.

C.—Specimen X2.9 (GUN) from near base of Marjum Formation, Marjum Pass.



## Plate 63

## Eocrinoids

*Gogia* sp.

This eocrinoid is characterized by straight nonspiralled brachioles, a globular or conical shaped calyx, and a long, cylindrical holdfast. It occurs in the upper regions of the Spence Shale at several localities.

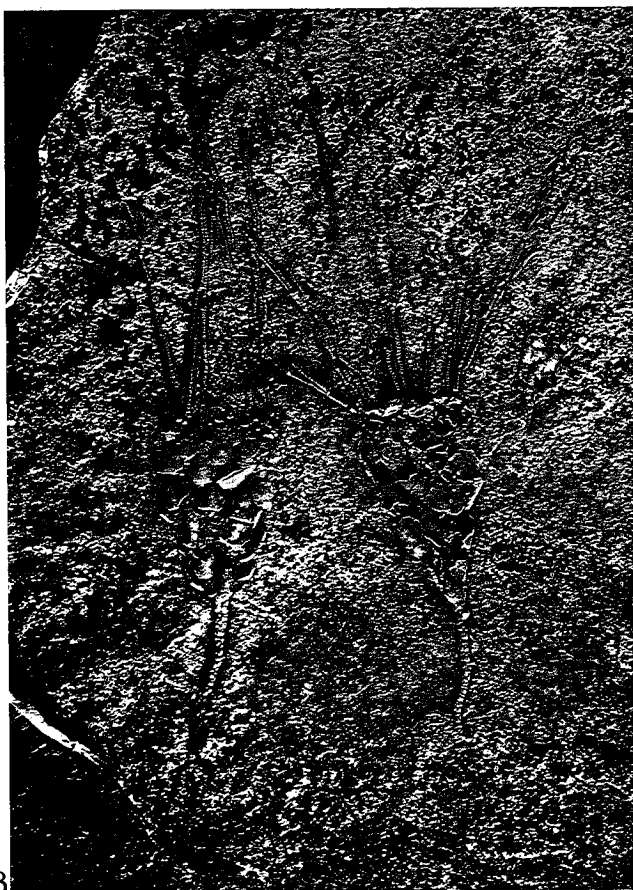
A.—An exceptionally large specimen X1 (GUN) from Spence Shale, Antimony Canyon, Wellsville Mountain. Photo taken of a “smoked” silicone rubber cast.

B.—Two large and one small individual X1.3 (GUN) with nearly same orientation. From near top of Spence Shale, Antimony Canyon, Wellsville Mountain.

C.—A group of several individuals X1.3 (GUN) from near top of Spence Shale, Antimony Canyon, Wellsville Mountain. Photo of silicone rubber cast.



A



B



C



## Plate 64

## Hyolithids

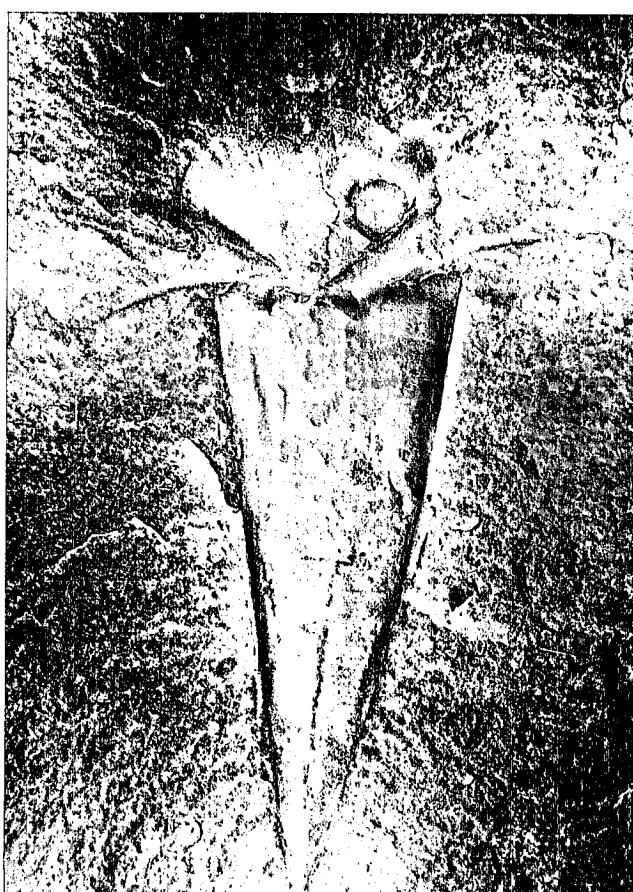
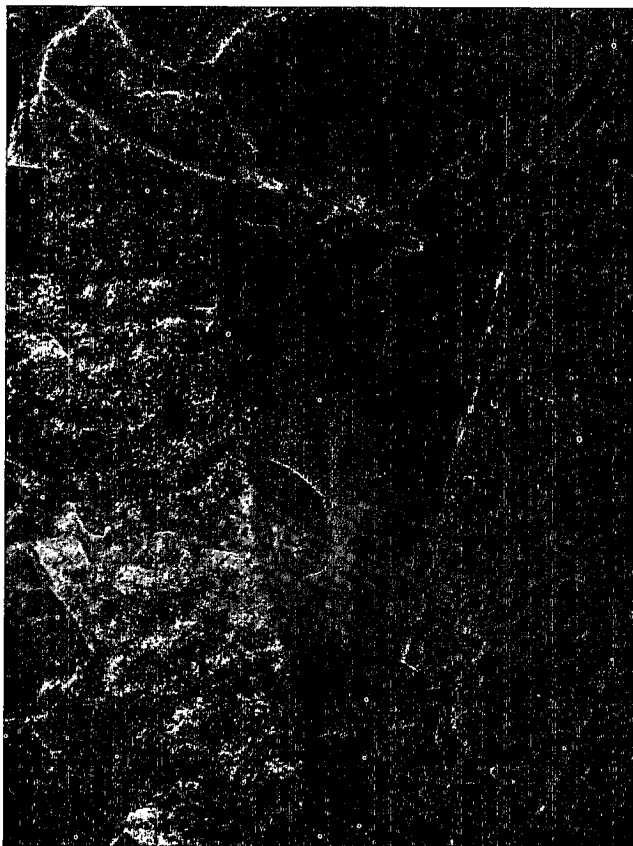
*Hyolithes cecrops* Walcott

These cone-shaped animals are all classed as belonging to the genus *Hyolithes* and are believed by some authorities to belong to Mollusca and by others to be a small separate phylum. They are quite common, sometimes abundant in many localities, especially in the Spence Shale. Here they are often preserved with the operculum joined to the aperture and with two laterally projecting appendages (helens) attached.

A.—Specimen “smoked” X3.3 (GUN) showing helens attached. From upper Spence Shale, Antimony Canyon, Wellsville Mountain.

B.—An “unsmoked” specimen X3.8 from same locality.

C.—“Smoked” specimen X3.7 from near middle of Spence Shale, Miners Hollow, Wellsville Mountain.





## Plate 65

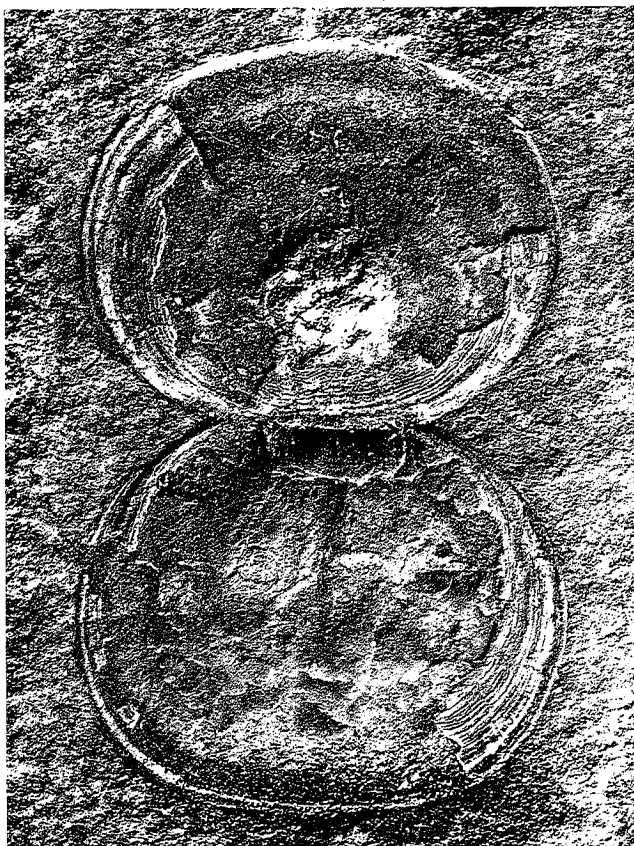
## Brachiopods

Middle Cambrian brachiopods are represented by both articulate and inarticulate forms. Inarticulate forms are especially numerous at many localities, particularly in the Spence and Wheeler Shales. A few representatives of this diverse group are shown in the following photographs:

A.—*Acrothele subsidua* (White) X5.3 (GUN) from the Spence Shale, Miners Hollow, Wellsville Mountain.

B.—*Acrothele subsidua* (White) X10.5 (KU) collected by A. J. Rowell from the lower Marjum Formation, House Range. Photo by A. J. Rowell.

C.—*Dictyonina* sp. X13.7 (GUN). An inarticulate brachiopod from near the middle of the Spence Shale, Antimony Canyon, Wellsville Mountain.



A



B



C

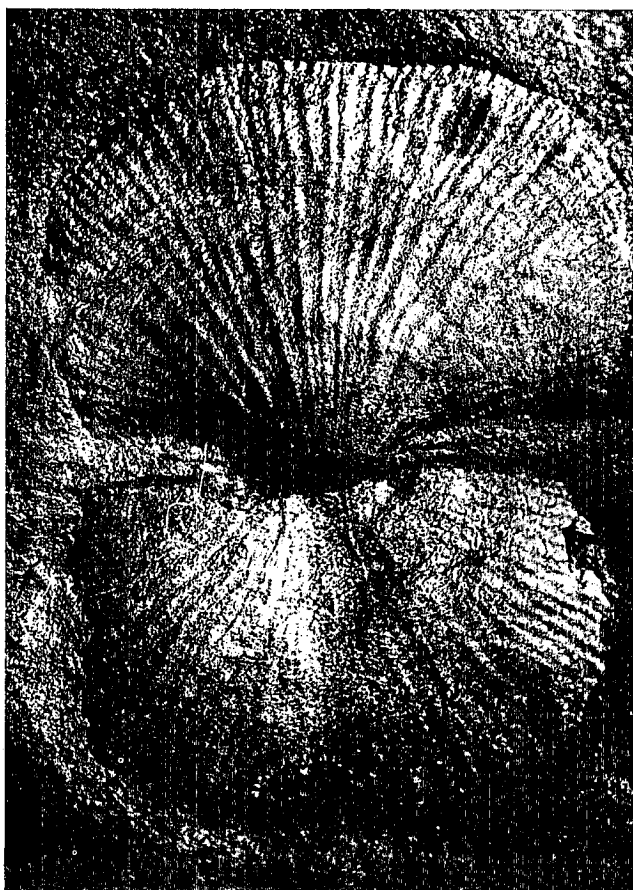
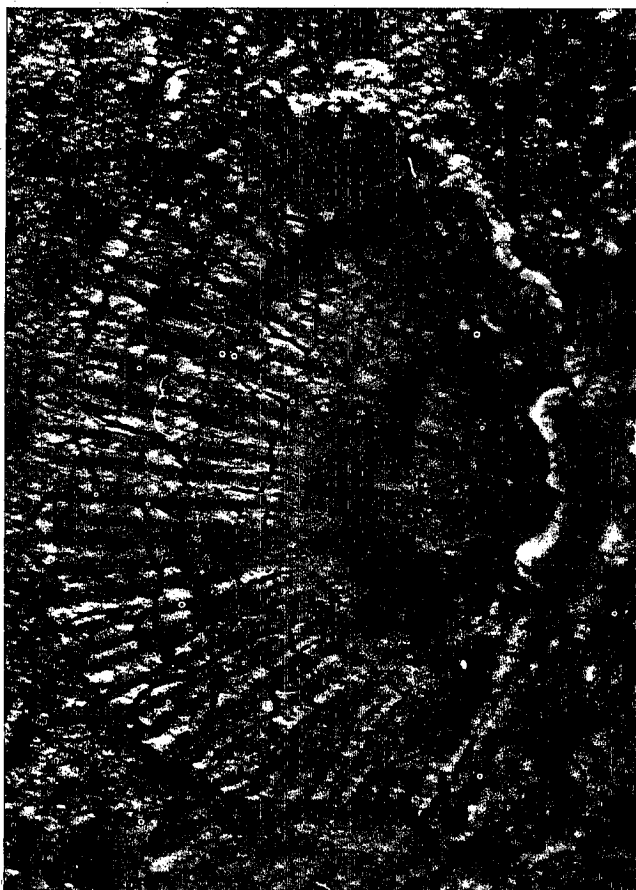
## Plate 66

## Brachiopods

A.—An undetermined linguloid X9.5 (GUN) from the Marjum Formation, east side of Wheeler Amphitheater, House Range.

B.—*Wimanelia spencei* (Walcott) X4.8 (GUN) from Spence Shale in first small canyon north of Hansen Canyon, Wellsville Mountain.

C.—*Wimanelia spencei* (Walcott) X7.4 (GUN) from Spence Shale, Antimony Canyon, Wellsville Mountain.





## Plate 67

## Algae

Relatively little attention has been given to algal seaweed fossils, which are often overlooked by collectors. This is partly due to less interest, their generally poor state of preservation, and failure to recognize them. Middle Cambrian rocks of Utah are fairly rich in megascopic algae (green and blue green), especially in the Spence and Wheeler shales.

A.—*Yuknessia simplex* Walcott X4.2 (GUN) from basal Pierson Cove Formation in the Drum Mountains. It is also found in the Wheeler Shale.

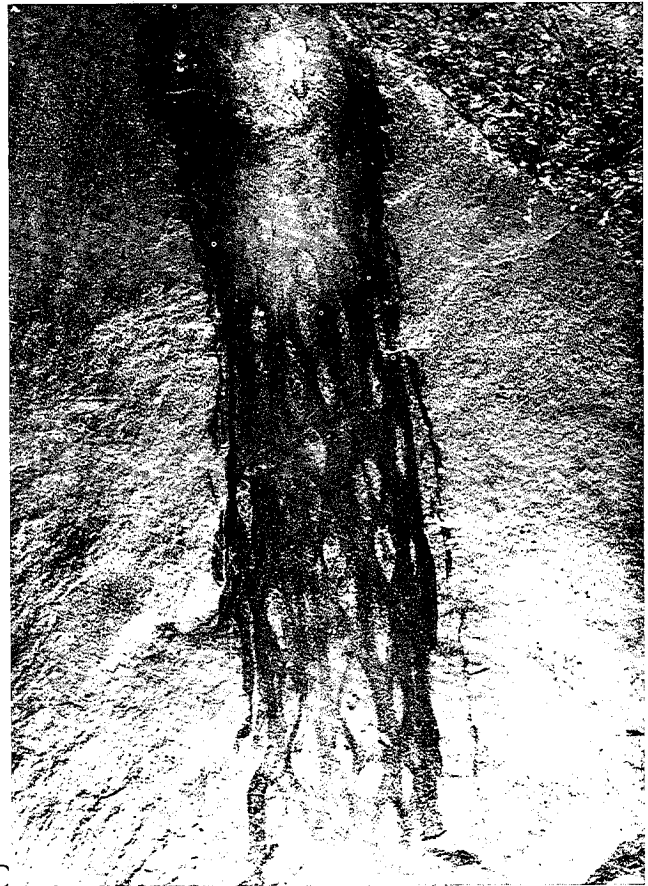
B.—*Marpolia spissa* Walcott X3.2 (GUN) from near top of Spence Shale in Antimony Canyon, Wellsville Mountain.

C.—*Margaretia dorus* Walcott X1.25 (GUN) from upper Wheeler Shale, near Wheeler Amphitheater, House Range. It is the most abundant megascopic algae in the Wheeler and Spence Shales.

A



B



C



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- Rowley, R. B., Geology and mineral deposits of the Lodi Hills, Nye County, Nevada, p. 141-151, 1 pl., 7 figs.
- Sperry, S. W., The Flagstaff Formation: Depositional environment and paleoecology of clastic deposits near Salina, Utah, p. 153-173, 2 pl., 16 figs.
- Wheeler, R. F., Geology of the Sewing Machine Pass Quadrangle, central Wah Wah Range, Beaver County, Utah, p. 175-191, 1 pl., 10 figs.

## Part 3

- Baer, J. L., and Rigby, J. K., Studies for Students No. 10, Geologic guide to Provo Canyon and Weber Canyon, central Wasatch Mountains, Utah, p. 1-33, 76 figs.
- Bushman, J. R., The rate of sedimentation in Utah Lake and the use of pollen as an indicator of time in the sediments, p. 35-43, 1 fig.
- Chamberlain, R. L., Structure and stratigraphy of the Rex Peak Quadrangle, Rich County, Utah, p. 44-54, 1 pl., 9 figs.
- Dommer, M. L., The geology of the Drum Mountains, Millard and Juab Counties, Utah, p. 55-72, 1 pl., 3 figs.
- Oberhansley, G. G., Geology of the Fairview Lakes Quadrangle, Sanpete County, Utah, p. 73-95, 1 pl., 18 figs.
- Steed, D. A., Geology of the Virgin River Gorge, northwest Arizona, p. 96-115, 1 pl., 15 figs.
- Weaver, C. L., Geology of the Blue Mountain Quadrangle, Beaver and Iron Counties, Utah, p. 116-132, 1 pl., 10 figs.

## Maps

- Preliminary geologic map of the Cricket Mountains, Millard County, Utah, by L. F. Hintze, 1959, scale 1" equals 4,000 ft., ozalid print 36" x 48".
- Preliminary geologic map of the Burbank Hills and Northern Needle Range, Millard County, Utah, by L. F. Hintze, 1960, scale 1" equals 4,000 ft., ozalid print.
- Geology of the southern Wasatch Mountains and vicinity, by L. F. Hintze (from vol. 9, pt. 1), two colors, 20" x 32".
- Preliminary geologic map of the Y mountain area, east of Provo, Utah, by L. F. Hintze, 1969, scale 1" equals 2,000 ft.

## Special Publication 1

- Hamblin, W. K., and Murphy, R., Grand Canyon perspectives: A guide to the canyon scenery by means of interpretive panoramas.

## Special Publication 2

- Hintze, L. F., 8½ x 11" colored geological map of Utah with roads.

## Special Publication 3

- Utah geological highway map, scale 1" equals 15 miles. Full color with seven stratigraphic sections, seven cross-sections, ERTS photomosaic of Utah and a summary of Utah's geologic history.

## Special Publication 4

- Rigby, J. K., and Roberts, H. H., Geology, reefs, and marine communities of Grand Cayman Island, British West Indies, p. 1-95, 26 pls., 36 text-figs.
- Roberts, H. H., Carbonate sedimentation in a reef-enclosed lagoon. North Sound, Grand Cayman Island, p. 97-122, 5 pls., 10 tables, 11 text-figs.



## NOTES





# ERRATA

Page 11. The word POSTERIOR should be placed below specimen A.

Page 35 and 36. The illustrations are reversed. Plate 21 illustrations should be on Plate 22, and Plate 22 illustrations should be on Plate 21.

