



Notes on the trilobite faunas of the Henson Gletscher Formation (Lower and Middle Cambrian) of central North Greenland

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Cambrian trilobite faunas collected from a 90 m section of the Henson Gletscher Formation in southern Freuchen Land are described. Nineteen species are discussed, six of which are new. Aspects of the ontogenies of two species of *Ogygopsis* Walcott, 1889 are outlined, and initial correlations of *Ogygopsis* made with North America and Siberia. The first occurrences outside China of species assigned to *Arthricocephalus* Bergeron, 1889 and *Changaspis* Lee, 1963 are reported. Problems of ptychopariid classification for the early Cambrian are covered, and proposals for a new approach to understanding ptychopariid relationships are outlined.

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During regional mapping of the Lower and Middle Cambrian of southern Freuchen Land, central North Greenland, by J. S. Peel and S. C. Wright in 1984, extensive collections of trilobites were made from a well-exposed section of the Henson Gletscher Formation of the Brønlund Fjord Group north of Jungersen Gletscher (figs 1 & 2). This material, together with further collections made from the same section by Peel, C. Møller-San Pedro and myself in 1985, will form the basis of a part of my Ph.D. thesis (University of Keele, U.K.). This report gives an initial appraisal of these trilobite faunas, as well as outlining some of the directions in which it is anticipated that the study will develop. A generalised stratigraphic section (fig. 3) indicates the relative positions of the trilobite faunas discussed. General descriptions of the Cambrian sequence in this part of North Greenland were given by Ineson & Peel (1980, in press), Peel (1982) and Peel & Wright (1985).

Fauna 1

One of the lowermost faunas collected (fig. 3) consists of large olenellids, the largest cephalon having a maximum transverse width of 147 mm. Although somewhat weathered, this specimen has areas of 'Wanneria'-type ornamentation preserved, which is a strong reticulate network of distinctly raised ridges. Other characters of the cephalon, however, are inconsistent with assignment to *Wanneria* Walcott, 1910. The material will be assigned to a new spe-

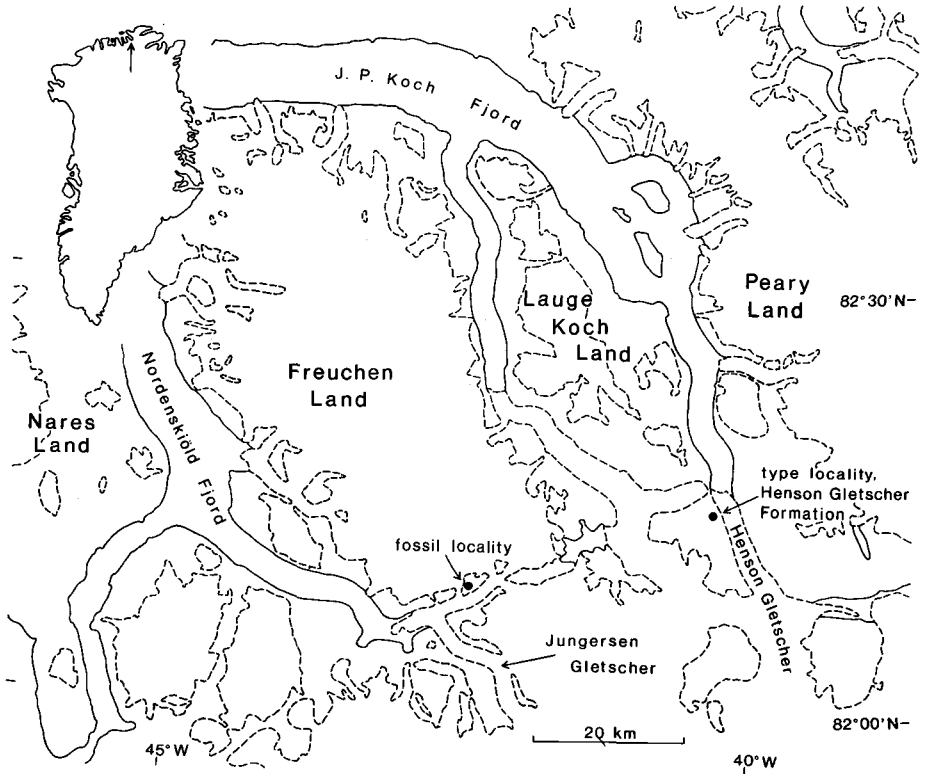


Fig. 1. Locality map.

cies of *Olenellus* Billings, 1861 and differs from all others in the genus in its sculpture and particularly the structure of the frontal glabellar lobe.

Fauna 2

A 5 m section immediately above this level was extensively collected (fig. 3). The fauna of the lower beds is dominated by species of *Ogygopsis*, including *O. antiqua* Palmer, 1968 and two new species of this genus. Species of *Zacanthopsis* Resser, 1938 and *Bonnia* Walcott, 1916 also occur, as well as a few specimens of *Olenellus* sp. The two new species of *Ogygopsis* are considered to be closely related forms. However, the study of large numbers of specimens collected from individual horizons has enabled consistent differences in their morphology to be recognised. Several aspects of one of the new species of *Ogygopsis* have already been studied, including ontogenetic development and intraspecific variation. An ontogenetic sequence consisting of late meraspides and holaspides of *O. sp. nov. 1* has been studied. One of the most important features of the ontogeny is the relatively large size attained whilst segments are still being added to the thorax. The smallest complete holaspide specimen examined to date has a sagittal length of some 17.4 mm, about twice the length at which trilobites attaining considerable final lengths (e.g. *Paradoxides* Brongniart, 1822)

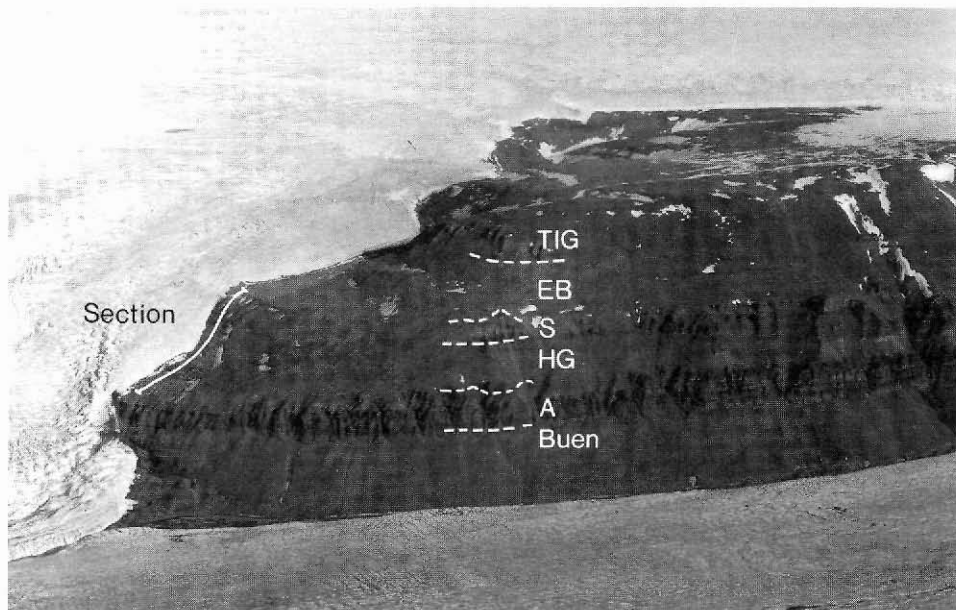


Fig. 2. Nunatak north of Jungersen Gletscher in southern Freuchen Land, viewed from the south, showing the Cambrian section from which the trilobites under discussion were collected. Buen, Buen Formation; A, Aftenstjernesø Formation; HG, Henson Gletscher Formation; S, Sydpasset Formation; EB, Ekspedition Bræ Formation; TIG, Tavsens Iskappe Group (A, HG, S, EB, Brønlund Fjord Group).

reach the holaspid condition. The longest degree seven meraspis (the final meraspid stage) has a length of 13.8 mm. The largest specimen of *O. sp. nov.* 1 has a sagittal length of 49 mm. A collection of over 70 articulated specimens made in 1985 will enable the ontogeny to be more fully studied and interpreted. *Ogygopsis antiqua* Palmer, 1968 has also been identified from higher in the section than both of the new species of *Ogygopsis*. *O. antiqua* has previously only been reported from early Cambrian strata of the Tatonduk River area of east central Alaska (Palmer, 1968, p. B50).

For *O. antiqua* a different aspect of ontogeny is being investigated. The samples contain several hundred cranidia with sagittal length less than 2 mm. By measuring the major dimensions of every specimen, growth stages have been recognised. It is hoped that use of this method on material collected in 1985 will permit a more complete understanding of the early ontogenetic development of the cranidium.

Fauna 3

Higher in the sequence, strata dominated by limestone concretions (fig. 4) have yielded a variety of trilobites (fig. 3). Most significant perhaps is material that has been assigned to two genera of the family Oryctocephalidae Beecher, 1897 (*Arthricocephalus* Bergeron, 1899 and *Changaspis* Lee, 1963) for this family is of importance in international correlation of early Cambrian rocks.

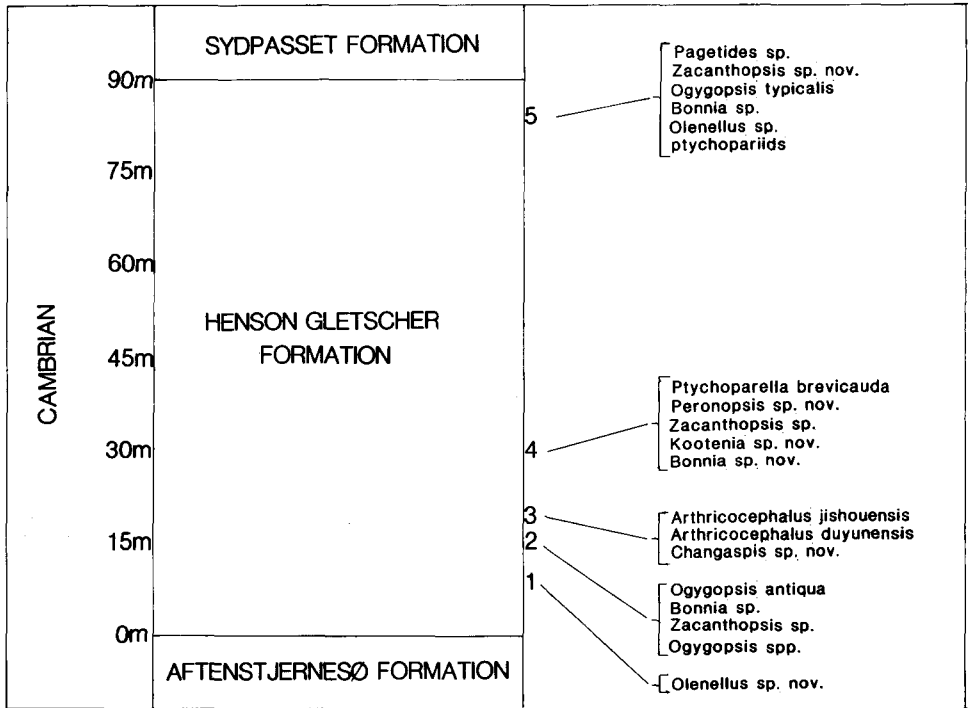


Fig. 3. Distribution of trilobite faunas within the Henson Gletscher Formation from the collection locality in southern Freuchen Land (figs 1 & 2).

Two species of the genus *Arthrocoephalus* (*A. duyunensis* Chien, 1961 and *A. jishouensis* Zhou, 1977) and one new species of *Changaspis* have been identified. Both genera have previously only been reported from the Lower Cambrian of China. Both species of *Arthrocoephalus* have been described from late Lower Cambrian strata in south-west China (Chien, 1961; Zhou, 1977), with *A. duyunensis* first being described from the Balang Shale, Duyan, Kweichow and most recently from Kunshan County, Jiangsu Province (Zhang & Zhou, 1985). However, the significance of the records in terms of palaeogeography is difficult to assess, as palaeogeographical reconstructions for the Cambrian are speculative. The reconstruction of Morel & Irving (1978) for the end of the Precambrian (tentatively referred to a time of about 600 Ma) has the Siberian Shield, Laurentia and Gondwanaland forming a single supercontinent, with Greenland and China at virtually opposite ends, and also at considerably different latitudes. There is also considerable separation between Greenland and China in the Late Cambrian to Early Ordovician reconstruction in which Baltica, Laurentia and the Siberian and Chinese shields are all isolated land masses. The Cambrian to Early Ordovician projections of Briden *et al.* (1974) and Smith *et al.* (1973) also make it unexpected that a species coexisted in North Greenland and China during the Lower Cambrian. The reconstruction of Cambrian palaeogeography by Scotese *et al.* (1979) places Greenland and China closer together and at similar latitudes, making it more feasible that a geographically widespread species could colonise both regions. It would, however, be ex-



Fig. 4. Limestone concretions within the lower part of the Henson Gletscher Formation. Faunas 3 and 4, discussed in the accompanying text, were collected from this interval.

pected from this reconstruction that the species would also occur in Siberia, but no record has been traced.

Fauna 4

Towards the top of the concretion-dominated part of the sequence an association of ptychopariid, agnostid and occasional oryctocephalid trilobites occurs (fig. 3). I have assigned specimens to a new species of *Kootenia* Walcott, 1889. This species is characterised by seven pairs of pygidial border spines, and prominent axial spines on the anterior four rings. As discussed by Dutro *et al.* (1984) both are unusual features for species of *Kootenia*. The pygidia have similarities to those of both *K. jakutensis* Lermontova, 1951 and *K. anabarensis* Lermontova, 1951 from Early or Middle Cambrian boundary beds of Siberia. A new species of *Bonnia* is distinctive by the combination of two pairs of long, slender pygidial border spines, and five or six complete axial rings. A collection of 10 pygidia of similar morphology assigned to 'genus and species undetermined 1' by Palmer (1964, p. F11) from Lower Cambrian beds of the Saline Valley Formation in Nevada has been studied, and I consider this material to be conspecific with that assigned to *Bonnia* sp. nov. from North Greenland. Associated with these two new species are specimens assigned to *Olenoides* spp. and *Ogygopsis batis* (Walcott, 1916). *Ogygopsis batis* has previously been recorded from the upper part of the Lower Cambrian of Nevada (Nelson, 1963; Palmer, 1964), from the Sekwi Formation of

the Mackenzie Mountains, north-western Canada (Fritz, 1976), and from Siberia (Egorova *et al.*, 1976). I have assigned an agnostid from this fauna to the geographically widespread genus *Peronopsis* Hawle & Corda, 1847 and the specimens represent a new Lower Cambrian species of this genus.

The ptychopariid *Ptychoparella brevicauda* Poulsen, 1927 has also been identified; it is also known from Inglefield Land in North-West Greenland, some 600 km to the south-east, where it was described from the Middle Cambrian Cape Frederik VII Formation by Poulsen (1927). This formation was included by Troelsen (1950) within his Cape Wood Formation, a revision accepted by subsequent workers.

At present, ptychopariid classification is very confused and in the view of Palmer *in* Palmer & Halley (1979, p. 99) "... provides the greatest problems for suprageneric classification among all the trilobites." Palmer emphasised that the problem is particularly acute in the early part of the Cambrian as most of the ptychopariid trilobites of this age are of generalised form. In addition, many forms are known only from cranidia. This affects not only suprageneric classification, but also makes generic and particularly specific classification difficult. I contend that present ptychopariid classification at the generic level for the early forms is unusable. A need exists for a new approach to these systematic problems which have been recognised by previous workers, but so far not overcome. A new approach to suprageneric groupings is discussed under fauna 5, below.

The approach of previous classifications such as those by Lochman (1947), Rasetti (1955), Shaw (1962) and most recently Zhang *et al.* (1980), has been to maintain many genus level taxa that are morphologically very similar, not least because they are largely known only from their cranidia. It has been admitted that many of the taxa intergrade; Rasetti (1955, p. 14) stated "... if lack of intermediate species were required for generic separation one would have to place most of the Ptychopariidae in a single genus." Study of the North Greenland material offers the possibility of a new approach to the question of ptychopariid relationships since large numbers of specimens of all sizes are available from individual collection localities; this allows analysis of the range of at least cranidial variation (now known to be considerable) within a single ptychopariid species.

In addition to the problem of many ptychopariid genera being only known from cranidia, comparisons between forms have not always been based on similarly-sized specimens. It has generally been the practice to allow little variation within ptychopariid taxa which has led to the formation of yet more subdivisions at all taxonomic levels. The collections to hand demonstrate the considerable variation in morphology during growth, even within the holaspid stage.

The genus *Ptychoparella* is a good example of the present stage of ptychopariid classification. *Ptychoparella* was described by C. Poulsen in 1927 with his new species *P. brevicauda* as type species. Subsequently, Resser (1937, 1938) and Lochman (1947) assigned Lower Cambrian specimens to several new species of *Ptychoparella*. Rasetti (1955, p. 7) discussed the assignment of the Lower Cambrian representatives, concluding that *Ptychoparella* should be confined to the Middle Cambrian type species and that no Lower Cambrian species should be referred to it. Rasetti established a new genus *Eoptychoparia* Rasetti, 1955 which incorporated Lower Cambrian species previously assigned to *Ptychoparella*.

Shaw (1962, p. 343) agreed with Rasetti on the restriction of *Ptychoparella*, and considered the genus to be distinguished by a combination of convergent facial sutures, an anterior border without a median inbend and small eyes situated towards the posterior. It is now

known from the new material of *Ptychoparella brevicauda* that a median inbend in the anterior border is present. The other two features are not diagnostic, being features that occur in both *Eoptychoparia* and *Ptychoparella*.

Rasetti (1955, p. 13) remarked that the species he attributed to the genus *Eoptychoparia* 'are about average' for Lower Cambrian ptychopariids, and that the genus was difficult to characterise, for it intergraded with *Antagmus* Resser, 1936, *Piazella* Lochman, 1947 and *Onchocephalus* Resser, 1937. Rasetti there also commented that *Eoptychoparia* essentially corresponded to the concept of *Ptychoparella* employed by both Resser (1937, 1938) and Lochman (1947), which he believed neither author based on the type species, but rather on Lower Cambrian species. Further reasons were proposed by Rasetti why *Eoptychoparia* should be separate from *Ptychoparella*:

1. "The position of the eyes is more posterior in *Ptychoparella*." From my examination of specimens of *Ptychoparella* I can find no evidence to support this statement.

2. "The anterior facial sutures are slightly convergent in *Eoptychoparia*." The anterior facial sutures in both forms vary from slightly convergent to slightly divergent.

3. "The pygidium may have more segments in *Ptychoparella*." This criterion was at the time speculative. Only two pygidia have subsequently been assigned to *Eoptychoparia*; one is on a complete specimen assigned to *E. wutingensis* (Chang, 1964) by Zhang *et al.* (1980), but no detail can be seen. The second is on a complete specimen of the Middle Cambrian *E. piochensis* Palmer in Palmer & Halley, 1979; the pygidium is not distinguishable from that of *Ptychoparella brevicauda*.

Rasetti (1963, p. 582) recognised a Middle Cambrian species of *Eoptychoparia* which he believed "... resembles in all essential features the Lower Cambrian species on which the genus is based." Palmer in Palmer & Halley (1979, p. 104) also recognised a Middle Cambrian species and compared *Eoptychoparia* with *Inglefieldia* Poulsen, 1927, *Luxella* Rasetti, 1955, *Piazella* and *Antagmus*. Palmer made no mention of *Ptychoparella* despite his recognition of this Middle Cambrian form. Indeed, for *E. piochensis*, Palmer concluded that there are no consistent criteria by which it can be differentiated from the Lower Cambrian forms, in spite of *Ptychoparella* having been considered to be the Middle Cambrian form of the Lower Cambrian *Eoptychoparia*.

Poulsen (1964, p. 40) advocated that the use of *Ptychoparella* should be restricted to the type species until the genus was better known. Study of the specimens recently collected from the Henson Gletscher Formation now permits this re-evaluation. From a study of the type material of the type species of both *Ptychoparella* and *Eoptychoparia*, I consider that the latter is a junior synonym of the former. There is, however, clearly a need for a more detailed revision of other species assigned to both these taxa and of other generalised ptychopariids. Zhang *et al.* (1980) produced the most recent classification. Although I consider that *Ptychoparella* and *Eoptychoparia* are synonyms, they were placed in different families in this classification: *Ptychoparella* in the Ptychopariidae Matthew, 1887 and *Eoptychoparia* in the Antagmidae Hupé, 1953. At present I am in agreement with Palmer in Palmer & Halley (1979) that suprageneric groupings cannot be recognised with any certainty. Palmer (p. 99) did suggest, however, that at least one suprageneric grouping might be recognised which he termed the kochaspid trilobites, an informally defined group seemingly typical for trilobites only from the Middle Cambrian *Glossopleura* Zone and older North American strata. This

approach will be applied to material from North Greenland, and is briefly mentioned under fauna 5.

Fauna 5

At least 56 m of siltstones and fine-grained sandstones in which fossils were not found occur above the limestone concretion sequence. These siliciclastics are succeeded by 4 m of thinly-bedded dark dolomites and occasional limestones with a rich trilobite fauna (fig. 3). I have identified *Pagetides* sp., *Bonnia* sp., *Olenellus* sp., *Ogygopsis typicalis* (Resser, 1939) and a new species of *Zacanthopsis*. Following study of the large number of ptychopariid cranidia, two suprageneric groupings have been recognised. Both of these informal suprageneric taxa are of very generalised ptychopariids, but it is anticipated that this approach will result in a clearer understanding of ptychopariid relationships at the suprageneric level. It is their distribution in time and space that will be of critical importance in determining which genera will be placed in these higher level groupings.

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