A new Silurian *Hemiarges* (Trilobita) from North Greenland and the question of the Polaris Harbour Formation

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Trilobites collected nearly 60 years ago by Lauge Koch at Newmann Bugt, North Greenland, and said to be probably derived from the so-called Polaris Harbour Formation, are described as *Hemiarges ethnikos* n. sp. Comparisons with Canadian species suggest a possible Pridoli (Late Silurian) age. The history of the Polaris Harbour Formation is reviewed in the light of the recent publication of a geological map prepared by Koch in 1931 showing the distribution of the formation. However, on account of difficulties concerning the type locality and the supposed lithology, an earlier recommendation that use of the formation name be discontinued is supported.

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Christian Poulsen (1974, p. 5) recorded the presence of trilobite pygidia which he considered to be "extremely similar to (or identical with?) that of *Trochurus ptyonurus* (Hall & Clarke)" from an erratic boulder of calcareous sandstone collected by Lauge Koch in 1922 at Newmann Bugt, North Greenland (fig. 1). The species was previously known, according to Poulsen, from the McKenzie Formation of Maryland and the Cobleskill limestone of New York, and indicated "the presence of late Silurian (Ludlow) sandstone beds somewhere in North Greenland".

The record of the collection with trilobites is not as new as the publication date of Poulsen's paper might suggest. Forty-five years previously, Koch (1929) reported the presence of the block in connection with his description of the Polaris Harbour Formation, from which he suggested that the block was possibly derived. Poulsen (1934, p. 43) also mentioned the block and reported that its fauna contained in addition to the trilobite remains "a few species of brachiopods". The precise sampling locality of the fossiliferous block in Newmann Bugt is unknown, but from Koch's travelling route the sample was most probably picked up somewhere along the eastern coast of central Hall Land, presumably in the area designated by Koch as the Polaris Harbour Formation. It is in this context that the trilobite

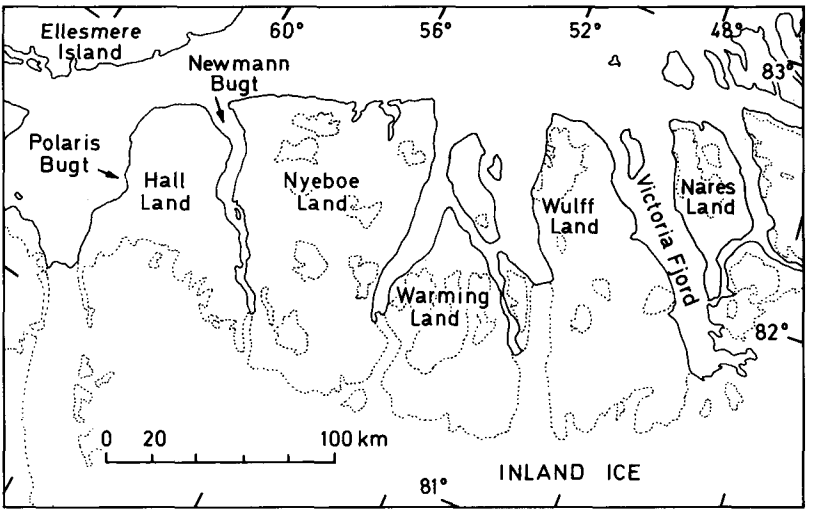

Fig. 1. Index map of western North Greenland.

identification by Poulsen (1974) is of special interest since Dawes (1966), after visiting the type locality in western Hall Land, recommended that the use of the stratigraphic term be discontinued.

The nomenclative history of the Polaris Harbour Formation is here reviewed as a prelude to the description of the trilobite material collected by Lauge Koch and subsequently identified by Poulsen (1974). The trilobites are referred to *Hemiarges ethnikos* n. sp., the first record of the genus from the Silurian of Greenland. The similarity of *H. ethnikos* to species of the same genus described from Arctic Canada suggests that the former may be early Pridoli (Late Silurian) age. This age is somewhat younger than the Ludlow age suggested by Poulsen (1974), although it is now known that the Cobleskill limestone is of Pridoli age and not Ludlow as suggested by Poulsen (Berry & Boucot, 1970).

The precise derivation of the fossiliferous erratic block remains enigmatic. However, through the recent publication of a map compiled by Lauge Koch and scheduled for publication in the early 1930's (Dawes & Haller, 1979), it is now possible to recognise the deposits to which Koch (1929) applied the name Polaris Harbour Formation. It is of interest to note that these deposits have yielded graptolites of Ludlow age in western Nyeboe Land (Berry *et al.*, 1974; Dawes, 1976), while Pridoli or possibly earliest Devonian fossils have also been identified from partially equivalent sediments at Observatory Bluff, western Hall Land (Bendix-Almgreen & Peel, 1974; Bendix-Almgreen, 1976; Berry *et al.*, 1974).

The Polaris Harbour Formation

Clastic sediments were first recorded from the north coast of Greenland during the U.S. 'Polaris' expedition 1871–1873 (Davis, 1876; Bessels, 1879) and these were described later by Feilden & De Rance (1878). They gave the name Cape Rawson Beds to a series of folded

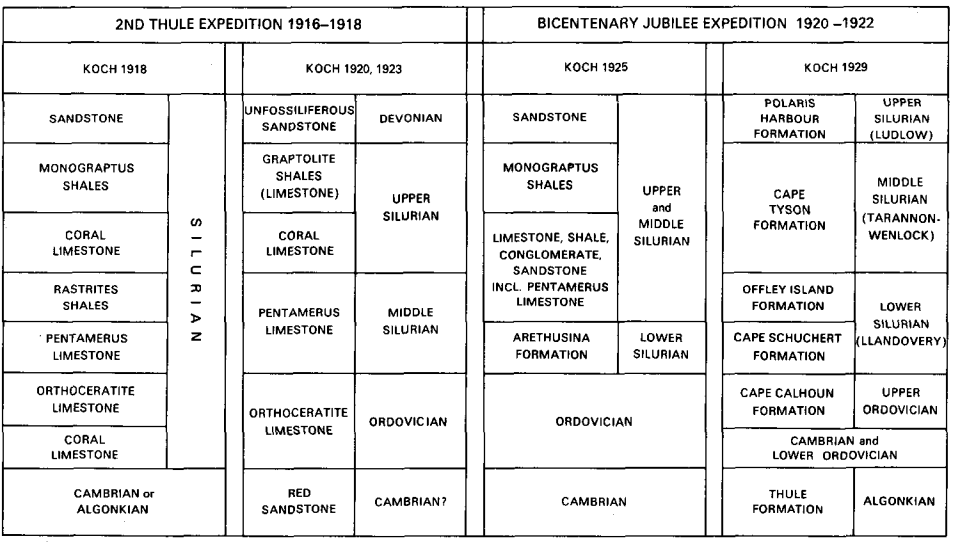

Fig. 2. Schemes of stratigraphic nomenclature from Lauge Koch's early North Greenland expeditions.

strata in northern Hall Land and Nyeboe Land (and in Ellesmere Island) which outcrop in the belt of 'Caledonian Folding' as outlined by Koch (fig. 3; Dawes & Haller, 1979, plate 3).

Koch first examined the sandstones south of the fold belt, to which he later gave the name Polaris Harbour Formation, during the 2nd Thule Expedition of 1916–18 (Koch, 1918). His stratigraphic scheme recognised a number of supposed Silurian units, overlying the Cambrian or Algonkian, of which the sandstone unit was the youngest (fig. 2). This scheme was subsequently revised (Koch, 1920, 1923) with the sandstones being considered to be of Devonian age by comparison with Devonian rocks from Ellesmere Island mentioned by Schei (1903). In Koch's 1920 paper the sandstones were described as "The Unfolded Post-silurian Sandstone Formation" but were considered to be at least in part of a similar age to the Cape Rawson Beds. After the Bicentenary Jubilee Expedition of 1920–23, when Koch was able to revisit the northern coast of Greenland, he revised his stratigraphic scheme, considering that the sandstones were more likely Silurian (Koch, 1925, 1929).

In 1929, Koch (p. 241) gave the name Polaris Harbour Formation to the sandstones south of the fold belt, describing them as "Coarse, loose, unbanded sandstone, occasionally containing slaty bands and numerous mica laminae of grey or brownish colour" (see Koch, 1920, pp. 58–61 for further description). The formation was considered to extend from Hall Land in the west to Nares Land, and possibly Peary Land in the east (figs 1, 3). Koch gave the date of authorship of the formation as 1917, but this date apparently relates to his recognition of the strata in the field. The name is derived from Polaris Harbour, western Hall Land, the Polaris Bugt of present usage (fig. 1), and the type locality is stated to be the plain south of Polaris Harbour. At least 500 m of strata along Victoria Fjord were assigned to the formation.

Koch (1929, p. 242) states that "the formation is part of Feilden's Cape Rawson beds". Koch (1920, p. 58) had previously refrained from using the term Cape Rawson Beds to

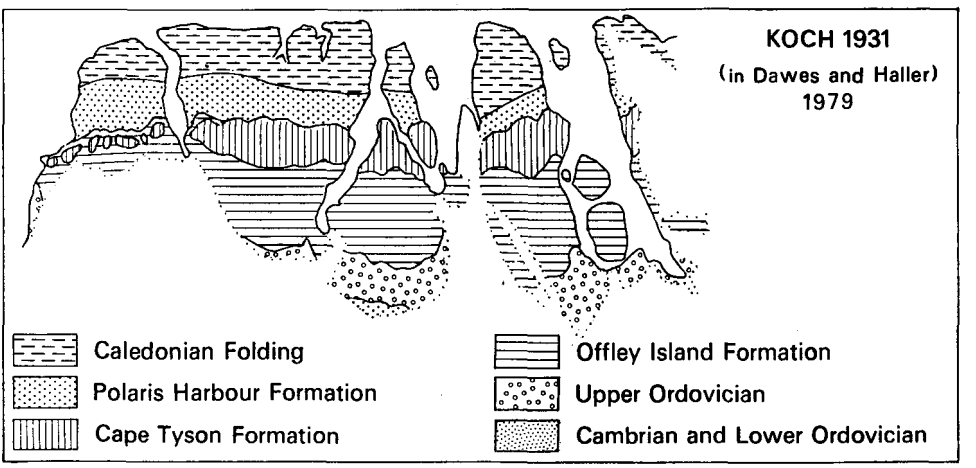

Fig. 3. Geological map of western North Greenland showing the distribution of Koch's Polaris Harbour Formation. Redrawn from Koch's 1931 coloured map (published in Dawes & Haller, 1979, pl. 3).

cover the unfolded sandstones south of the fold belt since Feilden & De Rance (1878) established that term to apply to only the deformed, and in places metamorphosed, rocks of the fold belt in which "strata from earlier periods are certainly to be found". Feilden & De Rance (1878) correlated the Cape Rawson Beds with the Huronian rocks of Nova Scotia.

In 1965 the type of the Polaris Harbour Formation was visited by J. H. Allaart and P. R. Dawes during 'Operation Grant Land'. The overwhelming dominance of thick, often coarse Quaternary deposits, with only minor and sporadic exposures of bedrock prompted Dawes (1966) to suggest that the use of the formation name be discontinued. Furthermore, as Koch had surmised during his reconnaissance work, it became clear that there was considerable overlap between the two terms, i.e. clastic strata south of the fold belt (Polaris Harbour Formation of Koch, 1929) being of the same lithology and age as some of the folded strata to the north (Cape Rawson Beds of Feilden & De Rance, 1878). Consequently, Dawes (1971) retained Feilden & De Rance's (1878) nomenclature.

The choice of name and type locality was inappropriate; however, Lauge Koch's concept of his Polaris Harbour Formation has been clarified (Dawes & Haller, 1979, pl. 3). Koch's map (fig. 3) indicates a wide belt of the Polaris Harbour Formation extending from Hall Land to Nares Land. In reviewing the map, Dawes & Haller (1979, p. 30) comment that the formation is mainly equivalent to the dominantly argillaceous fore-reef facies of the belt of Silurian carbonate mounds which stretches west to east across northern Greenland. The fore-reef strata pass gradually north into the more arenaceous strata characteristic of the North Greenland trough. Some of these turbiditic units also occur south of the fold belt, for example in central Nyeboe Land where turbiditic sandstones overlie a dark shale sequence (*Monograptus* Shales of Koch, 1925) and overlap onto Silurian limestones. These turbidites undoubtedly lie within the area referred by Koch to the Polaris Harbour Formation.

Nevertheless, it is difficult to reconcile Koch's (1929) lithological description of coarse, loose, unbanded sandstones with either the fore-reef graptolitic argillaceous strata, or even the turbidites, particularly since the latter are mostly fine to medium grained, of distal type.

Thus Dawes & Haller (1979) referred to unconsolidated, coarse fluvial deposits of Quaternary or possibly Tertiary age located by Hans F. Jepsen (GGU) in Washington Land during 1977, and speculated that Koch may have seen similar deposits elsewhere in North Greenland. However, in the absence of a systematic examination of the entire area of outcrop of the formation it is not possible to further evaluate Koch's description.

Meanwhile, it is clear that the term Polaris Harbour Formation cannot be employed since no satisfactory type locality exists and the supposed lithology is not easily reconcilable with bedrock strata occurring within that area of Koch's map showing the distribution of the formation (fig. 3). Koch's map at least presents the concept of the formation from which he supposed that the specimens of *Hemiarges* descriped below may have been derived. In the absence of systematic geological investigation of this part of North Greenland, the question of the precise origin of the fossils and the nature of the containing strata must be left in abeyance.

Systematic description

Family Lichidae Hawle & Corda, 1847
Subfamily Ceratarginae Tripp, 1957

Genus *Hemiarges* Gurich, 1901

Type species. By subsequent designation (Reed, 1902); *Lichas (Arges) wesenbergensis* Schmidt, 1885.

Hemiarges ethnikos n. sp.

Fig. 4

Derivation of name. From the Greek 'belonging to a race' referring to the close similarity of this species to a well documented group of *Hemiarges* species.

1974 *Trochurus ptyonurus* (Hall & Clarke); Poulsen, p. 5.
1976 *Trochurus ptyonurus;* Dawes, p. 281, fig. 243.

Material. Holotype pygidium MGUH 15080. Paratypes MGUH 15079 (cranidium), MGUH 15081–3 (fragmentary pygidia).

Locality. From a locally derived calcareous sandstone boulder, Newmann Bugt area, Hall Land, western North Greenland; probably from the "Clastic Unit" of Dawes, 1971.

Description. Cranidium with glabella 10.5 mm long, and the same width at the widest point (posterior 1L). Occipital ring narrowest (tr.) part of glabella (about 3/4 maximum width), in front of which from posterior of 1L, it narrows only a little, slightly more so at first, to the rounded antero-lateral and anterior margins. Axial furrow very distinct adjacent to bullar lobe, much less distinct adjacent to 1L. Distinct portion of 3S very short, forward adaxially directed on slope of glabellar convexity, continuing for a short distance curving transversely, and exceedingly indistinct. 1S confluent with axial furrow adjacent to bullar lobe, sinuous, between 1L and bullar lobe running a little obliquely back adaxially, and ending at a deep depression where it meets the less distinct longitudinal furrow. This latter furrow is narrower, and most distinct adjacent to bullar lobe, where it isolates a median glabellar lobe

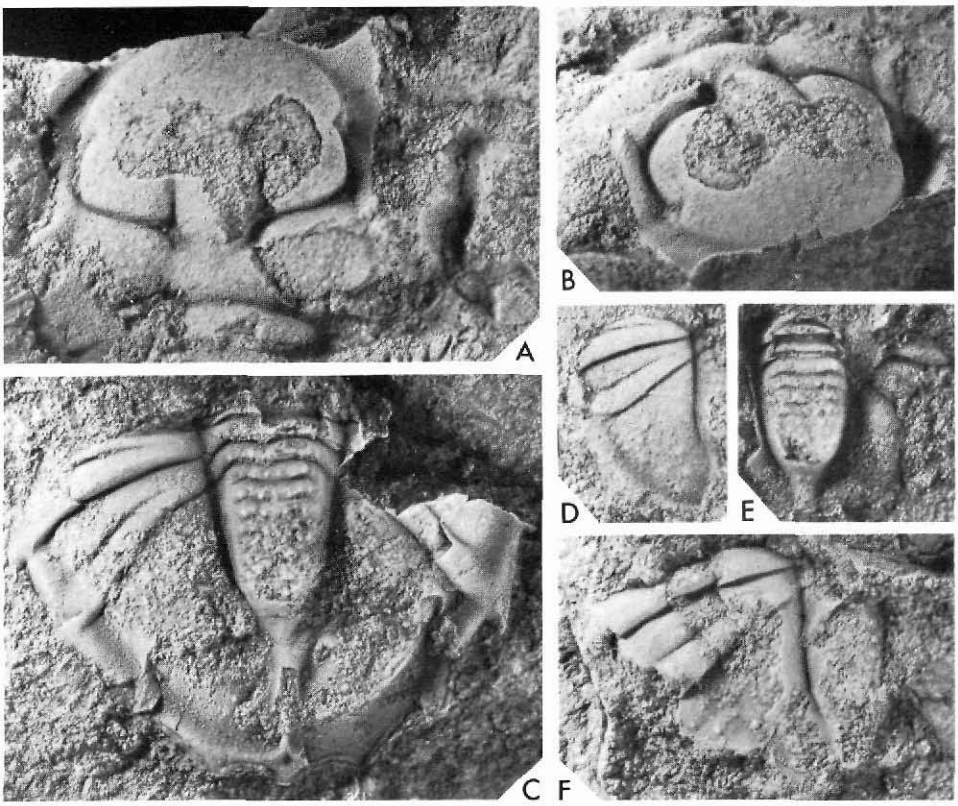

Fig. 4. *Hemiarges ethnikos* n. sp., × 4. A, B, MGUH 15080; paratype cranidium, dorsal and oblique lateral views. C, MGUH 15079; holotype pygidium, dorsal view. D, MGUH 15081; paratype fragmentary pygidium, dorsal view. E. MGUH 15082; paratype fragmentary pygidium, dorsal view. F, MGUH 15083; paratype fragmentary pygidium, dorsal view.

which is parallel sided, narrower (less than 1/3 width of glabella), higher and more convex than it is adjacent to 1L where it also widens markedly posteriorly. These two sections of the median glabellar lobe are demarcated by a wide transverse middle portion of the 1S, which is here the most posteriorly placed portion of this furrow. 1L subquadrate, the most independently inflated of all the lobes, larger than the similarly shaped bullar lobe. Anterior of palpebral lobe opposite anterior of 1L. Prepalpebral portion of fixed cheek widens (tr.) anteriorly to an apparently wide anterolateral border (although it is broken in the only specimen). External surface with no definite sculpture (possibly due to the preservation); visceral surface of 1L with coarse and fine low punctae.

Pygidium 3/4 as long (sag.) as wide at widest point (across anterior marginal spines). Axis narrow, about half the pygidial length and merging with post-axial ridge. Axial furrows distinct and deep especially posterior to the two anterior axial rings. These two rings bounded by distinct complete interring furrows; behind these at least 7 more rings indicated, their interring furrows not reaching the axial furrows laterally and each with a transverse row

of about 7 tubercles. Pleural areas with two pairs of ribs. Anterior band of first pleural rib gently convex; posterior band less convex, wider, and ending in a short posteriorly directed spine. Interpleural furrow very distinct, extending from axial furrow almost to margin. Anterior band of second rib much lower than posterior band of anterior rib, wider (exs.) than its corresponding posterior band which bears a spine like the anterior rib; both these bands widen (exs.) abaxially. Pleural furrows of these two bands are less distinct than the first and second interpleural furrows, and reach neither the axial furrow nor the lateral margin. Lateral and posterior border and border furrow clearly developed, especially posterior to the first pleural rib. Lateral margin with two other pairs of thorn-like spines spaced about equally to the anterior pairs, and a similar terminal spine, making nine in all. Terminal spine separated from post-axial ridge by a diamond shaped depression of very small size. Surface of pygidium (which is better preserved than the cranidium) with scattered low tubercles of different sizes.

Discussion. Hemiarges ethnikos is morphologically close to two species which are known from arctic Canada: *H. aquilonius* Whittington (1961, p. 439, pl. 56, figs 1–34; pl. 57, figs 1–28) and *H. bigener* Bolton (1965, p. 10, pl. III, figs 1–9, 11). The features by which *H. ethnikos* is most readily distinguished from the former are the relatively shorter glabella, the very short distance over which 3S is distinct, the much shorter 1L and the wider more rapidly posteriorly widening posterior section of the median glabellar lobe. Additionally, even though it is broken, the anterolateral border seems to be wider. The anterior of the palpebral lobe is relatively more posteriorly placed. In the relatively much shorter pygidium the axis is posteriorly more pointed; the post-axial ridge is better defined, and possesses the tiny distinct diamond shaped depression on the posterior border. The interring furrows, especially those posterior to the second are better developed. In the second pleural rib the anterior and posterior bands are more equal in exsagittal length, and the border spines are smaller, and more thorn-like; the posterior three are more closely spaced. The pygidial border and border furrow are also better developed and narrower. A wide range of morphology is shown by the figured material of *H. bigener,* but *H. ethnikos* differs consistently from it all by the relatively shorter glabella with narrower medial lobe, wider anterolateral border and much more posteriorly placed palpebral lobe. The pygidium of *H. ethnikos* is relatively much shorter, and in *H. bigener* the pygidial axis is bluntly terminated with subquadrate outline.

H. ethnikos is immediately distinguishable from *H. ptyonurus* (Hall & Clarke, 1888; see Whittington, 1961, p. 435, pl. 55, figs 1–9, 11) by the shorter and wider glabellar and 1L lobes, the much wider anterolateral border and, amongst other features of the relatively much shorter pygidium, the presence of a terminal spine.

The material upon which *H. ethnikos* is based has been used by Poulsen (1974, p. 5) and Dawes (1976, p. 281, fig. 243) to ascribe a Ludlow age to rocks in Hall Land, although *H. ptyonurus* (to which this material was formerly referred) is apparently restricted to the Cobleskill Limestone of latest Pridoli age.

The hope that re-examination of this material would allow it to be referred to a described species of stratigraphic value has not unfortunately been realised. However, the broad morphological similarities of *H. ethnikos* with *H. bigener* and *H. aquilonius* are taken to indicate that a stratigraphic horizon not widely removed from that at which these two species occur is probably represented. Consequently, it is probable that rocks of Pridoli age, and

probably Lower Pridoli age, are present in the Newmann Bugt area. As noted in the introductory section, this is in general agreement with ages indicated from graptolites and vertebrates collected from western Hall Land.

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