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SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 152, NUMBER 4

**Charles D. and Mary Vaux Walcott
Research Fund**

**LOWER AND MIDDLE CAMBRIAN
TRILOBITE FAUNAS FROM THE
TACONIC SEQUENCE OF
NEW YORK**

(WITH 14 PLATES)

By

FRANCO RASETTI

Johns Hopkins University, Baltimore, Maryland
Honorary Research Associate, Smithsonian Institution



(PUBLICATION 4710)

CITY OF WASHINGTON
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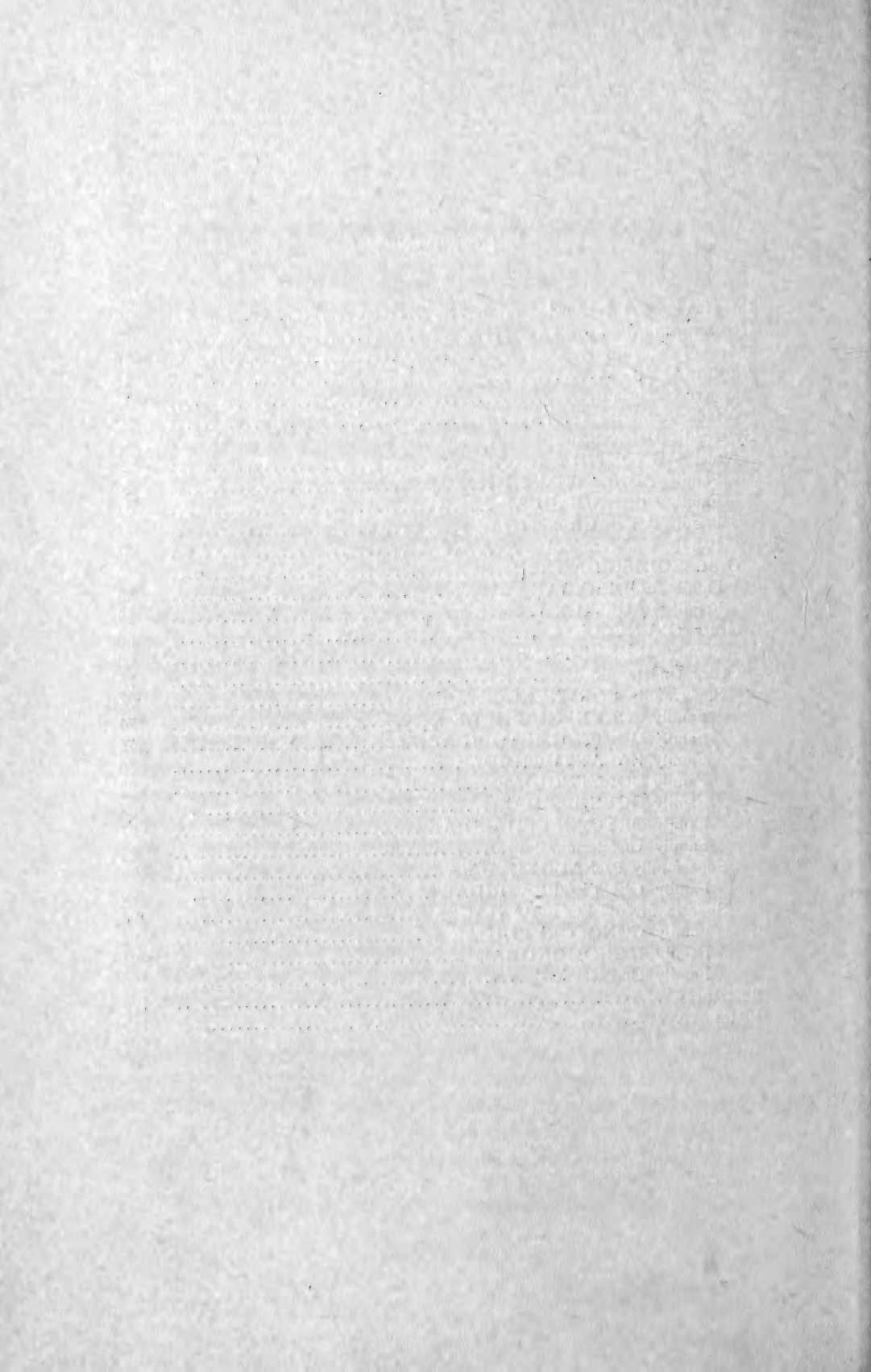
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(WITH 14 PLATES)

INTRODUCTION AND ACKNOWLEDGMENTS

IN A PREVIOUS PAPER (Rasetti, 1966a) the writer described a new faunule of Early Cambrian age discovered in bedded limestone of the Taconic sequence in the East Chatham 7½-minute quadrangle, Columbia County, New York. The faunule was exceptional in the large number of new genera and species of the trilobite family Eodiscidae, exceeding the total formerly known for all of North America. This finding stimulated an intensive search for fossils in Cambrian outcrops in northern Columbia County, with highly gratifying results. A greater variety of Early Cambrian faunules than previously known from the Taconic sequence was discovered, and Middle Cambrian trilobites belonging to two faunizones were collected, thereby proving the existence of Cambrian strata of that age, contrary to the general belief held by previous students of that area. For the first time in the study of the Cambrian of the Taconic sequence, it was possible to obtain several faunules in certain stratigraphic order from a single section. Study of the Middle Cambrian faunas allowed a very precise correlation of the strata with those of northern Europe and the western United States.

This paper is essentially based on the results of stratigraphic studies and fossil collecting in northern Columbia County. However, comparisons with strata and fossils in the more northerly parts of the Taconic sequence, in Rensselaer and Washington Counties, are occasionally made, even though those areas were by far not as thoroughly

explored by the writer. The early work of Ford, Dale, and Walcott, and the more recent one of Lochman (1956) has given a fairly complete description of the Early Cambrian fauna of this area, even though the existence of Early Cambrian faunules not referable to the *Elliptocephala asaphoides* assemblage had not been recognized (Theokritoff, 1964; Rasetti and Theokritoff, 1967).

A paper on the stratigraphy of the Cambrian of Columbia County, describing in detail the sections which supplied the fossils discussed herein, will be published by Bird and Rasetti (in press).

The present work was supported by two grants (nos. 3454 and 4028) from the Penrose Fund of the American Philosophical Society, and the writer gratefully acknowledges his indebtedness to the Society. Thanks are also due to several persons who gave valuable help in the course of the field work. Dr. John M. Bird, responsible for the first finding of new Early Cambrian trilobites in Columbia County, continued to cooperate enthusiastically in the discovery and search of new fossiliferous localities and study of the stratigraphy, and accompanied the writer in a number of field excursions. Dr. Donald W. Fisher contributed his knowledge of the area and suggested the examination of several potentially fossiliferous exposures, some of which were productive. Dr. A. R. Palmer accompanied the writer on a field excursion and collected valuable fossils. Dr. George Theokritoff also contributed to collecting, and accompanied the writer on an excursion in northern Washington County where he had thoroughly studied and mapped the rocks of the Taconic sequence. To all these persons, and to Dr. E-An Zen, the writer is also indebted for discussions on the stratigraphy and faunas.

OCCURRENCE OF THE FOSSILS

General statement.—The trilobites described herein, with a few exceptions of specimens from other areas illustrated for comparison, were collected by the writer, aided by the persons mentioned in the acknowledgments, in a limited portion of Columbia County, New York, chiefly either in the East Chatham 7½-minute quadrangle (Kinderhook 15-minute quadrangle) or the Hudson North 7½-minute quadrangle (Coxsackie 15-minute quadrangle).

Almost all the material, excepting a few Lower Cambrian trilobites of the *Elliptocephala asaphoides* assemblage from shale deposits at Judson Point, was recovered from more or less pure limestone beds or lenses (only in exceptional cases from conglomerate boulders). The specimens are seldom flattened or distorted, and in general preserve

the test and exhibit the aspect of the outer surface. Further details on the manner of preservation are mentioned in the discussion of the various localities.

Most of the fossils were collected from outcrops, usually in measured sections, hence in several cases the relative stratigraphic position of various faunules could be established. Some of the specimens illustrated herein, which were recovered from loose limestone blocks in stone walls, belong to faunules that are also known from bedded rocks.

Localities, as in the previous paper (Rasetti, 1966a) are designated by the letters cs, followed by a locality number. A list indicating the topographic position of each locality, determined by coordinates on the U. S. Geological Survey maps, is given hereafter. When a collection is from a loose block in a stone wall on or near the Griswold farm (the only area where collections from loose blocks were made), it is labeled by the letters cs followed by the locality number (which may be that of a nearby outcrop, if any), and the letter L or M, to indicate a Lower or Middle Cambrian boulder, respectively, followed by a boulder number.

An asterisk preceding the name in fossil lists indicates the type locality for the species.

For brevity, author's names are not indicated, since all the listed species are described either in the present paper or the previous one (Rasetti, 1966a).

When the collection is sufficiently large, an indication of the frequency of species is given by the symbols (rr), very rare, (r), rare, and (c), common. These indications are purely relative; e.g., a species indicated as common may be very rare in an absolute sense, only less so than another designated as rare in the same collection.

East Chatham quadrangle: Griswold farm.—The area is located on a hill about one mile SE. of North Chatham, Columbia County, on the property of Mr. Grafton Griswold, and it supplied a great number of trilobites, belonging to several Lower and Middle Cambrian faunules, both from outcrops and loose blocks. This is the area where unusual Cambrian fossils were first discovered in Columbia County in 1963.

A new Lower Cambrian faunule, chiefly characterized by an exceptionally large number of eodiscid trilobites, was already described (Rasetti, 1966a) from one bed exposed on the Griswold farm (collection cs-4), and conjectures were advanced concerning the relationship of the fossil bed to nearby outcrops. After that paper was written, a trench deep enough to expose bedrock was excavated eastward from

the fossil locality, revealing a sequence of black shales with several interstratified limestone intervals, some of which did not appear on the surface. All the strata show a uniform dip of 55° E. and unquestionably represent a sedimentary sequence. The trench was not extended further in either direction, since surface exposures indicate that only green and black shales would have been encountered westward and eastward, respectively, for considerable distances. Fossil evidence obtained by comparison with another section (Malden Bridge road cut) indicates that the strata are not inverted; i.e., higher beds are exposed eastward. A lens of intraformational limestone conglomerate in green shale is exposed 20 feet stratigraphically below the lowest limestone listed below. The coarsely granular, light-gray matrix holds good specimens of *Salterella*, but no other, more diagnostic, fossils could be obtained.

The trilobites collected from the limestone beds exposed in the trench are the following:

Collection cs-5 (USGS coll. 4215), 58 feet above base:

Olenellid fragments
Pagetides elegans
Pagetides rupestris
Peronopsis, sp. undet.
Prozacanthoides, sp. undet.

Collection cs-4c, 55 feet above base:

Pagetides elegans
Pagetides rupestris

Collection cs-4b, 53 feet above base:

Pagetides amplifrons
Pagetides elegans
Pagetides minutus
Prozacanthoides, sp. undet.

Collection cs-4a, 40 feet above base:

Bonnia, sp. undet.
Neopagetina tacomica
Olenellid fragments
Pagetides minutus
Peronopsis, sp. undet.
Ptychopariacea, cranidium no. 1

Collection cs-4 at base (USGS coll. 4216; *Acimetopus bilobatus* bed):

* <i>Acidiscus birdi</i>	c
* <i>Acidiscus hexacanthus</i>	r
* <i>Acimetopus bilobatus</i>	c
* <i>Analox bipunctata</i>	c
* <i>Bathydiscus dolichometopus</i>	r

* <i>Bolboparia superba</i>	r
* <i>Bolboparia elongata</i>	r
<i>Bonnia</i> , sp. no. 1	r
<i>Bonnia</i> , sp. no. 2	r
<i>Bonnia</i> , sp. no. 3	r
<i>Bonnia</i> , sp. no. 4	r
* <i>Calodiscus fissifrons</i>	r
* <i>Calodiscus occipitalis</i>	rr
* <i>Calodiscus reticulatus</i>	r
Eodiscidae, pygidium no. 2	rr
Eodiscidae, pygidium no. 3	rr
<i>Kootenia</i> , sp. undet.	rr
* <i>Leptochilodiscus punctulatus</i>	r
* <i>Litometopus longispinus</i>	r
<i>Olenellus</i> , sp. no. 1	c
* <i>Oodiscus binodosus</i>	rr
* <i>Oodiscus longifrons</i>	r
* <i>Oodiscus subgranulatus</i>	r
<i>Paedeumias</i> , sp. no. 1	c
<i>Paedeumias</i> , sp. no. 2	r
* <i>Serrodiscus griswoldi</i>	rr
* <i>Serrodiscus latus</i>	rr
* <i>Serrodiscus spinulosus</i>	r
* <i>Serrodiscus subclavatus</i>	c
<i>Serrodiscus</i> , sp. undet.	rr
* <i>Stigmatiscus gibbosus</i>	r
* <i>Stigmatiscus stenometopus</i>	r

All the species from collection cs-4 were described by Rasetti (1966a) except *Serrodiscus griswoldi*, which is described herein, (p. 52).

Several other outcrops on the Griswold farm yielded a few fossils of the *Pagetides* fauna, showing approximate equivalence to collections cs-4b and cs-5 listed above. In the wooded area just north of the Griswold farm are several isolated outcrops, some of which produced a few, very fragmentary fossils. Only one collection is worth listing.

Collection cs-15:

Pagetia bigranulosa
Pagetides minutus

An important exposure was found in the densely forested area W. of the Griswold farm, S. of a pond not marked on the USGS quadrangle. Limestone beds, partly fine-grained, partly granular with many small pebbles and fossil fragments, form outcrops at this locality and produced an interesting *Pagetides* faunule including two representatives of the family Eodiscidae.

Collection cs-29:

<i>Bonnia</i> , sp. undet.	r
Eodiscidae, cephalon no. 3	rr
<i>Leptochilodiscus punctulatus</i>	rr
<i>Pagetia bigranulosa</i>	c
<i>Pagetia laevis</i>	c
<i>Pagetides amplifrons</i>	r
<i>Pagetides elegans</i>	c
<i>Pagetides minutus</i>	c
<i>Peronopsis</i> , sp. undet.	rr

Numerous blocks holding Lower Cambrian fossils, in all but one case (cs-15/L3) belonging to the *Pagetides* fauna, were collected from the stone walls on or north and west of the Griswold farm. In all cases outcrops of the same age were located in the immediate vicinity. However, in several cases the loose blocks produced more numerous or better preserved examples of some of the trilobite species. The species from those blocks that supplied illustrated specimens are listed hereafter.

Collection cs-3/L1:

<i>Pagetides elegans</i>	
<i>Pagetides rupestris</i>	
Corynexochacea, pygidium no. 4	

Collection cs-3/L2:

<i>Acidiscus?</i> sp. undet.	rr
* <i>Analox obtusa</i>	r
<i>Bonnia</i> , sp. undet.	r
Olenellid fragments	c
<i>Oodiscus</i> , sp. undet.	rr
<i>Pagetia bigranulosa</i>	c
<i>Pagetides elegans</i>	r
<i>Pagetides leiopygus</i>	r
<i>Pagetides minutus</i>	c
<i>Pagetides rupestris</i>	r
<i>Protypus</i> , sp. undet.	rr
<i>Prozacanthoides</i> , sp. undet.	r

Collection cs-3/L3:

<i>Analox obtusa</i>	r
Eodiscidae, pygidium no. 5	rr
<i>Pagetia bigranulosa</i>	c
<i>Pagetides elegans</i>	r
<i>Pagetides minutus</i>	c
<i>Pagetides rupestris</i>	r

Collection cs-15/L1:

<i>Calodiscus</i> , sp. undet.	rr
Conocoryphidae, cranidium no. 1	rr

Dorypygidae, cranidium no. 1	r
Olenellid fragments	r
<i>Pagetides amplifrons</i>	r
<i>Pagetides elegans</i>	c
<i>Pagetides rupestris</i>	r
<i>Prozacanthoides</i> , sp. undet.	r
Ptychopariacea, cranidium no. 1	r
Collection cs-15/L2:	
<i>Bonnia</i> , sp. undet.	r
<i>Olenellus</i> , sp. no. 2	r
<i>Paedeumias</i> , sp. no. 5	r
<i>Pagetides elegans</i>	c
Collection cs-15/L3:	
<i>Analox bipunctata</i>	r
<i>Olenellus</i> , sp. no. 1	c
<i>Paedeumias</i> , sp. no. 1	c
<i>Paedeumias</i> , sp. no. 2	r
<i>Paedeumias</i> , sp. no. 4	r
<i>Paedeumias</i> , sp. no. 6	r
Collection cs-15/L4:	
<i>Bolboparia</i> , sp. no. 2	rr
<i>Bonnia?</i> sp. undet.	r
<i>Neopagetina taconica</i>	r
<i>Oodiscus</i> , sp. undet.	rr
<i>Pagetides minutus</i>	c
Collection cs-15/L5:	
<i>Olenellus</i> , sp. no. 2	r
<i>Olenellus</i> , sp. no. 3	r
<i>Paedeumias</i> , sp. no. 5	r
<i>Pagetides elegans</i>	c
<i>Pagetides rupestris</i>	r
<i>Peronopsis</i> , sp. undet.	rr
Collection cs-17/L1:	
Eodiscidae, pygidium no. 6	rr
* <i>Pagetia bigranulosa</i>	c
<i>Pagetides</i> , sp. undet.	r
<i>Prozacanthoides</i> , sp. undet.	r
<i>Serrodiscus spinulosus</i>	r

One outcrop on the Griswold farm yielded Middle Cambrian trilobites of the *Bathyuriscus-Elrathina* zone.

Collection cs-6:

<i>Elrathina</i> , sp. undet.	r
<i>Peronopsis</i> , sp. no. 3	r
* <i>Pagetia clytioides</i>	c
<i>Oryctocephalus</i> , sp. undet.	rr

Faunules approximately of the same age were also recovered from loose blocks in stone walls. The lists from the following boulders give the associations observed.

Collections cs-7/M1 and cs-8/M1:

<i>Meneviella</i> , sp. undet.	r
<i>Peronopsis</i> , sp. undet.	r
<i>Ptychagnostus gibbus</i>	c

Collections cs-7/M3, cs-7/M4, and cs-7/M5:

<i>Bathyriscus</i> , sp. undet.	rr
<i>Ogygopsis?</i> sp. undet.	rr
* <i>Pagetia erratica</i>	c
<i>Peronopsis</i> , sp. undet.	r
<i>Zacanthoides</i> , sp. undet.	rr

East Chatham quadrangle: Malden Bridge road cut.—Excellent exposures occur in a deep road cut on Columbia County Route 32, about one mile W. of Malden Bridge (Bird and Rasetti, in press). In the eastern part of the cut, a few medium-gray, granular, 1-3 inches thick limestone beds yielded a rather large Lower Cambrian faunule (coll. cs-9a) very similar to the *Acimetopus bilobatus* faunule from the Griswold farm. The strata holding this faunule are hereafter referred to as the *Leptochilodiscus* beds. Fossils were first collected here by J. M. Bird, A. R. Palmer, G. Theokritoff, and the writer in March 1965. In addition to the fossils exposed in breaking the rock, etching with hydrochloric acid produced rare silicified trilobites, some belonging to species not otherwise observed. The trilobite tests are replaced by a spongy, brittle, siliceous layer, and are often incrustated with sand grains and other deposits that cannot be removed without destroying the specimen. Several of the species from these beds are known from one or very few individuals, an almost certain indication that the faunule included more species than have been found. The trilobites are listed below.

Collection cs-9a (*Leptochilodiscus punctulatus* beds):

<i>Acidiscus birdi</i>	r
<i>Acimetopus bilobatus</i>	rr
<i>Analex bipunctata</i>	r
<i>Bathydiscus dolichometopus</i>	rr
<i>Bolboparia</i> , sp. no. 1	rr
<i>Bonnia</i> , sp. undet.	r
<i>Calodiscus lobatus</i>	r
<i>Calodiscus theokritoffi</i>	rr
* <i>Chelediscus chathamensis</i>	rr
Eodiscidae, cephalon no. 1	rr
Eodiscidae, cephalon no. 2	rr
Eodiscidae, cephalon no. 4	rr

<i>Eodiscidae</i> , pygidium no. 7	rr
<i>Leptochilodiscus punctulatus</i>	c
<i>Olenellus</i> , sp. no. 2	r
<i>Oodiscus</i> , sp. no. 1	rr
<i>Paedeumias</i> , sp. no. 1	c
<i>Paedeumias</i> , sp. no. 2	r
<i>Paedeumias</i> , sp. no. 3	rr
<i>Serrodiscus latus</i>	rr
<i>Serrodiscus spinulosus</i>	c
<i>Stigmatiscus stenometopus</i>	rr

Farther W. in the road cut, on the N. side, 32 feet higher stratigraphically than the *Leptochilodiscus* beds, another limestone interval yielded a *Neopagetina* faunule, including the following trilobites.

Collection cs-9:

* <i>Neopagetina taconica</i>	c
<i>Pagetides minutus</i>	rr
<i>Peronopsis</i> , sp. no. 5	rr
<i>Ptychopariacea</i> , cranidium no. 1	rr

West of this interval, the beds are so folded and faulted that their sequence cannot be ascertained; presumably a considerable shale interval was faulted out. Dark gray, partly laminated limestone beds exposed on both sides of the road cut, 80 feet W. of the *Neopagetina* beds (the strata being almost vertical), yielded a Middle Cambrian faunule characterized by *Ptychagnostus gibbus* and other trilobites of the *Bathyriscus-Elrathina* zone (coll. cs-9c, cs-9c' on N. side, coll. cs-9d, cs-9d* on S. side of cut). Even though all these collections were recovered within a 2-foot interval, they are listed separately, as the associations varied even between adjacent beds. The faunules from this locality are listed below.

Collection cs-9c

<i>Pagetia clytioides</i>	r
---------------------------	---

Collection cs-9c':

<i>Ptychagnostus gibbus</i>	c
-----------------------------	---

Collection cs-9d:

<i>Bathyriscus</i> , sp. undet.	r
<i>Peronopsis</i> , sp. no. 1	c
<i>Peronopsis</i> , sp. no. 2	c
<i>Ptychagnostus gibbus</i>	c

Collection cs-9d *, from adjacent bed above cs-9d:

<i>Bathyriscus</i> , sp. undet.	r
<i>Kootenia</i> , sp. no. 1	c
<i>Meneviella</i> , sp. undet.	r
<i>Peronopsis</i> , sp. no. 1	c

East Chatham quadrangle: other localities.—Trilobites of the Lower Cambrian *Pagetides* fauna were collected from about a dozen outcrops of bedded limestone in the NW. quarter of the East Chatham quadrangle, in addition to the Griswold Farm and Malden Bridge road cut localities previously discussed. In the same area, a few conglomerate exposures yield pebbles with the *Elliptocephala asaphoides* fauna.

Two outcrops located on the Lopez farm, east of the Nassau-Malden Bridge road, yielded interesting *Pagetides* faunules. Both show approximately vertical beds trending north-south, and the field evidence is inadequate to determine their stratigraphic order. However, comparison of the faunules with those collected from the measured section on the Griswold farm leaves little doubt that the collection cs-20 is from older beds than the collection cs-18. The trilobites from these collections are listed below.

Collection cs-20, Lopez farm:

<i>Neopagetina taconica</i>	c
<i>Pagetides minutus</i>	c
<i>Peronopsis</i> , sp. undet.	rr

This faunule seems to be a precise equivalent of those occurring at localities cs-4a on the Griswold farm and cs-9 at the Malden Bridge road cut.

Collection cs-18, Lopez farm:

<i>Bonnia</i> , sp. undet.	r
<i>Calodiscus lobatus</i>	rr
Olenellidae, undet. fragments	r
<i>Oodiscus</i> , sp. undet.	rr
<i>Pagetides elegans</i>	r
<i>Pagetides minutus</i>	c
<i>Peronopsis</i> , sp. undet.	rr

Fossiliferous localities are much scarcer in the NE. quarter of the East Chatham quadrangle, E. of the "Chatham thrust" (Craddock, 1957), and the two known to the writer yielded exclusively Lower Cambrian fossils.

Fossiliferous limestone beds are rather extensively exposed on the W. slope of a wooded ridge about one mile SE. of Riders Mills and one mile S. of Ashley Hill. Dale (1904, p. 24) and Craddock (1957, p. 695) discussed the age of the limestone at this locality; both mention conglomerate beds that the writer was unable to find. Trilobites collected from a blue-gray, bedded limestone are listed below.

Collection cs-26:

<i>Bomia</i> , sp. undet.	r
<i>Calodiscus walcotti</i>	r
<i>Kootenia</i> , sp. no. 2	rr
* <i>Pagetia laevis</i>	c
<i>Pagetides elegans</i>	r
<i>Pagetides minutus</i>	c
<i>Prozacanthoides</i> , sp. undet.	r

This is a typical *Pagetides* faunule, unusual only in the presence of *Calodiscus walcotti*.

The other Cambrian fossiliferous locality in the NE. quarter of the East Chatham quadrangle is the classic exposure of limestone conglomerate at Ashley Hill, discussed by Dale (1904), Lochman (1956), and Craddock (1957). The conglomerate is associated with massive quartzite, a relationship not observed at the numerous conglomerate exposures in the Troy area, at Schodack Landing, and in the NW. quarter of the East Chatham quadrangle. In other respects, particularly the lithology of the pebbles and boulders, all these conglomerates are quite similar. Some of the boulders at Ashley Hill are the usual coquina of *Elliptocephala asaphoides* fragments, and occasionally yield well-preserved examples of the smaller trilobites, in addition to many fossils of other phyla. Lochman (1956) listed the species from the boulders in the Ashley Hill Conglomerate. The writer, in addition to previously listed species, collected good examples of *Rimouskia typica*, a trilobite hitherto unknown from the Taconic sequence (coll. cs-19).

Hudson North quadrangle: Stockport Station.—An excellent exposure of 9 feet of sandy, medium-bedded limestone underlain and overlain by thick-bedded sandstones occurs near the New York Central Railroad tracks at the site of the former Stockport Station. Fossils were discovered at this locality by J. M. Bird and D. W. Fisher in April 1965, and are confined to one limestone bed with a much lesser sand content than any other. Over 1,000 pounds of rock from this bed were quarried and examined for the minute trilobite fragments. Usually, only specimens not exceeding a millimeter in length have been preserved without excessive breakage; occasionally cranidia, free cheeks, and pygidia of larger sizes can be recovered. The trilobites described and figured herein are listed below.

Collection cs-21, Stockport Station:

<i>Athabaskiella</i> , sp. undet.	r
* <i>Baltagnostus stockportensis</i>	r
* <i>Bathyriscus eboracensis</i>	c
<i>Bathyriscidella</i> , sp. undet.	rr

* <i>Bolaspidella fisheri</i>	c
<i>Corynexochacea</i> , pygidium no. 1	rr
* <i>Corynexochides? expansus</i>	c
<i>Elrathia?</i> sp. undet.	
<i>Hemirhodon</i> , sp. undet.	r
<i>Hypagnostus parvifrons</i>	r
* <i>Olenoides stockportensis</i>	rr
<i>Olenoides</i> , sp. undet.	r
<i>Leioptyge?</i> sp. no. 1	rr
<i>Leioptyge?</i> sp. no. 2	rr
<i>Peronopsis</i> , sp. no. 4	rr
<i>Ptychagnostus punctuosus</i>	rr
<i>Ptychagnostus</i> , sp. undet.	r
Ptychopariacea, cranidium no. 2	rr
Ptychopariacea, cranidium no. 3	rr
Ptychopariacea, cranidium no. 4	rr
Ptychopariacea, pygidium no. 1	rr

This bed supplied also many different forms of immature (protaspid and meraspid) stages, probably representing a number of additional genera and species. These were not described or figured since there seemed to be no point in describing ontogenetic stages not referable to adult forms. Similar remarks apply to the faunules of the next two localities to be discussed, Judson Point and Nutten Hook.

In addition to the trilobites, excellent shells of *Pegmatreta* cf. *ophirensis* (Walcott) were recovered by etching samples of rock with formic acid (Palmer, private communication). The brachiopod is important as it establishes a relation with the faunule of locality cs-22 where the trilobites are less indicative of a precise age.

The above faunule is clearly of very late Middle Cambrian age and has many elements in common with both the *Bolaspidella* zone faunas of western Utah described by Robison (1964a) and the uppermost zone of the *Paradoxides paradoxissimus* stage in Scandinavia.

Hudson North quadrangle: Judson Point.—A continuously exposed section of about 250 feet of strata in conformable sedimentary sequence occurs along the New York Central Railroad tracks on the E. shore of the Hudson River at Judson Point. Goldring (1943, fig. 11) reproduced a photograph of part of the strata, referred to the Lower Cambrian Nassau beds of Ruedemann (1942). All the strata dip uniformly 40° E. and seemingly about 130 feet of exposed black shale overlie 120 feet of alternating sandstones, shales, sandy or relatively pure limestones, and limestone conglomerates. However, the fossil evidence (Bird and Rasetti, in press) unquestionably shows that the strata are overturned, the black shale underlying the sandstone-shale-limestone sequence. Fossils at Judson Point were first collected

by D. W. Fisher about 40 feet below the top of the shale, and indicate the Lower Cambrian *Elliptocephala asaphoides* fauna. Additional fossils in this interval were collected by H. B. Whittington, J. M. Bird, and the writer (collections cs-24, cs-24b, respectively, 30-40 and 75 feet below the top of the shale). The same species of trilobites occur throughout this interval and are listed below.

Collections cs-24, cs-24b, Judson Point :

Atops trilineatus
Elliptocephala asaphoides
Rimouskia typica
Serrodiscus speciosus

Elliptocephala is represented by fragments of large individuals, recognizable by the characteristic ornamentation. *Serrodiscus speciosus* is particularly common in an interval of green shale (coll. cs-24b), where excellent articulated specimens were found.

Fossils also occur in a 2-5-inch bed of sandy, partly tan-weathering limestone 52 feet above the top of the black shale. The trilobites, mostly of diminutive size, are generally comminuted and unrecognizable. However, by careful search through hundreds of pounds of rock, small but at least in part identifiable specimens were recovered. The following list includes only the species that were deemed well enough represented to be worth describing and figuring.

Collection cs-23, Judson Point (*Centropleura* bed) :

Agnostida, pygidium no. 1
 Agnostida, pygidium no. 2
Baltagnostus, sp. undet.
Bathyriscus eboracensis
Centropleura, sp. undet.
 Corynexochacea, pygidium no. 2
 Corynexochacea, pygidium no. 3
Corynexochides? *expansus*
Grandagnostus? sp. undet.
Hypagnostus parvifrons
 Ptychopariacea, cranium no. 8
 Ptychopariacea, pygidium no. 2

The faunule is unquestionably of late Middle Cambrian age, proving that the section is inverted. In addition to the trilobites, the same *Pegmatreta* occurring at Stockport Station and Nutten Hook was etched from this bed.

Hudson North quadrangle: Nutten Hook.—A sequence of shales,

sandy or pure, aphanitic, thin-bedded limestones, underlain by thick-bedded sandstone, is exposed at the N. end of the S. hill of Nutten Hook, a rocky promontory on the E. shore of the Hudson River. Goldring (1943, p. 75, figs. 16, 17) described and figured this section, referring all the strata to the Lower Cambrian. A more detailed description is given by Bird and Rasetti (in press). A sandy limestone bed was found to contain very small and fragmentary trilobites, besides a well-preserved, inarticulate brachiopod. Specimens of the latter, etched and identified by Palmer (private communication), appear identical with the species of *Pegmatreta* recovered from the Stockport Station bed. The trilobites are listed below.

Collection cs-22, Nutten Hook:

- Agnostida, pygidium no. 1
- * *Baltagnostus angustilobus*
- Goniagnostus*, sp. undet.
- Hypagnostus parvifrons*
- Hypagnostus*, sp. undet.
- Ptychopariacea, cranidium no. 5
- Ptychopariacea, cranidium no. 6
- Ptychopariacea, cranidium no. 7
- Ptychopariacea, pygidium no. 3
- Ptychopariacea, pygidium no. 4
- Ptychopariacea, pygidium no. 5

The cranidia no. 5 and no. 7 and the pygidium no. 4 are suggestive of early Upper Cambrian forms. However, the presence of *Goniagnostus* and *Hypagnostus* is definitely indicative of the uppermost Middle Cambrian *Bolaspidella* zone like the beds at Stockport Station and Judson Point.

INDEX OF LOCALITIES

Localities where the collections were made are here specified by coordinates on the U. S. Geological Survey 7½-minute quadrangles, scale 1:24,000. In the absence of contrary indication, the abscissa is measured from the west edge, the ordinate from the south edge of the map. A minus sign in front of the value of the coordinate means that it was measured from the opposite edge (east edge for the abscissa, north edge for the ordinate). This practice was followed in order to refer a location to the nearer margin of the map, thus minimizing errors due to variation of the map size with humidity.

Locality Symbol	USGS Quadrangle	Abscissa (mm.)	Ordinate (mm.)	Description
cs-3	East Chatham	29	-185	Griswold farm (loose blocks)
cs-4 to cs-5	" "	27-28	-165	Griswold farm
cs-6	" "	35	-160	Griswold farm
cs-7	" "	27-35	-158	Griswold farm (loose blocks)
cs-8	" "	28-32	-172	Griswold farm (loose blocks)
cs-9 to cs-9d ...	" "	84-86	-148	Malden Bridge road cut
cs-15	" "	34	-150	N. of Griswold farm
cs-17	" "	16	-164	W. of Griswold farm
cs-18	" "	115	-91	Lopez farm
cs-19	" "	269	-72	Ashley Hill
cs-20	" "	115	-88	Lopez farm
cs-26	" "	261	-129	Riders Mills
cs-29	" "	19	-176	W. of Griswold farm
cs-21	Hudson North	-77	281	Stockport Station
cs-22	" "	-135	-83	Nutten Hook
cs-23	" "	-86	-246	Judson Point
cs-24, cs-24b ...	" "	-85	-244	Judson Point

BIOSTRATIGRAPHY

LOWER CAMBRIAN

Elliptocephala fauna.—The oldest Early Cambrian fauna in the Taconic sequence is believed to be the *Elliptocephala asaphoides* assemblage. This fauna is known from Columbia and Rensselaer Counties, where it occurs chiefly in conglomerate boulders, and from Washington County, where it was generally recovered from lenticular, irregularly bedded limestone bodies in the Mettawee Slate and the West Castleton Formation (Theokritoff, 1964), or exceptionally from black shale. Even though the widespread occurrence of the fauna in rocks of various lithologies suggests that the assemblage is rather long-ranging in the Taconic sequence, it has not been possible to establish the total stratigraphic range of the *Elliptocephala* fauna.

In the particular area studied in the present work, northern Columbia County, the *Elliptocephala* fauna occurs in limestone conglomerate boulders at Ashley Hill and several other localities in the East Chatham quadrangle, in black or green shale in the Judson Point section, where it ranges through at least 50 feet of beds, and south of Scho-dack Landing. Bird and Rasetti (in press) restudied the Schodack Landing section, showing that there are exposed in conformable succession at least 217 feet of beds, green shale prevailing in the lower part, black shale and sandstone in the upper third, with limestone present both as bedded rock and as conglomerate boulders in several

intervals. The *Elliptocephala asaphoides* fauna was found in limestone 60-70 feet above the base of the exposed section. Ford (1884) reported *Serrodiscus speciosus* from thin-bedded limestone about 45 feet higher in the section. In the still higher intervals, diagnostic fossils were collected only from conglomerate pebbles. It is possible that all the exposed strata fall within the range of the *Elliptocephala asaphoides* assemblage.

Lochman (1956) listed the fossils of the *Elliptocephala* fauna and compared the composition of that assemblage with faunas from other areas of North America and Europe. However, Rasetti and Theokritoff (1967) have shown that forms of the *Pagetides* fauna were included, owing to misleading interpretation of some of the fossil lists from Walcott's localities. A list of the trilobites, probably not complete but based exclusively on the writer's first-hand evidence, follows.

Elliptocephala asaphoides fauna

- Atops trilineatus*
- Calodiscus lobatus*
- Calodiscus meeki*
- Elliptocephala asaphoides*
- Fordaspis nana*
- Hebediscus marginatus*
- Kootenia troyensis*
- Rimouskia typica*
- Serrodiscus speciosus*

When only the genera and species of this restricted list are considered, the *Elliptocephala* assemblage appears closer to the European Early Cambrian faunas and less related to the faunas of the Appalachian and Cordilleran provinces of North America than Lochman had deduced from her more extensive list. Cobbold (1936) has shown that *Atops* occurs in Comley, Shropshire, with *Calodiscus lakei* Rasetti (1952), closely related to *C. lobatus*. *Hebediscus* is a typical Acado-Baltic genus, known in North America from Newfoundland (Hutchinson, 1962) and Massachusetts. *Elliptocephala* and *Fordaspis* have not been found outside the Taconic sequence, and *Rimouskia* has been found only in association with unknown Olenellids in boulders in Quebec. *Serrodiscus speciosus*, or extremely similar forms, are known from various areas in Europe and Africa. R. and E. Richter (1941) described *Serrodiscus* cf. *speciosus* from Andalusia, Spain, and Silesia, Germany. Hupé (1952) described *Serrodiscus coloi*, almost identical with *S. speciosus*, from the Anti-Atlas of Morocco. Recent stratigraphic work has clearly established the position of the

Serrodiscus or *Calodiscus* beds in the Lower Cambrian sequence. In Shropshire, according to Whittard (1952), the "Eodiscus limestone" overlies the *Callavia* beds (but still includes representatives of that Olenellid genus) and underlies the *Protolenus* and *Strenuella* limestones. In Germany, according to Sdzuy (1960, 1961) the shales with *Serrodiscus* underlie *Protolenus* shales. In Spain, the extensive work of Lotze (1961, pp. 467-469) has established the most detailed zonation of the Lower Cambrian so far obtained in Europe. *Serrodiscus* cf. *speciosus* occurs above the strata characterized by members of the family Dolerolenidae and just below those carrying *Saukianda* and *Perrector*. These are immediately overlain by beds holding a number of genera of the Protolenidae. An entirely analogous stratigraphic position is occupied by *Serrodiscus* in Morocco (Hupé, 1952, p. 94), where it occurs in the *Termierella* zone, in association also with *Kingaspis*, *Micmacca*, *Strenuella*, and other genera.

We may thus tentatively correlate the strata holding the *Elliptocephala asaphoides* assemblage in the Taconic sequence with the beds carrying *Serrodiscus speciosus* or similar species in Europe and North Africa, which also correlate closely with each other on the basis of other trilobite families. There is, however, little similarity between the *Elliptocephala* fauna and the faunas of Europe and North Africa aside from the Eodiscidae and the Pagetiidae. In particular, the Protolenidae and Ellipsocephalidae, which play a dominant role in those faunas, are totally absent from the Taconic sequence.

When some of the species listed by Lochman are excluded, there remains only one genus of trilobites, *Kootenia*, common between the *Elliptocephala* assemblage and the faunas of the Lower Cambrian of the Appalachian and Cordilleran provinces, and furthermore, the only ascertained species in the *Elliptocephala* fauna, *Kootenia troyensis*, is quite different from any of the species known from Quebec, Vermont, the southern Appalachians, and the western United States.

In conclusion, while the *Elliptocephala asaphoides* fauna has a character of its own, substantially different from both the faunas of "Atlantic" and "Pacific" facies, on the basis of some of the trilobites it can be correlated much more closely with the former than the latter.

The *Elliptocephala* assemblage, in addition to the trilobites and several species of brachiopods, contains an unusually large number of invertebrates belonging to miscellaneous, partly undetermined phyla. These have been adequately described and illustrated by Lochman (1956).

Acimetopus fauna.—The next younger Early Cambrian fauna is presumably the one discussed in the previous paper (Rasetti, 1966a) and designated the *Acimetopus bilobatus* fauna. It is so far known in the Taconic sequence only from two outcrops, cs-4 (Griswold farm) and cs-9a (Malden Bridge road cut), both in the East Chatham quadrangle. The collection from loose block cs-15/L3 probably may be included in the assemblage, since most of the species are common either to collection cs-4 or cs-9a. Since the species from these three collections were already listed in the discussion of localities, repetition seems unnecessary. The fauna includes 24 named plus a few unnamed species of Eodiscidae, in part belonging to new genera known exclusively from the assemblage. The Olenellidae are represented by 3 species referred to *Olenellus* and 6 species referred to *Paedeumias*, all known exclusively from immature forms and hence not comparable with species described from other formations and based on mature individuals. The Agnostida and the Pagetiidae are totally absent. The opisthoparian trilobites are represented by several, unnamed species of *Bonnia* and one species of *Kootenia*. No ptychoparioid trilobites are known from the assemblage.

Even though the *Acimetopus bilobatus* fauna seemingly has no trilobite species in common with the *Elliptocephala asaphoides* fauna, the representation of the various trilobite families is similar in the abundance of individuals of Eodiscidae and Olenellidae, absence of Agnostida and Pagetiidae, and near absence of Ptychopariacea. The chief difference is that the families Olenellidae and Dorypygidae in the *Acimetopus* fauna are mainly represented by the widespread genera *Olenellus*, *Paedeumias*, and *Bonnia*, in the *Elliptocephala* fauna by the endemic genera *Elliptocephala* and *Fordaspis*, respectively.

The evidence suggesting that the *Acimetopus* fauna is younger than the *Elliptocephala* fauna is discussed by Bird and Rasetti (in press). Both in the Griswold farm and Malden Bridge road cut sections, the earliest faunule of the *Pagetides* fauna, the *Neopagentina taconica* faunule, overlies about 30-35 feet stratigraphically the beds carrying the *Acimetopus* fauna. Since the *Elliptocephala* fauna ranges through a considerable thickness of beds, presumably several hundred feet, in Washington and Columbia Counties (in the latter at Schodack Landing and Judson Point) it appears quite unlikely that the time equivalent of all the beds carrying the *Elliptocephala* fauna can be represented by a portion of those 30-35 feet of unfossiliferous shale. This leads to the almost certain conclusion that the *Elliptocephala asaphoides* fauna must be either older, or younger, than both the *Acimetopus*

and *Pagetides* faunas. The presence of the *Elliptocephala* fauna in numerous conglomerate outcrops, both in the East Chatham quadrangle and elsewhere, which certainly occupy a lower stratigraphic position than the *Pagetides* beds, definitely indicates that the *Elliptocephala* fauna is the oldest of the three here discussed.

The *Acimetopus* fauna, in addition to the trilobites, contains a few inarticulate brachiopods. Other phyla are only represented by rare specimens of *Hyolithellus*.

In the previous paper (Rasetti, 1966a, p. 21) it was pointed out that the discovery of *Bolboparia canadensis*, closely related to one of the Eodiscidae in the *Acimetopus bilobatus* fauna, in Lower Cambrian strata near Elgin Station, L'Islet County, Quebec (about 40 miles NE of Levis, Quebec), seemingly indicated the presence of an equivalent fauna outside of the Taconic sequence. This conclusion is fully confirmed by the finding, through a search at that locality by G. Theokritoff, of two species of the *Acimetopus* fauna known from the Columbia County localities, *Calodiscus theokritoffi* and *Leptochilodiscus punctulatus*. Unfortunately these fossils occur at the Canadian locality in an isolated outcrop and therefore cannot be related to other Lower Cambrian faunas known from Quebec.

Pagetides fauna.—The third and youngest Early Cambrian fauna known from the Taconic sequence was named (Rasetti, 1966a) the *Pagetides* fauna from the frequent occurrence of species of that genus. It is widespread in northern Columbia County and is represented in Washington County by the *Pagetia connexa* faunule (Rasetti and Theokritoff, 1967), known from several localities and previously confused with the *Elliptocephala asaphoides* fauna. *Pagetia connexa* has not been found in Columbia County, even though other Lower Cambrian species of the genus are relatively common, but the presence of common species in the *Pagetia connexa* faunule of Washington County and the *Pagetides* faunules of Columbia County indicates that we are dealing with essentially contemporaneous assemblages.

In the *Pagetides* fauna of Columbia County it seems appropriate to distinguish an earliest faunule which shall be designated the *Neopagetina taconica* faunule (coll. cs-4a, cs-9, and cs-20 in place, loose block cs-15/L4) and includes the following species:

Neopagetina taconica faunule

Bolboparia, sp. no. 2

Bonnia, sp. undet.

Neopagetina taconica

Oodiscus, sp. undet.

Pagetides minutus
Peronopsis, sp. no. 5
 Ptychopariacea, cranidium no. 1
 Undetermined Olenellidae

The other, presumably younger collections of the *Pagetides* fauna cannot be placed in stratigraphic order, and since they have many species in common, are united into a single faunule, characterized by *Pagetides elegans* and including the following species of trilobites:

Pagetides elegans faunule

Acidiscus? sp. undet.
Analox obtusa
Bolboparia, sp. no. 2
Bonnia, sp. undet.
Calodiscus lobatus
Calodiscus walcotti
Calodiscus, sp. undet.
 Conocoryphidae, cranidium no. 1
 Dorypygidae, cranidium no. 1
 Eodiscidae, cephalon no. 3
 Eodiscidae, pygidium no. 5
 Eodiscidae, pygidium no. 6
Kootenia, sp. no. 2
Leptochilodiscus punctulatus
Olenellus, sp. no. 2
Olenellus, sp. no. 3
Oodiscus, sp. undet.
Paedeumias, sp. no. 5
Pagetia bigranulosa
Pagetia laevis
Pagetides amplifrons
Pagetides elegans
Pagetides leiopygus
Pagetides minutus
Pagetides rupestris
Peronopsis, sp. undet.
Protypus, sp. undet.
Prozacanthoides, sp. undet.
 Ptychopariacea, cranidium no. 1
Serrodiscus spinulosus

The character of the faunule depends not only on the genera and species present but also on the number of individuals representing them. The Pagetiidae (*Pagetia*, *Pagetides*) are by far the most common trilobites. Olenellid fragments are relatively abundant but seldom identifiable; *Bonnia* and *Prozacanthoides* are moderately frequent. All the other trilobites, i.e., the few Ptychopariacea, the Eodis-

cidae, and the Agnostida (*Peronopsis*), are excessively rare, many of the genera and species being represented in the collections by a single fragment. Of particular interest are the genera and species common to the underlying *Acimetopus* fauna. These are the genera of Eodiscidae, *Acidiscus*, *Analox*, *Bolbaparia*, *Calodiscus*, *Leptochilodiscus*, and *Serrodiscus*, and among the other families *Bonnia*, *Kootenia*, *Olenellus*, and *Paedeumias*. The only species in common that have been identified are *Olenellus* sp. no. 2, *Leptochilodiscus punctulatus*, and *Serrodiscus spinulosus*. There is only one species, *Calodiscus lobatus*, common to the *Pagetides* and *Elliptocephala* faunas; it is represented by a single cephalon in collection cs-18.

Outside of the Taconic sequence, faunules where *Pagetides* is common are known from one outcrop of bedded limestone and numerous conglomerate boulders in Quebec (Rasetti, 1945, 1948a, 1955). In the "Austinvillia" bed (correctly *Bicella* bed), *Pagetides amplifrons* and *P. pustulosus* are associated with *Bonnia* sp. and the Ptychoparioids *Bicella bicensis* and *Periomma punctata*. In the boulders, *Pagetides amplifrons*, *P. elegans*, *P. leiopygus*, *P. minutus*, and *P. rupestris*, all species occurring in the *Pagetides* fauna of Columbia County, are associated with species of Olenellidae, *Bonnia*, *Kootenia*, *Prozacanthoides* and the Ptychopariacea *Bicella*, *Periomma*, and *Periomella*. The presence of several species of *Pagetides* and genera of Corynexochacea common to this fauna from Quebec and the *Pagetides* fauna in Columbia County is almost certain indication of approximately equivalent age. The chief differences between the two faunas are the total absence of the Eodiscidae from the Quebec fauna and the near absence of Ptychopariacea from the Columbia County fauna. In this respect, the *Pagetides* fauna of the Taconic sequence has less in common with the typical, late Early Cambrian faunas of the Appalachian and Cordilleran provinces and shows some relationship with the faunas of the Acado-Baltic province of North America and Europe, where the Eodiscidae are well represented. However, in the *Pagetides* fauna the Acado-Baltic character is less pronounced than in the *Elliptocephala asaphoides* and *Acimetopus bilobatus* faunas, where the Eodiscidae predominate.

Species of *Pagetides* are also known from the *Olenellus* shales of the Appalachian province, as *Pagetides elegans* occurs (Rasetti, 1948a) in the Parker Shale at the Kelly quarry near Swanton Junction, Vermont, and the generically, but not specifically, identifiable *Pagetides parkeri* (Walcott) was described from the same formation at the classic locality near Georgia, Vermont (Rasetti, 1952, p. 439).

Undescribed, poorly preserved specimens of *Pagetides* from the Kinzers Shale of the Lancaster, Pennsylvania basin are preserved in the U. S. National Museum. It is therefore plausible to assume that the *Pagetides* fauna of Columbia County is approximately contemporaneous with the typical *Olenellus* fauna described by Resser and Howell (1938), the prevalence of Olenellidae in the latter being probably determined by the shaly character of the deposits.

In New York State the *Pagetides* fauna has never been observed in conglomerate boulders, in contrast to the most frequent mode of occurrence of the *Elliptocephala* fauna.

MIDDLE CAMBRIAN

Discovery of Middle Cambrian faunas in the Taconic sequence.—It has been a widely held opinion of stratigraphers that the Taconic sequence does not include strata of Middle Cambrian age, owing to non-deposition or erosion during that epoch, and possibly part or all of the Late Cambrian. Such conditions may well obtain in the northern part of the Taconic region, in Washington County, where graptolite-bearing, Early Ordovician shales seemingly overlie directly the black shales of the West Castleton Formation (Theokritoff, 1964) or are separated by a thin interval of the Hatch Hill Formation, believed of Late Cambrian age. Lochman (1956, p. 1366) reported and figured (pl. 5, figs. 22, 23) a fragmentary cephalon referred to *Eodiscus punctatus*, a characteristic trilobite of the Middle Cambrian of the Acado-Baltic province, collected from a loose boulder in the Cambridge quadrangle, Washington County. The writer does not consider the specimen complete enough to warrant positive identification, especially in view of the discovery of Lower Cambrian Eodiscidae with a similarly punctate surface. The other, supposedly Middle Cambrian trilobite cited by Lochman, *Mallagnostus desideratus* (Walcott) was shown (Rasetti and Theokritoff, 1967) to belong to the Eodiscidae and to be a member of the Early Cambrian *Pagetia connexa* faunule.

Unquestionable Middle Cambrian trilobites were first discovered in the Taconic sequence of Columbia County by J. M. Bird and the writer in the fall of 1963. The fossils, among which the most common species was *Ptychagnostus gibbus*, were at that time recovered only from loose blocks on the Griswold farm. Subsequently an outcrop yielding trilobites approximately of the same age (collection cs-6) was discovered in the same area. More numerous trilobites of the *Bathyriscus-Elrathina* zone were found by the writer in 1965 in the

Malden Bridge road cut. In the same year fossiliferous beds of the latest Medial Cambrian *Bolaspidella* zone were discovered in the sections along the bluffs on the east shore of the Hudson River, at Stockport Station, Judson Point, and Nutten Hook, in the Hudson North quadrangle.

Fauna of the Bathyriscus-Elrathina zone.—The oldest Middle Cambrian fossils known from Columbia County, and the Taconic sequence in general, belong to the *Bathyriscus-Elrathina* zone. At least provisionally 3 faunules may be separated, two collected from outcrops at different localities, the third known exclusively from loose boulders; therefore their time order is unknown, but age differences are probably small.

The first faunule (collections cs-9c, cs-9c', cs-9d, cs-9d*) occurs within a narrow stratigraphic interval in the Malden Bridge road cut section, and is represented by the identical species in loose blocks on the Griswold farm (collections cs-7/MI, cs-8/MI). The trilobites of this *Ptychagnostus gibbus* faunule include the following species:

Ptychagnostus gibbus faunule

- Bathyriscus*, sp. undet.
- Kootenia*, sp. no. 1
- Meneviella*, sp. undet.
- Pagetia clytioides*
- Peronopsis*, sp. no. 1
- Peronopsis*, sp. no. 2
- Ptychagnostus gibbus*

The second faunule occurs in an isolated outcrop on the Griswold farm (collection cs-6) and is designated by the trilobite *Pagetia clytioides*.

Pagetia clytioides faunule

- Elrathina?* sp. undet.
- Pagetia clytioides*
- Peronopsis*, sp. no. 3
- Oryctocephalus*, sp. undet.

The third faunule of the *Bathyriscus-Elrathina* zone was only recovered from loose blocks (collections cs-7/M3, cs-7/M4, and cs-7/M5). It is designated by the trilobite *Pagetia erratica* and includes the species:

Pagetia erratica faunule

- Bathyriscus*, sp. undet.
- Ogygopsis*, sp. undet.
- Pagetia erratica*
- Peronopsis*, sp. undet.
- Zacanthoides*, sp. undet.

These faunules are typical of the *Bathyriscus-Elrathina* zone of the Cordilleran province. They may be compared with the faunules occurring at several levels in the Stephen Formation of British Columbia (Rasetti, 1951). All the genera occur in the Stephen Formation, except *Meneviella*, which is typical of the Acado-Baltic province. The type and only described species, *Meneviella venulosa*, occurs in Britain, and good material was recently figured by Hutchinson (1962) from Newfoundland, where the species ranges from the uppermost *Paradoxides hicksi* through the *Paradoxides davidis* stages. The *Ptychagnostus gibbus* faunule, of which *Meneviella* is a member, can be more accurately correlated with zone B1, the lowest of the *Paradoxides paradoxissimus* stage of Sweden, since *Ptychagnostus gibbus* is the guide fossil of that zone and is confined to it. The suggested equivalence of the *Ptychagnostus gibbus* beds in Sweden and the Taconic sequence is in agreement with Robison's (1964b) correlation of the Middle Cambrian of Sweden and Utah, according to which the *Ptychagnostus gibbus* zone corresponds to the upper part of the *Bathyriscus-Elrathina* zone.

For the other two faunules, designated by the species *Pagetia clytioides* and *Pagetia erratica*, no direct correlation with faunas of the Acado-Baltic province is possible, since all the species either belong to western North American genera or to the long-ranging Agnostid genus *Peronopsis*. The long stratigraphic range of the genera also prevents more accurate correlation with faunules of the Cordilleran province than reference to the *Bathyriscus-Elrathina* zone.

Fauna of the Bolaspidella zone.—The other Middle Cambrian faunules, found only in the Hudson North, quadrangle, belong to the *Bolaspidella* zone, the latest Middle Cambrian faunizone of the Cordilleran province.

The best represented of these faunules is the one from Stockport Station (collection cs-21). The list of trilobite species was given with the description of that locality. The faunule will be designated by the trilobite *Bathyriscus eboracensis*, one of the most common of the named species. Correlation with some portion of the *Bolaspidella* zone is obvious as it is supported by a number of trilobite genera and the presence of *Pegmatreta* cf. *ophirensis*. However, as suggested by Robison (1964b), the *Bolaspidella* faunizone represents a long time span, believed equivalent to all but the lowest, *Ptychagnostus gibbus* zone of the *Paradoxides paradoxissimus* stage plus the entire *Paradoxides forchhammeri* stage. A comparison of the *Bathyriscus eboracensis* faunule with the range of genera and species in the

Bolaspidella zone of western Utah suggests as most likely an equivalence to the upper part of the lower, *Bathyriscus fimbriatus* subzone (Robison, 1964a, p. 512). This conclusion would also be in agreement with the occurrence of *Ptychagnostus punctuosus*, which in Sweden is the guide fossil of the uppermost zone (B4) of the *Paradoxides paradoxissimus* stage (Westergård, 1946, pp. 98-103). The only difficulty with the suggested correlation is the apparent presence in the *Bathyriscus eboracensis* faunule of representatives of the genus *Leiopyge*, which in Utah is confined to the uppermost portion of the upper, *Bolaspidella contracta* subzone of the *Bolaspidella* zone, and in Sweden is only known from the two upper zones, C2 and C3, of the *Paradoxides forchhammeri* stage. The evidence of all the other species, however, makes it unlikely that the *Bathyriscus eboracensis* faunule is as young as suggested by the presence of *Leiopyge*. It is possible that either *Leiopyge* appeared in the Taconic sequence earlier than in Scandinavia and Utah, or, perhaps more likely, the smooth Agnostid cephalons have been misidentified as *Leiopyge* in the absence of pygidia, and should instead be referred to some other genus. Species referred by Westergård to *Ciceragnostus* and *Phalacroma* already occur in the *Paradoxides paradoxissimus* stage.

The second faunule of late Middle Cambrian age occurs in a sandy limestone bed at Judson Point (coll. cs-23) and is designated the *Centropleura* faunule from its most characteristic trilobite. The list of species was given in the discussion of the locality. Three of the species, *Bathyriscus eboracensis*, *Corynexochides? expansus*, and *Hypagnostus parvifrons*, are common to the Stockport Station faunule. In Sweden, *Centropleura* occurs (Westergård, 1953) in the *Solenopleura brachymetopa* zone (C2) of the *Paradoxides forchhammeri* stage. This occurrence would suggest that the bed at Judson Point is somewhat younger than the *Bathyriscus eboracensis* bed at Stockport Station, which was tentatively correlated with zone B4 of Sweden from the presence of *Ptychagnostus punctuosus*.

The faunule from Judson Point, like the preceding, contains a mixture of genera of Pacific biofacies (*Bathyriscus*, *Baltagnostus*), Atlantic biofacies (*Centropleura*), and cosmopolitan Agnostids (*Hypagnostus*). A fauna of somewhat similar composition was described by Howell (1937) from the St. Albans Shale of northwestern Vermont and designated the *Centropleura vermontensis* fauna. This was the only previously known occurrence of *Centropleura* in the United States. The faunule of the St. Albans Shale was recently revised by Shaw (1966).

The third faunule of late Middle Cambrian age was collected from

a sandy limestone bed at Nutten Hook (coll. cs-22). Several ptychoparioid trilobites occur in this faunule, but as they are represented by fragmentary, meraspid cranidia and pygidia, they are not even generically identifiable. Some of these trilobites would be suggestive of an early Late Cambrian age. However, the occurrence of a species of *Pegmatreta* common to the Stockport Station and Judson Point faunules is strong indication for a late Middle Cambrian age. Among the other trilobites, *Baltagnostus angustilobus* is similar to *B. stockportensis* from Stockport Station. *Hypagnostus parvifrons* is common to the Stockport Station and Judson Point faunules and is a well-known late Middle Cambrian trilobite. *Goniagnostus* is a characteristic genus of the *Paradoxides forchhammeri* stage in Scandinavia. The Agnostid pygidium no. 1, an unusual form not referable to described genera, is common to the Judson Point faunule. Therefore, the faunule from Nutten Hook should definitely be referred to the late Middle Cambrian. The biofacies seems again intermediate between the Acado-Baltic and Pacific provinces, since *Goniagnostus* is characteristic of the former, *Baltagnostus* of the latter, and *Hypagnostus* is a cosmopolitan genus.

SYSTEMATIC DESCRIPTIONS

The repositories of the fossils described herein are abbreviated as follows: USNM (U. S. National Museum); GSC (Geological Survey of Canada); MCZ (Museum of Comparative Zoology, Harvard University). NYSM (New York State Museum, Albany). All the material collected by the writer was deposited in the U. S. National Museum.

The abbreviations (tr.) for transverse, (sag.) for sagittal, and (exsag.) for exsagittal, qualify such terms as "wide," "short," etc., whenever the direction of the measurement might be misinterpreted.

All described and figured specimens show the outer surface of the test unless otherwise indicated.

Order AGNOSTIDA

Family AGNOSTIDAE McCoy, 1849

Genus LEIOPYGE Hawle and Corda, 1847

Type species: *Battus laevigatus* Dalman, 1828.

LEIOPYGE?, species no. 1

Plate 9, figures 31, 32

Available material.—One cephalon.

Description.—Cephalon ovate, somewhat narrowed anteriorly. Very

shallow furrows define the basal lobes at the side. Posterior border well defined, lateral and anterior border very narrow, defined by a shallow border furrow, not visible in dorsal view on account of the steep slope of the shield near the margin. Length of cephalon 3.2 mm., width 2.7 mm.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Discussion.—The specimen very closely resembles *Leiopyge calva* Robison (1964a) differing only in the slightly narrower shape. However, smooth agnostid cephalons are difficult to classify in the absence of the pygidium. Hence even the generic reference remains doubtful, especially in view of the fact that the associated trilobites suggest that the Stockport Station bed is older than the strata where *Leiopyge* occurs in Scandinavia and the western United States. From the cephalon alone it is difficult to distinguish *Leiopyge* from such species as "*Phalacroma*" *marginatum* and "*P.*" *glandiforme*, illustrated by Westergård (1946), which occur in somewhat older beds. As the recent work of Šnajdr (1958) and Öpik (1961) has shown, these Agnostids do not belong in *Phalacroma*, and even the reference to *Phalagnostus* seems questionable in view of the considerations suggested herein in discussing the Agnostid pygidium no. 1.

Disposition of material.—Figured specimen: USNM 156549.

LEIOPYGE?, species no. 2

Plate 9, figure 33

Available material.—One cephalon.

Cephalon proportionately wider and shorter than in preceding species, of equal width and length, of more nearly subquadrate shape. Border furrow and border very narrow, but well defined. Basal lobes defined by very shallow furrows but distinct. Glabella elevated in posterior portion, defined by a trace of an axial furrow for a short distance in front of the basal lobes. Length and width of cephalon 1.4 mm.

Discussion.—The specimen falls well within the limits of variability of *Leiopyge laevigata* (Dalman) as illustrated by Westergård (1946). However, in the absence of the pygidium, the same uncertainty prevails as discussed for the preceding species.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Disposition of material.—Figured specimen: USNM 156550.

Genus **PTYCHAGNOSTUS** Jaekel, 1909Type species: *Agnostus punctuosus* Angelin, 1851.**PTYCHAGNOSTUS PUNCTUOSUS (Angelin)**

Plate 9, figures 28-30

Agnostus punctuosus ANGELIN, 1851, p. 8, pl. 6, fig. 11.*Ptychagnostus (Ptychagnostus) punctuosus* (Angelin) WESTERGÅRD, 1946, p. 78, pl. 11, figs. 34, 35; pl. 12, figs. 1-7. Complete synonymy to date.*Ptychagnostus punctuosus* (Angelin) HUTCHINSON, 1962, p. 84, pl. 9, figs. 9-19.

Represented in the collection by a fragmentary cephalon and two fragmentary pygidia. All the visible features, mainly the segmentation of the glabella and pygidial axis, and the characteristic ornamentation of coarse granules and scrobiculate cheeks, agree with the specimens illustrated by Westergård.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Types.—Plesiotypes: USNM 156551.

PTYCHAGNOSTUS GIBBUS (Linnarsson)

Plate 10, figures 1-8

Agnostus gibbus LINNARSSON, 1869, p. 81, pl. 2, figs. 52, 53.*Triplagnostus gibbus* (Linnarsson) HOWELL, 1935, p. 14.*Ptychagnostus (Triplagnostus) gibbus* (Linnarsson) WESTERGÅRD, 1946, p. 78, pl. 9, figs. 17-24. Complete synonymy to date.

Represented in the collections by numerous cephalata and pygidia. The cephalon fully agrees with the types in all features, except that the posterior border being more or less completely broken off, the presence of long spines as in the type material cannot be ascertained. One cephalon shows the base of a spine of unknown length.

The pygidium has the strong, highly elevated node on the second axial ring, which may be described as a blunt spine, like the Swedish specimens. The median postaxial furrow is generally deep, shallow only in some of the larger specimens. Both these features according to Westergård distinguish the species from *P. praecurrens* (Westergård), of which *Triplagnostus burgessensis* Rasetti is regarded as a synonym.

Occurrence.—Collections cs-9c' and cs-9d, Malden Bridge, and loose blocks (cs-7/M1 and others) on the Griswold farm; associated with other trilobites of the *Bathyuriscus-Elrathina* zone.

Types.—Plesiotypes: USNM 156552-3.

PTYCHAGNOSTUS, species undetermined

Plate 10, figures 27-31

Available material.—A few cephala and pygidia, the latter mostly in the meraspid stage.

Description.—Glabella divided by shallow furrow into elevated posterior lobe and low frontal lobe, the latter defined by a very shallow axial furrow, tapering to a sharp point. Preglabellar furrow well defined. Basal lobes of average size, defined laterally by a shallow furrow. Border furrow and border both very narrow, but well defined. Length of largest cephalon 3.2 mm.

Pygidial axis with first lobe wider (tr.) than other lobes, defined by transverse furrow convex forward. Second lobe in meraspid pygidia wider medially, since both defining furrows turn the concavity toward it; in holaspid pygidium this portion of the axis is not well preserved, but the second lobe is seen to bear a tubercle near its posterior margin. Posterior lobe tapered to a rather sharp point. Postaxial furrow shallow. Pygidial border considerably wider than cephalic border, defined by well-impressed furrow. Length of largest pygidium 2.4 mm. Surface smooth.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Discussion.—As far as can be ascertained from the small or not well preserved specimens, this form does not appreciably differ from *Ptychagnostus elegans* (Tullberg) as illustrated by Westergård (1946).

Disposition of material.—Figured specimens: USNM 156554.

Genus GONIAGNOSTUS Howell, 1935

Type species: *Agnostus nathorsti* Brögger, 1878.

GONIAGNOSTUS, species undetermined

Plate 9, figures 18, 19

Available material.—Fragments of two cephala.

Description.—Glabella in posterior portion divided into strongly elevated median lobe and lower lateral lobes, the distinction becoming effaced toward the front and disappearing in the frontal lobe. Frontal lobe rapidly tapered to a sharp point, not elevated above the genae, defined by narrow, well-impressed axial and transverse furrows; the latter shallower medially. Remainder of glabella markedly divided, at least in the lateral portions, into three lobes of approximately equal

lengths. These lobes are distinguishable not only by the furrows that divide them, but also by the outwardly convex course of the axial furrow around each separate lobe. The first pair of lateral furrows after the transverse furrow which separates the frontal lobe is straight, well impressed laterally, but not across the elevated, median part of the glabella. The next pair of furrows has the form of a pair of deep pits adjacent to the elevated, median lobe, connecting with the axial furrow through a shallow, transverse furrow. The lateral parts of the glabella posterior to this pair of furrows should probably be interpreted as the basal cephalic lobes, which in more primitive Agnostids are part of the occipital ring, being continuous with its median portion and well separated from the glabella (Rasetti and Theokritoff, 1967). However, in certain forms of *Ptychagnostus* and *Goniagnostus* the basal lobes assume the aspect of lateral parts of the posterior glabellar lobe (Westergård, 1946). Unfortunately in the present form the basal lobes are incomplete in their outer portion. The elevated, median lobe of the glabella slopes down steeply to a narrow (long.) band that tapers at the sides, and must represent part of the occipital ring. There is a very narrow median ridge on the downsloping, rear portion of the glabella. The specimen showing all these features shows but small portions of the innermost areas of the genae, and a few scrobicules are seen to radiate from the axial furrow. The other fragment represents part of the frontal glabellar lobe and the anteriormost area of the genae up to the border furrow; no portion of the border is preserved. The genae are divided by a narrow, well-impressed median furrow reaching the border furrow, and show several narrow, well-impressed scrobicules. The surface of the test, aside from the scrobicules, is ornamented by an exceedingly fine granulation, observable only on coated specimens under high magnification. Length of glabella 2.6 mm.

Occurrence.—Collection cs-22 (*Bolaspidella* zone), Nutten Hook.

Discussion.—Even though the cephalon is represented only by fragments, and the pygidium is unknown, this Agnostid may be confidently referred to *Goniagnostus* since the glabellar lobation is essentially of the type occurring in the type species (Westergård, 1946, pl. 12, figs. 12-16), the present form being only somewhat more extreme in its unusual features. The genus occurs in Sweden in zones C1 and C2 of the *Paradoxides forchhammeri* stage, being more common in the former. This fact tends to confirm the suggested approximate correlation of the fossiliferous bed at Nutten Hook with the *Centropleura* bed at Judson Point.

Disposition of material.—Figured specimens: USNM 156555.

Family PERONOPSIDAE Westergård, 1935

Genus PERONOPSIS Hawle and Corda, 1847

Type species: *Battus integer* Beyrich, 1845.

PERONOPSIS, species no. 1

Plate 10, figures 9-12

Available material.—Several pygidia, and a cephalon tentatively referred to the same species.

Description.—Glabella divided by deep transglabellar furrow. Frontal lobe slightly narrower than posterior lobe, semicircular, well defined by axial furrow. Posterior lobe more than twice longer than anterior lobe, widest in front, narrowed toward the rearward portion which is well rounded, with a barely indicated node in advance of the midpoint. A pair of lateral furrows as indentations some distance behind the transglabellar furrow; there seems to be also a shorter indentation corresponding to the anterior end of the basal lobes. The latter, conspicuous, subtriangular. Border furrow wide, especially anteriorly; border narrow. Length of cephalon 3.7 mm. Surface smooth.

None of the pygidia preserve the test. Axis wide, not quite reaching the border furrow, with first and second lobe defined by two pairs of lateral furrows; anterior lobe somewhat wider (tr.) than second lobe. Second lobe with a prominent, elongate tubercle slightly extending beyond the second pair of furrows. Axis fairly pointed posteriorly. General shape of pygidium subquadrate, on account of the widening of the border at the position of the marginal spines and consequent fairly straight lateral outline. Border furrow wide, border also wide; spines short. Length of largest pygidia 3 mm.

Occurrence.—Collection cs-9d (*Bathyuriscus-Elrathina* zone), Malden Bridge.

Discussion.—This form might well be included in *Peronopsis fallax* (Linnarsson) as illustrated by Westergård (1946) but for the fact that it seems to possess better defined lateral furrows on the pygidial axis. Furthermore, neither identification with a described species, nor proposing a new one, seems proper in view of the uncertain reference of the cephalon to the pygidia. Two types of pygidia occur at the locality, but the two cephalons could not always be distinguished with certainty, in part owing to poor preservation. The more common cephalon was tentatively combined with the more common pygidium.

Disposition of material.—Figured specimens: USNM 156556.

PERONOPSIS, species no. 2

Plate 10, figures 13-18

Available material.—Numerous cephalata and pygidia, all poorly preserved.

Description.—Glabella of the same proportions as in preceding species, with frontal lobe slightly wider than posterior lobe. One pair of lateral furrows barely indicated on posterior lobe, which has an indistinct, elongated tubercle near its midpoint. Basal lobes as in preceding species. Border furrow moderately wide, border narrow. Length of larger cephalata 2.5 mm.

Pygidial axis relatively narrow, reaching maximum elevation at second lobe, sloping down to pointed posterior end, reaching border furrow. Lateral furrows of first pair very short and shallow, of second pair indistinct. A low, elongated tubercle on the second lobe. Border furrow moderately wide and fairly deep, regularly curved. Border of moderate and fairly uniform width, barely showing a slight widening at the position where spines are located in similar species. Length of pygidium 2.4 mm.

Occurrence.—In the same bed as the preceding species: collection cs-9d (*Bathyriscus-Elrathina* zone), Malden Bridge.

Discussion.—This form resembles *Peronopsis scutalis* (Hicks) as figured by Westergård (1946) in the lack of pygidial spines and non-confluent pleural regions behind the axis. The same reasons mentioned for the preceding species make a positive identification inadvisable.

Disposition of material.—Figured specimens: USNM 156557.

PERONOPSIS, species no. 3

Plate 10, figures 19-21

Available material.—A few, poorly preserved cephalata and pygidia.

Description.—Glabella with both lobes of equal width. Frontal lobe somewhat wider than long. Posterior lobe parallel-sided, showing vaguely a pair of lateral indentations somewhat in front of the middle, and a faint tubercle about two-thirds of the distance from the transglabellar furrow. Basal lobes lower and narrower than in the two preceding species. Border furrow and border narrow. Length of cephalon 0.75 mm.

Pygidia much larger, up to 3.5 mm. in length. Axis about parallel-sided in anterior two-thirds, then tapered to a sharp point, not reaching border furrow.

First pair of lateral furrows impressed at the sides, causing a slight

constriction of the axis; second pair barely indicated. A low tubercle on the second axial lobe. Pleural regions confluent behind the axis. Border furrow moderately wide and deep; border expanded laterally but not extended into spines.

Occurrence.—Collections cs-6 (*Bathyriscus-Elrathina* zone), Griswold farm.

Discussion.—This form is typical of *Peronopsis*, being somewhat intermediate between the two preceding ones, although it differs from both in the confluent pleural regions. The location of the node on the glabella is a distinguishing characteristic. In view of the scarcity of the material and immature condition of the available cephala, identification with described species is not suggested.

Disposition of material.—Figured specimens: USNM 156558.

PERONOPSIS, species no. 4

Plate 9, figure 26

Available material.—A small cephalon.

Description.—Frontal glabellar lobe as wide as posterior lobe, twice wider than long, defined by shallow transglabellar furrow showing a median forward bend. There is a suggestion of a notch on the front of the glabella. Posterior lobe rising and slightly narrowing toward the rear, lacking distinct node. Basal lobes low, rather wide (tr.) and short (exsag.). Border furrow and border narrow. Length of cephalon 0.9 mm.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Discussion.—Among the agnostid cephala recovered at the locality, the present one is distinctive, especially in the course of the transglabellar furrow. In the absence of a pygidium even generic identification is not certain.

Disposition of material.—Figured specimen: USNM 156559.

PERONOPSIS, species no. 5

Plate 7, figures 17, 18

Available material.—A fragmentary cephalon and a fragmentary pygidium.

Description.—Posterior glabellar lobe parallel-sided in anterior two-thirds, in the rear narrowing to a blunt point, reaching but not overhanging the posterior cephalic margin. Transverse furrow slightly concave toward the front, well impressed. Axial furrow well im-

pressed around frontal lobe, which is well rounded and 1.5 times wider than long. Occipital ring in form of long (tr.) and narrow (exsag.), subtriangular lobes, well defined by axial furrow laterally, completely separated medially by the rearward extension of the glabella. Other cephalic parts not preserved.

Pygidial axis well defined by axial furrow, expanding backward in anterior half, rearward tapered to a sharp point, almost reaching the posterior border furrow which connects with the axial furrow through a short median depression. No other features of the axis besides the outline are preserved. Pleural regions narrow (tr.), downsloping. Anterior border furrow well impressed; anterior border widest at geniculation, which is situated close to axial furrow, much reduced distally. Border furrow and posterolateral border well defined; border wide, of almost uniform width, lacking spines. Length of pygidium 1.7 mm. Cephalon and pygidium lie very close to each other on the rock surface and are likely to belong to one individual.

Occurrence.—Lower Cambrian *Neopagetina* faunule; collection cs-9 at the Malden Bridge road cut.

Discussion.—Several features clearly distinguish the species from the few known Lower Cambrian Agnostids (Rasetti and Theokritoff, 1967). The main characteristics of the cephalon are the curved transverse furrow and the complete separation of the basal lobes. The pygidium is distinctive in the long axis and wide border. Unfortunately, intensive search for Agnostids at all known Lower Cambrian fossil localities in the East Chatham quadrangle produced, in addition to the specimens under discussion, less than half a dozen cephalons, all seemingly referable to *Peronopsis*, but more similar to *Peronopsis primigena* (Kobayashi) and an allied form described from Washington County (Rasetti and Theokritoff, 1967).

Disposition of material.—Figured specimens: USNM 156560.

Genus HYPAGNOSTUS Jaekel, 1909

Type species: *Agnostus parvifrons* (Linnarsson), 1869.

HYPAGNOSTUS PARVIFRONS (Linnarsson)

Plate 9, figures 23-25

Agnostus parvifrons LINNARSSON, 1869, p. 82, figs. 56, 57.

Hypagnostus parvifrons (Linnarsson) COBBOLD and POCKOCK, 1934, p. 343, pl. 44, figs. 13-19.

Hypagnostus parvifrons (Linnarsson) WESTERGÅRD, 1946, p. 45, pl. 4, figs. 27-31.

Complete synonymy to date.

Hypagnostus metisensis RASETTI, 1948b, p. 320, pl. 45, figs. 21-27.

Hypagnostus parvifrons (Linnarsson) HUTCHINSON, 1962, p. 73, pl. 6, figs. 6a-b, 7.

Hypagnostus parvifrons (Linnarsson) ROBISON, 1964a, p. 529, pl. 81, figs. 4-23.

Represented in the collections by a few cephalala, which do not differ in any visible feature from those described and figured from the type area.

Occurrence.—Collections cs-21, Stockport Station; cs-22, Nutten Hook; and cs-23, Judson Point. The faunules at all three localities are attributed to the *Bolaspidella* zone.

Types.—Plesiotypes: USNM 156561-3.

HYPAGNOSTUS, species undetermined

Plate 9, figure 27

Available material.—An immature cephalon.

Description.—Posterior glabellar lobe parallel-sided, elevated posteriorly, truncate in front, with a low node in posterior part, showing a trace of lateral furrows. Frontal lobe effaced. Basal lobes low, subtriangular. Border furrow well impressed, border moderately wide. Length of cephalon 0.78 mm., width 0.72 mm.

Occurrence.—Collection cs-22, Nutten Hook.

Discussion.—The specimen resembles *Hypagnostus truncatus* (Brögger) as illustrated by Westergård (1946), but even the generic reference is uncertain lacking an associated pygidium. From the cephalon alone, *Hypagnostus* and *Kormagnostus* are difficult to distinguish.

Disposition of material.—Figured specimen: USNM 156564.

Family DIPLAGNOSTIDAE Whitehouse, 1936

Genus BALTAGNOSTUS Lochman, 1944

Type species: *Proagnostus? centerensis* Resser, 1938.

BALTAGNOSTUS ANGUSTILOBUS, new species

Plate 9, figures 4-11

Available material.—Several small holaspid cephalala and pygidia.

Description.—Glabella sloping from a strongly elevated, posterior portion to a low anterior end. Frontal lobe small, about half the maximum width of posterior lobe, about as wide as long, slightly pointed in front, defined by well-impressed transverse and axial furrows, not rising above the level of the genae. Posterior lobe slightly tapered forward, reaching maximum elevation near posterior

end, tapered backward to a rounded rear end. Occipital ring consisting of fairly wide (sag.) median band, concealed in dorsal view by glabella, and unusually large basal lobes. There is no distinct node on the glabella. Genae of moderate convexity; there is a faint, short median preglabellar furrow fading out well before reaching border furrow. Border furrow well impressed; border wide. Surface finely and rather indistinctly granulate.

Pygidium with strongly prominent axis showing but traces of segmentation. Anterior segment tapered backward; second segment slightly narrower; terminal segment usually as wide as second segment, in some specimens expanded posteriorly, well rounded at rear end, almost reaching the broad border furrow. There is a node at the posterior end of the second axial segment. Border furrow wide and relatively shallow, slightly inflected forward medially. Border wide, rather flat, widest medially, extended into a pair of flat, broad, short spines. Ornamentation indistinct. Cephalae and pygidia, probably immature, not exceeding 1 mm. in length.

Occurrence.—Collection cs-22 (*Bolaspidella* zone), Nutten Hook.

Discussion.—This species seems to fit in *Baltagnostus* better than in other described genera, even though it does not entirely conform to the diagnosis of the genus recently given by Robison (1964a), since the pygidial border does not have the characteristic crescentic shape, and the glabella lacks a node on the posterior lobe. Neither, however, appears to be a sufficiently important feature to exclude the species from the genus. Compared with *B. eurypyx* Robison, the best-known species of the genus, *B. angustilobus* differs in the narrow frontal glabellar lobe, great elevation of posterior lobe, lack of median node, proportionally shorter and somewhat narrower pygidial axis.

Types.—Holotype: USNM 156565. Paratypes: USNM 156566.

BALTAGNOSTUS STOCKPORTENSIS, new species

Plate 9, figures 12-17, 22

Available material.—Several small holaspidean cephalae and pygidia.

Description.—Glabella moderately elevated posteriorly. Frontal lobe almost semicircular, about two-thirds the width of posterior lobe, well defined by axial and transverse furrows but not rising above the level of the genae. Posterior lobe parallel-sided, abruptly constricted to a pointed posterior end; showing an elongated, low node on its posterior portion. Occipital ring expanded into basal lobes somewhat smaller than in preceding species; median portion almost entirely visible in dorsal view. Genae of moderate convexity; median pre-

glabellar furrow shallow, fading out anteriorly. Border furrow well impressed, border of moderate width.

Pygidial axis strongly elevated, slightly tapered backward in anterior portion, well rounded posteriorly, almost reaching the wide border furrow. Segmentation of axis indistinct; median node not very prominent, slightly posterior to midpoint. Border furrow wide and shallow, somewhat inflected forward medially. Border increasing in width toward the rear, widest medially, somewhat crescent-shaped, extended into a pair of short spines. Surface of test of cephalon and pygidium smooth. Length of largest cephalon 2 mm., of other cephalons and pygidia averaging about 1 mm.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Discussion.—This species is more typical of the genus than the preceding, most of the differences occurring in the cephalon. Compared with *B. eurypyx* Robison, *B. stockportensis* differs in the narrowness of the frontal glabellar lobe, and somewhat shorter and narrower pygidial axis. Compared with *B. angustilobus*, the present species differs chiefly in the wider frontal glabellar lobe, less elevated posterior portion of glabella, presence of a node on posterior glabellar lobe, and slightly more posterior location of the node on the pygidial axis.

Types.—Holotype: USNM 156567. Paratypes: USNM 156568.

Family undetermined

Genus GRANDAGNOSTUS Howell, 1935

Type species: *Grandagnostus vermontensis* Howell, 1935.

Öpik (1961) has given the most recent discussion of the Agnostids with effaced axial furrows. *Grandagnostus* differs from *Phalagnostus* in the effaced basal cephalic lobes. No satisfactory family assignment seems available for these genera once Öpik correctly removed them from the Phalacromidae.

GRANDAGNOSTUS?, species undetermined

Plate 9, figures 20, 21

Available material.—One cephalon.

Description.—Cephalon convex, widest about the middle, well rounded in front. All furrows totally effaced, but for a slightly differentiated, subtriangular portion of the posterior border. Length 1.5 mm., width 1.36 mm.

Occurrence.—Collection cs-23 (*Centropleura* faunule), Judson Point.

Discussion.—The cephalon closely resembles species of *Grandagnostus* figured by Öpik (1961). However, even the generic reference is uncertain owing to lack of the pygidium.

Disposition of material.—Figured specimen: USNM 156569.

Genus undetermined

Agnostida, pygidium no. 1

Plate 10, figures 22-26

Available material.—About a dozen specimens.

Description.—Pygidium with well-developed articulating half-ring and anterior border furrow, the latter setting off an anterior border which becomes effaced before attaining the lateral margin. Lateral and posterior border lacking. Axis unfurrowed, elevated, defined by a deep furrow all around, occupying about half the width and from two-thirds to three-fourths the length of the pygidium, tapering backward to a narrowly rounded point. There is a bare suggestion of a median node. Pleural regions convex marginally, downrolled. Length of largest pygidium 1 mm.

Occurrence.—Collections cs-23 (*Centropleura* bed), Judson Point, and cs-22, Nutten Hook.

Discussion.—To the writer's knowledge, no agnostid pygidium has been described in the literature as lacking a border. However, it seems possible that such is the case for the pygidia of *Phalagnostus* (referred by Westergård to *Phalacroma*), in particular *Phalagnostus scanicus* (Tullberg) figured by Westergård (1946, pl. 14, figs. 16-18) and *P. nudus* (Beyrich) figured by Šnajdr (1958, pl. 5, figs. 1-24) and Hutchinson (1962, pl. 11, figs. 6-8). In these Agnostids the wide rim around the pygidium has been described as the border. This interpretation, however, seems questionable because the anterior border furrow and border are well developed, but the former crosses the supposed lateral "border" instead of extending into the lateral border furrow as in all other Agnostids. Therefore the writer tentatively suggests as an alternative interpretation that these Agnostids lack lateral and posterior border.

According to Westergård (1946) in *Phalagnostus marginatus* (Brögger) the anterior border furrow does not cross the "border," even though in other respects the species appears very similar to *P. scanicus*. In "*Phalacroma*" *glandiforme* (Angelin) the anterior border

furrow clearly merges with the lateral border furrow, leaving no doubt that in this species we are dealing with a true border. Therefore, if the suggested interpretation is correct, the pygidia of *P. scanicus* and *P. glandiforme* would have substantially different structure and could not be referred to the same genus. The writer, fully aware of the pitfalls of interpretations based on illustrations (even as excellent as those under discussion), refrains from drawing any definitive conclusions; and to the paleontologists who have access to the relevant material from Sweden, Bohemia, and Newfoundland suggests further study in the light of these remarks.

The pygidia described herein unquestionably lack a border, and the elevated, central portion has the usual structure of an axis, rather than the peculiar subcircular shape observed in *Phalagnostus*. The latter structure must be considered a "pseudolobe" resulting from fusion of the axis and the pleural platforms, or only part of the latter according to the suggested interpretation.

The present species cannot be considered congeneric with any described Agnostid, but it would be improper to propose a new genus without an associated cephalon.

Disposition of material.—Figured specimens: USNM 156570-1.

Agnostida, pygidium no. 2

Plate 10, figure 35

Available material.—One specimen.

Description.—Pygidium of unusually low convexity, parallel-sided, well rounded posteriorly, somewhat longer than wide. Axis undefined, possibly with a very low tubercle in anterior part. Pleural platforms slightly down-sloping to a broad border furrow. The border furrow is sharply defined along the anterior pygidial margin, which has an unusually strong backward slant, turns sharply into the lateral border furrow which becomes progressively wider and shallower toward the rear, and almost disappears medially where there is but a vague distinction between the pleural platforms and the wide border. Length of pygidium 2.4 mm.

Occurrence.—Collection cs-23 (*Centropleura* bed), Judson Point.

Discussion.—This pygidium is unusual in the low convexity, parallel-sided shape, and strongly slanted anterior outline of the pleural lobes. Too little is known to suggest significant comparisons with described genera.

Disposition of material.—Figured specimen: USNM 156572.

Order EODISCIDA

Family EODISCIDAE Raymond, 1913

The Lower Cambrian strata in the East Chatham quadrangle continued to supply new forms of Eodiscidae, in addition to 19 named and 3 unnamed species described (Rasetti, 1966a) from the *Acimetopus bilobatus* bed. Some of these new Eodiscidae occur in association with the *Acimetopus* fauna, others are members of the *Pagetides* fauna. Four new named species and 10 unnamed ones are described herein, the latter too poorly represented to warrant proposing new genera and species. Including 3 species of Eodiscidae described before 1966, *Calodiscus lobatus*, *C. walcotti*, and *Serrodiscus speciosus*, the Lower Cambrian strata of the East Chatham quadrangle are known to contain at least 39 species of Eodiscidae, a number vastly exceeding the species of the family previously known from North America, and also greater than the number of species described from the rest of the world.

To avoid nomenclatural confusion, no taxa were based on pygidia, even if well preserved and clearly distinct from named species.

Cephala and pygidia of uncertain generic reference are designated by numbers. Numbers used in the previous paper (Rasetti, 1966a) are not used again in a different meaning, to avoid confusion in the faunal lists. Thus the first unassigned pygidium in the present paper is no. 5, since numbers 1-4 were previously used.

Genus ACIDISCUS Rasetti, 1966

Type species: *Acidiscus birdi* Rasetti, 1966.

ACIDISCUS BIRDI Rasetti

Plate 2, figure 4

Acidiscus birdi RASETTI, 1966a, p. 11, pl. 1, fig. 2; pl. 6, figs. 11-19.

An additional, large cephalon collected at the type locality shows one feature that was overlooked in describing the species. The posterior cephalic border, between the axial furrow and the genal spine, possesses an articulating feature similar to that described in *Lito-metopus longispinus* and *Serrodiscus subclavatus*. A narrow furrow sets off a triangular ridge, widening distally into a slight projection of the otherwise straight posterior margin.

Occurrence.—The type locality is cs-4, Griswold farm. Rare, fragmentary specimens also in collection cs-9a near Malden Bridge.

Types.—Holotype: USNM 145987. Paratypes: USNM 145988. Plesiotype figured herein: USNM 156573.

ACIDISCUS HEXACANTHUS Rasetti

Plate 2, figures 1-3

Acidiscus hexacanthus RASETTI, 1966a, p. 13, pl. 7, figs. 1-6.

A pygidium from the type locality is illustrated in order to show the excellently preserved ornamentation, consisting of granules enclosed in the meshes of an irregular, reticulate pattern of raised lines. Ornamentation in the pygidia of *A. birdi* and *A. hexacanthus* seems to vary from an almost entirely smooth test to the kind illustrated herein, making it difficult to classify some specimens.

Occurrence.—Collection cs-4, Griswold farm.

Types.—Holotype: USNM 145989. Paratypes: USNM 145990. Plesiotype figures herein: USNM 156573.

Genus ANALOX Rasetti, 1966

Type species: *Analox bipunctata* Rasetti, 1966.

ANALOX OBTUSA, new species

Plate 2, figures 5-7

Available material.—A few cephala and pygidia.

Description.—Cephalon somewhat wider than long (excluding the glabellar spine), fairly convex. Glabella divided by deep, straight transverse furrow into a tapered, rounded anterior lobe and a larger, fusiform posterior lobe strongly elevated posteriorly and projecting well beyond the posterior outline of the cephalon. This glabellar extension, however, is not as pronounced as in *A. bipunctata* and is more bluntly rounded distally. Occipital ring present, narrow (sag.), almost hidden in dorsal view. Genae convex, lacking lateral border. A pair of furrows diverge from the anterior part of the axial furrow and end in a pair of pits some distance from the anterior cephalic margin. Posterior border set off by deep border furrow; genal angle seemingly not extended into spine.

Pygidium somewhat wider than long. Axis well defined by the axial furrow, but not much elevated above the pleural lobes, moderately tapered, composed of 4 well-defined rings plus a terminal, unsegmented section, ending a short distance from the pygidial margin. Anterior border furrow on pleural regions deep and wide; lateral and posterior border exceedingly narrow, set off by an equally narrow furrow. Doublure forming a vertical face as in *A. bipunctata*. Surface more or less distinctly pitted. Length of largest cephalon, including glabellar extension, 3.2 mm., of largest pygidium 2.7 mm.

Occurrence.—Associated with the *Pagetides* fauna in collections cs-3/L2 and cs-3/L3.

Discussion.—The species can be clearly distinguished from *A. bipunctata* by the proportionately wider cephalon, wider glabella, deeper transglabellar furrow, lesser rearward extension of the glabella, and the smaller number of segments in the pygidial axis.

Types.—Holotype: USNM 156575. Paratypes: USNM 156576.

Genus BOLBOPARIA Rasetti, 1966

Type species: *Bolboparia superba* Rasetti, 1966.

BOLBOPARIA CANADENSIS Rasetti

Plate 2, figures 13, 14

Bolboparia canadensis RASETTI, 1966a, p. 21, pl. 5, figs. 13, 14.

A single pygidium, collected by G. Theokritoff from the type locality, almost certainly belongs to the species, on account of the close resemblance to the pygidium of *B. elongata* previously described.

Axis narrow, tapered, almost reaching the border furrow, composed of about 14 rings plus a terminal section, the precise number uncertain due to imperfect preservation of the posterior portion. A strong, rapidly tapered, upright spine on the second ring as in *B. elongata*. Pleural regions unfurrowed, apart from the well-impressed anterior border furrow, rather flat medially but sloping down vertically in the marginal portion and concealing in dorsal view the border furrow and most of the border. Border furrow wide and well impressed; border moderately wide, slightly decreasing in width rearward, vertical, extended into about 10 pairs of short, downward-directed spines of decreasing length. Surface of axis and pleural regions densely covered with granules of different sizes, the larger ones presumably representing the bases of short spines; border with small granules only. Length of pygidium 7.5 mm., width 8.0 mm.

Occurrence.—Limestone beds $\frac{1}{2}$ mile north of Elgin Station, L'Islet County, Quebec (Hubert's locality 63-F24).

Types.—Holotype: GSC 19887. Plesiotype figured herein: GSC 10563.

BOLBOPARIA, species no. 1

Plate 2, figures 8-12

Available material.—Two fragmentary cephalae and a fairly complete pygidium, plus fragments of silicified pygidia.

Description.—Cephalon, as far as can be observed, having the general features of the genus, including the tapered glabella, preglabellar depression, lateral border with a pair of marginal spines, and subtriangular posterior border, the posterior border furrow running outward and forward as in other species. Ornamentation consisting of small granules and short spines observable only on silicified fragments. Length of cephalon 4.5 mm.

Pygidium with tapered axis not reaching border furrow. Axis seemingly composed of not more than 7 or 8 rings, defined by shallow ring furrows; there was a large spine on the second ring as in other species. Axial furrows deep; pleural regions rising above axial furrows, rather flat in proximal portion, sloping down vertically at the sides and concealing at least part of the lateral border in dorsal view. Border steeply down-sloping, extended into several pairs of small spines not visible from above; border furrow well impressed. Ornamentation same as cephalon. Length of pygidium 2.7 mm., width 3.2 mm.

Occurrence.—Collection cs-9a (*Leptochilodiscus punctulatus* bed) in the Malden Bridge road cut.

Discussion.—The cephalon, compared with *B. superba*, appears to have a proportionately longer, less rapidly tapered glabella, and the genae are less bulging and more rounded in outline. The pygidium, compared with the known pygidia of *B. elongata* and *B. canadensis*, has the same general structure, but differs markedly in the much lesser number of axial segments and the greater proportional width.

Disposition of material.—Figured specimens: USNM 156577 (the pygidium on same piece of rock with a plesiotype of *Leptochilodiscus punctulatus*).

BOLBOPARIA, species no. 2

Plate 2, figure 15

Represented by a single example, a poorly preserved pygidium. The pygidium is wider than long, and has a narrow, multisegmented axis on which 9 or 10 rings are visible on the incomplete, preserved portion. There may have been a spine on the second segment. Pleural lobes unfurrowed, aside from the well-impressed anterior border furrow; other portions of border not preserved. Ornamentation consisting of relatively large granules, appearing as broken spines, plus smaller granules. Length of pygidium about 3 mm.

Occurrence.—Loose Lower Cambrian block cs-15/L4, in wooded

area north of the Griswold farm, in association with a *Pagetides* faunule.

Disposition of material.—Figures specimen: USNM 156578.

Genus CALODISCUS Howell, 1935

Type species: *Agnostus lobatus* Hall, 1847.

CALODISCUS LOBATUS (Hall)

Plate 3, figures 2-6

Agnostus lobatus HALL, 1847, p. 258, pl. 57, figs. 5a-f.

Calodiscus lobatus (Hall) HOWELL, 1935, p. 224.

Calodiscus lobatus (Hall) RASETTI, 1952, p. 441, pl. 51, figs. 1-11. Complete synonymy to date.

Calodiscus lobatus (Hall) LOCHMAN, 1956, p. 1378, pl. 8, figs. 1-11.

The species is one of the most common and characteristic forms of the *Elliptocephala asaphoides* assemblage in the entire Taconic sequence from northern Washington County to northern Columbia County. In the East Chatham quadrangle the occurrence in the conglomerate at Ashley Hill was cited by Lochman (1956). Here the presence of the species in other faunal assemblages is reported. The cephala from the new localities fall well within the wide limits of variability observed within the *Elliptocephala asaphoides* assemblage.

Occurrence.—Several silicified cephala and pygidia were etched with hydrochloric acid from limestone of the *Leptochilodiscus* bed (collection cs-9a) at the Malden Bridge road cut. A single cephalon, also illustrated herein, was found in association with a *Pagetides* faunule (coll. cs-18).

Types.—Figures plesiotypes: USNM 156579-80.

CALODISCUS THEOKRITOFFI, new species

Plate 2, figures 16-19

Available material.—A cephalon from the type locality in Quebec and a few, fragmentary, silicified cephala from Columbia County.

Description.—Glabella deeply divided into anterior and posterior lobes by wide transglabellar furrow. Anterior lobe about equally wide and long, tapered, rounded in front, almost reaching the border furrow. Posterior lobe strongly elevated posteriorly, rounded at the top, extending rearward somewhat beyond the general outline of the cephalon, overhanging the occipital ring which remains visible in dorsal view only at the sides. Occipital ring strongly curving forward laterally, narrow, lacking spine. Genae very convex, in posterolateral

part overhanging the border furrow, divided in front of the glabella by an exceedingly short (sag.) depression. Border furrow semi-circular, not appreciably indented backward medially, well impressed throughout, very deep posterolaterally, connecting with deep posterior border furrow which is slanted outward and forward from the axial furrow. Anterior and lateral border in a horizontal plane, slightly convex, tapering from maximum width medially to a minimum near genal angle. Doublure wide, especially in median part, reflexed to parallel the dorsal test. Posterior border subtriangular, wide distally where it extends into a short spine, at higher level than lateral border. Surface finely and rather indistinctly reticulate. Length of holotype cephalon 4.6 mm.

Occurrence.—The type locality is Hubert's locality 63-F24, limestone beds $\frac{1}{2}$ mile N. of Elgin Station, L'Islet County, Quebec. Paratypes were etched from the *Leptochilodiscus* beds (coll. cs-9a) at the Malden Bridge locality.

Discussion.—This species is very similar to *C. reticulatus* Rasetti which is also a member of the *Acimetopus bilobatus* fauna. It differs mainly in the flatter border which is regularly curved, lacking median inbend, and in the much lesser rearward extension of the glabella, even though the last feature may have been exaggerated in the restoration of *C. reticulatus* (Rasetti, 1966a, pl. 1, fig. 1).

Types.—Holotype: GSC 10564. Paratypes: USNM 156581.

CALODISCUS WALCOTTI Rasetti

Plate 1, figure 4; plate 3, figures 7-10

Calodiscus walcotti RASETTI, 1952, p. 443, pl. 54, fig. 17.

Available material.—Previously known only from the holotype cephalon. Several additional cephalata and associated pygidia were collected, allowing a more complete description. The new material, even though preserved in limestone, is somewhat flattened.

Description.—Regarding the cephalon, it is only necessary to correct the statement that the "occipital ring and posterior glabellar lobe [are] apparently extended together into a strong spine, broken off in the available specimen." Some of the new cephalata preserve the posterior part of the glabella, which is considerably elevated, but rounded, sloping down vertically to the occipital furrow. The latter is impressed throughout and sets off a short (sag.) occipital ring.

Pygidia certainly belonging to the species in account of the identical, granulate ornamentation, somewhat wider than long, well rounded

posteriorly. Axis narrow, tapered at moderate rate, defined by deep axial furrows but barely rising above the general convexity of the pygidium, composed of 6 rings plus a terminal unsegmented section, reaching the border furrow. First ring with a strongly elevated median node, all others lacking nodes. Pleural lobes very convex, unfurrowed; border furrow relatively wide, setting off a flat border. Surface with small, sparse granules. None of the specimens attain the size of the holotype.

Occurrence.—The type locality is USNM 36b, near Greenwich, Washington County, New York, where the associations of the species are unknown. The writer was unable to find a limestone outcrop at that location, possibly due to the rather vague indication "near Schoolhouse No. 12" given by Walcott. The new material occurs in collection cs-26, Riders Mills, in association with *Pagetides minutus* and other representatives of the *Pagetides* fauna.

Types.—Holotype: USNM 26710. Plesiotypes: USNM 156583.

CALODISCUS, species undetermined

Plate 3, figure 1

Known from a single, incomplete cephalon. The general structure is much as in *C. reticulatus*, the glabella being divided by a transverse furrow into posterior and anterior lobes. The anterior border is strongly swollen medially, the border furrow merging with the axial furrow. The convexity of the frontal border definitely distinguishes this species from *C. fissifrons*, *C. reticulatus*, and *C. theokritoffi*, but the condition of the specimen does not warrant a new name. Length of cephalon 5 mm. Surface apparently smooth.

Occurrence.—Loose Lower Cambrian block cs-15/L1, in association with a *Pagetides* faunule.

Disposition of material.—Figured specimen: USNM 156582.

Genus CHELEDISCUS Rushton, 1966

Type species: *Chelediscus acifer* Rushton, 1966.

CHELEDISCUS CHATHAMENSIS, new species

Plate 3, figures 11-17

Available material.—Several, more or less fragmentary cephalae, and two tentatively assigned pygidia, all in silicified condition.

Description.—Glabella strongly tapered forward to a sharp point, occupying about two-thirds of cephalic length, sloping down from a

highly elevated, rounded posterior portion to a low anterior end. There is a broad, very shallow depression in front of the elevated posterior part of the glabella. Glabella sloping vertically to occipital furrow, but not concealing the occipital ring; the latter apparently simple, of moderate length (sag.), but not well preserved in any of the specimens. Genae strongly convex, laterally sloping vertically to deep border furrow, divided in front by narrow, deep median furrow. Frontal and lateral border of even width throughout, convex, down-sloping, showing a series of faint radial impressions. Posterior border furrow deep and wide, directed outward and forward, giving the posterior border an elongate triangular shape. Posterior cephalic margin with somewhat concave profile as the border is raised and expanded backward toward the genal angle, where it extends into a short spine. Beyond the spine the border slopes down to join the lateral border. Length of largest cephalon 4.0 mm.

Pygidium, tentatively referred to the species on account of similarity to the pygidium of *C. acifer*, also with strong relief. Axis relatively wide, occupying most of pygidial length, strongly elevated above the pleural regions, also convex in longitudinal profile, composed of 5 rings plus a terminal section. Ring furrows deep throughout; at least the anterior rings have an elevated median node. Pleural regions convex and strongly down-sloping, unfurrowed. Anterior and lateral border furrow rather wide, moderately deep. Border narrow, extended downward into a vertical doublure. Length of larger pygidium 2.1 mm.

Surface of cephalon and pygidium densely covered with relatively small granules.

Occurrence.—Collection cs-9a (*Leptochilodiscus* beds), Malden Bridge.

Discussion.—The first cephalons were found associated with the peculiar pygidium described herein as pygidium no. 7, and since the granulate ornamentation appeared similar, the two parts were tentatively referred to the same species. When later a few pygidia resembling the pygidia of *C. acifer* (known from articulated, enrolled specimens) were recovered, it became more plausible to combine these pygidia with the cephalon of *Chelediscus chathamensis*. Nevertheless, the writer does not feel entirely certain that this is the correct assignment.

The cephalon of *C. chathamensis*, compared with *C. acifer*, has much greater overall relief; the glabella is less tapered and does not possess a definite transglabellar furrow. The border furrow is much

deeper and the border more strongly convex. The tentatively assigned pygidium differs from that of *C. acifer* mainly in the proportionately narrower axis, deeper ring furrows, and greater width of border furrow and border. The vertical doublure, which as shown by Rushton (1966) in *C. acifer* fits inside the cephalic doublure like the lid into a box, is present in both species.

Types: Holotype: USNM 156584. Paratypes: USNM 156585.

Genus **LEPTOCHILODISCUS** Rasetti, 1966

Type species: *Leptochilodiscus punctulatus* Rasetti, 1966.

LEPTOCHILODISCUS PUNCTULATUS Rasetti

Plate 1, figure 1; plate 3, figures 18-28

Leptochilodiscus punctulatus RASETTI, 1966a, p. 26, pl. 1, fig. 5; pl. 11, figs. 1-7.
Undetermined pygidium No. 1, RASETTI, 1966a, p. 38, pl. 11, figs. 17-21.

The species is rare at the type locality and the description of *Leptochilodiscus* was based on the cephalon alone, suggesting that the "undetermined pygidium No. 1" might belong to the species. This is now proved correct by the close association of numerous specimens at a new locality.

This better-preserved material shows a few features to be added to the description. The posterior cephalic border has a sharp geniculation near the distal end, where the margin is suddenly bent downward and forward. A slender, not very long spine is an extension of the posterior and lateral borders at the genal angle. New drawings of both shields of the species are presented (pl. 1, fig. 1) in place of the incorrect restoration of the cephalon previously published.

Several excellently preserved pygidia clearly show the small, downward and rearward directed border spines. There are usually 8 pairs, the posterior ones partially visible in dorsal view. The spines somewhat increase in length toward the rear, the longest ones being those of the seventh and eighth pairs, which extend slightly beyond the outline of the pygidium. In most of the specimens, dense pits cover the surface of the genae and pleural regions; this ornamentation is indistinct in some of the examples, especially those from the *Pagetides* fauna.

One cephalon from Quebec, associated with *Bolboparia canadensis*, is referred to the species and illustrated herein. The only difference from the types is the slightly narrower lateral cephalic border. How-

ever, there is variation in this feature within the population from a single bed.

Occurrence.—The types are from locality cs-4, Griswold farm. The new material illustrated herein is from: Collection cs-9a, Malden Bridge (discovered by A. R. Palmer); collection cs-29, in association with a *Pagetides* faunule; and C. Hubert's locality 63-F24, $\frac{1}{2}$ mile N. of Elgin Station, L'Islet County, Quebec (collected by G. Theokritoff).

Types.—Holotype: USNM 146009. Paratypes: USNM 146010-1. Specimens described as "undetermined pygidium No. 1": USNM 146033. Plesiotypes figured herein: USNM 156586-7; GSC 10565.

Genus OODISCUS Rasetti, 1966

Type species: *Oodiscus subgranulatus* Rasetti, 1966.

OODISCUS, species undetermined

Plate 5, figures 12-15

Pygidia referable to *Oodiscus* are exceedingly rare in association with the *Pagetides* faunules. So far only four examples were recovered and are illustrated herein in order to present all the Eodiscidae known from the assemblage. It is not certain that the four pygidia belong to the same species, but this is a possibility.

The best-preserved of the pygidia is somewhat wider than long, of low convexity, showing the subquadrate shape characteristic of the genus. Axis tapered, showing but a trace of ring furrows, occupying about two-thirds of the pygidial length. Pleural regions, border furrow and border as in the type species. Surface of pleural regions covered with scattered, rather large granules. Another pygidium seems proportionately narrower and longer, but this may be the result of distortion as the specimen is very poorly preserved. The third specimen is very small and may belong to a different species as the axis appears more sharply pointed, and the pygidial outline more rounded; this individual also seems to have a granulate surface. The fourth pygidium has a slightly shorter axis and seems to lack ornamentation.

Occurrence.—The specimens are respectively from collections cs-3/L2, cs-15/L4, and cs-17/L1, loose Lower Cambrian blocks on the Griswold farm; and cs-18, Lopez farm. All were found in association with *Pagetides*.

Disposition of material.—Figured specimens: USNM 156588-91.

OODISCUS, species no. 1

Oodiscus, species undetermined No. 1, RASETTI, 1966a, p. 31, pl. 11, figs. 8-11.

This unnamed form was described on a few pygidia, possibly belonging to one of the species based on the cephalon. A single pygidium, not illustrated herein as it would not supply additional information, was collected from the *Leptochilodiscus* beds at the Malden Bridge road cut (coll. cs-9a).

Genus SERRODISCUS R. and E. Richter, 1941

Type species: *Eodiscus* (*Serrodiscus*) *serratus* R. and E. Richter, 1941.

SERRODISCUS SPECIOSUS (Ford)

Plate 3, figure 29

Microdiscus speciosus FORD, 1873, p. 137, figs. 2a-b.

Eodiscus (*Serrodiscus*) *speciosus* (Ford) R. and E. RICHTER, 1941, p. 27, pl. 1, figs. 15-21; pl. 4, fig. 61.

Serrodiscus speciosus (Ford) RASETTI, 1952, p. 444, pl. 52, figs. 1-11. Complete synonymy to date.

Serrodiscus speciosus (Ford) LOCHMAN, 1956, p. 1381, pl. 5, figs. 13-21.

The species is recorded for its stratigraphic importance as a typical representative of the *Elliptocephala asaphoides* assemblage. An articulated exoskeleton, flattened but otherwise well preserved in shale, is figured.

Occurrence.—The figured specimen is from collection cs-24b in the Judson Point section.

Types.—Plesiotype: USNM 156592.

SERRODISCUS SPINULOSUS Rasetti

Plate 1, figure 3; plate 4, figures 1-8

Serrodiscus spinulosus RASETTI, 1966a, p. 33, pl. 7, figs. 7-11.

This species, rare at the type locality, is one of the more common trilobites in collection cs-9a at Malden Bridge. The new material confirms the tentative previous assignment of the pygidium and shows additional features.

Contrary to the previous statement, the posterior cephalic margin at the geniculation shows the same articulating feature described (Rasetti, 1966a) in *Serrodiscus subclavatus*. A short, narrow furrow parallel to the posterior margin set off a low, narrow ridge which extends slightly beyond the straight outline of the margin.

The pygidial border has 8 pairs of blunt spines, visible in dorsal view only as a slight waviness of the outline. The pygidial axis in some specimens vaguely shows 6 rings, in others no trace whatever. In most examples there is a small, horizontally directed spine on the sixth ring. In one specimen, however (pl. 4, fig. 4), at this place there is only a low node, even though the test is well preserved and a broken spine would be conspicuous. The writer (Rasetti, 1966b) described a similar variation in the pygidia of *Pagetia billingsi*.

Occurrence.—The type locality is cs-4, Griswold farm. Numerous cephalo and pygidia occur in collection cs-9a at the Malden Bridge road cut. A fragmentary cephalon illustrated herein was recovered from loose Lower Cambrian block cs-17/L1 on the Griswold farm in association with a *Pagetides-Pagetia* faunule.

Types.—Holotype: USNM 146026. Paratypes: USNM 146027. Plesiotypes figured herein: USNM 156593-4.

SERRODISCUS LATUS Rasetti

Plate 4, figures 9-12

Serrodiscus latus RASETTI, 1966a, p. 34, pl. 10, figs. 12-15.

Available material.—The species was based on the cephalon. Two specimens of an associated pygidium in collection cs-9a are tentatively referred to the species.

Description.—Pygidium somewhat wider than long, with uniformly curved lateral and posterior margin. Axis tapered, somewhat pointed posteriorly, unfurrowed, almost reaching the border furrow. Pleural lobes convex, unfurrowed but for the anterior border furrow which is deeply impressed, and continues into a deep lateral and posterior border furrow. Genuation on anterior margin well marked, somewhat closer to axial furrow than to lateral angle. Border of uniform, medium width, somewhat convex. Doublure apparently not extended into spines; however, the preservation is not adequate to ascertain this feature. Surface smooth like the cephalon. Length of larger pygidium 2.4 mm, width 3.2 mm.

Discussion.—The pygidium closely resembles the pygidium of *Litometopus longispinus*, but seems to differ from example of that species of similar size in the somewhat narrower and convex rather than flat border. The cephalo of the two species, aside from the spines in *Litometopus*, are also rather similar. The present species partakes of the features of *Serrodiscus*, *Litometopus* and *Cobboldites*.

Occurrence.—The type locality is cs-4, Griswold farm. The

cephalon and pygidia illustrated herein are from collection cs-9a, Malden Bridge.

Types.—Holotype; USNM 146024. Paratypes: USNM 146025. Plesiotypes: USNM 156595.

SERRODISCUS GRISWOLDI, new species

Plate 4, figures 13-17

Available material.—An imperfectly preserved cephalon and a pygidium.

Description.—Cephalon with strong relief. Glabella with undifferentiated occipital ring slightly tapered, especially in anterior portion, rounded in front, totally unfurrowed, defined by a deep axial furrow. Genae rising somewhat above the axial furrow, strongly and about uniformly convex, sloping down vertically to border furrow. Preglabellar field convex, about one-eighth the glabellar length, lacking any preglabellar depression. Border furrow deep and wide; border rather narrow, strongly convex, showing 6 pairs of strong tubercles giving the margin an irregular outline. Posterior cephalic border and genal angle not preserved. Surface covered densely with small granules, and more sparse spines of which only the broken base is preserved. The ornamentation is identical with that observed in species of *Bolboparia*. Length of cephalon 8.0 mm., width 8.6 mm.

Pygidium with strong relief, subtriangular. Axis strongly elevated, defined by deep axial furrows, composed of 7 rings plus a short, terminal section, occupying almost entire pygidial length. Ring furrows very deep anteriorly, progressively shallower, until the last two are only represented by short, shallow lateral impressions and are totally effaced medially by the base of a strong spine, centered on the seventh ring and presumably directed upward and backward, broken off in the specimen. There are no nodes or spines on any of the other rings. Pleural regions strongly convex, attaining vertical slope laterally, overhanging the lateral and posterior parts of the border furrow but not entirely concealing the lateral border in dorsal view. Border furrow wide and unusually deep; border of medium width, presumably narrower in posterior, not preserved portion, convex, extended ventrally into relatively strong, widely spaced spines, of which 5 pairs are preserved; from the spacing one may infer the presence of a sixth pair. Anterior border deep and wide; geniculation located slightly closer to axial furrow than to anterior angle of pygidium, facet well developed. Surface of test, except in the furrows

and on the articulating half ring, which are smooth, identical with that of cephalon. Length of pygidium 6.0 mm., width 7.0 mm.

Occurrence.—Collection cs-4 (*Acimetopus* bed), Griswold farm.

Discussion.—Even though only one example of the cephalon and one of the pygidium are known, reference of the two shields to one species is suggested by the identical ornamentation, and by the number, spacing and size of the pygidial spines and the tubercles on the cephalic border, which seem to match perfectly to allow a tight enrollment of the exoskeleton. Among the other Eodiscidae from the locality, the same type of ornamentation only occurs in *Bolboparia*, and the matching of cephalia and pygidia of that genus is well substantiated by association at three localities.

The species is markedly distinct from all forms of *Serrodiscus* previously known. The strong convexity of the cephalon and the narrow, tuberculate border show some similarity to *S. subclavatus*, but the glabella is tapered rather than expanded in front. The pygidium does not closely resemble that of *S. subclavatus* or any other species. Its chief distinctive features are the unusually deep axial and ring furrows, the latter being obsolete or shallow in most of the other species of the genus, the small number of axial segments, and the strong spine on the seventh ring. The spinose ornamentation is not known in other species of *Serrodiscus*.

Types.—Holotype (cephalon): USNM 156596. Paratype: USNM 156597.

Genus **STIGMADISCUS** Rasetti, 1966

Type species: *Stigmadiscus stenometopus* Rasetti, 1966.

STIGMADISCUS STENOMETOPUS Rasetti

Plate 1, figure 2; plate 5, figures 1-4

Stigmadiscus stenometopus RASETTI, 1966a, p. 36, pl. 12, figs. 1-7.

Undetermined pygidium No. 4, RASETTI, 1966a, p. 46, pl. 6, figs. 20, 21.

The description of *Stigmadiscus stenometopus* was based exclusively on the cephalon. A peculiar pygidium was described and figured with the statement that it seemed unlikely that it could be referred to any of the cephalia in the collection. The recovery of additional material showing further details now suggests the possibility that this is the pygidium of the species.

All together, about 10 fragmentary specimens of the pygidium are known. It would seem strange that no cephalic parts of such a large trilobite had been recovered. On the other hand, the size and

abundance would match the cephalo of *Stigmatiscus stenometopus*. Both cephalon and pygidium seemingly had a thinner test than the other Eodiscidae in the collection, thus accounting for the usually more fragmentary condition than it was observed in other genera of the family.

The feature that is most suggestive of an Eodiscid, and could only be observed in new material, is the presence of a series of small, downward directed border spines, much as in *Serrodiscus*, *Acidiscus*, *Leptochilodiscus* and other Eodiscid genera. If the pygidium belongs to the Eodiscidae, the reference to *Stigmatiscus* becomes virtually certain since all the other large cephalo from the locality already have a reliably assigned pygidium.

One pygidium preserves most of the axis and portions of the pleural lobes. Together with the other specimens this allowed the reconstruction of the entire pygidium. The first axial ring is narrower medially than laterally, due to widening of the first ring furrow. The rings 2-5 have their posterior margin extended medially into a very short, horizontally directed spine accompanied by a slight median inbend of the ring furrows. The seventh ring seemingly had a large spine, broken off in the available specimens. The rings 8-13 lack the short median spine, even though the inbend of the ring furrows is still present. It is not certain whether the 13th ring is the last before the terminal section or there are one or two more rings.

The pygidium showing the border spines is only preserved in its anterior portion, where 5 spines are visible, one for each pleural segment. Hence there were probably about a dozen pairs of spines all together. The largest pygidium indicates a length of 14 mm., approximately agreeing with the size of the largest cephalo.

Occurrence.—Described from locality cs-4, Griswold farm. A few fragmentary cephalo in collection cs-9a, Malden Bridge.

Types.—Holotype: USNM 146029. Paratypes: USNM 146030. Specimens figured as "undetermined pygidium No. 4:" USNM 146000. Plesiotype pygidia figured herein: USNM 156598.

Genus undetermined

Eodiscidae, cephalon no. 1

Plate 5, figure 11

Available material.—An imperfectly preserved example.

Description.—Cephalon semicircular, moderately convex. Glabella occupying slightly more than half the cephalic length, tapered, sloping

down toward the front, possibly with short lateral furrows. The occipital ring seemingly was differentiated from the glabella, but this part of the cephalon is incompletely preserved. Genae convex, sloping down to a broad preglabellar depression medially. Border furrow moderately impressed, border rather flat, of even width. The posterior border may have been extended into a spine at the genal angle. Surface lacking distinct ornamentation. Length of cephalon 1.9 mm., width 2.7 mm.

This cephalon differs from those of most Eodiscidae in the relatively small glabella.

Occurrence.—Collection cs-9a (*Leptochilodiscus* beds) in the Malden Bridge road cut.

Disposition of material.—Figured specimen: USNM 156599.

Eodiscidae, cephalon no. 2

Plate 5, figures 5, 6

Available material.—A somewhat incomplete, silicified example.

Description.—Cephalic outline representing about three-fourths of an ellipse; maximum width somewhat behind the middle, slightly less than the midlength. Glabella approximately parallel-sided in posterior part, slightly constricted at midlength, somewhat expanded in front, and tapering to a narrowly rounded point. In longitudinal profile the glabella reaches maximum elevation just in front of the occipital furrow, where it extends into an upright spine; it is lowest at midlength, where a broad, very shallow transglabellar depression occurs; the frontal portion rises somewhat higher. Occipital ring short (sag.), of uniform width, convex backward in outline, extending beyond the outline of the genae. Genae convex all around the glabella, not divided by a preglabellar depression; preglabellar field moderately long. Border furrow well impressed; border relatively narrow, of even width throughout, possibly extended into a short spine at the genal angle. Posterior border short (tr.) on account of the narrowing of the posterior part of the cephalon, straight. The only specimen is incrustated with siliceous deposits that prevent observation of the ornamentation, if any. Length of cephalon 2.9 mm.

Occurrence.—Collection cs-9a (*Leptochilodiscus* beds), Malden Bridge.

Discussion.—This cephalon is unusual among the numerous Eodiscidae of the *Acimetopus* fauna in the outline narrowing toward the genal angle, whereas almost all other cephalata are widest at the

posterior end. The shape of the glabella is also distinctive, and the convex, relatively long preglabellar field precludes reference to genera, such as *Calodiscus*, which possess a preglabellar depression. Were the species better known, it might form the basis for a new genus.

Disposition of material.—Figured specimen: USNM 156600.

Eodiscidae, cephalon no. 3

Plate 5, figures 7, 8

Available material.—A somewhat incomplete example.

Description.—Cephalon approximately semielliptical, with somewhat flattened frontal outline. Glabella together with totally undifferentiated occipital ring undefined from the genae, except posteriorly where it extends beyond their posterior outline. On the left side of the specimen there seems to be a portion of the axial furrow extending for a short distance from the posterior margin, but this is believed to be, at least to a large extent, a crack of the test caused by the compaction of the sediment. Unfortunately on the other side this part of the cephalon is not preserved. Genae convex both in transverse and longitudinal profile. Frontal, lateral, and posterior border furrow and border well developed. Border relatively narrow, of even width throughout. The posterior border furrow and border curve slightly forward distally. The border at the genal angle is not preserved; the portion of posterior border preserved does not show a sharp geniculation. Surface smooth. Length of cephalon 4 mm.

Occurrence.—Collection cs-29, W. of the Griswold farm, in association with *Pagetides elegans*, *P. minutus*, *Pagetia laevis*, and *Leptochilodiscus punctulatus*. The first three species are typical of the *Pagetides* fauna, whereas *Leptochilodiscus*, known in that assemblage only from this locality, is a holdover from the older *Acimetopus* fauna.

Discussion.—This peculiar cephalon should possibly be referred to *Weymouthia*, the only genus of Eodiscidae of North America with an undifferentiated glabella. The genus is poorly known; the only specimen definitely referable to the species, the holotype of *Weymouthia nobilis* (Ford), was lost soon after its description and is only known from Ford's illustration; and furthermore, the posterior part of the cephalon of the specimen was stated to be missing. The general shape of the cephalon described herein agrees with Ford's figure, except in lacking the tubercles on the border. Owing to the difficulty of assessing the affinities of such almost featureless cephal,

and the imperfect knowledge of *Weymouthia*, it is deemed preferable to refer the present form to an undetermined genus.

Disposition of material.—Figured specimen: USNM 156601.

Eodiscidae, cephalon no. 4

Plate 5, figures 9, 10

Available material.—A single, poorly preserved example.

Description.—Cephalon semielliptical, of moderate convexity. Glabella not greatly elevated, defined by a moderately deep dorsal furrow, on the average tapered forward, divided by a broad, shallow transverse furrow into two lobes. Anterior lobe narrow, somewhat pointed in front; posterior lobe wider, seemingly elevated posteriorly, possibly into a spine. Occipital ring not preserved. Cheeks moderately convex, the convexity increasing toward the margin, divided by a very shallow, median furrow connecting the axial and border furrows. Border furrow and border both narrow but well defined, neither being preserved in the posterior half of the cephalon. The border seemingly possessed a pair of short spines at the approximate level of the anterior third of the cephalon, but too little of this feature is preserved to allow a positive statement. Test apparently smooth, but too poorly preserved to show a fine ornamentation, if any. Length of cephalon 3.5 mm., width 4.0 mm.

Occurrence.—Collection cs-9a (*Leptochilodiscus* beds), Malden Bridge.

Discussion.—The glabella has the same features as in *Anaxol bipunctata*, but otherwise the cephalon is quite different from that species in possessing an anterior and lateral border of even width and a median preglabellar furrow. No satisfactory generic reference can be suggested.

Disposition of material.—Figured specimen: USNM 156602.

Eodiscidae, pygidium no. 5

Plate 4, figures 22, 23

Available material.—An incomplete example.

Description.—Pygidium proportionately long and narrow, tapered toward the rear. Axis preserved only in posterior part, slightly tapered, moderately raised above the pleural region, almost reaching the border furrow, seemingly unfurrowed. Pleural regions unfurrowed, almost flat over most of their area, but sloping down steeply in the median portion on each side. Anterior border furrow gradually curving into the lateral border furrow, which becomes shallower

toward the rear but is distinct throughout. Anterior border wide, with well-developed facet; lateral border narrow, extended into several pairs of blunt, very short spines not visible in dorsal view. Posterior portion of the border again wider. A pair of strong spines, seemingly long judging by the moderate rate of tapering near the base, and directed horizontally backward and slightly outward, appear as extensions of the border at the posterolateral angles of the pygidium. Surface smooth. Length of pygidium 5.6 mm., width 4.3 mm.

Occurrence.—Loose Lower Cambrian block cs-3/L3, Griswold farm, in association with a *Pagetides* faunule.

Discussion.—No generic reference can be suggested in the absence of a cephalon. This pygidium differs from any described among the Eodiscidae in the presence of a pair of large posterolateral spines.

Disposition of material.—Figured specimen: USNM 156603.

Eodiscidae, pygidium no. 6

Plate 4, figure 21

Available material.—A poorly preserved example.

Description.—Pygidium fairly convex, tapered toward the rear. Axis tapered, straight-sided, well defined by the axial furrow but not raising greatly above the pleural regions, long but not reaching the border furrow. Traces of numerous ring furrows visible on coated specimen. Pleural regions very convex laterally, sloping down to border that almost certainly was developed all around the pygidium. Only the wide, straight anterior border and a portion of very narrow posterolateral border are preserved. Pleural regions unfurrowed aside from the anterior border furrow. A pair of large, closely spaced spines, directed backward and slightly curving inward, arise from the border. Surface too poorly preserved to detect a fine ornamentation, if any. Length of pygidium 2.5 mm., width 2.4 mm.

Occurrence.—Loose Lower Cambrian block cs-17/L1, in association with a *Pagetides* faunule.

Discussion.—This pygidium has in common with the preceding the presence of a pair of posterior border spines, which in the present form are more closely spaced. In all other observable features, the pygidium recalls *Leptochilodiscus punctulatus*, differing from that species in the great development of one of the pairs of marginal spines and the narrower axis. However, no definite generic reference can be made in the absence of the cephalon.

Disposition of material.—Figured specimen: USNM 156604.

Eodiscidae, pygidium no. 7

Plate 4, figures 18-20

Available material.—Two specimens, of which one is well preserved, in silicified condition.

Description.—Pygidium semielliptical with very strong relief. Axis strongly elevated, about a third the pygidial width, parallel-sided, rounded posteriorly, not quite reaching the border furrow. Articulating furrow and two ring furrows well impressed across the axis; a third ring furrow shallower. The terminal section is extended into a strong spine, at the base almost as wide as the axis itself, sloping upward at a low angle, in one of the pygidia somewhat curving downward, in the other almost straight, fully as long as the remainder of the pygidium. Anterior pygidial border set off by deep border furrow, and showing well-developed facet. One pleural furrow, narrow but deep, is almost parallel to anterior border furrow and is uniformly impressed from axial furrow to border furrow; there is no trace of other pairs of furrows. Border furrow moderately deep and wide; border of even width, with very narrow doublure, lacking spines.

Pygidium covered with small granules. Length of pygidium exclusive of spine, 2.4 mm., with spine 4.7 mm., width 2.8 mm.

Occurrence.—Collection cs-9a (*Leptochilodiscus* bed), Malden Bridge.

Discussion.—Two features characterize this pygidium, the exceedingly strong, terminal axial spine and the presence of one, relatively deep pair of pleural furrows. In the discussion of *Chelediscus chathamensis* it was mentioned that reference of this pygidium to that species cannot be excluded. It seems more likely, however, that it belongs to an unknown cephalon. To avoid nomenclatural confusion, the policy of not proposing taxa of the Eodiscidae on the basis of pygidia is applied to this case, even though the pygidium may be different enough from known forms to justify a separate genus.

Disposition of material.—Figured specimens: USNM 156605.

Family PAGETIIDAE Kobayashi, 1935

Genus PAGETIA Walcott, 1916

Type species: *Pagetia bootes* Walcott.

The Lower Cambrian strata of Columbia County yielded copious material of two species of *Pagetia* which are quite different from *P. connexa* (Walcott), occurring at several localities in the Taconic

sequence of Washington County. No specimens of the latter were found in Columbia County. The Middle Cambrian strata yielded two species, closely related to forms of the western United States.

PAGETIA BIGRANULOSA, new species

Plate 7, figures 1-9

Available material.—Large numbers of cranidia and pygidia.

Description.—Glabella tapered, narrowly rounded in front, indistinctly furrowed. Occipital furrow well impressed laterally; posterior part of glabella and occipital ring jointly extended into a horizontal, rapidly tapered spine. Preglabellar field on average shorter (sag.) than border, forming a shallow depression where the axial and border furrows merge. Palpebral area convex, somewhat upsloping proximally but slightly down-sloping distally, about as wide as glabella. Ocular ridges not marked; palpebral furrow deep, straight, directed longitudinally; palpebral lobe somewhat wider at midlength, almost a third the glabellar length. Anterior border rather wide (sag.) medially, somewhat tapered at the sides, slightly convex, with broad, shallow radial markings. Posterior border furrow deep from axial furrow to facial suture. At the inner, posterior angle of the genae formed by the axial and border furrows is a slight, poorly defined, subtriangular elevation set off by a very shallow, oblique furrow. Examination of Middle Cambrian material shows that a similar feature, although more effaced, is visible at least in some specimens of most forms of *Pagetia*. The writer (Rasetti, 1966b) failed to mention this characteristic, which in the present species and the next is particularly well marked.

Pygidial axis strongly elevated, overhanging posterior border furrow, barely tapered, showing 3 or 4 rings defined by increasingly shallow furrows plus a terminal section extended into a slender, somewhat upward-directed spine. Moderately elevated nodes appear on the first 2 or 3 rings. Pleural regions showing 3 or 4 pairs of pleural furrows (including the anterior border furrow) and very narrow, shallower interpleural furrows. Border furrow shallow, border narrow.

Surface of test covered with dense, excessively fine granules visible only on perfectly preserved material under thin coating of magnesium oxide, plus large, but not greatly elevated granules well developed on glabella, genae, and the ribs between the pleural furrows in the pygidium. Length of largest cranidium, exclusive of spine, 1.9 mm.,

the average being about 1.5 mm. Pygidia averaging about 1.4 mm. in length.

Occurrence.—Holotype from loose block cs-17/L1; also in blocks cs-3/L2, cs-3/L3, all on the Griswold farm. Found in bedded rocks in collections cs-15 and cs-29, north and west of the Griswold farm. In association with Lower Cambrian *Pagetides* faunules.

Discussion.—The species is markedly distinct from all previously described, chiefly in the depth and straight course of the palpebral furrow, wider palpebral lobe, pleural and interpleural furrows on the pygidium, and characteristic ornamentation. The palpebral lobes are rather like in *Pagetides* than *Pagetia*, but other features, such as the anterior border with well-developed radial impressions, and the pygidial spine, are indicative of *Pagetia*. The species does not resemble *P. connexa* (Walcott) from approximately contemporaneous (Rasetti and Theokritoff, 1967) Lower Cambrian strata in Washington County. The latter species resembles the Middle Cambrian forms in the features mentioned above.

Types.—Holotype: USNM 156606. Paratypes: USNM 156607-9.

PAGETIA LAEVIS, new species

Plate 7, figures 10-16

Available material.—Numerous cranidia and a lesser number of pygidia.

Description.—It is unnecessary to give a complete description, as the species appears almost identical with the preceding, except in the ornamentation. This consists only of exceedingly fine, often indistinct granules, the large granules being absent. The pleural furrows on the pygidium may be somewhat less deeply impressed than in *P. bigranulosa*, but this character varies within a population and does not seem of specific importance. Length of largest cranidium, exclusive of spine, 2.0 mm.

Occurrence.—The type locality is cs-26, near Riders Mills, where *P. bigranulosa* seems absent. Also in loose blocks cs-3/L2, cs-3L/3 on the Griswold farm, and in collection cs-29 from bedded rock, in association with the preceding species.

Types.—Holotype: USNM 156610. Paratypes: USNM 156611-2.

PAGETIA ERRATICA, new species

Plate 13, figures 1-7

Available material.—Numerous cranidia and pygidia.

Description.—Glabella slightly tapered, narrowly rounded in front,

occupying (without spine) about two-thirds the cranial length. Lateral furrows faint to indistinct; occipital furrow deep laterally; occipital ring and glabella drawn into a long, horizontal spine. Preglabellar field about twice the sagittal length of border, with shallow medial depression. Palpebral area upsloping, slightly convex, appreciably wider than the glabella when the palpebral lobe is included. Ocular ridges curved, faintly visible. Palpebral lobe narrow and long, relatively well defined by a palpebral furrow which fades out both in front and back of the palpebral lobe without reaching the facial sutures. Anterior border relatively narrow, of constant width from midline to facial suture, set off by a shallow but distinct border furrow, horizontal, slightly concave in profile, with usual radial markings. Posterior border deep. In some of the specimens an exceedingly fine granulation is observable. Length of largest cranidium, exclusive of spine, 1.7 mm.

Pygidial axis strongly elevated, showing 4 rings plus a terminal section separated by deep ring furrows; each ring provided with a strongly elevated node, the terminal section extended into the usual spine, broken off in the specimens. Pleural regions with very shallow furrows fading out distally; border furrow wide and moderately impressed, border narrow. Surface densely covered with very fine granules. Length of pygidium, exclusive of spine, 1.4 mm.

Occurrence.—Loose blocks cs-7/M4 (type locality), cs-7/M3, cs-7/M5, cs-7/M7, Griswold farm, in association with trilobites of the *Bathyriscus-Elrathina* zone.

Discussion.—This species shares with *P. rugosa* Rasetti (1966b) the relatively small glabella, long preglabellar field, and distinct palpebral furrows. However, the anterior border is slightly concave and better defined on the inner side by the border furrow, and the ornamentation is much weaker. Other species with which *P. erratica* may be compared are *P. fossula* Resser and *P. clytia* Walcott (Rasetti, 1966b). Neither of them, however, has a well-developed palpebral furrow, the border in either species is slightly convex rather than concave and tapers in width at the sides, and the glabella is larger in proportion to the entire cranidium. The pygidium closely resembles that of *P. fossula*. The last species is from the Lakeview Limestone of Idaho, referable to the *Bathyriscus-Elrathina* zone. *P. erratica* does not closely resemble any of the species previously known from eastern North America.

Types.—Holotype: USNM 156613. Paratypes: USNM 156614.

PAGETIA CLYTIODES, new species

Plate 13, figures 8-16

Available material.—About two dozen specimens, mostly cranidia.

Description.—Glabella almost parallel-sided, well rounded in front. Lateral furrows very shallow to indistinct; occipital furrow impressed laterally; posterior part of glabella and occipital ring extended into long, horizontal spine. Preglabellar field with broad, shallow depression, on average of equal sagittal length as the border. Ocular ridges indistinct; palpebral area upsloping and slightly convex; palpebral furrow and lobe as in preceding species. Anterior border flat, defined by a shallow, broad border furrow, of approximately even width or slightly narrowed laterally, with usual radial markings.

Pygidium with elevated axis showing 3 rings plus a terminal section. Rings with moderately elevated nodes; terminal section extended into slender spine generally broken off. Pleural regions showing but traces of pleural furrows. Border furrow fairly wide, border narrow. Surface of test seemingly smooth. Length of largest cranidium, exclusive of spine, 1.6 mm., length of largest pygidium 1.3 mm.

Occurrence.—Collection cs-6, Griswold farm (*Bathyriscus-Elrathina* zone). A few, small specimens in collection cs-9c are tentatively referred to the species.

Discussion.—This species is somewhat intermediate between *P. erratica* and *P. clytia* Walcott (Rasetti, 1966b). It differs from *P. erratica* chiefly in the less rapidly tapered, more rounded glabella, greater proportional length of glabella relative to the cranidium and consequently shorter preglabellar field, and less distinct pleural furrows on the pygidium. All these differences appear significantly statistically, but variability within a population is such that it might not be easy to classify a single specimen, especially an immature one. *P. clytioides* is almost identical with *P. clytia* in the general proportions of the various parts, the chief differences being the less tapered and more rounded glabella and especially the better developed palpebral furrow.

Types.—Holotype: USNM 156615. Paratypes: USNM 156616-7.

Genus PAGETIDES Rasetti, 1945

Types species: *Pagetides elegans* Rasetti, 1945.

Species of *Pagetides* are among the most common trilobites in the Lower Cambrian limestones of Columbia County. Specimens closely

matching the types of all 5 species described by the writer from the conglomerate boulders of the lower St. Lawrence valley were obtained. However, partly owing to intraspecific variability, partly to the imperfect preservation and immature condition of much of the material, not all the cranidia or pygidia could be unambiguously classified. *Pagetides elegans* can always be clearly separated. *P. amplifrons* and *P. rupestris* could be separated in the Quebec material, but they are very similar and, especially in the case of isolated cranidia, difficult to distinguish. Another pair of similar species are *P. minutus* and *P. leiopygus*. In the original material the cranidia were virtually indistinguishable, the two species being separated by association with quite different pygidia, those of *leiopygus* almost lacking axial and ring furrow. In the Columbia County material only a few pygidia of *leiopygus* were identified, whereas copious cranidia and associated pygidia of *minutus* occur at several localities.

Pygidia of all species of *Pagetides* possess pleural furrows when immature.

PAGETIDES ELEGANS Rasetti

Plate 5, figures 16-24

Pagetides elegans RASSETTI, 1945, p. 313, pl. 1, figs. 15-18; 1948a, p. 11, pl. 1, figs. 1-7.

This is among the most common trilobites in the *Pagetides* fauna. Specimens from the Taconic sequence match the types from Quebec except in usually showing pronounced nodes on the axial rings. Since species of *Pagetia* and *Pagetides* frequently show variation in this feature, even among individuals from one stratum, specific separation is not warranted. A cranidium and pygidium from the Quebec boulders are illustrated for comparison.

Occurrence.—Found in place in collections cs-4b, cs-5, cs-26, cs-29, and in several loose Lower Cambrian blocks (see fossil lists).

Types.—Plesiotypes figured herein: USNM 156618-20.

PAGETIDES MINUTUS Rasetti

Plate 6, figures 1-10

Pagetides minutus RASSETTI, 1945, p. 313, pl. 1, figs. 11, 12; 1948a, p. 12, pl. 1, figs. 13, 14.

This is also one of the more common species of the genus. In the area investigated it first appears in slightly lower beds than *P. elegans*, already occurring in association with *Neopagetina*, and is present in

all strata carrying the *Pagetides* fauna. A cranidium and pygidium from the Quebec boulders are figured for comparison.

Occurrence.—Found in place in collections cs-4a, cs-4b, cs-18, cs-20, cs-26, and in several loose Lower Cambrian boulders (see fossil lists).

Types.—Plesiotypes figured herein: USNM 156621-5.

PAGETIDES LEIOPYGUS Rasetti

Plate 6, figures 11-14

Pagetides leiopygus RASETTI, 1945, p. 314, pl. 1, figs. 7-10; 1948a, p. 12, pl. 1, figs. 10-12.

A few pygidia approaching in smoothness the type material were recovered. Since they occurred in association with far more copious pygidia of *P. minutus*, no attempt was made to identify cranidia of the species. Topotypes from Quebec are illustrated for comparison.

Occurrence.—The figured pygidia occur in collection cs-3/L2, loose Lower Cambrian block on Griswold farm.

Types.—Plesiotypes figured herein: USNM 156626-8.

PAGETIDES RUPESTRIS Rasetti

Plate 5, figures 25-29

Pagetides rupestris RASETTI, 1948a, p. 12, pl. 1, figs. 15-21.

This species is moderately common in the *Pagetides* fauna in Columbia County. Usually the cranidia can be readily distinguished, unless they are very small, in which case they may be confused with *P. minutus*. Pygidia are more difficult to distinguish from the latter species, especially when immature. Topotypes from Quebec are figured for comparison.

Occurrence.—Found in place in collections cs-4c, cs-5, and in several loose Lower Cambrian blocks on the Griswold farm.

Types.—Plesiotypes figured herein: USNM 156629-31.

PAGETIDES AMPLIFRONS Rasetti

Plate 6, figures 15-18

Pagetides amplifrons RASETTI, 1945, p. 314, pl. 1, figs. 1-6; 1948a, p. 12, pl. 1, figs. 8, 9.

A few cranidia are tentatively referred to the species rather than *P. rupestris* on the basis of the proportionately narrower, longer shape and the less upright attitude of the occipital spine.

Occurrence.—Collections cs-4b and cs-15/L1, Griswold farm.

Types.—Plesiotypes figured herein: USNM 156632-3.

Genus NEOPAGETINA Pokrovskaya in Tchernysheva, 1960

Types species.—*Pagetina rjonsnitzkii* Lermontova, 1940.

The writer (Rasetti, 1966b) pointed out that only the type species should be left in the genus, other forms described by Lermontova (1951) and Lazarenko (1962) appearing more typical of *Pagetia*. *Neopagetina* seems to differ from *Pagetides* mainly in the presence of pleural furrows, hardly a feature of generic significance, especially in view of the fact that pygidia of *Pagetides* (see *P. minutus* figured herein, pl. 6) have furrows in immature stages. However, there may be more important differences in unknown characters (e.g., the number of thoracic segments), hence the writer refrains from proposing that *Neopagetina* be considered a subjective junior synonym of *Pagetides*.

NEOPAGETINA TACONICA, new species

Plate 6, figures 20-28

Available material.—Numerous cranidia and a lesser number of pygidia.

Description.—Glabella, exclusive of spine, about two-thirds as long as cranidium, sloping down anteriorly, somewhat pointed in front, showing two pairs of broad, shallow, short furrows at the sides. Glabella extended into a thick, upsloping spine. Occipital ring distinct at the sides, medially merging with the rearward glabellar extension; occipital furrow impressed at the sides in the form of a pair of broad pits. Cheeks convex, highest posteriorly, sloping down anteriorly, divided by a narrow, shallow preglabellar depression. Palpebral lobes somewhat in advance of the glabellar midpoint, widest at their midpoint, defined by a well-impressed palpebral furrow; distance from posterior end of palpebral lobe to posterior margin somewhat greater than length of palpebral lobe. Facial sutures as in *Pagetia* and *Pagetides*. Border furrow broad and shallow, medially merging with the preglabellar depression. Anterior border slightly raised, rather flat, slightly wider medially; posterior border set off by deep furrow, which turns forward and extends to posterior branch of facial suture; genal angle fairly sharp but not extended into spine.

Pygidium 1.5 times wider than long. Axis defined by deep axial furrow, slightly tapered, almost reaching posterior border furrow, composed of 5 or 6 rings plus a terminal section. Nodes of decreasing

elevation occur on the first 4 rings. Pleural regions convex and down-sloping, with 5 pairs of pleural furrows in addition to the anterior border furrow; traces of interpleural furrows visible in some of the specimens. Border furrow shallow, moderately wide; border very narrow. Surface of test smooth. Length of largest cephalon 2.0 mm., of pygidium 1.5 mm.

Occurrence.—Lower Cambrian. Collections cs-9 (type locality), road cut near Malden Bridge; cs-4a, Griswold farm; and cs-20, Lopez farm.

Discussion.—Comparing with the illustrations of *Neopagetina rjonsnitzkii* published by Lermontova (1951) and Pokrovskaya (in Tchernysheva, 1960) the present species seems to differ in the better-defined palpebral lobes, lack of ocular ridges, more transverse pygidium, and broader, shallower pleural furrows. The cephalon might also be compared with *Pagetides elegans*, which it resembles in the proportions of the various parts. In the latter species the preglabellar depression is broader, the anterior border convex and more definitely expanded medially, the genal angle more widely rounded, and the labellar furrows are almost indistinct.

Types.—Holotype: USNM 156634. Paratypes: USNM 156635-6.

Genus **HEBEDISCUS** Whitehouse, 1936

Type species: *Ptychoparia attleborensis* Shaler and Foerste, 1888.

HEBEDISCUS MARGINATUS, new species

Plate 6, figure 19

Available material.—One cranidium.

Description.—Glabella prominent, especially elevated in posterior portion, unfurrowed, extended together with occipital ring into a strong, upsloping spine of unknown length. There is an indication of the occipital furrow as a pair of lateral impressions. Genae with moderate relief. Frontal area flat, about a third as long (sag.) as glabella. A broad, shallow depression, medially confluent with the axial furrow, should presumably be interpreted as the border furrow by comparison with other species of the genus. However, the border so defined shows a narrow, shallow furrow paralleling the anterior cranial margin and setting off a narrow rim. Palpebral area somewhat convex and upsloping; ocular ridges visible, directed outward from axial furrow and curving slightly backward. Palpebral lobes conspicuous, set off by a deep palpebral furrow, wider in posterior part, convex transversely, about a third the length of glabella excluding

the occipital ring. Anterior branch of facial suture directed forward and outward; posterior branch directed backward, and also somewhat downward and outward. Posterior border furrow deep; posterior border forming sharp posterolateral angle. Surface of test smooth. Length of holotype cranium with incomplete spine 2.3 mm.

Occurrence.—Collections cs-51, limestone lens in black shale about one mile E. of Salme, Washington County, New York. In association with *Calodiscus lobatus*, *Elliptocephala asaphoides*, *Fordaspis nana*, *Serrodiscus speciosus*.

Discussion.—The general shape of the cranium agrees with *Hebediscus*, but the present form differs from all described species in several important features, chiefly the strong occipital spine, deep palpebral furrow with well-differentiated palpebral lobe, and the unusual frontal rim. The palpebral lobe is like in *Neocobboldia*, but other features are more suggestive of *Hebediscus*.

Types.—Holotype: USNM 156637.

Order OLENELLIDA

Family OLENELLIDAE Vogdes, 1893

Olenellid fragments are common in the *Acimetopus* and *Pagetides* faunas. However, the overwhelming majority of their delicate tests were reduced to fragments too small even for generic identification. The few reasonably complete cephala in the collections are immature, generally 3-6 mm. in length. No attempt at identification with described species was made, since the latter were usually based on large specimens, often characterized by features of the entire exoskeleton. Nevertheless, the immature specimens show specific characteristics that allow comparison with individuals similarly preserved from other localities. No new taxa are proposed herein. Species of *Olenellus* and *Paedeumias* are labeled by a number, the same number being used for species described in a previous paper (Rasetti, 1966a).

Genus PAEDEUMIAS Walcott, 1910

Type species: *Paedeumias transitans* Walcott, 1910.

PAEDEUMIAS, species no. 1

Plate 8, figures 11-14, 18

Paedeumias, species undetermined no. 1, RASETTI; 1966a, p. 40, pl. 12, figs. 23-25.

Several well-preserved cephala were collected, none exceeding 3.3

mm. in length. Some show the characteristic features better than the original material.

Occurrence.—Collection cs-9a (*Acimetopus bilobatus* faunule) near Malden Bridge. Also in loose block cs-15/L3 north of the Griswold farm.

Disposition of material.—Figured specimens: USNM 156639-40.

PAEDEUMIAS, species no. 2

Plate 8, figures 6-8

Paedeumias, species undetermined no. 2, RASETTI, 1966a, p. 41, pl. 12, figs. 19, 20.

Unfortunately even in the new material only the glabella and palpebral lobes are preserved. A relatively large glabella, 5 mm. in length inclusive of the occipital ring, shows a weak ornamentation in fingerprint pattern. The species is chiefly characterized by the narrowness of the frontal glabellar lobe and the well-defined, narrow rim around the palpebral lobes.

Occurrence.—Collection cs-9a (*Acimetopus bilobatus* faunule) near Malden bridge. Also loose block cs-15/L3 north of the Griswold farm.

Disposition of material.—Figured specimens: USNM 156641-2.

PAEDEUMIAS, species no. 3

Plate 8, figure 15

Available material.—A complete cephalon.

Description.—Glabella approximately parallel-sided, with frontal lobe as wide as the posterior portion. Glabellar furrows straight, transverse, fairly deep, extended for a third the glabellar width. Occipital ring as long (sag.) as the glabellar lobes; there may have been a small spine at its posterior margin. Portion of the genae comprised between glabella and palpebral lobe narrow, at its widest not exceeding one sixth the glabellar width. Palpebral lobe moderately elevated, widest medially and tapered at both ends, with a definite rim set off by a narrow furrow; rim width about a third the width of palpebral lobe. Preglabellar field of average length (sag.) for the genus, with a faint median ridge. Cephalic border very narrow, convex, defined by a shallow furrow. Intergenal spine very small, located at somewhat less than half the distance from axial furrow to genal angle, appearing as the extension of a ridge originating at the posterior end of palpebral lobe. Genal spine short and slender, appearing as extension of the lateral border. Posterior

cranial margin between intergenal and genal spines directed outward and slightly forward. Surface smooth. Length of cephalon 2.8 mm.

Occurrence.—Collection cs-9a near Malden Bridge.

Discussion.—This form differs from species no. 1 in several features, chiefly the narrower area between glabella and palpebral lobe, better defined rim of palpebral lobe, narrower cephalic border, and different position and size of the intergenal spine.

Disposition of material.—Figured specimen: USNM 156643.

PAEDEUMIAS, species no. 4

Plate 8, figure 18

Available material.—A single, fragmentary cephalon.

Description.—Glabella approximately parallel-sided, with frontal lobe approximately as wide as the others. Glabellar furrows of first pair meeting across the glabella; second pair interrupted medially, transverse in direction. Furrows of third pair curving inward and backward. Occipital furrow similar to third glabellar furrow, consisting of deeper lateral portions convex forward, barely joined medially. Occipital ring not enough well preserved to determine if it bore a spine. Area of the genae inside palpebral lobe narrow. Palpebral lobe about uniformly wide, one-third of the width consisting of rim, set off by a well-impressed furrow. Other parts not preserved.

Occurrence.—Collection cs-9a near Malden Bridge.

Discussion.—This form resembles species no. 2 in the relatively wide glabella, narrow inner portion of cheek, and strongly rimmed palpebral lobe. It differs chiefly in the greater width of the frontal glabellar lobe.

Disposition of material.—Figured specimen: USNM 156644.

PAEDEUMIAS, species no. 5

Plate 8, figures 19-21

Available material.—Several, almost complete cephalons.

Description.—Glabella relatively narrow, parallel-sided, with frontal lobe as wide as the others. Glabellar lobation as in species no. 1 but for a slight expansion of the second glabellar lobe. Inner area of genae about half as wide as glabella. Palpebral lobes wide, with indefinite rim. Preglabellar field of average length for the genus, with faint median ridge. Border wirelike, very narrow. Genal spine short, not advanced in position. Intergenal spine stronger and longer than

genal spine and very close to it, appearing as extension of ridge originating as posterior end of palpebral lobes. Genae showing vague coeca; no other ornamentation present. Length of largest cephalon 5 mm.

Occurrence.—Loose blocks cs-15/L2 and cs-15/L5, north of Griswold farm, in association with a *Pagetides* faunule.

Discussion.—The glabellar shape and lobation indicate close relationship with species nos. 1 and 3. The present form agrees with species no. 3 in the narrow border, but the position of the intergenal spine is like in species no. 1. The latter, however, has a much wider border.

Disposition of material.—Figured specimens: USNM 156645

PAEDEUMIAS, species no. 6

Plate 8, figures 16, 17

Available material.—Two fragmentary cephalae.

Description.—Glabella proportionately wide, very slightly tapered. Glabellar furrows deep, fairly straight, crossing somewhat more than a third of the glabellar width, directed inward and slightly backward, the first pair joined through a shallower, rearward-inbent median portion. Occipital ring similar to glabellar lobes, seemingly bearing a median spine at posterior margin. Palpebral lobes seemingly rather narrow, of even width, lacking rim, unless the latter is broken off. Inner portion of genae at its midpoint somewhat narrower than half the glabellar width. Other portions of cephalon not preserved.

Occurrence.—Loose block cs-15/L3, associated with *Paedeumias* species nos. 1 and 4 and with *Analox bipunctata*, hence seemingly with the *Acimetopus* faunule.

Discussion.—The glabellar lobation and width of the inner portion of the cheeks are similar to species nos. 1 and 5, but the glabellar lobes are proportionately wider (tr.) and shorter (sag.). The width of the inner portion of the cheeks separates this form from *Paedeumias* species nos. 2 and 4, and also the lack of a palpebral rim, if this is really a feature of the present species.

Disposition of material.—Figured specimens: USNM 156646.

Genus OLENELLUS Billings, 1861

Type species: *Olenus thompsoni* Hall, 1859.

OLENELLUS, species no. 1

Plate 8, figures 1-4

Olenellus, species undetermined, RASETTI, 1966a, p. 42, pl. 12, figs. 21, 22.

Additional material allows a complete description of the cephalon. The distance from the glabella to the anterior cephalic margin is somewhat less than the length of the frontal glabellar lobe. There is no preglabellar field, the very shallow border furrow merging with the axial furrow in front of the glabella. The border is exceptionally wide, flat, barely down-sloping near the margin. The genal angle is extended into a short, somewhat outward-directed spine. A much longer intergenal spine is located somewhat closer to the genal angle than to the axial furrow, and appears as the extension of a ridge originating at the posterior end of the palpebral lobe and crossing the posterior border.

Resser and Howell (1938) described several species of *Olenellus* with wide border, but not quite as wide as in the present form.

Occurrence.—The original material was from collection cs-4, Griswold farm. The examples illustrated herein are from loose block cs-15/L3, which seems to represent equivalent beds.

Disposition of material.—Figured specimens: USNM 156647.

OLENELLUS, species no. 2

Plate 8, figures 9, 10

Available material.—A few specimens, preserving only the glabella and palpebral lobes.

Description.—This species, as far as known, is almost identical with the preceding, hence it is sufficient to point out the differences. The main distinguishing feature is the lack of an upright spine in the occipital furrow. There seems to be, instead, a small spine at the posterior margin of the occipital ring. The first glabellar furrow has a more definite median inbend. A faint rim is visible on the palpebral lobes on one of the specimens. The largest glabella has a length of 3.6 mm. inclusive of occipital ring.

Occurrence.—Collection cs-9a (*Leptochilodiscus* bed) at the Malden Bridge road cut, and loose block cs-15/L2, in association with *Paedeumias* species no. 5 and a *Pagetides* faunule.

Disposition of material.—Figured specimens: USNM 156648-9.

OLENELLUS, species no. 3

Plate 8, figure 5

Available material.—A fragmentary cephalon.

Description.—Frontal glabellar lobe not preserved; furrow between frontal and second lobe impressed at the sides, directed backward

and inward. Second glabellar lobe expanded laterally, following for a considerable distance the boundary of the palpebral lobe, separated from the inner cheek by a furrow running outward and forward. The second lobe hence envelopes the third lobe, from which it is clearly separated by a furrow only at the sides. Third lobe narrowest (tr.) of all, tapering forward. Fourth lobe wider (tr.), also somewhat tapered forward. Occipital furrow well marked at the sides, very shallow medially. Occipital ring much like the fourth glabellar lobe, bearing a small spine at posterior margin. Entire glabella not greatly elevated. Palpebral lobe long, almost reaching the level of posterior margin of occipital ring, wide, lacking distinct rim. Surface rather indistinctly granulate and wrinkled. Presumed length of glabella with occipital ring, if complete, 5.5 mm.

Occurrence.—Loose block cs-15/L5.

Discussion.—The reference to *Olenellus* rather than *Paedeumias* is rather arbitrary, owing to lack of the external parts of the cephalon, and was chiefly suggested by the similarity to the 2 preceding species of *Olenellus* in the glabellar lobation. In the present form the glabellar furrows are shallower, the second glabellar lobe envelopes the third lobe more distinctly, the posterior lobes definitely taper forward, and there is no indication of a palpebral rim.

Disposition of material.—Figured specimen: USNM 146650.

Order undetermined

The Agnostida, Eodiscida, and Olenellida form natural and readily recognizable orders of trilobites, but, in the writer's opinion, no satisfactory classifications of the remainder of the Cambrian trilobites have been proposed. Several of the orders and suborders that have been suggested seem to have little phylogenetic basis and suffer from lack of sharp discriminating characters. In many cases, therefore, the assignment of a family or genus to one or the other of these proposed orders or suborders is more or less arbitrary.

These views were expressed by the writer (Rasetti, 1948a), and the classifications proposed since that time have not substantially altered his conclusions. Therefore, no taxa above the superfamily level are used. The trilobites of the Lower and Middle Cambrian strata discussed herein, other than the forms included in the three preceding orders, are referred to the superfamilies Corynexochacea (corresponding to the order Corynexochida of the *Treatise on Invertebrate Paleontology*), Paradoxidacea, and Ptychopariacea (including at least a large part of the suborder Ptychopariina of the

order Ptychopariida of the *Treatise*). In the *Treatise* the suborder Ptychopariina was split into a large number of superfamilies, mostly lacking either phylogenetic basis or diagnostic features.

Superfamily CORYNEXOCHACEA Angelin, 1854

Family CORYNEXOCHIDAE Angelin, 1854

Genus CORYNEXOCHIDES Rasetti, 1948

Type species: *Corynexochides gregarius* Rasetti, 1948.

CORYNEXOCHIDES ? EXPANSUS, new species

Plate 12, figure 1-17

Available material.—Numerous protaspides, meraspid cranidia, a few holaspid cranidia, hypostomes, and tentatively assigned pygidia.

Description.—The following description applies to the holaspid cranidium. Glabella narrow and parallel-sided in posterior half, expanded to twice the width in anterior portion, rounded in front, reaching anterior cephalic margin. Two posteriormost pairs of lateral furrows moderately deep at the sides, connecting through a shallow median portion; two other pairs of furrows short, appearing as shallow indentations of the glabellar side. Occipital furrow well impressed, deeper laterally; occipital ring extended into moderately long spine. Palpebral area wider than the posterior portion of glabella; palpebral lobes narrow, short, somewhat obliquely situated, at level of glabellar midpoint. Ocular ridges faint but distinct. Fixigenae anterior to ocular ridges present only at the sides, where a slightly raised border is developed. Posterior area large, triangular, twice as wide (tr.) as posterior portion of glabella, apparently extended into short, broad spine at genal angle as in meraspid cranidia. Furrow on posterior area deep and straight. Surface of test with low granules, more pronounced on fixigenae. Length of largest cranidium 3.0 mm.

Hypostome referred to the species of the general corynexochoid shape, mainly characterized by the great forward expansion of the anterior lobe. Anterior wings, representing the fused rostrum, forming on each side a straight, oblique outline. Median lobe narrow, defined anteriorly by a very shallow, transverse furrow, posteriorly by a pair of furrows deep at the sides, shallow medially, forming a semicircle concave toward the front. Posterior lobe with a pair of short lateral spines and a narrow posterolateral border. Terrace lines evident on anterior lobe and anterior wings. Length of largest hypostome 1.8 mm.

Ontogeny.—The earliest known stage is the metaprotaspis, which is relatively large for so small a trilobite. Glabella parallel-sided for most of its length, about a tenth the width of the shield, well defined by the axial furrow, expanding anteriorly to 3 times the posterior width, reaching the frontal margin. Three pairs of shallow furrows, plus the occipital furrow, impressed across the glabella. Occipital ring prominent. There is a pair of deep pits at the anterior corners of the glabella.

Frontal ridge tapering laterally and disappearing. Transverse convexity pronounced, especially at midlength, where the test is deeply downfolded. Posteriorly the convexity decreases, the margin being slightly raised and provided with a faint but distinct border ending in a blunt tooth that marks the posterolateral angle of the protocranidium. The protopygidium is bent downward vertically with respect to the protocranidium; its axis consists of a first ring in form of a round knob, and a second one barely distinguishable. The pleural regions are slightly concave, rather than convex, transversely. Length of average protaspis in dorsal view, 0.65 mm.

Meraspid cranidia in earlier stages not larger, or even smaller, than the corresponding portion of the protaspis, the smallest being 0.55 mm. long. Glabella with occipital ring, frontal ridges, and anterior pits as in protaspis. Small, anteriorly situated palpebral lobes are increasingly conspicuous in successive stages. The faint border at the posterolateral angles of the protocranidium gradually extends into a short, blunt spine; however, in the absence of free cheeks one cannot infer from this structure that the course of the facial suture is proparian. Changes in later stages are mainly the expansion of the glabella involving a greater portion of its length, but becoming correspondingly less sudden; the deepening of the glabellar furrows at the sides; the development of the occipital spine; the ocular ridge becoming gradually distinct from the marginal ridge; and the greater proportional length and elevation of the palpebral lobes. A cranidium 0.75 mm. long has already acquired most of the features of the holaspis.

Small pygidia that are common in association with the other parts are referred to the species because of their resemblance to the protopygidium of the protaspis. These pygidia vary little in structure and size, the average being 0.5 mm. long and 0.9 mm. wide, of subquadrate shape. Axis prominent, composed of 2 rings plus a terminal section, each ring preserving some of the globular appearance of the first ring of the protopygidium. Anterior margin of pygidium

straight, transverse, anterior angles sharp. Pleural lobes unfurrowed, slightly concave transversely, almost lacking longitudinal convexity. Lateral margin straight, extended posteriorly into a short spine. Posterior margin almost straight between the pair of shallow notches on the inner side of this spine. These pygidia presumably are meraspid transitory pygidia.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station. A few small cranidia in collection cs-23.

Discussion.—The cranium of this species resembles to some extent *Corynexochides latifrons* Rasetti (1948b) differing mainly in the more slender glabella, more anterior position of the palpebral lobes, larger and more triangular posterior area. These differences, plus the failure to find in association with the cranidia any pygidium resembling *Corynexochides* and, instead, the probable assignment to the species of an entirely different pygidium, make the reference to the genus unsatisfactory. However, no better assignment to described genera occurred to the writer. Were the holaspid pygidium definitely known, the best course would be to propose a new genus. The present species occurs in much younger beds than the described species of *Corynexochides*.

Types.—Holotype: USNM 156651. Paratypes: USNM 156652-3.

Family DOLICHOMETOPIDAE Walcott, 1916

Genus BATHYURISCUS Meek, 1873

Type species: *Bathyurus* (?) *heydeni* Meek, 1873.

BATHYURISCUS EBORACENSIS, new species

Plate 11, figures 1-14

Available material.—Entire immature cranidia, fragmentary larger cranidia, a few free cheeks, hypostomes, and several well-preserved pygidia.

Description.—Glabella in larger cranidia narrowing forward in posterior third, then expanding forward. Four pairs of lateral furrows visible; first three pairs exceedingly shallow, transverse; posterior pair deep, directed inward and strongly backward, at posterior end turning inward but not quite joining across the glabella. Occipital furrow well impressed; occipital ring bearing a spine. Anterior fixigenae expanding forward, the anterior facial suture diverging at about 45 degrees; border not well differentiated, upturned, much reduced but not vanishing medially. Palpebral lobe narrow, strongly curved, well defined by palpebral furrow; palpebral area elevated in posterior

part near the axial furrow, as in many related dolichometopid trilobites. Posterior area not completely preserved in any of the larger cranidia, slender as usual in the genus. Elevated parts of cranium finely granulate. Length of largest cranidium about 5 mm. Small, presumably meraspid cranidia with glabella more definitely expanded forward, palpebral lobes more obliquely directed, hence distant from axial furrow at rear end, and posterior area broader, less extended beyond the palpebral lobe than in the larger cranidia. Free cheek relatively flat, with poorly defined border furrow and border, and short, tapered genal spine. Among a few types of corynexochoid hypostomes present in the collection, shape and frequency of occurrence suggest that the one figured herein be tentatively referred to the species. Its most characteristic feature is a shallow, median depression a short distance from the anterior margin.

Among thoracic segments present in the collection, some are tentatively attributed to the species, since they seem to be too common and too large to be referred to any other species. The pleurae end in spines, longer than usually observed in species of the genus.

Pygidium with elevated, slightly conical axis showing generally 6 well-defined rings plus a terminal section, extended into a short post-axial ridge reaching the border furrow. Pleural regions almost horizontal, with vaguely defined border furrow and very narrow border. Seven pairs of broad pleural furrows and as many pairs of interpleural furrows, very narrow near the axial furrow and broadening distally, are all well impressed almost to the pygidial margin. Pygidia about 1.7 times wider than long, apparently increasing in proportional length with size; length of largest pygidium 4 mm.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station. Very fragmentary material in collection cs-23, Judson Point, is tentatively referred to the species.

Discussion.—This species appears closest to *Bathyriscus fimbriatus* Robison (1964a) from the lower part of the *Bolaspidella* zone of Utah. As far as can be determined from the smaller and partly fragmentary specimens available, the present species appears to differ in the stronger divergence of the anterior facial sutures, broader basal part of the glabella, and deeper posterior pair of glabellar furrows. The pygidia have very similar structure and pattern of the pleural and interpleural furrows, but those of the present species are proportionately shorter and wider. Since Robison has shown that the relative length increases with the size of the pygidia, the last difference may be partly due to the less mature examples available.

Types.—Holotype: USNM 156654. Paratypes: USNM 156655-6.

BATHYURISCUS, species undetermined

Plate 12, figures 29-31

Available material.—A fragmentary cranidium and a fragmentary pygidium, plus a complete pygidium from a different locality presumably representing the same species.

Description.—Glabella expanding in anterior portion, showing two shallow, broad pairs of lateral furrows. Occipital furrow shallow, occipital ring expanded medially but seemingly rounded. Anterior fixegenae only partly preserved, fairly wide even at anterior end of palpebral lobe, expanding forward. Palpebral lobe fairly straight in anterior portion, curved in posterior part, set off by broad palpebral furrow; palpebral area flat. Posterior area broadly furrowed, very slender, parallel-sided except near end where the facial suture curves backward to cut posterior margin, very long (tr.), the portion outside of palpebral lobe longer than inner portion. Surface seemingly smooth. Length of cranidium 5.5 mm.

Pygidium twice broader than long, with outline regularly curved but for a slight median notch. Axis well tapered, showing 5 rings separated by narrow furrows, plus a terminal section, almost reaching the border furrow. Pleural region with faint convexity, shallow border furrow, and flat, fairly wide border. Five pairs of shallow, broad pleural furrows and 4 pairs of shallow interpleural furrows, very narrow proximally and broadening distally, all end in the shallow border furrow. Opposite the first 3 axial rings there is on each pleura a low, wedge-shaped ridge dividing each pleural furrow in its proximal part. This is a frequent feature in corynexochoid trilobites (e.g., well developed in *Zacanthoides*). Length of complete pygidium 2.7 mm., width 5.3 mm.

Occurrence.—The cranidium and portion of a pygidium are from collection cs-9d*, Malden Bridge. The complete pygidium from loose block cs-7/M1, Griswold farm. At both localities in association with *Ptychagnostus gibbus* and other trilobites of the *Bathyuriscus-Elrathina* zone.

Discussion.—The material is too incomplete to allow a significant comparison with described species. The pygidium seems almost identical with the pygidia of small examples of *Bathyuriscus rotundatus* (Rominger) from the *Ogygopsis* shale of British Columbia. The cranidium seemingly has longer palpebral lobes and more slender posterior area.

Disposition of material.—Figured specimens: USNM 156657-8.

Genus ATHABASKIELLA Kobayashi, 1942

Type species: *Bathyriscus (Poliella) probus* Walcott, 1916.

ATHABASKIELLA, species undetermined

Plate 11, figures 15, 16

Available material.—Several pygidia.

Description.—Pygidial axis about equally wide and long, strongly elevated, about half the pygidial length, rounded posteriorly, extended into a narrow postaxial ridge. One axial ring distinct, the remainder unsegmented or at most with a shallow furrow visible at the sides. Pleural regions down-sloping near axis, somewhat concave; anterior angles widely rounded. Two shallow pairs of pleural and one or two pairs of interpleural furrows visible, all curving backward and tending to become parallel to the margin; border furrow and border indistinct. Length of largest pygidium 1.7 mm., width 2.4 mm.

Occurrence.—Collection cs-21 (*Bosaspidella* zone), Stockport Station.

Discussion.—This pygidium does not significantly differ from the type species; however, owing to the immature material and lack of a cranidium, specific identification is not attempted.

Disposition of material.—Figured specimens: USNM 156660.

Genus BATHYURISCIDELLA Rasetti, 1948

Type species: *Bathyriscidella socialis* Rasetti, 1948.

BATHYURISCIDELLA, species undetermined

Plate 11, figures 17, 18

Available material.—One pygidium.

Description.—Axis short and broad, strongly elevated, concave in longitudinal profile, raised into a knob at posterior end, followed by postaxial ridge. One ring furrow well impressed at the sides, a second one very shallow. Pleural platforms down-sloping; 3 pairs of rather shallow pleural furrows, and 2 pairs of equally shallow and narrower interpleural furrows are visible, all ending in a shallow border furrow. Border rather flat, wider laterally, almost disappearing medially on account of the postaxial ridge, bearing a pair of short spines some distance back of the anterior angles. Surface of pleural platforms finely granulate. Length of pygidium 1.9 mm., width 3.6 mm.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Discussion.—This pygidium has the unmistakable structure characteristic of the genus. It differs from *B. socialis* in the more definitely concave profile of the axis, presence of 1 rather than 2 well-defined ring furrows, pleural and interpleural furrows fairly parallel to each other, and granulate rather than smooth surface of the pleural regions.

Disposition of material.—Figured specimen: USNM 156659.

Genus HEMIRHODON Raymond, 1937

Type species: *Hemirhodon viator* Raymond, 1937.

HEMIRHODON, species undetermined

Plate 11, figure 19

Available material.—A few fragmentary pygidia.

Description.—Pygidial axis not greatly elevated, about two-thirds the pygidial length, consisting of 3 rings plus a terminal section, separated by shallow furrows. Pleural regions slightly convex proximally, becoming concave near the margin, lacking well-defined border furrow and border. Four pairs of broad, shallow pleural furrows and 3 pairs of narrower interpleural furrows are visible, all ending in the poorly defined border furrow. Length of largest pygidium 2.8 mm., width 4.5 mm.

Occurrence.—Collection cs-21, Stockport Station.

Discussion.—The pygidium is fully typical of the genus, but specific identification cannot be attempted with the material in hand.

Disposition of material.—Figured specimen: USNM 156661.

Family ZACANTHOIDIDAE Swinnerton, 1915

Genus ZACANTHOIDES Walcott, 1888

Type species: *Zacanthoides romingeri* Resser, 1942.

ZACANTHOIDES, species undetermined

Plate 10, figure 34

A single cranium is fully typical of the genus. Glabella almost parallel-sided, slightly expanded in frontal portion. Three pairs of shallow lateral furrows; occipital furrow well impressed, occipital ring expanded medially, presumably spinose. Palpebral area and lobe partly preserved, of typical structure. Anterior fixigenae expanded laterally due to the divergent course of the facial suture. Border poorly differentiated from preglabellar field. Length of cranium 7 mm.

The proportions of the cranium are about the same as in *Z. romingeri*, but the glabellar furrows appear to be shallower.

Occurrence.—Loose block cs-7/M3, in association with *Pagetia erratica* and other trilobites of the *Bathyriscus-Elrathina* zone.

Disposition of material.—Figured specimen. USNM 156662.

Genus PROZACANTHOIDES Resser, 1937

Type species: *Olenoides stissingensis* Dwight, 1889.

PROZACANTHOIDES, species undetermined

Plate 7, figures 19-22

Available material.—Several cranidia and pygidia from different outcrops or boulders, generally immature and not well preserved. It is not certain that this material represents one species.

Description.—Glabella expanded forward in anterior half, parallel-sided in posterior portion. Glabellar furrows very shallow; occipital furrow distinct, occipital ring bearing a spine. Preglabellar field short (sag.), border elevated. Anterior fixigenae expanded laterally on account of divergence of anterior facial sutures. Palpebral area flat; palpebral lobe as usual in the genus, fairly straight in anterior portion, curved in medial part; posterior end of palpebral lobe considerably distant from axial furrow. Posterior area not preserved in any of the specimens.

Pygidia with strongly elevated, relatively short and wide axis showing at least one ring plus a terminal section. Anterior outline of pleural regions widely rounded. Pleural furrows wide and shallow, curving backward; 2 pairs of interpleural furrows very shallow and narrow. Border differentiated only by lack of furrows, extended into 3 or 4 pairs of short, backward-directed spines.

Occurrence.—The figured specimens are from collections cs-4, cs-3/L2, and cs-26. For other occurrences see faunal lists by localities. *Prozacanthoides* was only found in the Lower Cambrian *Pagetides* faunules.

Discussion.—The specimens are typical of *Prozacanthoides* but their poor preservation and immature character preclude any attempt at specific identification. Furthermore, most of the named species were based on very few examples, hence one cannot evaluate the variability within a population and the validity of these species. A form of this genus from the Taconic sequence was described by Walcott (1891) under the name *Zacanthoides catoni*. The type locality is USNM 43a, near Salem, Washington County, New York.

Also specimens collected at locality USNM 38a, near North Granville, were referred by Walcott to the species. The holotype is a relatively well-preserved cranidium, similar to the specimens collected in Columbia County. The associations of *Prozacanthoides eatoni* (Walcott) indicate that the species is a member of the *Pagetides* fauna (Rasetti and Theokritoff, 1967). It is possible that at least part of the material from Columbia County is conspecific with Walcott's type, but neither is known well enough for a positive identification.

Disposition of material.—Figured specimens: USNM 156663-5.

Family DORYPYGIDAE Kobayashi, 1935

The family is mainly represented in the collections from the Lower Cambrian beds of the Taconic sequence by species of *Bonnia*, which in the Columbia County localities occur both with the *Acimetopus* and *Pagetides* faunules. These trilobites are not common, and usually only fragmentary pygidia, specifically unidentifiable and contributing nothing to the knowledge of the genus, were recovered. This material was not deemed worth illustrating; however, the presence of *Bonnia* in the various collections was reported in the faunal lists.

Genus KOOTENIA Walcott, 1888

Type species: *Bathyriscus (Kootenia) dawsoni* Walcott, 1888.

KOOTENIA, species no. 1

Plate 12, figures 18-21

Available material.—Several, poorly preserved cranidia and pygidia, mostly lacking the test.

Description.—Glabella somewhat expanded forward, with but traces of lateral furrows. Occipital furrow well impressed, occipital ring apparently spinose. Only fragments of other cranidial parts preserved.

Pygidia better preserved than the cranidia. Axis slightly tapered, showing 4 rings plus a terminal section; on exfoliated material one more ring furrow may be visible. Four pairs of pleural furrows (including the anterior border furrow) wide, shallow on outer surface, fairly deep on internal impressions. Traces of the interpleural furrows are visible on the proximal part of the pleural regions. Border furrow shallow; border flat, relatively wide. Marginal spines short, rapidly tapered, rather flat; there are 6 pairs, with spacing gradually decreasing toward the rear. Surface of test smooth. Length of cranidium 3 mm., of largest pygidium 4 mm.

Occurrence.—Collection cs-9d*, Malden Bridge (*Bathyriscus-Elrathina* zone).

Discussion.—This form is typical of the 6-spined group of species which are the most common in the Middle Cambrian. It closely resembles *K. elongata* Rasetti (1948b) but has shorter marginal spines, and *K. ellsii* (Walcott) (Rasetti, 1948b), which has short spines but a proportionately longer and narrower pygidium. The material is inadequate for specific identification.

Disposition of material.—Figured specimens: USNM 156666.

KOOTENIA, species no. 2

Plate 6, figure 32

Available material.—One incomplete pygidium.

Description.—Pygidial axis with at least 7 segments, presumably plus a terminal section. The few rings preserved do not show nodes. Pleural regions of moderate convexity, showing 6 pairs of pleural furrows (inclusive of the anterior border furrow), all about equally and uniformly impressed from the axial furrow to the border. Traces of interpleural furrows are visible near the axial furrow. Border furrow and border barely differentiated. Margin extended into a series of evenly spaced, slender, backward-directed spines of unknown length. Owing to the fragmentary condition of the specimen, the number of spines cannot be determined with certainty, but there were at least 6 pairs and the most likely number is 7. Surface of test indistinctly granulate.

Occurrence.—Lower Cambrian *Pagetides* faunule at locality cs-26.

Discussion.—This form resembles *Kootenia marcoui* (Whitfield) from the Parker Shale of Vermont, which has 7 pairs of marginal spines. There are 3 species of *Kootenia* previously known from the Taconic sequence. *Kootenia troyensis* Resser, recently redescribed and illustrated by Lochman, greatly differs from all other known species in the subtriangular pygidium, great relief of the axis, and vertical slope of the marginal portion of the pleural regions. The cranidium is also distinctive in the vertical slope of the genae anterior to the ocular ridges. Excellent material was recently collected in Washington County by R. Metz, in association with *Calodiscus lobatus*, *Serrodiscus speciosus*, and *Elliptocephala asaphoides*. A second, unnamed species, described by the writer (Rasetti, 1966a) as a member of the *Acimetopus bilobatus* faunule, shows no resemblance to the form discussed herein. The third species of *Kootenia*

described from the Lower Cambrian of the Taconic sequence is *K. fordi* (Walcott). Of the two illustrated cotypes, the cranidium (Walcott, 1891, pl. 94, fig. 3) is from USNM locality 38c. Additional material from this locality in the U. S. National Museum shows that both the cranidia and pygidia are identical with *Kootenia troyensis* and occur with an *Elliptocephala asaphoides* assemblage. The cotype pygidium (Walcott, 1891, pl. 94, fig. 3a) is from USNM locality 38a, and the same collection in the Museum includes cranidia, hypostomes, and pygidia of the species. This form is associated with a *Pagetia connexa* faunule. Hence the cotype cranidium and pygidium belong to different species, from different localities and of different ages. Walcott's pygidium is hereby selected as lectotype to avoid discarding the name *troyensis* as a junior synonym and proposing a new name for the species occurring with *Pagetia connexa*. *Kootenia fordi*, as now defined by the selection of the lectotype, is quite different from the species described herein in the smaller number of segments both in the axis and pleural regions.

Disposition of material.—Figured specimen: USNM 156667.

Genus **OLENOIDES** Meek, 1877

Type species: *Paradoxides nevadensis* Meek, 1877

OLENOIDES STOCKPORTENSIS, new species

Plate 11, figure 23

Available material.—One pygidium.

Description.—Pygidial axis not greatly elevated, tapered, composed of 4 distinct rings plus a terminal section, extended into a very short postaxial ridge. Pleural regions with 3 pairs of well-impressed pleural furrows and as many interpleural furrows, all fading out at the position of the indistinct border furrow. The first pleural furrow slightly converges toward the following interpleural furrow distally, pleural and interpleural furrows of the other 2 pairs are about parallel to each other. Indefinite pygidial border extended into 4 pairs of strong, long spines of slightly decreasing spacing toward the rear, the distance between the spines of the fourth pair being the smallest, less than the thickness of the spines at the base. Spines of first pair somewhat more slender and probably shorter than others, directed outward and backward; spines of second pair stronger and longer, directed more definitely backward; spines of third and fourth pairs directed straight backward. Each spine of the second to fourth pair has a protuberance on the outer side near the base. Length of

pygidium exclusive of spines, 2.6 mm., width 4.7 mm. Surface of test finely and rather indistinctly granulate.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Discussion.—The writer in general considers it poor taxonomic practice to propose a species on a single specimen, especially a pygidium. Here, however, the differences from all described species are striking enough to allow identification from one individual. Main characteristic features are the presence of only 3 pairs of pleural and interpleural furrows, and especially the size, direction, and peculiar structure of the marginal spines.

Types.—Holotype: USNM 156668.

OLENOIDES, species undetermined

Plate 11, figures 20-22

Available material.—One holaspid and a few meraspid pygidia.

Description.—Holaspid pygidium with long, slightly tapered axis occupying most of pygidial length, extended into a postaxial ridge that crosses the border furrow reaching the margin. Axis composed of 4 distinct rings plus a terminal, unsegmented section. Pleural regions rather flat, with a broad, shallow border furrow and a flat, fairly wide border. Four pairs of broad, shallow pleural furrows and 3 pairs of equally shallow, narrower interpleural furrows impressed. First furrow somewhat converging toward next interpleural furrow distally, pleural and interpleural furrows of second and third pairs almost parallel to each other, furrow of fourth pair very close and parallel to axis, leaving no space for a fourth interpleural furrow. Border extended into 4 pairs of marginal spines, all directed more or less backward; those of first pair slightly outward, those of last two pairs slightly inward, and tapering at faster rate than the others. Surface of test smooth.

Transitory meraspid pygidia similar to holaspid except in having an extra segment that will become part of the thorax. Length of holaspid pygidium, exclusive of spines, 2.7 mm., width 5.4 mm.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Discussion.—This form is typical of the 4-spined group of *Olenoides*. The pattern of the pleural furrows and the spacing of the marginal spines seem somewhat intermediate between those observed in *O. curticei* Walcott from the Conasauga Shale of Alabama and *O. rasettii* Ivshin (1957) [pro *Olenoides convexus* Rasetti, 1948,

non *Olenoides convexus* Lermontova, 1940]. Too little is known of the present form to attempt specific identification.

Disposition of material.—Figured specimens: USNM 156669.

Genus undetermined

Dorypygidae, cranidium no. 1

Plate 6, figures 29, 30

Available material.—A few cranidia, possibly representing the same species.

Description.—Glabella in largest specimen expanding forward, about $1\frac{1}{2}$ times wider at anterior than at posterior end. Four pairs of glabellar furrows visible, the fourth pair fairly deep laterally and connecting medially through a shallower portion. Occipital furrow well impressed, occipital ring apparently extended into a short spine. Apparently there is no frontal area; anterior fixigenae only developed at the sides, not entirely preserved. Palpebral lobes relatively small, somewhat more than a fourth the glabellar length; palpebral area about half as wide as glabella. Other portions of cranidium not preserved. Surface smooth. Length of largest cranidium 2.9 mm.

A cranidium 1.5 mm. long, tentatively attributed to the same species, differs in the much more strongly and abruptly expanded glabella, longer palpebral lobes, and palpebral area at least as wide as the posterior part of the glabella.

Occurrence.—Loose block cs-15/L1, Griswold farm, in association with the Lower Cambrian *Pagetides* fauna.

Discussion.—The generic reference of these cranidia is uncertain in the absence of a pygidium, since a number of corynexochoid genera are almost indistinguishable from the cranidia, especially in immature stages. Similar forms from Lower Cambrian strata were referred to *Dolichometopsis* (?) by Rasetti (1948a) and a new genus *Bonnaria* by Lochman (1956), included in the family Dorypygidae and considered a close relative of *Bonnia*. The writer has observed that the features supposed to characterize *Bonnaria* are found in immature specimens of *Bonnia*, e.g., undescribed material of *Bonnia bicensis* Resser. Since the holotype of *Bonnaria salemensis* (Resser) is a cranidium only 2.2 mm. long, most of the other examples attributed to the species by Lochman are still smaller, and the pygidium is unknown, the basis for the genus seems questionable. Seemingly many of the corynexochoid trilobites of the families Dorypygidae,

Corynexochidae, and Dolichometopidae possess a suddenly expanded glabella in immature stages.

Disposition of material.—Figured specimens: USNM 156670.

Family OGYGOPSIDAE Rasetti, 1951

Genus OGYGOPSIS Walcott, 1889

Type species: *Ogygia klotzi* Rominger, 1887.

OGYGOPSIS, species undetermined

Plate 10, figure 32

Available material.—One pygidium.

Description.—Pygidium somewhat less than twice wider than long, approximately semicircular. Axis straight-sided, moderately tapered, reaching the border furrow, showing 9 or 10 rings, the last few somewhat indistinct. About eight pairs of pleural furrows, almost straight and uniformly impressed from axial furrow to border. Interpleural furrows very shallow, visible only in distal part of pleurae. Border furrow very shallow, border flat, moderately wide. Length of pygidium 2.7 mm., width 4.7 mm.

Occurrence.—Loose block cs-7/M3, in association with *Pagetia erratica* and other trilobites of the *Bathyriscus-Elrathina* zone.

Discussion.—This pygidium resembles *Ogygopsis* more than other described genera, but the reference cannot be considered certain. The main difference from described species is in the wider and shorter proportions.

Disposition of material.—Figured specimen: USNM 156671.

Family ORYCTOCEPHALIDAE Beecher, 1897

Genus ORYCTOCEPHALUS Walcott, 1886

Type species: *Oryctocephalus primus* Walcott, 1886

ORYCTOCEPHALUS, species undetermined

Plate 10, figure 33

A single, very small cranium agrees in all respects with *Oryctocephalus* but is inadequate for specific identification. Glabella somewhat expanded in the middle. Posterior glabellar furrows a pair of pits connected across the glabella; other two pairs represented by unconnected pits. Occipital furrow well impressed, occipital ring narrower (tr.) than glabella, widened medially. Palpebral area, palpebral lobe, ocular ridges, and border as in typical forms of the genus. Length of cranium 1 mm.

Occurrence.—Collection cs-6 (*Bathyriscus-Elrathina* zone), Griswold farm.

Disposition of material.—Figured specimen: USNM 156672.

Family undetermined

Genus PROTYPUS Walcott, 1886

Type species: *Angelina hitchcocki* Whitfield, 1884

PROTYPUS, species undetermined

Plate 6, figure 31

A single, immature cranidium seems definitely referable to the genus. The specimen differs in no observable features from *Protypus marginatus* Rasetti (1948a), which is a rather variable species. All the features of the specimen are shown by the illustration. Length of cranidium 2.0 mm.

Occurrence.—Loose block cs-3/L2, Griswold farm (*Pagetides* fauna).

Disposition of material.—Figured specimen: USNM 156673.

Genus undetermined

Corynexochacea, pygidium no. 1

Plate 12, figures 22, 23

Available material.—Three well-preserved examples.

Description.—Pygidium subelliptical, about twice wider than long, of moderate convexity. Axis tapered, extended into a short post-axial ridge that reaches the posterior margin. About 4 rings plus a terminal section, defined by very shallow furrows, are distinguishable. Pleural platforms with moderate convexity, sloping down to a broad, undefined border furrow and flat border. Three pairs of broad, well-impressed pleural furrows and as many pairs of very shallow, narrow, interpleural furrows are impressed, the pleural furrows cutting somewhat obliquely across each pleura. Pygidial margin with one pair of very short, obtuse spines extending from the first pleura and a trace of a second, more posterior pair. Surface of test smooth. Length of largest pygidium 1.6 mm., width 3.0 mm.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Discussion.— This pygidium resembles to some extent the pygidia of *Olenoides*, but lacks the strong marginal spines of that genus; it

also somewhat resembles the pygidia of *Athabaskia*, *Bathyriscus*, and related genera. More precise identification is not possible without an associated cranidium.

Disposition of material.—Figured specimens: USNM 156674.

Corynexochacea, pygidium no. 2

Plate 14, figure 14

Available material.—One incomplete example.

Description.—Pygidium approximately semicircular, of low convexity. Axis not completely preserved, moderately tapered, seemingly composed of 4 rings plus a terminal section separated by shallow furrows, not reaching the posterior margin. Pleural lobes almost flat, with vaguely defined border furrow and border. Four pairs of pleural furrows and 3 pairs of interpleural furrows all about equally impressed; the anterior border furrow curves backward distally, almost paralleling the rounded anterior angle of the pygidium, thus merging into the indefinite lateral border furrow. The outline of the pygidium may have had a shallow median notch. Surface of test smooth. Length of pygidium 1.7 mm., width 3.4 mm.

Occurrence.—Collection cs-23 (*Centropleura* bed), Judson Point.

Discussion.—This pygidium has many of the features of *Hemirhodon*, differing mainly in the backward curve of the anterior border furrow. If it does not belong to that genus it is likely to be at least a close relative.

Disposition of material.—Figured specimen: USNM 156675.

Corynexochacea, pygidium no. 3

Plate 14, figure 18

Available material.—One incomplete example.

Description.—Pygidium of low convexity, seemingly subquadrate in shape. Axis fairly prominent, apparently consisting of 5 rings plus a terminal section, extended into a short postaxial ridge that probably reached the margin. There is a low node on each axial ring. Outline of pleural lobe first directed straight outwardly from axial furrow, sharply curving backward, and for some distance running backward in straight line. The appearance of the broken test suggests that there may have been a lateral spine, an extension of the straight portion of the margin. The remainder of the pygidial margin is broken off, and it cannot be excluded that there may have been more pairs of spines. Three pairs each of pleural and interpleural

furrows all about equally impressed, the anterior ones with a fairly sharp backward bend, posteriorly becoming less curved and on the average more backwardly directed. Surface of test smooth. Length of pygidium approximately 2 mm., width 3.0 mm.

Occurrence.—Collection cs-23 (*Centropleura* bed), Judson Point.

Discussion.—This peculiar pygidium probably belongs to a dolichometopid trilobite, but cannot be more closely identified owing to its imperfect preservation and lack of an associated cranidium. The straight parallel sides are an unusual feature.

Disposition of material.—Figured specimen: USNM 156676.

Corynexochacea, pygidium no. 4

Plate 7, figure 23

Available material.—One well-preserved example.

Description.—Pygidium approximately twice wider than long, semi-circular, with well-rounded anterior angles. Axis very prominent, moderately tapered, rounded posteriorly, almost reaching posterior margin. One axial ring well defined by a ring furrow; traces of a second ring furrow indicated only at the sides. Pleural regions with moderate relief, showing 3 pairs of broad, shallow pleural furrows, and no trace of interpleural furrows. All the furrows die out in the shallow, poorly defined border furrow. Border slightly convex, also poorly defined. Anterior pygidial margin possessing a sharp geniculation halfway between axial furrow and anterior angle. Entire surface finely and densely granulate. Length of pygidium 3.4 mm., width 6.6 mm.

Occurrence.—Collection cs-3/L1 (*Pagetides* fauna), Griswold farm.

Discussion.—This pygidium resembles *Corynexochus* and *Bonaspis*, and may therefore represent a trilobite closely related to these genera, which, however, occur in the late Middle Cambrian. No definite statement about the affinities can be made in the absence of an associated cranidium.

Disposition of material.—Figured specimen: USNM 156677.

Superfamily PARADOXIDACEA Hawle and Corda, 1847

Family CENTROPLEURIDAE Angelin, 1854

Genus CENTROPLEURA, Angelin, 1854

Type species: *Centropleura loveni* Angelin, 1854.

CENTROPLEURA, species undetermined

Plate 11, figures 24-29

Available material.—Fragments of two immature cranidia, genal spines, a thoracic segment, and a pygidium.

Description.—Larger cranidium preserving the anterior portion of glabella and one palpebral lobe. All the observable features agree with *Centropleura*, in particular the longitudinal course of the first pair of glabellar furrows, which do not reach the second (transglabellar) furrow.

The smaller (meraspid) cranidium preserves only the glabella with occipital ring; seemingly it represents the youngest stage of *Centropleura* so far illustrated. The glabella expands considerably forward, and is characterized by a shallow longitudinal furrow through the first three glabellar lobes. This furrow does not extend onto the fourth glabellar lobe, which is shorter (sag.) than the first three and defined by a deeper furrow anteriorly. The occipital furrow is deep, and the occipital ring much narrower (tr.) than the anterior part of the glabella. Fragments of genal spines show the peculiar ornamentation illustrated by Öpik (1961) in *Centropleura phoenix*.

A thoracic segment, belonging to the anterior or middle portion of the thorax, shows the characteristically short (tr.) pleurae, and diagonal pleural furrow.

A small pygidium shows a short, sharply tapered axis including two rings plus a terminal section. Pleural furrows curving backward; pleural region with a low, transverse ridge behind the axis. The marginal portion is not preserved enough to ascertain the presence of spines.

Occurrence.—Collection cs-23 (*Centropleura* faunule), Judson Point.

Discussion.—The fragmentary material presented herein, while contributing nothing to the knowledge of the genus, is of considerable biostratigraphic significance, indicating the presence of late Middle Cambrian strata in the Taconic sequence, and relation of the fauna to the Acado-Baltic province.

The reference to the genus is unquestionable, but it would be meaningless to attempt specific identification. The fragments known do not differ in any visible character from *C. phoenix* Öpik from Queensland, the best known of all species of *Centropleura*, but probably the same could be said for most of the described species. This trilobite seems to have been common, since fragments of the genal

spines, recognizable by the characteristic ornamentation, frequently occur on the bedding surfaces where fossil debris are concentrated.

Disposition of material.—Figured specimens: USNM 156678.

Superfamily PTYCHOPARIACEA Matthew, 1887

Family CONOCORYPHIDAE Angelin, 1854

R. and E. Richter (1941, pp. 50-55) and Sdzuy (1961, pp. 658-660) gave excellent discussions of the family Conocoryphidae, pointing out that loss of the eyes in trilobites has little taxonomic significance. As in modern organisms, it represents an adaptation to a mode of life, which can occur in a number of unrelated groups. When the blind Ptychopariacea become better known, each of their genera must be referred to the family that includes closely related, oculate forms.

Meneviella, and an unnamed form described herein, seem sufficiently related to *Conocoryphe* to be referred to the family Conocoryphidae in a restricted sense. However, as the above-cited authors have pointed out, *Atops* has a different pattern of glabellar furrows and should be excluded from the family. The writer fully agrees with their suggestion that *Atops* is a very close relative of *Rimouskia*, differing from the latter only in the loss of eyes and migration of the facial suture toward the cephalic margin. Sdzuy (1961, p. 629) suggests that *Rimouskia* should be excluded from the family Saoidae (or subfamily Saoinae of the Solenopleuridae) where it was placed by Hupé (1953) and the writer (1955). Therefore, *Atops* and *Rimouskia* are referred herein to an undetermined family of the Ptychopariacea.

Genus MENEVIELLA Stubblefield, 1951

Type species: *Erinnys venulosa* Salter, 1872

MENEVIELLA, species undetermined

Plate 14, figures 1-6

Available material.—Small, mostly fragmentary cranidia, thoracic segments, and a few pygidia.

Description.—The following description is based on cranidia 3-5 mm. in length; features of smaller, presumably meraspid cranidia are mentioned later. Cranidium very regularly semicircular, exactly twice wider than long, with straight posterior outline. Glabella moderately tapered, occupying two-thirds of the cranidial length, narrow

in proportion to cranidium. Three pairs of lateral furrows short but well impressed, of usual generalized ptychoparioid pattern. Occipital furrow well impressed throughout; occipital ring somewhat expanded medially. Border furrow well impressed all around the cranidium. Border convex, widest medially, but not narrowing much to the genal angle, continued into the posterior border. The facial suture must have been entirely marginal as it does not cut off any portion of the border. A vague ocular ridge is directed outward and slightly backward and disappears about the middle of the fixigenae. Surface densely granulate, not showing the genal coeca even in cranidia 5 mm. long.

Thoracic segments easily identifiable by the ornamentation. The anterior ones with long, straight portion of pleurae and geniculation very distally located. Posterior segments with geniculation situated somewhat beyond halfway from axial furrow to pleural termination, somewhat curving backward to a pointed end. All pleurae with broad, deep furrow.

Pygidium more than twice wider than long, subelliptical. Axis about two-thirds the pygidial length, not greatly elevated, posteriorly almost merging with the pleural regions, showing 2 rigs plus a terminal section. Pleural regions with 3 pairs of increasingly shallow pleural furrows. Border furrow and border indistinct. Surface densely granulate.

Cranidia about 1 mm. in length with glabella slightly expanded rather than tapered in anterior portion, proportionately much longer than in mature stages, reaching not far from border furrow. Glabellar furrows indistinct; occipital furrow well impressed; occipital ring bearing a node. Fixigenae with strong convexity, showing faint ocular ridges. Border well defined; border furrow almost merging with the axial furrow medially through a preglabellar depression. The facial suture seems to have been entirely marginal. Surface granulate.

Occurrence.—Most of the illustrated specimens are from loose blocks on the Griswold farm (coll. cs-7/M1 and cs-8/M1). Also present in collection cs-9d* at the Malden Bridge road cut. In all cases in association with *Ptychagnostus gibbus* and other trilobites of the *Bathyriscus-Elrathina* zone.

Discussion.—The reference to the genus seems unquestionable, as only minor differences separate the species from *Meneviella venulosa*, chiefly the convex rather than flat cephalic border and the lack of distinct genal coeca. The immature cranidia are extremely similar to specimens of the same size figured by Hutchinson (1962).

The occurrence of *Meneviella* is particularly interesting in view of the association of this typically Acado-Baltic trilobite with genera representative of the Cordilleran province such as *Bathyuriscus* and *Kootenia*. In Newfoundland Hutchinson (1962) found *Meneviella venulosa* in the upper part of the *Paradoxides hicksi* and throughout the *Paradoxides davidis* zones, indicating approximately the same age as for the present species.

Disposition of material.—Figured specimens: USNM 156679-80.

Genus undetermined

Conocoryphidae, cranidium no. 1

Plate 8, figure 22

Known from one immature example. Glabella parallel-sided, well rounded in front, with but traces of lateral furrows. Occipital furrow well impressed, occipital ring apparently simple. Genae with considerable convexity; preglabellar field longer (sag.) than border width. Border furrow deep, anterior border convex, apparently reduced in width at the sides and possibly totally cut off by the facial suture in posterolateral part of genae. Posterior border furrow deep, straight. Ocular ridges lacking. Surface granulate. Length of cranidium 1.8 mm., maximum width 2.8 mm.

The cranidium is typical of the Conocoryphidae but too immature for generic identification. The specimen is illustrated because trilobites of this type do not seem to have been reported from Lower Cambrian strata.

Occurrence.—Loose block cs-15/L1, in association with a Lower Cambrian *Pagetides* faunule.

Disposition of material.—Figured specimen: USNM 156681.

Family MENOMONIIDAE Walcott, 1916

Genus BOLASPIDELLA Resser, 1937

Type species: *Ptychoparia housensis* Walcott, 1886.

BOLASPIDELLA FISHERI, new species

Plate 13, figures 17-30

Available material.—A few holaspid cranidia and free cheeks, and numerous meraspid cranidia. The material is well preserved in limestone.

Description.—The following description applies to the larger crani-

dia and free cheeks, believed to represent holaspid stages. Glabella defined by deep axial furrow, slightly tapered, truncate in front. Two pairs of short furrows impressed laterally; occipital furrow deep and straight; occipital ring considerably expanded backward medially, rounded, bearing a small node. Preglabellar field short (sag.); border elevated, convex, tapering in width laterally. Palpebral area upsloping, somewhat more than half the glabellar width. Palpebral lobe large, almost half the glabellar length, bean-shaped, considerably elevated above the palpebral area, connected to glabella by a low ocular ridge. Distance from posterior end of palpebral lobe to posterior cranial margin somewhat less than length of palpebral lobe. Anterior facial sutures not divergent, curving inward and rounding off the anterior angles of the cranium. Posterior branch directed outward, defining a parallel-sided posterior area, downsloping in distal portion and deeply furrowed.

Free cheek with steeply downsloping ocular platform. Border relatively wide, sharply raised above the border furrow, somewhat increasing in width posteriorly, extended into short, rapidly tapered genal spine. Border extending inward, hence forming portion of posterior border of cephalon, the facial suture showing a sharp angle corresponding to the termination of the posterior area of the cranium.

Surface covered with rather small granules of different sizes. On the border of cranium and free cheeks the distinction between large and small granules is sharper. Length of holotype cranium 2.2 mm.

Ontogeny.—Immature crania, mostly belonging to meraspid stages, are much more common than larger examples. Protaspides may be present in the collection, but are difficult to identify among the numerous ptychoparioid species. The smallest crania definitely referable to the species have a length of 0.5 mm. The glabella is narrow, well defined by axial furrows posteriorly, but fading out into the frontal area. Occipital furrow and ring are well developed. The entire area of the genae is convex, lacking a differentiated border. Crania 0.67 mm. long already show the entire outline of the glabella, defined by deep axial furrows and slightly tapered in posterior portion, the remainder defined by excessively shallow axial furrows, slightly expanding forward, sharply truncate in front, almost reaching frontal margin of cranium. Faint glabellar furrows are visible at this stage; the occipital furrow is deep. The short (sag.) frontal area is still undifferentiated by a border furrow. The palpebral lobes are indistinct. The posterior border on the fixigenae widens distally,

and is well defined by a deep border furrow. In cranidia 0.85 mm. long four pairs of shallow glabellar furrows are visible on coated specimens. The glabella still slightly expands in anteriormost portion. Faint ocular ridges and very small, inconspicuous palpebral lobes appear. The lateral cranidial outline becomes straight rather than rounded, especially in the portion that includes the palpebral lobe; the latter is located in a much more anterior position than in later stages. The frontal border becomes differentiated, but still there is no preglabellar field. Cranidia 1.1 mm. long are intermediate between the last described stage and the holaspid. The glabella no longer expands forward and there is a trace of preglabellar field. Ocular ridges and palpebral lobes become more conspicuous, the latter being longer and slightly elevated above a shallow palpebral furrow, but the great elevation of the palpebral area and lobe as observed in the holaspid does not yet occur. The general side outline of the cranidium becomes concave outward, the facial suture being directed definitely outward behind the palpebral lobe.

These features of the ontogeny closely parallel those observed by Robison (1964a) in *Bolaspidella housensis*, in particular the late development of large and elevated palpebral lobes that are characteristic of the holaspids of the genus.

The species is named for Dr. Donald W. Fisher.

Occurrence.—Collection cs-21, Stockport Station.

Discussion.—The species differs from both *B. housensis* and *B. drumensis*, well illustrated by Robison (1964a), in the lack of an occipital spine. *B. contracta* Robison shares with the present species the lack of an occipital spine, but has a proportionately narrow glabella, especially in its posterior part, and smaller, more anteriorly located palpebral lobes. The species from Utah have much longer genal spines.

Types.—Holotype: USNM 156682. Paratypes: USNM 156683.

Family undetermined

Genus RIMOUSKIA Resser, 1938

Type species: *Rimouskia typica* Resser, 1938.

RIMOUSKIA TYPICA Resser

Plate 9, figures 1-3

Rimouskia typica RESSER, 1938, p. 98, pl. 3, figs. 20-22.

Rimouskia spinosa RESSER, 1938, p. 98, pl. 3, fig. 19.

Rimouskia typica Resser, RASETTI, 1955, p. 31, pl. 1, fig. 10; pl. 6, figs. 1-6.

Two good cranidia and a librigena were recovered. Librigena very narrow, with a slightly raised border. Anterior and posterior branches of the facial suture almost in a straight line. The inner margin shows a narrow, short extension corresponding to the rounded distal portion of the posterior area of the cranidium. The librigena extends into a short, rapidly tapered genal spine. The ornamentation consists of granules of different sizes as that of the cranidium.

Occurrence.—The species had so far been found only in conglomerate boulders at Bic, Quebec, and its only known associations were olenellid fragments. In the Taconic sequence it was collected from boulders in the Ashley Hill Conglomerate at Ashley Hill (coll. cs-19), in association with *Elliptocephala asaphoides*, *Calodiscus lobatus*, *Hyolithellus micans*, and *Helcionella subrugosa*, and from shale at Judson Point (coll. cs-24b), associated with *Atops trilineatus*, *Elliptocephala asaphoides*, and *Serrodiscus speciosus*.

Types.—Plesiotypes figured herein: USNM 156684.

Genus **ATOPS** Emmons, 1844

Type species: *Atops trilineatus* Emmons, 1844

ATOPS TRILINEATUS Emmons

Plate 8, figure 23

Atops trilineatus EMMONS, 1844, p. 20, pl. 2, fig. 3.

Atops trilineatus Emmons, LOCHMAN, 1956, p. 1383, pl. 6, fig. 1. Complete synonymy to date.

In the area investigated, *Atops trilineatus* was collected only from shale at Judson Point. The species has been found at several localities in the Taconic sequence, almost invariably in shale, even though other members of the *Elliptocephala asaphoides* assemblage are much more common in limestone.

The cranidium of *Rimouskia typica* is virtually identical with that of *Atops trilineatus*, except in the course of the facial suture and presence of palpebral lobes. Unfortunately the other parts of the exoskeleton of *Rimouskia* are unknown. The two species were collected from the same shale bed at Judson Point.

Occurrence.—Same beds as author's collection 24b, Judson Point (collected by H. B. Whittington).

Types.—Plesiotype: MCZ 8536.

Genus **ELRATHIA** Walcott, 1924

Type species: *Conocoryphe (Conocephalites) kingii* Meek, 1870

ELRATHIA?, species undetermined

Plate 14, figures 7, 8

Available material.—Two cranidia, presumably immature.

Description.—Glabella almost parallel-sided, moderately truncate in front, unfurrowed. Occipital furrow well impressed, occipital ring short (sag.), bearing a small node. Frontal area about half as long (sag.) as glabella. Preglabellar field more than twice as wide (sag.) as border; the latter convex, moderately elevated. Palpebral area slightly convex, on the average horizontal, somewhat less than the glabellar width. Palpebral lobes about a third the glabellar length, moderately elevated, at level of glabellar midpoint; ocular ridges transverse, not greatly elevated. Posterior area of fixigenae somewhat tapered distally, well furrowed, wider (tr.) than occipital ring or glabella. Surface of test indistinctly granulate. Length of larger cranidium 2.0 mm.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Discussion.—This cranidium resembles *Elrathia* in the general proportions, but differs from described species in the narrow and more parallel-sided glabella. This may be a feature due to the immature condition of the specimens.

Disposition of material.—Figured specimens: USNM 156685.

Genus ELRATHINA Resser, 1937

Type species: *Conocephalites cordillerae* Rominger, 1887.

ELRATHINA?, species undetermined

Plate 14, figure 20

Available material.—A few imperfect cranidia.

Description.—Glabella slightly tapered in posterior part, becoming parallel-sided, rounded in front, rising above the genae. Traces of two pairs of glabellar furrows visible at the sides. Occipital furrow moderately deep; occipital ring extended into a small spine. Frontal area moderately arched transversely; preglabellar field short (sag.), about equaling the width of the border medially. Border tapering in width at the sides, well defined by border furrow which is deeper laterally, very shallow medially. Palpebral area convex transversely, almost as wide as glabella; ocular ridges slightly arched, on the average transverse in direction; palpebral lobes incompletely preserved, at level of anterior third of glabella. Anterior facial sutures definitely convergent in dorsal view. Posterior branch almost straight,

with little change of direction from anterior branch, forming large, widely furrowed posterior area. Surface of test smooth. Length of best-preserved cranidium 5.6 mm.

Occurrence.—Collection cs-6 (*Bathyriscus-Elrathina* zone), Griswold Farm.

Discussion.—This form is too incompletely known for a reliable generic identification; however, it appears to fit better in *Elrathina* than in any other described genus. The anterior position of the palpebral lobe is the only characteristic which disagrees with the typical forms of the genus.

Disposition of material.—Figured specimen: USNM 156686.

Genus *MODOCIA* Walcott, 1924

Type species: *Arionellus (Crepicephalus) oweni* Meek and Hayden, 1861.

MODOCIA PUNCTATA, new species

Plate 12, figures 24-28

Available material.—Several cranidia, very small and presumably immature.

Description.—Glabella strongly convex in both directions, unfurrowed, well rounded in front. Occipital furrow deep; occipital ring expanded medially, lacking node or spine. Fixigenae convex and downsloping; preglabellar field somewhat longer (sag.) than border, at least in the larger cranidia. Border elevated, convex, tapering in width at the sides. Palpebral area convex transversely, mostly downsloping, less than half the glabellar width in the larger cranidia. Ocular ridges indistinct; palpebral lobe increasing in relative size in the larger examples, attaining somewhat more than a fourth the glabellar length, defined by palpebral furrow deeper in posterior part. Anterior facial sutures not appearing divergent in dorsal view; posterior branch directed progressively more outward in larger cranidia, producing blunt, deeply furrowed posterior area, which is somewhat narrower (tr.) than occipital ring. Distance from posterior end of palpebral lobe to posterior cranial margin somewhat greater than length of palpebral lobe. Surface of test markedly punctate, especially in the larger cranidia. The available cranidia vary in length from 1.0 to 2.7 mm.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Discussion.—This form resembles *Modocia metisensis* (Walcott)

in the plump appearance of the glabella, differing from that species in the longer preglabellar field, somewhat different form of the palpebral lobe, and especially the pitted rather than granulate surface. Were it not for the last feature, so far unique in the genus, one might suspect that the differences from *M. metisensis* or possibly other described species are due to the immature condition of the specimens.

Types.—Holotype: USNM 156687. Paratypes: USNM 156688.

MODOCIA, species undetermined

Plate 14, figure 26

Two cranidia associated with *Modocia punctata* differ from that species in the less plump, more nearly straight-sided glabella, longer (sag.) frontal area, wider and less convex border equaling in width (sag.) the preglabellar field, and somewhat divergent anterior facial sutures. This form resembles *M. brevispina* Robison (1964a). The occipital ring is broken off, hence it cannot be ascertained whether an occipital spine was present. The surface is smooth.

Occurrence.—Collection cs-21.

Disposition of material.—Figured specimen: USNM 156689.

Genus undetermined

Ptychopariacea, cranidium no. 1

Plate 7, figures 24-26

Available material.—A few examples, probably immature.

Description.—Glabella parallel-sided, rounded in front. Two or 3 pairs of shallow to moderately deep lateral furrows visible, of generalized ptychoparioid pattern. Occipital furrow deeper laterally, occipital ring rounded, bearing a node. Preglabellar field at least in smaller specimens shorter (sag.) than border medially, in larger specimen about equaling border. Border convex, tapered in width laterally. Palpebral area approximately horizontal, with little convexity; ocular ridges broad and low, first directed outward, curving backward. Palpebral lobe about one fourth the glabellar length, narrow, obliquely directed, slightly elevated, situated in advance of glabellar midpoint. Anterior facial sutures definitely convergent in front of the eyes, probably marginal for a short median portion; posterior branch extending without much change of direction to posterior margin. Posterior area with well impressed, straight furrow, considerably wider (tr.) than occipital ring. Surface finely

granulate. Length of smaller, better preserved cranidia 2.0 mm, of larger example 2.8 mm.

Occurrence.—Collections cs-9, Malden Bridge, cs-4a, Griswold farm, and loose block cs-15/L1. Examples from the last collection are poorly preserved and reference to the same species is somewhat doubtful. In the first two collections associated with *Neopagetina* and *Pagetides*.

Discussion.—This generalized ptychoparioid resembles several genera known from the Lower Cambrian of North America but the parallel-sided glabella, anterior position of eyes, and narrowness of the frontal part of the cranium are somewhat unusual. It is possible that these features are emphasized by the immaturity of the specimens. *Eoptychoparia* is probably the nearest described genus.

Disposition of material.—Figured specimens: USNM 156690-2.

Ptychopariacea, cranidium no. 2

Plate 14, figures 11-13

Available material.—Several, well preserved examples, all very small and presumably immature.

Description.—Glabella approximately parallel-sided, reaching anterior border, in the smaller specimens slightly hourglass-shaped, in larger ones becoming straight-sided and very slightly tapered. All specimens show a very shallow median notch in the truncate anterior outline. Two pairs of very shallow glabellar furrows visible at the sides. Occipital furrow well impressed; occipital ring extended into a rapidly tapered spine. Anterior border narrow, convex, wirelike, strongly arched in dorsal view. Fixigenae convex and downsloping, broadening posteriorly, the facial sutures continuing the outline of the anterior border without much change in direction. Palpebral area about two-thirds the width of glabella; palpebral lobes very narrow, inconspicuous, located in advance of glabellar midpoint. Ocular ridges very faint, parallel and close to anterior border. Transverse width of posterior area slightly exceeding width of occipital ring. Furrow on posterior area deep, diverging outward from posterior cranial margin; posterolateral angles of cranium narrowly rounded. Surface of test smooth. Length of largest cranidium 1.2 mm.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Discussion.—This cranidium does not seem referable to any described genus. However, in view of the almost certainly immature

features of the available specimens, it would be improper to use the material for proposing new taxa.

Disposition of material.—Figured specimens: USNM 156693.

Ptychopariacea, cranidium no. 3

Plate 14, figures 9, 10

Available material.—A few, fairly well preserved, presumably immature examples.

Description.—Cranidium subtrapezoidal, fairly convex. Glabella almost parallel-sided, slightly constricted medially in smaller individuals, becoming slightly tapered in the larger ones, bearing but traces of lateral furrows, truncate or even slightly indented in front, reaching border furrow. Occipital furrow deep; occipital ring extended into spine. Anterior border convex, wide (sag.) medially, rapidly tapered laterally, with curved anterior outline but posteriorly bounded by almost straight border furrow. Palpebral area somewhat narrower than glabella; ocular ridges parallel and close to anterior border furrow, very faint; palpebral lobes very narrow and but slightly elevated, somewhat anterior to level of glabellar midpoint. Anterior facial sutures strongly convergent; posterior branch showing little change of direction from anterior branch, only curving inward sharply in crossing the posterior border furrow, producing fairly sharp posterolateral angle of cranidium. Posterior border furrow well impressed, broadening and becoming shallower outward. Surface of test with coarse, very shallow puncta. Length of largest cranidium 1.4 mm.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Discussion.—This form, as far as can be evaluated from immature material, closely resembles the preceding and should presumably be considered congeneric. It differs from cranidium no. 2 in the straighter, wider and laterally tapered anterior border, less complete merging of border and axial furrows, and punctate surface.

Disposition of material.—Figured specimens: USNM 156694.

Ptychopariacea, cranidium no. 4

Plate 14, figure 17

Available material.—A single, small and presumably immature example.

Description.—Glabella straight-sided, very slightly tapered, well

rounded in front, unfurrowed. Occipital furrow straight, well impressed; occipital ring broadened medially, rounded, lacking spine or node. Preglabellar field short (sag.); border furrow well impressed; border convex, moderately wide, uniformly curved in anterior outline, not much tapered in width at the sides. Palpebral area somewhat less than half the glabellar width; ocular ridges indistinct; palpebral lobes almost half the length of glabella, defined by very shallow palpebral furrow, curved, not greatly elevated. Distance of posterior end of palpebral lobe to cranial margin less than length of palpebral lobe. Posterior area not preserved, seemingly slender. Surface of test smooth. Length of cranium 1.7 mm.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Discussion.—This cranium is of a fairly generalized ptychoparioid type. It would be futile to attempt generic identification on an immature individual.

Disposition of material.—Figured specimen: USNM 156695.

Ptychopariacea, cranium no. 5

Plate 14, figure 24

Available material.—A few, imperfect, presumably immature examples.

Description.—Glabella parallel-sided, truncate in front, reaching anterior border furrow. Two pairs of glabellar furrows impressed at the sides; anterior pair shallower, transverse; posterior pair deeper, directed slightly inward and backward, at inner end extended into a very shallow portion curving backward. Occipital furrow deep; occipital ring subtriangular, forming a short, obtuse spine. Anterior border convex, well defined by border furrow, not greatly curved, tapered in width laterally. Other portions of cranium not preserved. Surface granulate. Length of best-preserved cranium 1.1 mm.

Occurrence.—Collection cs-22 (*Bolaspidella* zone), Nutten Hook.

Discussion.—As far as one can evaluate the poorly preserved, immature material, this cranium seems closely related to *Welleraspis*, a genus so far known from Dresbachian strata. In the discussion of the faunas it was shown that associated fossils give strong indication for a late Middle Cambrian age.

Disposition of material.—Figured specimen: USNM 156696

Ptychopariacea, cranium no. 6

Plate 14, figure 15

Available material.—An exceedingly small, immature example.

Description.—Cranidium short and wide, with little convexity. Glabella very long and narrow, parallel-sided, reaching anterior border furrow, unfurrowed. Occipital furrow straight and deep; occipital ring short (sag.), rounded. Fixigenae very wide, posteriorly about $2\frac{1}{2}$ times as wide as glabella. Anterior border flat, fairly well defined, very short (tr.) in proportion to posterior part of cranium. Palpebral lobes about as distant from glabella as glabellar width, very anteriorly situated, at about one fifth the distance from anterior to posterior cranial margin. Fixigenae greatly expanded behind palpebral lobes. Posterior angles of cranium very sharp, possibly indicating proparian suture. Furrow on posterior area narrow and very close to margin. Surface of test with a few, widely spaced granules. Length of cranium 0.55 mm.

Occurrence.—Collections cs-22 (*Bolaspidella* zone), Nutten Hook.

Discussion.—Even though it is difficult to estimate the features of the adult from such an immature, presumably meraspid cranium, the characters of the specimen are so unusual that it is likely to belong in an undescribed genus of uncertain affinities.

Disposition of material.—Figured specimen: USNM 156697.

Ptychopariacea, cranium no. 7

Plate 14, figures 21, 22

Available material.—Two imperfect, very small examples.

Description.—Glabella large, with slightly concave sides, somewhat expanded forward, rising high above the fixigenae, reaching anterior cranial margin. Posteriormost pair of glabellar furrows impressed in form of short, oblique furrows at the sides; another pair of furrows similar but very shallow. Occipital furrow deep, strongly concave forward; occipital ring not well preserved, seemingly extended into spine. Anterior cephalic border very narrow or entirely missing. Ocular ridge very close and parallel to cranial margin, extending into very narrow, oblique palpebral lobe, the poor preservation not allowing to determine the precise boundary between the two. Surface of test finely granulate. Length of cranium 0.7 mm.

Occurrence.—Collection cs-22 (*Bolaspidella* zone), Nutten Hook.

Discussion.—This cranium, as far as its features can be ascer-

tained, is most suggestive of the Trempealeauian genus *Theodemisia* or the Dresbachian *Pemphigaspis*. However, the resemblance may be due to the juvenile features of the present material, as the writer (Rasetti, 1954) has shown that meraspid forms of lonchocephalid trilobites may assume a similar aspect. Relatives of the above-mentioned genera are known from late Middle Cambrian strata, such as *Catillicephala* in the St. Albans Shale (Shaw, 1966).

Disposition of material.—Figured specimens: USNM 156698.

Ptychopariacea, cranidium no. 8

Plate 14, figure 25

Available material.—A very small, probably immature example.

Description.—Glabella narrow and long, parallel-sided, subtruncate in front, lacking distinct furrows. Occipital furrow deep, occipital ring extended into a strong, subhorizontal spine. Frontal area consisting of short (sag.) preglabellar field and elevated, laterally tapered, rather straight border. Palpebral area flat, wider than glabella; ocular ridges indistinct; palpebral lobe small, not considerably elevated, anterior to glabellar midpoint. Facial sutures slightly convergent in front of eyes; posterior branch directed outward and backward, producing large, distally rounded posterior area. Furrow on posterior area deep and wide. Surface apparently smooth. Length of cranidium, exclusive of occipital spine, 0.9 mm.

Occurrence.—Collection cs-23, Judson Point.

Discussion.—It is difficult to assess the affinities of this form on account of the immature stage of the only specimen available. It may represent a relative of *Bolaspidella*, even though the species of that genus, as for example *B. fisheri* described herein, show very different features in examples of the same size.

Disposition of material.—Figured specimen: USNM 156638.

Ptychopariacea, pygidium no. 1

Plate 14, figure 16

Available material.—One example.

Description.—Pygidium subelliptical, with considerable relief. Axis rapidly tapered, prominent, rounded posteriorly, reaching the border furrow, composed of 3 definite rings plus a terminal section. Pleural regions downsloping; 3 pairs of pleural furrows well impressed, with even curvature, ending in poorly defined border furrow. Interpleural furrows shallower, impressed only distally. Border poorly

defined, flat, narrower medially. Surface of test apparently smooth. Length of pygidium 0.9 mm, width 1.6 mm.

Occurrence.—Collection cs-21 (*Bolaspidella* zone), Stockport Station.

Discussion.—This generalized ptychoparioid pygidium resembles *Modocia* and a number of other genera.

Disposition of material.—Figured specimen: USNM 156699.

Ptychopariacea, pygidium no. 2

Plate 14, figure 19

Available material.—One example.

Description.—Pygidium approximately semicircular. Axis tapered, reaching about three fourths the length of pygidium, composed of 3 rings plus a terminal section, narrowly rounded posteriorly. Pleural regions moderately convex; anterior outline straight, transverse for over half the distance from axial furrow to anterior angle, rather sharply curving backward in distal portion; remainder of pygidial outline of almost even curvature. Anterior border furrow deep and broad; two other pairs of pleural furrows vaguely impressed proximally, fading out distally; one pair of interpleural furrows faintly defined in proximal portion. Border furrow and border undifferentiated. Surface of test with fine granulation, plus a few pairs of larger, scattered granules. Length of pygidium 1.0 mm., width 2.0 mm.

Occurrence.—Collection cs-23 (*Centropleura* bed), Judson Point.

Discussion.—The pattern of pleural furrows and the lack of border furrow and border give this pygidium a somewhat unusual aspect. Lack of an associated cranidium prevents any attempt at classification.

Disposition of material.—Figured specimen: USNM 156700.

Ptychopariacea, pygidium no. 3

Plate 14, figure 29

Available material.—One example.

Description.—Pygidium broadly subtriangular, with moderate overall relief. Axis proportionately broad and short, elevated, composed of 2 rings plus a terminal section, well rounded posteriorly, occupying two thirds of the pygidial length. Pleural regions almost flat and horizontal; anterior border furrow and one pair of narrow pleural furrows impressed only proximally; no interpleural furrows.

Posterior margin of pygidium downrolled, lacking definite border furrow or border. Surface densely covered with small, elevated granules. Length of pygidium 1.1 mm., width 2.2 mm.

Occurrence.—Collection cs-22 (*Bolaspidella* zone), Nutten Hook.

Discussion.—This pygidium, even though the proportions are the same as in most ptychoparioid genera, has characteristic features in the small number of axial segments, flatness of the pleural regions, and lack of differentiated border furrow and border. In the absence of an associated cranidium, even generic identification cannot be attempted.

Disposition of material.—Figured specimen: USNM 156701.

Ptychopariacea, pygidium no. 4

Plate 14, figures 27, 28

Available material.—A few fragmentary examples, of which two are relatively complete.

Description.—Pygidium subtriangular, with considerable relief. Axis very prominent, slightly tapered, occupying the entire pygidial length, composed of 4 well-defined rings plus a terminal section; in the latter further traces of segmentation may be visible. Anterior margin of pleural region with geniculation situated very close to axial furrow; portion of outline distal to geniculation directed obliquely outward and backward. Remainder of outline posterior to anterior angles fairly straight on each side, rather sharply rounded behind axis. Pleural regions convex and downsloping, showing 4 rather deep pairs of pleural furrows, and in the smaller of the figured specimens also distally impressed interpleural furrows. All furrows terminate in shallow border furrow, which sets off a narrow, flat border. Ornamentation indistinct. Length of largest pygidium 1.2 mm., width 2.2 mm.

Occurrence.—Collection cs-22 (*Bolaspidella* zone), Nutten Hook.

Discussion.—This pygidium somewhat resembles *Welleraspis*, but its generalized ptychoparioid features make a definite identification inadvisable. The pygidium might conceivably belong with the ptychoparioid cranidium no. 5. Even though the two illustrated specimens show difference in the depth of the furrows, they are probably to be considered conspecific.

Disposition of material.—Figured specimens: USNM 156702.

Ptychopariacea, pygidium no. 5

Plate 14, figure 23

Available material.—One example.

Description.—Entire pygidium short and wide, of moderate relief, with almost straight anterior and uniformly curved posterior outline. Axis elevated above the pleural regions, slightly tapered, showing 5 rings plus a short terminal section separated by shallow furrows, almost reaching the posterior border. Pleural regions downsloping only in outer portion, showing 4 pairs of pleural furrows (including the anterior border furrow) and as many pairs of interpleural furrows, all equally impressed, directed outward in proximal portion, curving backward only distally, all ending in narrow, shallow border furrow. Border narrow, wirelike, defined rather by its elevation than by a border furrow. Surface of test smooth. Length of pygidium 0.75 mm., width 1.75 mm.

Occurrence.—Collection cs-22 (*Bolaspidella* zone), Nutten Hook.

Discussion.—The depth of both pleural and interpleural furrows, combined with the narrow, elevated border represent unusual features among late Middle Cambrian ptychoparioid trilobites.

Disposition of material.—Figured specimen: USNM 156703.

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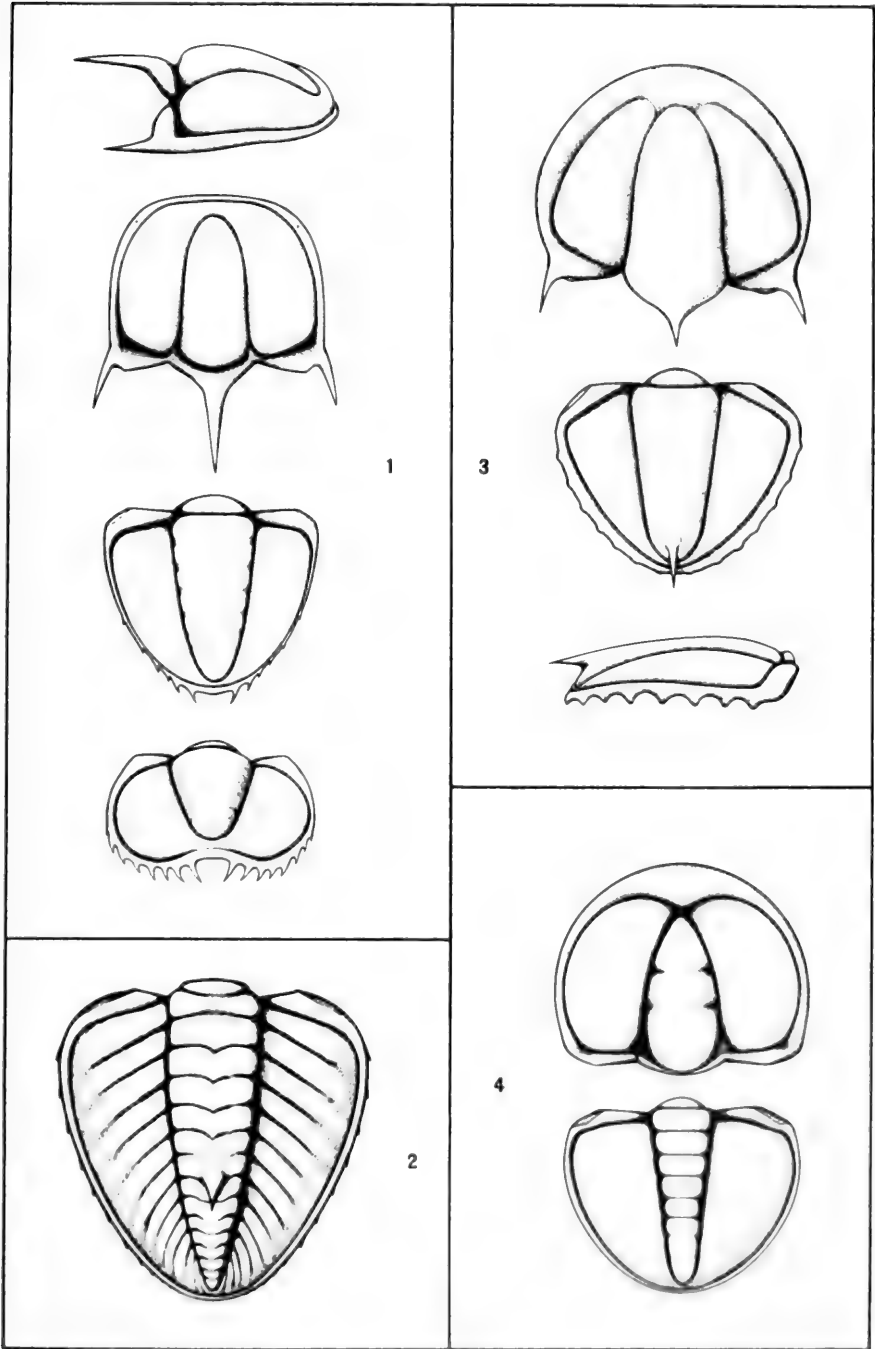
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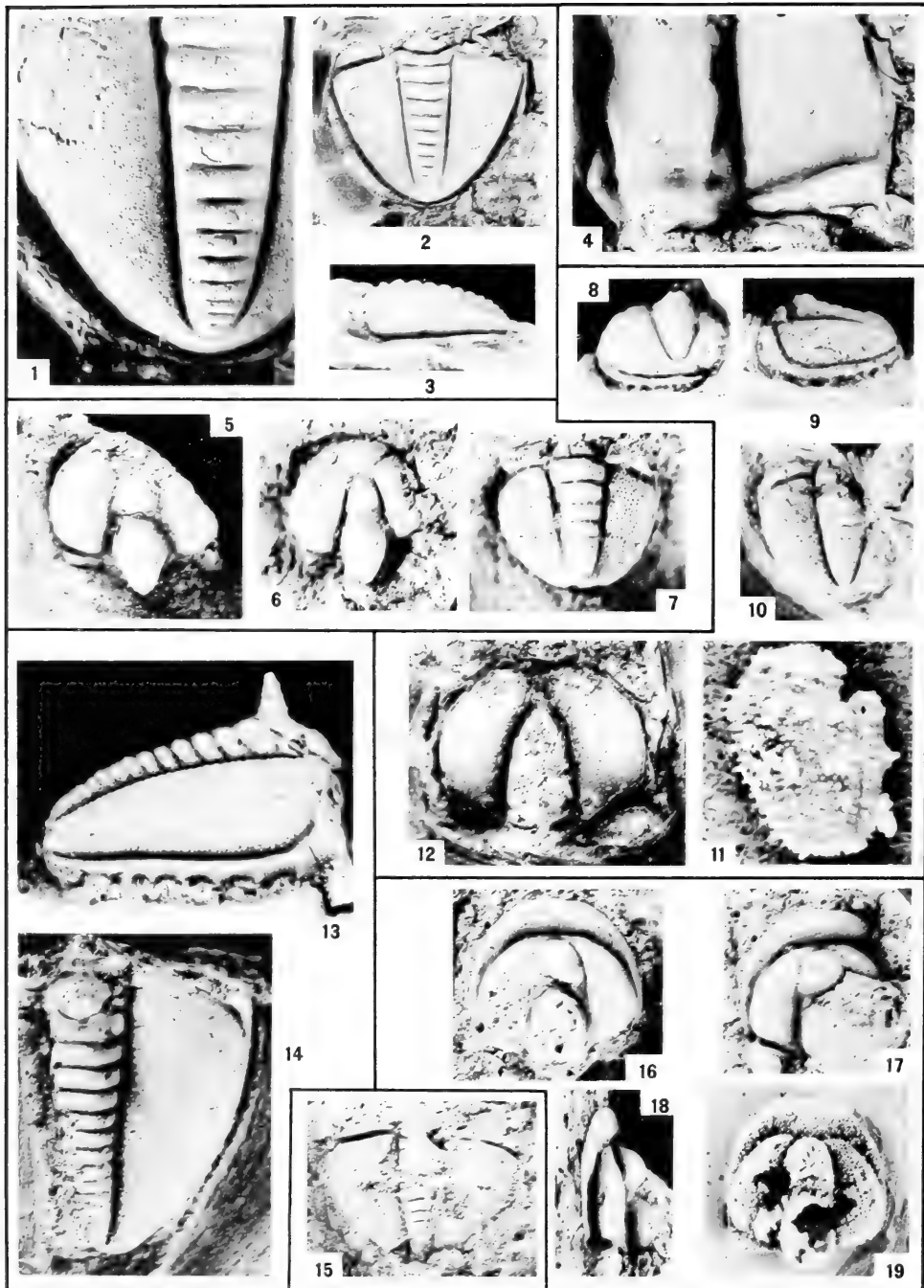
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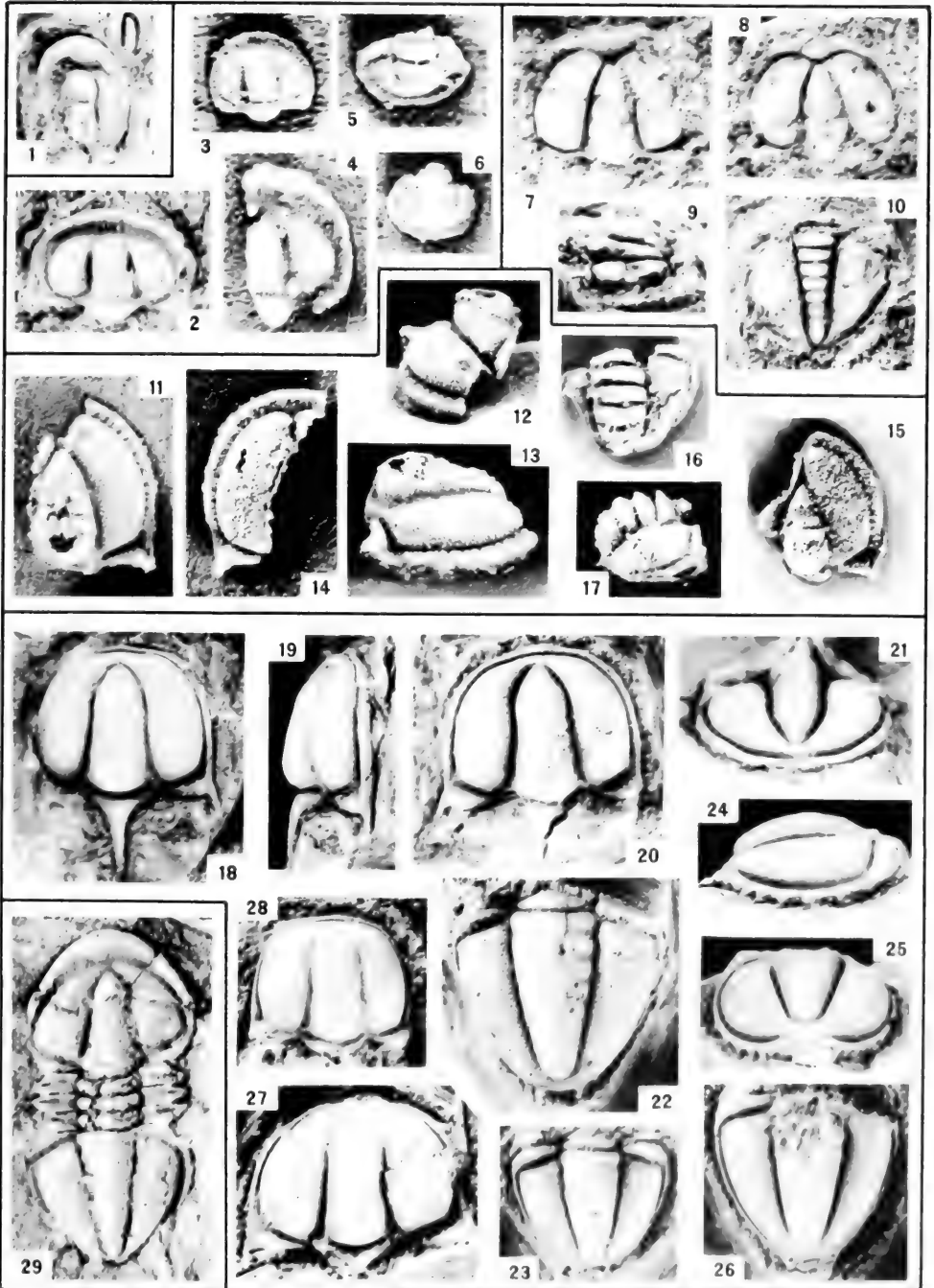
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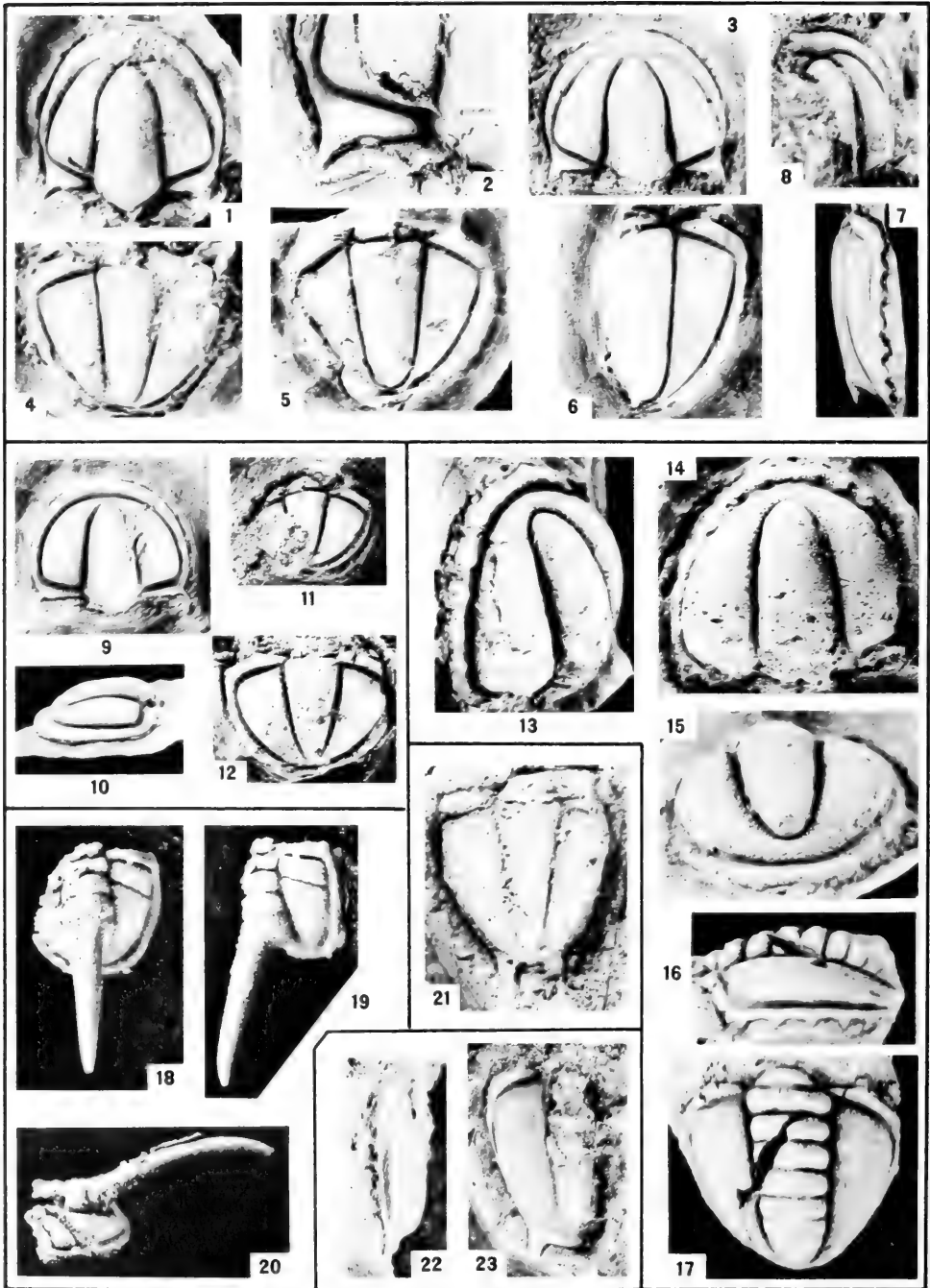
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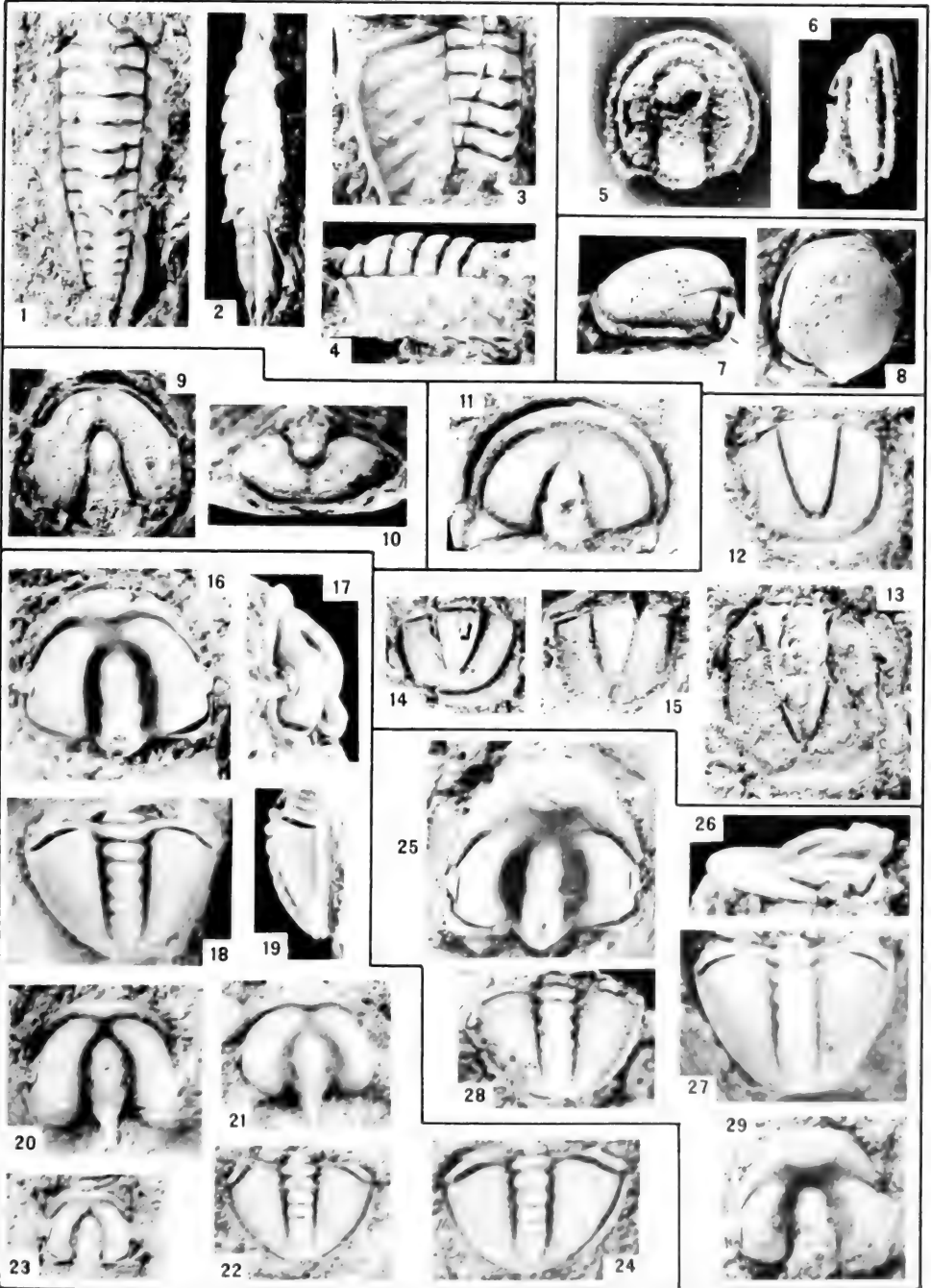
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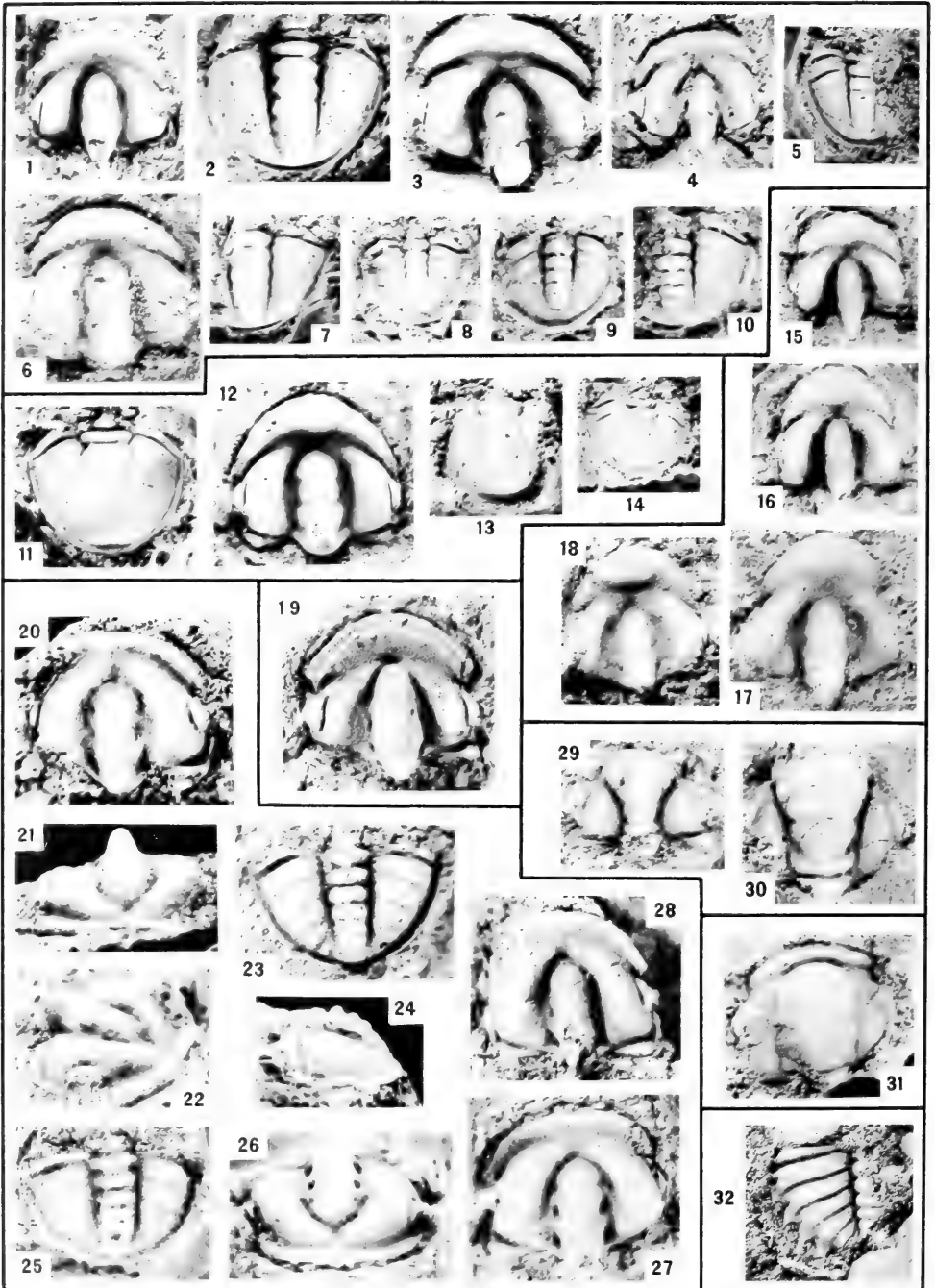
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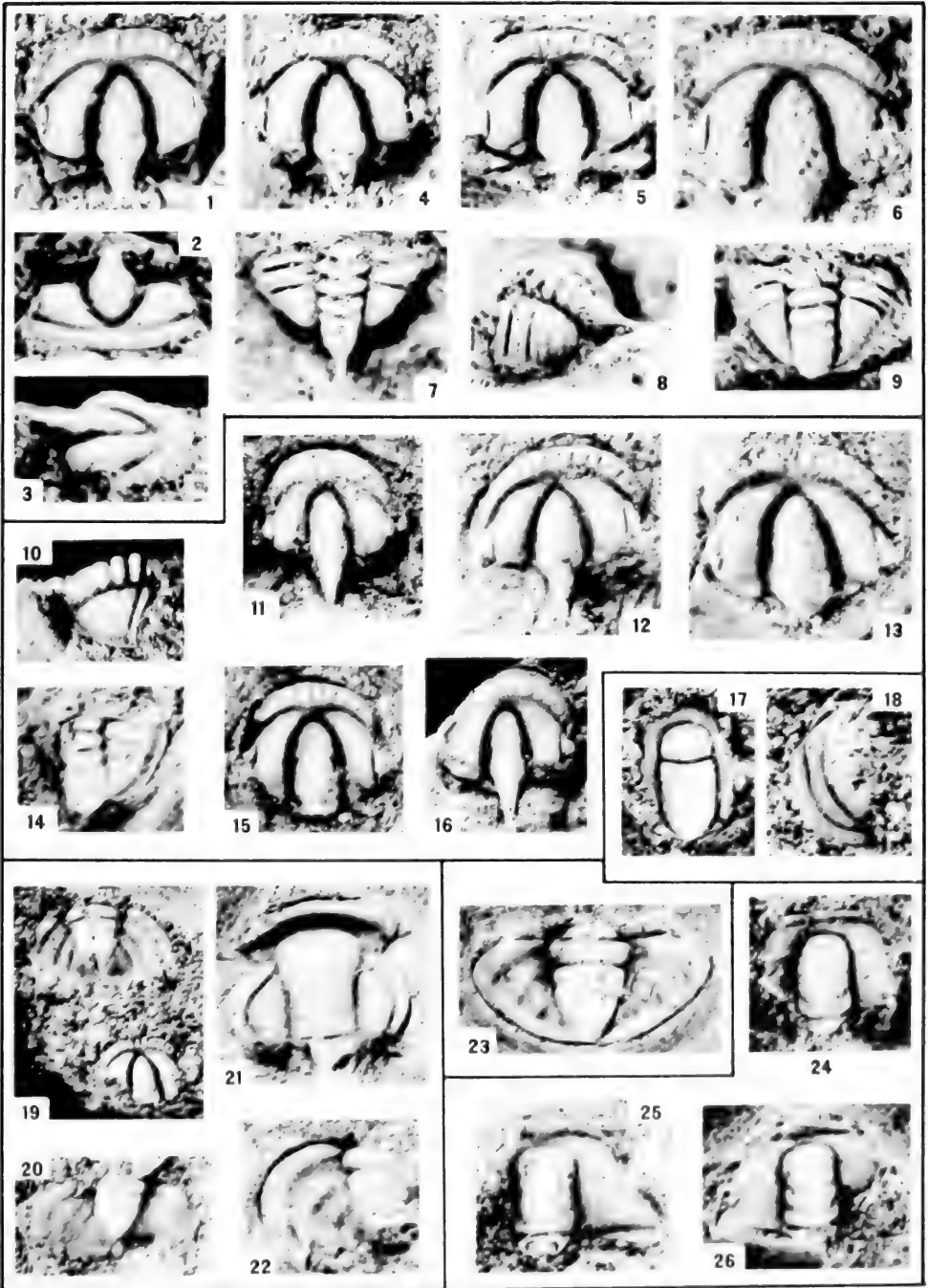
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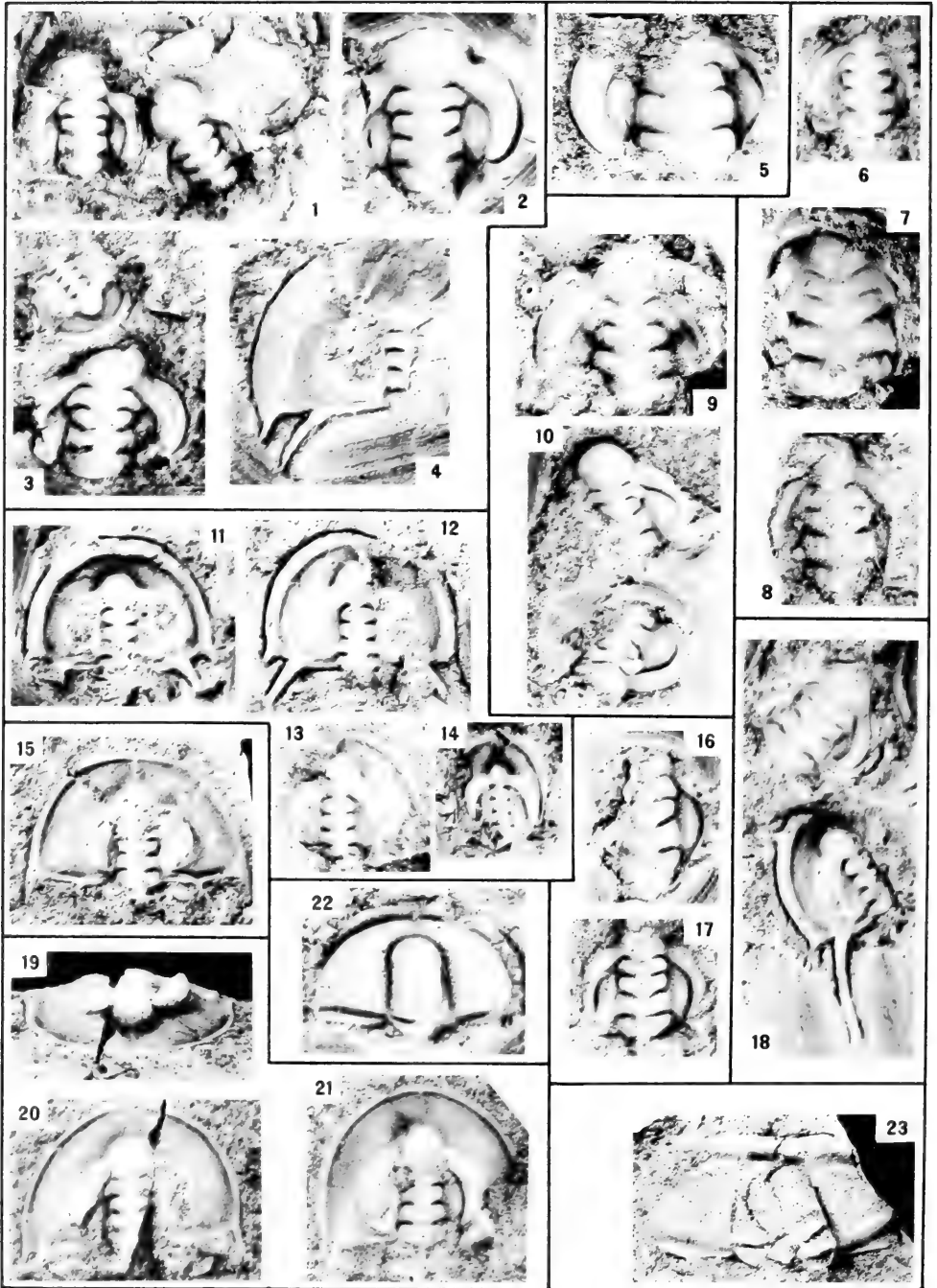
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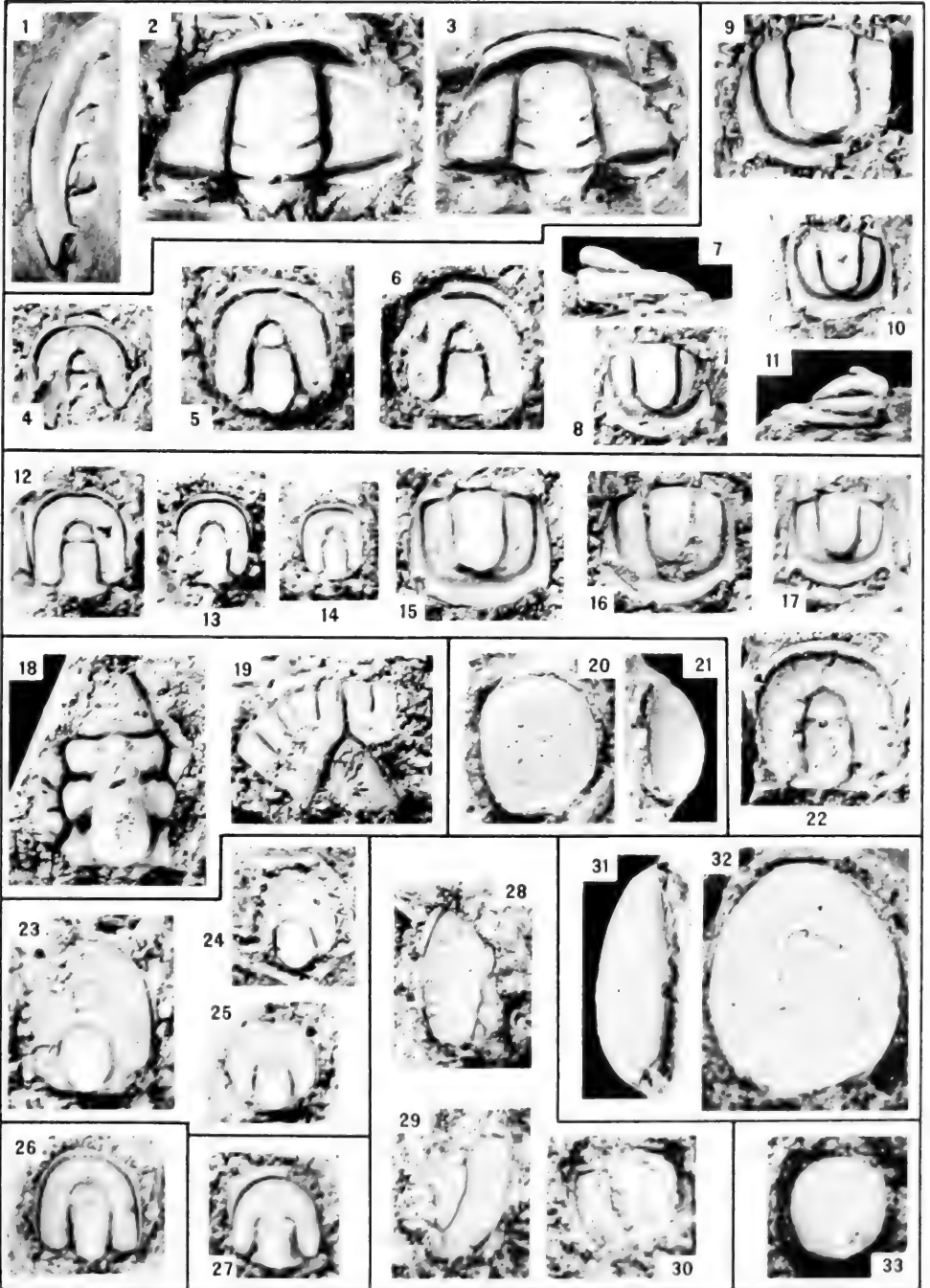
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PLATE 8

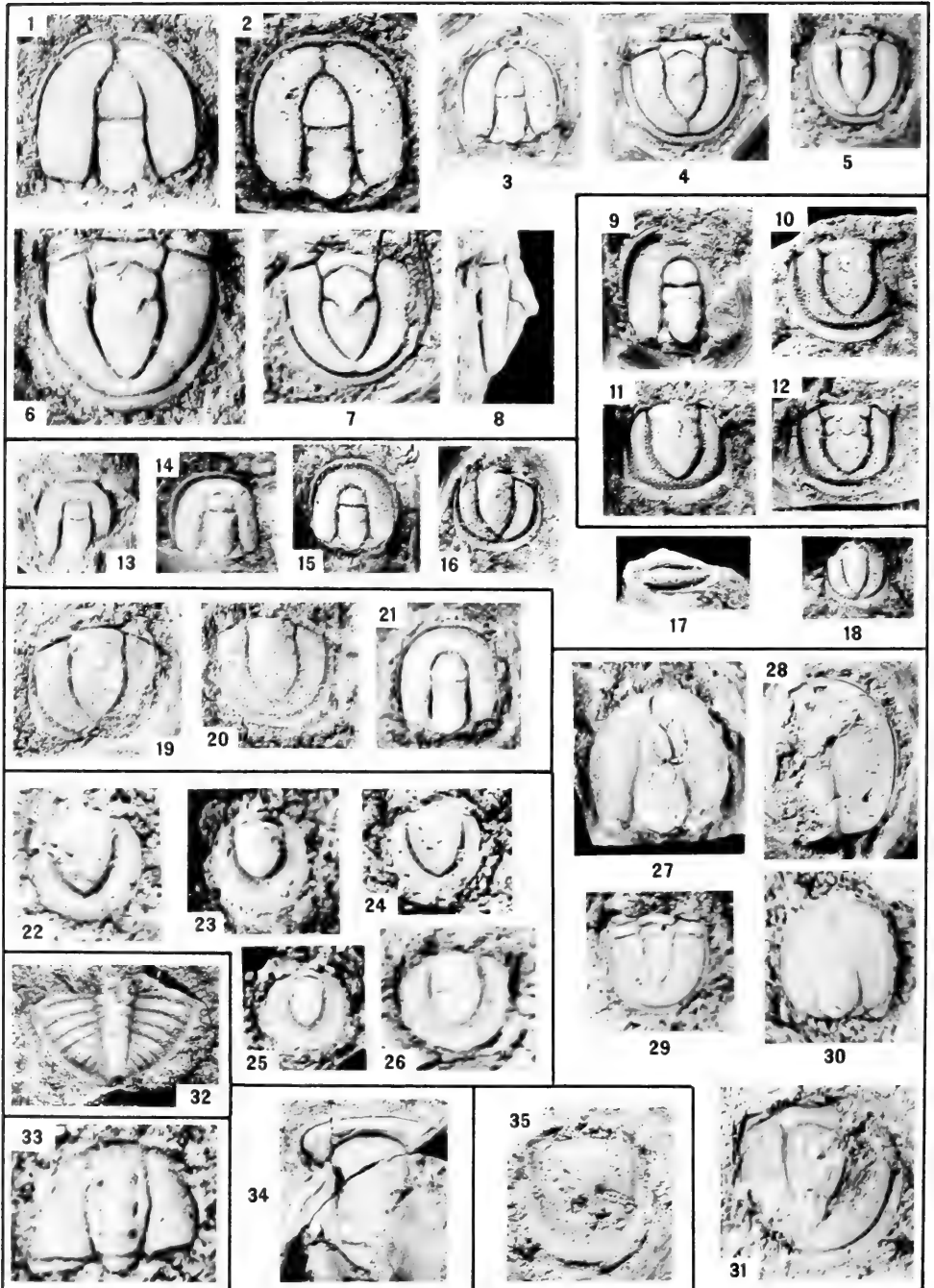
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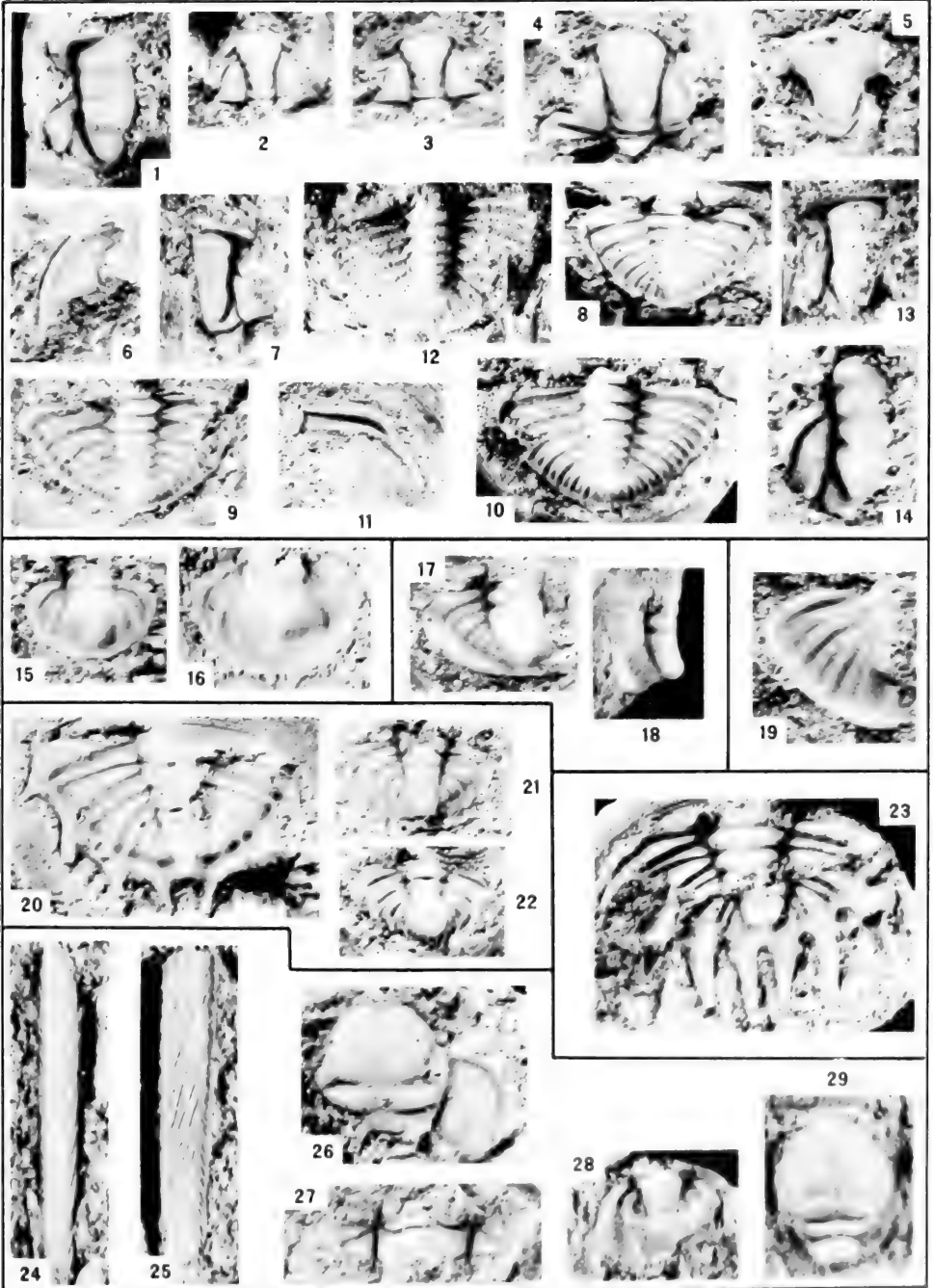
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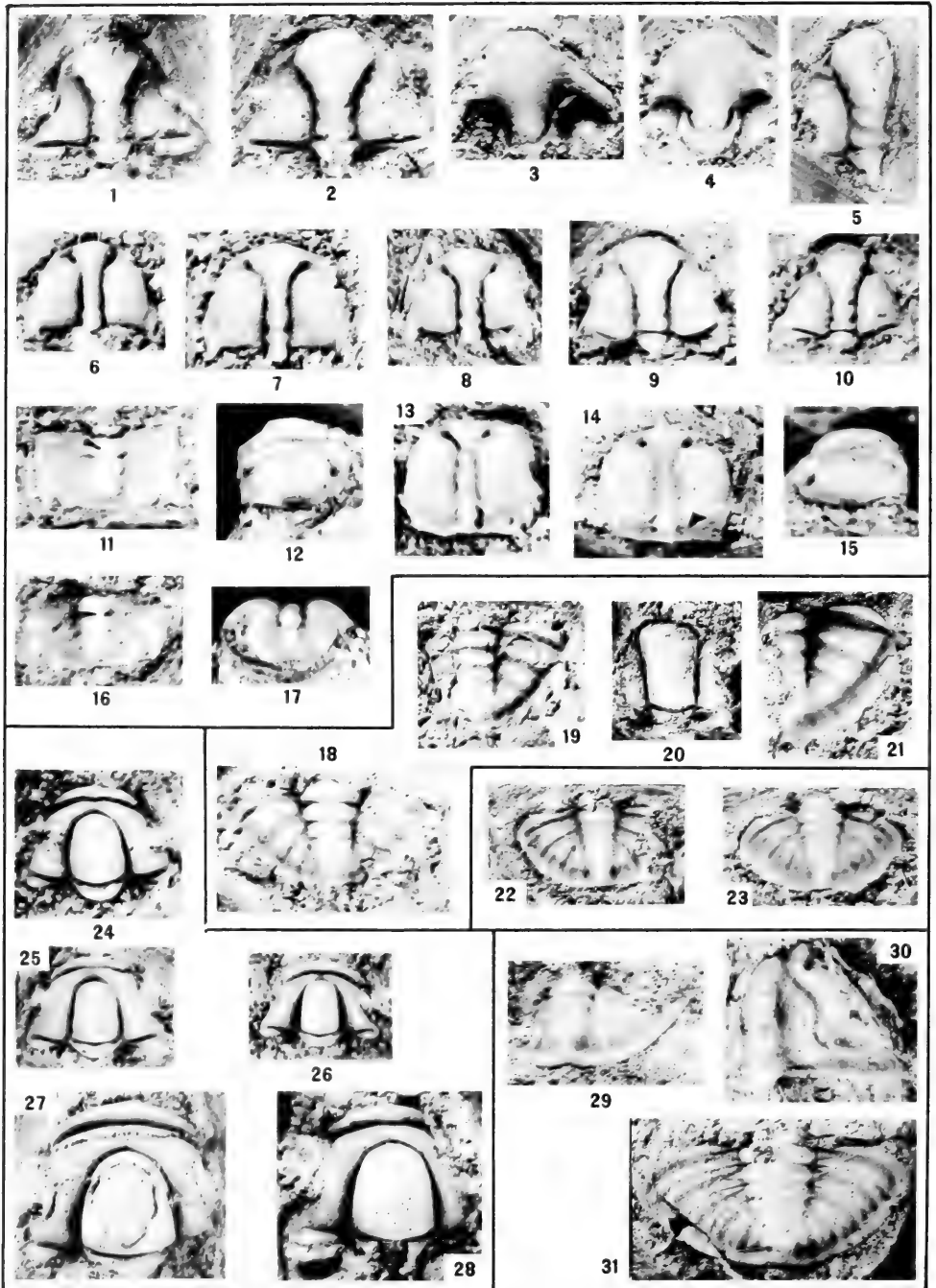
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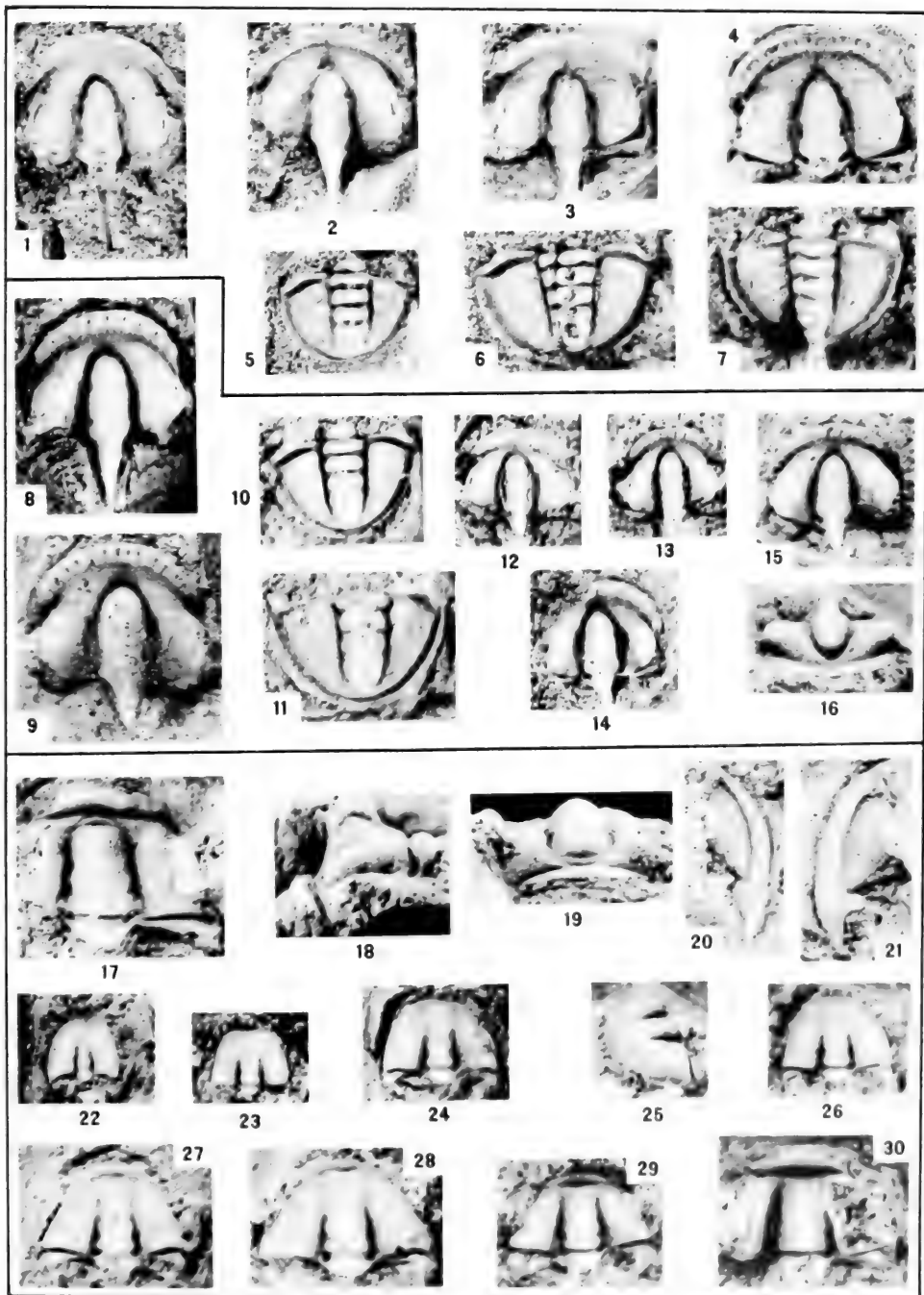
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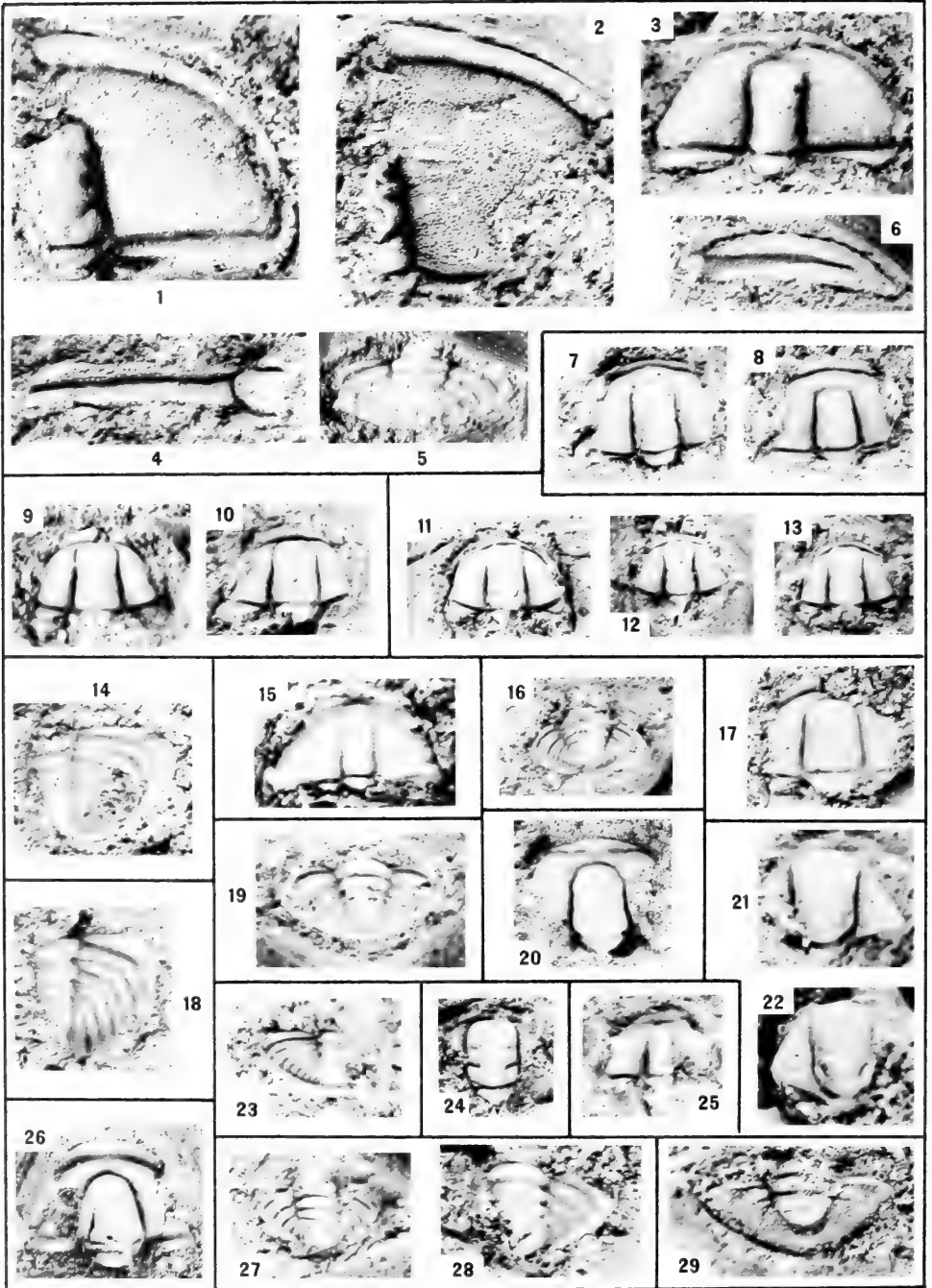
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