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Trilobite fauna of the Telt Bugt Formation (Cambrian Series 2–Miaolingian Series), western North Greenland (Laurentia)

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Trilobites dominantly of middle Cambrian (Miaolingian Series, Wuliuan Stage) age are described from the Telt Bugt Formation of Daugaard-Jensen Land, western North Greenland (Laurentia), which is a correlative of the Cape Wood Formation of Inglefield Land and Ellesmere Island, Nunavut. Four biozones are recognised in Daugaard-Jensen Land, representing the Delamaran and Topazan regional stages of the western USA. The basal *Plagiura–Poliella* Biozone, with *Mexicella* cf. *robusta*, *Kochiella*, *Fieldaspis*? and *Plagiura*?, straddles the Cambrian Series 2–Miaolingian Series boundary. It is overlain by the *Mexicella mexicana* Biozone, recognised for the first time in Greenland, with rare specimens of *Caborcella arrojosensis*. The *Glossopleura walcotti* Biozone, with *Glossopleura*, *Clavaspidella* and *Polypleuraspis*, dominates the succession in eastern Daugaard-Jensen Land but is seemingly not represented in the type section in western outcrops, likely reflecting the drastic thinning of the formation towards the north-west. The *Ehmaniella* Biozone, with *Ehmaniella*, *Clappaspsis*, *Blainia* and *Blainiopsis*, is the youngest recognised biozone. The presence of Drumian Stage strata reported elsewhere in North Greenland and adjacent Ellesmere Island has not been confirmed in Daugaard-Jensen Land. Lower beds of the Cass Fjord Formation, which directly overlie the Telt Bugt Formation, are assigned to the Guzhangian Stage. New species: *Fieldaspis*? *iubilaei*, *Ehmaniella tupeqarfik*.

Keywords: Cambrian, Miaolingian (Wuliuan), trilobites, North Greenland, Laurentia.

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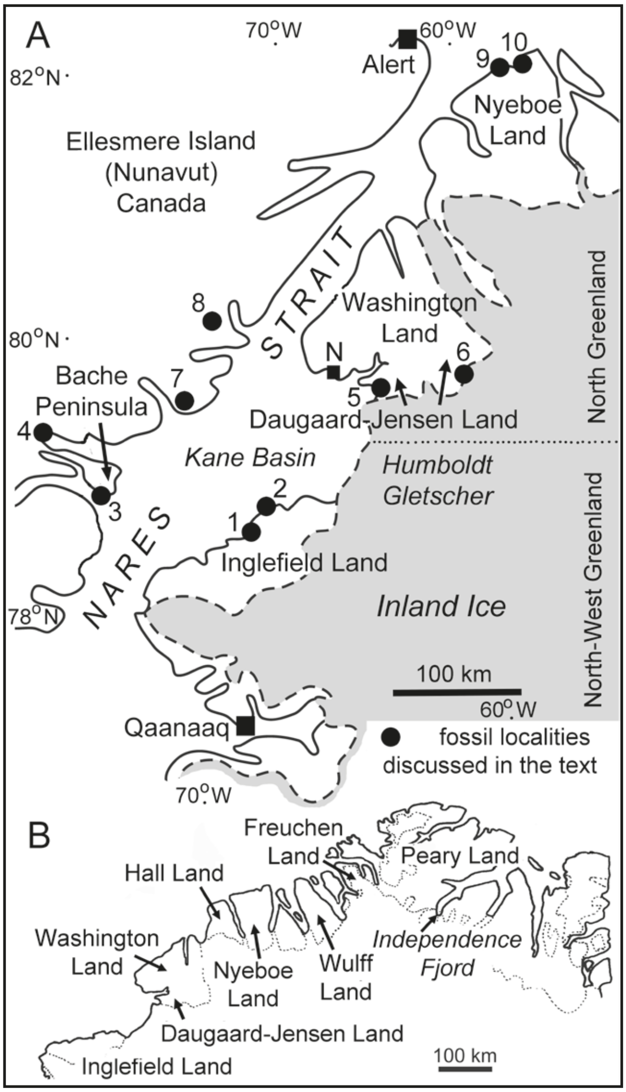
On 11th August 1921, the Danish explorer, cartographer and geologist Lauge Koch (1892–1964) and three Inughuit (North Greenlandic) companions fixed tent cloth to their dog sledge and sailed before the wind down Humboldt Gletscher (Glacier) in North Greenland to safety, thus narrowly escaping death by starvation while crossing the Inland Ice (Fig. 1). A glimpse of the dramatic descent of Humboldt Gletscher in Koch's own words was presented by Dawes (2016, vol. 1, p. 41–42). The group of four left the glacier in south-western Daugaard-Jensen Land, south of Telt Bugt (Fig. 2), reaching a previously established food cache on the small island of Pullassuaq [Putlersuak of Koch 1929, pl. 3] on the next day. The three Inughuit expedition members were named as Etukussuk, Inuiterk and Nugapiinguak by Koch (1926). Dawes (2016, vol. 2, p. 3–4) provided portrait photographs and gave their names as Ittukusuk, Inuuteq and Nukagpiaanguaq. As members of the Danish Bicentenary Jubilee Expedition North of Greenland 1920–23 (Jubilæumsekspeditionen Nord om Grønland 1920–23), the four had survived a harrowing journey of more than 600 km across the Inland Ice, ascending the ice cap at Independence Fjord in eastern North Greenland (Fig. 1B) on 26th June after journeying around the northern coast of Greenland. For much of the homeward journey across the ice they were sustained by eating their sledge dogs, none of which survived the transect.

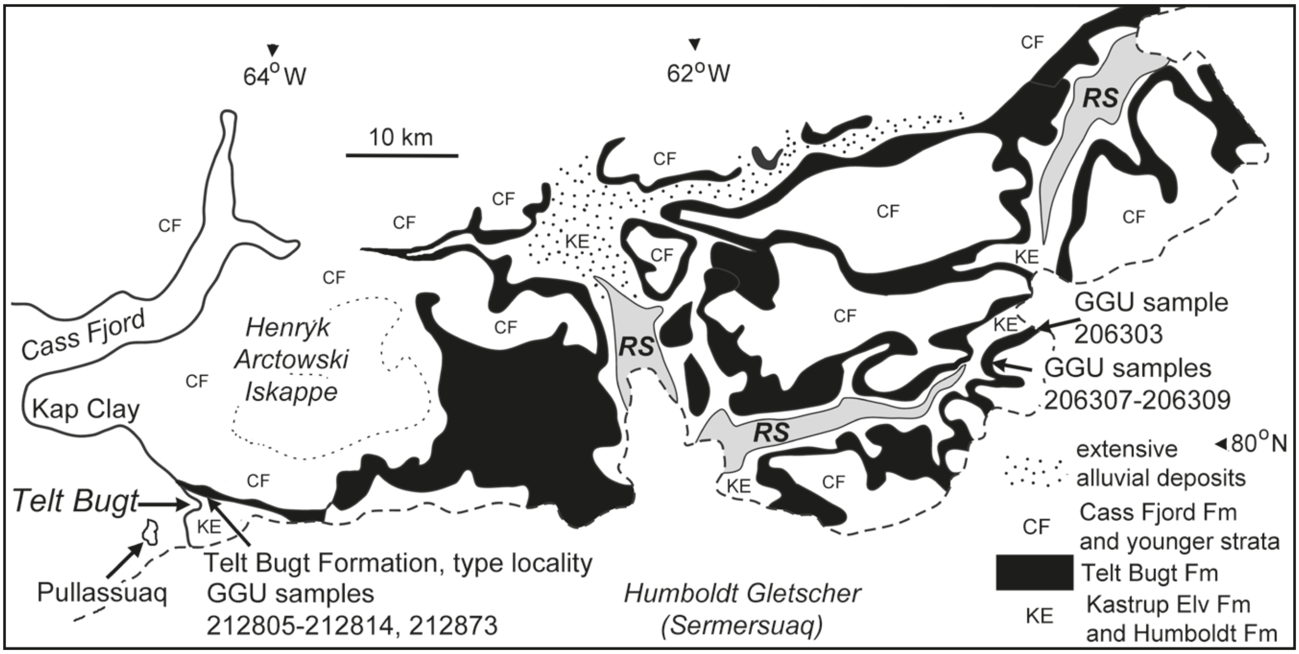
During subsequent evacuation to a small pre-arranged Inughuit camp at Nunatami in southern

Washington Land (Fig. 1A, locality N), Koch (1929) recognised three units that comprise the geological succession between Humboldt Gletscher and Kap Clay (Fig. 2). Yellow saccharoidal dolomites, indicated as Thule Formation on the accompanying map (Koch 1929, pl. 3), are overlain by limestones that he claimed resembled the Cape Wood Formation of Inglefield Land (Poulsen 1927), and above these is the extensive outcrop of Cass Fjord Formation with its beds of intraformational limestone conglomerates. No fossils were found in the lower two units, but a poorly preserved assemblage from the uppermost part of the Cass Fjord Formation at Kap Clay yielded an Early Ordovician fauna that was described by (Poulsen 1927). The dolomites are now referred to the Kastrup Elv Formation, equivalent to Cambrian (Series 2) carbonates in Inglefield Land (Henriksen & Peel 1976; Peel & Christie 1982; Dawes *et al*. 2000; Fig. 3), whereas the overlying limestones, which were correctly compared by Koch



◀ **Fig. 1. A:** The Nares Strait area showing fossil localities discussed in the text. 1, Kap Russell and Marshall Bugt; 2, Blomsterbækken, Kap Frederik VII, Kap Wood and Kap Kent; 3, Bache Peninsula; 4, head of Copes Bay; 5, Telt Bugt; 6, Romer Søer; 7, north of Dobbin Bay; 8, north of Scoresby Bay; 9, Hand Bugt; 10, Frankfield Bugt. N, location of Inughuit camp at Nunatami. **B:** Geographical map of northern Greenland.

▼ **Fig. 2.** Outcrops of the Telt Bugt Formation in Daugaard-Jensen Land showing the derivation of GGU samples. RS, the three lakes referred to collectively as Romer Søer.



(1929) to the Cape Wood Formation, are assigned to the Telt Bugt Formation (Henriksen & Peel 1976; Peel 2020a), the subject of the present paper.

In this centenary year of their epic journey around the coast of North Greenland and the arduous return journey across the Inland Ice to the Telt Bugt area, it is appropriate to recall the many geological and cartographical successes of the expedition, and the logistic and scientific contributions of its members (Koch 1926 and numerous subsequent publications by various authors in Meddelelser om Grønland volumes 70–73; Dawes 1991). In describing the Cambrian (Miaolingian Series) trilobite fauna of the Telt Bugt Formation in southern Daugaard-Jensen Land, the present paper acknowledges these achievements in proposing *Fieldaspis*? *iubilaei* sp. nov., in commemoration.

The Telt Bugt Formation fauna is of Laurentian inner craton aspect and its trilobites are assigned to four biozones comprising the Wuliuan Stage of the Miaolingian Series: *Plagiura–Poliella* (in part), *Mexicella mexicana*, *Glossopleura walcotti* and *Ehmaniella* biozones (Fig. 4). These biozones are equivalent to the Delamaran and Topazan stages of western North America usage, for review see Babcock *et al.* (2011). The *Mexicella mexicana* Biozone is recognised for the first time in Greenland, but trilobites from the other three biozones have been described from Inglefield Land, Daugaard-Jensen Land and Bache Peninsula (Nunavut), around Kane Basin (Fig. 1A), by C. Poulsen (1927, 1946), his son V. Poulsen (1964) and Peel (2020a,b).

Geological background

Nares Strait, named after Captain Sir George Nares who led the British Expedition of 1875–1876, separates western North Greenland from easternmost Ellesmere Island, Nunavut (Fig. 1A) and provided a conduit for early ship-borne expeditions exploring the high Arctic (Christie & Dawes 1991; Dawes 2012, 2016).

Nares Strait is also the proposed site of a prominent strike–slip complex, the interpretation of which is of fundamental importance to the understanding of the evolution of the seaways between Greenland and Canada, and the placement through geological time of Greenland relative to the Laurentian mainland (Dawes & Kerr 1982; Harrison 2006; Pulvertaft & Dawes 2011; Oakey & Chalmers 2012; Frisch & Dawes 2014; Gosen *et al.* 2019). The nature, timing and magnitude of the supposed displacements along the zone are highly controversial, with estimates of the lateral displacement of Greenland relative to the rest of Laurentia ranging from as much as 350 km to 25 km or less. However, Oakey & Chalmers (2012) presented a model that attempted to accomodate both extremes, with large-scale movements between Greenland and Baffin Island – Labrador in the south, but only small displacement between eastern Ellesmere Island and Greenland in the north. The latter was advocated by geologists familiar with local stratigraphy and tectonics (Dawes & Kerr 1982; Pulvertaft & Dawes

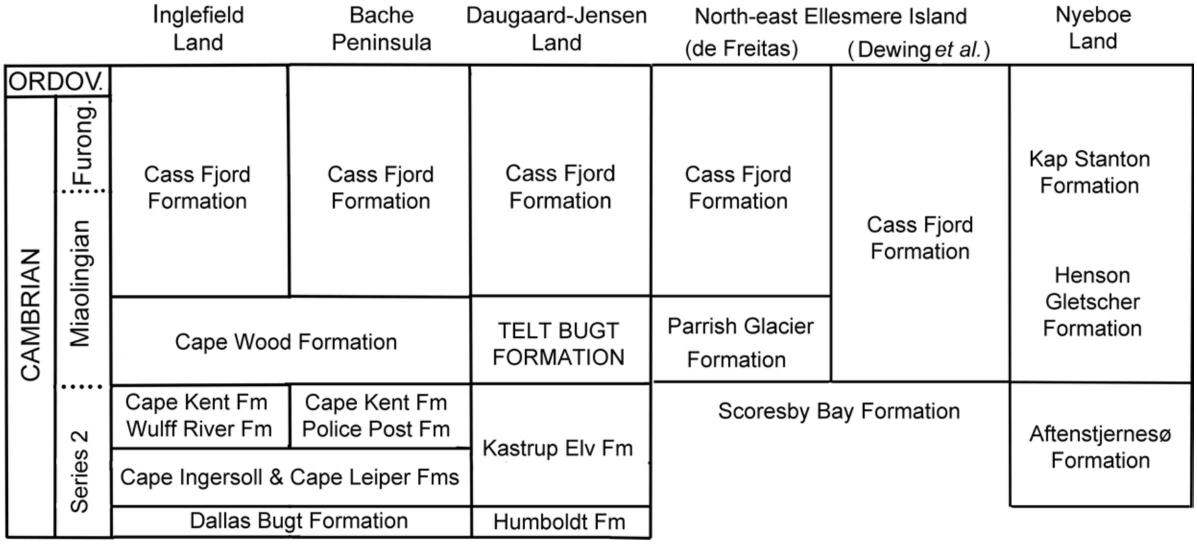


Fig. 3. Cambrian stratigraphy around Nares Strait. Furongian and Ordovician are abbreviated. Terminology in North-east Ellesmere Island derives from de Freitas (1998a,b,c) and Dewing *et al.* (2001).

2011; Frisch & Dawes 2014). Oakey & Chalmers (2012) followed Harrison (2006) in envisaging essentially structural continuity between Inglefield Land and the area from Bache Peninsula southwards on Ellesmere Island (Fig. 1A), the Bache Peninsula arch or Inglefield Land High, the latter regarded as part of the Greenland Plate. The main zone of lateral displacement of the strike–slip complex was located on the Canadian side of the present strait and passed around the Inglefield Land High on its western side. Thus, localities 4, 7 and 8 in eastern Ellesmere Island (Fig. 1A) lie within this mobile belt. Detailed analysis of early Palaeogene faults in eastern Nunavut by Gosen *et al.* (2019) indicated some post-Mesozoic tectonism affecting the Palaeozoic outcrops, but displacement of older geological markers by this is minimal.

Cambrian strata in the Inglefield Land, Bache Peninsula and Daugaard-Jensen Land areas (Fig. 1A) were deposited on the southern inner shelf of the transarctic Franklinian Basin and their similarity confirms the integrity of the Inglefield Land High. Siliciclastic sediments of the Dallas Bugt and Humboldt formations (Fig. 3) deposited during the original Cambrian transgression are overlain by a succession dominated by carbonates that forms the lower part of the Ryder Gletscher Group (Higgins *et al.* 1991a,b; Ineson & Peel 1997; Dawes *et al.* 2000; Dawes 2004; Watt 2019; Peel 2020a). Dawes (2004) presented an overview of the geology of the Humboldt Gletscher area of Greenland, including a 1:500 000 geological map.

Christian Poulsen (1927) described Cambrian stratigraphy and faunas from Inglefield Land on the basis of collections made by Lauge Koch between 1916 and 1923. Subsequent field work by Johannes C. Troelsen during 1939–1941 resolved several lithostratigraphic problems arising from the initial surveying (Troelsen 1950) and provided new fossil collections, which were described by C. Poulsen (1958), his son V. Poulsen (1964) and Peel (2020a,b).

Peel (2020a) noted that Cambrian fosssils were not discovered in Daugaard-Jensen Land on the northern margin of Humboldt Gletscher until 1969 (Dawes 1976; Palmer & Peel 1981). The fossil assemblages described in the present paper, and material documented by Palmer & Peel (1981) and Peel (2020a,b), were collected during field work carried out by Grønlands Geologiske Undersøgelse (GGU) during 1975–1977 (Henriksen & Peel 1976; Palmer & Peel 1981; Peel 2020a). Regional geological investigations on both sides of Humboldt Gletscher by the Geological Survey of Denmark and Greenland (GEUS) were resumed in 1999 (Dawes *et al.* 2000; Dawes 2004), but additional collections of Cambrian fossils were not forthcoming.

The Telt Bugt Formation was formally described by Peel (2020a) on the basis of its original naming by Henriksen & Peel (1976) and is lithostratigraphically equivalent to the Cape Wood Formation of Inglefield Land and Bache Peninsula (Christie 1967; Peel & Christie 1982; Fig. 3).

Peel (2020b) described the trilobites *Glossopleura* and *Polypleuraspis*, originally described by Poulsen (1927), from Miaolingian (Wuliuan Stage; *Glossopleura walcotti* Biozone) strata of the Cape Wood Formation in Inglefield Land and on Bache Peninsula, Ellesmere Island (Fig. 1A), and from the lower Telt Bugt Formation in Daugaard-Jensen Land. Slightly younger trilobite assemblages (Miaolingian Series, Wuliuan Stage; *Ehmaniella* Biozone) from the Telt Bugt Formation were described by Peel (2020a). These studies are integrated into the present description of the trilobite fauna of the Telt Bugt Formation as a whole.

Biostratigraphy and correlation

In discussing the biostratigraphy of the middle Cambrian of Inglefield Land, V. Poulsen (1964, pl. 4) used the scheme with five biozones employed by Lochman-Balk & Wilson (1958) in Laurentia (Fig. 4), but only three of these biozones were recognised from collections available to him: *Plagiura–Poliella* Biozone, *Glossopleura* Biozone, and *Bathyuriscus–Elrathina* Biozone. The original five zones comprise the Delamaran, Topazan and the lower part of the Marjuman stages of some subsequent North American regional usage, the last stage also including the *Cedaria* and *Crepicephalus* biozones of the former Dresbachian Stage in addition to the zones recognised by V. Poulsen (1964). In terms of the global standard, most of this stratigraphic interval is now assigned to the Wuliuan, Drumian and Guzhangian Stages of the Miaolingian Series, the third series of the Cambrian (Babcock *et al.* 2011; Robison & Babcock 2011; Peng *et al.* 2012; Geyer 2019; Zhao *et al.* 2019; Fig. 4).

Robison (1976, 1984) introduced a biostratigraphic zonation that recognised ecological and lithological differences among trilobites from the Great Basin (mostly Utah), western USA, complementing the scheme presented by Lochman-Balk & Wilson (1958; Fig. 4). Separate zonal patterns were recognised for restricted shelf polymerids, open shelf polymerids, and open shelf agnostoids. Agnostoids from outer shelf and shelf margin environments enable worldwide correlation (Robison 1976, 1984; Babcock *et al.* 2011, 2017; Robison & Babcock 2011; Peng *et al.* 2012). Sundberg (1994, 2005), Sundberg & McCollum (2003a,b) and McCollum & Sundberg (2007) introduced a biostratigraphic scheme with speciesbased biozones for mainly inner shelf environments of the western

Great Basin (mostly Nevada) as a replacement for the previous genus-based biostratigraphy of the Delamaran and Topazan regional stages (Fig. 4). In particular, the *Plagiura–Poliella* Biozone was subdivided into three biozones, and also a number of subzones (assemblages) was proposed (Sundberg & McCollum 2003a,b; McCollum & Sundberg 2007; Fig. 4). Open shelf strata were assigned to the internationally recognised *Oryctocephalus indicus* Biozone (McCollum & Sundberg 2007).

Robison (1984) and Robison and Babcock (2011) defined six agnostoid intervalzones in middle Cambrian strata (Fig. 4). Agnostoids have not been collected from the Telt Bugt Formation but are well documented in North Greenland from Miaolingian strata in northern Nyeboe Land (Fig. 1A, localities 9, 10) and outcrops to the east (Robison 1984, 1988, 1994).

As with polymeroid zonations from elsewhere, the biozonal scheme from the western USA is based mainly on species endemic to the craton, and the refined subdivision established in that area through detailed study is not immediately applicable outside of the western USA. Rasetti (1951) described an equivalent zonation in British Columbia. While noting the close overall similarity to the Great Basin, Pratt & Bordonaro (2014) suggested a combined *Amecephalus arrojosensis–Eokochaspis nodosa* Biozone in the Precordillera of Argentina and did not record the *Poliella denticulata* Biozone. In the present context, an undivided *Plagiura–Poliella* Biozone is employed, largely on account of the scarcity of material.

As a consequence of the definition of the base of the Miaolingian Series and the Wuliuan Stage at the base of the *Oryctocephalus indicus* Biozone (Zhao *et al.* 2019), the two lowest biozones of the Delamaran regional stage recognised in the western USA by Sundberg (2018 and earlier literature) were re-assigned to Cambrian Series 2, Stage 4 (Geyer 2019; Sundberg *et al.* 2020; Fig. 4). Thus, trilobite assemblages from the Telt Bugt Formation described herein range in age from Cambrian Series 2, Stage 4 through the Wuliuan Stage of the Miaolingian.

One of the main areas of uncertainty regarding Cambrian biostratigraphy in Inglefield Land that remains after the studies of Poulsen (1927, 1958), Troelsen (1950) and V. Poulsen (1964) concerns the relationship between the historic lower and middle Cambrian (Cambrian Series 2 and 3), the latter roughly corresponding to the Miaolingian Series (Geyer 2019; Zhao *et al.* 2019). Poulsen (1927) recorded two new trilobite genera, *Kochiella* and *Dolichometopsis*, which occurr together with olenelloids in the Cape Kent Formation, referred to Cambrian Series 2 (Fig. 3). Both Poulsen (1927) and V. Poulsen (1964) were firm in their interpretation of the Cape Kent Formation as of early Cambrian age (Cambrian Series 2), but the apparent restriction of *Kochiella* to supposed middle Cambrian (Early Delamaran) in western North

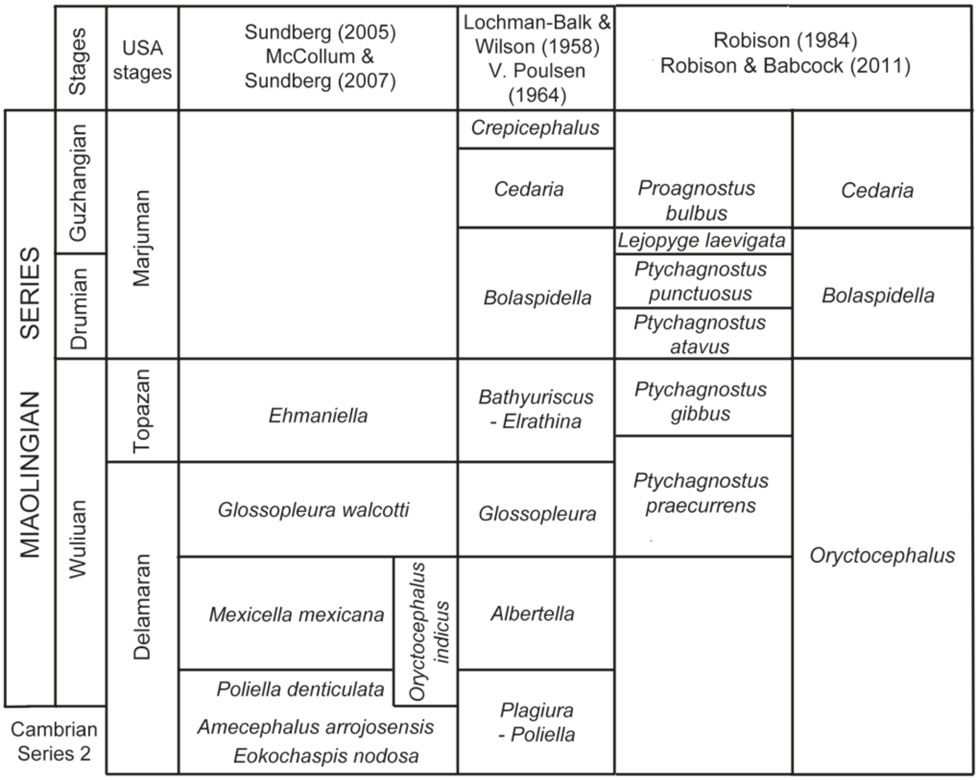


Fig. 4. Miaolingian biostratigraphic schemes.

America prompted Sundberg & McCollum (2002) to suggest that the mainly talus-based collections from the Cape Kent Formation available to Poulsen (1927) could indicate the presence in the formation of separate faunas of early and middle Cambrian age, the latter with *Kochiella* but without olenelloids. However, Sundberg & McCollum (2003b) described a possible kochaspid occurring together with olenelloids in the basal Emigrant Formation at Split Mountain, Nevada. In current formal international nomenclature, these occurrences of *Kochiella* in western USA are derived from strata now referred in part to Cambrian Series 2, Stage 4 (Geyer 2019; Fig. 4). Resser (1933, p. 744) had previously suggested that this supposedly post-olenelloid *Kochiella* zone might be middle Cambrian in age, and Norford (1968) described *Kochiella* from strata in the District of MacKenzie interpreted as early middle Cambrian in age. The issue was discussed by Rasetti (1951, p. 85) who noted written confirmation from Christian Poulsen of the occurrence of *Kochiella* with olenelloids in the Cape Kent Formation, a position restated by V. Poulsen (1964, p. 60).

The Cape Kent Formation is overlain by the Cape Wood Formation in Inglefield Land and this has yielded a *Glossopleura* assemblage of middle Cambrian age (Miaolingian Series, Wuliuan Stage) first described by Poulsen (1927, see also V. Poulsen 1964). Faunas from the latest part of Cambrian Stage 4 and the earliest Wuliuan Stage were not identified between the Cape Kent Formation and the *Glossopleura* horizons of the Cape Wood Formation, possibly due to the sporadic nature of collection. However, V. Poulsen (1964) subsequently identified rare trilobites from clasts within a conglomerate apparently derived from the basal Cape Wood Formation, which he interpreted as a *Plagiura–Poliella* Biozone fauna.

It has not been possible to examine collections in Copenhagen made by Lauge Koch or J.C. Troelsen from Inglefield Land, with the exception of some type specimens. V. Poulsen (1964) commented on substantial extra material of several taxa in Troelsen's collections from Inglefield Land in general, but presented few illustrations, and the possibility to assess variation within previously described taxa is limited. Such examination would prove valuable to the understanding of the ontogeny and relationships of several Cambrian trilobite genera proposed by Poulsen (1927) from Inglefield Land, as well as providing increased insight into the biostratigraphy. Thus, no new information is offered here concerning the age range of the Cape Kent Formation and the composition of its fauna. The formation is not recognised in Daugaard-Jensen Land and presumed equivalent uppermost beds of the Kastrup Elv Formation (Dawes *et al.* 2000; Fig. 3) have not yielded fossils. There is no reason to question the opinions of Christian and Valdemar Poulsen that *Kochiella* occurs together with olenelloids in Inglefield Land. However, *Kochiella* is reported herein in a small assemblage without olenelloids described from the basal Telt Bugt Formation of Daugaard-Jensen Land, on the north side of Humboldt Gletscher at Romer Søer (Fig. 2, GGU sample 206307; Fig. 5), although this description does not invalidate its reported occurrence with olenelloids in the Cape Kent Formation. The assemblage is attributed to the *Plagiura–Poliella* Biozone, which straddles the Cambrian Series 2–Miaolingian Series boundary, and it is succeeded in the Telt Bugt Formation by assemblages referred to the *Mexicella mexicana*, *Glossopleura walcotti* and *Ehmaniella* Biozones (Miaolingian Series, Wuliuan Stage; Figs 5–12). Drumian Stage assemblages (Fig. 4) have not been recognised. Faunas attributed to the Guzhangian Stage and Furongian Series from the overlying Cass Fjord Formation in Daugaard-Jensen Land were partly described by Palmer & Peel (1981).

Correlation in Daugaard-Jensen Land

The trilobite faunas described herein are derived from the Telt Bugt Formation in two areas, namely the type area around Telt Bugt, and at Romer Søer some 75 km to the east (Fig. 2). Peel (2020a) noted that the Telt Bugt Formation attained a thickness of about 45 m at Telt Bugt, increasing to approximately 100 m at Romer Søer. The formation, however, thins rapidly to the north and north-west; it is only about 5 m thick at the head of Cass Fjord but no fossils are known from that area. The available faunas from the two fossiliferous outcrops share no common taxa. The *Plagiura–Poliella* Biozone is recognised in both areas, but the *Glossopleura walcotti* Biozone is only recognised at Romer Søer. At Telt Bugt the *Plagiura–Poliella* Biozone is followed by the *Mexicella mexicana* Biozone and the *Ehmaniella* Biozone (Fig. 5). Particularly noteworthy is the absence of *Glossopleura* and related taxa from the Telt Bugt area, whereas *Glossopleura* occurs through at least 30 m of strata at Romer Søer. It is uncertain to what extent the faunal differences reflect lithostratigraphic and facies variation between the two areas witnessed by the substantial thickness variation. Available fossil collections are mainly sporadic in nature and generally small, such that gaps in collecting may accommodate unrecognised assemblages to some extent.

Plagiura–Poliella Biozone

This biozone is recognised in one small sample (GGU sample 206307) from 2 m above the base of the Telt Bugt Formation at Romer Søer (Fig. 1A, locality 6; Figs 2, 5) and in GGU sample 212806 at Telt Bugt, about 13 m above the base of the formation. GGU sample 206307 has yielded *Kochiella* sp. associated with *Fieldaspis*? *iubilaei* and *Plagiura*? sp. (Figs 5, 6). Their presence suggests comparison with the Mount Whyte Formation of British Columbia (Rasetti 1951) but also the *Plagiura–Poliella* Biozone of the Carrara Formation in the southern Great Basin (Palmer & Halley 1979), although *Kochiella* was not recorded from the latter. Norford (1968) described the morphologically similar *Kochiella mackenziensis* from the District of Mackenzie in association with *Fieldaspis* cf. *F. superba*, *Fieldaspis*? *nahanniensis* and *Inglefieldia* sp. in an association also interpreted as *Plagiura–Poliella* Biozone. *Fieldaspis*? *nahanniensis* compares well with *Fieldaspis*? *iubilaei*. *Fieldaspis* species are also well represented in strata from Nevada referred to the *Poliella denticulata* Biozone by Sundberg & McCollum (2003a), corresponding to the upper *Plagiura–Poliella* Biozone (Fig. 4).

GGU sample 212806 contains *Mexicella* cf. *robusta*, suggesting correlation with the *Amecephalus arrojosensis* Biozone of Nevada (Sundberg & McCollum 2000, p. 624), equivalent to the basal *Plagiura–Poliella* Biozone (Fig. 4). Following the international standard, the *Eokochaspis nodosa* Biozone is pre-Miaolingian, assigned to uppermost Stage 4 of Cambrian Series 2 (Geyer 2019).

The *Plagiura–Poliella* Biozone was recognised in Inglefield Land by V. Poulsen (1964) on the basis of three loose-lying specimens in clasts within a conglomerate considered to have been deposited at the base of the Cape Wood Formation. The fragment of a pygidium attributed to *Fieldaspis* by V. Poulsen (1964) is reminiscent of specimens identified as *Fieldaspis bilobata* by Sundberg & McCollum (2003a), but has a narrower and longer axis. Rasetti's (1951) material from the Mount Whyte Formation is wider, with more axial rings and prominent furrowing on the pleural areas than both of these. Although similar in general morphology to *Kochiella* sp., the co-occurring *Amecephalus troelseni* has narrower interocular areas, which slope away from the glabella rather than towards it, a longer (sag.), more convex, preglabellar area passing into a narrower border, and robust eye ridge (V. Poulsen 1964).

Mexicella mexicana Biozone

GGU sample 212808 (Figs 5, 7) from Telt Bugt yielded

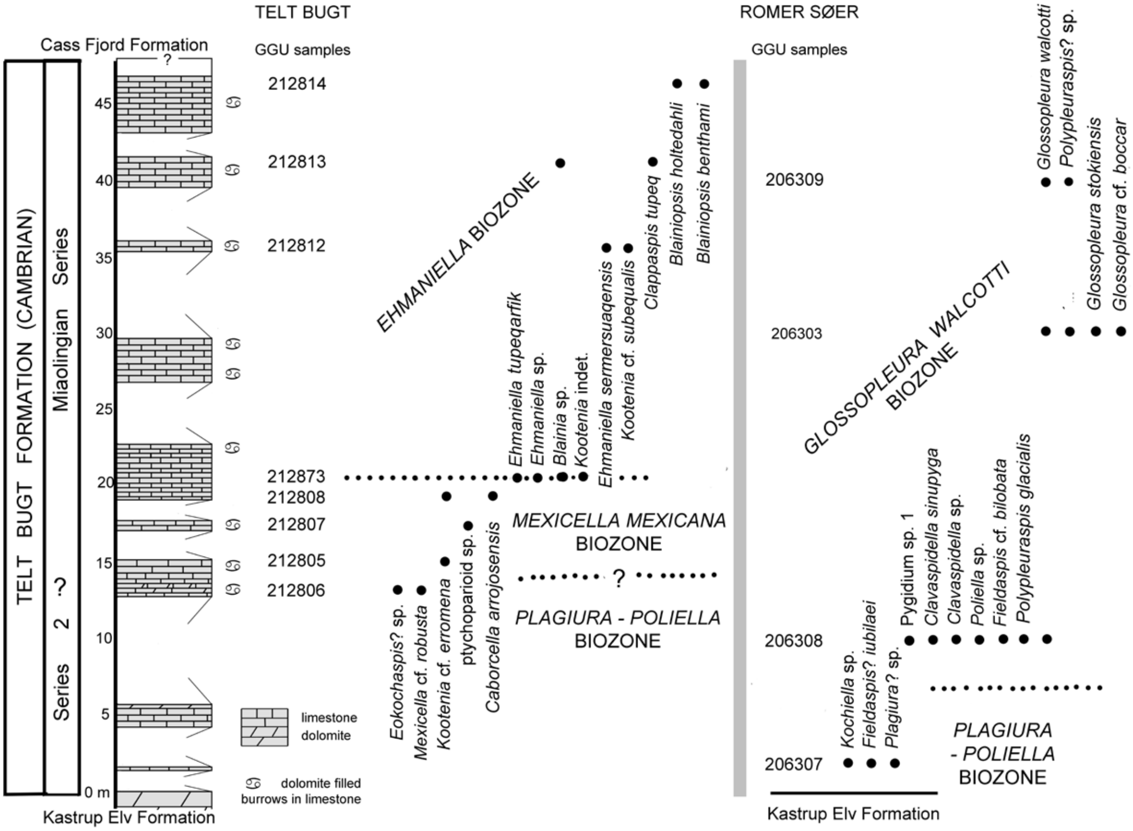


Fig. 5. Distribution of trilobites in the Telt Bugt Formation of Daugaard-Jensen Land at the type locality at Telt Bugt and at Romer Søer (Fig. 2). Lithological details are not available from Romer Søer, although the section height of GGU samples was recorded. Samples are located on the same vertical scale as the type section at Telt Bugt but no correlation is implied from stratigraphic thicknesses.

rare *Caborcella arrojosensis*, originally described from the Arrojos Formation of Sonora, northern Mexico (Lochman 1948). These are associated with sclerites compared to *Kootenia erromena*, described by Deiss (1939) from the Damnation Limestone (*Glossopleura walcotti* Biozone) of Montana. This *Mexicella mexicana* Biozone (or its equivalent *Albertella* Biozone) is recognised extensively in western North America (Resser 1939a; Rasetti 1951; Fritz 1968; Campbell 1974; Palmer & Halley 1979) but this is the first record from Greenland. It has not been recognised in the Romer Søer area.

Glossopleura walcotti Biozone

V. Poulsen (1964) noted almost 20 trilobite species from the *Glossopleura walcotti* Biozone in Inglefield Land, but few of these have been found in the available small samples from the Telt Bugt Formation (Fig. 5). At least 30 m of section at Romer Søer have yielded rare *Glossopleura*, including *Glossopleura walcotti*, *Clavaspidella* and *Polypleuraspis* (Figs 8–10), the last described by Peel (2020b), but the *Glossopleura walcotti* Biozone is not recognised at Telt Bugt (Fig. 5). The fauna from GGU sample 206308 at Romer Søer contains elements suggesting both the *Plagiura–Poliella* Biozone (Sundberg &

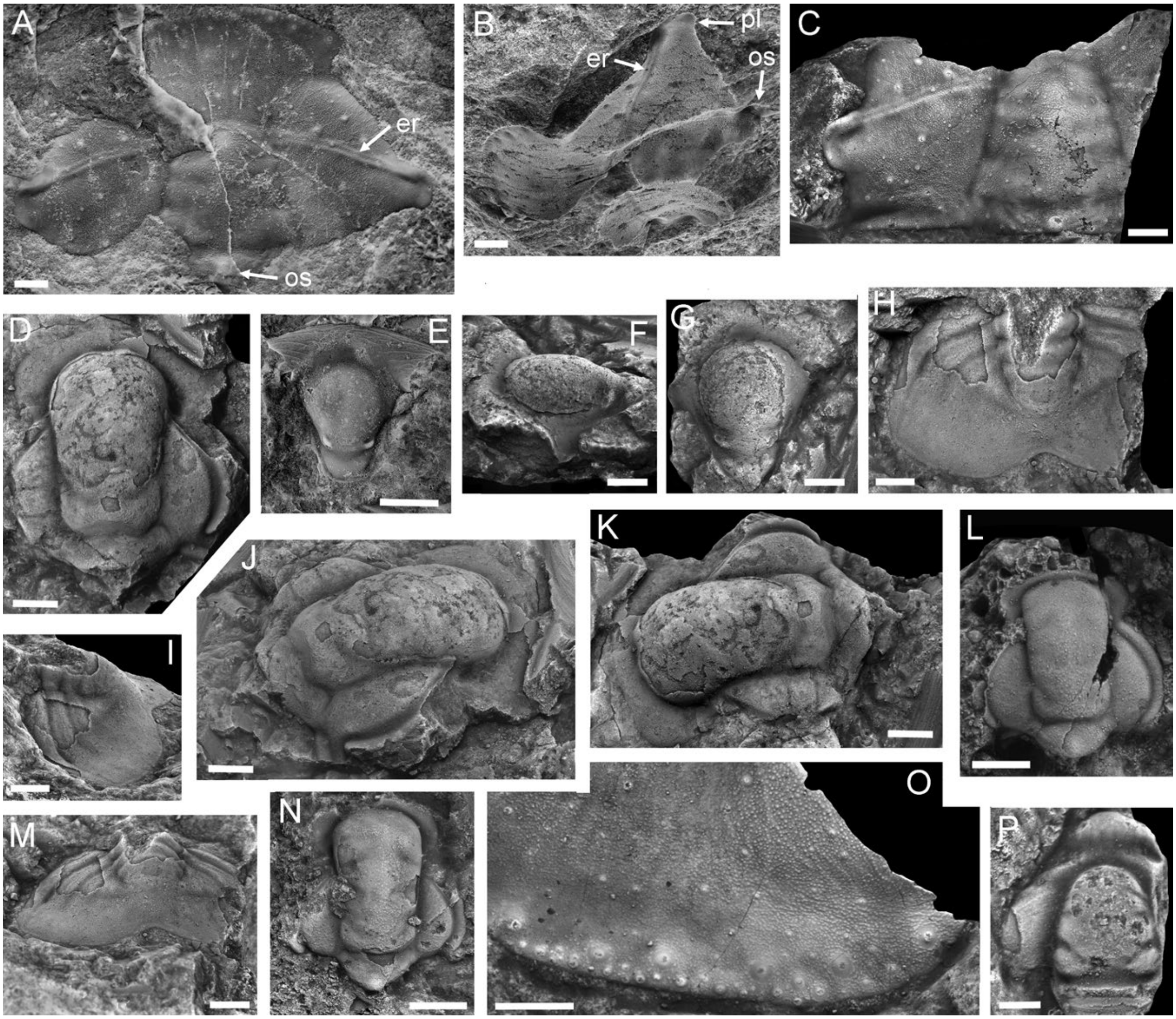


Fig. 6. Trilobites of the *Plagiura–Poliella* Biozone, Telt Bugt Formation, GGU sample 206307, Romer Søer, Daugaard-Jensen Land. **A–C**, **O**: *Kochiella* sp. **A**, **B**: MGUH 33473, digitally prepared cast of external mould of incomplete cranidium. **C**: MGUH 33474, fragment of cranidium. **O**: MGUH 33475, fragment of free cheek border. er, eye ridge; os, occipital spine; pl, palpebral lobe. **D–N**: *Fieldaspis*? *iubilaei* sp. nov. **D**, **J**, **K**: MGUH 33476, holotype, cranidium showing the flattened preglabellar field in dorsal (**D**) and oblique views. **E–G**: hypostomes. **E**: MGUH 33477. **F**, **G**: MGUH 33478. **N**, **L**: MGUH 33479 and MGUH 33480, cranidia of small individuals. **H**, **I**, **M**: MGUH 33481, pygidium. **P**: *Plagiura*? *sp.*, PMU 33482, fragment of cranidium. Scale bars: 1 mm (L, P); otherwise 2 mm.

McCollum 2003a) and the *Glossopleura walcotti* Biozone, but is referred to the latter on account of the incoming of *Clavaspidella sinupyga*.

GGU sample 212873 from Telt Bugt yielded *Ehmaniella tupeqarfik* and *Ehmaniella* sp. (Fig. 11) indicating the *Ehmaniella* Biozone. Immediately underlying strata (GGU sample 212808) contain a fauna assigned to the *Mexicella mexicana* Biozone (Fig. 7). The apparent disappearence of the *Glossopleura walcotti* Biozone from Romer Søer to Telt Bugt is likely due to regional thinning.

V. Poulsen (1964) recognised an upper *Clavaspidella* faunule and a lower *Glossopleura* faunule within the *Glossopleura* [*walcotti*] Biozone in Inglefield Land, but evidence for this separation was not unequivocal and it is not supported here. At Romer Søer, *Clavaspidella* appears before *Glossopleura*, together with species that are reminiscent of the underlying *Plagiura–Poliella* Biozone.

***Ehmaniella* Biozone**

Trilobites indicative of the *Ehmaniella* Biozone (Figs 5, 12) were described from the upper half of the Telt Bugt Formation at Telt Bugt by Peel (2020a) and the range of the zone is extended downwards by some 15 m to include GGU sample 212873 (Figs 5, 11). The biozone has not been recognised at Romer Søer, where the upper part of the formation is talus covered.

Blainiopsis benthami, *Blainiopsis holtedahli* and *Blainia* occur in the Cape Wood Formation of Inglefield Land in a fauna referred by V. Poulsen (1964, p. 66) to the *Bathyuriscus–Elrathina* zone [= *Ehmaniella* Biozone].

Correlation in North Greenland

Miaolingian fossils were first described from northern Nyeboe Land (Fig. 1A, locality 9) by V. Poulsen (1969) on the basis of collections made by P.R. Dawes in 1966 as part of a joint Canadian–Danish project, Operation Grant Land 1965–1966. Early Cambrian fossils were recognised in the same series of collections by Peel (1974) and Dawes & Peel (1984). V. Poulsen (1969) referred the agnostoids to the *Pychagnostus punctuosus* Biozone, Drumian Stage (Fig. 4) and therefore younger than the Wuliuan Stage faunas described herein from Daugaard-Jensen Land, which lack agnostoids.

Collections from northern Nyeboe Land made during 1985 by J.S. Peel (Fig. 1A, locality 9) and A.K. Higgins (Fig. 1A, locality 10) were described by Babcock (1994a,b) and Robison (1994) who documented faunas from the *Glossopleura walcotti*, *Ptychagnostus gibbus*, *Ptychagnostus atavus* and *Ptychagnostus punctuosus* biozones (late Wuliuan and Drumian Stages; Fig. 4) from the Henson Gletscher and Kap Stanton formations (Fig. 3). The absence of other biozones may reflect the sparse nature of collecting, not least since no fossils were available from the lowest 80 m of the Henson Gletscher Formation at this locality, but the Henson Gletscher Formation is strongly diachronous in North Greenland (Ineson & Peel 1997). The oldest assemblage in northern Nyeboe Land contains *Glossopleura walcotti* associated with *Kootenia*, *Ogygopsis*, *Syspacephalus* and undetermined ptychoparioids, but only the first of these is recognised in the Telt Bugt Formation (Figs 5, 9). In westernmost Peary Land (Fig. 1B), the lower part of the Henson Gletscher Formation is of Cambrian Series 2, Stage 4 age (Blaker & Peel 1997; Ineson & Peel 1997; Geyer & Peel 2011). The occurrence of a single specimen of *Oryctocephalus* cf. *indicus* in the upper part of the formation indicates the base of both the Miaolingian Series and the Wuliuan Stage, above an uppermost Cambrian Series 2 assemblage with *Ovatoryctocara granulata* (Geyer & Peel 2011). However, immediately overlying strata yield a *Ptychagnostus gibbus* Biozone assemblage indicating that much of the Wuliuan Stage is missing; *Glossopleura* is not recorded from this area.

Ineson & Peel (1997, p. 116) reported sparse late Miaolingian fossils from the Blue Cliffs Formation of the Ryder Gletscher Group in southern Wulff Land (Fig. 1B), likely correlative with the Cass Fjord Formation of western outcrops. Peel (in press) described an *Eldoradia* assemblage from the basal Blue Cliffs Formation in southern Wulff Land indicating a Guzhangian age (Fig. 4).

Correlation with eastern Nunavut

Poulsen (1946) recognised the similarity of Cambrian stratigraphy and faunas from Inglefield Land and Bache Peninsula (Fig. 1A, locality 3), and Troelsen (1950) and V. Poulsen (1964) presented an integrated stratigraphy. The Cape Wood Formation of Inglefield Land and Bache Peninsula is the direct equivalent of the upper Telt Bugt Formation (Peel & Christie 1982; Peel 2020a,b) and has yielded a lower assemblage with *Glossopleura* and *Polypleuraspis*, and an upper assemblage with *Blainiopsis*, which Poulsen (1946) referred to as the *Blainiopsis* horizon. V. Poulsen (1964) correlated this horizon with strata assigned to the *Bathyuriscus–Elrathina* Biozone [=*Ehmaniella* Biozone] at Blomsterbækken in Inglefield Land (Fig. 1A, locality 2). Peel (2020a) described *Blainiopsis holtedahli* and *B. benthami* from the uppermost of three fossiliferous horizons (GGU samples 212812–212814) referred to the *Ehmaniella* Biozone in the Telt Bugt Formation (Figs 5, 12), in which *Ehmaniella sermersuaqensis*, *Clappaspis tupeq*, *Blainia* and *Kootenia* also occur.

The Parrish Glacier Formation was correlated with the Cape Wood and Telt Bugt formations by de Freitas & Fritz (1995), although Dewing *et al.* (2001) integrated the Parrish Glacier Formation into the overlying Cass Fjord Formation. Fossil collections were reported, but not described, from several localities by de Freitas (1998a–c). *Glossopleura* assemblages were noted by de Freitas (1998a) from the type section of the Parrish Glacier Formation at the head of Copes Bay (Fig. 1A, locality 4). To the north-east, at Dobbin Bay (Fig. 1A, locality 7), de Freitas (1998b) commented that the base of the Parrish Glacier Formation was dated to the *Ehmaniella* Biozone, and thus younger than the age at its type section. This observation may be relevant given the apparent absence of the underlying *Glossopleura walcotti* Biozone in the Telt Bugt Formation in its westernmost exposures, at Telt Bugt (Fig. 1A, locality 5).

Farther to the north (Fig. 1A, locality 8), de Freitas (1998c) reported highly fossiliferous limestone beds yielding diverse faunas assigned to the *Ptychagnostus gibbus* Biozone; associated assemblages were assigned to the stratigraphically older *Albertella* and *Glossopleura* Biozones. A stratigraphically younger assemblage was referred to the *Bolaspidella* Biozone (Drumian Stage). The diversity of these assemblages from locality 8 and the presence of agnostoids, eodiscoids, *Ogygopsis* and *Oryctocephalus* indicates more open shelf conditions than those present during deposition of the Telt Bugt Formation, and the faunas are more closely comparable with those in northern Nyeboe Land and western Peary Land (Babcock 1994a; Robison 1994; Blaker & Peel 1997; Geyer & Peel 2011).

Derivation of samples

With the exception of the large collection from GGU sample 212812, most of the available samples (Figs 2, 5) are small and most of the specimens are illustrated. No macrofossils other than trilobites were observed.

GGU sample 206303 was collected by J.S. Peel on 15th July 1976 from 30 m above the base of the Telt Bugt Formation, which is about 100 m thick in this section. The locality lies near the eastern extremity of the southernmost of three large lakes in Daugaard-Jensen Land, collectively referred to as Romer Søer (80°5.6′N, 60°23′W; Fig. 1A, locality 6; Fig. 2).

GGU samples 206307–206309 were collected from the Romer Søer area (80°03′N, 60°41′W; Fig. 2) by J.S. Peel on 16th July 1976 from 2 m, 10 m and 40 m, respectively, above the base of the Telt Bugt Formation, of which about 70 m are exposed in this section (Fig. 5). The boundary with the overlying Cass Fjord Formation is talus covered.

GGU samples 212805–212814 and GGU 212873 were collected by J.S. Peel on 6th–18th July 1975 from the type section of the Telt Bugt Formation (Fig. 1a, locality 5; Figs 2, 5), north-east of Telt Bugt, Daugaard-Jensen Land (79°56.3′N, 60°15′W).

Methods. Following mechanical preparation, specimens were coated with black colloidal carbon and then whitened with ammonium chloride sublimate prior to photography using a Lumenera Infinity X32 digital camera and MicroNikkor 55 mm lens. Images were assembled in Adobe Photoshop CS4; some images were stacked using Helicon Focus.

Systematic palaeontology

Repositories and abbreviations. Type and figured specimens are deposited in the type collection of the Natural History Museum of Denmark, Copenhagen (MGUH prefix) and in the palaeontological type collection of the Museum of Evolution, Uppsala University, Uppsala, Sweden (PMU prefix). GGU prefix indicates a sample made during regional geological campaigns of Grønlands Geologiske Undersøgelse (Geological Survey of Greenland), Copenhagen, Denmark (now GEUS). In the following descriptions, sagittal and transverse measurements are abbreviated to (sag.) and (trans.), denoting dimensions measured parallel and transverse to the longitudinal axis, respectively.

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Class Trilobita Walch 1771

Order Corynexochida Kobayashi 1935

Family Dorypygidae Kobayashi 1935

Genus *Kootenia* Walcott 1889

Type species. *Bathyuriscus (Kootenia) dawsoni* Walcott 1889.

Discussion. Sundberg (1994) clarified the distinction between *Kootenia* Walcott 1889, *Olenoides* Walcott 1889 and *Dorypyge* Dames 1883.

Dorypyge resseri Poulsen 1927 and *Dorypyge obliquespina* Poulsen 1927 from the Cape Wood Formation of Inglefield Land were referred to *Kootenia* by Resser (1937) and V. Poulsen (1964). V. Poulsen (1964) also recorded the latter from the *Glossopleura* Biozone of Bache Peninsula (Fig. 1A, locality 3) and described, as *Kootenia* cf. *billingsi* Rasetti 1948, a pygidium from the upper part of the Cape Wood Formation at Blomsterbækken (Fig. 1A, locality 2). An indeterminate fragment of *Kootenia* is recorded from GGU sample 212873 (Fig. 5).

Kootenia cf. erromena Deiss 1939
Fig. 7A–G, J–M

Figured material. Cranidia: MGUH 33483 and MGUH 33488 from GGU sample 212805; MGUH 33486 from GGU sample 212808. Hypostomes: MGUH 33484 and MGUH 33485 from GGU sample 212805. Pygidia: MGUH 33487 from GGU sample 212805; MGUH 33489 and MGUH 33490 from GGU sample 212808. Telt Bugt Formation, Telt Bugt. Miaolingian Series, Wuliuan Stage, *Mexicella mexicana* Biozone.

Description. Small cranidium is wider than long, with posterior limb of fixigenae as wide as maximum transverse width (*c*. 4 mm) at the front of the slightly concavesided glabella (Fig. 7G). Palpebral lobe terminating at just anterior of mid-length (sag.) of glabella. Frontal areas of fixigenae with concave brim, reduced to a narrow groove and rim in front of the shallowly convex effaced glabella.

Large cranidium with parallel-sided glabella rather strongly curved from the occipital ring almost to the anterior margin. Axial furrow broad, shallowing slightly at the anterior limbs of the fixigenae and narrowing, as does the brim, as it passes in front of the glabella. Glabella and fixigenae uniformly convex, the latter sloping down steeply as the distal margins of the posterior fixigenae are approached. Occipital furrow broad, deeper laterally. Occipital ring posteriorly extended, probably with a short, blunt spine or node.

Thorax and librigenae not known. Hypostome with parallel sides and truncated posterior (Fig. 7C); anterior margin uniformly convex in plan view with flattened, stout, anterior wings passing in front of the oval anterior lobe of the median body as a shallowly concave border. Anterior lobe separated from posterior lobe by a shallow, posteriorly convex, transverse furrow, which joins laterally with a broad marginal furrow that extends from close to the anterior wings around the posterior margin. Junction between lateral margins and posterior margin sharply angular, with minute incipient spine, two more of which may be located equidistantly on the lateral margins posterior to the transverse furrow.

Length of pygidium about three quarters of its maximum transverse width, including spines, with maximum anterior width of axis greater than pleural area. Axis strongly convex, tapering posteriorly with three prominent rings delimited by transverse furrows and a fourth ring grading into the terminal piece, the latter terminating just prior to the posterior margin of the border. Pleural areas with well defined pleural and interpleural furrows terminating at abrupt transition to the shallowly convex border. Margin with five or six pairs of needle-shaped spines arising from flattened triangular bases; spines forming the sixth pair short, about half the length of those forming the fifth pair, or absent.

Smooth, or with ornamentation of fine pits in a dimpled pattern.

Discussion. *Kootenia erromena* Deiss 1939 was described from the Damnation Limestone of north-western Montana where it forms part of a *Glossopleura–Kootenia* assemblage (Deiss 1939) of early Wuliuan age; it has a slightly narrower axis than specimens from the Telt Bugt Formation. Pygidia of *Kootenia* cf. *erromena* are also distinguished from those of *Kootenia resseri* (Poulsen 1927), *K. obliquespina* (Poulsen 1927) and *K.* cf. *billingsi* of V. Poulsen (1964) from the Cape Wood Formation of Inglefield Land by the greater width of their axis. In specimens of *Kootenia* cf. *erromena* from the Telt Bugt Formation, the maximum transverse width of the pygidial axis is also greater than each pleural area whereas it is narrower in species described by Poulsen (1927) and V. Poulsen (1964).

Specimens of *Kootenia* cf. *erromena* from GGU sample 212805 are otherwise similar to *K. resseri* in that the pygidium usually has six pairs of spines, an axis with three rings and long tail piece (the latter includes an incipient fourth ring in *K.* cf. *erromena*), and a well-developed border; cranidia of *K. resseri* were not described by Poulsen (1927) nor by V. Poulsen (1964). Poulsen's (1927) figures of *Kootenia obliquespina* are too small to permit precise comparison, but four axial rings appear to be present. An associated but poorly preserved cranidium seems comparable to those from Telt Bugt. *Kootenia* cf. *billingsi* of V. Poulsen (1964, pl. 1, fig. 8) is similar to *Kootenia* cf. *erromena* in preserving six pairs of pygidial spines, with the spines forming the sixth, most posterior, pair being greatly reduced in length. This is a feature of specimens from GGU sample 212805 (Fig. 7E,L) but also of other described species of *Kootenia*, e.g. *Kootenia quadriceps* (Hall & Whitfield 1877) and *Kootenia quebecensis* Rasetti 1948. However, three pygidia of *Kootenia* cf. *erromena* from GGU sample 212808, and a single specimen from GGU sample 212873, possess only five pairs of shorter spines (Fig. 7M) or just a rudimentary sixth pair (Fig. 7J).

Pygidia of *Kootenia* cf. *erromena* resemble a poorly preserved specimen, reportedly with six pairs of spines, from the *Glossopleura walcotti* Biozone figured by Sundberg (2005, fig. 6.15) from the Chisholm Formation, Drum Mountains, Utah, in the proportions of the axis, but the spines in the latter are more robust and pleural furrowing is less distinct. *Kootenia quadriceps*, as illustrated by Palmer (1954, pl. 14, figs 1–4) from the Ute Limestone of Blacksmith Fork, Utah, has longer pygidial spines but its axis is narrower than *Kootenia* cf. *erromena*. Both *Kootenia quadriceps and Kootenia* cf.

erromena have a parallel-sided glabella but the eyes are located more posteriorly in the latter, whereas the border in front of the anterior fixigenae is more strongly upturned in *Kootenia quadriceps*.

***Kootenia* cf. *subequalis* Deiss 1939**
Fig. 12E

2020a *Kootenia* cf. *subequalis*; Peel, p. 6, fig. 3K.

Figured material. Cranidium, PMU 35702 from GGU sample 212812, Telt Bugt Formation, Telt Bugt. Miaolingian Series, Wuliuan Stage, *Ehmaniella* Biozone.

Discussion. This poorly preserved glabella is similar to *Kootenia subequalis* Deiss 1939 from the Pentagon Shale (Miaolingian) of Montana, but the posterior fixed cheeks are shorter in the Telt Bugt specimen.

Family Dolichometopidae Walcott 1916

Genus *Poliella* Walcott 1916
Type species. *Bathyuriscus (Poliella) anteros* Walcott 1916.

***Poliella*? sp.**
Fig. 8A

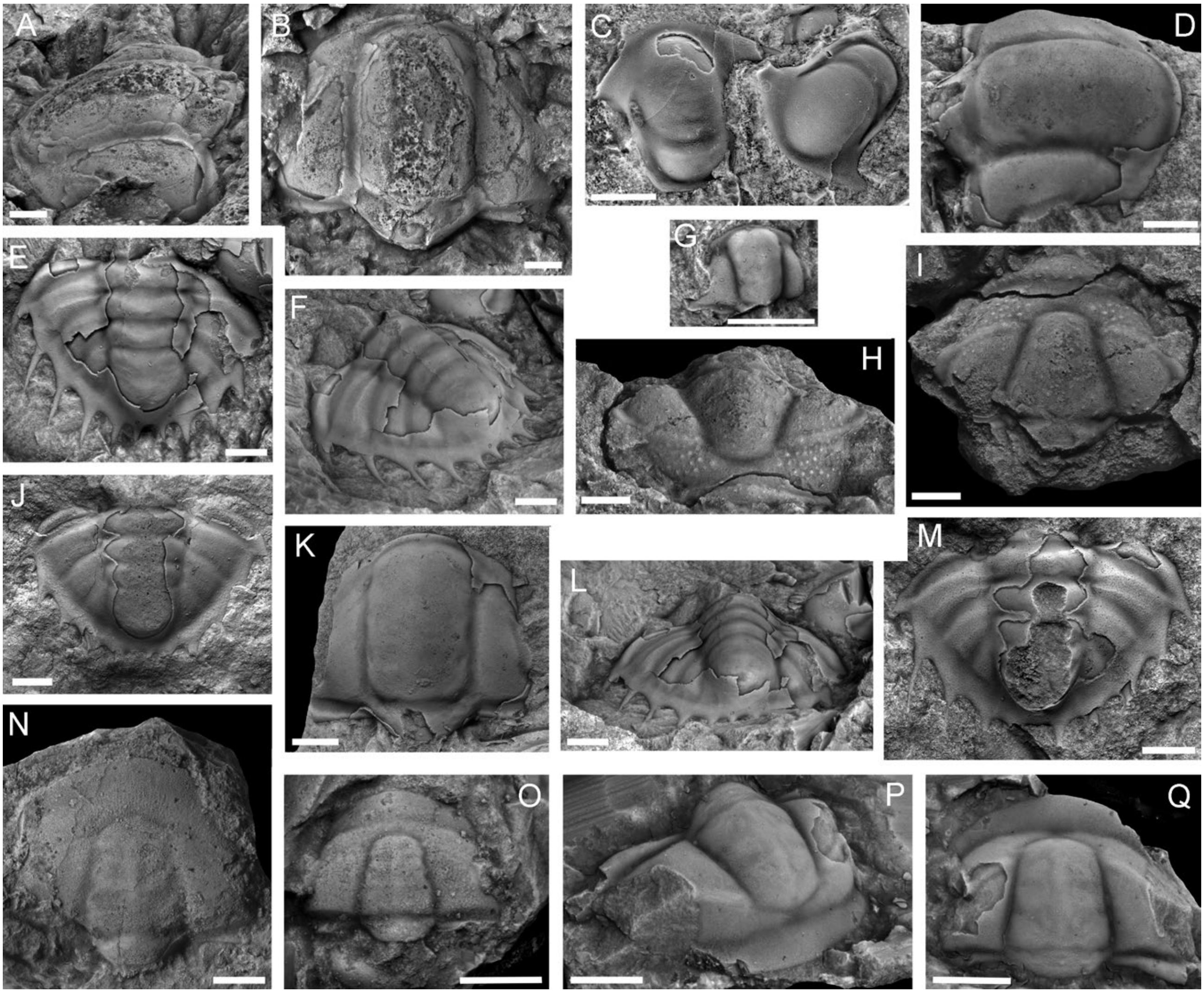

Fig. 7. Trilobites of the *Mexicella mexicana* Biozone, Telt Bugt Formation, GGU samples 212805–212808, Telt Bugt, Daugaard-Jensen Land. **A–G**, **J–M**: *Kootenia* cf. *erromena* Deiss 1939. **A**, **B**: MGUH 33483, cranidium, GGU sample 212805. **C**: MGUH 33484 and MGUH 33485, hyperstomes, GGU sample 212805. **D**, **K**: MGUH 33486, cranidium, GGU sample 212808. **E**, **F**, **L**: MGUH 33487, pygidium, GGU sample 212805. **G**: MGUH 33488, small cranidium, GGU sample 212805. **J**: MGUH 33489, pygidium, GGU sample 212808. **M**: MGUH 33490, pygidium, GGU sample 212808. **H**, **I**: *Caborcella arrojosensis* Lochman 1948, MGUH 33491, cranidium, GGU sample 212808. **N**: *Mexicella* cf. *mexicana* Lochman 1948, MGUH 33492, cranidium, GGU sample 212806. **O**: *Eokochaspis*? sp., MGUH 33493, cranidium, GGU sample 212806. **P**, **Q**: ptychoparioid sp., MGUH 33494, cranidium, GGU sample 212807. Scale bars: 2 mm.

Figured material. Cranidium, MGUH 33495 from GGU sample 206308. Telt Bugt Formation, Romer Søer. Miaolingian Series, Wuliuan Stage, *Glossopleura walcotti* Biozone.

Discussion. The single fragmentary cranidium has a glabella with almost parallel sides, a broad occipital furrow and four pairs of glabellar furrows, which are effaced medially. The axial furrow shallows anteriorly, almost disappearing at S4, but re-appearing as a broad, shallowly concave, preglabellar field. A shallowly convex brim anterior to this preglabellar furrow widens as it passes laterally into the anterior lobes of the fixigenae. The palpebral lobes are broad, uniformly convex in transverse profile and with a well-defined broad furrow on their axial side delimiting shallowly convex interocular areas from the axial furrow. The palpebral lobes terminate anteriorly at the axial furrow. The occipital ring is seemingly broad (sag.); posterior lobes of fixigenae and other skeletal elements are not known. The surface is ornamented with an irregular cellular pattern of fine ridges in which individual cells become elongated, passing into terrace ridges parallel to the margin on the frontal area. The ornamentation is only weakly expressed on the palpebral lobes and in the glabellar furrows.

The cranidium can be compared to a specimen from the Mount Whyte Formation (early Miaolingian) of British Columbia, which Rasetti (1951, pl. 12, fig. 10) assigned to *Poliella prima* Walcott 1916, in terms of the narrowness of the glabella and the shape of the frontal area, although the glabella expands slightly towards the anterior in that specimen. It differs in terms of its cellular ornamentation, with the Canadian material reportedly smooth (Rasetti 1951), and its glabellar furrows being equally developed.

Poliella? sp. differs from the co-occurring *Fieldaspis*? *iubilaei* sp. nov. in the form of the axial groove around the front of the glabella in the latter species. Its ornamentation is finely granular in contrast to the cellular pattern on the cranidium of *Poliella*? sp. Cranidia of *Fieldaspis bilobata* illustrated by Rasetti (1951) are distinguished by the anterior brim being turned up, in contact with the front of the glabella, and the corresponding very narrow anterior groove.

The cranidium of *Poliella*? sp. occurs together with two pygidia in GGU sample 206308, each of which could be referred to *Poliella*? sp. One of these (Fig. 9K–M) is described herein as *Fieldaspis* cf. *bilobata* Rasetti 1951 but the presence of similar ornamentation around the border may suggest reference to *Poliella*? sp. The second pygidium (Pygidium sp. 1; Fig. 9G,I,J) is similar in shape to pygidia of *Poliella* species illustrated by Sundberg & McCollum (2003a, fig. 10). It differs from these in having a greater number of axial rings, in which respect it is similar to *Fieldaspis* cf. *bilobata*.

Genus *Clavaspidella* Poulsen 1927

Type species. *Clavaspidella sinupyga* Poulsen 1927 from the Cape Wood Formation, Marshall Bugt, Inglefield Land.

Discussion. Poulsen (1927) assigned three species from Inglefield Land to his new genus *Clavaspidella*. The material was collected from boulders at Kap Frederik VII and assigned to the Cape Frederik VII Formation, erroneously thought at that time to be of Lower Ozarkian(?) age (Poulsen 1927). Resser (1935, 1939a,b) applied the generic name to a number of North American species, considering the genus to be a senior synonym of *Athabaskia* Raymond 1928, an opinion not shared by Kobayashi (1942). Lochman *in* Cooper *et al.* (1952, p. 128) also rejected the synonymy, following comparison of type material, concluding that all species from the Cordilleran region should be assigned to *Athabaskia* and confirming the opinion of Kobayashi (1942). Bordonaro (2014) referred material from Argentina previously assigned to *Clavaspidella* to *Athabaskia*. V. Poulsen (1964) accepted the conclusions of Lochman *in* Cooper *et al.* (1952) noting, as did Kobayashi (1942), that *Clavaspidella* was probably restricted to North-West Greenland. He observed that *Clavaspidella* occurred in the *Glossopleura* Biozone of Inglefield Land, following Troelsen's (1950) inclusion of the Cape Frederik VII Formation within the Cape Wood Formation, and described an additional species, *Clavaspidella ovaticauda* V. Poulsen 1964, based on four pygidia.

Clavaspidella was tentatively reported from Bache Peninsula by Poulsen (1946), from the Hawke Bay Formation of western Newfoundland (Knight & Boyce 1987) and from the Parrish Glacier Formation of eastern Ellesmere Island (de Freitas 1998a).

Poulsen *in* Harrington *et al.* (1959, p. O224) noted the well-defined eye ridges as characteristic of *Clavaspidella*, a feature not mentioned by Lochman *in* Cooper *et al.* (1952) or V. Poulsen (1964) but evident in the illustration of the lectotype figured by Poulsen (1927, pl. 17, fig. 19; not holotype as stated by V. Poulsen 1964, p. 23). Lochman *in* Cooper *et al.* (1952) stressed the greater width of the fixigenae in *Clavaspidella* relative to *Athabaskia* and differences in the shape of the posterior glabella. V. Poulsen (1964) emphasized the presence in pygidia of *Clavaspidella* of the axial indentation, a morphological feature not seen in *Athabaskia*.

Clavaspidella sinupyga Poulsen 1927

Fig. 8P–S

1927 *Clavaspidella sinupyga* Poulsen, p. 277, pl. 17, figs. 21–22.

Figured material. Pygidia: MGUH 33498 and MGUH 33499 from GGU sample 206308, Telt Bugt Formation, Romer Søer. Miaolingian Series, Wuliuan Stage, *Glossopleura walcotti* Biozone.

Discussion. Two large exfoliated pygidia display the characteristic narrow axis and broad, concave brim, which is indented medially at the posterior margin. The transition from the pleural areas to the brim is abrupt and angular, but without a furrow. Pleural furrows are deeper at this transition, producing a pitted appearance. *Clavaspidella ovaticauda* V. Poulsen 1964 from the Cape Wood Formation at Kap Frederik VII (Fig. 1A, locality 2) differs in its wider axis and more backwards curved pleurae.

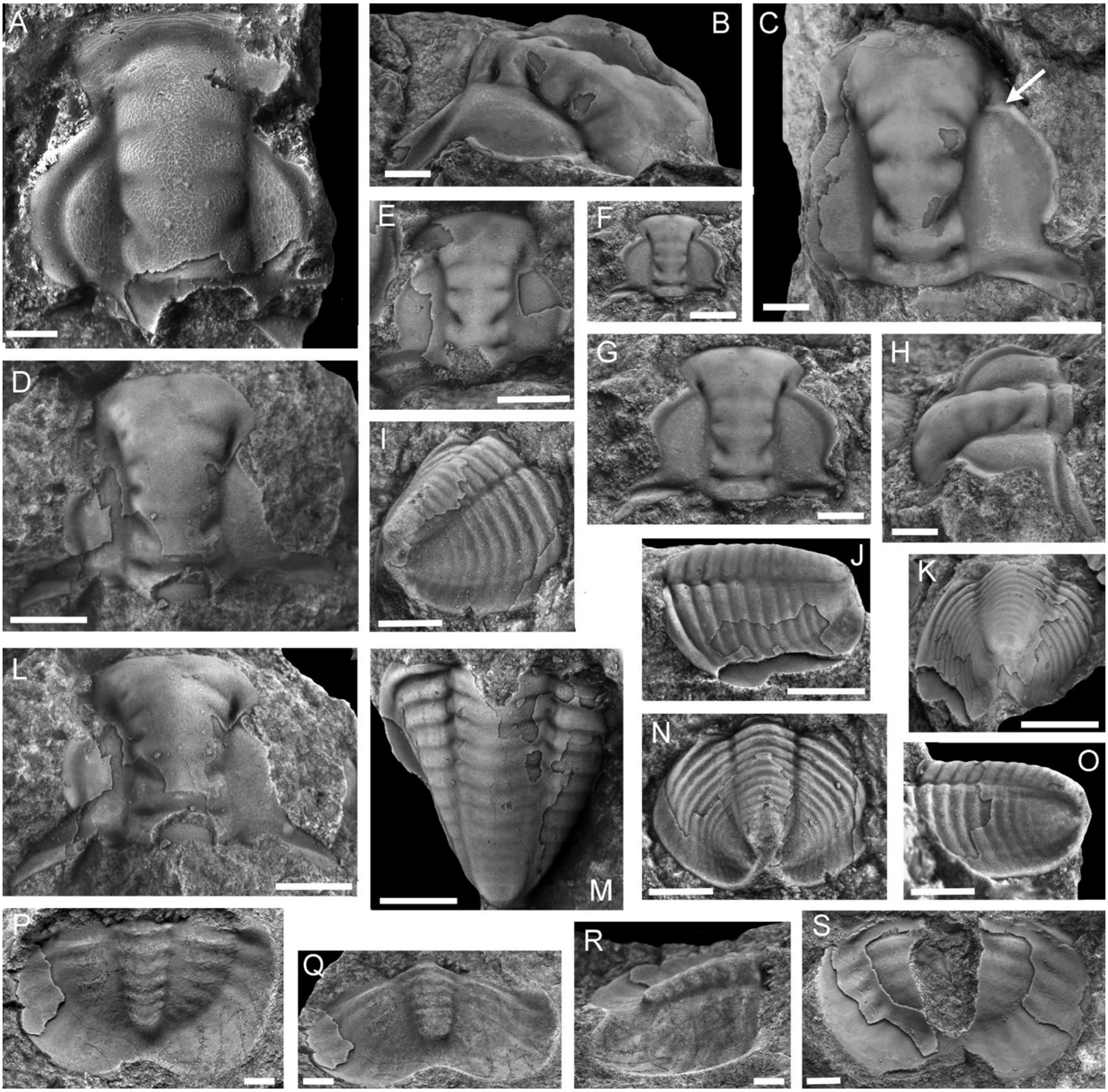

Fig. 8. Trilobites of the *Glossopleura walcotti* Biozone, Telt Bugt Formation, GGU sample 206308, Romer Søer, Daugaard-Jensen Land. **A**: *Poliella*? sp., MGUH 33495, cranidium with prominent honeycomb-like ornamentation. **B**, **C**, **F–H**: *Clavaspidella* sp., **B**, **C**: MGUH 33496, cranidium with arrow indicating eye ridge. **F–H**: MGUH 33497, small cranidium (**F** at same scale as **C**). **D**, **E**, **I–O**: *Polypleuraspis glacialis* Peel 2020b. **D**, **L**: PMU 35037, cranidium. **E**: PMU 35039, cranidium. **I**, **N**, **O**: PMU 35038 (.14), holotype, pygidium. **J**, **K**, **M**: PMU 35040 (.16), pygidium. **P–S**: *Clavaspidella sinupyga* Poulsen 1927. **P–R**: MGUH 33498 (.12), internal mould of pygidium. **S**: MGUH 33499, exfoliated, broken pygidium. Scale bars: 1 mm (A), otherwise 2 mm.

Clavaspidella sp.

Fig. 8B, C, F–H

Figured material. Cranidia: MGUH 33496 and MGUH 33497 from GGU sample 206308, Telt Bugt Formation, Romer Søer. Miaolingian Series, Wuliuan Stage, *Glossopleura walcotti* Biozone.

Discussion. While the rapidly expanding glabella with concave sides, wide fixigenae and transverse eye ridge (Fig. 8C, arrrow) indicate assignment to *Clavaspidella*, the narrowness of the glabella in *Clavaspidella* sp. is not characteristic of any of the three species described by Poulsen (1927) and invites comparison with *Polypleuraspis solitaria* Poulsen 1927, as illustrated by Peel (2020b). The latter, however, has narrower interocular areas and eye ridges that curve in gradually to meet the axial furrow. The posterior limb of the fixed cheeks in *Clavaspidella* sp. is shorter (trans.) than in *Polypleuraspis*, relative to the width of the interocular area (Fig. 8C).

The ratio of glabellar length (sag.) to glabellar maximum width (trans.) is about 1.25 in the lectotype of the type species *Clavaspidella sinupyga* and in *Clavaspidella platyrrhina* Poulsen 1927, but about 1.75 in the largest available specimen of *Clavaspidella* sp. from GGU sample 206308 (Fig. 8B,C). The same ratio is 1.5 in the single cranidium described as *Clavaspidella quinquesulcata* Poulsen 1927, but the nature of the palpebral lobes and eye ridges (if present) is not clear from the single tiny illustration (Poulsen 1927, pl. 17, fig. 23).

Eye ridges are not seen in small specimens of *Clavaspidella* sp. which are placed here on account of the perpendicular relationship between the anterior end of the palpebral lobes and the lateral margin of the anterior fixigenae (Fig. 8F–H). In these, the anterior margin is more shallowly convex than in the illustrated large specimen (Fig. 8C), shown at the same scale, a feature which Poulsen (1927) considered characteristic of *Clavaspidella platyrrhina*. However, the lectotype of that species, here designated as the specimen illustrated as Poulsen (1927, pl. 17, fig. 24), has well developed eye ridges.

V. Poulsen (1964) did not discuss *Clavaspidella platyrrhina* and *Clavaspidella quinquesulcata*, although the names were retained in his faunal list (Poulsen 1964, p. 64). In view of the variation in glabellar form in the available small sample, the current material from Daugaard-Jensen Land is not assigned at species level. However, *Clavaspidella* sp. occurs in the same sample as pygidia that are referred to *Clavaspidella sinupyga* (Fig. 8P–S).

Genus *Glossopleura* Poulsen 1927

Type species. *Dolichometopus boccar* Walcott 1916 from the Stephen Formation, Miaolingian Series, British Columbia.

Glossopleura walcotti Poulsen 1927

Fig. 9A–F, H; Fig. 10K–M

1927 *Glossopleura walcotti* Poulsen, p. 268, pl. 16, figs 20–30.
1964 *Glossopleura walcotti*, Poulsen, p. 25, pl. 1, figs 2–4, text-fig. 3–4.
1979 *Glossopleura walcotti*, Palmer & Halley, p. 79, pl. 16, figs 6–8, 11–19.
1994 *Glossopleura walcotti*, Babcock, 1994a, p. 94, fig. 12.
2018 *Glossopleura walcotti*, Sundberg, p. 19, fig. 13.1–13.7.
2020b *Glossopleura walcotti*, Peel, fig. 3A–G.

Figured material. Cranidium, PMU 35046; free cheek, MGUH 33500; pygidium, PMU 35047; hypostome, MGUH 33501, all from GGU sample 206308. Cranidia: MGUH 33512 and MGUH 33513; pygidia: MGUH 33510 and MGUH 33511, all from GGU sample 206309. Telt Bugt Formation, Romer Søer, Miaolingian Series, Wuliuan Stage, *Glossopleura walcotti* Biozone.

Discussion. Following its original description, *Glossopleura walcotti* Poulsen 1927 was fully described by V. Poulsen (1964), Palmer & Halley (1979) and Foglia & Vaccari (2010). It was described from the Henson Gletscher Formation in northern Nyeboe Land (Fig. 1A, locality 9), North Greenland, by Babcock (1994a) and illustrated by Peel (2020b) from the Cape Wood Formation of Inglefield Land and Bache Peninsula, and the Telt Bugt Formation of Daugaard-Jensen Land. A *Glossopleura* Biozone has been widely recognised for many years but McCollum & Sundberg (2007) refined this to the *Glossopleura walcotti* Zone, the *Glossopleura walcotti/Ptychagnostus praecurrens* Zone of Sundberg (2018).

Glossopleura stokiensis Rasetti 1951

Fig. 10H

1951 *Glossopleura stokiensis* Rasetti, p. 166, pl. 23, figs 6–10.

Figured material. Pygidium with thoracic segments, MGUH 33506 from GGU sample 206303, Telt Bugt Formation, Romer Søer. Miaolingian Series, Wuliuan Stage, *Glossopleura walcotti* Biozone.

Discussion. This distinctive pygidium is known as an external mould with parts of five pleural segments and is illustrated as a digital cast, corresponding to the outer surface (Fig. 10H). A second example is associated with a *Polypleuraspis solitaria* specimen designated MGUH 2305 (Peel 2020b, fig. 2D) from the Cape Wood Formation of Blomsterbækken in Inglefield Land (Fig. 1A, locality 2). The pleural segments are sharply pointed with a fine proximal tuberculation and prominent terrace lines distally.

The pygidium is elliptical, with length about two thirds of width. The axis is broad with five rings, the most posterior of which grades into a slightly raised terminal piece. The articulating half ring is sharply delimited by a complete furrow. The three following axial furrows are broad, shallow and only weakly expressed medially, and become indistinct posteriorly. Pleural fields are each about half the width of the axis and lack furrows. They steepen in profile before passing abruptly, but without a delimiting furrow, onto a flat border, which is equal in width to the maximum transverse width of the axis and terminates in a shallow median excavation. Ornamentation consists of fine meandering ridges, which are most prominent on the axis, and numerous small pores. On the border, the ridges pass distally into an increasingly coarser, sub-parallel pattern of terrace ridges.

Glossopleura stokiensis Rasetti 1951 was originally described from the Cathedral Limestone of British Columbia by Rasetti (1951) who considered it to be closely related to *Glossopleura walcotti.* However, pygidia of *Glossopleura walcotti* from Daugaard-Jensen Land differ in having a narrower axis, a less curved anterior margin, welldeveloped pleural furrows and a narrower border (Fig. 9E). *Glossopleura expansa* Poulsen 1927 also has a narrow axis and was placed in synonymy of *Glossopleura walcotti* by V. Poulsen (1964) and by Babcock (1994a, in part).

A similar specimen from the Spence Shale of Antimony Canyon, northern Utah, was illustrated by Campbell (1974, pl. 6, figs 7,8) as *Glossopleura* sp. undet. 1. The latter differs in having a border which becomes wider posteriorly and in preserving traces of furrows on the pleural fields not seen in the Greenland specimen. The pygidium of *Glossopleura yatesi* Robison & Babcock 2011 is closely similar to the Greenland

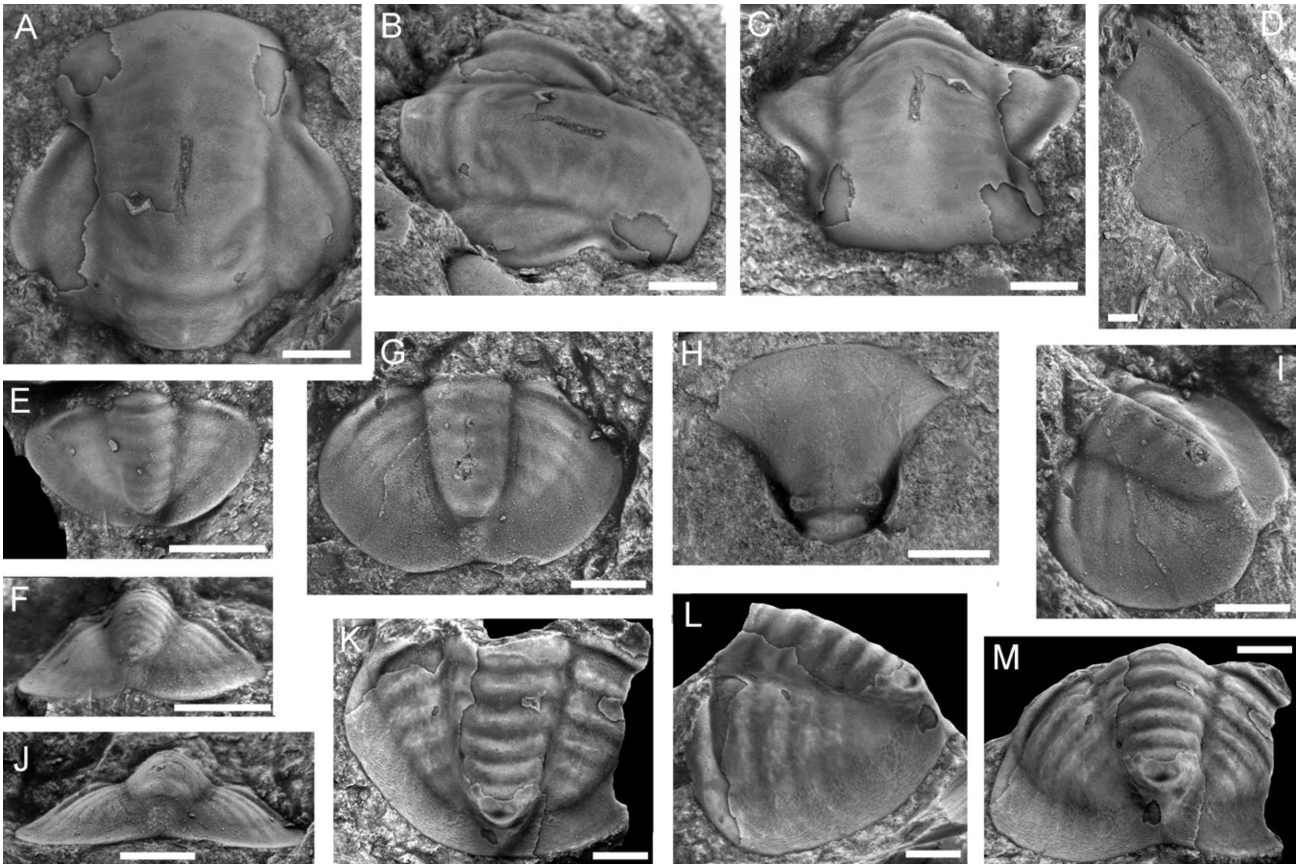

Fig. 9. Trilobites of the *Glossopleura walcotti* Biozone, Telt Bugt Formation, GGU sample 206308, Romer Søer, Daugaard-Jensen Land. **A–F**, **H**: *Glossopleura walcotti* Poulsen 1927. **A–C**: PMU 35046, testate cranidium. **D**: MGUH 33500, librigena. **E**, **F**: PMU 35047, pygidium. **H**: MGUH 33501 hyperstome. **G**, **I**, **J**: Pygidium sp. 1, MGUH 33502. **K–M**: *Fieldaspis* cf. *bilobata* Rasetti 1951. Pygidium, MGUH 33503. Scale bars: 2mm.

material but this species from the Spence Shale of the Wellsville Mountains of Utah is readily distinguished by the long medial spines on axial rings in the thorax (Robison & Babcock 2011, fig. 6).

Glossopleura cf. *boccar* Walcott 1916
Fig. 10A–C, G, J

Figured material. Cranidium, MGUH 33504, and pygidium, MGUH 33505, both from GGU sample 206303, Telt Bugt Formation, Romer Søer. Miaolingian Series, Wuliuan Stage, *Glossopleura walcotti* Biozone.

Discussion. The cranidium is narrower, with shallowly concave sides, and interocular areas are of similar width to cranidia referred to *Glossopleura walcotti* (Fig. 9A), but with slightly more deeply incised palpebral furrows. Glabellar furrows are weakly expressed, except for the obliquely directed pair of posterior furrows (Fig. 10A,B,J), and the slightly sinuous palpebral lobes contact the glabella at an acute angle, as is the case in *Glossopleura walcotti* (Fig. 10L). The palpebral lobes terminate posteriorly at the posterior glabellar furrows (Fig. 10J) but closer to the occipital ring in *Glossopleura walcotti* (Fig. 10L).

The pygidium is semicircular, with length (sag.) about three quarters of width (Fig. 10G); it is inflated, with only a narrow, ill-defined, border. Its maximum width is at the lateral angulations, at about one third of the distance from the anterior to the posterior margins. The axis is slightly shorter than pygidial length; its width slightly less than that of the upper surface of the pleural areas. There are six axial rings with deep pits at the junction betweeen the axial furrows and the axial border furrow. Pleural surfaces are smooth between broad, shallow, pleural furrows, although traces of furrowing can be seen as the pleural areas pass onto the border.

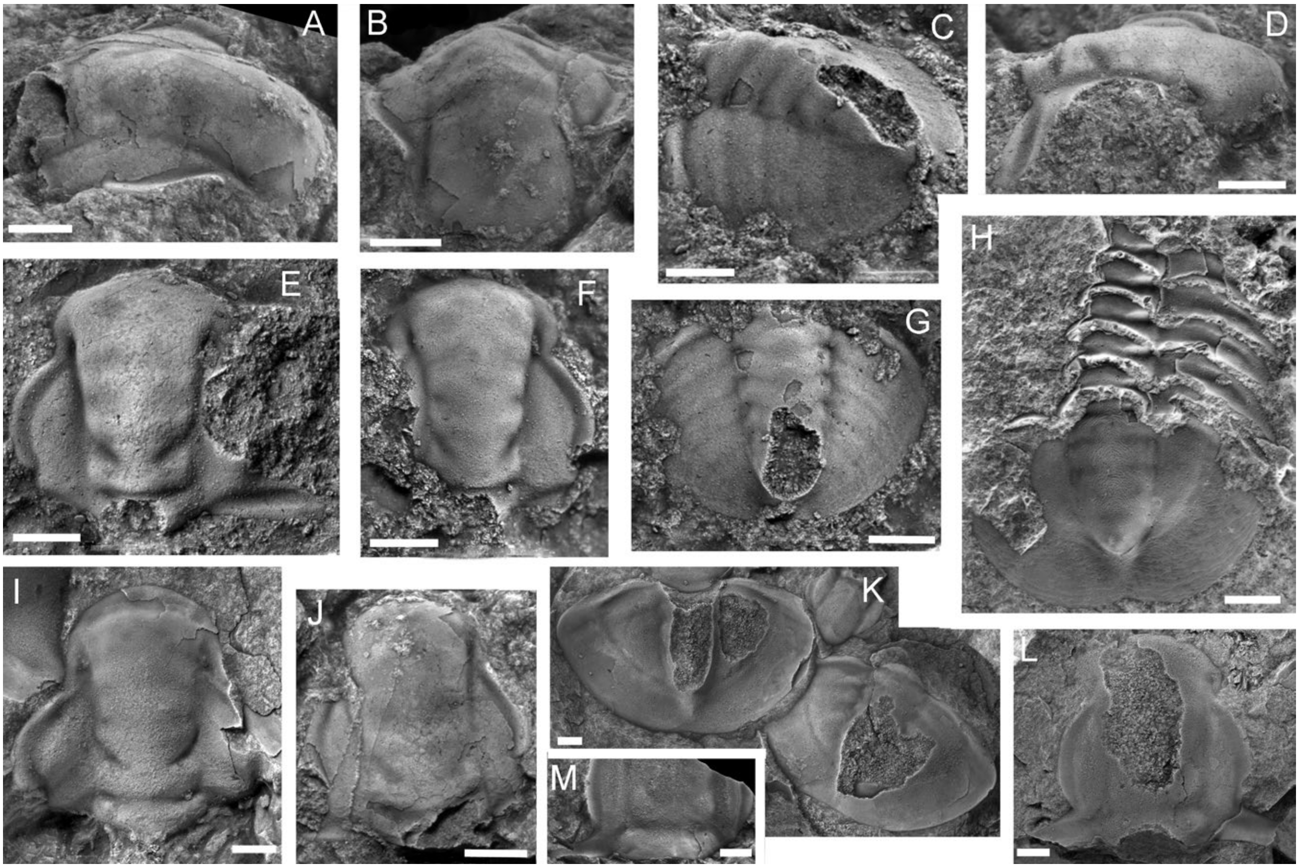

Fig. 10. Trilobites of the *Glossopleura walcotti* Biozone, Telt Bugt Formation, GGU sample 206303 and 206309. Romer Søer, Daugaard-Jensen Land. **A–C**, **G**, **J**: *Glossopleura* cf. *boccar* Walcott 1916, from GGU sample 206303. **A**, **B**, **J**: cranidium, MGUH 33504 from GGU sample 206303. **C**, **G**: pygidium, MGUH 33505 from GGU sample 206303. **H**: *Glossopleura stokiensis* Rasetti 1951, pygidium with thoracic segments, MGUH 33506 from GGU sample 206303. **D–F**, **I**: *Polypleuraspis*? sp., from GGU sample 206303. **D**, **E**, cranidium, MGUH 33507. **F**: cranidium, MGUH 33508. **I**: MGUH 33509 from GGU sample 206309, cranidium. **K–M**: *Glossopleura walcotti* Poulsen 1927, from GGU sample 206309. **K**: pygidia, MGUH 33510 and MGUH 33511. **L**: cranidium, MGUH 33512. **M**: occipital area of cranidium, MGUH 33513. Scale bars: 1 mm (C–G, I), 2 mm (A, B, H, J–M).

Most pygidia illustrated as *Glossopleura boccar* by Rasetti (1951, pl. 24, figs 2,4,5) from the Mount Whyte Formation of British Columbia are similar in terms of the width of the axis but they are less inflated and transversely wider on account of the greater breadth of the border. Pygidia from the Great Basin referred to *G. boccar* by Sundberg (2005, figs 6.13,6.14) have a shorter axis and wider border. Pygidia of *Glossopleura arrecta* Resser 1939a from the Wasatch Mountains of western USA (Resser 1939a; Campbell 1974) are inflated, with a similar broad axis, but have a wider border and obscure furrowing. Pygidia of *Glossopleura walcotti* from Telt Bugt, and from the Cape Wood Formation of Inglefield Land and Bache Peninsula, are readily distinguished by their narrower axis, more lenticular form, and well-developed wide border (Fig. 9E,F,J; Fig. 10K).

Genus *Polypleuraspis* Poulsen 1927

Type species. *Polypleuraspis solitaria* Poulsen 1927 from the lower Cape Wood Formation, Kap Kent, Inglefield Land.

Discussion. *Polypleuraspis* Poulsen 1927 was originally described from a single pygidium from the lower Cape Wood Formation, Kap Kent, Inglefield Land (Fig. 1A, locality 2). V. Poulsen (1964) referred cranidia of *Glossopleura longifrons* Poulsen 1927 from boulders of the Cape Wood Formation at Kap Frederik VII, Inglefield Land to *Polypleuraspis solitaria* and the relationship to *Glossopleura longifrons* was re-evaluated by Peel (2020b). V. Poulsen (1964) referred, however, to abundant additional material from Bache Peninsula (Fig. 1A, locality 3).

Peel (2020b) revised *Polypleuraspis*, describing the type specimen of *Polypleuraspis solitaria* and additional material from the Cape Wood Formation of Inglefield Land and Bache Peninsula. The species was not recognised in Daugaard-Jensen Land, where a new species, *Polypleuraspis glacialis* Peel 2020b, was described from the Telt Bugt Formation.

A feature of *Polypleuraspis* and other similar cranidia is the relationship between the occipital ring and the interocular area. The axial boundary furrow is very shallow or even discontinuous at the posterior margin of the cranidium, such that the antero-lateral margins of the occipital ring continue as an arch into the interocular area at its postero-axial corner (Figs 6L, 8L). The prominent border furrow paralleling the posterior margin of the fixed cheeks is not continuous across the axis, via the occipital furrow, but curves as if to pass around the posterior margin of the occipital ring. Thus, the posterior border furrow consists of a distinct groove or channel on each fixed cheek, which curves to join the posterior margin of the cranidium at the line of the axial groove.

***Polypleuraspis glacialis* Peel 2020b**

Figs 8D, E, I–O

2020b *Polypleuraspis glacialis* Peel, p. 22, fig. 2A–C, E–J, M,O,R.

Holotype. Pygidium, PMU 35038 from GGU sample 206308 (Fig. 8I,N,O), Telt Bugt Formation, Romer Søer. Miaolingian Series, Wuliuan Stage, *Glossopleura walcotti* Biozone.

Figured material. In addition to the holotype, cranidia: PMU 35037 and PMU 35039; pygidium, PMU 35040, all from GGU sample 206308, Telt Bugt Formation, Romer Søer. Miaolingian Series, Wuliuan Stage, *Glossopleura walcotti* Biozone.

Discussion. *Polypleuraspis glacialis* is known from about ten cranidia and fragments of several pygidia in GGU sample 206308. It differs from the type species *Polypleuraspis solitaria* in lacking axial nodes on its more elevated pygidium (Peel 2020b).

***Polypleuraspis*? sp.**

Fig. 10D–F, I

Material. Cranidia: MGUH 33507 and MGUH 33508 from GGU sample 206303; MGUH 33509 from GGU sample 206309. Telt Bugt Formation, Romer Søer. Miaolingian Series, Wuliuan Stage, *Glossopleura walcotti* Biozone.

Discussion. The three specimens placed here are not associated with pygidia of *Polypleuraspis* in the available small collections and differ from *Polypleuraspis glacialis* and *Polypleuraspis solitaria* in terms of glabellar characters. The glabella is more slowly expanding, with straight (Fig. 10E) or shallowly concave sides (Fig. 10F). The anterior margin of the glabella passes abruptly into a narrow anterior border (Fig. 10F) with a convex anterior margin (Fig. 10I), in which respect it is similar to *Bathyuriscus* Meek 1873, whereas the transition in *Polypleuraspis glacialis* and *Polypleuraspis solitaria* is less sharply defined. The palpebral lobes are more uniformly convex (Fig. 10E) than in both these described species.

Family Zacanthoididae Swinnerton 1915

Genus *Fieldaspis* Rasetti 1951

Type species. *Fieldaspis furcata* Rasetti 1951 from the

Mount Whyte Formation (Miaolingian) of British Columbia.

Discussion. The dificulties of delimiting dolichometopine and zacanthoidean genera on the basis of the cranidium alone are well known (Rasetti 1951; Palmer & Halley 1979). Reference of disarticulated sclerites from GGU sample 206307 to *Fieldaspis* relies heavily on the characters of the weakly bilobed pygidium, although similar, less strongly bilobed, lenticular pygidia with fewer rings are present in *Poliella* Walcott 1916 (Sundberg & McCollum 2003a).

***Fieldaspis*? *iubilaei* sp. nov.**
Fig. 6D–N

Derivation of name. From the latin, iubilaeum, meaning jubilee year, commemorating *Jubilæumsekspeditionen Nord om Grønland 1920–23* (Danish Bicententenary Jubilee Expedition North of Greenland 1920–23), 100 years after its expedition members arrived in the Telt Bugt area of Daugaard-Jensen Land.

Holotype. MGUH 33476 from GGU sample 206307. Telt Bugt Formation, Romer Søer. Miaolingian Series, Wuliuan Stage, *Plagiura–Poliella* Biozone.

Figured material. In addition to the holotype: cranidia: MGUH 33479 and MGUH 33480; pygidium: MGUH 33481; hypostomes: MGUH 33478 and MGUH 33477. All from GGU sample 206307, Telt Bugt Formation, Romer Søer. Miaolingian Series, Wuliuan Stage, *Plagiura–Poliella* Biozone.

Diagnosis. Glabella with poorly defined glabellar furrows; occipital ring extended posteriorly, with low posterior spine. Anterior border narrower in front of glabella; strongly convex in small specimens, becoming wider (sag.) and flattened in large specimens. Pygidium about twice as wide as long, with maximum width reached at about two thirds of distance from anterior to posterior margin; bilobed with broad, distinct, medial notch in posterior margin. Axis prominent with three rings and terminal axial piece; pleural furrows well marked, effaced on broad border.

Description. The cranidium is sub-trapezoidal in shape with its overall length (sag.) about four-fifths of width (trans.) and the glabella occupying almost all of the cranidial length. Glabella parallel-sided at its posterior, expanding slightly at about mid-length from the occipital ring to the front border; the anterior is uniformly convex (Fig. 6D). However, in a small specimen (Fig. 6L), the glabella is almost parallel-sided at all stages and the transition to the convex anterior is abrupt. In transverse profile, the glabella is uniformly convex and raised above the shallowly convex interocular areas and especially the anterior areas of the fixed cheeks. Three pairs of obscure short glabellar furrows are present, of which the posteriormost pair is strongly oblique. The occipital furrow is broad and shallow (Fig. 6K), curved towards the anterior medially, but deeper and narrower in the small specimen (Fig. 6L). The occipital ring expands medially and terminates in a prominent node or short spine (Fig. 6N). The axial border furrow is narrow and deep, particularly anterior to the eye ridges where the interocular surface steps down abruptly to the anterior fixed cheek (Fig. 6J,K), and where a fossula is developed on each side of the glabella. At the occipital ring, the axial border furrow is shallow as the interocular area and the occipital ring are conjoined.

The anterior area is broad and shallowly convex between the axial border furrow and the anterior margin (Fig. 6D), although it is narrow and more strongly convex in the small specimen (Fig. 6L). Preocular areas are wide, with sutures curving in to join the eye ridge–palpebral lobe at almost half of the transverse width of the interocular area. Interocular areas, at their point of maximum width, are about two thirds width (trans.) of the glabella. Deep, wide palpebral furrows narrow anteriorly before joining the anterior border furrows (Fig. 6J). The anterior limit of the palpebral lobes is not well known, but seemingly close to the axial border furrow; in the small specimen (Fig. 6L) the lobes are of uniform curvature and width and extend from close to the axial border furrow to their posterior termination at the occipital furrow. Posterior fixed cheek narrow (sag.), lateral extent not known, border furrow terminating against the conjoined occipital ring and interocular area (Figs 6J,L,N).

Free cheeks and thorax are not known. Hyperstome triangular with broadly extended uniformly convex anterior margin delimited from anterior lobe by a deep groove that is excavated medially. Anterior border shallowly convex, sloping in towards anterior border groove (Fig. 6F). Lateral border areas narrow adjacent to middle furrows, with tubercles developed at posterior of anterior lobe. Small, triangular posterior lobe separated from globose anterior lobe by broad shallow transverse furrow (Fig. 6G).

Pygidium elliptical, with maximum transverse width almost twice length (sag.), and reached at about two thirds of distance from anterior to posterior margin. Anterior margin with almost perpendicular junction between pleural areas and lateral margin sloping towards point of maximum transverse width. Axis prominent, wide, convex, about half of length (sag.) of pygidium, with three axial rings and short tail piece. Pleural areas triangular, with prominent furrows and, distally, weakly marked pleural grooves. Posterior border with broad medial notch.

Ornamentation of fine pits and granules, the latter conspicuous on the small specimen (Fig. 6L).

Discussion. The few available specimens suggest that the development of the broad and unusually flattened frontal area of *Fieldaspis*? *iubilaei* is ontogenetically controlled. A small specimen (Fig. 6L, length 3.3 mm) shows a convex rim separated from the front of the glabella by a groove of similar width. The rim is less strongly convex in a larger specimen (Fig. 6N, length about 6.4 mm) and only shallowly convex in the holotype (Fig. 6D, length about 13.1 mm).

The type species and other species of *Fieldaspis* described by Rasetti (1951) differ from *Fieldaspis*? *iubilaei* in that their upturned anterior border is almost in contact with the front of the glabella, which consequently has a rather angular transition to the glabellar sides. A distinct anterior border furrow is present in small specimens assigned to *Fieldaspis*? *iubilaei*, but the glabellar front in the holotype is more rounded and slightly overhangs the flattened preglabellar area. The presence of a definite border in *Fieldaspis*? *nahanniensis* Norford 1968 from the Nahanni River of the District of Mackenzie caused Norford (1968) to question the assignment to *Fieldaspis*, as is also the case here.

Fieldaspis? *nahanniensis* is similar to *Fieldaspis*? *iubilaei* in the broad and deep palpebral furrows but has a more strongly expressed occipital furrow and a long occipital spine. Its anterior border is wide (sag.) and shallowly convex, although it may be broken away in some specimens figured by Norford (1968, pl. 4, fig. 3) and appear to be acutely upturned, thereby resembling *Fieldaspis* from Mount Whyte. In *Fieldaspis*? *iubilaei* the border in front of the glabella is flattened, only shallowly convex.The pygidium of *Fieldaspis*? *iubilaei* is similar to that of *Fieldaspis bilobata* Rasetti 1951 from the Mount Whyte Formation of British Columbia and *Fieldaspis* cf. *bilobata* from GGU sample 206308 but has fewer rings and a wider brim. The brim is also wide in the pygidium of *Fieldaspis*? *nahanniensis* from the Nahanni River of the District of Mackenzie but this has one fewer axial ring and more steeply sloping, straight, furrows crossing the pleural surfaces.

Poliella lomataspsis Palmer *in* Palmer & Halley 1979 from the *Plagiura–Poliella* Biozone (*Poliella denticulata* Biozone of McCollum & Sundberg 2007; Sundberg 2011) of the Carrara Formation in Nevada, has a more lenticular pygidium with a similar wide brim, but fewer rings. The frontal area in the holotype cranidium of *Poliella lomataspsis* is narrow with an upturned rim (Palmer & Halley 1979, pl. 6, fig. 2), unlike the flat preglabellar area in the holotype of *Fieldaspis*? *iubilaei* (Fig. 6D,J,K). The frontal area of the cranidium of *Poliella leipalox* Fritz 1968, from the Pioche Shale of Nevada, is flattened, as in *Fieldaspis*? *iubilaei*, but not strongly delimited from the front of the glabella.

***Fieldaspis* cf. *bilobata* Rasetti 1951**
Fig. 9K–M

Material. Pygidium, MGUH 33503 from GGU sample 206308. Telt Bugt Formation, Romer Søer, Daugaard-Jensen Land. Miaolingian, Wuliuan Stage, *Glossopleura walcotti* Biozone.

Discussion. The length (sag.) of this single specimen is about two thirds of its maximum width (trans.), the latter occurring just anterior of mid-length. The anterior margin is convex, angled at the margin of the pleural areas; the posterior margin is uniformly convex (Fig. 4K) but arched medially (Fig. 4L,M). The axis is strongly convex, wider than the pleural areas, seemingly consisting of five rings and a small tail piece, with a low triangular ridge persisting across the border. The pleural areas steepen abruptly with passage onto the outward-sloping, broad, but shallowly concave border. Furrows are broad and deep, but hardly discernible except on the anterior parts of the border (Fig. 9L).

In terms of shape and strong expression of the rings and furrows, the pygidium is close to *Fieldaspis bilobata* Rasetti 1951 from the Mount Whyte Formation of British Columbia, although the latter shows greater curvature of the furrows on the pleural areas and has one less axial ring. The border and distal portions of the pleural areas of the pygidium (Fig. 9L) show the same cellular ornamentation as the single cranidium described here as *Poliella*? sp. (Fig. 8A), suggesting that the two may represent the same taxon. The latter, however, shows a much longer (sag.) preglabellar area and more prominent border than the narrow, abruptly upturned anterior margin of *Fieldaspis bilobata* illustrated by (Rasetti 1951), while the pygidium shows a greater number of axial rings than described *Poliella* species (Rasetti 1951; Sundberg & McCollum 2003a).

Specimens from the Pioche Shale assigned to *Fieldaspis bilobata* by Sundberg & McCollum (2003a) have a more angulated anterior margin, shorter axis, fewer axial rings and a much more pronounced lobation of the border than either Rasetti's (1951) material from British Columbia or the specimen from Romer Søer.

Fieldaspis cf. *bilobata* differs from the pygidium of *Fieldaspis*? *iubilaei* (Fig. 6H) in terms of its greater number of rings and furrows, the axis extending almost to the posterior margin and the narrower border without a substantial median indentation. The morphological differences are substantial but not greater than those encompassed in species within the concept originally applied to *Fieldaspis* by Rasetti (1951).

V. Poulsen (1964, pl. 1, fig. 9) assigned a fragment of a pygidium from the basal Cape Wood Formation Blomsterbækken, Inglefield Land, (Fig. 1A, locality 2) to *Fieldaspis* in which the margin from anterior to posterior is uniformly convex, the border lobes long (sag.) and only two rings are present on the axis. In these aspects it is more closely similar to the specimens illustrated by Sundberg & McCollum (2003a), and unlike the material from the Telt Bugt or Mount Whyte formations.

Order Ptychopariida Swinnerton 1915

Suborder Ptychopariina Richter 1932

Family Ptychopariidae Matthew 1887

Genus *Kochiella* Poulsen 1927

Type species. *Kochiella tuberculata* Poulsen 1927 from the Cape Kent Formation (Cambrian Series 2), Inglefield Land, North-West Greenland.

Discussion. Poulsen (1927) assigned four species from the Cape Kent Formation to *Kochiella*, which is a ptychoparioid characterised by a rather flat cephalon with extended lateral areas and a distinctive ornament of scattered, large tubercles. He distinguished *Kochiella* from *Amecephalus* Walcott 1924 by the way in which the frontal groove in *Kochiella* curves back towards the glabella as it crosses the axial plane, while it remains parallel to the anterior margin in the latter genus. No pygidia were assigned originally to *Kochiella*, but Resser (1935) referred a pygidium described as *Crepicephalus* cf. *cecinna* Walcott 1917 by Poulsen (1927, pl. 16, figs 17 and 18) to the type species. Rasetti (1951) questioned the certainty of this assignment but V. Poulsen (1964) accepted Resser's (1935) action, considering the scattered tubercles on the bilobed pygidium to indicate its assignment to *Kochiella*. V. Poulsen (1964) also referred to *Kochiella* a bilobate pygidium illustrated but not described by Poulsen (1927, pl. 16, fig. 19), although this action seems questionable. Sundberg & McCollum (2002) considered the pygidium that Poulsen (1927, pl. 16, figs 17 and 18) referred to *Crepicephalus* cf. *cecinna* Walcott 1917 to belong probably in their new genus *Hadrocephalites*, but noted that cranidia of this had not been identified in material illustrated by Poulsen (1927).

Kochiella, as originally described by Poulsen (1927), was revised by V. Poulsen (1964) who reduced the four original species from the Cape Kent Formation (Cambrian Stage 2) to three, but he gave no additional illustrations. V. Poulsen (1964) concluded that *Kochiella*? *maxeyi* Rasetti 1951, the type species of *Eiffelaspis* Chang 1963, should be placed in a new genus, although Sundberg & McCollum (2002) regarded it as a junior synonym of *Kochiella*. V. Poulsen (1964) also excluded *Kochiella crito* (Walcott 1917) of Resser (1935), *Kochiella*? *pennsylvanica* Resser 1938 and *Kochiella fitchi* (Walcott 1887) of Lochman (1956) from *Kochiella* but Sundberg & McCollum (2002) commented that poor preservation prevented proper generic assignment.

Sundberg & McCollum (2002) emended *Kochiella* in reviewing species from western North America, which they noted were restricted to early Delamaran strata (late Stage 4) and Miaolingian. Pratt & Bordonaro (2014) reviewed *Kochiella* in describing Miaolingian trilobites from the Precordillera of western Argentina. Much of the discussion of *Kochiella* by these authors and V. Poulsen (1964) has centred on the nature of the pygidium. No relevant pygidia occur in the small collection from GGU sample 206307 from the Telt Bugt Formation.

Kochiella sp.
Fig. 6A–C, O

Figured material. Cranidia: MGUH 33473 and 33474, and fragment of free cheek, MGUH 33475 from GGU sample 206307, Telt Bugt Formation, Romer Søer. *Plagiura–Poliella* Biozone.

Description. This species is represented by three cephalic fragments, of which an external mould, illustrated as a digitally produced cast (Fig. 6A,B), is the most complete. In this, the posterior fixigenae are not preserved but the transverse (trans.) distance between the outer margins of the palpebral lobes is 1.5 times the length of the cranidium. The glabella, including occipital ring, comprises about 60 % of the cranidial length (15 mm), measured along the axial plane. The cranidial profile in lateral perspective shows the shallowly convex glabella curving along the sagittal line from the short occipital spine (Fig. 6B, os) to the frontal area, where it becomes uniformly concave towards the anterior margin. A border furrow is hardly discernible in the preglabellar field (Fig. 6A) but appears laterally at the junction between the preocular area and the border.

The glabella is broad, length inclusive occipital ring equal to width, tapering forward with straight or shallowly inflected (Fig. 6C) sides from the occipital ring to about half its width at the rounded anterior margin. The axial border furrow around the glabella is narrow and shallow, obscure in front of the glabella. The occipital furrow is shallow, but complete; there are three pairs of shallow glabellar furrows. The occipital ring is narrow (sag.) with a median tubercle. Each shallowly convex inner ocular area, measured at the outer margin of the palpebral lobe, is somewhat wider (trans.) than the glabella at the same point. The surfaces slope in towards the axial border furrow such that the palpebral lobes are strongly elevated (Fig. 6B, pl). The palpebral lobes are short, much less than half the length (sag.) of the glabella, raised, and strongly crescentic (Fig. 6C). An eye ridge consisting of two narrow ridges joins the anterior margin of each palpebral lobe to the axial border furrow in front of the glabella (Fig. 6A). Posterior limb of fixigenae poorly known in terms of its lateral extent; its posterior margin straight with the border furrow curving posteriorly to join the posterior margin rather than joining the axial border furrow. Thorax and pygidium not known, librigenae represented by a fragment of the border with well preserved ornamentation (Fig. 6O).

Ornamentation finely granular, the individual granules sometimes arranged in lines in an anastomising pattern (Fig. 6O). Tubercles of two size orders are scattered over the surface, but concentrated around the sclerite margins (Fig. 6O), where large tubercles are surrounded by a granule-free collar and may be perforate.

Discussion. Although fragments, the three available specimens of *Kochiella* sp. preserve exquisite details of the ornamentation of tubercles set against a background of fine granules (Fig. 6A–C,O).

Of particular note in the two cranidial fragments is the structure of the eye ridges, each of which consists of two parallel, narrow, rounded ridges, of which the posterior one is slightly more prominent (Fig. 6A,B, er). A similar structure has not been discerned in illustrations of Poulsen (1927), Sundberg & McCollum (2002) or Pratt & Bordonaro (2014) where the eye ridges are single and broader. Similar double eye ridges were described in *Pianaspis sors* (Öpik 1961) from the Miaolingian of Queensland and Tasmania by Öpik (1961, pl. 15, fig. 2) and by Bentley & Jago (2014). Öpik (1967, pl. 17, figs 1–3; pl. 18, fig. 3; fig. 89) also described double eye ridges in *Pagodia (Idamea) baccata* Öpik 1967 from the Mindyallan of Queensland, while Palmer (1968, pl. 5, fig. 9) illustrated similar double ridges in *Prohedinia brevifrons* Palmer 1968 from the Miaolingian of Akaska. Their presence may be inferred in an internal mould referred to *Amecephalus arrojosensis* (Lochman *in* Cooper *et al.* 1952) illustrated by Sundberg & McCollum (2000, figs 5.1,5.2) from the Comet Shale Member of the Pioche Shale of Nevada.

In terms of the concavity of the frontal area and lack of differentiation of the preglabellar area, *Kochiella* sp. resembles *Kochiella mackenziensis* Norford 1968 from the *Plagiura–Poliella* faunule of the District of MacKenzie, but the latter has more deeply incised glabellar furrows and more dense tuberculation (Norford 1968).

The type species, *Kochiella tuberculata* Poulsen 1927 from the Cape Kent Formation of Inglefield Land, and other species described by Poulsen (1927) and Poulsen (1964) have a clearly marked border, as do specimens attributed to *Kochiella* by Sundberg & McCollum (2002). Half way between the front of the glabella and the anterior margin, a comarginal groove curves shallowly towards the posterior as it crosses the axial plane, a feature discussed both by Poulsen (1927) and V. Poulsen (1964), but this groove is medially obscure in the Telt Bugt specimen (Fig. 6A) and in most of the specimens illustrated by Norford (1968).

Amecephalus troelseni V. Poulsen 1964 from the Cape Wood Formation at Blomsterbækken, Inglefield Land (Fig. 1A, locality 2) lacks the tuberculation seen in *Kochiella* sp. It differs also in having a distinct axial border furrow in front of the glabella, with a longer (sag.) and shallowly convex preglabellar area; its eye ridges are convex towards the anterior (V. Poulsen 1964, pl. 2, figs 10–11), as distinct from straight in *Kochiella* sp. The only specimen of *Amecephalus troelseni* was derived from a loose pebble from the basal conglomerate of the *Glossopleura* Zone, which he interpreted as *Plagiura–Poliella* Zone (V. Poulsen 1964).

Genus *Caborcella* Lochman 1948

Type species. *Caborcella arrojosensis* Lochman 1948 from the middle Cambrian of Sonora, northern Mexico.

Caborcella arrojosensis Lochman 1948
Fig. 7H, I

1948 *Caborcella arrojosensis* Lochman, p. 461, pl. 70, figs 19–21.

Figured material. Cranidium, MGUH 33491 from GGU sample 212808, Telt Bugt Formation, Telt Bugt, Daugaard-Jensen Land. Miaolingian, Wuliuan Stage, *Mexicella mexicana* Biozone.

Discussion. This species is known from the illustrated specimen and an additional broken cranidium, both from GGU sample 212808. The width of the illustrated cranidium is about one third greater than its length. It is characterised by the conical glabella, which decreases in transverse width by half from posterior to anterior, and is almost as wide at its posterior as it is long (Fig. 7I). Glabellar furrows are weakly impressed and the occipital furrow is deep laterally but shallow axially, whereas it is of more uniform depth in the Mexican material figured by Lochman (1948). Ornamentation is finely granulose; large tubercles are scattered over the entire cranidium, most densely on the border and most weakly on the anterior part of the glabella and the preglabellar area.

Genus *Eokochaspis* Sundberg & McCollum 2000

Type species. *Eokochaspis nodosa* Sundberg & McCollum 2000 from the Comet Shale Member, Pioche Shale, of Nevada. Miaolingian, *Poliella denticulata* Biozone.

Eokochaspis? sp.

Fig. 7O

Figured material. Cranidium, MGUH 33493 from GGU sample 212806, Telt Bugt Formation, Telt Bugt. Miaolingian, Wuliuan, *Plagiura–Poliella* Biozone.

Discussion. This single cranidium from GGU sample 212806 has a tapering glabella with almost straight sides and effaced glabellar furrows. The occipital furrow is deep laterally and shallow medially. The occipital ring is trapezoidal in plan view, narrowing towards the posterior and seemingly with a low median node. The front margin is slightly arched medially. The frontal area is divided by a broad and shallow furrow into a steepened preglabellar field and a shallow convex border, which is more than twice the length (sag.) medially of the preglabellar field (Fig. 7O). Fixigenae are of similar transverse width to the corresponding glabellar width. The palpebral lobes are small and located at mid-length (sag.) of the glabella. The prominent posterior border furrows are essentially continuous with the occipital furrow; posterior limbs of the fixigenae appear to be short and robust. The surface is slightly weathered, but seemingly a wrinkled granular ornamentation was developed on the glabella and fixigena.

In general proportions, the cranidium resembles *Eokochaspis*? *cabinensis* Sundberg & McCollum 2003a from the Log Cabin Member (Wuliuan Stage, *Poliella denticulata* Biozone) of the Pioche Shale, although the glabella narrows more rapidly and the anterior fixigenae are proportionately slightly wider in that species. It is also similar to a small cranidium of *Mexicella robusta* Sundberg & McCollum 2000 from the *Eokochaspis nodosa* Biozone, although the anterior brim is more elliptical, and the posterior border furrows more strongly defined.

Genus *Mexicella* Lochman 1948

Type species. *Mexicella mexicana* Lochman 1948, from the Arrojos Formation of Sonora, northern Mexico.

Mexicella cf. *robusta* Sundberg & McCollum 2000

Fig. 7N

Figured material. Cranidium, 33492 from GGU sample 212806, Telt Bugt Formation, type locality, Telt Bugt, Daugaard-Jensen Land. *Plagiura–Poliella* Biozone.

Discussion. The only known specimen is a partially exfoliated cranidium that compares with specimens illustrated by Sundberg & McCollum (2000, fig. 13) from the Pioche Shale (*Amecephalus arrojosensis* Biozone) in Nevada in terms of the shape of the glabella. The glabella is more strongly tapering, with shallowly convex sides, in the type species *Mexicella mexicana* Lochman *in* Cooper *et al.* (1952) from the Arrojos Formation in Sonora, Mexico. Additionally, the frontal slope is less steep in the Greenland specimen than in some illustrated specimens of *Mexicella mexicana* from Mexico (Lochman *in* Cooper *et al.* 1952). The cranidium from the Telt Bugt Formation is about 9.5 mm long, about two thirds of the size of the largest Sonora specimens, but about the same size as specimens of *Mexicella robusta* from Nevada. The fine radial venation is expressed most clearly in the preglabellar area. Scattered coarse granules noted by Palmer & Halley (1979, p. 109) in specimens from Mexico and the Carrara Formation in Nevada and California (*Albertella* Biozone), and a central tubercle on the occipital ring have not been observed. *Mexicella granulata* Eddy & McCollum 1998 from the Pioche Shale (*Albertella* Zone) of south-eastern Nevada has a more pointed anterior margin and longer (sag.) pre-frontal field.

Mexicella robusta occurs in the *Amecephalus arrojosensis* Biozone of Nevada, equivalent to the middle *Plagiura–Poliella* Biozone (Fig. 4). In terms of the international standard (Geyer 2019), the biozone is pre-Miaolingian, assigned to uppermost Stage 4 of Cambrian Series 2.

Genus *Plagiura* Resser 1935

Type species. *Ptychoparia*? *cercops* Walcott 1917 from the Mount Whyte Formation, British Columbia.

Plagiura? sp.

Fig. 6P

Figured material. Cranidium, 33482 from GGU sample 206307, Telt Bugt Formation, Romer Søer. *Plagiura–Poliella* Biozone.

Discussion. Three broken cranidia from GGU sample 206307 are referred to an undetermined species, which is only questionably referred to *Plagiura* on account of its longer palpebral lobes. The illustrated specimen (Fig. 6P) has a narrower glabella, with less rapidly tapering sides and more rounded front than specimens from the Mount Whyte Formation of British Columbia, referred by Rasetii (1951, 1957) to *Plagiura cercops* (Walcott 1917), or from species described from the Carrara Formation (Palmer & Halley 1979) and the Log Cabin Member of the Pioche Shale (Sundberg & McCollium 2003a) of Nevada.

Family Alokistocaridae Resser 1939b

Genus *Ehmaniella* Resser 1937

Type species. *Crepicephalus* (*Loganellus*) *quadrans* Hall & Whitfield 1877, from the Spence Shale (Miaolingian) of Utah, USA.

***Ehmaniella sermersuaqensis* Peel 2020a**
Fig. 12A, C, D, I

2020a *Ehmaniella sermersuaqensis* Peel, p. 6, fig. 3A–J, L.

Holotype. Cranidium, PMU 35701 (212812.20 D) from GGU sample 212812, Telt Bugt Formation, Telt Bugt. Miaolingian, Wuliuan Stage, *Ehmaniella* Biozone.

Figured material. In addition to the holotype, cranidium, PMU 35698; pygidia: PMU 35693 and PMU 35700, all from GGU sample 212812. Telt Bugt Formation, Telt Bugt.

Discussion. *Ehmaniella sermersuaqensis* is characterised by its narrow (sag.), convex preglabellar field, without a sharply defined border furrow, passing into a broad (sag.), concave border (Peel 2020a). The transversely elliptical pygidium has five or six rings and a well-developed concave border, which differentiates it from other previously described species of *Ehmaniella* (Sundberg 1994).

***Ehmaniella tupeqarfik* sp. nov.**
Fig. 11A, D–I

Holotype. Cranidium, MGUH 33515, from GGU sample 212873, Telt Bugt Formation, Telt Bugt. Miaolingian, Wuliuan Stage, *Ehmaniella* Biozone.

Figured material. In addition to the holotype, cranidia: MGUH 33514, MGUH 33516; pygidia: MGUH 33517, MGUH 33518, all from GGU sample 212873, Telt Bugt Formation, Telt Bugt. Miaolingian, Wuliuan Stage, *Ehmaniella* Biozone.

Derivation of name. From the Greenlandic word *tupeqarfik*, meaning tent place (Danish: teltplads), referring to the locality at Telt Bugt with numerous palaeo-eskimo archaeological remains (Peel & Frykman 1975).

Diagnosis. Pygidium transversely elliptical, with lateral angulations lying at about half of its length (sag.). Axis strongly convex with five? or six axial rings. Pleural areas becoming steeply convex before passage into the wide concave border, with furrows strongly incised at transition to border, extending well into the border area, and a narrow groove on the pleural surfaces. Anterior cranidial area with narrow preglabellar field separated from shallowly convex, outward sloping brim by a well-defined but shallow groove which curves forward in front of glabella.

Description. Cranidium sub-trapezoidal with length (sag.) almost three quarters of width (trans.); frontal margin uniformly convex with crescentic brim. Axial border furrow well defined, deep, shallowing in front of glabella. Glabella conical, with straight sides and rather angular transition to the shallowly convex front. Glabella with three pairs of broad, shallow furrows that may be effaced; the posterior glabellar furrows are strongly oblique. Occipital ring narrow laterally, trapezoidal and broadly convex, with small node; occipital furrow broad, wave-formed in dorsal view (Fig. 11D). Frontal area divided into the shallowly convex, outward sloping brim and convex anterior preglabellar field by a well defined but shallow groove that shallows slightly and curves forward in front of the glabella. Preocular areas usually slightly narrower (trans.) than anterior glabella; sutures curving in to meet palpebral lobes at right angles.

Broad, shallowly convex eye ridges terminate anteriorly at the axial border furrow and continue posteriorly into palpebral lobes, which increase in relief posteriorly. Palpebral lobes long, extending over two thirds of glabellar length from the point where the anterior branches of the suture contact the eye ridges to just anterior of occipital furrow. Palpebral furrows broad and shallow. Interocular areas convex, sloping in towards axial furrow, their maximum transverse width about half of corresponding glabellar width. The interocular areas are strongly elevated above the palpebral furrow at the posterior of palpebral lobe (Fig. 11E), but shallow forwards. Posterior fixigenae stout, triangular and somewhat shorter (trans.) than corresponding glabellar width (Fig. 11D); posterior furrow prominent. Thorax and free cheeks not known.

The pygidium is transversely elliptical, with length (sag.) about half of width (Fig. 11G,I). The lateral angulations, at the point of maximum width (trans.), lie at about half the length (sag.). Axis strongly convex with five? or six axial rings, becoming less clearly defined towards the posterior termination. Pleural areas are initially shallowly convex before becoming steeply convex with passage into the wide concave border. Furrows strongly incised, slightly channelled, deepened to form pits at the transition to border, and extending well into the border area. Pleurae with shallow groove near posterior margin (Fig. 11I).

Ornamentation usually consists of fine granules.

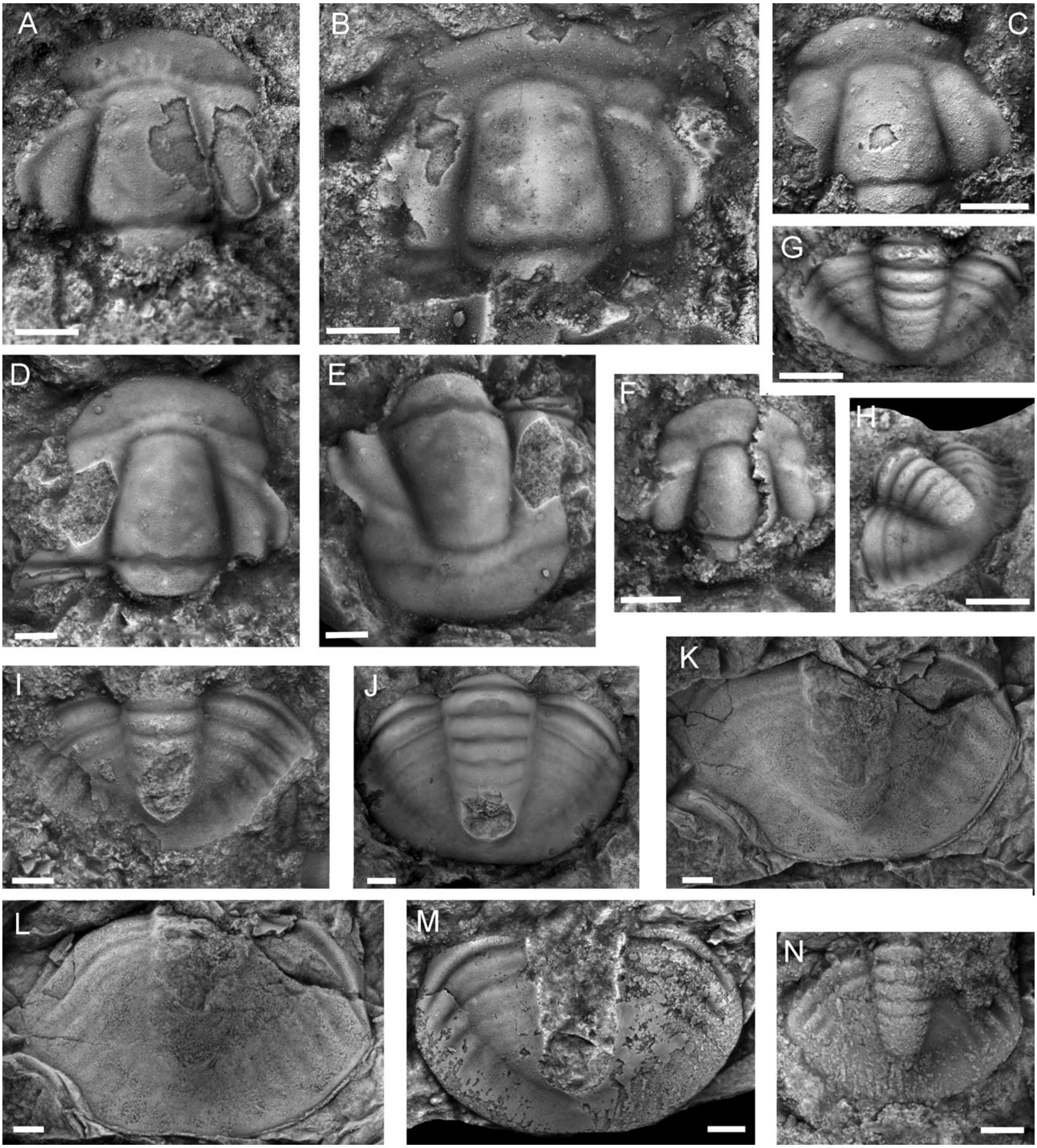

Fig. 11. Trilobites of the *Ehmaniella* Biozone, Telt Bugt Formation, GGU sample 212873, Telt Bugt, Daugaard-Jensen Land. **A**, **D–I**: *Ehmaniella tupeqarfik* sp. nov., **A**: cranidium, MGUH 33514. **D**, **E**: cranidium, holotype, MGUH 33515. **F**: cranidium, MGUH 33516. **G**, **H**: pygidium, MGUH 33517. **I**: pygidium, MGUH 33518. **B**, **C**: *Ehmaniella* sp., **B**: cranidium, MGUH 33519. **C**: cranidium with tuberculate ornamentation, MGUH 33520. **J**?, **K–N**: *Blainia* sp., **J**: tentatively assigned pygidium, MGUH 33521. **K**, **L**: pygidium, MGUH 33522. **M**: pygidium, MGUH 33523. **N**: pygidium, MGUH 33524. Scale bars: 1 mm.

Discussion. Cranidia of *Ehmaniella tupeqarfik* sp. nov. are quite common in GGU sample 212873. *Ehmaniella tupeqarfik* and *Ehmaniella sermersuaqensis* Peel 2020a are distinguished from species of *Ehmaniella* described by Sundberg (1994) from Utah and Nevada by the lenticular pygidium with its concave border. *Ehmaniella tupeqarfik* differs from *Ehmaniella sermersuaqensis* in that the axis is less tapering and the furrows on the pleural areas tend to be deepened at the transition to the border. The border furrow in the frontal area of cranidia in *Ehmaniella tupeqarfik* is more strongly delimited and tends to swing forward in front of the glabella (Fig. 11D). The brim in *Ehmaniella sermersuaqensis* is concave whereas it is shallowly convex and sloping outwards in *Ehmaniella tupeqarfik*. Ornamentation in the latter is dominated by fine granules of similar size, whereas coarser granules are characteristic of the occipital ring and central glabella of *Ehmaniella sermersuaqensis* (Fig. 12C,D).

***Ehmaniella* sp.**

Fig. 11B, C

Figured material. Cranidia: MGUH 33519 and MGUH 33520, from GGU sample 212873, Telt Bugt Formation, Telt Bugt. Miaolingian, Wuliuan Stage, *Ehmaniella* Biozone.

Discussion. A few cranidia in GGU sample 212873 develop an upturned, shallowly convex border with scattered coarse tubercles on the border and posterior glabella and fixigenae.

Genus *Clappaspis* Deiss 1939

Type species. *Clappaspis typica* Deiss 1939 from the Pentagon Shale of Montana.

Discussion. *Clappaspis* was regarded as a junior syno-

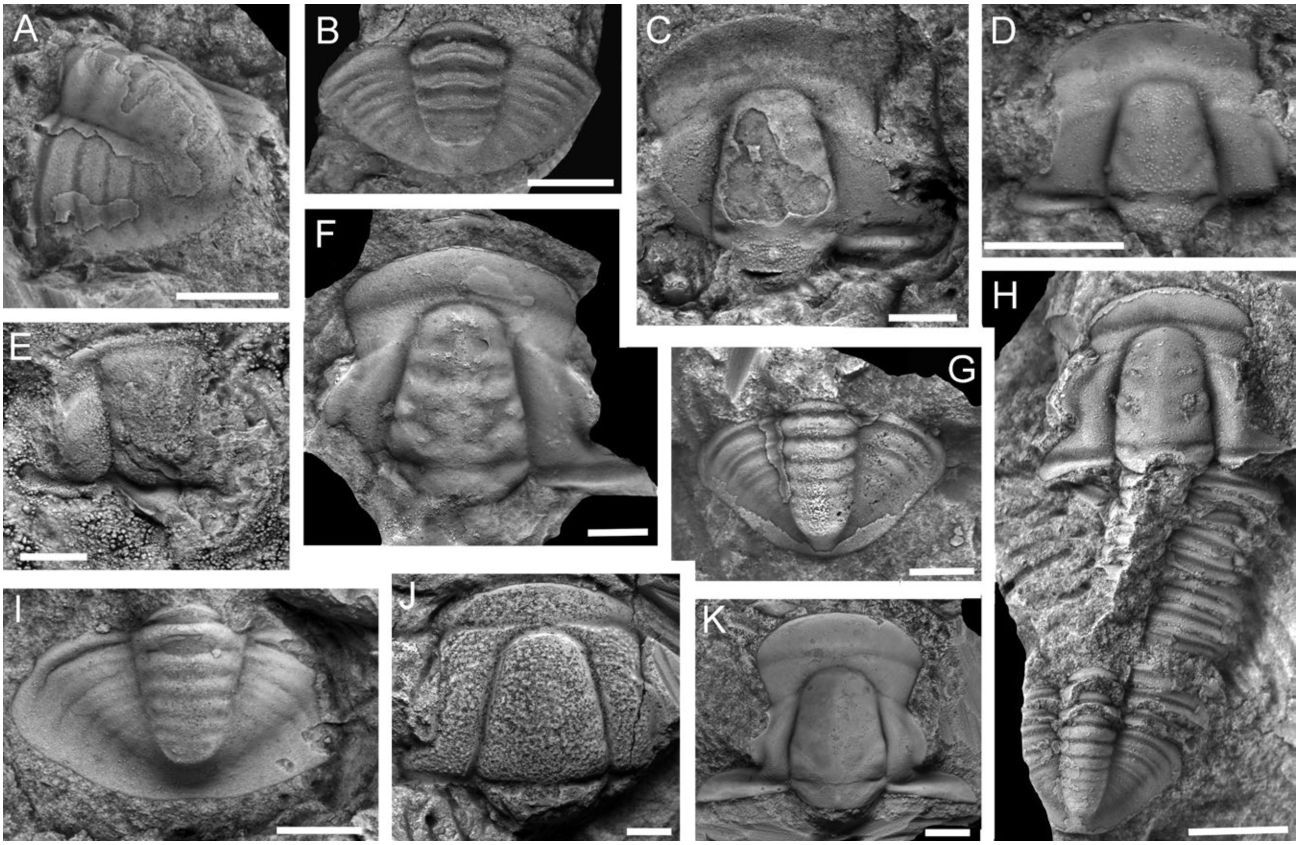

Fig. 12. Trilobites of the *Ehmaniella* Biozone, Telt Bugt Formation, Telt Bugt. Daugaard-Jensen Land. **A**, **C**, **D**, **I**: *Ehmaniella sermersuaqensis* Peel 2020a from GGU sample 212812. **A**: pygidium, PMU 35693. **C**: cranidium, PMU 35698. **D**: cranidium, PMU 35701, holotype. **I**: pygidium, PMU 35700. **B**, **J**: *Clappaspis tupeq* Peel 2020a from GGU sample 212813. **B**: pygidium, PMU 35703. **J**: cranidium, holotype, PMU 35705. **E**: *Kootenia* cf. *subequalis* Deiss 1939, cranidium, PMU 35702, from GGU sample 212812. **F**: *Blainiopsis holtedahli* Poulsen 1946, cranidium, PMU 35715 from GGU sample 212814. **G**, **H**: *Blainiopsis benthami* Poulsen 1946 from GGU sample 212814. **G**: pygidium, PMU 35714. **H**: damaged articulated specimen, PMU 35713. **K**: *Blainia* sp., cranidium, PMU 35710 from GGU sample 212813. Scale bars: 2 mm.

nym of *Ehmaniella* by Rasetti (1951) and Harrington *et al.* (1959) but Peel (2020a) employed it for *Clappaspis tupeq* Peel, 2020a on account of the occluded preglabellar field, straight anterior border furrow and relatively coarse granular ornamentation of the Telt Bugt material.

Classaspis tupeq **Peel 2020a**
Fig. 12B, J

2020a *Classaspis tupeq* Peel, p. 7, fig. 4A–J, M.

Holotype. Cranidium: PMU 35706 from GGU sample 212813, Telt Bugt Formation, Telt Bugt, Daugaard-Jensen Land.

Figured material. In addition to the holotype, pygidium, PMU 35703 from GGU sample 212813, Telt Bugt Formation, Telt Bugt. Miaolingian, Wuliuan Stage, *Ehmaniella* Biozone.

Ptychoparioid sp. indet.
Fig. 7P, Q

Figured material. Cranidium, MGUH 33494 from GGU sample 212807, Telt Bugt Formation, Telt Bugt. Miaolingian, Wuliuan Stage, *Mexicella mexicana* Biozone.

Discussion. This single cranidium, the only specimen preserved in GGU sample 212807, is noteworthy on account of its steeply inclined anterior area, with the transition between the palpebral lobes and the anterior fixigenae being close to perpendicular. Additionally, the border furrow is joined to the axial furrow in front of the glabella by a short sagittal furrow. The preglabellar area is thus divided at the median line, in which character it is reminiscent of Ehmaniellinae sp. indet. of Sundberg (1994, fig. 56) from the Eldorado Formation of Nevada. Specimens attributed to *Achlysopsis liokata* Fritz 1968 by Sundberg (2018, fig. 23) from the *Glossolpeura walcotti*/*Ptychagnostus praecurrens* Biozone of Split Mountain, Nevada, have an undivided, short, steep preglabellar field, but this is less steep than in the narrower Telt Bugt specimen.

Superfamily Asaphiscoidea Raymond 1924

Family Asaphiscidae Raymond 1924

Genus *Blainia* Walcott 1916

Type species. *Asaphiscus (Blainia) gregarius* Walcott 1916 from the Conasauga Formation of Alabama, USA.

Discussion. *Blainia* was described by Walcott (1916) from the Conasauga Formation of Alabama as a subgenus of *Asaphiscus* Meek 1873 and revised by Resser (1935, 1938) and Schwimmer (1989). Bordonaro *et al.* (2013) placed *Glyphaspis* Poulsen 1927 as a junior subjective synonym of *Blainia*, which was followed by Peel (2020a) with reservations concerning the extensive synonymy proposed by Bordonaro *et al.* (2013) on the basis of material just from Argentina. The small amount of material from the Telt Bugt Formation does not contribute to the solution of this problem.

Glyphaspis perconcava Poulsen 1927 was proposed for a single cranidium and a few pygidia from boulders of the Cape Wood Formation in Inglefield Land. V. Poulsen (1964) reported, but neither illustrated nor described, numerous additional cranidia and pygidia. V. Poulsen (1964) described *Glyphaspis parkensis* Rasetti 1951, originally described from the Stephen Formation (Miaolingian) of British Columbia, occurring together with *Glyphaspis perconcava*, proposing derivation from the *Bathyuriscus–Elrathina* Biozone.

Blainia **sp.**
Fig. 11J, K–N, Fig. 12K

2020a *Blainia* sp., Peel, p.10, fig. 4K, L, N–Q.

Figured material. Cranidium, PMU 35710 from GGU sample 212813. Pygidia: MGUH 33521–MGUH 33524, from GGU sample 212873. Telt Bugt Formation, Telt Bugt. Miaolingian, Wuliuan Stage, *Ehmaniella* Biozone.

Discussion. Three cranidia from GGU sample 212813 described by Peel (2020a), corresponding to cranidial morphotype 2 of Bordonaro *et al.* (2013), closely resemble *Glyphaspis dearbornensis* as illustrated by Deiss (1939, pl. 16, fig. 22) from the Steamboat Limestone (Miaolingian, Marjumian Stage) of Dearborn Canyon, Montana. No pygidia from sample 212813 have been assigned to the same genus.

Pygidia assigned to *Blainia* sp. are common in GGU sample 212873 from Telt Bugt (Fig. 11J–N); they are smooth to finely granulose. Corresponding cranidia have not been recognised. The available sample of pygidia shows a high degree of morphological variation, as described by Bordonaro *et al.* (2013) in samples from Argentina attributed to *Blainia gregarius* Walcott 1916, and they are treated collectively here.

Their length (sag.) is about two thirds of width, and in plan view they vary from lenticular (Fig. 11L,N), with maximum width (trans.) at about mid-length, to oval with the maximum width closer to the anterior (Fig. 11M). The anterior margin is angulated close to the transition from the pleural areas to the border. The posterior margin is uniformly convex, slightly flattened behind the axis. The axis is prominent (weathered in Fig. 11K–M) and variable in width; it is usually broad, equal in width to each pleural area (Fig. 11J), but less frequently somewhat narrower (Fig. 11N). The axis is of variable length, slowly tapering, with six or seven rings with deep furrows that are prominent anteriorly but fade towards a short tail piece. Pleural areas are convex towards their abrupt, steepened, transition to the border; furrowing of the pleural areas curves strongly towards the posterior, but fades posteriorly; the anteriormost furrow is prominent. The pygidial border is of variable width (trans.), often as wide as each pleural area, with several furrows conspicuous anteriorly. The furrows are deepened near the steep transition from the pleural areas to the shallowly convex, outwards sloping border, but fade towards the margin and also posteriorly. In some specimens, a narrow groove parallels the posterior margin of each pleura (Fig. 11J).

Deiss (1939) described similar pygidia from the Steamboat Limestone of Dearborn Canyon, Montana, as *Glyphaspis dearbornensis* and *Glyphaspis similis*, assigned to *Blainia* by Bordonaro *et al*. (2013). *Glyphaspis perconcava*, *Glyphaspis parkensis* Rasetti 1951 of V. Poulsen (1964, pl. 3, fig. 9) from the Cape Wood Formation of Inglefield Land (Fig 1A, localities 1,2), and Rasetti's (1951) original specimens from the Stephen Formation have a narrower pygidial axis.

Genus *Blainiopsis* Poulsen 1946

Type species. *Blainiopsis holtedahli* Poulsen 1946 from the Cape Wood Formation of Bache Peninsula, Ellesmere Island, Nunavut (Fig. 1A, locality 3).

Discussion. Poulsen (1946) described *Blainiopsis* from the Cape Wood Formation of Bache Peninsula. V. Poulsen (1964) reported *Blainiopsis holtedahli* Poulsen 1946 and *B. benthami* Poulsen 1946 from west of Blomsterbækken in Inglefield Land (Fig. 1A, locality 2), suggesting a late *Bathyuriscus–Elrathina* Zone age [= *Ehmaniella* Biozone] for the upper Cape Wood Formation. Peel (202a) reported about ten specimens of *Blainiopsis* in GGU sample 212814 from the Telt Bugt Formation at Telt Bugt, where both species seem to be present. *Blainiopsis* has been recorded also from western Newfoundland (Boyce 1979) and from the Cambrian of San Juan, Argentina (Bordonaro 1980).

Blainiopsis holtedahli Poulsen 1946
Fig. 12F

1946 *Blainiopsis holtedahli* Poulsen, p. 313, pl. 19, figs 10–15.
2020a *Blainiopsis holtedahli*, Peel, p. 11, fig. 5B,D,E,H.

Figured material. Cranidium, PMU 35715 from GGU sample 212814, Telt Bugt Formation, Telt Bugt. Miaolingian, Wuliuan Stage, *Ehmaniella* Biozone.

Discussion. Blainiopsis holtedahli is represented by five cranidia in GGU sample 212814 from the upper Telt Bugt Formation at Telt Bugt (Peel 2020a).

Blainiopsis benthami Poulsen, 1946
Fig. 12G, H

1946 *Blainiopsis benthami* Poulsen, p. 314, pl. 19, fig. 16, pl. 20, figs 1–2.
2020a *Blainiopsis benthami*, Peel, p. 12, fig. 5A,C,F,G,I,J.

Figured material. Partially articulated specimen, PMU 35713 and pygidium, PMU 35714 from GGU sample 212814, Telt Bugt Formation, Telt Bugt. Miaolingian, Wuliuan Stage, *Ehmaniella* Biozone.

Discussion. *Blainiopsis benthami* differs from *Blainiopsis holtedahli* in the greater curvature of the anterior margin, greater curvature of the anterior part of the facial suture and the greater curvature of the palpebral lobes. In addition, the glabella has shallowly convex sides and a less conical form than the tapering glabella of *B. holtedahli*.

Pygidium sp. 1
Fig. 9G, I, J

Material. Pygidium, MGUH 33502 from GGU sample 206308. Telt Bugt Formation, Romer Søer. Miaolingian, Wuliuan Stage, *Glossopleura walcotti* Biozone.

Discussion. This pygydium is oval in shape, with its greatest width (trans.) at mid-length (sag.) and overall length about two thirds of width; the posterior margin has a shallow median indentation.The prominent axis is about the same width (trans.) as the upper surfaces of the pleural fields before they pass across a shallow furrow onto the downward sloping border area, which becomes slightly concave as the margin is approached. The axis is about two thirds the length (sag.) of the pygidium and terminates abruptly at the posterior end, although a broad low ridge continues to the margin. Five axial rings and a short tail piece are defined by broad, shallow furrows, with four segments on the pleural areas rapidly fading as they pass into the border. It is ornamented with a fine dimpled pattern.

The pygidium is similar in shape and curvature of the pleural furrowing to pygidia of *Poliella* species illustrated by Sundberg & McCollum (2003a, fig. 10), but differs in having a greater number of axial rings. Rasetti (1951) reported only two rings and a tail piece in *Poliella prima*, where furrowing also extends more prominently onto the narrower border. A similar number of axial rings is present in the co-occurring pygidium *Fieldaspis* cf. *bilobata* (Fig. 9K–M) but this is distinguished by its more tapering axis, stronger delimitation of the border and more pronounced furrowing.

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