Early and Middle Cambrian Trilobites From Antarctica

GEOLOGICAL SURVEY PROFESSIONAL PAPER 456-D

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By ALLISON R. PALMER *and* COLIN G. GATEHOUSE

CONTRIBUTIONS TO THE GEOLOGY OF ANTARCTICA

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Biostratigraphy and regional significance of nine trilobite faunules from Antarctic outcrops and moraines; 28 species representing 21 genera are described

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CONTRIBUTIONS TO THE GEOLOGY OF ANTARCTICA

EARLY AND MIDDLE CAMBRIAN TRILOBITES FROM ANTARCTICA

By Allison R. Palmer [1] and Colin G. Gatehouse [2]

ABSTRACT

Eight trilobite faunules ranging in age from Early Cambrian to late Middle Cambrian have been recovered from fossiliferous moraine boulders at Mount Spann in the northeastern Argentina Range, Antarctica. One of the late Middle Cambrian faunules from Mount Spann and one additional Middle Cambrian faunule were collected in place in the lowermost part of the Nelson Limestone of the Neptune Range. Badly deformed and slightly metamorphosed Middle Cambrian trilobites from the Harold Byrd Mountains represent a probable tenth faunule. Almost all trilobites in these faunules are close relatives of Australian, Chinese, or Siberian forms. There are no significant relations between any of the faunules and the Cambrian trilobites of South or North America. Within Antarctica, the areas of the Neptune Range and possibly also the Harold Byrd Mountains were the last to be inundated by transgressing Cambrian seas. Limestones in the Argentina Range at the Weddell Sea end of the Transantarctic Mountains, and the Shackleton Limestone at the Ross Sea end of the mountains, are considerably older than the oldest limestones in the Neptune Range.

The trilobite faunas include 28 species representing 21 genera; of these, 22 species and four genera are new. New taxa are: *Pagetia longispina* n. sp., *Pagetides? antarcticus* n. sp., *Australaspis magnus* n. gen., n. sp., *Xystridura glacia* n. sp., *X. multilinia* n. sp., *Chorbusulina subdita* n. sp., *C. wilkesi* n. sp., *Amphoton oatesi* n. sp., *Kootenia styrax* n. sp., *Bathyuriscellus australis* n. sp., *B. modestus* n. sp., *Goldfieldia ninguis* n. sp., *Chondranomocare australis* n. sp., *Liopeishania spannensis* n. sp., *Suludella? davnii* n. sp., *S. spinosa* n. sp., *Trinepea trinodus* n. gen., n. sp., *Solenopleura pruina* n. sp., *Glabrella? pitans* n. sp., *Nelsonia schesis* n. gen., n. sp., *Pensacola isolata* n. sp., *Schopfaspis granulosus* n. gen., n. sp.

INTRODUCTION

Antarctica is the last of the world's continents to be explored geologically. It is also a key element of the late Paleozoic continent of Gondwana that has been fragmented into the present continents of Africa, South America, Australia, and Antarctica during the Mesozoic and Cenozoic eras. Until now there has been little direct evidence for the early Paleozoic regional relationships of Antarctica. Although Cambrian fossils were first described from Antarctica by Gordon (1920), that report and all subsequent descriptive studies recorded only Archaeocyatha. These fossils lack sufficient provinciality to assist greatly in problems relating to early Paleozoic geography (Zhuravleva, 1968). Thus, the discovery of Cambrian trilobites in 1964 opened up the possibility for more precise evaluation of early Paleozoic geographic relations of Antarctica. In this paper, the problems of the regional Cambrian stratigraphy of Antarctica and its relation to the other southern continents during the Cambrian is explored, and all known Early and Middle Cambrian trilobites of Antarctica are described.

Outcropping sequences of sedimentary rocks that include fossiliferous Cambrian limestones are known from five scattered areas in Antarctica (fig. 1). Four of these, the Argentina Range, the Neptune Range, the Harold Byrd Mountains, and areas adjacent to the ice shelf in southern Victoria Land are within the Transantarctic Mountains. The fifth area, the Heritage Range, is now in West Antarctica, but Schopf (1969) has suggested that it is part of a dislocated segment of the Transantarctic Mountains that originally was north of the Argentina and Neptune Ranges.

Trilobite-bearing beds were first discovered in the 1963–64 field season in the Heritage Range (Webers, 1965) and the Neptune Range (Schmidt and others, 1965). The following year, trilobites were collected in the Harold Byrd Mountains (Minishew, 1966). Additional collections from the Neptune Range and new collections from the Argentina Range were obtained during the 1965–66 field season. Trilobites have not yet been found in the ice-shelf areas of southern Victoria Land.

Trilobites from the Argentina and Neptune Ranges and the Harold Byrd Mountains constitute all the known Early and Middle Cambrian trilobites from Antarctica. The only known Late Cambrian trilobite fauna, from the Heritage Range, is being studied sep-

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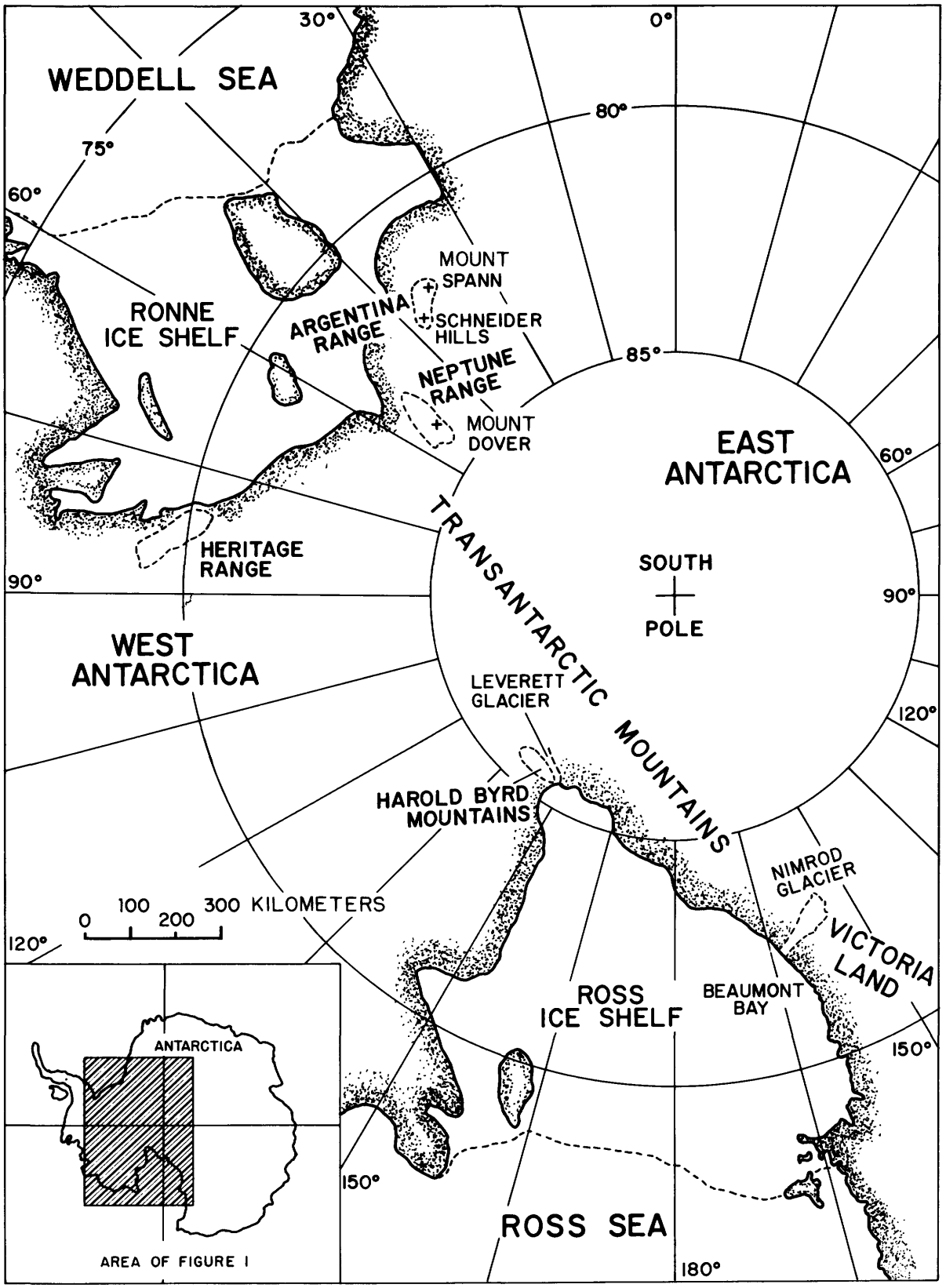

FIGURE 1.—Index map of part of Antarctica showing localities mentioned in this report.

arately by G. F. Webers of Macalester College, St. Paul, Minn.

All the trilobite collections, except the one made by Webers from the Heritage Range, were sent to Palmer at the U.S. Geological Survey for identification. After Palmer had moved to the State University of New York at Stony Brook, Gatehouse was assigned these collections for a study that resulted in a Master's thesis. Thus, much of the preparation of specimens and photography, and some of the suggestions about relations to described faunas, are the work of Gatehouse. The thesis has been completely revised by Palmer, however, and expanded to include some material not covered in the thesis study. Final responsibility for all conclusions are his.

Valuable stratigraphic and locality data have been provided by D. L. Schmidt (Neptune and Argentina Ranges) and J. M. Schopf (Argentina Range) of the U.S. Geological Survey and V. H. Minishew (Harold Byrd Mountains) of the University of Mississippi.

The systematics in this paper have benefitted greatly from comments by L. I. Yegorova of the Research Institute of Geology, Geophysics and Mineral Resources in Novosibirsk and L. N. Repina of the Institute of Geology and Geophysics of the Academy of Sciences in Academgorodok, who examined replicas of some of the Antarctic trilobites.

Typing of the final manuscript, much of the photography, and help with numerous details of specimen numbering by Miss Janet Gardner are gratefully acknowledged and sincerely appreciated.

BIOSTRATIGRAPHY

With the exception of trilobite assemblages from the Neptune Range, and the deformed and generically indeterminate trilobites from the Harold Byrd Mountains, all the Early and Middle Cambrian trilobites from Antarctica are from morainal debris or talus. In this paper, assemblages of species that occur in one or more samples are designated as faunules, and each faunule is named after its commonest constituent.

All the Antarctic Cambrian trilobite faunules have their strongest affinities with faunas from Australia, China, or Siberia. There is no common biostratigraphic framework for these areas; each has its own local nomenclature of zones and stages. Detailed correlation of these local biostratigraphic sequences is still not stabilized, and one of the largest unsolved problems, which affects the Antarctic faunas, involves the placement of the boundary between the Early and Middle Cambrian.

In Siberia, the Early Cambrian has traditionally been divided into two stages, an older Aldan Stage and a younger Lena Stage (fig. 2). The definitive Early Cambrian fossils from the Russian viewpoint are Archaeocyatha. Olenellid trilobites, which are the defintive elements of the Early Cambrian, as originally defined by Walcott (1891), are found only in the Aldan Stage. Öpik (1968 has pointed out this inconsistency and has suggested that beds of Lena Age be excluded from the Early Cambrian epoch. However, the problem is not so simply solved because precise correlation at the zone level between the American sequences that served as the original basis for the Early Cambrian and zone sequences elsewhere in the world is not yet possible. Khomentovskiy and Repina (1965) proposed a revision of the Early Cambrian biostratigraphy of Siberia based on careful analysis of the excellent exposures of beds of this age along the Lena River at the southern margin of the Siberian platform. They divided the old Lena Stage into two parts, a lower Botoma Stage and a younger Lena Stage (restricted). Furthermore, Repina (written commun., May 8, 1970) indicates that she has discovered in Siberia trilobites suggestive of forms from American lower Middle Cambrian beds in association with trilobites typical of beds of restricted Lena Age. Thus, Öpik's views seem to be in part substantiated, but a consistent position for the Early Cambrian-Middle Cambrian boundary in all Cambrian sequences is not yet possible. Thus, throughout this paper, the primary age assignment for each faunule is in terms of the geographic area with which it has its greatest affinities.

Description of the position of faunules within the Lower Cambrian Series in general terms presents no major problems. However, the general positioning of the Middle Cambrian faunules may lead to some confusion. Most generalizations about the placement of faunas within the Middle Cambrian of Asia and Australia are best phrased in terms of a twofold division into early Middle Cambrian (Amga, pre-Taitzu and correlative beds) and late Middle Cambrian (Maya, Taitzu and correlative beds) (fig. 2). In northwestern Europe and North America, a threefold division into early, middle and late Middle Cambrian is generally used. Because the Antarctic Middle Cambrian faunas have their greatest affinities with Asia and Australia, their relative placement is phrased in this paper in terms of the twofold subdivision.

Figure 2 shows the approximate correlation of most of the biostratigraphic units mentioned in the discussions relating to the age of each faunule.

The nine faunules that have been recognized in Antarctica represent four age groups. The relative ages of each group of two or more faunules can be established with reasonable confidence (fig. 2), but the relative ages

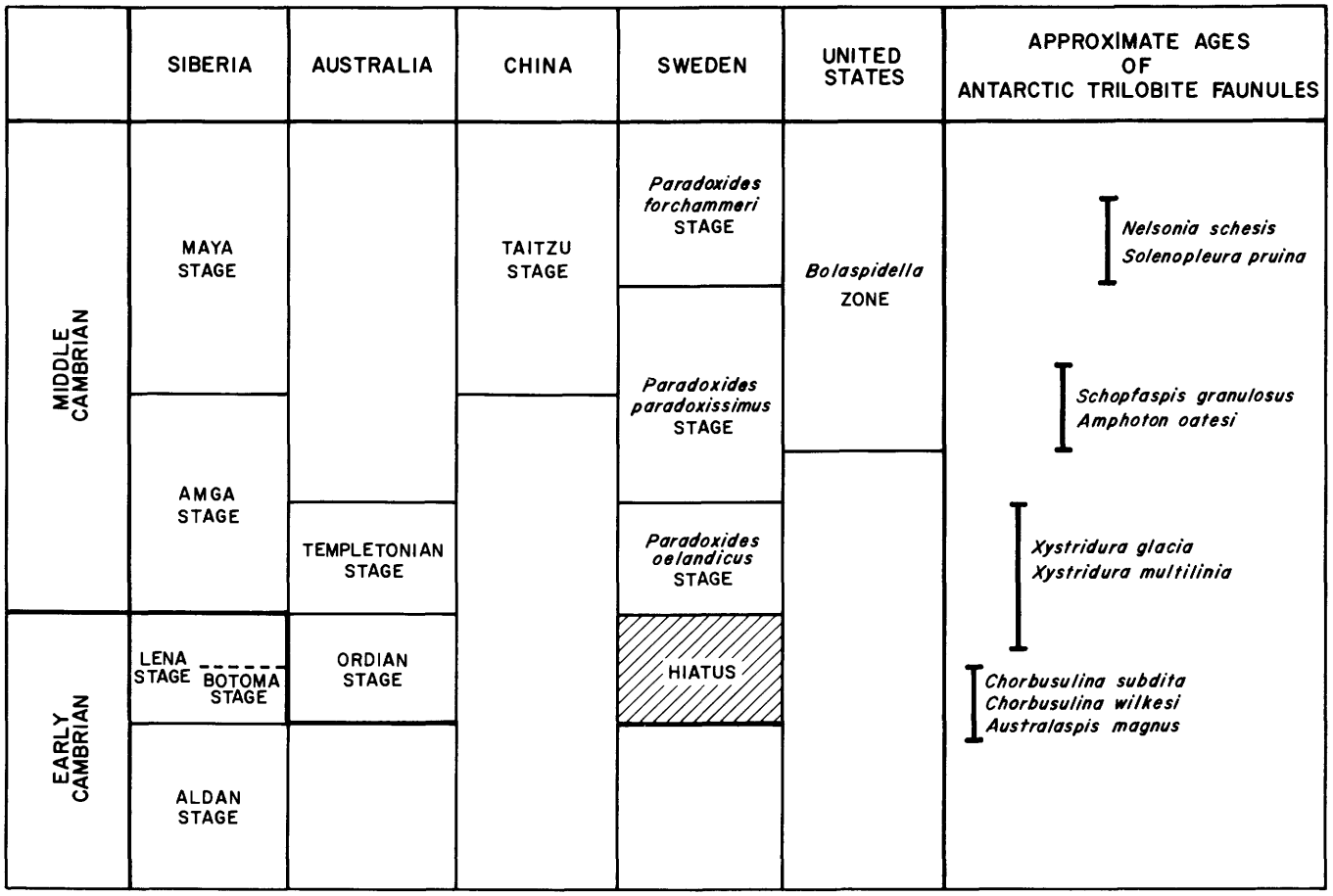

FIGURE 2.—Correlation chart showing the biostratigraphic units (stages or zones) mentioned in the text and the approximate relative positions of the Antarctic trilobite faunules.

of faunules within an age group cannot be satisfactorily determined from presently available evidence.

The oldest age group includes the *Australaspis magnus*, *Chorbusulina wilkesi*, and *C. subdita* faunules that contain predominantly Siberian elements. They are approximately equivalent to Early Cambrian faunas of Botoma (early Lena unrestricted) Age. The next younger group contains the *Xystridura multilinia* and *X. glacia* faunules which have predominantly Australian elements of either Ordian or Templetonian (early Middle Cambrian) age. The third group includes the *Amphoton oatesi* and *Schopfaspis granulosus* faunules whose elements have affinities to Australian, Chinese, and Siberian faunas of about early late Middle Cambrian age. The youngest group includes the *Solenopleura pruina* and *Nelsonia schesis* faunules of probable later Middle Cambrian age that have some affinities to Siberian faunas.

The composition of each faunule and the evidence for its age within the Cambrian are given below.

EARLY CAMBRIAN FAUNULES

AUSTRALASPIS MAGNUS FAUNULE

This faunule consists of two species, *Australaspis magnus* n. sp. and *Glabrella? pitans* n. sp., both of which are moderately common in two boulders (USGS colln. 5939–CO and 6311–CO) from moraines on Mount Spann. The age of the faunule is based on the affinities of both species to species from the Early Cambrian of Siberia.

Australaspis has many peculiar cranidial features, particularly the structure of the palpebral lobes, ocular ridges, and frontal area, in common with *Bulaiaspis*, and it is almost certainly assignable to the Early Cambrian family Neoredlichiidae. *Bulaiaspis* ranges from the Tolbachan and Kameshkov horizons of late Aldan Age into the Uritsk horizon at the base of the Botoma (or Lena unrestricted) Stage.

Glabrella? pitans is certainly congeneric with *G. mrassina* Yegorova from the Obruchev horizon of Lena Age in southern Siberia.

The position of this faunule relative to the *Chorbusulina wilkesi* faunule is not determinable from presently available evidence.

CHORBUSULINA WILKESI FAUNULE

This faunule includes four species of trilobites, *Bathyuriscellus australis* n. sp., *Chorbusulina wilkesi* n. sp., *Pensacola isolata* n. gen., n. sp., and *Redlichia* sp. undet., and an undetermined archaeocyathid. All the species were found associated in a single boulder (USGS colln. 6308–CO) at Mount Spann. Four other boulders in the same area had at least two of the trilobite species. The commonest species, both in numbers of individuals and frequency of occurrence are *P. isolata* and *C. wilkesi*. Determination of the age of the faunule is based on comparison with the Cambrian faunas of Siberia. *Redlichia* is reported only from the Olekminsk and Sanashtykgol horizons of the Botoma or early Lena (unrestricted) Stages (Repina, 1966) of the Siberian Early Cambrian. *Bathyuriscellus* ranges from the uppermost part of the Aldan Stage (Lazarenko, 1964) to the Angarsk horizon of the post-Botoma part of the Lena Stage (unrestricted) (Chernysheva, 1961) of the Siberian Early Cambrian but is most common in the intervening Olekminsk and Sanashtykgol horizons (Repina and others, 1964; Suvorova, 1960b). *Chorbusulina* is reported only from the *Judomia* zone of the late Aldan Stage (Lazarenko, 1962; Lazarenko, 1964; Yegorova and Savitskiy, 1969). Thus, the most likely correlation of the *C. wilkesi* faunule is with latest Aldan or earliest post-Aldan (Lena, unrestricted, or Botoma) beds in Siberia.

CHORBUSULINA SUBDITA FAUNULE

This faunule includes two species of trilobites, *Chorbusulina subdita* n. sp. and *Bathyuriscellus modestus* n. sp., that are associated in one boulder. A second boulder at Mount Spann containing only *C. subdita* n. sp. is also considered to be representative of this fauna. Very little time difference probably exists between the *Chorbusulina wilkesi* and *C. subdita* faunules, and the suggested correlation for the *C. wilkesi* faunule is also valid for the *C. subdita* faunule.

EARLY MIDDLE CAMBRIAN FAUNULES

XYSTRIDURA MULTILINIA FAUNULE

This faunule includes four species of trilobites and several species of stenothecoidid, hyolithid, and helcionellid mollusks associated in a coquina from one boulder (USGS, colln. 6333–CO) in the moraines on Mount Spann. The trilobites include *Xystridura multilinia* n. sp., *Pagetia longispina* n. sp., *Goldfieldia ninguis* n. sp., and an undetermined ptychoparioid designated as "Genus and species undetermined 1."

Neither *Pagetia*, which is a genus ranging from Early to medial Middle Cambrian in age, nor *Goldfieldia*, a member of the long-ranging Oryctocephalidae that has been found previously at only one locality in Lower Cambrian beds in Western United States, contribute much to the problem of the age of the *X. multilinia* faunule.

Xystridura, however, is a genus found principally in beds dated as early Middle Cambrian in Australia and assigned to either the Ordian or overlying Templetonian Stages (Öpik, 1968). The absence of species of *Redlichia* in the Antarctic faunule, a genus associated with *Xystridura* in beds of Ordian Age, suggests that the *X. multilinia* faunule may come from beds correlative with the Templetonian Stage. However, precise correlation of the faunule must await description of more of the Ordian and Templetonian trilobite faunas of Australia.

XYSTRIDURA GLACIA FAUNULE

This faunule consists only of the nominal species which occurs in a single boulder (USGS colln. 5938–CO) from the moraines on Mount Spann. *X. glacia* is distinct from all described species and is not associated with other trilobites. The genus is found in Australia in beds assigned by Öpik (1968) to either the Ordian or Templetonian Stages of early Middle Cambrian age. Until *X. glacia* is found in context with elements of either of these stages, its age cannot be stated more precisely than early middle Cambrian.

LATE MIDDLE CAMBRIAN FAUNULES

AMPHOTON OATESI FAUNULE

This faunule, from USGS colln. 4446–CO in the lower part of the Nelson Limestone in the Neptune Range, is characterized by six trilobites: *Amphoton oatesi* n. sp., *Chondranomocare australis* n. sp., *Trinepea trinodus* n. gen., n. sp., *Kootenia styrax* n. sp., *Peronopsis* cf. *P. fallax* (Linnarsson), and Genus and species undetermined 4.

Amphoton is a characteristic genus of the late Middle Cambrian Taitzu Stage of eastern Asia (Kobayashi, 1967). It is also found in upper Middle Cambrian beds of Australia (Öpik, 1961) and in beds of Amga Age in Siberia (Chernysheva, 1961). *Chondranomocare*, on the other hand, is found only in beds of late Amga Age in Siberia, which Kobayashi (1967, p. 515) correlates with pre-Taitzu beds of Asia. Nepeidae are characteristic of upper Middle Cambrian beds in Australia, and species of *Peronopsis* most similar to those from the *A. oatesi* faunule are known from upper Middle Cambrian beds in China, Scandinavia, and Siberia. *Kootenia* is a long-

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ranging genus of little stratigraphic value. Most of the elements of the *A. oatesi* faunule are consistent with an early late Middle Cambrian age.

SCHOPFASPIS GRANULOSUS FAUNULE

This faunule includes five species of trilobites: *Schopfaspis granulosus* n. sp., *Pagetides? antarcticus* n. sp., *Liopeishania spannensis* n. sp., *Olenoides* sp., and Genus and species undetermined 2. Rare mollusks are also present. The first three species are abundantly represented in four boulders (USGS collns. 6313–CO, 6325–CO, 6327–CO, and 6364–CO) from the moraine on Mount Spann. *Olenoides* sp. and the undetermined ptychoparioid are rare elements in USGS colln. 6325–CO.

Schopfaspis granulosus is a ptychoparioid trilobite with no close relatives that might help to identify its stratigraphic age.

Liopeishania spannensis n. sp. is an asaphiscid trilobite that is extremely similar to *Liopeishania lubrica* Chang (1959) from the Middle Cambrian Changhsia Formation of Taitzu Age in Shantung, China. Asaphiscidae are also present in the Middle Cambrian *Bolaspidella* zone and lower Upper Cambrian beds in North America. *L. spannensis* n. sp. shares many features with *Asaphiscus wheeleri* (Meek) from the lower part of the *Bolaspidella* zone which seems to be approximately correlative with the Taitzu Stage.

Pagetides? antarcticus is as abundant as *P.? granulosus*, but pagetiids of the general aspect of this species which lack a terminal pygidial spine are presently known only from Lower Cambrian beds. The species differs significantly from typical species of *Pagetides*, however, in structure of the occipital spine and palpebral lobes.

Olenoides is a long-ranging Early to Late Cambrian genus.

Because the stratigraphic range of the Asaphiscidae is well established as late Middle Cambrian or younger and because *Liopeishania spannensis* shares so many features with known trilobites of this age, the age of this faunule is here considered to be late Middle Cambrian; *Pagetides? antarcticus* is considered to be a pagetiid that may be a derivative of *Pagetia* that has lost its spine and that only superficially resembles species of *Pagetides*.

SOLENOPLEURA PRUINA FAUNULE

This is a small faunule from a single boulder (USGS colln. 6320–CO) from the moraines on Mount Spann. It includes two trilobites, *Solenopleura pruina* n. sp. and *Suludella? davnii* n. sp., and fragmentary orthoid brachiopods. *Solenopleura* is a characteristic Late Middle Cambrian genus, and the Antarctic species is most like species described by Chernysheva (1953) from beds assigned to the *Paradoxides forchammeri* and *P. davidus* zones in eastern Siberia. *Suludella* is a genus characteristic of the *Proasaphiscus privus* zone of the middle part of the Maya Stage in Siberia (Yegorova and Savitskiy, 1969). Thus, both elements in the *S. pruina* faunule suggest a late Middle Cambrian age for the faunule. This faunule, with its strongest affinities to the late Middle Cambrian Maya Stage, is probably from slightly younger beds than the *Amphoton oatesi* faunule which contains some elements indicating affinity with the older Amga Stage.

NELSONIA SCHESIS FAUNULE

This faunule is characterized by two trilobites, *Nelsonia schesis* n. gen., n. sp. and *Suludella? spinosa* n. sp., and is particularly significant because it is the only faunule common to the outcrop areas of the Neptune Range (USGS colln. 4443–CO, 4445–CO, 4448–CO) and boulders from the moraines on Mount Spann more than 165 miles away (USGS colln. 6355–CO).

Nelsonia schesis has no apparent close relatives, and the dating of the faunule depends on *Suludella? spinosa*. This trilobite is most like species from the middle part of the late Middle Cambrian Maya Stage in Siberia. On this basis, the *N. schesis* faunule is tentatively dated as late Middle Cambrian.

PHYSICAL STRATIGRAPHY

Details are lacking for most stratigraphic sequences of Cambrian or possible Cambrian age in Antarctica. Nevertheless, enough information is now available to permit some regional considerations, and the stratigraphic data for each of the Cambrian areas are summarized below.

In the southern Argentina Range, the Schneider Hills in the south part have extensive outcrops of archaeocyathid limestone (D. L. Schmidt, written commun., Dec. 1966). At Mount Spann, about 40 miles to the northeast, moraine boulders (J. M. Schopf, written commun., May 1966) bear archaeocyathids, mixed archaeocyathids and trilobites, and trilobite-mollusk associations which indicate the presence of limestones ranging in age from Early Cambrian to late Middle Cambrian.

In the Neptune Range, the Cambrian sequence begins with the Nelson Limestone, a unit 600 to 700 feet thick, which lies with angular unconformity on the Patuxent Formation. Overlying the Nelson Limestone conformably is the Gambacorta Formation, a unit of volcanic and hypabyssal rocks more than 1,000 feet thick. The Wiens Formation, a unit of shale, siltstone, sandstone, and some oolitic limestone less than 1,000 feet thick conformably overlies the Gambacorta Formation.

All these units were deformed before deposition of the Elliott Sandstone (Schmidt and others, 1965).

The Nelson Limestone is the only fossiliferous unit in the Neptune Range. It consists of five members: "(1) a basal red quartz-fragment conglomerate, 1 to 20 feet thick, which is composed largely of erosional detritus of the Patuxent Formation; (2) a local red-bed clastic succession which is as much as 60 feet thick; (3) a lower gray limestone, 200 to 300 feet thick, which consists of thin-bedded limestone containing interbedded lamellae of limy shale; (4) a middle gray limestone 200 to 300 feet thick, which consists of thick-bedded massive limestone; and (5) an upper gray limestone, about 100 to 150 feet thick, which consists of thin-bedded limestone and shaly limestone. The thin-bedded limestones, members 3 and 5, are commonly oolitic, pisolitic, and nodular." (Schmidt and others, 1965, p. D114.)

In the 1965–66 field season, Schmidt collected trilobites from the basal beds of member 3 and from two other horizons about 30 feet above the base of the member at Mount Dover. All of these collections contain the *Nelsonia schesis* faunule. Trilobites of this faunule and the *Amphoton oatesi* faunule were also collected earlier from unknown horizons within the Nelson Limestone about 8 miles to the northeast. Thus, in the Neptune Range area, the oldest limestone beds in the Cambrian section are medial or late Middle Cambrian in age.

In the Heritage Range, a partial section of Cambrian and possible Cambrian rocks includes a limestone unit ranging from 25 to 300 feet in thickness near the top that has yielded a rich trilobite-mollusk assemblage of Late Cambrian age (Webers, 1965). Below this is about 2,000 feet of dark pelitic rocks with rare thin carbonate interbeds; this overlies another limestone unit about 900 feet thick that has not as yet yielded any fossils (Craddock and others, 1964).

In the Harold Byrd Mountains, a sequence of limestones and shales above a unit of coarse arkosic arenites and below a unit of rhyolitic volcanic rocks. (V. H. Minishew, written commun., July 1966) has yielded a single collection of trilobites from a badly deformed and slightly metamorphosed limestone bed. Minishew believes that these units are unconformable above an older and more metamorphosed sedimentary sequence.

In the Nimrod Glacier-Beaumont Bay region of southern Victoria Land, Grindley and Laird (1969) have reported about 20,000 feet of limestones and terrigenous rocks assigned to the Shackleton Limestone. Massive limestones in the lowest exposed limestone unit in the type section have yielded archaeocyathids described by Hill (1964) that are comparable in age to the oldest trilobite-archaeocyathid associations at Mount Spann.

REGIONAL CORRELATION WITHIN ANTARCTICA

The key unit for regional correlation and interpretation of the regional stratigraphy is the Nelson Limestone. This is a part of a relatively thin Cambrian sequence that has a base no older than medial Middle Cambrian; it occupies a central position in the Transantarctic Mountains in the Atlantic sector. Toward the Weddell Sea, the Schneider Hills of the Argentina Range have outcrops of archaeocyathid-bearing limestones that must be older than the Nelson Limestone. Closer to the coast, the boulders from Mount Spann contain trilobite faunules found also in the Nelson Limestone as well as older archaeocyathid faunas. If the Heritage Range is placed on the Atlantic extension of the Transantarctic Mountains, as suggested by Schopf (1969), the Cambrian section there represents a still more seaward location, and the thick section of gray pelites with thin limestone interbeds that underlies the limestone unit bearing Late Cambrian trilobites could represent deeper water sediments beyond the main areas of carbonate sedimentation. Some confirmation of this would come from discovery of agnostid trilobites in the pelitic sequence, because these trilobites are only abundant in deposits below water bodies that had free access to the open ocean (Palmer, 1972). Because the Nelson Limestone has yielded trilobites only from its basal beds and these are of late Middle Cambrian age, it is reasonable to suggest that the younger beds of the formation could correlate with the thin Late Cambrian limestone of the Heritage Range.

In the Ross Sea sector of the Transantarctic Mountains, the section in the Harold Byrd Mountains is analogous to the section in the Neptune Range. The trilobite-bearing limestone unit is, at least in part, of Middle Cambrian age and probably correlative with the Nelson Limestone. In both areas, the trilobite-bearing limestones are overlain by a unit of volcanic rocks. Although the terrigenous units underlying the limestones in both areas differ in thickness, they are unconformable on older deformed and metamorphosed sediments.

In southern Victoria Land, the extremely thick carbonate succession of the Shackleton Limestone has archaeocyathids in its lower beds that are comparable in age to the oldest beds dated in the Mount Spann area. Documentation for the age of the younger part of the Shackleton Limestone has not yet been presented, but it could include most of the Cambrian System and be analogous to the formation or formations that yielded the boulder sequences at Mount Spann.

Figure 3 is a speculative diagram with an interpretation of the Cambrian stratigraphic relationships of

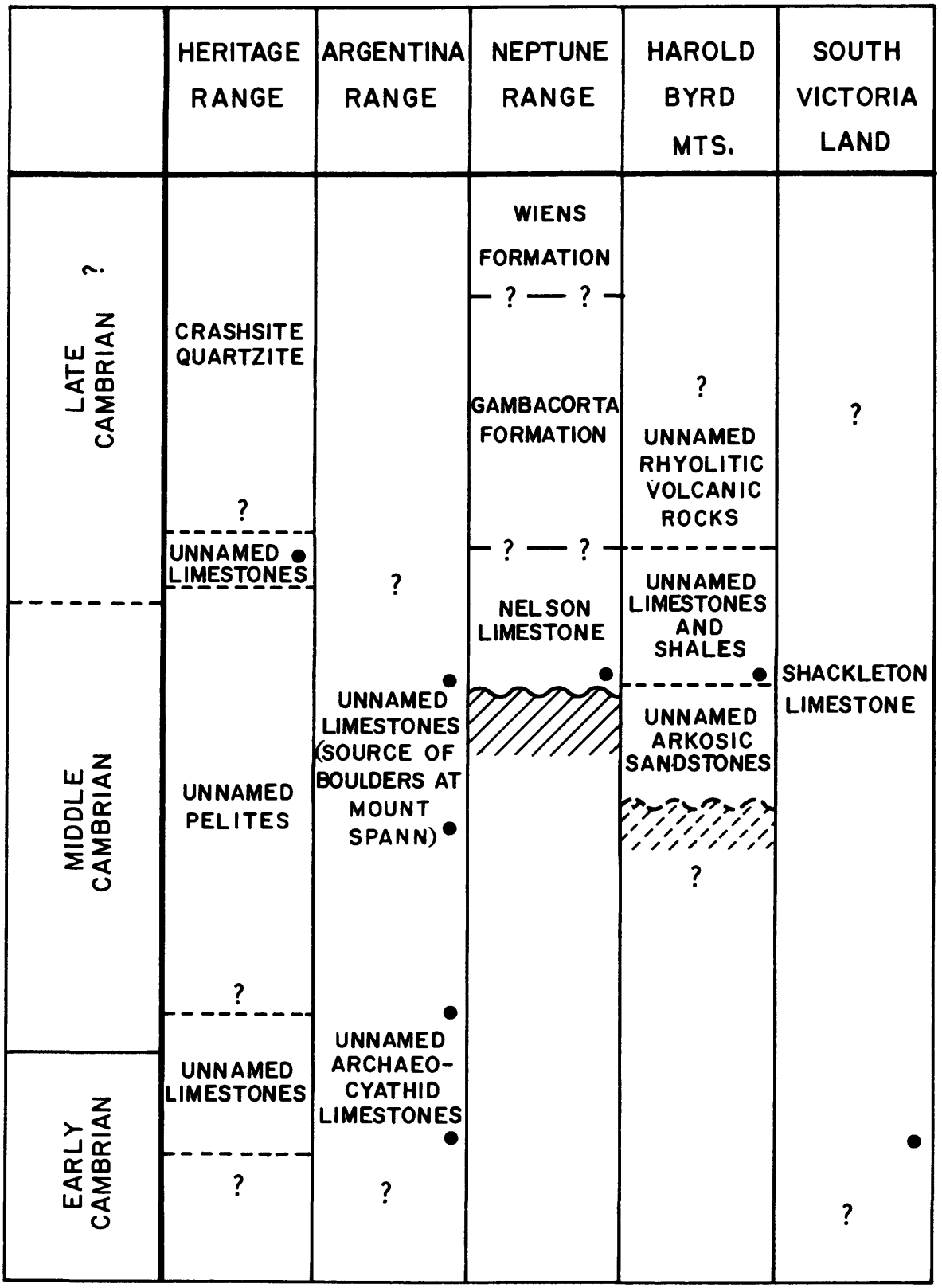

FIGURE 3.—Correlation chart suggesting possible relations of the Cambrian rock units of Antarctica. Dots indicate level of beds in which fossils have been found.

Antarctica. Further work in Antarctica should develop new evidence to test the ideas expressed here.

SYSTEMATIC PALEONTOLOGY

The classification of the Early and Middle Cambrian trilobites of Antarctica is summarized below. The taxa are listed in the order that they appear on the following pages. A diagnosis or description is provided for each species and for new genera. Lack of discussion of a supraspecific taxon indicates acceptance of this taxon as it is constituted in Part O of the "Treatise on Invertebrate Paleontology" (Harrington and others, 1959) unless otherwise indicated. Most descriptive terms used here are defined or illustrated in the Treatise on pages 42, 44, 46, 47, and 117–126.

All illustrated specimens have been given U.S. National Museum catalog numbers and are deposited in the collections of that institution. The collection numbers are recorded in the Cambrian-Ordovician locality catalogs of the U.S. Geological Survey.

All figures show the exterior of the exoskeleton unless otherwise specified. All dimensions in the vertical plane that includes the axis of symmetry of the trilobite are sagittal dimensions, those in planes parallel to the sagittal plane are exsagittal dimensions, and those in a vertical plane at right angles to the sagittal plane are transverse dimensions. Particular dimensions on all parts were measured as straight-line distances between furrows or from margins to furrows as described earlier (Palmer, 1965, p. 23).

SUMMARY OF CLASSIFICATION OF ANTARCTIC EARLY AND MIDDLE CAMBRIAN TRILOBITES

Agnostida
- Agnostina
  - Quadragnostidae
    - *Peronopsis* Hawle and Corda
    - *P.* cf. *P. fallax* (Linnarsson)
- Eodiscina
  - Pagetiidae
    - *Pagetia* Walcott
    - *P. longispina* n. sp.
    - *Pagetides* Rasetti
    - *P.? antarcticus* n. sp.

Redlichiida
- Neoredlichiidae
  - *Australaspis* n. gen.
  - *A. magnus* n. sp.
- Paradoxididae
  - *Xystridura* Whitehouse
  - *X. glacia* n. sp.
  - *X. multilinia* n. sp.
- Protolenidae
  - *Chorbuslina* Lazarenko
  - *C. subdita* n. sp.
  - *C. wilkesi* n. sp.
- Redlichiidae
  - *Redlichia* Cossmann
  - *Redlichia* sp.

Corynexochida
- Dolichometopidae
  - *Amphoton* Lorenz
  - *A. oatesi* n. sp.
- Dorypygidae
  - *Kootenia* Walcott
  - *K. styrax* n. sp.
  - *Olenoides* Meek
  - *Olenoides* sp.
- Jakutidae
  - *Bathyuriscellus* Lermontova
  - *B. australis* n. sp.
  - *B. modestus* n. sp.
- Oryctocephalidae
  - *Goldfieldia* Palmer
  - *G. ninguis* n. sp.

Ptychopariida
- Anomocaridae
  - *Chondranomocare* Poletaeva
  - *C. australis* n. sp.
- Asaphiscidae
  - *Liopeishania* Chang
  - *L. spannensis* n. sp.
- Conokephalinidae
  - *Suludella* Yegorova and Savitskiy
  - *S.? davnii* n. sp.
  - *S.? spinosa* n. sp.
- Nepeidae
  - *Trinepea* n. gen.
  - *T. trinodus* n. sp.
- Solenopleuridae
  - *Solenopleura* Angelin
  - *S. pruina* n. sp.

Unassigned trilobites
- *Glabrella* Lermontova
- *G.? pitans* n. sp.
- *Nelsonia* n. gen.
- *N. schesis* n. sp.
- *Pensacola* n. gen.
- *P. isolata* n. sp.
- *Schopfaspis* n. gen.
- *S. granulosus* n. sp.
- Genus and species undetermined 1
- Genus and species undetermined 2
- Genus and species undetermined 3
- Genus and species undetermined 4

Order AGNOSTIDA Kobayashi
Suborder AGNOSTINA Salter
Family QUADRAGNOSTIDAE Howell

Genus PERONOPSIS Hawle and Corda

Peronopsis Hawle and Corda, 1847, p. 115; Robinson, 1964, p. 529; Palmer, 1968, p. 31 (see this for full synonymy).

Type species.—*Battus integer* Beyrich, 1845, p. 44, pl. 1, fig. 19.

Discussion.—The diagnosis of this genus by Robison (1964) summarizes the current concept of this common Middle Cambrian genus to which the Antarctic species conforms fully.

Peronopsis cf. P. fallax (Linnarsson)

Plate 4, figures 6, 7

Agnostus chinensis Dames. Walcott, 1913, p. 99, pl. 7, figs. 4, 4a, 4b.

Peronopsis fallax minor (Brögger), Westergård, 1946, p. 38, pl. 3, figs. 4, 5, 7.

Peronopsis fallax (Linnarsson), Chernysheva, 1961, p. 48, pl. 1, figs. 15–18.

Peronopsis ex. gr. *fallax* (Linnarsson), Yegorova and Savitskiy, 1969, p. 107, pl. 6, figs. 1–7.

Discussion.—The specimens cited above all share with the Antarctic specimens a well-defined bilobed glabella, no trace of a preglabellar median furrow, a long well-defined bluntly pointed pygidial axis that reaches to the posterior border furrow, a well-developed axial node on the pygidium, and no traces of transverse furrows on the pygidial axis.

A name for this group is not clear. When Endo and Resser (1937) described *A. comes*, which might be an appropriate name, they included not only the specimens figured by Walcott (1913), but also other specimens with well-developed furrows at the sides of the pygidial axis, and they stressed this character in their comments (Endo and Resser, 1937, p. 161). Thus, although no type was designated, their most representative specimens were not the specimens with an unfurrowed axis.

All other citations to *Peronopsis* specimens with an unfurrowed axis reaching to the border furrow are made with varying degrees of confidence to *P. fallax*, an apparently variable species which typically has a slightly shorter axis with indications of one or two furrows. Until a major revision of the species of *Peronopsis* is made, I prefer not to suggest another taxonomic assignment for the Antarctic species, and they are tentatively referred to *P. fallax*. This kind of agnostid has been reported only from beds of late Middle Cambrian age, that is, temporally equivalent to the American *Bolaspidella* zone.

Occurrence.—*Amphoton oatesi* faunule. Moderately common (11 cephala, 11 pygidia), USGS colln. 4446–CO, Nelson Limestone, Neptune Range.

Suborder EODISCINA Kobayashi
Family PAGETIIDAE Kobayashi

Genus PAGETIA Walcott

Pagetia Walcott, 1916, p. 407; Cobbold, 1931, p. 462; Lermontova, 1940, p. 121; Richter and Richter, 1941, p. 17; Kobayashi, 1943, p. 40; Kobayashi, 1944, p. 63; Shimer and Shrock, 1944, p. 615; Rasetti, 1945, p. 315; Lermontova, 1951b, p. 36; Yegorva and others, 1955, p. 104; Howell, 1959, p. 189; Pokrovskaya, 1960, p. 55; Yegorova, 1961, p. 215; Repina and others, 1964, p. 253; Lazarenko, 1964, p. 176; Rasetti, 1966, p. 503; Palmer, 1968, p. 35.

Type species.—*Pagetia bootes* Walcott, 1916, p. 408, pl. 67, figs. 1a–1f.

Discussion.—The characteristics of *Pagetia* have been thoroughly reviewed by Rasetti (1966), and the Antarctic species described below conforms in all essential respects to Rasetti's concept of the genus.

Pagetia longispina Palmer n. sp.

Plate 3, figures 1–6

Description.—Cephalon semicircular, gently convex transversely and longitudinally, moderately to strongly rounded anteriorly. Glabella well defined by broad deep axial furrows, tapered forward, bluntly pointed anteriorly. Occipital and glabellar furrows absent; posterior part of glabella extends backward into long slender horizontal spine about as long as glabella. Frontal area divided into broad, gently convex border and slightly narrower brim with median depression in front of glabella. Sagittal length of border slightly less than one-half length of glabella exclusive of spine.

Fixed cheeks gently convex, horizontal; width, exclusive of palebral lobes, slightly more than basal glabellar width. Narrow ocular ridge extends in gentle curve laterally from anterior part of glabella to small well-defined palebral lobes situated opposite glabellar midlength.

Posterior limbs broad exsagittally; transverse length slightly less than twice basal glabellar width; posterior border expands distally and bears short fixigenal spine. Posterior border furrow moderately broad, deep, curved forward distally.

Anterior and posterior sections of facial sutures subparallel, directed slightly anterolaterally from ends of palpebral lobe. Ornamentation consists of scattered granules on the cranidial border only. Radiating furrows are present on the border of some specimens.

Pygidium semicircular, gently convex transversely and longitudinally. Axis slender, elevated above pleural regions, tapered very slightly posteriorly, reaches nearly to narrow posterior border; width at anterior margin slightly more than one-third width of pleural region; posterior part continued into slender, horizontal spine about as long as pygidium. Two distinct ring furrows present posterior to articulating furrow on axis; each ring has low, broad median node. Pleural regions have narrow, weakly developed pleural furrows; only anterior pair retained on largest specimens. Border narrow. Lateral margin smooth. External surfaces of all parts smooth.

Discussion.—This species differs from all others in the genus by having a combination of relatively well defined palpebral lobes, narrow ocular ridges, granular ornamentation on the cranidial border only, and short fixigenal spines.

Occurrence.—*Xystridura multilinia faunule.* Rare

(10 cranidia, seven pygidia), USGS colln. 6333–CO, boulder from moraine on Mount Spann.

Genus PAGETIDES Rasetti

Pagetides Rasetti, 1945, p. 311; Howell, 1959, p. 190; Lazarenko, 1959, p. 5; Rasetti, 1967, p. 63; Palmer, 1968, p. 36.
?*Pagetina*, Lermontova, 1940, p. 121 [not *Pagetina* Barnard, 1931]; Lermontova, 1951b, p. 27.
?*Neopagetina*, Pokrovskaya, 1960, p. 56; Yegorova, 1961, p. 217; Lazarenko, 1962, p. 37; Lazarenko, 1964, p. 177.

Type Species.—*Pagetides elegans* Rasetti, 1945, p. 313, pl. 1, figs. 15–18.

Diagnosis.—"Pagetidae that have a well-developed, strongly upturned occipital spine and well-defined palpebral furrows; and that lack significant development of axial pygidial spines" (Palmer, 1968, p. 36).

Discussion.—The difficulties of distinguishing *Pagetides* from *Neopagetina* have been discussed by Rasetti (1967) and Palmer (1968). The Antarctic species conforms in most respects to the characteristics of *Pagetides* (*sensu stricto*) but differs in several possibly critical characters that raise questions about its generic assignment.

Examination of the 14 species assigned to *Pagetides* shows that eight bear a medially expanded cephalic border, three do not, and it is not clearly present on three others. Six eastern North American species (*Pagetides ampliforns* Rasetti, *P. elegans* Rasetti, *P. leiopygus* Rasetti, *P. minutus* Rasetti, *P. pustulosus* Rasetti, and *P. rupestris* Rasetti) and two Soviet species (*P. rjonsnitzkii* Lermontova and *P. primaeva* Lermontova) appear to form a group characterized by an expansion of the anterior cephalic border. Two Alaskan species (*P. occidentalis* Palmer and *P. granulosus* Palmer) and the Antarctic species (*P. antarcticus* n. sp.) characterize another group not bearing such an expansion.

In addition, the Antarctic species lacks distinct palpebral lobes, and the occipital spine is not upturned as in typical species of the genus. If this species is to be retained in *Pagetides*, the generic diagnosis will have to be modified, and the principal diagnostic features of *Pagetides* will be a narrow, multisegmented pydigial axis lacking a terminal axial spine. Until more species are found that share the distinctive characteristics of the Antarctic species, I hesitate to separate it from *Pagetides*.

Pagetides? antarcticus n. sp.

Plate 5, figures 1–7

Description.—Complete specimen ovoid, twice as long as wide. Cephalon semicircular, uniformly downsloping from tip of occipital spine to anterior border. Genal spines absent.

Glabella tapered forward, strongly convex transversely and well defined by deep axial furrows; anterior end strongly rounded; anterior lobe almost circular, variable in shape and separated from posterior lobe by a broad barely apparent transverse furrow; other glabellar furrows not distinctly discernible. Occipital furrow indistinct, variable in depth. Occipital ring poorly defined, extended into a short blunt spine of variable shape. Frontal area subequally divided into brim and border on axial line; sagittal length about four-tenths glabellar length including occipital ring, divided by a broad shallow depression in front of the glabella, slightly convex transversely. Anterior border furrow generally absent in front of glabella; border defined laterally by change in slope of frontal area. Border almost flat to flatly convex, not expanded in front of glabella; radial grooves barely apparent on some specimens.

Fixed cheeks as wide as glabellar base, convex, upsloping laterally, more inflated posteriorly. Ocular ridges present only in young stages; not present externally or internally in adult stages. Palpebral furrows absent.

Posterior border furrow deep at genal angle, divided anterolaterally, fades into posterior border midway from genal angle to axial furrow. Posterior border elevated at genal angle. Point of geniculation directly posterior to eye.

Anterior section of facial suture straight, directed forward at 70° to axial line; course of posterior section straight, perpendicular to border and axial line.

Free cheek simple, exsagittal length three times the width, consists of the border with narrow (transverse) slightly inflated subocular area. Eye surface not preserved. Length of eye about one-fourth sagittal length of glabella including occipital spine; line connecting anterior ends of eyes crosses glabella just behind anterior lobes.

Thorax of two segments. Width of segments slightly less than maximum width of pygidium; anterior segment with wide (sagittal) articulating half-ring; axial ring low and narrow. Pleural furrows developed on distal half of pleurae only, pleural tips directed posteriorly. Posterior segment has blunt axial node, pleural tips directed forward.

Pygidium as wide at anterior margin as maximum width of cephalon, tapering more rapidly than cephalon so as to fit inside cephalic doublure; outline semicircular; strongly inflated. Axis clearly defined anteriorly, barely apparent posteriorly, five or six ring furrows apparent posterior to articulating furrow; anterior three rings bear moderately large axial nodes. Axial width one-quarter greatest pygidial width. Pleural regions smooth, except on youngest individuals where

shallow furrows are barely apparent. Pygidial border narrow, one-tenth anterior axial width. Articulating facet as long transversely as half maximum pleural width.

External surfaces of all parts generally smooth. Fixed cheeks of some specimens have crude shallow pits only after whitening.

Discussion.—This species differs from all other species of *Pagetides* by having a short, subhorizontal occipital spine and by lacking distinctly defined palpebral lobes. The uniform width of the cephalic border, poor definition of the border in front of the glabella, and presence of axial nodes on the first three axial segments of the pygidium are additional distinctive characteristics. Reasons for questioning the generic assignment are given in the generic discussion.

The probability that this species is from beds of medial or late Middle Cambrian age, whereas all other species of *Pagetides* are found in beds of Early Cambrian age, also raises doubts about the real relationship of this species to undoubted representatives of *Pagetides.*

Occurrence.—*Schopfaspis granulosus* faunule. Common (>40 cranidia and pygidia; one complete specimen), USGS colln. 6313–CO, 6325–CO, 6327–CO, 6364–CO, boulders from moraine on Mount Spann.

Order REDLICHIIDA Richter

Family NEOREDLICHIIDAE Hupé

The general characteristics of the Neoredlichiidae and a good discussion of the generic content of this family are given by Repina (1966). The Antarctic species described below has the long convex palpebral lobes, short frontal area, and divided ocular ridge characteristic of several genera of Neoredlichiidae, such as *Resserops* and *Bulaiaspis*, and is here added to that family.

Genus AUSTRALASPIS n. gen.

Type species.—*Australaspis magnus* n. sp.

Diagnosis.—Neoredlichiidae that have glabella elongate, gently tapered, bluntly rounded anteriorly, reaching to anterior border; sides slightly concave. Palpebral lobes elongate, strongly curved. Ocular ridge bifurcated towards the glabella with anterior branch continuous around and adaxial to the anterolateral corners of the glabella. Posterior limbs moderately long, slender.

Free cheek has broad-based genal spine continuing curvature of lateral margin.

Pygidium has broad axis reaching nearly to posterior margin, with four narrow axial rings. Pleural regions less than half width of axis. Margin smoothly curved.

Discussion.—Cranidia of the type species of this genus most closely resemble some of those assigned to *Bulaiaspis* (Repina, 1966). However, specimens and replicas were examined of several *Bulaiaspis* species provided by Dr. L. N. Repina of the Institute of Geology and Geophysics at Academgorodok, Siberia, U.S.S.R., and the Antarctic species differs from species of *Bulaiaspis* by having slightly concave sides to the glabella and particularly by having relatively long slender posterior limbs. The pygidium has a much broader axis than pygidia known for any genus of the Neoredlichiidae.

For these reasons, the Antarctic species is assigned to a new genus.

Australaspis magnus n. sp.

Plate 1, figures 1–8

Desecription.—Cranidium subquadrate, gently convex transversely and longitudinally; width between palpebral lobes slightly greater than length. Glabella moderately to poorly defined by changes in slope of exoskeleton; sides subparallel or slightly concave most distinct behind ocular ridges; anterior end poorly defined, bluntly rounded, separated from border by anterior branch of ocular ridge that wraps around glabellar front. Three pairs of glabellar furrows moderately deep on cranidia less than 1 cm (centimeter) in length, moderately to very deep on larger specimens; posterior pair curved slightly backward; large specimens have shallow fourth pair of furrows opposite junction with ocular ridge. Occipital furrow moderately deep. Occipital ring has axial node on posterior margin. Frontal area consists only of gently convex border. Border furrow shallow, curves backward from distal parts of frontal area towards anterolateral corners of glabella so that border is distinctly broader in front of glabella. Sagittal length of border increases from one-fifth to about two-fifths of sagittal glabellar length, exclusive of occipital ring, from small to large specimens.

Fixed cheek wide, flat, horizontal or slightly upsloping; width, exclusive of palpebral lobe, one-half or slightly more than one-half basal glabellar width. Palpebral lobes long, strongly curved, raised above cheek level and continuous with ocular ridge; exsagittal length between two-thirds and three-fourths sagittal glabellar length exclusive of occipital ring; line connecting posterior tips passes over glabella just anterior to occipital furrow. Ocular ridge divided by shallow furrow so that poorly defined anterior part continues in sigmoid course around anterolateral corners of glabella.

Posterior limb, slender, sharply pointed, transverse length about equal to basal glabellar width. Posterior border furrow shallow.

Course of anterior section of facial suture slightly

divergent forward from palpebral lobe to strongly curved anterolateral corners of cranidium. Course of posterior section divergent-sinuous.

Free cheek gently convex, lateral margin evenly curved. Border gently convex, slightly narrower than anterior breadth of ocular platform, defined by shallow lateral border furrow that meets shallow posterior border furrow at sharply rounded angle near base of genal spine. Genal spine long, slender; total length not known, but it exceeds length of posterior section of facial suture.

Pygidium(?) subovate, moderately convex transversely and longitudinally. Axis very broad, low, barely tapered, extended nearly to posterior margin, poorly defined; width slightly greater than two-thirds width of pygidium; one complete ring furrow and three furrows impressed only at sides of axis are present posterior to articulating furrow. Pleural regions small, border absent; one or two shallow furrows on inner part. Margin smooth.

External surfaces of all convex parts covered by very fine, closely spaced granular ornamentation.

Discussion.—The differences between this species and other Neoredlichiidae are reviewed in the generic discussion. *A. magnus* is more variable than many trilobites in development of the glabellar furrows and in the distinctness of the border furrows and the furrows on the ocular ridges. This may be related to the comparatively large size of some specimens. Fragments indicate that cranidia 2 to 3 cm long were present.

Occurrence.—*Australaspis magnus* faunule. Common (>40 cranidia, seven free cheeks, and two pygidia), USGS collns. 5939–CO, 6311–CO, boulders from moraine on Mount Spann.

Family PARADOXIDIDAE Hawle and Corda
Subfamily XYSTRIDURINAE Whitehouse

Genus XYSTRIDURA Whitehouse

Xystridura Whitehouse, 1936, p. 74; Whitehouse, 1939, p. 197; Poulsen, 1959, p. 214.

Type species.—*Milesia templetonensis* Chapman, 1929, p. 214 (synonymized with *Bathyuriscus saint-smithi* Chapman, 1929, p. 209, by Whitehouse, 1939, p. 199).

Discussion.—Whitehouse (1939, p. 197) gives a good description of this genus that needs to be modified only by being less specific about the number of pygidial border spines to accommodate the Antarctic species described below. Trilobites of this genus differ from those assigned to *Paradoxides* by having the posterior glabeller furrows not connected across the glabella, generally wider fixed cheeks, a rostral plate separate from the hypostome, and a wide pygidium with several pairs of border spines.

Whitehouse (1936, p. 74) created confusion with regard to the type species of *Xystridura* that has been rectified in part by Öpik (1957, p. 40) but without comment. Whitehouse unequivocally proposed *Xystridura* to replace the preoccupied name *Milesia*, Chapman, 1929 [not Latrielle, 1804]. Thus the type species for *Xystridura* automatically became *Milesia templetonensis*, the only species assigned by Chapman to *Milesia*. The designation by Whitehouse of *Olenellus? brownii* Etheridge as the type species was improper according to the rules of zoological nomenclature (Int. Rules Zool. Nomenclature, 1961, p. 65, Art. 67i). Further complication was added when Whitehouse (1939, p. 199), as first revisor, placed *Milesia templetonensis* in the synonymy of *Xystridura saint-smithi* (Chapman) and thus *saint-smithi* is the present valid name for the type species of *Xystridura* and not *templetonensis* as claimed by Öpik (1957, p. 40; 1968, p. 136) (see Int. Rules Zool. Nomenclature, 1961, p. 25, Art. 24a).

Xystridura glacia n. sp.

Plate 3, figures 9, 13–17

Description.—Cranidium subquadrate, width slightly greater than length; anterior margin gently and evenly curved. Glabella long, low, unequally hourglass shaped, defined by abrupt change in slope from brim and fixed cheeks. Sides converge slightly forward from occipital ring to posterior glabellar furrow, than diverge forward to junction with poorly defined ocular ridges; margin anterior to ocular ridges nearly a semicircle; anterior end reaches nearly to border furrow. Two or three pairs of shallow glabellar furrows present; posterior pair directed slightly backward; middle pair almost straight transversely; anterior pair directed slightly forward; all furrows extend inward from sides of glabella about one-third glabellar width. Occipital furrow deep at sides of glabella, shallow or absent over axis. Frontal area consists of extremely narrow brim on axial line and gently convex, moderately wide border that maintains nearly constant sagittal and exsagittal length; sagittal length of frontal area about one-eighth sagittal length of glabella including occipital ring; sagittal length of brim about one-fourth sagittal length of border.

Fixed cheeks nearly flat, horizontal; width, including poorly defined palpebral lobe, about equal to glabellar width on line through posterior glabellar furrows. Palpebral lobes strongly curved, situated opposite posterior part of glabella; exsagittal length on large specimens slightly less than one-half sagittal glabellar length including occipital ring; posterior end adjacent to posterior border furrow; width about one-fourth of intraocular part of fixed cheek.

Posterior limb, adjacent to posterior section of facial

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suture, short, bluntly rounded, not extended laterally beyond margin of palpebral lobe; transverse length from occipital ring about two-thirds basal glabellar width.

Course of anterior section of facial suture moderately divergent forward from palpebral lobe to border furrow, then curved inward across border. Course of posterior section strongly curved from posterior end of palpebral lobe to posterior margin.

Hypostome, known only from fragments, has large inflated anterior body.

Free cheek narrow; lateral and posterior borders defined by shallow border furrows that meet in sharp curve at genal angle. Width of border lateral to eye notch slightly less than width of ocular platform. Genal spine long, slender; lateral margin continues curvature of cheek margin; distance from tip to inner genal angle about twice distance from inner genal angle to posterior section of facial suture.

Structure of thorax and number of thoracic segments not known.

Pygidium has axial length about twice width at anterior margin. Axis elevated above pleural regions, defined at sides by abrupt change in slope, not defined posteriorly; one distinct ring furrow present posterior to articulating furrow. Pleural regions gently convex, bear three or four shallow posterolaterally curved and divergent furrows that disappear before reaching margin; distal parts of first, third, and fourth furrows point to bases of border spines. Margin bears three pairs of spines decreasing in length posteriorly; distance between middle pair and posterior pair about equal to distance between posterior pair, distinctly less than distance between anterior pair and middle pair; all spines directed nearly straight posteriorly.

External surfaces of all parts except border regions smooth. Borders of cranidium, free cheek, and pygidium have low terrace lines; on mold, surfaces of brim and fixed cheek, exclusive of palpebral lobe, have dense network of anastomosing caecae.

Discussion.—The presence of three pairs of border spines distinguishes this species from *X. saint-smithi* (Chapman). The differences between this and *X. multilinia* n. sp. are discussed under that species.

Several immature cranidia of *X. glacia* (pl. 3, figs. 15, 16) are characterized by having a wide brim in front of the glabella traversed by a median longitudinal preglabellar ridge analogous to the ridge on species of *Paedeumias*. Similar cranidia were illustrated by Whitehouse (1939, pl. 21, fig. 16) for *X. saint-smithi*. Such changes in the structure of the frontal area seem to be characteristic of many paradoxidid trilobites (cf. Hutchinson, 1962; Snadjr, 1958).

Occurrence.—*Xystridura glacia* faunule. Common (six cranidia, two free cheeks, four pygidia—only trilobite in sample), USGS colln. 5938–CO, boulder from moraine, Mount Spann.

Xystridura multilinia n. sp.

Plate 2, figures 18–25

Description.—Cranidium subquadrate, width slightly greater than length; anterior margin a slightly parabolic curve. Glabella long, low, unequally hourglass shaped, defined by abrupt change in slope from brim and fixed cheeks. Sides converge gently forward from occipital ring to posterior glabellar furrow, then diverge forward to junction with ocular ridge; anterior to ocular ridge sides again converge forward in gentle curve to bluntly pointed anterior end of glabella adjacent to border furrow; width of glabella at posterior glabellar furrows about two-thirds width at ocular ridges. Two pairs of glabellar furrows apparent; posterior pair deep, directed slightly posteriorly; anterior pair shallow, directed nearly straight laterally; furrows extend inward from glabellar sides about one-third of glabellar width. Occipital furrow deep near sides of glabella, continuous across axial line only on small specimens. Occipital ring has low median node. Frontal area consists only of narrow, gently convex slightly downsloping border in front of glabella; sagittal length of border about one-tenth of sagittal length of glabella including the occipital ring. Anterior border furrow shallow, deepens slightly towards facial sutures.

Fixed cheek nearly flat, horizontal; width, including palpebral lobe, about equal to basal glabellar width on line through posterior glabellar furrows. Palpebral lobe broad, gently convex, poorly defined, strongly curved, situated opposite posterior part of glabella; width about two-thirds of interocular part of fixed cheek; relative length decreases with increasing size from slightly more than one-half sagittal glabellar length exclusive of occipital ring on small specimens, to about one-third sagittal glabellar length on large specimens; posterior tip adjacent to posterior border furrow.

Posterior limb, adjacent to posterior section of facial suture, short, bluntly rounded, not extended laterally beyond margin of palpebral lobe; transverse length about four-fifths basal glabellar width.

Course of anterior section of facial suture moderately divergent forward from palpebral lobe to anterior margin. Course of posterior section strongly curved from posterior end of palpebral lobe to posterior margin.

Hypostome has large, inflated anterior body; posterior body short, with narrow, convex, striated posterior

border; maculae well developed. Margin lateral to maculae has short blunt broad-based spine.

Free cheek narrow. Lateral border broad, gently convex, well defined by lateral border furrow that is continuous with posterior border furrow through a sharp curve at genal angle; width of lateral border slightly less than width of narrowest part of ocular platform lateral to eye notch. Genal spines slender; lateral margin continuous with lateral margin of remainder of cheek; distance from tip to inner genal angle about equal to length of posterior section of facial suture.

Number of thoracic segments and structure of thorax not known.

Pygidium has axial length slightly less than one-half greatest width. Axis moderately convex, elevated above pleural regions, defined at sides by abrupt change in slope, not defined posteriorly; width about one-fifth anterior pygidial width. Two ring furrows present posterior to articulating furrow. Pleural regions gently convex, bear three or four posterolaterally curved and divergent furrows that disappear before reaching margin; distal parts of first, third, and fourth furrows point to bases of border spines. Margin bears three pairs of spines; two anterior pairs moderately long and slender; posterior pair short; distance between middle pair and posterior pair less than distance between posterior pair and between middle and anterior pairs; all spines directed nearly straight backward.

External surfaces of all parts except border regions smooth. Borders of cranidium, free cheek, and pygidium generally have well-developed terrace lines. All surfaces of internal molds smooth.

Discussion.—This species is represented by abundant but generally fragmented parts in a trilobite coquina from one boulder. Thus, only relatively small specimens are available for illustration. Fragments indicate that whole individuals, based on comparison with proportions of complete Australian specimens, exceeded 75 mm (millimeters) in length. This species differs from *X. saint-smithi* (Chapman) by having only two pairs of glabellar furrows developed, and by having three, rather than two, pairs of pygidial border spines. It differs from *X. glacia* n. sp. by having a bluntly pointed anterior glabellar margin, wider palpebral lobes, two ring furrows on the pygidial axis, less even spacing between the posterior two pairs of pygidial spines, and by lacking any evidence of a brim in front of the glabella.

Occurrence.—*Xystridura multilinia* faunule. Abundant (100 fragments of various parts), USGS colln. 6333–CO, boulder from moraine on Mount Spann.

Family PROTOLENIDAE Richter and Richter

Genus CHORBUSULINA Lazarenko

Chorbusulina Lazarenko, 1962, p. 56; Lazarenko, 1964, p. 196; Yegorova and Savitsky, 1969, p 134.

Type species.—*Chorbusulina bella* Lazarenko, 1962, p. 56, pl. 6, figs. 1–5.

Discussion.—*Chorbusulina* is a monotypic genus of small Early Cambrian trilobites characterized by a short broad frontal area with a narrow well-defined border and a median transversely elongate swelling on the brim; a well-defined anteriorly tapered, furrowed, bluntly rounded glabella; eye ridges that are continuous with posteriorly located palpebral lobes; and short posterior limbs not extending laterally beyond the outer margins of the palpebral lobes. It is most closely similar to another monotypic genus, *Charaulaspis* (Lazarenko, 1962, p. 54), but differs by having the glabella elevated so that it does not appear sunken between the fixed cheeks and the swelling on the brim. Both genera are found in the upper part of the *Judomia* zone at the top of the Aldan Stage in northern Siberia.

The Antarctic species described below seem to conform in most important respects to the concept of *Chorbusulina* and are not closely similar to any other described trilobites.

Chorbusulina subdita n. sp.

Plate 2, Figures 11–15

Description.—Cranidium subquadrate, gently convex transversely and longitudinally, moderately rounded anteriorly; width slightly greater than length. Glabella gently convex transversely and longitudinally, tapered slightly forward, bluntly rounded anteriorly, moderately well defined by broad shallow axial and preglabellar furrows; sides straight or slightly bowed outward. Three pairs of glabellar furrows barely apparent. Occipital furrow broad, shallow, deepest near posterolateral corners of glabella. Occipital ring gently convex and longest in sagittal plane; median node situated adjacent to posterior margin. Frontal are gently downsloping; sagittal length one-half to slightly more than one-half length of glabella exclusive of occipital ring. Border narrow, flat or gently convex, best defined on small specimens, not apparent on some larger specimens; sagittal length slightly more than one-half sagittal length of gently convex brim. Brim somewhat more convex than border, has broad low median swelling that is defined posteriorly by broad shallow furrow extending slightly forward towards anterolateral corners of cranidium from anterolateral corners of glabella.

Fixed cheek gently convex, horizontal; width, exclusive of palpebral lobe between one-half and two-thirds

basal glabellar width. Ocular ridge broad, indistinct, directed only slightly posterolaterally from axial furrow opposite anterior end of glabella. Palpebral lobe gently arcuate, poorly defined anteriorly, situated opposite posterior part of glabella; transverse width between one-third and one-half that of infraocular part of cheek; exsagittal length between one-half and two-thirds sagittal glabellar length exclusive of occipital ring.

Posterior limb short, blunt, not extended laterally beyond outer edge of palpebral lobe; transverse length about two-thirds basal glabellar width; exsagittal length slightly more than one-third exsagittal length of palpebral lobe. Posterior border furrow broad, shallow.

Course of anterior section of facial suture slightly divergent forward from palpebral lobe, curved across border to anterior margin and continued along margin to sagittal line. Course of posterior section of facial suture directed slightly outward in broad curve from palpebral lobe to posterior margin.

Free cheek narrow; border lateral to large, convex eye notch is slightly wider than ocular platform. Posterior margin of cheek directed anterolaterally so that moderately long genal spine was somewhat advanced on cephalon; lateral margin of genal spine continuous with cheek margin. Anterior extension of doublure extended to sagittal plane of cephalon.

Rostral plate apparently absent; hypostome, thorax, and pygidium unknown.

External surface of exoskeleton on specimens that have glabellar lengths greater than 1 mm has fine scattered granules principally in axial furrows; top of glabella and occipital ring, surface of swelling on brim, border, outer parts of fixed cheeks, and palpebral lobes smooth. However, smaller specimens have fine granular ornamentation on all parts.

Discussion.—This species is most similar to *C. wilkesi* n. sp. from which it differs principally in ornamentation of the larger specimens. In *C. wilkesi*, the granular ornamentation is retained on specimens of all sizes, whereas in *C. subdita*, specimens with glabellas longer than 1 mm have increasingly subdued granulation of the convex parts of the cranidium and loss of clarity of the occipital and border furrows. These differences are consistent between samples and are interpreted here to be differences between species.

C. subdita differs from the type and only other described species *C. bella* Lazarenko, by having shallower occipital and border furrows, a less prominent and somewhat more laterally directed ocular ridge, and granular ornamentation on only part of the cranidium.

The absence of a rostral plate, as indicated by the long anterior doublure on the free cheek, is an unusual and distinctive feature that may be characteristic for all species of *Chorbusulina* and should be looked for on other Asiatic Early Cambrian ptychoparioid trilobites. Most American Early Cambrian ptychoparioids have a rostral plate almost as broad transversely as the anterior margin of the cranidium.

Occurrence.—*Chorbusulina subdita* faunule. Common (20 cranidia; three free cheeks), USGS colln. 6312–CO and 6321–CO, boulders from moraine on Mount Spann.

Chorbusulina wilkesi n. sp.

Plate 2, figures 1, 2

Discussion.—This species is known only from cranidia that have essentially the same proportions of their individual parts as do cranidia of *C. subdita*, but that consistently differ in their ornamentation. Thus, the description for *C. subdita* suffices also for *C. wilkesi* exclusive of ornamentation. *C. wilkesi* specimens of all sizes are completely covered with closely spaced granules, whereas larger specimens of *C. subdita* are consistently smooth on their convex parts. Specimens of *C. wilkesi* also have slightly better definition of the border, occipital, and palpebral furrows. Forms with the two types of ornamentation are not found associated. For this reason, they are considered here to represent two different specific taxa within *Chorbusulina*.

This species differs from *C. bella* Lazarenko by having the ocular ridge narrower and not so clearly a continuation of the palpebral lobe and by having the ocular ridges more nearly directed straight laterally.

Occurrence.—*Chorbusulina wilkesi* faunule. Common (>20 cranidia), USGS colln. 5937–CO, 6308–CO, 6329–CO, 6331–CO, 6352–CO; boulders from moraine on Mount Spann.

Family REDLICHIIDAE Poulsen

Genus REDLICHIA Cossman

Redlichia Cossman, 1902, p. 62; Kobayashi, 1961, p. 195 (for synonymy to that date); Sdzuy, 1961, p. 532; Repina, 1966, p. 36.

Type species.—*Hoeferia noetlingi* Redlich, 1899, p. 3, pl. 1, figs. 1–8.

Discussion.—Trilobites assigned to *Redlichia* are found in Lower and Middle Cambrian(?) beds in southern Asia, Australia, and the Mediterranean region, and more than 30 species have been described for this genus. Their cranidia are typified by a slender, anteriorly tapered glabella, long palpebral lobes terminating backward near the occipital ring, a short frontal area, and widely divergent anterior sections to the facial sutures. Associated free cheeks, when found,

indicate that the genal spine is usually advanced. A number of fragmentary cranidia in one Antarctic collection represent an indeterminate species of *Redlichia*.

Redlichia sp.

Plate 2, figures 3, 4

Discussion.—No complete cranidia of this Antarctic species have been found, but two specimens provide most of the important morphologic information. The cranidia seem to represent a species of the *R. nobilis* group (Kobayashi, 1961, p. 197) which is characterized by having anterior sections of the facial sutures that extend anterolaterally from the palpebral lobe to the border furrow and then outward along the border furrow before curving sharply across the border. Most of the surface except the border has closely spaced granules; the border has well-developed terrace lines.

Redlichia forresti from northwestern Australia (Öpik, 1958), *R. noetlingi* from the Salt Range in Pakistan (Schindewolf and Seilacher, 1955), and *R. nobilis* from north China, all have similarities to the Antarctic species. However, *R. forresti* has palpebral lobes much narrower transversely than the infraocular part of the fixed cheek, *R. noetlingi* has the posterior glabellar furrow moderately deep and continued across the glabella, and *R. nobilis* is shown by Walcott (1913, pl. 7, fig. 2) to have a distinct brim. The specimen from Iran described by King (1937, pl. 17, fig. 1) as *R. chinensis* is remarkably similar to the Antarctic species (cf. pl. 2, figs. 4, 5), but, as shown by the structure of the frontal area, it is certainly not correctly identified. King's specimen seems to have a slightly broader infraocular fixed cheek than the Antarctic specimens, but in all other features, including ornamentation, they are practically indistinguishable. Until more Antarctic material is collected, a definitive specific identification is not practicable.

Occurrence.—*Chorbusulina wilkesi* faunule. Moderately rare (three cranidia), USGS colln. 6308–CO, boulder from moraine on Mount Spann.

Order CORYNEXOCHIDA Angelin
Family DOLICHOMETOPIDAE Walcott

Genus AMPHOTON Lorenz

Amphoton, Lorenz, 1906, pl. 75; Kobayashi, 1935, p. 137; Whitehouse, 1939, p. 236; Kobayashi, 1942, p. 162; Poulsen, 1959, p. 222; Chernysheva, 1961, p. 83; Öpik, 1961, p. 139.

Type species.—*Amphoton steinmanni* Lorenz, 1906, p. 75, pl. 4, figs. 15–17 (synonymized with *Dolichometopus deois* Walcott, 1905, p. 94 by Kobayashi, 1935, p. 137).

Discussion.—Kobayashi (1942), Öpik (1961), and Chernysheva (1961) have all given good discussions of the characteristics and relationships of *Ampoton*. The Antarctic species conforms in all respects to the characteristics of this genus. Kobayashi (1942) recognized three subgenera: *Amphotonella*, which has an anteriorly tapered glabella; *Sunia*, which has an anteriorly expanded glabella, occipital spine, and undivided frontal area; and *Fouchouia*, which has an anteriorly expanded glabella and a well-defined cranidial border. These all differed from the typical subgenus which included forms with an anteriorly expanded glabella, undivided frontal area, and an occipital ring lacking a spine. Öpik (1961) questioned the value of such subgeneric separations.

The Antarctic species has the occipital spine and essentially undivided frontal area considered by Kobayashi as typical for *Sunia*. Öpik placed *Sunia* in synonymy with *Amphoton* because the principal differences between the subgenera were presence or absence of an occipital spine—a character that is more often of value only for discrimination of species. His suggestion is followed here.

Amphoton oatesi n. sp.

Plate 4, figures 8, 11–13

Description.—Cranidium elongate, trapezoidal, gently rounded anteriorly; length exclusive of occipital spine, four-fifths width between tips of posterior limbs. Glabella elongate, unfurrowed, slightly expanded forward, bluntly rounded anteriorly, gently convex longitudinally, moderately convex transversely, well defined by abrupt changes in slope of exoskeleton, basal glabellar with about five-eights length, exclusive of occipital ring. Occipital furrow deep near axial furrows, shallow across axis. Occipital ring bears short, slender, slightly upsloping, occipital spine. Frontal area short, slightly downsloping; sagittal length slightly more than one-fifth sagittal glabellar length exclusive of occipital ring. A faint, narrow transverse ridge in front of glabella barely outlines a brim about half as wide as border.

Fixed cheek flat, horizontal; greatest width, exclusive of palpebral lobe, slightly less than one-half basal glabellar width. Palpebral lobe gently arcuate, anterior end much closer to glabella than posterior end; weakly defined by shallow palpebral furrow paralleling palpebral margin; situated opposite middle third of glabella; exsagittal length about one-half glabellar length exclusive of occipital ring.

Posterior limb moderately broad based, tapered laterally to blunt point. Posterior border furrow shallow.

Course of anterior section of facial suture slightly divergent forward to sharply rounded anterolateral

corners of cranidium. Course of posterior section divergent-sinuous.

Free cheek has moderately curved lateral margin that is continuous with genal spine. Border poorly defined by shallow lateral border furrow that disappears near genal angle, width at anterior margin slightly less than width of gently convex ocular platform. Genal spine short, sharp; length from tip to posterior suture about one-half length of sutural margin. Posterior suture intersects margin near base of genal spine.

Pygidium transversely subovate, lateral margins sharply rounded; length about one-half greatest width. Axis elevated, well defined at sides by changes in slope, tapered slightly posteriorly, bluntly rounded at back and connected to margin by low, posteriorly tapered postaxial ridge. Two moderately deep ring furrows present posterior to articulating furrow. First axial ring has low median node. Pleural regions gently convex. Border poorly defined, width about equal to greatest width of pleural platform. Two broad shallow, posterolaterally directed pleural furrows cross pleural platform but do not extend onto border.

External surfaces of all parts smooth.

Discussion.—This species differs from other species of *Amphoton* that have occipital spines by having fixed cheeks that are almost half as wide as the posterior part of the glabella and by having an axial node on the first axial ring, two ring furrows, and two pleural furrows on the pygidium. In addition, *A. typica* Kobayashi has much longer genal and occipital spines; *A. bensoni* Öpik has shorter palpebral lobes, sharper posterolateral limbs, and more axial and pleural furrows on the pygidium; *A. spinigerum* Whitehouse has long genal spines; and *A. serotinum* Whitehouse has a better defined border and much shallower ring furrows on the pygidium.

Occurrence.—*Amphoton oatesi* faunule. Common (>40 cranidia, pygidia, and free cheeks), USGS colln. 4446–CO, Nelson Limestone, Neptune Range.

Family DORYPYGIDAE Kobayashi

Genus KOOTENIA Walcott

Bathyuriscus (*Kootenia*) Walcott, 1889, p. 446.

Kootenia Walcott, 1925, p. 92; Kobayashi, 1935, p. 156; Lermontova, 1940, p. 139; Shimer and Shrock, 1944, p. 613; Rasetti, 1948, p. 332; Thorslund, 1949, p. 4; Lermontova, 1951b, p. 122; Palmer, 1954, p. 64, Hupé, 1955, p. 91; Ivshin, 1957, p. 37; Poulsen, 1959, p. 218; Suvorova, 1960a, p. 78; Chernysheva, 1961, p. 126; Lazarenko, 1962, p. 60; L. N. Repina, in Repina and others, 1964, p. 301; Suvorova, 1964, p. 86; Lazarenko, 1964, p. 204; Palmer, 1968, p. 47.

Notasaphus Gregory, 1903, p. 155; Whitehouse, 1939, p. 241.

Type species.—*Bathyuriscus* (*Kootenia*) *dawsoni* Walcott, 1889, p. 446.

Discussion.—I have recently given a diagnosis of the critical characters of this genus (Palmer, 1968). The Antarctic species conforms in all respects to this diagnosis. The diagnosis should be modified, however, with regard to the number of pygidial border spines. R. A. Robison (written commun., 1970) pointed out that *K. mendosa* Resser (1939) has only two pairs of border spines. Except for that species and *K. styrax*, described below, all other species of *Kootenia* for which pygidia are known have at least five pairs of border spines.

Kootenia styrax n. sp.

Plate 4, figures 4, 5

Description.—Cranidium elongate, moderately rounded anteriorly, moderately convex transversely, gently convex longitudinally. Glabella long, unfurrowed, expanded very slightly forward, straight sided, reaches to anterior margin, well defined at sides by broad, shallow axial furrows. Occipital furrow deepest near axial furrows, shallow on midline. Occipital ring has short, slender, sharp upturned occipital spine. Frontal area absent on axial line; lateral parts without well-differentiated border.

Fixed cheeks narrow, gently convex, nearly horizontal; width, exclusive of palpebral lobe, about one-third basal glabellar width. Palpebral lobe gently curved, situated slightly posterior to glabellar midlength; palpebral furrow broad, shallow; exsagittal length of palpebral lobe about one-fourth of glabella exclusive of occipital ring.

Posterior limb blunt; transverse length slightly greater than basal glabellar width. Posterior border furrow broad, shallow.

Course of anterior section of facial suture nearly straight forward from palpebral lobe to anterior margin. Course of posterior section widely divergent behind palpebral lobe, strongly curved backward near tip to intersect posterior margin perpendicularly.

Pygidium semicircular, bears four pairs of moderately short, slender evenly spaced border spines. Axis prominent, sides slightly concave. Three ring furrows present posterior to articulating furrow. First axial ring distinctly wider than more posterior rings. Terminal section of axis bears prominent posteriorly directed spine. Pleural fields crossed by three pleural furrows. Interpleural furrows not apparent. Border defined only by change in slope of pleural region; two anterior pleural furrows continued, but very faintly, across border between border spines.

External surfaces of all parts smooth.

Discussion.—This species is easily distinguished from all other species of *Kootenia* by having a posteriorly directed axial spine on the terminal section of the

pygidial axis and only four pairs of border spines. All other species for which pygidia are known, except *K. mendosa* Resser (see generic discussion above) have at least five pairs of border spines, and only *Kootenia elongata ornata* (Ivshin, 1957, p. 49, pl. 2, figs. 12, 13) has a terminal axial spine on the pygidium.

Occurrence.—*Amphoton oatesi* faunule. Rare (three cranidia, one pygidium), USGS colln. 4446–CO, Nelson Limestone, Neptune Range.

Genus OLENOIDES Meek

Olenoides sp.

Plate 5, figure 18

Discussion.—Two fragmentary pygidia from one collection have a long, well-segmented axis, pleural, and interpleural furrows on the pleural platforms, and a spinose pygidial margin—all typical characteristics of species of *Olenoides*. Lack of preservation of the form of the pygidial spines and lack of knowledge of other parts prevents identification or comparison of the specimens. The species that they represent is characterized by having four ring furrows on the axis posterior to the articulating furrow, three pleural-interpleural furrow pairs on the pleural regions, four pairs of large lateral border spines, and a fifth tiny pair behind the axis. The external surface is covered with low closely spaced granules that are barely apparent on most parts even after whitening.

Occurrence.—*Schopfaspis granulosus* faunule. Rare (two pygidia), USGS colln. 6325–CO, boulder from moraine, Mount Spann.

Family JAKUTIDAE Suvorova

Genus BATHYURISCELLUS Lermontova

Bathyuriscellus Lermontova, 1951b, p. 102; Suvorova, 1960b, p. 94; Suvorova and Chernysheva, 1960, p. 72; Chernysheva, 1961, p. 68; L. N. Repina, in Repina and others, 1964, p. 290; Lazarenko, 1964, p. 203.

Type species.—*Bathyuriscellus robustus* Lermontova, 1951b, p. 103, pl. 14, figs. 2–2a.

Discussion.—This genus is well described and discussed by Suvorova (1960b) and Chernysheva (1961). One of the principal features that distinguishes species of *Bathyuriscellus* from those of *Jakutus* (Lermontova, 1951b, p. 105) is their relatively narrow fixed cheeks. I have examined replicas of the type species of both *Bathyuriscellus* and *Jakutus*. Although the cranidial proportions of both Antarctic species described below are most like those of *B. robustus* Lermontova, their ornamentation of terrace lines on the border and granules on the remainder of the cranidium is most like that of *Jakutus quadriceps* Lermontova. Other species of *Bathyuriscellus*, such as *B. firmus* Ogienko, have granular ornamentation, however, so that the ornamentation of the Antarctic species merely serves to emphasize the close relationship between the genera. The relationship is further emphasized by the remarkable similarity in detail between the structure of the ocular ridge of *B. modestus* n. sp. and the type species of *Jakutus*, *J. quadriceps* Lermontova.

Except for the relatively narrow fixed cheeks, which the Russian workers consider to be a significant character, the Antarctic species could be assigned to either *Jakutus* or *Bathyuriscellus*. Perhaps the validity of the characters used to distinguish these genera should be reevaluated. According to the criteria presently in use, however, the Antarctic species conform in all critical features to *Bathyuriscellus*.

Bathyuriscellus australis n. sp.

Plate 2, figures 6–10

Description.—Cranidium, exclusive of posterior limbs, elongate, subquadrate, anterior margin gently rounded, gently convex transversely, moderately convex longitudinally. Glabella elongate, very slightly tapered forward, bluntly rounded at front, axial part reaches to border furrow, basal glabellar width about three-fourths glabellar length exclusive of occipital ring. Glabellar furrows broad, shallow, barely apparent. Occipital furrow straight, narrow, shallow on axial line, deeper towards axial furrows. Occipital ring gently convex in profile, upsloping; median node present at posterior margin. Brim absent in front of glabella. Border well defined by shallow, slightly curved border furrow, gently convex in sagittal profile; sagittal length between one-fourth and one-fifth sagittal glabellar length exclusive of occipital ring.

Fixed cheeks horizontal, gently convex; width slightly more than one-fourth basal glabellar width. Ocular ridge poorly defined, directed strongly posterolaterally from anterior end of glabella, imperceptibly merged with palpebral lobe. Palpebral lobe poorly defined by palpebral furrow, crescentic; midlength slightly posterior to glabellar midlength; exsagittal length about four-ninths of sagittal glabellar length exclusive of occipital ring.

Posterior limb moderately short, sharply-pointed; transverse length slightly less than basal glabellar width. Posterior border furrow moderately broad and deep.

Course of anterior section of facial suture very slightly divergent forward in gentle curve from palpebral lobe to border furrow, then turned diagonally inward across border to intersect anterior margin distal to for-

ward projection of anterolateral corners of glabella. Course of posterior section sigmoid, intersects posterior margin at acute angle.

Free cheek subtriangular, lateral margin gently curved, continuous with short, sharp, broad-based genal spine. Lateral and posterior border furrows merged in a sharp curve at genal angle. Border gently convex in profile; width constant, at anterior end about three-fourths length of anterior section of facial suture. Distance from tip of genal spine to intersection of posterior section of facial suture with posterior margin slightly more than one-half length of posterior section of facial suture.

Pygidium, thorax, and hypostome not known.

Ornamentation on the glabella, lateral parts of the brim, inner part of the border, fixed cheeks and posterior limbs, exclusive of furrows and edges of palpebral lobes, consists of closely packed granules that merge with each other so that with some lighting the surface appears coarsely pitted. The outer half to three-fourths of the border on both the canidium and the free cheek bears a strong terrace ornamentation, and the areas between the terrace lines are pitted. The ocular platform and genal spine are covered with closely spaced, but distinct, granules.

Discussion.—This species has the general cranidial proportions of several Siberian species of *Bathyuriscellus*, such as *B. robustus* Lermontova, *B. grandis* Suvorova, and *B. firmus* Ogienko. It differs from these and all other species assigned to the genus by having short genal spines and by its unusual granular-pitted ornamentation. The anterior sections of the facial sutures are slightly less divergent forward than most described species of *Bathyuriscellus*.

None of these differences are great enough to warrant separation of *B. australis* at the generic level from the Siberian species of *Bathyuriscellus*. Ornamentation and the structure of the ocular ridge are the principal features that distinguish this species from the other Antarctic species, *B. modestus* n. sp.

Occurrence.—*Chorbusulina wilkesi* faunule. Moderately rare (seven cranidia, one free cheek), USGS colln. 5937–CO, 6308–CO, boulders from moraine on Mount Spann.

Bathyuriscellus modestus n. sp.

Plate 2, figures 16, 17

Description.—The general morphology of the cranidium of this species is essentially the same as that of *B. australis* except for the structure of the ocular ridges and the cranidial ornamentation. Because of this, only these features are separately described.

Ocular ridges poorly defined, directed strongly posterolaterally from anterior end of glabella; axial end bifurcated by shallow furrow, and the anterior part of this ridge forms a sinuous structure that wraps around the anterolateral corner of the glabella and extends inward nearly to the axial line, separating the glabella from the border furrow.

Ornamentation consists of low granules on all convex parts except the border and the palpebral lobe. There is a tendency for some of the granules to merge and form short variously oriented sinuous segments of ridges on the top of the glabella. The border and palpebral lobes have low terrace lines. The exoskeleton between the granules and terrace lines has scattered tiny pits.

Discussion.—The features described above distinguish this species from all other species of *Bathyuriscellus*. The structure of the ocular ridges is essentially the same as it is for the specimen of *Jakutus quadriceps* figured by Lermontova (1951b, pl. 15, fig. 1c) of which I have a replica.

Occurrence.—*Chorbusulina subdita* faunule. Rare (one cranidium), USGS colln. 6312–CO, boulder from moraine on Mount Spann.

Family ORYCTOCEPHALIDAE Beecher

Genus GOLDFIELDIA Palmer

Goldfieldia Palmer, 1964, p. 7.

Type species.—*Goldfieldia pacifica* Palmer, 1964, p. 7, pl. 1, figs. 14, 16–18.

Diagnosis.—"Oryctocephalidae which have glabella poorly defined at front, narrowest at occipital ring; frontal lobe with median depression in anterior part. Posterior pair of glabellar furrows connected laterally to axial furrows. Anterior cranidial border wirelike" (Palmer, 1964, p. 7).

Discussion.—Most oryctocephalid genera are widespread and have moderately long stratigraphic ranges. *Goldfieldia* is no exception. The Antarctic species described below conforms in all respects to the generic diagnosis just cited, which was based on a single species from Lower Cambrian beds in Nevada. The Antarctic occurrence greatly extends the geographic range of *Goldfieldia*. The stratigraphic range is also extended because the Antarctic species appears to be in an early Middle Cambrian assemblage.

Goldfieldia ninguis n. sp.

Plate 3, figures 7, 8

Description.—Oryctocephalidae which have cranidium subtrapezoidal in outline, gently convex transversely, moderately convex longitudinally; width between anterior sections of facial sutures about three-

fourths width between tips of posterior limbs. Anterior margin gently curved.

Glabella well defined at sides; axial furrows shallow, subparallel between preoccipital and occipital furrows; divergent slightly forward between preoccipital and second glabellar furrows and then continued nearly straight forward to junction with ocular ridge. Anterior end of glabella defined laterally by change of slope, not defined at front, reaches nearly to narrow wirelike border. Brim, lateral to glabella, gently concave. Four pairs of lateral glabellar furrows present but not connected across top of glabella; posterior and anterior pairs connected laterally to axial furrows; middle two pairs are transversely elongate pits. Frontal glabellar lobe has shallow median depression on anterior part. Occipital furrow shallowest on axial line, moderately deep, narrow, adjacent to axial furrows.

Fixed cheek gently convex, slightly downsloping; width, exclusive of palpebral lobes about equal to basal glabellar width. Palpebral lobe well defined by sharp change in slope, slightly curved; exsagittal length slightly less than basal glabellar width; line connecting posterior tips passes over preoccipital furrow. Ocular ridge poorly defined, reaches axial furrow about opposite anterior glabellar furrow.

Posterior limbs bluntly rounded; transverse length about 1½ times basal glabellar width. Posterior border furrow moderately deep except at tip of limb and near axial furrow.

Course of anterior section of facial suture nearly straight forward from palpebral lobe to anterior margin. Course of posterior section of facial suture moderately to strongly convex; strongly divergent immediately behind palpebral lobe.

Eternal surfaces of all parts of cranidium smooth.

Other parts not known.

Discussion.—This species is remarkably similar to the type species, *G. pacifica* Palmer from Lower Cambrian beds of Nevada. The principal differences are the more slotlike middle glabellar furrows and slightly shorter palpebral lobes and posterior limbs.

Occurrence.—*Xystridura multilinia* faunule. Rare (6 cranidia), USGS colln. 6333–CO, boulder from moraine on Mount Spann.

Order PTYCHOPARIIDA Swinnerton
Family ANOMOCARIDAE Poulsen

Genus CHONDRANOMOCARE Poletaeva

Chondranomocare Poletaeva, 1956, p. 169; Yegorova and others, 1960, p. 214; Chernysheva, 1961, p. 196.

Type species.—*Chondranomocare bidjensis* Poletaeva, 1956, p. 170, pl. 31, figs. 4, 5.

Discussion.—A good diagnosis of this genus with a discussion of its relations to other genera is given by Chernysheva (1961). The combination of a long, gently tapered, poorly furrowed glabella that is bluntly rounded anteriorly, narrow fixed cheeks, short brim, and broad concave border distinguishes cranidia of this genus from all others. The concave rather than flat or convex border distinguishes *Chondranomocare* from *Pseudanomocarina*.

Pygidia are generally transversely subovate and have several ring furrows on the axis and several pleural or interpleural furrows on the pleural regions. The margin lacks spines.

Chondranomocare is known at present only from the Amga Stage of early Middle Cambrian age in many parts of Siberia.

Chondranomocare australis n. sp.

Plate 3, figures 18–24

Description.—Cranidium elongate, subquadrate, gently rounded anteriorly; length slightly greater than width between palpebral lobes. Glabella long, gently convex transversely and longitudinally, tapered slightly forward, bluntly rounded anteriorly; moderately well defined at sides by shallow axial furrows, defined at front by abrupt change in slope. Glabellar furrows shallow to not apparent; posterior pair directed strongly backward from axial furrows. Occipital furrow very shallow on axial line, moderately deep near axial furrow. Occipital ring flat or slightly convex; small median axial node present. Frontal area gently concave, slightly downsloping. Brim narrow, separated from border by poorly developed border furrow that is barely apparent on larger cranidia. Border weakly concave in front of glabella, nearly flat laterally; sagittal length slightly more than twice sagittal length of brim.

Fixed cheek narrow, gently convex, horizontal; width, exclusive of palpebral lobes, about one-fourth basal glabellar width. Palpebral lobe strongly arcuate, both ends near axial furrows; palpebral furrow shallow, parallel to lobe margin; exsagittal length of palpebral lobe slightly more than one-half sagittal glabellar length exclusive of occipital ring. Short poorly defined ocular ridge connects palpebral lobe to glabella well back of anterior end.

Posterior limb slender, short, sharply pointed; transverse length about two-thirds basal glabellar width. Posterior border furrow shallow, straight.

Course of anterior section of facial suture strongly divergent forward to sharply rounded anterolateral corners of cranidium. Course of posterior section sinuous.

Free cheek has gently curved lateral margin. Ocular platform gently convex. Border flat, defined by shallow

lateral border furrow that joins posterior border furrow in sharp curve at genal angle; width at anterior sutural margin about half width of ocular platform. Genal spine flat, sharply pointed; length from tip to posterior sutural margin about 1½ times length of posterior section of facial suture.

Pygidium transversely subovate, lateral margins sharply curved; length about one-half greatest width. Posterior margin evenly curved, nonspinose. Axis well defined at sides by abrupt change in slope, tapered slightly backward, bluntly rounded at rear, merged posteriorly with border. Two shallow ring furrows present posterior to articulating furrow. Pleural regions gently convex; border poorly defined, downsloping, about as wide as greatest width of pleural platform. Pleural platform and inner part of border crossed by three interpleural furrows; posterior furrow much shallower than anterior furrows; depth of all furrows decreases abruptly at inner margin of border.

External surfaces of pygidial axis, posterior part of glabella, and borders on cranidium, free cheek, and pygidium are covered with very fine low granules apparent only after whitening. Surfaces of all other parts smooth.

Discussion.—The pygidial structure, structure of the frontal area, and ornamentation are the most distinctive characters of *C. australis*. This species differs from all described species of *Chondranomocare* by having a weakly concave cranidial border and a poorly developed anterior border furrow. Pygidia are known for only two species of *Chondranomocare*. The pygidia of *C. australis* lack the development of interpleural furrows that characterizes *C. speciosum* Romanenko (Yegorova and Savitskiy, 1969, pl. 39, figs. 17–21), and they have one less pleural furrow and two less ring furrows than *C. exilis* Yegorova (Yegorova and Savitskiy, 1969, pl. 40, figs. 6–13).

Occurrence.—*Amphoton oatesi* faunule. Moderately common (six cranidia, one free cheek, eight pygidia), USGS colln. 4446–CO, Nelson Limestone, Neptune Range.

Family ASAPHISCIDAE

Genus LIOPEISHANIA Chang

Liopeishania Chang, 1963, p. 486.

Type species.—*Psilaspis? convexus* Endo and Resser, 1937, p. 350, pl. 59, figs. 1–4.

Diagnosis.—Asaphiscidae having glabella poorly defined on external surface; glabellar furrows absent; occipital furrow shallow. Brim and fixed cheeks downsloping, nearly continuing curvature of glabella. Anterior border distinctly defined by abrupt change in slope. Fixed cheeks about one-half basal glabellar width. Palpebral lobes situated about opposite glabellar midlength, poorly defined on external surface. Posterior limbs shorter than basal glabellar width; posterior border furrow shallow.

Free cheek narrow, lateral border poorly defined. Genal spine absent.

Pygidium semicircular. Axis narrower than pleural regions, tapered slightly, strongly rounded at rear, not extended to posterior margin. Border narrow, poorly defined. Axial and pleural furrows absent on external surface.

Surfaces of all parts smooth.

Discussion.—Cranidia of the Antarctic species described below conform to the diagnosis of this genus given by Chang (1963) based only on cranidia. Yegorova (written commun., 1970) reported that in 1965, Chang included *Peishania lubrica* (Chang, 1959, p. 234, pl. 4, figs. 7–11) in *Liopeishania* in a Chinese book, "Trilobites in China", that is not available to me. The Antarctic species is so similar to *L. lubrica* (Chang) that the diagnosis of the genus is expanded here to include information about the free cheek and pygidium based on the Antarctic material.

Liopeishania spannensis n. sp.

Plate 4, figures 9, 10, 14–22

Description.—Cranidium subtrapezoidal, anterior margin moderately rounded. Sagittal length about three-fourths width between tips of posterior limbs. Only posterior part of glabella defined on external surface by faint change in slope apparent only after whitening; entire glabella defined on mold, tapered forward, sharply rounded anteriorly, gently convex transversely and longitudinally, slides opposite palpebral lobes have slight short outward bulge. Occipital ring barely differentiated on external surface. Frontal area subsequently divided into brim and border. Brim continues downward curvature of front of galbella and is separated from border by strongly curved change in slope so that outer part of border is nearly horizontal and at distinct angle to brim. Small cranidia (pl. 4, fig. 16) have glabella better defined and a median longitudinal depression on brim.

Fixed cheek downsloping, gently convex, continuing lateral curvature of glabella; width, including palpebral lobes, one-half or slightly less than one-half basal glabellar width. Palpebral lobe not defined by palpebral furrow, differentiated only by slight change in slope; situated opposite middle third of glabella; exsagittal length slightly less than one-fourth sagittal length of cranidium. Ocular ridges narrow, apparent only on surface of mold.

Posterior limb short, bluntly rounded; transverse

length about one-half basal glabellar width. Posterior border furrow not defined on external surface.

Course of anterior section of facial suture slightly convergent forward from palpebral lobe to border, then curved inward across margin; distance between intersections with margin about equal to basal glabellar width indicating moderately wide (transverse) rostral plate. Course of posterior section of facial suture directed outward behind palpebral lobe, then strongly curved backward to intersect posterior margin perpendicularly.

Free cheek narrow. Lateral border defined only in anterior part. Lateral margin evenly curved, genal angle strongly rounded. Border about equal in width to ocular platform.

Pygidium semicircular, moderately convex transversely; sagittal profile straight over axis, depressed posterior to axis. Axis defined only by change in slope, not furrowed on external surface, bluntly rounded posteriorly. Pleural regions smooth, convex, downsloping laterally; border not differentiated from pleural platform. Mold shows three or four shallow ring furrows posterior to articulating furrow and three or four pleural-interpleural furrow pairs on the pleural platform and inner part of border posterior to anterior pleural furrow. Border poorly defined, maintains nearly constant width that is about one-half maximum width of pleural platform. Axis reaches to inner margin of border.

External surfaces of all parts smooth, except for anterior part of cranidial border and anterolateral pygidial margins which have low terrace lines. Anterolateral facets of pygidium project slightly laterally beyond pygidial margin and have very faint granules on some specimens. Surfaces of mold coarsely pitted.

Discussion.—This species is extremely similar to *Liopeishania lubrica* (Chang, 1959) from the *Peishania* zone of the Changhsia Formation in Shantung, China. The species are almost certainly congeneric, and the differences between them, based only on comparison with Chang's photographs and brief description, are minor.

L. spannensis has an occipital ring that is nearly uniform in breadth, whereas the occipital ring of *L. lubrica* is triangular. The pygidial border on *L. spannensis* seems to be narrower than that of *L. lubrica*. The validity of these apparent differences can only be determined by comparison of actual specimens. Until this can be done, the Antarctic specimens are considered to represent a species distinct from *L. lubrica*.

Occurrence.—*Schopfaspis granulosus* faunule. Common (40 cranidia, pygidia, and free cheeks), USGS colln. 6313–CO, 6325–CO, 6327–CO, 6364–CO, boulders from moraine on Mount Spann.

Family CONOKEPHALINIDAE Hupé

Genus SULUDELLA Yegorova and Savitskiy

Sududella Yegorova and Savitskiy, 1968, p. 64; 1969, p. 213.

Type species.—*Suludella solita* Yegorova and Savitskiy, 1968, p. 64, pl. 10, fig. 7.

Discussion.—This genus is well characterized, with good illustrations of several species, by Yegorova and Savitskiy (1969). It includes trilobites that have cranidia with an anteriorly tapered, bluntly rounded, poorly furrowed glabella; a flat or concave border as wide or wider than the brim; anteriorly flared facial sutures; long arcuate palpebral lobes; and fixed cheeks one-third to one-half of the glabellar width. Pygidia are relatively small, with several axial and pleural furrows and with short anterolateral spines.

The Antarctic species described below are only questionably assigned to *Suludella*, because the palpebral lobes are longer and more posteriorly placed than in the illustrated species of *Suludella*. Cranidia, without the associated pygidia, might be placed in *Chondranomocare*, except that the fixed cheeks are wider than other species of that genus, and the inner ends of the palpebral lobes are farther from the glabella. Also, if the pygidial association is correct, the large axis and spinose margin are unlike all species of *Chondranomocare*.

Suludella? davnii n. sp.

Plate 6, figures 1,2,5

Description.—Cranidium subquadrate, anterior margin gently rounded; length slightly greater than width across palapebral lobes. Glabella gently convex transversely and longitudinally, tapered slightly forward, bluntly rounded anteriorly, moderately well defined at sides by shallow axial furrows, poorly defined at front by very shallow preglabellar furrow. Glabellar furrows barely apparent. Occipital furrow deep only near axial furrow, shallow across axis. Occipital ring gently convex, bears median axial node. Frontal area concave; sagittal length about one-half sagittal length of glabella exclusive of occipital ring. Brim flat, downsloping, separated from border by shallow border furrow. Border concave; sagittal length slightly more than twice sagittal length of brim.

Fixed cheeks gently convex, slightly upsloping; width, exclusive of palpebral lobes, about two-fifths basal glabellar width. Palpebral lobes strongly arcuate, moderately well defined by shallow palpebral furrow; exsagittal length about three-fourths lengths of glabella exclusive of occipital ring.

Posterior limb not known.

Course of anterior section of facial suture strongly divergent forward from palpebral lobe to strongly

rounded anterolateral corners of cranidium. Course of posterior section not known.

Free cheek has evenly curved lateral margin. Genal spine slightly concave on proximal part; length from tip to posterior suture slightly greater than length of posterior section of facial suture. Ocular platform gently convex. Border concave, well defined by shallow lateral border furrow that meets posterior border furrow at sharp curve at genal angle. Width of border at anterior margin about half anterior width of ocular platform.

Pygidium known only from fragment of pleural region. Border gently concave, downsloping, separated from pleural field by slight change in slope; width about equal to greatest width of pleural platform. Short anterolateral spine present. Pleural field and inner part of border crossed by four pleural furrows that have distinct geniculation at inner edge of border. Posterior furrow very shallow, other furrows moderately deep.

External surfaces of all parts covered with fine, closely spaced granules apparent only after whitening.

Discussion.—This species differs from all others in *Suludella* by having a line connecting the posterior tips of the palpebral lobes passing nearly over the occipital furrow rather than distinctly anterior to the furrow, and by having a considerably narrower brim. The cranidium is very similar to that of *S.? spinosa* n. sp., from which it differs by having a slightly wider brim and a more concave border on the free cheek. The pygidium has only one pair of short anterolateral spines, thus being more typical of *Suludella*, whereas *S.? spinosa* has several pairs of short spines.

Occurrence.—*Solenopleura pruina* faunule. Moderately common (three cranidia, 10 free cheeks, one fragmentary pygidium), USGS colln. 6320–CO, boulder from moraine, Mount Spann.

Suludella? spinosa n. sp.

Plate 6, figures 16–18, 20–23

Description.—Cranidium subquadrate, gently convex transversely and longitudinally gently rounded anteriorly, width between palpebral lobes distinctly greater than length. Glabella low, well defined at sides by abrupt changes in slope of exoskeleton or by shallow axial furrows present only along midlength of sides; tapered slightly forward, bluntly rounded anteriorly. Anterrior end poorly defined. Glabellar furrows shallow, narrow, posterior pair directed posteriorly. Occipital furrow deep at glabellar sides, shallow across midline. Occipital ring simple. Frontal area short, concave, divided by shallow border furrow with slight median posterior inflection into broad, concave border and extremely narrow brim. Sagittal length of frontal area about three-eight's sagittal glabellar length exclusive of occipital ring; sagittal length of border about three-fourths sagittal length of frontal area.

Fixed cheek gently convex, flat or slightly upsloping; width, exclusive of palpebral lobe, about two-fifths basal glabellar width. Palpebral lobe long, strongly arcuate, continuous with short ocular ridge; situated opposite posterior half of glabella; exsagittal length slightly less than one-half sagittal glabellar length exclusive of occipital ring.

Posterior limb slender, length not known.

Course of anterior section of facial suture directed strongly anterolaterally from palpebral lobe to sharply curved anterolateral corner of cranidium. Course of posterior section divergent-sinuous.

Free cheek has gently curved lateral margin and flat genal spine of unknown length. Border flat, defined by shallow lateral border furrow that meets posterior border furrow at sharp angle near base of genal spine. Posterior border furrow deeper than lateral border furrow, continued as shallow furrow onto genal spine. Width of border at anterior sutural margin about two-thirds width of ocular platform.

Pygidium subovate, moderately to strongly convex transversely and longitudinally. Axis high, tapered posteriorly to point nearly above posterior margin, bluntly rounded at back; width about equal to width of pleural platform. Two or three ring furrows present posterior to articulating furrow; anterior two furrows deepest. Pleural regions gently convex, downsloping; crossed by two or three moderately deep pleural furrows that continue onto narrow poorly defined border. Two shallow diagonal interpleural furrows are present on pleural platforms only. Border narrow, tapered towards axis, bears five pairs of short, sharp, slender spines.

Axial part of glabella and pygidium, outer part of border on cranidium, free cheek, and pygidium including spines covered with closely spaced coarse granules. Fixed cheek and ocular platform of free cheek have less dense covering of granules. Brim, inner parts of border on cranidium and free cheek, part of ocular platform, and all of pleural platform of pygidium lack distinct ornamentation.

Discussion.—This species is assigned to *Suludella* because of the general cranidial characters and the presence of a narrow border and relatively large furrowed axis on the pygidium. The assignment is questioned because the palpebral lobes are more posteriorly situated than those of the Siberian species, and the pygidium has a multispinose margin. These characters distinguish *S.? spinosa* from all other species in the genus.

The association of pygidium and cranidium is based

on their presence in two collections, from localities more than 100 miles apart, in which they occur with only one other common trilobite, *Nelsonia schesis* n. sp. The style of ornamentation, with granules principally on the axial parts and the outer margins, supports the association.

Occurrence.—*Nelonia schesis* faunule. Moderately common (10 cranidia, one free cheek, six pygidia), USGS colln. 4443–CO, 6378–CO, 6379–CO, 6380–CO Nelson Limestone, Neptune Range; 6355–CO, boulder from moraine on Mount Spann.

Family NEPEIDAE Whitehouse

Genus TRINEPEA n. gen.

Type species.—*Trinepea trinodus* n. sp.

Diagnosis.—Nepeidae with three prominent bosses on brim; wide, upsloping fixed cheeks; prominent undivided ocular ridges; palpebral lobes opposite anterior third of glabella; and large backwardly flared posterior limbs.

Discussion.—Öpik (1963, 1967) has provided good discussions of the character and content of the Nepeidae. All genera in the family are characterized by a median boss on the brim. *Trinepea* differs from all other nepeids and all other Cambrian trilobites by having a pair of prominent lateral bosses on the brim as well as the median boss. It also lacks a divided ocular ridge that is stated by Öpik (1963, p. 340) to be typical of all nepeids. However, in view of the great majority of characters shared with *Nepea* and other nepeids, this difference is considered here to be of no more than generic importance.

Trinepea trinodus n. sp.

Plate 4, figures 1, 2

Description.—Cranidium trapezoidal, moderately rounded anteriorly; sagittal length slightly more than half of width between tips of posterior limbs. Glabella prominent, slightly sunken, moderately tapered forward, truncate anteriorly, gently convex transversely, moderately convex longitudinally, well defined by deep axial and preglabellar furrows; sagittal length, exclusive of occipital ring, about equal to basal glabellar width. Three pairs of short deep lateral glabellar furrows indent lateral glabellar margin at axial furrow; posterior pair longest, directed strongly backward. Posterior glabellar lobes extended laterally onto inner part of fixed cheeks. Occipital furrow deep adjacent to axial furrow, shallow across axis. Structure of occipital ring not known. Frontal area consists of broad moderately convex brim and narrow gently convex border, separated by broad deep border furrow; sagittal length frontal area about equal to sagittal length of glabella exclusive of occipital ring; sagittal length of border about one-fourth sagittal length of brim. Brim has three large poorly defined bosses, one at midlength on axial line and others lateral to this and slightly closer to the facial suture than to the median boss.

Fixed cheek wide, upsloping; width, exclusive of palpebral lobe, about equal to basal glabellar width. Palpebral lobe short, sharply arcuate, well defined by broad palpebral furrow, connected to front of glabella by straight, nearly transverse, narrow well-defined undivided ocular ridge; exsagittal length of palpebral lobe slightly more than one-half sagittal glabellar length exclusive of occipital ring.

Posterior limb long, broad; downsloping lateral to palpebral lobe and posterior border strongly backswept. Posterior border furrow nearly straight, transverse, deep, broadens distally. Transverse length of posterior limb slightly more than 1½ times basal glabellar width.

Course of anterior section of facial suture nearly straight forward from palpebral lobe to anterior margin, further course not known. Course of posterior section of facial suture almost straight laterally from palpebral lobe, then curved strongly backward to posterior margin.

External surfaces of all convex parts covered with coarse granules. Furrows and extension of posterior glabellar lobe onto fixed cheek smooth.

Free cheek, thorax, and pygidium not known.

Discussion.—This striking species, although represented by only two cranidia, is so unusual that it cannot be closely compared with any other described Cambrian trilobite. Both cranidia are quite large (length 12 to 14 mm). An associated nepeid cranidium about one-third as large has only a median boss on the brim. This small specimen may be a younger individual on which the lateral bosses have not developed, but there is no indication of even incipient development, and it is recorded here as a separate, unnamed, nepeid (p. D32).

Occurrence.—*Amphoton oatesi* faunule. Rare (two cranidia), USGS colln. 4446–CO, Nelson Limestone, Neptune Range.

Family SOLENOPLEURIDAE Angelin

Genus SOLENOPLEURA Angelin

Solenopleura Angelin, 1854, p. 26; Lake 1931, p. 133; Kobayashi 1935, p. 262; Westergård, 1953, p. 7; Chernysheva, 1953, p. 34; Yegorova and others, 1960, p. 231; Chernysheva, 1961, p. 242.

Type species—*Calymene canaliculata* Angelin, 1851, p. 23, pl. 18, figs. 9, 9a.

Discussion.—Westergård (1953) and Chernysheva (1953) both give excellent summaries of the characters of this genus. Westergård points out that the correct

type species is *S. canaliculata* and not *S. holometopa* and compares all the Scandinavian species. Chernysheva tabulated the characters of eight Russian species in addition to her diagnosis of the genus.

Solenopleura, as presently constituted, includes a variety of ptychoparioids that have a well-defined anteriorly tapered strongly rounded glabella, well-defined border, moderately wide fixed cheeks, generally small palpebral lobes variously situated with respect to the glabellar midlength, free cheeks with variably developed and directed genal spines, nonspinose pygidia with a variable number of axial and pleural segments and a generally granular ornamentation.

The Antarctic species seems closest in overall characters to the Siberian species described and illustrated by Chernysheva. They share relatively wide fixed cheeks and small upturned palpebral lobes on the cranidium, a pygidium with few axial and pleural furrows, and granular ornamentation. The Scandinavian species included in *Solenopleura* have a greater variety of cranidial and pygidial characters, and none of the species closely resembles the Antarctic species.

Solenopleura pruina n. sp.

Plate 5, figures 19–22

Description.—Cranidium subquadrate, gently convex transversely, moderately convex longitudinally, moderately rounded anteriorly; length slightly less than width between palpebral lobes. Glabella well defined by deep axial and moderately shallow preglabellar furrows, moderately convex transversely and longitudinally, tapered forward, strongly rounded at front; length, exclusive of occipital ring, about equal to width. Glabellar furrows barely apparent. Occipital furrow straight, moderately deep. Occipital ring moderately convex, without occipital spine; width uniform. Frontal area includes strongly downsloping, gently convex brim and nearly horizontal gently convex border separated by broad shallow border furrow; sagittal length of brim about one-fourth sagittal length of glabella exclusive of occipital ring; sagittal length of border slightly less than three-fourths sagittal length of brim.

Fixed cheek gently convex, horizontal; width, exclusive of palpebral lobe, about one-half basal glabellar width. Palpebral lobe small, upturned, connected to anterolateral end of glabella by narrow, poorly defined ocular ridge, situated opposite middle third of glabella; exsagittal length slightly less than one-third sagittal glabellar lentgh exclusive of occipital ring.

Posterior limb blunt, transverse length about two-thirds basal glabellar width. Posterior border furrow deep, straight.

Course of anterior section of facial suture slightly divergent forward to strongly rounded anterolateral cranidial corners. Course of posterior section convex, intersects posterior margin nearly perpendicularly.

Free cheek has narrow, convex border defined by deep lateral border furrow that becomes shallow towards genal angle; width of border about two-thirds width of gently convex ocular platform along anterior sutural margin. Lateral margin gently curved, continuous with margin of moderately short sharp genal spine; distance from tip of spine to posterior facial suture about four-fifths length of posterior section of facial suture. Posterior suture intersects margin near base of genal spine.

Pygidium transversely subovate, lateral margins sharply rounded, posterior margin gently rounded, without spines. Axis prominent, broad, barely tapered, bluntly rounded posteriorly, reaches to inner edge of narrow poorly defined border; width slightly greater than width of pleural region. One or two ring furrows, present posterior to articulating furrow; anterior furrow deepest. Pleural regions gently convex, crossed by two or three broad shallow pleural furrows that reach to inner edge of a narrow border that is defined only by slight change in slope of pleural region.

External surfaces of all parts except glabellar and axial furrows, and palpebral lobes, covered with closely spaced fine granules; glabellar lobes, fixed cheeks, and brim on the cranidium and ocular platform on free cheek also have scattered larger granules.

Discussion.—This species differs from the several Russian species of *Solenopleura* described by Chernysheva (1953), with which it shares more characters than it does with the Scandinavian species described by Westergård (1953), by having narrower fixed cheeks than all but *S. zverewi* Lermontova. The axis of the pygidium of the Antarctic species does not reach the posterior margin as it does in *S. zverewi.*

Occurrence.—*Solenopleura pruina* faunule. Moderately common (seven cranidia, four free cheeks, four pygidia), USGS colln. 6320–CO, boulder from moraine, Mount Spann.

UNASSIGNED TRILOBITES

Genus GLABRELLA Lermontova

Glabrella Lermontova, 1940, p. 120; Lermontova, 1951a, p. 28; Repina, 1960, p. 157; Yegorova, 1962, p. 158.

Type species.—*Glabrella ventrosa* Lermontova, 1940, p. 120, pl. 35, figs. 9, 9a–d.

Discussion.—This genus was proposed by Lermontova for small Middle Cambrian trilobites that lacked differentiation of the glabella and border on the cranidium. Yegorova (1962) included an Early Cambrian species that differed from the type species by lacking

the upturned palpebral lobes and by having the longitudinal profile of the cranidium more evenly curved. The Antarctic species described below is most like *Glabrella mrassina* Yegorova, the only obvious difference being ornamentation. However, the description of that species is brief and the illustration is not clear so that other possible differences cannot be determined. The contrast in structure of the palpebral lobes and in the longitudinal profile between *G. mrassina* and the type species, *G. ventrosa*, suggests that they may be quite unrelated trilobites that have been grouped primarily because they both lack development of most cranidial furrows. For this reason, the generic assignment of the Antarctic species is questioned.

All Russian workers have included *Glabrella* in the Pagetiidae. The structure of the palpebral lobe, course of the facial sutures, and breadth of the glabella for *G. mrassina* are all unlike any described pagetiids, and if the affinities to *G. pitans* n. sp. are real, this trilobite is an effaced ptychoparioid trilobite rather than a pagetiid trilobite. Without the opportunity to examine specimens of the type species of *Glabrella*, this is further reason to question the assignment of the Antarctic species to this genus.

Glabrella? pitans n. sp.

Plate 1, figures 9, 10, 13, 14

Description.—Cranidium subquadrate, moderately convex transversely and longitudinally; width between palpebral lobes slightly greater than length. Glabella not differentiated on external surface, barely recognizable even on surface of mold, low, tapered forward, strongly rounded anteriorly. Glabellar furrows absent. Occipital furrow extremely weak, barely apparent on many specimens. Occipital ring continues convexity of glabella. Frontal area not differentiated into brim and border, downsloping, continues anterior curvature of glabella; sagittal length about one-fourth sagittal length of glabella including occipital ring.

Fixed cheek gently convex, downsloping, continues lateral curvature of glabella; width, including undifferentiated palpebral lobe about three-fourths basal glabellar width. Very faint posterolateral ridges apparent on some specimens. Palpebral lobe situated opposite cranidial midlength, gently curved, not defined by palpebral furrow; exsagittal length about one-fourth sagittal length of cranidium.

Posterior limb short, blunt; transverse length about three-fourths basal glabellar width. Posterior border furrow shallow, divergent laterally from posterior margin.

Course of anterior section of facial suture nearly straight forward from palpebral lobe to moderately rounded anterolateral cranidial margin. Course of posterior section convex.

Free cheek elongate, lateral margin gently curved, border not differentiated. Genal spine convex, broad based, margin slightly deflected from margin of anterior part. Distance from tip of spine to posterior section of facial suture about twice length of posterior section of facial suture.

Thoracic segments and pygidium not known.

Exterior surfaces of all specimens longer than 5 mm covered with scattered fine pits; smaller specimens are smooth. Terrace lines present along anterior margin of cranidium, posterior cranidial margin only at juncture of posterior limb and glabella, lateral margin of free cheek, and all of genal spine.

Discussion.—The ornamentation, structure of the palpebral lobes, absence of almost all dorsal furrows, and presence of a large spine on the free cheek are the most characteristic features of this species that differentiate it from other smooth trilobites. The change from smooth to pitted ornamentation at a cranidial length about 5 mm is an unusual feature that may also be characteristic of this species. Fragments indicate that some specimens of this species had cranidia about 3 cm long.

Occurrence.—*Australaspis magnus* faunule. Common (>30 cranidia, one free cheek), USGS colln. 5939-CO, 6311-CO, boulders from moraine on Mount Spann.

Genus Nelsonia n. gen.

Type species.—*Nelsonia schesis* n. sp.

Diagnosis.—Tiny ptychoparioid trilobites. Glabella prominent, unfurrowed, tapered forward, well defined by axial and preglabellar furrows. Prominent median pit in preglabellar furrow on axial line. Occipital ring broad. Frontal area subequally divided by border furrow that is deep laterally and shallow on axial line. Fixed cheeks nearly flat, horizontal, wide. Palpebral lobes not well defined, about one-half glabellar length exclusive of occipital ring. Posterior limb blunt.

Course of anterior sections of facial sutures nearly straight forward from palpebral lobe. Course of posterior section convex, moderately divergent behind palpebral lobe.

Free cheek narrow. Border about as wide as ocular platform. Genal spine long, broad-based, continues curvature of margin. Most specimens retain the eye surface.

Pygidium subtriangular, strongly convex transversely and longitudinally. Axis defined only at sides, tapered posteriorly and sloped downward to posterior margin. Two ring furrows continuous across axis, one or two additional rings shown by furrows only at sides of axis. Pleural regions downsloping, crossed by four or five

closely spaced pleural furrow-interpleural furrow pairs. Border not present.

External surfaces of all parts obscurely granular.

Discussion.—This distinctive little trilobite differs from all other ptychoparioids by the presence of a large deep pit in the preglabellar furrow on the axial line. The tendency for the free cheek to retain the visual surface is probably also a significant generic character.

No described trilobites can be closely compared with this trilobite.

Nelsonia schesis n. sp.

Plate 6, figures 3, 4, 6–14

Description.—Cranidium small. Adult specimens rarely exceed 3 mm in length. Cranidium subquadrate, moderately rounded anteriorly, gently convex transversely and longitudinally; width between palpebral lobes slightly greater than length. Glabella prominent, unfurrowed, tapered forward or subparallel-sided, strongly rounded at front, strongly convex transversely, gently convex longitudinally, well defined by axial and preglabellar furrows. Large pit situated in preglabellar furrow on axial line. Occipital furrow deep, straight. Occipital ring broad; sagittal length about one-half sagittal length of remainder of glabella. Frontal area subequally divided by border furrow into convex border and nearly flat brim; sagittal length slightly less than one-half sagittal length of glabella exclusive of occipital ring. Border furrow very shallow on axial line, deep laterally.

Fixed cheek gently convex, slightly downsloping; width, including poorly defined palpebral lobe, from slightly more to slightly less than basal glabellar width. Exsagittal length of palpebral lobe about one-half or slightly more than one-half sagittal glabellar length.

Posterior limb blunt, transverse length equal to or slightly less than basal glabellar width. Posterior border furrow deep, narrow, of uniform depth.

Course of anterior section of facial suture nearly straight forward from palpebral lobe to moderately rounded anterolateral corners of cranidium. Course of posterior section convex, moderately divergent behind palpebral lobe.

Free cheek narrow, lateral margin gently curved, continuous with long, broad-based genal spine. Border convex, poorly defined by lateral border furrow; about as wide as ocular platform. Eye surface retained on most specimens, covered with obscure round facets. Distance from tip of genal spine to posterior section of facial suture about twice length of posterior section of facial suture.

Pygidium strongly convex transversely and longitudinally. Axis prominent, tapered posteriorly to margin, defined only at sides. Height decreases toward rear so that posterior part is barely elevated above pleural regions. Two ring furrows continue across axis behind articulating furrow. First ring furrow has crescentic pseudoarticulating ring on axial line. One or two additional ring furrows marked only at sides of axis. Muscle scars show on axis as low raised paired protuberances. Pleural regions not differentiated into pleural fields and border. Three or four pleural furrows cross pleural regions. All but anterior furrow are paired with shallow subparallel interpleural furrow. Posterior margin smooth.

External surfaces of all parts covered with obscure closely spaced granules.

Discussion.—The distinctive characteristics of this species were discussed after the generic description.

Occurrence.—*Nelsonia schesis* faunule. Abundant (>40 cranidia, pygidia, and free cheeks), USGS colln. 4443–CO, 6378–CO, 6379–CO, 6380–CO, Nelson Limestone, Neptune Range; 6355–CO, boulder from moraine on Mount Spann.

Genus PENSACOLA n. gen.

Type species.—*Pensacola isolata* n. sp.

Diagnosis.—Redlichioid trilobites with prominent anteriorly tapered well-defined weakly furrowed glabella that is bluntly rounded anteriorly and reaches to nearly straight border furrow. Occipital furrow deep. Occipital ring with median node on posterior margin. Border convex in sagittal profile; anterior margin moderately rounded. Fixed cheeks upsloping, crescentic. Palpaberal lobes, situated about opposite glabellar midlength, form continuous J-shaped structure with ocular ridges. Posterior limbs slender, tapered to sharp points.

Anterior sections of facial sutures extend nearly straight forward from palpebral lobes; posterior sections widely divergent.

Free cheek has well-defined lateral border furrow and broad shallow poorly defined posterior border furrow. Genal spine short, sharp, broad-based.

Pygidium(?) has transversely elliptical outline and is occupied mostly by a broad poorly defined axis with two ring furrows. Pleural regions small, subtriangular, with deep anterior pleural furrows and shallow second furrow. Pygidian margin smooth.

Discussion.—This genus most closely resembles Asiatic Early Cambrian genera such as *Minusinella* (Repina, 1966, pl. 14, figs. 1–6) and *Asiatella* (Repina, 1966, pl. 23, figs. 9–15) by having a J-shaped palpebral lobe-ocular ridge combination and a relatively long glabella. However, these genera differ from *Pensacola* by having the anterior part of the ocular ridge bifurcated and extended in part in front of the glabella.

The association of the free cheek with the cranidium is based on similarity of ornamentation and comparable abundance in several samples. The pygidial association is less certain, but its form is consistent with an assignment to the Redlichioidea, and *P. isolata* is the commonest trilobite in the samples yielding pygidia.

Pensacola isolata n. sp.

Plate 1, figures 11, 12, 15–22

Description.—Cranidium moderately convex transversely and longitudinally; outline trapezoidal, anterior width twice posterior width; anterior margin moderately rounded. Glabella well defined, tapered forward, bluntly rounded anteriorly, moderately convex transversely and longitudinally, extended to inner margin of border furrow. Three pairs of glabellar furrows present slightly indenting sides of glabella and continuing inward about one-third of glabellar width; posterior pair deepest, directed inward and backward from side of glabella. Occipital furrow deep, straight, moderately wide, shallowest on axial line. Occipital ring convex, maintains nearly constant sagittal and exsagittal width, bears strong median node adjacent to posterior margin. Basal glabellar width about four-fifths glabellar length exclusive of occipital ring. Frontal area composed of moderately broad convex border and broad deep border furrow. Border gently arched in anterior view; sagittal length about one-third sagittal glabellar length.

Fixed cheek upsloping from broad deep axial furrow; width, exclusive of palpebral lobe about one-half basal glabellar width. Palpebral lobe broad, arcuate, well defined posteriorly by palpebral furrow, merged imperceptibly forward with poorly defined broad ocular ridge that extends posterolaterally from near anterior end of glabella, situated opposite middle third of glabella; width of palpebral lobe about one-half width of infraocular part of cheek; length between one-half and two-thirds length of glabella exclusive of occipital ring, longest on smaller specimens.

Posterior limb slender, tapered laterally to sharp point. Posterior border furrow broad, deep; posterior border increases in width distally. Length of posterior limb about equal to basal glabellar width.

Anterior section of facial suture directed nearly straight forward from palpebral lobe to border furrow, then turned inward across border to intersect anterior margin about two-thirds of distance from anterior cranidial corner to axial line. Posterior section of suture sigmoid, intersects posterior margin at acute angle.

Free cheek short, broad, lateral margin gently curved, slightly deflected outward by short broad-based sharp genal spine. Lateral border well defined by border furrow that is deep at anterior margin but broadens, shallows, and merges backward with broad shallow posterior border furrow. Width of border at anterior margin about one-half length of anterior section of facial suture from border furrow to eye notch. Length of posterior margin from intersection of posterior section of facial suture to tip of genal spine slightly more than one-half length of posterior section of facial suture.

Pygidium, believed to be of this species, transversely subovate in outline, length slightly more than one-half greatest width. Axis broad, low, poorly defined, occupies most of pygidial surface, bears one distinct and one barely apparent ring furrow posterior to articulating furrow; width slightly less than three-fifths greatest pygidial width.

Pleural regions not differentiated into pleural field and border, anterior pleural furrow present along inner half of anterior margin. A second shallow furrow, marked by pits in the positions of the axial and border furrows, extends laterally from the first ring furrow. Lateral parts of pleural region concave. Posterior margin smooth.

Ornamentation consists of closely-spaced granules on all convex parts of the cranidium and free cheek and all parts of the pygidium. The outer part of the cranidial border on some specimens and the lateral border of the free cheek have well-developed terrace lines. The furrows of the cranidium and free cheek and a narrow band along the outer margin of the palpebral lobe are smooth or have scattered very fine pits. Surface of the mold has scattered pits. On the free cheek, the granular part of the ocular platform has an irregular lateral margin near the border furrow that seems to be consistently indented at two places lateral and posterolateral to the eye notch. On the largest specimen, the indentations have a much finer granular ornamentation than the other parts of the ocular platform. On smaller cheeks, these areas seem to be smooth.

Discussion.—The possible relationships of this species were discussed after the generic diagnosis.

Occurence.—*Chorbusulina wilkesi* faunule. Common (20 cranidia and free cheeks; two pygidia). USGS colln. 5937–CO, 6308–CO, 6329–CO, 6331–CO, 6352–CO, boulders from moraine on Mount Spann.

Genus SCHOPFASPIS n. gen.

Type species.—*Schopfaspis granulosus* n. sp.

Diagnosis.—Ptychoparioid trilobites with cranidium subquadrate, strongly rounded anteriorly. Glabella well defined, straight sided, tapered forward, bluntly rounded anteriorly. Glabellar furrows shallow to moderately deep. Occipital furrow straight, deepest near axial furrows. Occipital ring has small centrally located axial node. Frontal area nearly as long as glabella, ex-

clusive of occipital ring. Subequally divided into gently to moderately convex downsloping brim and gently convex subhorizontal border by broad shallow border furrow. A pair of shallow depressions is variably developed in the border furrow anterolateral to glabellar corners.

Fixed cheek gently convex, horizontal; width, exclusive of palpebral lobe, about one-half basal glabellar width. Palpebral lobes upturned, defined by change in slope, situated opposite glabellar midlength; exsagittal length slightly more than one-half sagittal glabellar length exclusive of occipital ring. Ocular ridges weak.

Posterior limb pointed; transverse length about equal to basal glabellar width. Posterior border furrow moderately deep.

Course of anterior section of facial suture slightly divergent forward from palpebral lobe; course of posterior section convex outward.

Free cheek narrow. Border convex, slightly wider than ocular platform. Lateral and posterior border furrows well defined, joined sharply at genal angle. Genal spine slender, continues curvature of margin of cheek.

Rostral plate wide transversely, with strong lateral notches.

Pygidium small, transversely subovate. Axis elevated, well defined, about one-third width of pygidium, reaches nearly to posterior margin, bluntly rounded posteriorly. One ring furrow present posterior to articulating furrow. Pleural regions crossed by several shallow pleural and interpleural furrows. Border not clearly defined. Posterior margin straight transversely behind axis, curved laterally, without spines.

Discussion.—The most distinctive features of this genus, which differentiate it from other superficially similar ptychoparioids, are the presence of a pair of shallow depressions in the anterior border furrow of the cranidium, the relatively long frontal area and the strong curvatures of the anterior border furrow and the anterior cranidial margin.

The cranidial proportions are similar to some Aphelaspidinae, but the presence of a wide (transverse) curved rostral plate in *Schopfaspis* instead of a triangular rostral plate and absence of depressions in the axial furrows at the anterolateral corners of the glabella typical of the Aphelaspidinae indicates that they are not closely related.

The cranidia also show relationships to some species of *Alokistocare* (cf. *A. aoris*, Rasetti, 1965, pl. 119, figs. 1–4), but they lack the preglabellar median swelling on the brim typical of that genus. However, *Schopfaspis* might be considered as a member of the Alokistocaridae when the characteristics of that diverse family are adequately clarified.

Schopfaspis granulosus n. sp.

Plate 5, figures 8–14

Description.—Cranidium subtrapezoidal, anterior margin strongly rounded; length about five-sixths width between tips of posterior limbs. Glabella well defined by shallow axial and preglabellar furrows, straight sided, moderately convex transversely, gently convex longitudinally, tapered slightly forward, bluntly rounded at front. Glabellar furrows short, weakly to moderately impressed, posterior pair directed slightly backward from axial furrow. Occipital furrow straight, deep near axial furrow, shallow across axis. Occipital ring gently convex, slightly expanded on axial line, has tiny centrally located axial node. Frontal area broad, with well-defined brim and border. Sagittal length slightly less than sagittal glabellar length exclusive of occipital ring. Border furrow broad, shallow, bears pair of shallow depressions, variably developed, slightly lateral to point midway between axial line and anterolateral cranidial margin; parallel to anterior margin. Brim gently to moderately convex, downsloping; sagittal length about equal to sagittal length of evenly convex subhorizontal border.

Fixed cheek gently convex, horizontal; width, exclusive of palpebral lobes about one-half basal glabellar width. Palpebral lobe upturned, defined only by change in slope, situated opposite glabellar midlength, gently curved in plan view; exsagittal length slightly more than one-half sagittal glabellar length exclusive of occipital ring. Ocular ridge weakly developed to barely apparent, directed slightly posterolaterally from anterolateral corner of glabella.

Posterior limb pointed; transverse length about equal to basal glabellar width. Posterior border furrow deep.

Course of anterior section of facial suture slightly divergent forward from palpebral lobe to border furrow, then curved inward across border to intersect anterior margin distal to depressions in border furrow. Course of posterior section divergent behind palpebral lobe, curved backward to intersect posterior margin nearly perpendicularly.

Rostral plate broad transversely, moderately curved in plan view, strongly curved in sagittal section; lateral margins strongly indented; posterior margin shorter than anterior margin. Ventral surface, except for concave zone along anterior margin and strongly upturned posterior part, has strong terrace lines.

Hypostome and thoracic segments not known.

Free cheek narrow. Lateral border convex, of uniform width, slightly wider than ocular platform, well defined by moderately deep lateral border furrow that intersects equally deep posterior border furrow sharply at genal angle. Genal spine slender, round in cross section, con-

tinues curvature of lateral margin; length from posterior sutural margin to tip about 1½ times length of posterior section of facial suture.

Pygidium small, transversely subovate, anterior and posterior margins gently curved, meet laterally at blunt point; posterior margin directly behind axis nearly straight transversely; margin without spines. Axis prominent, barely tapered posteriorly, reaches nearly to posterior margin, defined by abrupt change in slope. One broad shallow ring furrow present posterior to articulating furrow; one additional ring furrow indicated only at sides of axis. Pleural regions gently convex, crossed by two pleural and two interpleural furrows, all shallow, about equally spaced, and disappearing before reaching lateral margin. Border not clearly differentiated.

External dorsal surfaces of all parts except areas above glabellar muscle attachments and palpebral lobes are covered with closely spaced low granules.

Discussion.—This species cannot be closely matched to any described species. Its general affinities and distinctive characteristics were presented in the generic discussion.

Occurrence.—*Schopfaspis granulosus* faunule. Common (40 cranidia, free cheeks, pygidia, and rostral plates), USGS colln. 6313–CO, 6325–CO, 6327–CO, 6364–CO, boulders in moraine on Mount Spann.

Genus and species undetermined 1

Plate 3, figures 10–12

Description.—Cranidium subquadrate exclusive of posterior limbs, gently convex transversely and longitudinally; width between palpebral lobes about equal to length; anterior margin gently rounded. Glabella well defined by continuous narrow axial and preglabellar furrows, tapered forward, strongly rounded anteriorly. Occipital furrow slightly sinuous, deep near axial furrow, shallow across axis. Occipital ring widened slightly towards front on axial line, bears low median node. Frontal area downsloping, divided by narrow evenly curved border furrow into flat or gently convex border and brim; sagittal length about one-half sagittal length of glabella including occipital ring. Border has narrow poorly defined slightly raised anterior rim; sagittal length of border about three-fourths sagittal length of brim.

Fixed cheeks moderately wide, gently convex, slightly downsloping; width, exclusive of palpebral lobes, about three-fifths basal glabellar width. Palpebral lobes small, sharply upturned, defined by change in slope, situated opposite or slightly posterior to glabellar midlength, connected to glabella by low straight barely apparent ocular ridge; exsagittal length about one-third or slightly more than one-third of sagittal glabellar length exclusive of occipital ring.

Posterior limbs moderately long, bluntly pointed; transverse length about equal to basal glabellar width. Posterior border furrow deep.

Course of anterior section of facial suture slightly divergent forward from palpebral lobe to border furrow, then curved inward across border; intersection with anterior margin not apparent. Course of posterior section convex, widely divergent behind palpebral lobe, nearly perpendicular to posterior margin.

Free cheek narrow, width of border about equal to width of ocular platform. Lateral border furrow shallow, merges posteriorly with very shallow posterior border furrow. Genal spine flat, margin continuous with lateral margin of cheek; length of spine greater than length of posterior section of facial suture.

External surfaces of all parts generally smooth; one cranidium has faint closely-spaced granules on posterior axial part of glabella and occipital ring.

Discussion.—This species resembles many nondescript Middle Cambrian ptychoparioid trilobites; without more specimens and a better knowledge of the whole trilobite, a meaningful identification is not possible.

Occurrence.—*Xystridura multilinia* faunule. Rare (11 cranidia, two free cheeks) USGS colln. 6333–CO, boulder from moraine on Mount Spann.

Genus and species undetermined 2

Plate 5, figures 15–17

Discussion.—Two incomplete cranidia of a distinctive ptychoparioid trilobite are present in the *Schopfapsis granulosus* faunule. Possibly their discovery elsewhere may help to date this faunule more precisely.

The cranidia are characterized by a distinct anteriorly tapered truncate unfurrowed glabella that is defined only by abrupt changes in slope of the exoskeleton. The occipital furrow is very shallow, and the occipital ring is relatively broad and gently convex. The brim and fixed cheeks are gently convex, relatively broad, and downsloping from the glabella. The sagittal length of the brim is about half the sagittal length of the glabella exclusive of the occipital ring; the width of the fixed cheek, including the small, undifferentiated palpebral lobes, is slightly more than two-thirds the basal glabellar width. The border is concave, and its inner margin is extremely poorly defined by a faint narrow inflection of the exoskeleton. The deepest part of the concavity of the border gives the false impression of being a broad shallow border furrow. The sagittal length of the border is slightly less than the sagittal length of the brim. The anterior sections of the facial sutures are strongly flared forward from the palpebral lobes, which are situated

opposite the middle third of the glabella. The posterior section of the facial suture is strongly divergent behind the palpebral lobe, but its full course is not known because none of the specimens have the posterior limb preserved. Faint narrow ocular ridges are apparent on the fixed cheeks after whitening. The cranidia are smooth except for a crudely triangular area of granular ornamentation that includes the occipital ring and the posterior part of the glabella (pl. 5, fig. 17).

The unusual ornamentation, flaring frontal area, broad brim and fixed cheeks, and generally poor development of all furrows distinguish this species from other ptychoparioid trilobites. However, more complete specimens are needed to adequately characterize the species for formal naming.

Occurrence.—*Schopfaspis granulosus* faunule. Rare (two cranidia), USGS colln. 6325–CO, boulder from moraine, Mount Spann.

Genus and species undetermined 3

Plate 6, figures 15, 19

Discussion.—A single collection of badly deformed and slightly metamorphosed limestone from a nunatak in the Harold Byrd Mountains contains abundant and mostly indeterminate trilobite fragments. One distinctive trilobite is recorded here because it may help to date the sample. This species is characterized by a strongly developed plectrum on the frontal area, an anteriorly tapered strongly rounded glabella with two pairs of glabellar furrows, a simple occipital ring, arcuate palpebral lobes situated about opposite the glabellar midlength, and slender moderately long posterior limbs.

The most comparable trilobites are species assigned to *Mapania*, a late Middle Cambrian genus found in China and Australia. The specimens are not nearly well enough preserved to identify, but they indicate the probable presence of rocks of late Middle Cambrian age in the Harold Byrd Mountains.

Occurrence.—Moderately common (10 cranidia), USGS colln. 5466–CO, Harold Byrd Mountains.

Genus and species undetermined 4

Plate 4, figure 3

Discussion.—A single small nepeid cranidium is associated with *Trinepea trinodus* n. sp. and may be a small individual of that species although the differences are much greater than usual between small and large holaspids. The small specimen is essentially indistinguishable from *Trinepea trinodus* posterior to the ocular ridges. The ocular ridges have a very shallow longitudinal furrow that is typical of most nepeids. The brim contains only a single median boss, well defined by a pair of longitudinal furrows that extend from the preglabellar furrow to the border furrow. The border is downsloping rather than horizontal as in *T. trinodus*.

These differences would normally constitute adequate grounds for recognizing that the small specimen represents at least a species different from *T. trinodus*. However, until a larger sample of either taxon is obtained, the relationships between the two nepeids will be uncertain, and the nomenclature for the small specimen is kept open.

Occurrence.—*Amphoton oatesi* faunule. Rare (one cranidium), USGS colln. 4446–CO, Nelson Limestone, Neptune range.

COLLECTING LOCALITIES AND FAUNAL LISTS

ARGENTINA RANGE

Mount Spann, 82° S., 41°20′ W., close to west base of the mountain. Boulders from Holocene moraine. Collected by J. M. Schopf, D. L. Schmidt, and W. H. Nelson, January 1966.

Australaspis magnus faunule
- 5939–CO, 6311–CO
  - *Australaspis magnus* n. sp.
  - *Glabrella? pitans* n. sp.

Chorbusulina wilkesi faunule
- 6308–CO
  - *Chorbusulina wilkesi* n. sp.
  - *Pensacola isolata* n. sp.
  - *Bathyuriscellus australis* n. sp.
  - *Redlichia* sp.
- 5937–CO, 6331–CO
  - *Chorbusulina wilkesi* n. sp.
  - *Pensacola isolata* n. sp.

Chorbusulina subdita faunule
- 6312–CO
  - *Chorbusulina subdita* n. sp.
  - *Bathyuriscellus modestus* n. sp.
- 6321–CO
  - *Chorbusulina subdita* n. sp.

Xystridura multilinia faunule
- 6333–CO
  - *Xytridura multilinia* n. sp.
  - *Goldfieldia ninguis* n. sp.
  - *Pagetia longispina* n. sp.
  - Genus and species undetermined 1

Xystridura glacia faunule
- 5938–CO
  - *Xystridura glacia* n. sp.

Schopfaspis granulosus faunule
- 6325–CO
  - *Schopfaspis granulosus* n. gen., n. sp.
  - *Pagetides? antarcticus* n. sp.
  - *Liopeishania spannensis* n. sp.
  - *Olenoides* sp.
  - Genus and species undetermined 2
- 6313–CO, 6327–CO, 6364–CO
  - *Schopfaspis granulosus* n. gen., n. sp.
  - *Pagetides? antarcticus* n. sp.
  - *Liopeishania spannensis* n. sp.

Solenopleura pruina faunule
6320–CO
Solenopleura pruina n. sp.
Suludella? davnii n. sp.
Nelsonia schesis faunule
6355–CO
Nelsonia schesis n. gen., n. sp.
Suludella? spinosa n. sp.

NEPTUNE RANGE

1. Outcrop, Nelson Limestone, 83°40′ S., 55°15′ W. Collected by D. L. Schmidt, January 1964.
Nelsonia schesis faunule
4443–CO
Nelsonia schesis n. gen., n. sp.
Suludella? spinosa n. sp.
4445–CO (morainal debris, same area)
Nelsonia schesis n. gen., n. sp.

2. Outcrops, Nelson Limestone, Mount Dover, 83°50′ S., 55°45′ W. Collected by D. L. Schmidt, December 1965.
Nelsonia schesis faunule
6378–CO (basal beds of member 3, Nelson Limestone)
6379–CO (30 feet above base of member 3, Nelson Limestone)
6380–CO (31 feet above base of member 3, Nelson Limestone)
Nelsonia schesis n. gen., n. sp.
Suludella? spinosa n. sp.

3. Outcrop, Nelson Limestone. 38°37′ S., 55°05′ W. Collected by D. L. Schmidt, January 1964.
Amphoton oatesi faunule
4446–CO
Amphoton oatesi n. sp.
Chondranomocare australis n. sp.
Kootenia styrax n. sp.
Trinepea trinodus n. gen., n. sp.
Peronopsis cf *P. fallax* (Linnarsson)

HAROLD BYRD MOUNTAINS

Outcrop, isolated nunatak north of Leverett Glacier in the Harold Byrd Mountains, 85°40′ S., 146° W. Collected by V. H. Minishew, January 1965.
5466–CO
Genus and species undetermined 3

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PLATES 1–6

Contact photographs of the plates in this report are available, at cost, from U.S. Geological Survey Library, Federal Center, Denver, Colorado 80225.

PLATE 1

Early Cambrian

***Australaspis magnus* faunule**

FIGURES 1–8. *Australaspis magnus* n. sp., all figures from USGS colln. 5939–CO except figure 5 from USGS colln. 6311–CO (p. D12).

1. Latex cast of large cranidium, × 1, USNM 169057.
2. Holotype cranidium, × 2, USNM 169058.
3. Cranidium with deep glabellar furrows, × 2, USNM 169059.
4. Cranidium, × 3, USNM 169060.
5. Pygidium, × 4, USNM 169061.
6. Cranidium with shallow glabellar furrows, × 4, USNM 169062.
7. Latex cast of small cranidium, frontal area not fully exposed, × 5, USNM 169063.
8. Right free cheek, × 3, USNM 169064.

9, 10, 13, 14. *Glabrella? pitans* n. sp. (p. D27).

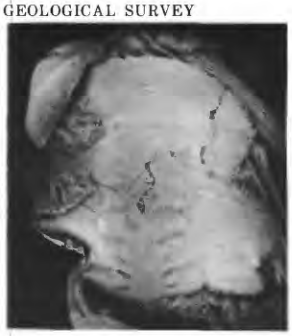
9, 10, 13. Top, left side, and front views of holotype cranidium, × 3, USNM 169065, USGS colln. 5939–CO.

14. Close-up of right posterolateral corner of holotype cranidium showing details of ornamentation, × 10.

***Chorbusulina wilkesi* faunule**

11, 12, 15–22. *Pensacola isolata* n. sp.; figures 11, 12, 15, 16, and 18 from USGS colln. 5937–CO; figures 17, 21, and 22 from USGS colln. 6331–CO; figures 19 and 20 from USGS colln. 6308–CO (p. D29).

11. Left free cheek, × 5, USNM 169066.
12, 15. Top and left profile of partly exfoliated cranidium, × 2, USNM 169067.
16, 18. Top and left profile of pygidium, × 7, USNM 169068.
17, 22. Top and oblique views of small cranidium, × 5, USNM 169069,
19. Holotype cranidium, × 9, USNM 169070.
20. Right free cheek, × 2, USNM 169071.
21. Immature cranidium, × 10, USNM 169072.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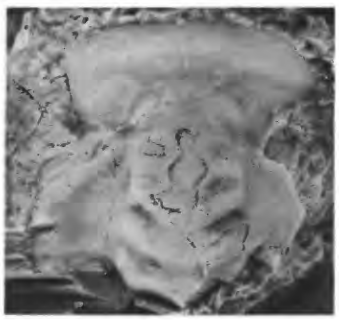
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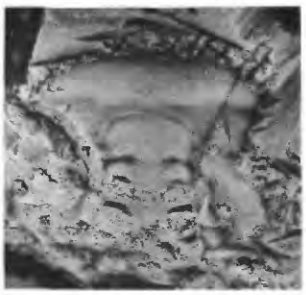
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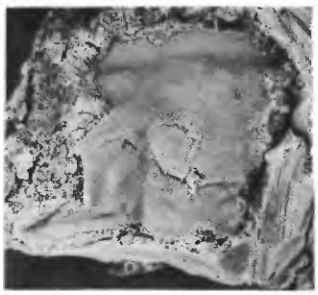
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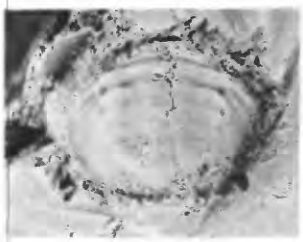
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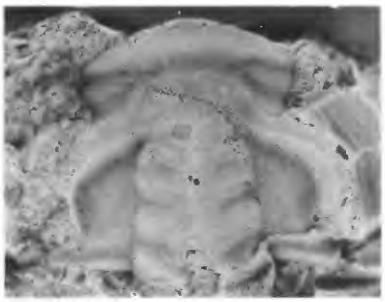
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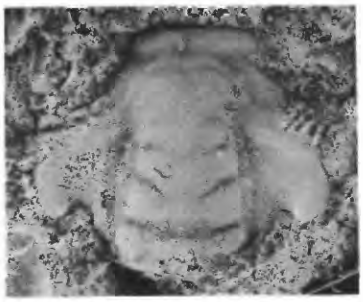
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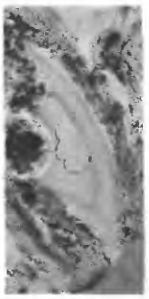
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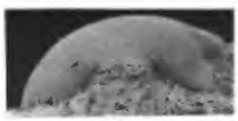
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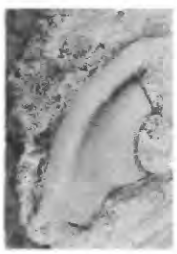
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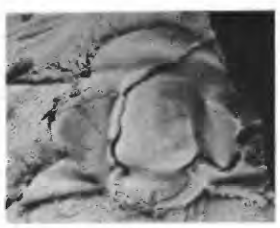
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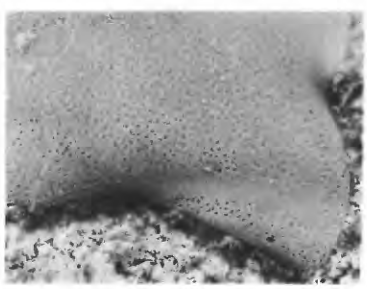
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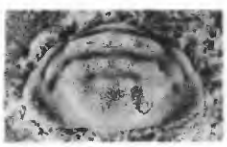
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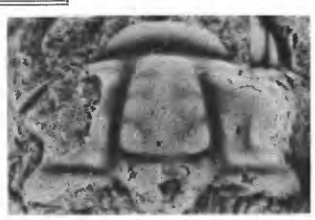
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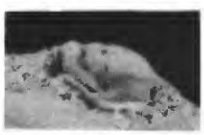
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EARLY CAMBRIAN *AUSTRALASPIS MAGNUS* AND *CHORBUSULINA WILKESI* FAUNULES

PLATE 2

Early Cambrian

Chorbusulina wilkesi faunule

FIGURES 1, 2. *Chorbusulina wilkesi* n. sp. (p. D16).
1. Holotype cranidium, × 6, USNM 169073, USGS colln. 6329–CO.
2. Small cranidium, × 10, USNM 169074, USGS colln. 6308–CO.

3–5. *Redlichia* sp. (p. D17).
3, 4. Fragmentary cranidia, × 4, USNM 169075, 169076, USGS colln. 6308–CO.
5. Cranidium of *Redlichia "chinensis"* from Iran, × 2, illustrated by King (1937, pl. 17, fig. 1) for comparison with Antarctic specimens. Photograph of silicone rubber replica 432 in Palmer replica collection, State University of New York at Stony Brook.

6–10. *Bathyuriscellus australis* n. sp., all specimens from USGS colln. 6308–CO (p. D19).
6, 7. Top and left side views of holotype cranidium, × 2, USNM 169077.
8. Cranidium, × 2, USNM 169078.
9. Right free cheek, × 2, USNM 169079.
10. Closeup of ornamentation of border of cranidium shown in figure 8, × 10.

Chorbusulina subdita faunule

11–15. *Chorbusulina subdita* n. sp., all figures from USGS colln. 6321–CO except figures 11 from USGS colln. 6312–CO (p. D15).
11. Cranidium, × 9, USNM 169080.
12. Right free cheek, × 5, USNM 169081.
13. Holotype cranidium, × 7, USNM 169082.
14, 15. Top and right side views of cranidium, × 5, note contrast in development of border, USNM 169083.

16, 17. *Bathyuriscellus modestus* n. sp. (p. D20).
16. Holotype cranidium, × 1, USNM 169084, USGS colln. 6312–CO.
17. Closeup of ornamentation of border of holotype cranidium, × 10.

Early Middle Cambrian

Xystridura multilinia faunule

18–25. *Xystridura multilinia* n. sp., all specimens from USGS colln. 6333–CO (p. D14).
18. Cranidium, × 5, USNM 169085.
19. Pygidium, ×4, USNM 169086.
20. Cranidium, × 2, USNM 169087.
21. Pygidium, × 4, USNM 169088.
22. Left free cheek, × 2, USNM 169089.
23. Holotype cranidium, × 2, USNM 169090.
24. Pygidium, × 2, USNM 169091.
25. Hypostome, × 3, USNM 169092.


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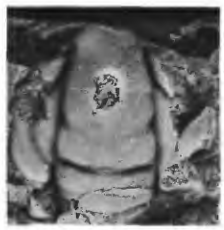
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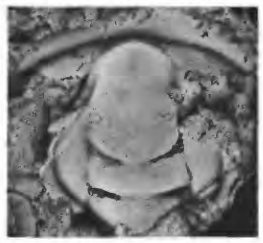
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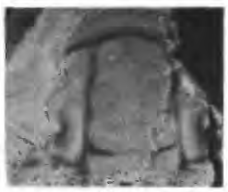
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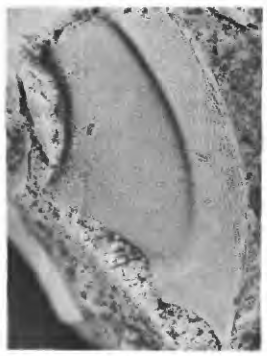
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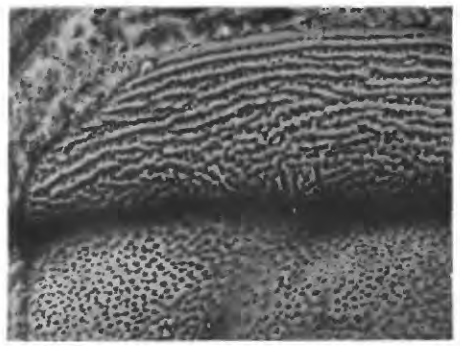
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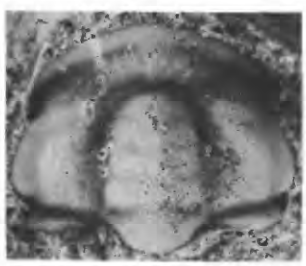
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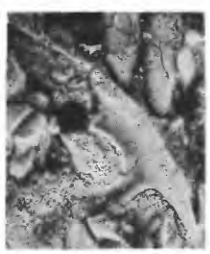
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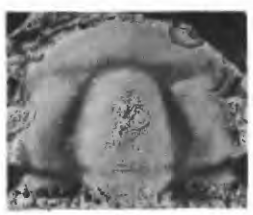
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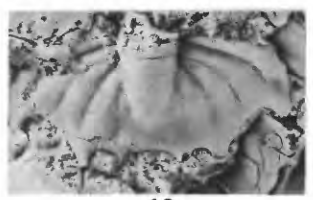
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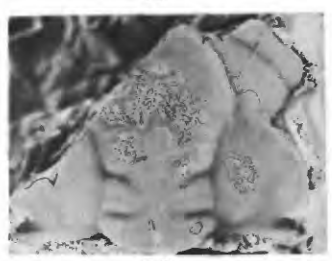
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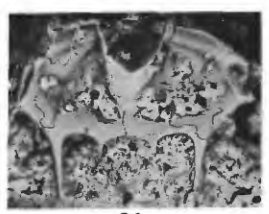
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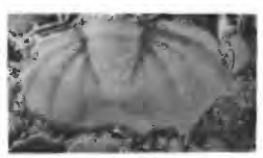
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EARLY CAMBRIAN *CHORBUSULINA WILKESI* AND *C. SUBDITA* FAUNULES AND EARLY MIDDLE CAMBRIAN *XYSTRIDURA MULTILINIA* FAUNULE

PLATE 3

Early Middle Cambrian

***Xystridura multilinia* faunule**

FIGURES 1–6. *Pagetia longispina* n. sp., all specimens from USGS colln. 6333–CO (p. D10).

1, 6. Top and right oblique views of cranidium, × 15, USNM 169093.

2. Holotype cranidium, × 15, USNM 169094.

3. Pygidium and cranidium, × 12, USNM 169095.

4, 5. Pygidia showing post-axial spine, × 15, USNM 169096, 169097.

7, 8. *Goldfieldia ninguis* n. sp., both specimens from USGS colln. 6333–CO (p. D20).

7. Holotype cranidium, × 4, USNM 169098.

8. Small cranidium, × 9, USNM 169099.

10–12. Genus and species undetermined 1, all specimens from USGS colln. 6333–CO (p. D31).

10, 12. Cranidia, × 6, USNM 169100, 169102.

11. Left free cheek, × 8, USNM 169101.

***Xystridura glacia* faunule**

9, 13–17. *Xystridura glacia* n. sp., all specimens from USGS colln. 5938–CO (p. D13).

9. Holotype cranidium, × 1.5, USNM 169103.

13. Latex cast of pygidium, view of doublure showing distribution of spines, × 2, USNM 169104.

14. Cranidium, × 1, USNM 169105.

15, 16. Immature cranidia, × 10, USNM 169106, 169107.

17. Latex cast of pygidium, × 2, USNM 169108.

Late Middle Cambrian

***Amphoton oatesi* faunule**

18–24. *Chondranomocare australis* n. sp., all specimens from USGS colln. 4446–CO (p. D21).

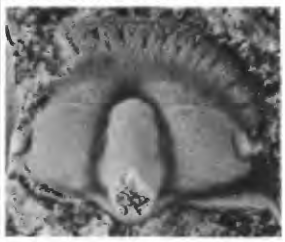
18. Small exfoliated cranidium, × 7, USNM 169109.

19, 20. Top and left oblique views of holotype cranidium, × 3, USNM 169110.

21. Left free cheek, × 5, USNM 169111.

22. Pygidium, × 3, USNM 169112.

23, 24. Right side and top views of partly exfoliated pygidium, × 3.5. USNM 169113.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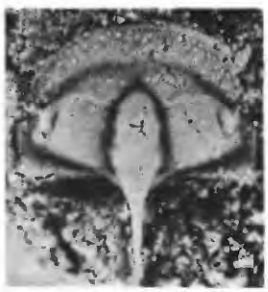
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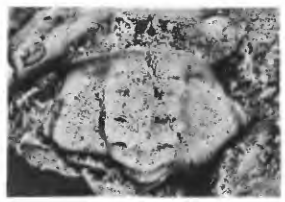
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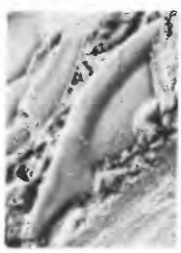
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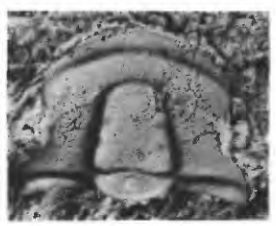
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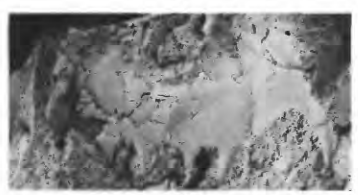
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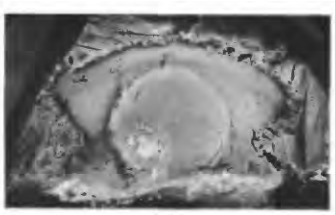
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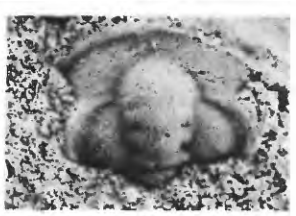
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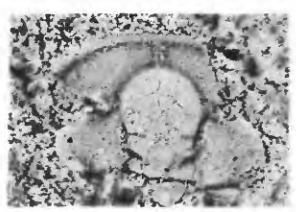
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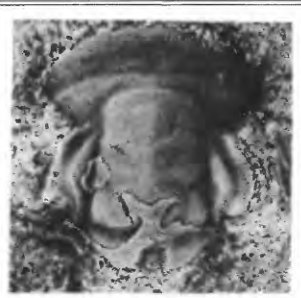
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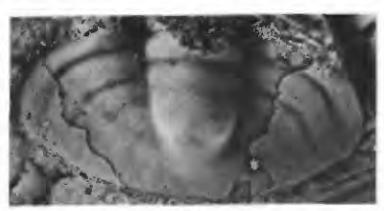
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EARLY MIDDLE CAMBRIAN *XYSTRIDURA MULTILINIA* AND *X. GLACIA* FAUNULES AND LATE MIDDLE CAMBRIAN *AMPHOTON OATESI* FAUNULE

PLATE 4

Late Middle Cambrian

***Amphoton oatesi* faunule**

FIGURES 1, 2. *Trinepea trinodus* n. gen., n. sp. (p. D25).
Top and left oblique views of holotype cranidium, × 3, USNM 169114, USGS colln. 4446–CO.

3. Genus and species undetermined 4 (p. D32).
Crandidium, × 7, USNM 169115, USGS colln. 4446–CO.

4, 5. *Kootenia styrax* n. sp., both specimens from USGS colln. 4446–CO (p. D18).
4. Cranidium, × 2.5, USNM 169116.
5. Holotype pygidium, × 3, USNM 169117.

6, 7. *Peronopsis* cf. *P. fallax* (Linnarsson), × 10, both specimens from USGS colln. 4446–CO (p. D10).
6. Cephalon, USNM 169118.
7. Pygidium, USNM 169119.

8, 11–13. *Amphoton oatesi* n. sp., × 4, all specimens from USGS colln. 4446–CO (p.).
8. Left free cheek, USNM 169120.
11, 12. Top and left side views of holotype cranidium, USNM 169121.
13. Pygidium, USNM 169122.

***Schopfaspis granulosus* faunule**

9, 10, 14–22. *Liopeishania spannensis* n. sp., all specimens from USGS colln. 6325–CO (p. D22).
9, 10, 14. Top, left side, and front views of holotype cranidium, × 5, USNM 169123.
15. Pygidium, × 3, USNM 169124.
16. Small cranidium, × 11, USNM 169125.
17, 21, 22. Top, front, and left side views of exfoliated cranidium, × 3, USNM 169126.
18. Left free cheek, × 5, USNM 169127.
19. Closeup of right anterolateral corner of pygidium shown in figure 15 showing detail of ornamentation, × 10.
20. Exfoliated pygidia, × 4, USNM 169128.


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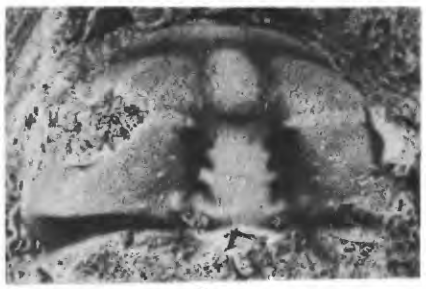
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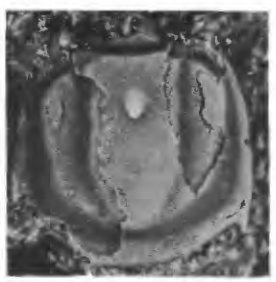
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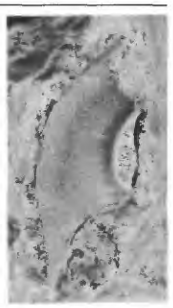
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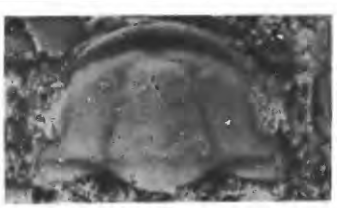
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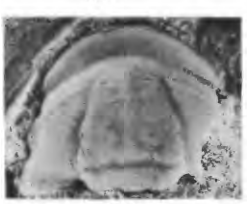
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LATE MIDDLE CAMBRIAN *AMPHOTON OATESI* AND *SCHOPFASPIS GRANULOSUS* FAUNULES

PLATE 5

Late Middle Cambrian

***Schopfaspis granulosus* faunule**

FIGURES 1–7. *Pagetides? antarcticus* n. sp., all specimens from USGS colln. 6325–CO (p. D11).

1–4. Cephalon, lateral profile, thorax, and pygidium of holotype, × 15, USNM 169129.

5. Pygidium, × 10, USNM 169130.

6, 7. Right oblique and top views of almost perfect cephalon, × 10, USNM 169131.

8–14. *Schopfaspis granulosus* n. sp., all specimens from USGS colln. 6325–CO (p. D30).

8. Holotype cranidium, × 6, USNM 169132.

9. Partly exfoliated cranidium, × 5, USNM 169133.

10. Small cranidium, × 9, USNM 169134.

11, 12. Top and left oblique views of cranidium, × 4, USNM 169135.

13. Pygidium, × 5, USNM 169136.

14. Free cheek, × 11, USNM 169137.

15–17. Genus and species undetermined 2, both specimens from USGS colln. 6325–CO (p. D31).

15. Latex cast of cranidium, × 5, USNM 169138.

16. Cranidium, × 5, USNM 169139.

17. Closeup of unusual ornamentation of occipital area on specimen shown in figure 16, × 10.

18. *Olenoides* sp. (p. D19).

Pygidium, × 5, USNM 169140, USGS colln. 6325–CO.

***Solenopleura pruina* faunule**

19–22. *Solenopleura pruina* n. sp., all from USGS colln. 6320–CO (p. D26).

19, 20. Top and front views of holotype cranidium, × 3.5, USNM 169141.

21. Pygidium, × 7, USNM 169142.

22. Right free cheek, X 7, USNM 169143.


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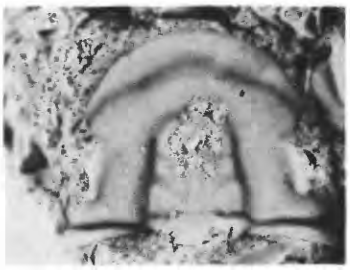
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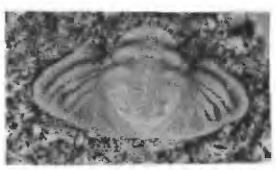
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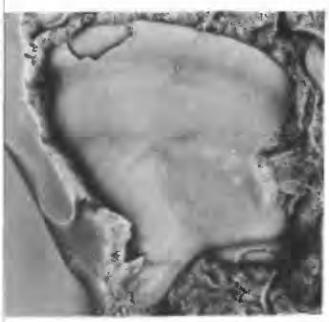
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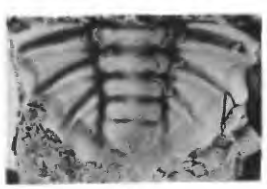
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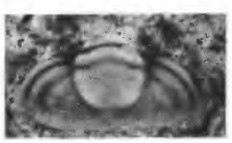
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LATE MIDDLE CAMBRIAN *SCHOPFASPIS GRANULOSUS* AND *SOLENOPLEURA PRUINA* FAUNULES

PLATE 6

Late Middle Cambrian

Solenopleura pruina faunule

FIGURES 1, 2, 5. *Suludella? davnii* n. sp., all from USGS colln. 6320–CO (p. D23).
1. Holotype cranidium, × 9, USNM 169144.
2. Free cheek, × 6, USNM 169145.
5. Incomplete pygidium, × 5, USNM 169146.

Nelsonia schesis faunule

3, 4, 6–14. ***Nelsonia schesis*** n. gen., n. sp.; figures 3, 4 from USGS colln. 6355–CO; figures 6–14 from USGS colln. 4443–CO (p. D28).
3, 4. Cranidia, × 10, USNM 169147, 169148.
6, 10. Right oblique and top views of holotype cranidium, × 10, USNM 169149.
7. Cranidium, × 10, USNM 169150.
8. Right free cheek, × 14, USNM 169151.
9. Close–up of visual surface of specimen shown in figure 8, × 40.
11, 14. Top and left side views of pygidium, × 20, USNM 169152.
12. Pygidium, × 10, USNM 169153.
13. Small cranidium, × 10, USNM 169154.

16–18, 20–23. *Suludella? spinosa* n. sp.; figures 17, 18, and 22 from USGS colln. 4443–CO; figures 16, 20, 21, and 23 from USGS colln. 6355–CO (p. D24).
16, 20, 21. Posterior, top, and right side views of holotype pygidium, × 5, USNM 169157.
17. Pygidium, × 5, USNM 169158.
18. Incomplete left free cheek, × 4, USNM 169159.
22. Cranidium, × 4, USNM 169160.
23. Cranidium, × 3, USNM 169161.

Faunule unassigned

15, 19. Genus and species undetermined 3, both specimens from USGS colln, 5466–CO (p. D32).
15. Cranidium, × 4, USNM 169155.
19. Cranidium, × 2, USNM 169156.


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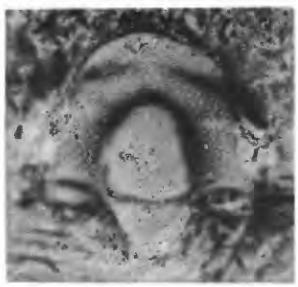
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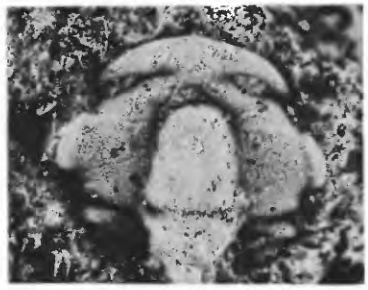
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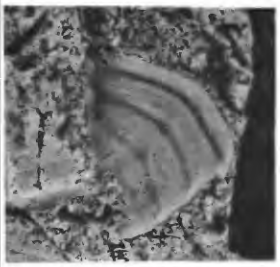
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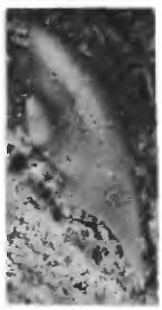
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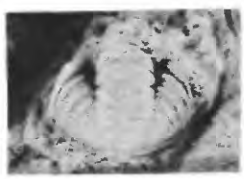
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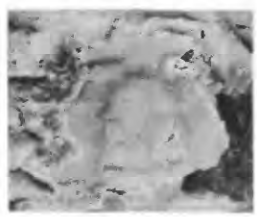
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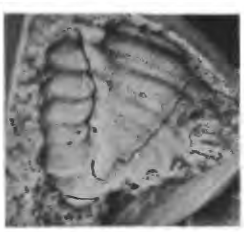
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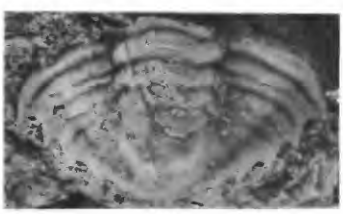
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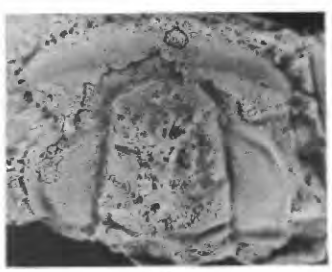
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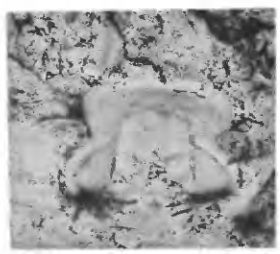
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LATE MIDDLE CAMBRIAN *SOLENOPLEURA PRUINA* AND *NELSONIA SCHESIS* FAUNULES AND AN UNASSIGNED FAUNULE