A new trilobite species of *Hemisphaerocoryphe* from the Arenig of the St. Petersburg area, Russia

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Hemisphaerocoryphe platinflata n.sp. is described from the Lower Middle Ordovician of north-western Russia (Upper Volkhov Stage). This species expands the stratigraphical occurrence of the genus downwards into the Upper Arenig and is therefore important for phylogenetic studies. The new data support the idea that the closely related genus *Krattaspis* Öpik, 1937 is an ancestor of *Hemisphaerocoryphe*.

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Introduction

The trilobite family Cheiruridae is widespread in the Upper Arenig of Baltoscandia and has received much attention through time (e.g. Angelin 1854; Brögger 1882; Krueger 1994, 1995, 1996; Männil 1958; Pärnaste 2003; Přibyl, Vaněk & Pek 1985; Schmidt 1881; Törnquist 1884). In spite of this only six Baltoscandian species and two subspecies have been described from the interval around the Volkhov-Kunda boundary (cf. Lamansky 1905; Männil 1958; Schmidt 1881, 1907).

In the spring of 2000 intensive sampling was carried out at the Lynna River east of St. Petersburg, Russia (Fig. 1). The field work formed part of a larger project involving the St. Petersburg State University, the University of Copenhagen and the Geological Survey of Denmark and Greenland, with the main purpose of studying the biostratigraphy of the Volkhov and Kunda stages (Upper Arenig – Lower Llanvirn). The present study deals with the uppermost part of the $B_{II}\beta$, the entire $B_{II}\gamma$ and the lower part of the $B_{III}\alpha$ zones sensu Lamansky (1905), representing the upper part of the Volkhov Stage (B_{II}) and the lower part of the Kunda Stage (B_{III}). The studied section was divided into 50 units and systematically sampled bed-by-bed. This yielded 3920 mostly disarticulated trilobite specimens of which 247 or approximately six percent belonged to the family Cheiruridae. The general biostratigraphic and ecostratigraphic results have been treated elsewhere (Hansen & Nielsen 2003). Although the cheirurids are relatively uncommon, the new material contains no less than nine species or subspecies of which one species is described here as an early representative of the genus *Hemisphaerocoryphe* Reed, 1896.

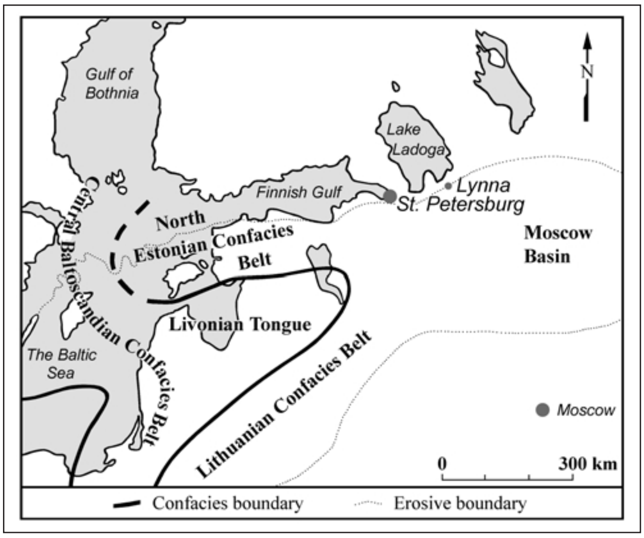

Fig. 1. Map showing location of the Lynna River. The Ordovician confacies belts are modified after Jaanusson (1982, 1995) and Nielsen (1995).

Geological setting

The exposure is located in the last curve of the Lynna River some hundreds of metres above its junction with the Syass River, about 150 km east of the city of St. Petersburg (Fig. 1). In geological terms this corresponds to the North Estonian Confacies Belt of Jaanusson (1982). The outcrop, which is more than 10 metres high, exposes Middle Ordovician rocks including the upper part of Volkhov Stage and the entire Kunda Stage. The section comprises beds of yellowish and grey calcareous packstone and wackestone intercalated by thin marl beds. There is a high

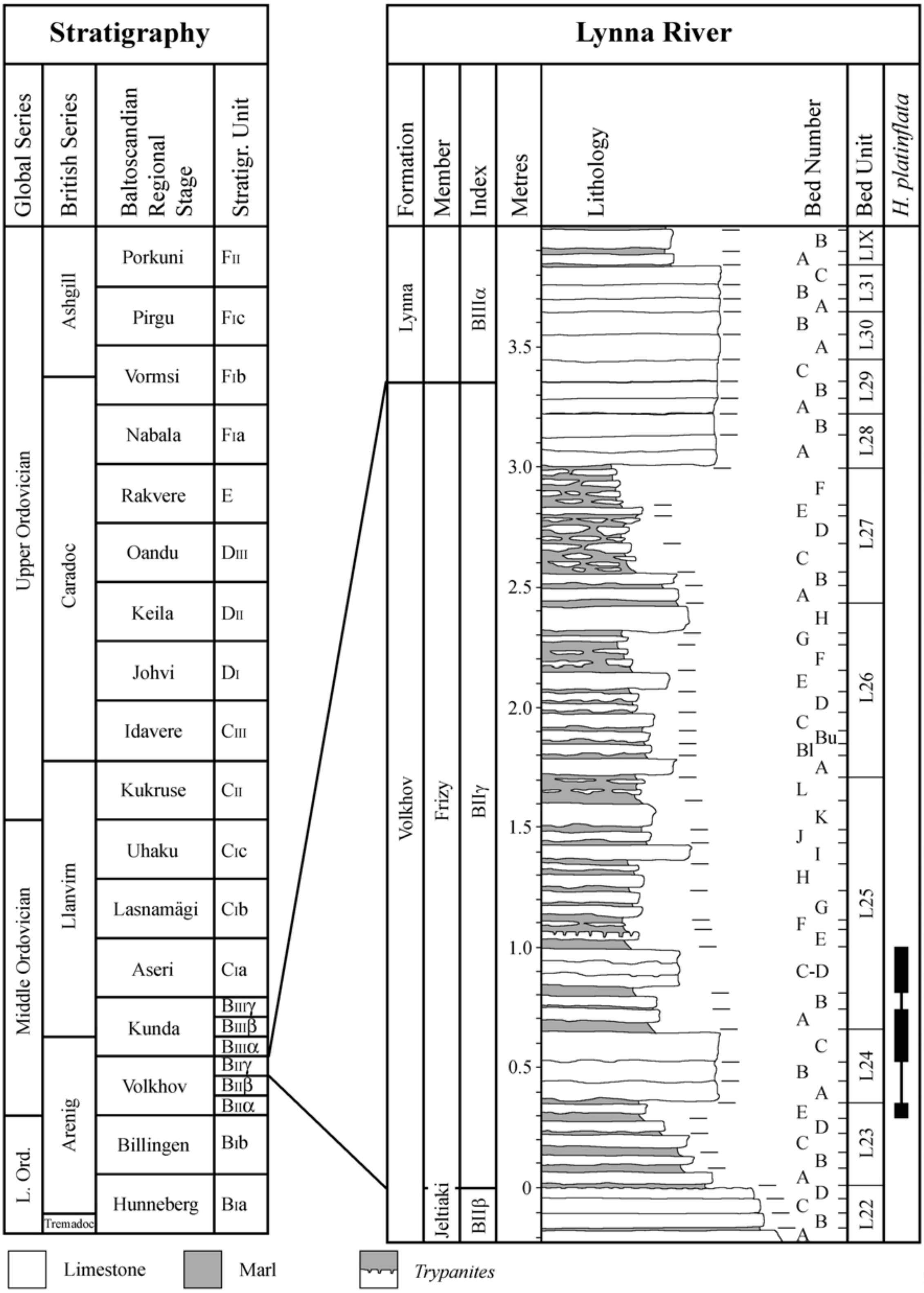

Fig. 2. Lithological log of the Lynna section based on data made available by Andrei Dronov. The stratigraphical units used for the Volkhov and Kunda Regional Stages follow the subdivision made by Lamansky (1905). The rest follow the coarser system proposed by Männil (1966). The stratigraphic occurrence of H. platinflata *n.sp. is shown to the right.*

glauconite content in the lower half. This paper deals with the lower 4.2 metres, which extend from the middle part of the Volkhov Formation (top of the $B_{II}\beta$ Zone) to the basal part of the Lynna Formation (lower part of the $B_{III}\alpha$ Zone) (Fig. 2).

At the time of deposition the Baltic continent was situated in the southern hemisphere in a temperate low-pressure zone at about 40°-60°S (Christiansen & Stouge 1999). The continent was largely covered by a flat-bottomed epicontinental sea. The sediments of the basin can be divided into a series of facies belts related to a general decrease in carbonate content westwards (Jaanusson 1982) (Fig. 1). This may reflect a corresponding increase in water-depth reaching a maximum in south-western Scandinavia (Nielsen 1995). Because of a low topography and extensive flooding the supply of terrigenous sediments was extremely low favouring development of wide spread cool-water carbonate ramps in the more shallow water of the Baltic area (Tolmacheva et al. 1999). The low sediment input together with bypass of clay particles and a low carbonate production resulted in a net rate of sedimentation as small as 1 to 3 mm/1000 years (Jaanusson 1982).

The sediments at Lynna were deposited below the fair weather wave base in a middle carbonate ramp environment supporting a rich benthic fauna. Except for the regular alternation between marls and more coarse-grained limestone the succession is very uniform, indicating a largely stable environment. Even the sea level changes occurring throughout the period only resulted in slight changes such as a generally coarsening of the sediments and a variable glauconite and clastic content.

Measurements

All measurements were made using goniometric and measuring oculars, and are given to the nearest degree or 0.1 mm. Cranidial measurements are shown on figure 3. The measurements and descriptions were made on cranidia orientated so the axial furrow described a horizontal line. For the measurements glabella is defined as the area outlined by the occipital, axial and preglabellar furrows. Abbreviations: **Ai** = angle of inflation between the tangent to glabella above S_3 and the double tangent to the occipital ring and frontal part of glabella (high angles denotes cranidia with a small sagittal curvature); **As** = angle between the longitudinal axis of the cranidium and the anterior half of the outer margin of the genal spine; **L** = cranidial length; **L1, L2** and **L3** = distance from occipital furrow to the opening of each of the lateral glabellar furrows; **Lg** = glabellar length; **Lp** = length between the pleuroccipital furrow and the posterior edge on the palpebral lobe; **W** = cranidial width; **Wl1**, **Wl2** and **Wl3** = the distance between the furrows in each pair of lateral glabellar furrows; **Wp** = distance from the posterior edge on the palpebral lobe to the axial furrow. The terminology is adopted from Kaesler (1997).

Systematic palaeontology

Suborder Cheirurina Harrington & Leanza, 1957
Family Cheiruridae Salter, 1864
Subfamily Deiphoninae Raymond, 1913

Genus *Hemisphaerocoryphe* Reed, 1896
Type species *Sphaerexochus pseudohemicranium* Nieszkowski, 1859 (subsequent designation by Barton (1915))

Remarks: There has been some discussion as to whether *Hemisphaerocoryphe* is a valid genus or just a junior synonym of *Sphaerocoryphe* Angelin, 1854 (Lane 1971; Holloway & Campbell 1974; Přibyl, Vaněk & Pek 1985; Tripp, Rudkin & Evitt 1997; Zhou, Dean, Yuan & Zhou 1998; Chen & Zhou 2002; Pärnaste 2004). I follow Pärnaste (2004, p. 128-129) in regarding them as distinct genera.

The genus ranges from Late Arenig (Volkhov Stage) to Ashgill and occurs in Europe, Asia and Australia (Přibyl et al. 1985; this study).

Hemisphaerocoryphe platinflata n.sp.

Derivation of name: platinflata alludes to the low inflation of glabella.

Diagnosis: The cranidium is characterized by a semicircular glabella with long (sag.) occipital ring, the extremely posteriorly located palpebral lobes and by the strongly sigmoid facial suture with a distal forward reaching curvature opposite S_2.

Occurrence: From bed L23E to L25C-D representing the lower to middle part of the $B_{II}\gamma$ Zone, upper Volkhov Stage (Fig. 2). The species appears to be rather rare, but this may relate to its small size.

Material: Four incomplete cranidia including the holotype, MGUH 27341 (sample RL1308), are from bed L25A, and paratypes MGUH 27342 (sample RL1510), MGUH 27343 (RL950 and RL1187) were collected from bed L25C-D, L23E and L24C respectively.

Description: The four cranidia are 4.5 to 6.8 mm long with a broad crescentic to triangular outline. Sagittal length equals 2/5 to 1/2 of width. Angle of inflation is between 155° and 159° sagittally and 90° in transverse view.

Glabella moderately convex transversely, while strongly convex sagittally. It is angularly oval in outline with its widest point corresponding to 68 to 77 % of the glabellar length just anterior to the transition between axial and preglabellar furrows. In profile the glabellar height increases markedly from the occipital furrow and forward to the opening of S_1 from where the increase in height declines. Highest point at L3. The front is slightly overhanging, while the flanks are steep.

Occipital ring relatively narrow with a length approximating 30 % of width. Anterior margin curves strongly backwards abaxially, while the posterior margin describes a nearly straight line. Occipital width equals 25 % of cranidial width. The occipital ring carries a small but distinct mesial tubercle.

Occipital furrow is wide and shallow mesially, becoming deeper and narrower abaxially.

The glabella has three pairs of lateral glabellar furrows of which the two foremost are inconspicuous. The posterior pair, S_1, meets the occipital furrow at an acute angle. The distance between the S_1-furrows approximates 12 % of the cranidial width. The opening is positioned 18-20 % of the cranidial length from the occipital furrow. S_2, positioned 31-35 % of the cranidial length from the occipital furrow, is very short and indistinct. The distance between the S_2 furrows is nearly twice the distance between the S_1-furrows. S_3, located 40-45 % of the cranidial length from the occipital furrow, is similar to S_2. The posterior lobe is nearly cut off from the glabella and lies almost completely in the occipital furrow. It is flatly inflated with a rounded triangular outline. The frontal glabellar lobe is broadly rounded anteriorly.

The axial furrow is forwardly diverging. The anterolateral border furrow is partly hidden by the matrix, but does not appear to be deep.

The anterior cranidial border is very short (sag.), expanding somewhat laterally. The palpebral area is broadly rectangular in outline; inflated posterolaterally. No eye-ridge is present. The palpebral lobe is short, posteriorly bending out on to the posterior fixigenal field. Its anterior margin lies slightly anterior of S_2, while the posterior edge is opposite the anterior margin of S_1. The distance from the posterior edge to the axial furrow is approximately 5/4 of the distance to the pleuroccipital furrow. Palpebral furrow is effaced. The posterior fixigenal field is short but wide and directed slightly forward distally. The transverse curvature is directed strongly downwards, whereas the exsagittal curvature is small. The pleuroccipital furrow is short and deep. It curves around 110° forward at the posterior fixigenal edge. No bridge between border and genal field is present at the genal angle. The proximal part of the posterior border is short (exsag.), but increases slightly in length on the distal part. The lateral border is relatively broad and moderately inflated. It continues out into a stout, curved genal spine with an oval cross-section. The proximal part runs outward in an angle between 34° and 55° to the symmetrical axis, but turns slightly inwards distally. The facial sutures converge anteriorly, but are more parallel around the palpebral areas. They turn out and forward in a small rounded curve outside the palpebral lobes. At the transition from the lateral border furrow to the lateral border the facial sutures reach a point opposite S_2. From there they turn posteriorly, merging with the lateral border margin.

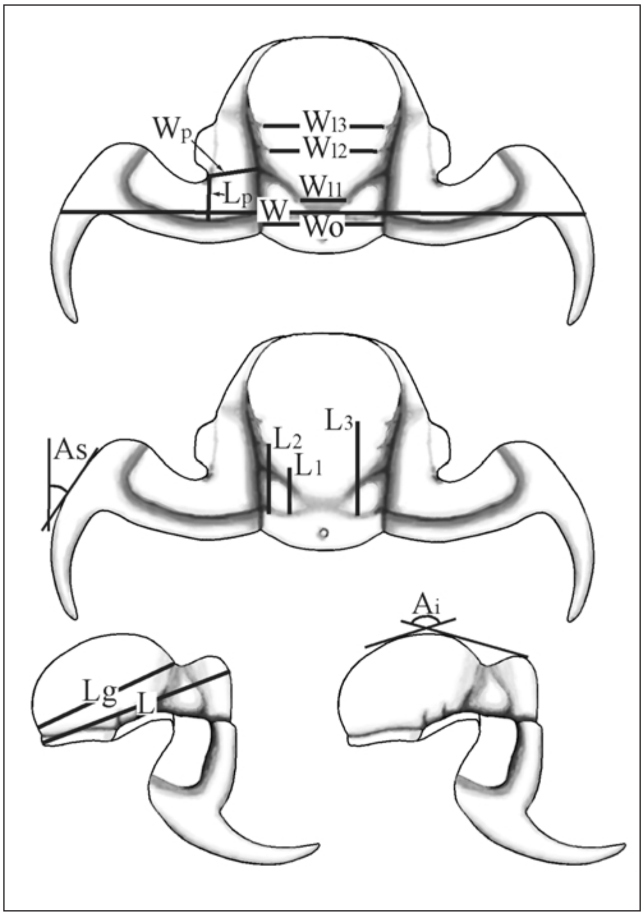

Fig. 3. Cranidial measurements used in the descriptions.

The cranidial surface is finely and evenly granulated. The posterior fixigenal field is characterized by coarse and densely placed pits.

Discussion

H. platinflata n. sp. possesses several primitive features distinguishing it from species assigned to the related genus *Krattaspis* Öpik, 1937. These are the semicircular glabella with its long (sag.) occipital ring; the strongly sigmoid curvature of the posterior facial suture and the

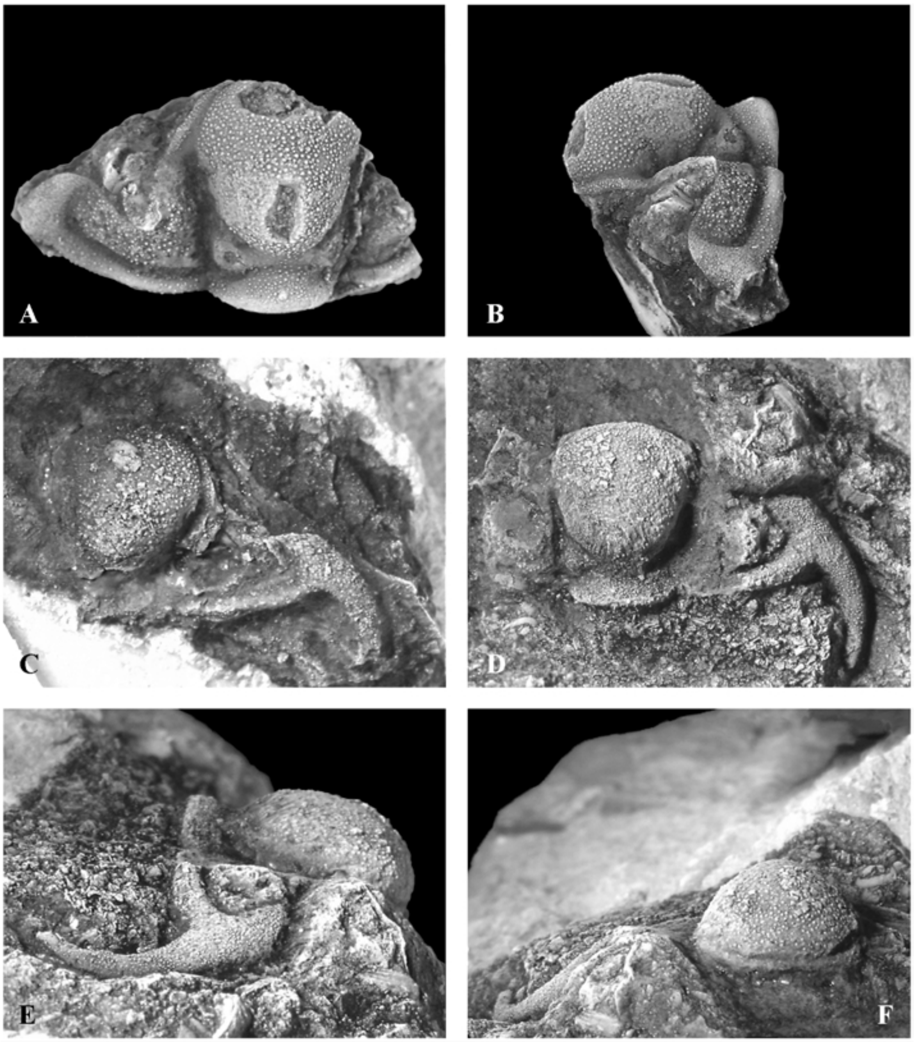

Fig. 4. Hemisphaerocoryphe platinflata *n.sp..* ■ *A, B. Dorsal and lateral view of cranidium. Holotype MGUH 27341. Bed L25A ($B_{II}\gamma$). Magnification ×11 and ×10 respectively. Note the low glabellar inflation.* ■ *C. Dorsal view of cranidium. Paratype MGUH 27342. Bed L25C-D ($B_{II}\gamma$). ×8.* ■ *D-F. Dorsal, lateral and frontal view of cranidium. Paratype MGUH 27343. Bed L23E ($B_{II}\gamma$). Magnification ×5, ×7 and ×6 respectively.*

posterior position of the eyes. However, features which suggest it should be assigned to *Hemisphaerocoryphe* are the strongly reduced S_2 and S_3 furrows; posterior glabellar lobes, which are partly circumscribed by the occipital furrow; a moderately strong sagittal inclination of the posterior part of the glabella, though weaker than on the rest of the genus, and the stout and curved genal spines. The many synapomorphies shared between this species and *Krattaspis* seem to support the notion of Pärnaste (2003, p. 255) that *Krattaspis* may constitute the ancestor of *Hemisphaerocoryphe.*

Hemisphaerocoryphe has previously not been known from below the Uhaku Stage (Upper Llanvirn) (Krueger 1994; Přibyl et al. 1985). The new species from the Upper Volkhov Stage, Upper Arenig, is therefore currently the oldest known representative of the genus, which together with its primitive characters makes it important for studies of the evolutionary relationship between cheirurid genera.

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