Late Cambrian trilobites from the Holy Cross Mountains, central Poland

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ABSTRACT:


Thirty-seven trilobite taxa from the Upper Cambrian of the Holy Cross Mountains are described; eighteen are noted for the first time in Poland. Eleven of the previously recognised species are considered to be junior synonyms. Restorations of the exoskeleton for Aphelaspis rara (ORLOWSKI), Leptoplastides irae (ORLOWSKI), Peltura propteloporum ORLOWSKI, and Triobagnostus rudis (SALTER) are provided. Large morphological variation in cephalon of Parabolina (Neoparabolina) frequens (BARRANDE), observed in the literature and exemplified by the analysed material indicates that the hitherto recognised subspecies, P. (N) frequens frequens (BARRANDE), P. (N) frequens argentinana (KAYSER) and P. (N) frequens Finnmarkica (NIKOLAISEN & HENNINGSMOEN), represent one taxon. Parabolina (Neoparabolina?) lapponica WESTERGÅRD is most probably related to Parabolina (Neoparabolina) frequens (BARRANDE). Bellella LAKE is considered a junior synonym of Leptoplastides RAW, and the genus belongs to the Pelturinae rather than the Oleninae.

Key words: Late Cambrian, Holy Cross Mountains, Trilobites.

INTRODUCTION

The paper presents a monographic description of the Late Cambrian trilobites from the Holy Cross Mountains in central Poland. The material studied comprises over 1300 variably preserved specimens, coming from elastic deposits of the Łysogory region of the Holy Cross Mountains (Text-fig. 1), and represents mostly older collections studied originally by SAMSONOWICZ (1934), TOMCZYKOWA (1964, 1968a, b) and ORŁOWSKI (1967, 1968b). Details of the lithology of the trilobite-bearing sections, as well as stratigraphic and bioecological analyses based on the restudied material will be presented in a separate paper (ŻYLIŃSKA in prep.). Stratigraphic ranges of the described fauna are given in Text-fig. 2.

PREVIOUS STUDIES OF THE LATE CAMBRIAN TRILOBITES IN THE HOLY CROSS MOUNTAINS

The research on Late Cambrian trilobites in the Holy Cross Mountains began with the discovery of an undetermined species of Olenus in the exposure at Chabowe Doly north of Kielce (GÜRICH 1896). Further investigations, more than thirty years later, were carried out by two prominent researchers of the Holy Cross Mountains area – JAN CZARNOCKI (1919, 1927a, b, 1950, 1957) and JAN SAMSONOWICZ (1916, 1920, 1934, 1956). Both authors pointed out that the Late Cambrian trilobites, comprising various olenid species, indicated zones 3 to 5 of the biostratigraphic scheme developed in Sweden (WESTERGÅRD 1922). Unfortunately they neither illustrated, nor gave any for-
Fig. 1. a. Geological sketch-map of the Holy Cross Mountains, with Cambrian deposits, after ORLOWSKI (1992), location of studied outcrops and boreholes after ORLOWSKI (1968a) and TOMCZYKOWA (1968b); b. Sketch-map of the western part of the Lysogóry region; c. Sketch-map of the Wąworków region.

The topic was undertaken again in the late 1960s by Stanisław ORLOWSKI and Ewa TOMCZYKOWA and resulted in formal description and illustration of Late Cambrian trilobites from exposures and boreholes of the Lysogóry region of the Holy Cross Mountains (ORLOWSKI 1967, 1968a, b; TOMCZYKOWA 1964, 1968a, b). ORLOWSKI (1968a, b) managed to rediscover almost all of the exposures mentioned in earlier papers and, after extensive excavations, gathered a rich collection of trilobites. The doubted earlier existence of a fauna indicating the youngest Late Cambrian (SAMSONOWICZ 1934) was confirmed by TOMCZYKOWA (1964, 1968a, b) on the basis of material from boreholes situated to the north of the Upper Cambrian outcrops in the area. The two authors described mainly new endemic species, and therefore the proposed biostratigraphic schemes (ORLOWSKI 1968b; TOMCZYKOWA 1968a, b) represented local zonations.

TERMINOLOGY APPLIED TO THE TRILOBITE EXOSKELETON

Terms applied to the trilobite exoskeleton are used according to the recommendations of the Trilobite
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TREATISE (KAESLER 1997); additional terms that apply to the Agnostina follow ROBISON (1982) and SHERGOLD & al. (1990) (Text-figs 3, 4).

TERMINOLOGY APPLIED TO SCLERITE DIMENSIONS AND PARAMETERS

Measurements of the analysed specimens were made with callipers, with an accuracy of 0.1 mm. Character lengths were measured either sagittally (sag.) or exsagittally (exs.) and widths were measured transversely (tr.). For each specimen the measurements were taken in one plane. Symbols used for sclerite dimensions of non-agnostidean trilobites are taken from SHAW (1956, 1957) and TEMPLE (1975) (Table 1, Text-fig. 5), and for the Agnostina from AHLBERG & AHLGREN (1996) (Table 2, Text-fig. 6).

The particular parameters were calculated and all values are presented as percentages. The values of parameters are preceded by the term “approximately” when only one specimen is measured; a range of values is given for 2 to 4 specimens, whereas for five specimens or more the mean value along with the standard deviation is given (after SUNDBERG & MCCOLLUM 1997, with modifications). The number of specimens, for which
Fig. 3. Terminology of the morphologic features of the cephalon (top) and pygidium (bottom) of non-agnostidean trilobites as applied in this paper (modified after KAESER 1997). S1-4 – lateral glabellar furrows, L1-3 – lateral glabellar lobes

Table 1. Symbols applied for the measured linear dimensions of non-agnostidean trilobites, after SHAW (1956, 1957) and TEMPLE (1975)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1</td>
<td>total cranidial length (sag.) - computed as a1 + f1</td>
</tr>
<tr>
<td>b</td>
<td>total glabellar length (sag.) - measured from the deepest point in the occipital furrow to the deepest point in the preglabellar furrow</td>
</tr>
<tr>
<td>b1</td>
<td>occipital glabellar length (sag.) - measured from the posterior margin of the occipital ring to the deepest part of the preglabellar furrow</td>
</tr>
<tr>
<td>c</td>
<td>palpebral length (exs.) - measured between the anterior and posterior tips of the palpebral lobe</td>
</tr>
<tr>
<td>d5</td>
<td>palpebral length (exs.) - measured from the posterior edge of the palpebral lobe to the projection of the posterior end of the palpebral lobe</td>
</tr>
<tr>
<td>f1</td>
<td>frontal area length (sag.) - measured from the deepest part of the preglabellar furrow to the anterior edge of the cranidium</td>
</tr>
<tr>
<td>g1</td>
<td>anterior border length (sag.) - computed as f1 – h</td>
</tr>
<tr>
<td>h</td>
<td>preglabellar area length (sag.) - measured from the deepest part of the preglabellar furrow to the deepest part of the anterior border furrow</td>
</tr>
<tr>
<td>j2</td>
<td>maximum width of the frontal area (tr.) - measured between the most widely extended points on the frontal area</td>
</tr>
<tr>
<td>j4</td>
<td>pre-palpebral cranidial width (tr.) - measured between angles generally formed at the intersection of palpebral lobes with anterior branches of facial sutures</td>
</tr>
<tr>
<td>k</td>
<td>cranidial width (tr.) - measured between the anterior and posterior tips of the cranidium</td>
</tr>
<tr>
<td>k1</td>
<td>preglabellar cranidial width (tr.) - measured between the deepest parts of the cranidium and the outer tip of the preglabellar furrow</td>
</tr>
<tr>
<td>k2</td>
<td>maximum width of the cranidium (tr.) - measured between the deepest parts of the cranidium and the outer tip of the preglabellar furrow</td>
</tr>
<tr>
<td>l</td>
<td>length of posterior limb (tr.) - measured between the deepest part of the posterior limb and the outer tip of the posterior limb</td>
</tr>
<tr>
<td>w</td>
<td>maximum pygidial width (tr.) - measured between the outermost tips of the pygidium</td>
</tr>
<tr>
<td>y1</td>
<td>anterior length of axis (sag.) - measured from the end of the anterior border furrow to the furrow marking off the articulating ring</td>
</tr>
<tr>
<td>z1</td>
<td>anterior length of pygidium (sag.) - measured from the end of the anterior border furrow to the posterior edge of the pygidium</td>
</tr>
<tr>
<td>z2</td>
<td>intramarginal pygidial length (sag.) - measured from the anterior edge of the articulating ring to the base of the marginal furrow</td>
</tr>
</tbody>
</table>
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Fig. 4. Terminology of the morphologic features of the cephalon (top) and pygidium (bottom) of agnostidean trilobites as applied in this paper (modified after Shergold & al. 1990)

Table 2. Symbols applied for linear dimensions of agnostidean trilobites, after Ahlberg & Ahlborn (1996) (modified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lc</td>
<td>length of cephalon (sag.) - measured from the posteriormost tip of glabella to anteriormost tip of cephalon</td>
</tr>
<tr>
<td>Lac</td>
<td>length of cephalic acrolobe (sag.) - measured from posteriormost tip of glabella to anteriormost tip of cephalic acrolobe</td>
</tr>
<tr>
<td>Lg</td>
<td>length (sag.) of glabella - measured from the posteriormost tip of glabella to anteriormost tip of glabella</td>
</tr>
<tr>
<td>Wc</td>
<td>maximum width of cephalon (tr.) - measured at the widest point of cephalon</td>
</tr>
<tr>
<td>Wg</td>
<td>maximum width of glabella (tr.) - measured at the widest point of glabella</td>
</tr>
<tr>
<td>Lp</td>
<td>length of pygidium (sag.) - measured from the anteriormost tip of the anteroaxis to the posteriormost tip of the pygidium</td>
</tr>
<tr>
<td>Lpa</td>
<td>length of pygidial axis (sag.) - measured from the anteriormost tip of the anteroaxis to the posteriormost tip of the posteroaxis</td>
</tr>
<tr>
<td>Wp</td>
<td>maximum width of pygidium (tr.) - measured at widest point of pygidium</td>
</tr>
<tr>
<td>Wa</td>
<td>maximum width of pygidial axis (tr.) - measured at widest point of posteroaxis</td>
</tr>
</tbody>
</table>
the length of the cranidium has been measured, is given in parentheses after the size range (e.g. n=6). The most frequently used parameters (Table 3) are applied after STRUVE (1958) and SHERGOLD & SOZUY (1991). Linear dimensions along with the calculated parameters are available upon request.

MATERIAL AND REPOSITORIES

The material comprises over 1300 specimens preserved entirely as internal or external moulds in sandstones or shales. In most cases the specimens represent detached fragments of the trilobite exoskeleton, in many cases incomplete. Tectonically distorted specimens are also present, being more common among specimens collected from shales.

The following prefixes and numbers identify the material housed in different institutions or private collections:

MUZWG - Museum of the Department of Geology, University of Warsaw, Poland:
ZI/29 - collection of Stanisław ORŁOWSKI
Fig. 6. Sclerite dimensions for agnostidean trilobites as applied in this paper (modified from AHLBERG & AHLGREN 1996)

MUZPIG - Museum of the Polish Geological Survey, Warsaw, Poland:
8.II. - collection of Jan SAMSONOWICZ
1042.II. - collection of Ewa TOMCZYKOWA
AK - private collection of Adrian KIN

SYSTEMATIC PALAEONTOLOGY

Order Agnostida SALTER, 1864
Superfamily Agnostidea M’COY, 1849
Family Agnostidae M’COY, 1849
Subfamily Agnostinae M’COY, 1849

Trilobagnostus HARRINGTON, 1938

TYPE SPECIES: Agnostus innocens CLARK, 1923, from the Upper Cambrian Levis Formation of Quebec, Canada; by original designation.

REMARKS: Trilobagnostus HARRINGTON was erected for Agnostus innocens CLARK and related trilobites (SHERGOLD 1975). KOYAYASHI (1939) considered Trilobagnostus as a subgenus of Lotagnostus WHITEHOUSE, treating it as an effaced derivative of the latter, and occurring in slightly younger strata. LUDVIGSEN & al. (1989) showed that Trilobagnostus should not be referred to Lotagnostus, because the holotype pygidium of Agnostus innocens (re-illustrated recently by LUDVIGSEN & al. 1989, Pl. I, Fig. 25) is not congeneric with Lotagnostus trisectus SALTER (type species of Lotagnostus) and belongs rather to Micragnostus HOWELL. SHERGOLD & al. (1990) separated Trilobagnostus from Micragnostus and gave it generic status. In this view, Micragnostus was restricted to contain Ordovician forms only (SHERGOLD & al. 1990; NIELSEN 1997, 1999), but this was not unanimously accepted (PRATI 1992). According to SHERGOLD & al. (1990), SHERGOLD & LAURIE (1997) and NIELSEN (1997, 1999), species referred to Trilobagnostus, Oncagnostus, Homagnostus, Sicagnostus and Micragnostus should be revised in order to reassess the differences between these genera. This, however, lies beyond the scope of this paper and is not attempted here. Rudagnostus LERMONTOWA, 1951 (based on Agnostus princeps var. rudis SALTER, 1864) is considered a junior synonym of Trilobagnostus (SHERGOLD & al. 1990; NIELSEN 1997, 1999), and this view is followed here.

Trilobagnostus rudis (SALTER, 1864) (Text-fig. 7; Pl. 1, Figs 1-10)

part 1864. Agnostus princeps var. rudis; SALTER, p. 4, Pl. 1, Fig. 3 (non Figs 1-2 - Homagnostus obesus).
1906. Agnostus rudis SALTER; LAKE, pp. 21-22, Pl. 2, Figs 13-16.
1922. Agnostus rudis SALTER; WESTERGÅRD, p. 118, Pl. 1, Fig. 17.
1947. Agnostus (Homagnostus) rudis SALTER (?); WESTERGÅRD, pp. 4-5, Pl. 1, Figs 13a-b.
1951. Rudagnostus rudis (SALTER); LERMONTOWA, p. 7.
1967. Agnostus (Homagnostus) pseudobesus n. sp.; ORŁOWSKI, p. 49.
1968b. Agnostus (Homagnostus) pseudobesus sp. n.; ORŁOWSKI, pp. 266-267, Text-fig. 4, Pl. 4, Figs 1-5.
1988. Rudagnostus rudis (SALTER); MORRIS, p. 205.
1990. Agnostus (Homagnostus) pseudobesus ORŁOWSKI; LENZDZION & ORŁOWSKI, p. 48, Pl. 10, Fig. 3.
1996. Trilobagnostus rudis (SALTER); AHLBERG & AHLGREN, p. 133, Figs 3H-I.
TYPES: The syntypes housed in the British Geological Survey, Keyworth, UK, BGS GSM 8723-28, are from the Merioneth Series, from Penmorfa Church, near Porthmadog, Gwynned, Wales, UK. The illustration of Salter (1864, Pl. 1, Fig. 3) is a composite drawn from among the syntypes (Lake 1906; Morris 1988).

MATERIAL: Eight cephalia and nine pygidia, in some cases with counterparts, MUZWG ZI/29/0141, 0306-0319, 0420 and 0506.

BIOMETRIC DATA: Five parameters measured on 4 cephalia, five parameters measured on 4 pygidia.

DESCRIPTION: Length of cephalon 1.9-3.5 mm (n=4). Cephalon anteriorly rounded; width of cephalon approximately equals its length. Cephalic acrolobe unconstricted, elongated, surrounded by narrow border, wider anteriorly; border furrow non-delicuate. Median preglabellar furrow straight, narrow, rather shallow, reaching to border furrow. Glabella almost parallel-sided, slightly broader posteriorly, with semi-ovate anteroglabella. Transglabellar furrow (F3) distinct, deep, curved backwards medially. F2 nearly obsolete, curved forwards, impressed only laterally, isolating M2 with faintly visible node. Basal lobes small, simple. Length of glabella 63-68% of maximum cephalic length.

Length of pygidium 2.6-2.8 mm (n=4). Pygidium rounded posteriorly, width of pygidium approximately equals its length. Pygidial acrolobe unconstricted, strongly convex, slightly elongated, slightly deliciuate, surrounded by border, broad laterally, slightly narrower between short, broadly-based posterolateral spines. Pygidial axis broad, sub-parallel, widely rounded posteriorly, not reaching border furrow, slightly constricted across M2; occupies 81-89% of pygidial length. Anterior axial furrow (F1) impressed laterally, curved forwards to isolate lateral lobes. Posterior axial furrow (F2) transverse, straight. Posteroaxis (M3) strongly rounded posteriorly, as long or slightly longer than M1 and M2 combined. Axial node present on M2, in some cases effaced. Pleural field confluent behind axis.

REMARKS: The discussed specimens are closest to Trilobagnostus rudis, considered by Lermontova (1951) and Shergold (1972) as the type species of Rudagnostus Lermontova, later assigned to the genus Trilobagnostus (Shergold & al. 1990). They were originally described by Orłowski (1968b) as Agnostus (Homagnostus) pseudobesus n. on the basis of resemblance to Homagnostus obesus Belt, particularly the presence of a median preglabellar furrow and the structure of the pygidial axis.

The differences between Homagnostus* and Trilobagnostus are rather small. Species of the two genera exhibit a large intraspecific morphological variability (see Pratt 1992, Ahlberg & Ahlgren 1996), both on the cephalia and on the pygidia. Although Robison (1988) emended the diagnosis of Homagnostus to include species having a uniformly developed preglabellar median furrow and a pygidial axis that extends to the posterior border furrow, the median preglabellar furrow in different species of Homagnostus shows a large vari-

ability (Rushton 1978), particularly in Homagnostus obesus, where the preglabellar median furrow can range from complete to nearly effaced but for slight depressions in front of the anterior glabellar lobe (Pratt 1992). In Thribagnostus rudi the development of the median preglabellar furrow is also variable. In the only specimen of the cephalon from Västerbotten in Sweden, the median preglabellar furrow is preserved as a very short, narrow, almost indistinct furrow (Ahlberg & Ahlgren 1996, Fig. 31). In Trilobagnostus rudis the development of the median preglabellar furrow is also variable. In the only specimen of the cephalon from Vastergotland in Sweden, the median preglabellar furrow is preserved as a very short, narrow, almost indistinct furrow (Ahlberg & Ahlgren 1996, Fig. 31). In the investigated specimens of Thribagnostus rudi, the median preglabellar furrow reaches from the anterior part of the glabella to the anterior border, and is quite distinct. This type of development of the median preglabellar furrow is similar to that in Geragnostus intermedius Palmer (considered a species of Micragnostus by Fortey 1980; Ludvigsen 1982; Ludvigsen & al. 1989; Pratt 1992; and a species of Thribagnostus by Shergold 1972; Nielsen 1997, 1999) from the Late Franconian, Hillard Peak, east-central Alaska, USA (Palmer 1968; Ludvigsen & al. 1989). The similarities in the axial part of the pygidium, particularly its anterior part, of Trilobagnostus rudis to that of Homagnostus obesus have already been noted by Ahlberg & Ahlgren (1996). The posterior segment of the pygidial axis, however, is usually shorter in Trilobagnostus than in Homagnostus, where it can reach right to the posterior pygidial border. Micragnostus sensu lato as well as Oncagnostus (Oncagnostus) sensu Shergold & al. (1990) also have a structure of the pygidial axis similar to that of Homagnostus.


Order Asaphida Salter, 1864 emend. Fortey & Chatterton, 1988
Suborder Asaphina Salter, 1864 emend. Fortey & Chatterton, 1988
Family Ceratopygidae Linnarsson, 1869

Gen. et sp. indet.
(Pl. 3, Fig. 1)

MATERIAL: Three probable pygidial spines, in one case with counterpart, MUZPIG 1042.11.93, 120-120a, 121.

DESCRIPTION: Flattened, long, slightly curved probable pygidial spines.

REMARKS: The specimens are fragmentary, but resemble pygidal spines of genera assigned to Ceratopygidae Linnarsson, i.e. of Hysteroelenus Moberg or Ceratopgyge Hawle & Corda. Following Fortey & Chatterton (1988), Ceratopygidae Linnarsson and Asaphidae Burmeister are united within the same superfamily. The Ceratopygidae range from the upper Middle Cambrian to the Lower Ordovician.


Order Ptychopariida Swinnerton, 1915
Suborder Olenina Swinnerton, 1915
Superfamily Olenacea Burmeister, 1844
Family Olenidae Burmeister, 1844
Subfamily Leptoplastinae Angelin, 1854
Cienopyge Linnarsson, 1880


REMARKS: The genus is subdivided into three subgenera (Henningsmoen 1957), e.g. Escienopyge, Mesocienopyge and Cienopyge, which appear stratigraphically in this order.

Subgenus Mesocienopyge Henningsmoen, 1957

TYPE SPECIES: Cienopyge spectabilis Brogger, 1882, from the Upper Cambrian of Norway, by original designation.

Cienopyge (Mesocienopyge) tumida Westergård, 1922
(Pl. 1, Figs 11-12)

part 1880. Cienopyge sp. indet.; Linnarsson, p. 26, Pl. 2, Fig. 15 (non Pl. 2, Fig. 14 – Cienopyge (Cl.) fletcheri).
part 1922. Cienopyge tumida n. sp.; Westergård, pp. 155-156, Pl. 11, Figs 15-18 (non Pl. 11, Figs 19-20 – Cienopyge (M.) tumidoides).
part 1923. Cienopyge tumida Westergård; Poulsen, pp. 39-41, Pl. 1, Fig. 14 (non Text-fig. 16 – Cienopyge (M.) tumidoides).
part 1947. Cienopyge tumida Wåård; Westergård, p. 24
(stratigraphic range including *Ctenopyge (M.) tumida*).

1957. *Ctenopyge (Mesocenopyge) tumida* WESTERGÅRD; HENNINGSMOEN, pp. 198-199, Pl. 5, Pl. 20, Fig. 16.

1972. *Ctenopyge (Mesocenopyge) tumida* WESTERGÅRD; RUSHTON & TAYLOR & RUSHTON, p. 32, Fig. 8c.


1992. *Ctenopyge (Mesocenopyge) tumida* WESTERGÅRD; COPE & RUSHTON, p. 547, Figs 5m, o.

**TYPES:** The lectotype is a cranidium from Andrarum, Scania, Sweden, figured by WESTERGÅRD (1922, Pl. 11, Fig. 16), selected by HENNINGSMOEN (1957, p. 199).

**MATERIAL:** Four librigenae, MUZWG ZI/29/0246, 0257, 0639 and 0682.

**DESCRIPTION:** Librigenae narrow, strongly convex, with long, slender spine, slightly curved inwards. Posterior margin straight, shorter than convex lateral margin. Genal angle obtuse. Inner spine angle close to a right angle.

**REMARKS:** The presence of *Ctenopyge (M.) tumida* has been determined on the basis of the shape of the librigena and its spine. The specimens are also similar to the librigena of *Ctenopyge (Ct.) bisulcata* (PHILLIPS), but differ in the shorter posterior margin and inner spine angle, which in the latter is acute.


**Subgenus Ctenopyge LINNARSSON, 1880**

**TYPE SPECIES:** As for genus.

*Ctenopyge (Ctenopyge) fletcheri* (MATTHEW, 1901) (Pl. 1, Fig. 13; Pl. 2, Figs 1b, 2)

part 1880. *Ctenopyge?* sp. indet.; LINNARSSON, pp. 26-27, Pl. 2, Fig. 14 (non Pl. 2, Fig. 15 – *Ctenopyge (M.) tumida*).

part 1894. *Sphaerophthalmus alatus* BOECK, var. canadensis, n. var.; MATTHEW, p. 108, Pl. 17, Figs 12a-b (non Pl. 17, Figs 11a-b – *Sphaerophthalmus humilis*).


part 1901. *Sphaerophthalmus Fletcheri*; MATTHEW, p. 280, Pl. 4, Fig. 7d (non Pl. 4, Figs 7a-c, e-f – *Sphaerophthalmus humilis*).

part 1903. *Sphaerophthalmus Fletcheri*; MATTHEW, p. 227, Pl. 17, Fig. 7d (non Pl. 17, Figs 7a-c, e-f – *Sphaerophthalmus humilis*).

part 1922. *Ctenopyge directa* LAKE; WESTERGÅRD, p. 159, Pl. 12, Fig. 17 (non Pl. 12, Fig. 16).

1923. *Ctenopyge directa* LAKE; POULSEN, p. 45, Pl. 3.

1944. *Ctenopyge laticornis* sp. n.; WESTERGÅRD, p. 42, Pl. 3, Figs 1-2.


part 1952. *Sphaerophthalmus major* LAKE; HUTCHINSON, p. 90, Pl. 4, Fig. 16 (non Pl. 4, Fig. 17).

1957. *Ctenopyge (Ctenopyge) fletcherii* (MATTHEW); HENNINGSMOEN, pp. 205-207, Pl. 5, Pl. 22, Figs 1-6.

part 1968b. *Sphaerophthalmus alatus* (BOECK); ORŁOWSKI, pp. 272-273, part Text-fig. 8 (librigena only), Pl. 6, Fig. 11 (part Text-fig. 8 (cranidium), non Pl. 4, Fig. 5, Pl. 5, Fig. 12, Pl. 6, Figs 2-5, 8-10, 12, 15 – *S. alatus*, non Pl. 6, Figs 1a-b, 6, 14 – *S. major*; part Text-fig. 8 (pygidium), non Pl. 6, Figs 7, 13 – *S. humilis*).

1988. *Ctenopyge Fletcherii* (MATTHEW); MORRIS, p. 60.

1992. *Ctenopyge (Ctenopyge) fletcherii* (MATTHEW); COPE & RUSHTON, p. 547, Figs 5p, q.

**TYPES:** The lectotype is a librigena, from the Upper Cambrian of East Bay, Nova Scotia, Canada, figured by MATTHEW (1901, Pl. 4, Fig. 7d; 1903, Pl. 17, Fig. 7d); selected by HENNINGSMOEN (1957, p. 205).

**MATERIAL:** Three librigenae, MUZWG ZI/29/0272, 0292 and 0605.

**DESCRIPTION:** Librigenae with long, flattened spine curved inwards. Posterior margin slightly convex, shorter than convex lateral margin. Genal angle acute. Inner spine angle obtuse.

**REMARKS:** Librigenae assigned here to this species bear flattened, long genal spines, which however do not possess prominent longitudinal ribs. They are similar to the librigenae from Norway with narrow flat lateral areas of the spines assigned to this species by HENNINGSMOEN (1957, p. 206, Pl. 11, Fig. 6).

**OCCURRENCE:** In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Shale Formation at Chabowe Doly Ravine, *Peltura scarabaeoides* Zone (*linnarssoni* Subzone). In Norway, Sweden, Denmark and the UK: *Peltura scarabaeoides* Zone (*linnarssoni* Subzone). In Canada: *Peltura Zone.*
Ctenopyge (Ctenopyge) cf. linnarssoni WESTERGÅRD, 1922
(Pl. 3, Figs 4-5)

TYPES OF Ctenopyge (Ctenopyge) linnarssoni: The lectotype is a cranidium from Andrarum, Scania, Sweden, figured by WESTERGÅRD (1922, Pl. 12, Fig. 2), selected by HENNINGSMOEN (1957, p. 207).

MATERIAL: Two incomplete librigenae, MUZWG ZI/29/0293, 0768.

DESCRIPTION: Librigenae with spine, which is only partly preserved in one specimen. Posterior margin convex, slightly shorter than slightly convex lateral mar­gin. Genal angle acute, inner spine angle obtuse.

REMARKS: Poor preservation of the specimens does not allow accurate assignation. They are however most similar to librigenae of Ctenopyge (Ct.) linnarssoni. HENNINGSMOEN (1957) considers Ctenopyge (Ct.) fal­cifera LAKÉ from the UK synonymous or at least relat­ed to Ctenopyge (Ct.) linnarssoni.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Shale Formation at Chabowe Doly Ravine, Peltura scarabaeoides Zone (linnarssoni Subzone). Ctenop­yge (Ct.) linnarssoni occurs in Sweden, Norway, Denmark and the UK in the Peltura scarabaeoides Zone (linnarssoni Subzone); and in Canada in the Peltura Zone.

Sphaerophthalmus ANGELIN, 1854

TYPE SPECIES: Trilobites alatus BOECK, 1838, from the Upper Cambrian of Norway; by subsequent designation of LINNARSSON (1880).

REM­ARKS: HENNINGSMOEN (1957) concluded that four species of the genus Sphaerophthalmus were valid: S. alatus (BOECK), S. humilis (PHILLIPS), S. majusculus LINNARSSON and S. major LAKE, and this view is accept­ed here. The cephalon of Sphaerophthalmus were originally very convex, with generally downsloping fixigenae and with genal spines of the librigenae either springing out laterally (as in S. alatus) or bent downwards below the cephalon (as in S. humilis).

Sphaerophthalmus alatus (BOECK, 1838) (Pl. 1, Fig. 6; Pl. 2, Figs 3-15; Pl. 6, Fig. 1; Pl. 10, Fig. 1, Pl. 14, Fig. 18)

1838. Trilobites alatus, BOECK, p. 143.
1922. Sphaerophthalmus major LAKE; WESTERGÅRD, p. 163, Pl. 13, Figs 9-19.
1923. Sphaerophthalmus major LAKE; POULSEN, p. 47, Text-figs 17a-b, Pl. 1, Fig. 15.
1940. Sphaerophthalmus alatus (BOECK); STEINER, pp. 144-145, Pl. 1, Figs 16-17.

part 1967. Sphaerophthalmus alatus (BOECK); ORLOWSKI, p. 49 (including S. humilis and S. major).

part 1968. Sphaerophthalmus alatus (BOECK); ORLOWSKI, pp. 272-273, part Text-fig. 8 (cranidium only), Pl. 4, Fig. 5, Pl. 5, Fig. 12, Pl. 6, Figs 2-5, 8-10, 12, 15 (non Pl. 6, Figs 1a-b, 6, 14 – S. major; part Text-fig. 8 (pygidium), non Pl. 6, Figs 7, 13 – S. humilis; part Text-fig. 8 (librigena), non Pl. 6, Fig. 11 – Ctenopyge (Ct.) fletcheri).

1968. Sphaerophthalmus alatus (BOECK); RUSHTON, p. 418, Text-fig. 3d; cf. Pl. 78, Figs 9-10.
1972. Sphaerophthalmus alatus (BOECK); RUSHTON in TAYLOR & RUSHTON, p. 33, Text-fig. 8c.
1973. Sphaerophthalmus alatus (BOECK); CLARKSON, p. 754, Text-figs 7a-d, Pl. 95, Figs 1-2.
1984. Sphaerophthalmus alatus (BOECK); BEDNARZYK, Pl. 5, Figs 4-5, Pl. 6, Fig. 1.
1988. Sphaerophthalmus alatus (BOECK); MORRIS, p. 216.
1990. Sphaerophthalmus alatus (BOECK); LENDZION, ORLOWSKI & TOMZYKOWA, p. 65, Pl. 20, Fig. 2.
1992. Sphaerophthalmus alatus (BOECK); COPE & RUSHTON, Figs 4a-b, c-f.

TYP­ES: The lectotype is cranidium No. 56371, Palaeontological Museum of Oslo, from the Upper Cambrian of Gamlebyen, Oslo, Norway, selected and illustrated by STØRMER (1940, p. 145, Pl. 1, Figs 16-17).

BIOMETRIC DATA: Five parameters measured on 94 cranidia.

DESCRIPTION: Length of glabella 1.4-3.2 mm (n=94). Pre-palpebral cranidial width 65±10% of occipital glabellar length, poorly size-dependent (Text-fig. 8). Glabella prominent, slightly tapering anteriorly. S1 oblique backwards, concave, connected across glabella. S2 typically preserved as a pair of faint impressions at the sides of the anterior part of glabella. Occipital spine rather short, slender, directed backwards; on most specimens (positives) preserved in form of a tubercle in the posterior part of the occipital ring, on negatives visible in form of external mould. Anterior part, directed outwards. Posterior margin convex. Eye-ridges not visible. Palpebral lobes narrow, centres of which are situated opposite the anterior ends of S1. Anterior part of fixigenae narrowing forwards. Fixigenae wide, between half as wide as and almost as wide as glabella at mid-palpebral level, and almost as wide as occipital ring posteriorly.


REMARKS: The confusion with S. alatus arose when LINNARSSON (1880) considered Olenus humilis PHILLIPS a junior synonym of S. alatus. His statement was subsequently followed by many British and Scandinavian workers, e.g. LAKE (1913), WESTERGÅRD (1922 and in JOHANSSON & al. 1943), until HENNINGSMOEN (1957) showed that the two species were distinct, and also that the Scandinavian specimens of another species, S. major, originally described from Great Britain, should be referred to S. alatus. Based on the latter, he doubted the presence of S. alatus in Great Britain, which, however, was confirmed by RUSHTON (1968), TAYLOR & RUSHTON (1972) and COPE & RUSHTON (1992).

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation at Chabowe Doly Mill, Peltura minor Zone; within the Leba Zone, Peltura minor Zone. In Norway, Sweden, Denmark, Peltura minor Zone and lower part of Peltura scarabaeoides Zone. In the UK: Peltura minor Zone.

*Sphaerophthalmus humilis* (PHILLIPS, 1848) (Pl. 2, Fig. 1a; Pl. 3, Figs 2-3)

1848. *Olenus humilis* n. sp.; PHILLIPS, pp. 55, 347, Figs 4-6.
1854. *Olenus sphaerophthalmus* n. sp., ANGELIN, p. 43, Pl. 25, Fig. 3.
1864. *Olenus* (*Sphaeroph.) humilis, PHILL.; SALTER, pp. 7-8, Pl. 8, Figs 9-11.
1866. *Olenus* (*Sphaerophthalmus*) humilis, PHILL.; SALTER, p. 302, Pl. 5, Fig. 12.
1871. *Olenus humilis* PHILLIPS; PHILLIPS, p. 69, Fig. 8.
1880. *Sphaerophthalmus alatus* BOECK sp.; LINNARSSON, pp. 7-11, Pl. 1, Figs 6-10.
1882. *Sphaerophthalmus alatus* BOECK; BRÖGGER, p. 119, Pl. 2, Figs 14-14a (according to HENNINGS­MOEN (1957), some of BRÖGGER’s specimens are of *S. alatus*).
1894. *Sphaerophthalmus alatus*, BOECK, var. Canadensis n. var.; MATTHEW, p. 107, Pl. 17, Figs 11a-b (non Figs 12a-b – Ctenopyge (Cl.) fletcheri).
1901. *Sphaerophthalmus alatus* ANG. [sic!]; LINSTROM, p. 29, Pl. 3, Figs 31-34.
1903. *Sphaerophthalmus Fletcheri*, MATTHEW, pp. 227-228, Pl. 17, Figs 7a-c, c-f (non Fig. 7d – Ctenopyge (Cl.) fletcheri).
1910. *Sphaerophthalmus alatus*; GOLDSCHMIDT, p. 5, Fig. 4.
1913. *Sphaerophthalmus alatus* (BOECK); LAKE, p. 74, Pl. 8, Figs 1-5 (non Fig. 6 – *S. majusculus*).
1922. *Sphaerophthalmus alatus* (BOECK); WESTERGÅRD, p. 165, Pl. 13, Figs 20-29.
1923. *Sphaerophthalmus alatus* (BOECK); POULSEN, p. 49.
1927a. *Sphaerophthalmus alatus* (BOECK); CZARNOCKI, p. 12.
1927b. *Sphaerophthalmus alatus* (BOECK); CZARNOCKI, pp. 199, 201.
1943. *Sphaerophthalmus alatus* (BOECK); WESTERGÅRD in JOHANSSON, SANDIU & WESTERGÅRD, p. 55, Text-figs 35a-e.
1953. *Sphaerophthalmus alatus* ANGELIN [sic!]; HUPPE, p. 78, Fig. 32-4.
1957. *Sphaerophthalmus humilis* (PHILLIPS); HENNINGS­MOEN, pp. 215-217, Pl. 5, Pl. 22, Figs 12-14 (non Pl. 22, Figs 7, 11, 15 – *S. major*).
1967. *Sphaerophthalmus alatus* (BOECK); ORLOWSKI, p. 49 (including *S. alatus* and *S. major*).
1968. *Sphaerophthalmus humilis* (PHILLIPS); RUSHTON, p. 415, Text-figs 2-3a, Pl. 78, Figs 11-15.

1968b. *Sphaerophthalmus alatus* (BOECK); ORLOWSKI, pp. 272-273, part Text-fig. 8 (pygidium only), Pl. 6, Figs 7, 13 (non Pl. 6, Figs 1a-b, 6, 14 - *S. major*; part Text-fig. 8 (cranidium), non Pl. 4, Fig. 5, Pl. 5, Fig. 12, Pl. 6, Figs 2-5, 8-10, 12, 15 - *S. alatus*; part Text-fig. 8 (librigena), non Pl. 6, Fig. 11 - *Ctenopyge* (Cl.) *fletcheri*).

1973. *Sphaerophthalmus humilis* (PHILLIPS); CLARKSON, pp. 754-756, Text-figs 8a-d, Pl. 94, Fig. 6, Pl. 95, Figs 3-6.


1992. *Sphaerophthalmus humilis* (PHILLIPS); COPE & RUSHTON, Fig. 4g.


MATERIAL: Two librigenae, three pygidia, MUZWG ZI/29/0269 - 0272, 0741, 0743-0744, 0748, 0757, 0768, 0777.


Pygidium triangular, pleural regions approximately half as wide as pygidial axis. Axis strongly tapering posteriorly with three inter-ring furrows.

REMARKS: *Sphaerophthalmus humilis* is considered an unusual species because of the large size of the palpebral lobe and its very posterior position (CLARKSON 1973). The trilobite was extremely convex and the librigenae pointed downwards in an almost vertical position (see RUSHTON 1968, Text-fig. 2; CLARKSON 1973, Text-fig. 8, for reconstruction of cephalon). Therefore the animal was not able to rest upon the sea floor, and probably was an active swimmer (HENNINGSMOEN 1957, CLARKSON & TAYLOR 1995). *S. humilis* was noted in boreholes in the Leba Elevation (LENDZION 1976, 1982).


*Sphaerophthalmus major* LAKE, 1913 (Pl. 3, Figs 6-11)

1913. *Sphaerophthalmus major*; LAKE, p. 77, Pl. 8, Figs 7, 9-13 (non Fig. 8, it shows two librigenae, probably of a *Ctenopyge* species and a thorax, possibly of *S. major*).

1952. *Sphaerophthalmus major* LAKE; HUTCHINSON, p. 90, Pl. 4, Fig. 17 (non Pl. 4, Fig. 16 - *Ctenopyge* (Cl.) *fletcheri*).


1957. *Sphaerophthalmus alatus*; HENNINGSMOEN, Pl. 22, Figs 7, 11, 15 (non Pl. 22, Figs 12-14 - *S. humilis*).

1957. *Sphaerophthalmus minor* (s. i.); HENNINGSMOEN, p. 218 (error for *S. major*).

1967. *Sphaerophthalmus alatus* (BOECK); ORLOWSKI, p. 49 (including *S. humilis* and *S. alatus*).

1968. *Sphaerophthalmus major* LAKE; RUSHTON, pp. 416-419, Text-fig. 3b, Pl. 78, Figs 1-8.

1968b. *Sphaerophthalmus alatus* (BOECK); ORLOWSKI, pp. 272-273, Pl. 6, Figs 1a-b, 6, 14; (part Text-fig. 8 (pygidium), non Pl. 6, Figs 7, 13 - *S. humilis*; part Text-fig. 8 (cranidium), non Pl. 4, Fig. 5, Pl. 5, Fig. 12, Pl. 6, Figs 2-5, 8-10, 12, 15 - *S. alatus*, part Text-fig. 8 (librigena), non Pl. 6, Fig. 11 - *Ctenopyge* (Cl.) *fletcheri*).


TYPES: The lectotype is cranidium BGS GSM 8903, British Geological Survey, Keyworth, from the White-Leaved Oak, Malvern, Herefordshire and Worcestershire, England, UK; illustrated by LAKE (1913, Pl. 8, Fig. 7), selected and re-illustrated by RUSHTON (1968, p. 416, Pl. 78, Fig. 2).

MATERIAL: 32 cranidia, 2 pygidia, MUZWG ZI/29/0180, 0273-0291, 0294-0295, 0608, 0733, 0740-0741, 0743-0744, 0748, 0757, 0768, 0777.

BIOMETRIC DATA: Five parameters measured on 6 cranidia.

DESCRIPTION: Length of glabella 2.0-3.3 mm (n=6). S1 oblique backwards, connected across glabel-
la in an even curve. S2 indistinct. Occipital spine long, and in cases when it is missing, the occipital ring is elongated posteriorly in form of pointed tubercle. Anterior border short, strongly arched in anterior view. Eye ridges almost effaced, distinct only in few specimens. Palpebral lobe narrow, arched up in lateral view. Centres of palpebral lobes opposite S1. Fixigenae moderately wide, about two-thirds of glabellar width at mid-palpebral level, and about two-thirds width of occipital ring. 

Pygidium sub-triangular, slightly rounded posteriorly. Axis triangular, tapering posteriorly, with three inter-ring furrows. Furrows also present on the pleural fields. 

REMARKS: Specimens of Sphaerophthalmus alatus from Scandinavia were erroneously assigned to S. major by many Scandinavian authors (see remarks for S. alatus). The species is distinct from S. alatus in having the palpebral lobes situated more posteriorly, and the anterior ends of S1 situated further backwards in relation to the length of cephalic axis. Moreover, L1 is shorter than in S. alatus, as long as or slightly shorter than the length of the occipital ring. Sphaerophthalmus major was also noted from Wales, UK (TAYLOR & RUSHTON 1972; ALLEN & al. 1981). 

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation at Lisie Jamy, Leptoplastides or Protopeltura prae­cursor Zone. 

Angelina Salter, 1844 

Subfamily Oleninae Burmeister, 1844 

Angelina cf. hyeronimi (Kayser, 1876) 

(PL. 4, Figs 1-3) 


TYPES OF Angelina hyeronimi: The holotype (by monotypy) is a cranidium figured by Kayser (1876, PL. 1, Fig. 5). It was erroneously designated as lectotype by Harrington & Leanza (1957, Fig. 35:2) (see Přibyl & Vaněk 1980). 

MATERIAL: Two incomplete cranidia, MUZPIG 1042.II.81-82, one fragment of cranidium tentatively assigned to the species, MUZPIG 1042.II.83. 

BIOMETRIC DATA: Eleven parameters measured on 3 cranidia. 

DESCRIPTION: Length of cranidium 11.4 mm (n=1). Glabella as wide as long, sub-parallel, slightly rounded or truncated anteriorly. Length of glabella approximately 63% of cranidial length and approximately 80% if occipital ring is included. Glabella with low lateral profile, occipital ring poorly preserved. Medium sized palpebral lobes, situated moderately close to glabella. Small eye index approximately 21%, large eye index approximately 26%. Lateral glabellar furrows poorly visible; a faint indication of one short, oblique furrow is visible on MUZPIG 1042.II.81 (PL. 4, Fig. 2) and two short oblique furrows are present on a cranidial fragment tentatively assigned to the species (MUZPIG 1042.II.83 – PL. 4, Fig. 3). Frontal area with almost flat preglabellar field, passing into flat, sub-triangular anterior border, poorly differentiated from preglabellar field. Frontal area approximately 20% of total cranidial length, approximately 25% of occipital glabellar length and approximately 32% of total cranidial length. No pits present on the frontal area. Fixigenae
moderately wide, about one-third width of glabella at mid-palpebral level. Posterior limbs large, triangular, length of posterior limb about three-quarters of occipital ring width. Anterior part of facial suture sub-parallel from palpebral lobes to anterior border furrow, then curved sharply adaxially across anterior border and meeting at median point of cranidium. Posterior part of facial suture directed obliquely backwards, almost straight.

REMARKS: The specimens to hand are most similar to Angelina hyeronimi rather than to any other species of this genus mainly because of a rather short glabella, almost effaced lateral glabellar furrows and considerably larger posterior limbs. When comparing them to specimens of Parabolina coelatifrons HARRINGTON & LEANZA (1957, p. 109, Figs 3-a-h) (considered as a synonym of Angelina hyeronimi by ROBISON & PANTOJA-ALOR (1968) and TORTELLO & al. (1999)), then the similarities are even more obvious. Lack of the characteristic row of pits on the frontal area may be a result of preservation, a feature noted in both Angelina hyeronimi and Parabolina coelatifrons by HARRINGTON & LEANZA (1957), but the incompleteness and flattening of specimens does not allow certain assignment.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation in the Jeleniów 3 Borehole (106-108.5 m), Acracare Zone sensu lato. Angelina hyeronimi occurs in the Parabolina argentina Zone of Bolivia, Argentina and Mexico.

Olenus DALMAN, 1827

TYPE SPECIES: Entomostracites gibbosus WAHLENBERG, 1818*, designated by SALTER (1864, VIII, p. 3).

* non 1821, according to BRONGNIART (1822) and LINDSTRÖM (1884), the main body of the paper was already available in 1818 – see BASSETT & COCKS (1974), p. 40 for discussion.

Olenus solitarius (WESTERGÅRD, 1922)  
(Pl. 4, Fig. 4)

part 1922. Beltella solitaria n. sp.; WESTERGÅRD, p. 140, Pl. 14, Fig. 1 (non Fig. 2 – Protopeltura? sp.).
1957. Protopeltura? solitaria (WESTERGÅRD); HENNINGS­MOEN, pp. 220-231, Pl. 3.
part 1967. Protopeltura olenusorum n. sp.; ORLOWSKI, p. 49  
(including Protopeltura aciculata).
REMARKS: The specimen to hand is the holotype of *Protopeltura olenusorum* ORLOWSKI. Although poorly preserved, it resembles the specimen figured by WESTERGÄRD (1922, Pl. 14, Fig. 1) and assigned to *Belilla solitaria*. The syntypes of *Protopeltura olenusorum* ORLOWSKI differ from the holotype in the shape of the glabella, the size and position of the palpebral lobes as well as in the different shape of the posterior limbs. They are assigned here to *Protopeltura aciculata* (ANGELIN). WESTERGÄRD (1922) also figured another specimen as *Belilla solitaria*, treating the specimen in his Pl. 14, Fig. 1 as a juvenile form of the species in Fig. 2. As already noted by HENNINGSMOEN (1957), the two specimens bear too many differences to be included within one taxon. RUSHTON (1983) has recognised more complete material of *solitaria* from North Wales. The large similarities to the contemporary *Olenus cataractes* SALTER, the number of thoracic segments, the entire pygidium and the cheek spine in the course of the lateral margin allowed the transfer of the taxon to *Olenus*. NILKOLAISEN & HENNINGSMOEN (1985, p. 13) considered RUSHTON's (1983) specimens as representatives of *Leptoplaxides* RAW; because of two pygidial axial rings, whereas the contemporary species of *Olenus* (*Olenus veles* RUSHTON; *Olenus cataractes* SALTER and *Olenus microeus* SALTER) possess three or more axial rings on the pygidium. This view is not followed here, as the general morphology of the cranidium and librigenae are much closer to *Olenus* than to *Leptoplaxides*. The smaller number of axial rings in the pygidium recalls later onelines, e.g. *Protopeltura BRÖGGER*. *Orygmaspis* (Parabolinoidea) *clavilimbata* WESTROP from the Upper Cambrian of the Mackenzie Mountains in Canada and the Rocky Mountains in Alberta, Canada resembles *Olenus solitarius* in some respects, but differs in its anteriorly rounded glabella and lack of eye-ridges (PRATT 1992).


*Parabolina SALTER, 1849*

**TYPE SPECIES:** *Entomostracites spinulosus* WÄHLINBERG, 1818, by monotypy. The specimen, from which WÄHLINBERG made his drawing (p. 38, Pl. 1, Fig. 3), was figured by REYMONT (1976, Figs 1a, b).

REMARKS: At present, *Parabolina SALTER* is a heterogeneous collection of species with up to four lateral glabellar furrows, long, short or no pygidial spines, and broad to narrow fixigenae (CHATTERTON & LUDVIKSEN 1998). NILKOLAISEN & HENNINGSMOEN (1985) introduced a new subgenus, *Parabolina* (*Neoparabolina*), presenting diagnoses for both the new and the nominate subgenera. Distinguishing the subgenera is possible only when complete specimens are available. In taxa known only from detached parts, subgeneric assignment herein is tentative.

Subgenus *Parabolina SALTER, 1849*

**TYPE SPECIES:** As for genus.

REMARKS: The subgenus encompasses species with generally paired lateral glabellar furrows, not connected across the glabella. No species are known to possess a single dominant pair of macropleural spines along with a macrospine.

*Parabolina (Parabolina) heres BRÖGGER, 1882*

**(Pl. 4, Figs 5-7)**

part 1968b. *Parabolina lobata lobata* (BRÖGGER); TOMCZYKOWA, pp. 31-32, Pl. 1, Fig. 5 (non Pl. 1, Fig. 4 - *Parabolina (P.) frequens*).

1968b. *Parabolina sp. C*; TOMCZYKOWA, p. 34, Pl. 1, Fig. 20.

part 1968b. *Peltura sp. C*; TOMCZYKOWA, p. 43, Pl. 3, Figs 3-4 (non Pl. 3, Figs 1, 72 - *Peltura cf. transiens*).

REMARKS ON THE TYPES: The *Parabolina heres* group consists of:  
- *Parabolina (Parabolina) heres heres* BRÖGGER, 1882 (*Peltura transiens* to Acerocarc ecorne Zones) - the lectotype is a pygidium, Palaeontological Museum of Oslo no. 19948, figured by BRÖGGER (1882, Pl. 1, Fig. 13d), selected by HENNINGSMOEN (1957, p. 119);  
- *Parabolina (Parabolina) heres lata* MATTHEW, 1892 (*Westergardia Zone*) - the lectotype is a pygidium figured by MATTHEW (1892, Pl. 13, Fig. 6b), selected by HENNINGSMOEN (1957, p. 120), re-illustrated by RUSHTON (1982, Pl. 2, Fig. 1);  
- *Parabolina (Parabolina) heres megalops* MOBERG & MÖLLER, 1898 (*Peltura paradoxus Subzone*) - the lectotype is a cranidium figured by MOBERG & MÖLLER (1898, Pl. 13, Fig. 2), reproduced by WESTERGÄRD (1922, Pl. 7, Fig. 17), selected and re-illustrated by WESTERGÄRD (1944, p. 40, Pl. 1, Fig. 12).
MATERIAL: Two librigenae, in one case with counterpart, MUZPIG 1042.II.45, 61-61a, one pygidium tentatively assigned to the species, with counterpart, MUZPIG 1042.II.73-73a.

DESCRIPTION: Librigena with slender spine, as long as librigena proper, in course of lateral margin. Genal angle slightly acute, inner spine angle slightly obtuse, close to a right angle. Border narrow.

Pygidium sub-triangular. Axis not reaching posterior border, poorly differentiated posteriorly from the pleural regions. Margin with at least three short spines, directed inwards and backwards.

REMARKS: One of the analysed librigenae (MUZPIG 1042.II.45 – Pl. 4, Fig. 7) was tentatively assigned by TOMCZYKOWA (1968b) to Parabolina lobata lobata (BRØGGER). In this species, however, the librigena is wider (tr.), the spine is less slender, the palpebral lobe is larger and the inner spine angle is acute. This specimen, as well as specimen MUZPIG 1042.II.61-61a (Pl. 4, Fig. 6) recalls rather librigenae from the Parabolina (P.) heres group, e.g. Parabolina (P.) heres megalops MOBERG & MOLLER, Parabolina (P.) heres heres BRØGGER and Parabolina (P.) heres lata MATTHEW (see WESTERGÅRD 1909, PI. 1, Fig. 6; 1922, Pl. 7, Figs 25, 31; 1944, Pl. 1, Fig. 15), but accurate determination is not possible due to incompleteness of the specimens and the lack of other parts of the shield. This also applies to the tentatively assigned pygidium.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation in the Wilków IG-1 Borehole (838 m), Acerocare Zone sensu lato; Jeleniów 3 Borehole (109-116 m), Acerocare Zone sensu lato. Parabolina heres ranges from the top of the Peltura scarabaeoides Zone to the top of the Acerocare ecorne Zone in Scandinavia (megalops, heres, lata), New Brunswick, Canada (heres, lata), Wales, UK (heres).

Parabolina (Parabolina?) jemtlandica WESTERGÅRD, 1922
(Text-fig. 9; Pl. 4, Fig. 8)

1957. Parabolina jemtlandica WESTERGÅRD; HENNINGSMOEN, p. 121.
1964. Parabolina acanthura (ANGELIN); TOMCZYKOWA, p. 904.

1968a. Parabolina acanthura (ANGELIN); TOMCZYKOWA, p. 45.
1968b. Parabolina acanthura (ANGELIN); TOMCZYKOWA, pp. 29-30, Text-fig. 6, Pl. 1, Figs 1-3.
1990. Parabolina acanthura (ANGELIN); LENDZION, ORLOWSKI & TOMCZYKOWA, p. 63, Pl. 19, Figs 3a-b.

TYPES: The lectotype is a pygidium figured by WESTERGÅRD (1922, Pl. 7, Fig. 37) from Jämtland, Sweden, selected by HENNINGSMOEN (1957, p. 121).

MATERIAL: Incomplete cranidium with counterpart, MUZPIG 1042.II.37a, b.

BIOMETRIC DATA: Nine parameters measured on one cranidium.

DESCRIPTION: Length of cranidium 11.9 mm (n=1). Glabella sub-quadrangular, tapering forwards, rounded anteriorly. Length of glabella approximately 62% of cranidial length, approximately 79% if occipital ring is included. Glabella with rather low lateral profile, although distinctly above surface of fixigenae, separated from occipital ring by a rather shallow occipital furrow, which reaches the axial furrows abaxially. Occipital ring composite, with small median node, slightly wider than the pre-occipital glabella. Small palpebral lobes, situated anteriorly, opposite L3. Small eye index approximately 11%, large eye index approximately 14%. Lateral glabellar furrows shallow, not connected
across glabella. S1-S2 sinuous, S3 oblique and much shallower. Fixigenae moderately wide, about half glabellar width at mid-eye level, and about three-quarters of glabellar width posteriorly. Preglabellar field distinct, flat, passing into slightly convex anterior border of equal length. Anterior border slightly arched in anterior outline. Frontal area approximately 21% of total cranidial length, approximately 27% of occipital glabellar length and approximately 34% of total glabellar length. Eye-ridges distinct, narrow, slightly oblique, connected with glabella at level of anterior ends of S3.

Anterior part of facial suture divergent forwards, convex, posterior part of facial suture divergent backwards, slightly sinuous.

REMARKS: The described specimen was assigned by TOMCZYKOWA (1964, 1968a, b) to *P. acanthura* (ANGELIN), from which it differs in having wider fixigenae, broader anterior border and eyes situated opposite L3 (cf. NIKOLAISEN & HENNINGSMOEN 1985). The specimen actually seems to represent *P. (P.) jemtlandica*, the exact stratigraphic position of which is not known, although commonly referred to as the Acerocare Zone (HENNINGSMOEN 1957, ALLEN & al. 1981). Specimens of *P. (P.) jemtlandica* described by WESTERGARD (1922) bear similarities with specimens assigned to species of the *P. (P.) heres* group, particularly to *P. (P.) heres lata* MATTHEW, which are common in the Acerocare Zone sensu lato of Sweden and Wales. Although TOMCZYKOWA (1968b) noted these similarities in the case of the specimen reassigned here, they cannot be confirmed unequivocally due to the lack of librigenae and of other parts of the exoskeleton.


Subgenus *Neoparabolina* NIKOLAISEN & HENNINGSMOEN, 1985

TYPE SPECIES: *Parabolina frequens* (BARRANDE, 1868), including *P. argentina* (KAYSER, 1876) and *Parabolinella andina* HOEK in STEINMANN & HOEK, 1912, by original designation (NIKOLAISEN & HENNINGSMOEN 1985).

REMARKS: The subgenus includes species of *Parabolina* with five protruding spines (genal spines, a pair of macropleural spines on the eighth thoracic ter-

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*Parabolina (Neoparabolina?) dawsoni* MATTHEW, 1901 (Text-fig. 10; Pl. 4, Figs 10-11)

1901. *Parabolina Dawsoni* n. sp.; MATTHEW, p. 282, Pl. 5, Figs 6a-f.
1903. *Parabolina Dawsoni*; MATTHEW, p. 223-225, Pl. 17, Figs 6a-f.

1967. *Parabolina bella* n. sp.; ORLOWSKI, p. 49 (including *Parabolina (N.?) lapponica*).
1968a. *Parabolina bella* sp. n.; ORLOWSKI, pp. 269-270, Pl. 6, Fig. 18 (non Text-fig. 6, Pl. 6, Figs 16-17, 19-21 – *Parabolina (N.?) lapponica*).
1990. *Parabolina bella* ORLOWSKI; LENDZION, ORLOWSKI & TOMCZYKOWA, p. 63, Pl. 20, Fig. 1.

TYPES: The syntypes include specimens from the Peltura Zone in Nova Scotia, Canada figured by MATTHEW (1901, Pl. 5, Figs 6a-f; 1903, Pl. 17, Figs 6a-f). As suggested by HENNINGSMOEN (1957, p. 118), the lectotype should be chosen from among them.

MATERIAL: One cranidium with counterpart, MUZWG ZI/29/0319 (counterpart), 0528.

BIOMETRIC DATA: Thirteen parameters measured on one cranidium.

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Fig. 10. *Parabolina (Neoparabolina?) dawsoni* MATTHEW, MUZWG ZI/29/0528, from the Peltura minor Zone, Klonówka Formation. Scale bar represents 5 mm
DESCRIPTION: Length of cranidium 4.4 mm (n=1). Glabella sub-rectangular, tapering forwards, truncate anteriorly. Length of glabella approximately 77% of cranidial length and approximately 84% if occipital ring is included. Glabella convex laterally, raised above surface of fixigenae, which slightly slope downwards. Glabella separated from occipital ring by shallow, narrow, occipital furrow, reaching the axial furrows abaxially. Occipital ring slightly wider than pre-occipital glabella. Palpebral lobes of medium length, situated opposite L2. Eye-ridges not preserved. Small eye index approximately 32%, large eye index approximately 35%. S1 and S2 sinuous, shallow, faintly connected across glabella. Frontal area separated into anteriorly sloping preglabellar field and flat anterior border of equal length. Anterior margin slightly arched. Frontal area approximately 16% of total cranial length, approximately 19% of occipital glabellar width at mid-eye level, posterior limbs slightly narrower than palpebral lobes posteriorly, bent downwards and with broken off tips.

REMARKS: ORŁOWSKI (1968b) chose the specimen reassigned here to Parabolina dawsoni as the holotype of a new species, Parabolina bella. This specimen differs, however, from the paratypes of Parabolina bella figured by ORŁOWSKI (1968b, Pl. 6, Figs 16-17, 19-21) in some significant features. Its cranidium is narrower anteriorly, the preglabellar field and the anterior border, although of similar length (sag.), are shorter, the palpebral lobes are situated more anteriorly, no eyeridges are visible, and the occipital ring is also narrower (sag.). The paratypes of Parabolina bella are assigned here to Parabolina (N.?) lapponica WESTÉRGÅRD.

In the general outline and proportions of the glabella the specimen resembles Parabolina dawsoni MATTHEW from the Peltura Zone of Nova Scotia, Canada. HUTCHINSON (1952) showed that the species had fixigenae wider posteriorly than is seen on the originals of MATTHEW. The fixigenae on the specimen under discussion are quite narrow, but are bent downward and their posteriormost tips are not preserved. The closely related Parabolina (N.) lobata lobata (BRÖGGER) reveals variations in the shape of the palpebral ridges, position of palpebral lobes versus the glabella and width of the fixigenae posteriorly (WESTÉRGÅRD 1922, Pl. 7, Figs 1-8 of P. longicornis – synonym of P. (N.) lobata lobata; HENNINGSMOEN 1957, Pl. 9, Figs 9-11). NIKOLAISEN & HENNINGSMOEN (1985) tentatively assigned P. dawsoni to the subgenus Neoparabolina.


Parabolina (Neoparabolina) frequens (BARRANDE, 1868) (Text-fig. 11; Pl. 5, Figs 1-14)

1868. Olenus Guembeli. BARR. BARRANDE, p. 78, Fig. 14.
1868. Olen. frequens. BARR. BARRANDE, p. 79, Figs 15-17, 19.
1868. Olenus; BARRANDE, p. 80, Figs 20-21.
1868. Olen. expectans. BARR.; BARRANDE, p. 81, Fig. 18.
1876. Olenus argentinus n. sp.; KAYSER, p. 6, Pl. 1, Figs 1-3.
1896. Parabolina frequens Giembeli, BARR. (emend. BRÖGGER); BRÖGGER, pp. 211-213.
1912. Olenus cf. argentinus KAYSER; HOEK in STEINMANN & HOEK, p. 209, Pl. 7, Fig. 10.
1925. Acantholenus frequens BARRANDE sp.; WURM, p. 50, Pl. 1, Fig. 6.
1936. Olenus (?) argentinus KAYSER; KOBAYASHI, p. 95.
1937. "Olenus" argentinus (KAYSER); KOBAYASHI, p. 474, Pl. 4, Figs 6-9.
1937. Parabolina andina (HOUK); KOBAYASHI, p. 477, Pl. 4, Figs 10-13.
1938. Parabolina andina (HOEK) KAYSER; HARRINGTON, p. 198; HARRINGTON & LEANZA, p. 79, Figs 7, 9, 11.
1943. Parabolina andina (HOEK) KAYSER; HARRINGTON & LEANZA, p. 347, Pl. 2, Figs 1, 6.
1955. Parabolina frequens (BARRANDE); SEZUY, p. 15, Text-fig. 10, Pl. 3, Figs 58-70.
1957. Parabolina argentina (KAYSER); HENNINGSMOEN, pp. 116-117.
1957. Parabolina frequens (BARRANDE); HENNINGSMOEN, pp. 118-119.
1957. Parabolina argentina (KAYSER); HARRINGTON & LEANZA, pp. 81-85, Figs 25/1-5, 26/1-17.
1958. Parabolina argentina (KAYSER); FREDERICKSON, pp. 542-543, Pl. 80, Figs 1-5.
1964. Parabolina lobata lobata (BRÖGGER); TOMCZYKOWA, p. 904.
1965. Parabolina argentina (KAYSER); BRANISA, Pl. 1, Fig. 5.
1965. Parabolina sp.; BRANISA, Pl. 1, Fig. 9.
1968a. Parabolina pavna TOMCZYKOWA; TOMCZYKOWA, p. 45.
1968a. Parabolina secretata TOMCZYKOWA; TOMCZYKOWA, p. 45.
1968a. Parabolina bukowiana TOMCZYKOWA; TOMCZYKOWA, p. 45.

1968b. Parabolina lobata lobata (Brogger); Tomczykowa, pp. 31-32, Pl. 1, Fig. 4 (non Pl. 1, Fig. 5 – Parabolina (?!) heres).

1968b. Parabolina minima sp. n.; Tomczykowa, p. 32, Text-fig. 9, Pl. 2, Figs 1-3.

1968b. Parabolina parva sp. n.; Tomczykowa, pp. 32-33, Text-fig. 10, Pl. 2, Figs 4-7.

1968b. Parabolina secreta sp. n.; Tomczykowa, pp. 33-34, Text-fig. 11, Pl. 1, Figs 11-13.

1968b. Parabolina sp. A; Tomczykowa, p. 34, Pl. 1, Fig. 17.

1968b. Parabolina sp. D; Tomczykowa, p. 34, Pl. 1, Fig. 21.

1968b. Parabolina sp. indet.; Tomczykowa, p. 34, Pl. 1, Figs 22-26.

1980. Parabolina frequens argentina (Kayser); Príbyl & Vanečk, pp. 14-15, Pl. 2, Figs 1-3, Pl. 3, Figs 1-6; Pl. 4, Fig. 1; Pl. 5, Fig. 1, Pl. 26, Fig. 1.

1981. Parabolina argentina (Kayser); Allen, Jackson & Rushton, p. 317.

1982. Parabolina frequens (Barrande); Rushton, p. 50, Pl. 2, Fig. 15.


1985. Parabolina (Neoparabolina) sp.; Nikolaisen & Henningsmoen, pp. 11-12, Figs 13 H-J.

1988. Parabolina (Neoparabolina) frequens (Barrande); Morris, p. 164.

1990. Parabolina bukowiana Tomczykowa; Lendzion, Orłowski & Tomczykowa, pp. 63-64, Pl. 19, Figs 7a-b, 78.

1990. Parabolina lobata lobata (Brogger); Tomczykowa, Lendzion, Orłowski & Tomczykowa, p. 64, Pl. 19, Figs 4a-b.

1990. Parabolina minima Tomczykowa, Lendzion, Orłowski & Tomczykowa, p. 64, Pl. 19, Fig. 2.

1990. Parabolina parva Tomczykowa, Lendzion, Orłowski & Tomczykowa, pp. 64-65, Pl. 19, Fig. 1.

1990. Parabolina secreta Tomczykowa, Lendzion, Orłowski & Tomczykowa, p. 65, Pl. 19, Fig. 5.

TYPES: The neotype is a cranidium (Forschungs-Institut Senckenberg, no. X 1802a) from the Lower Tremadocian in Leimitz, Germany, selected and illustrated by Szüzy (1955, p. 16, Pl. 3, Fig. 58). Szüzy (1955) showed that all the forms of Olenus described by Barrande (1868), e.g. guembeli, frequens, expectans and Olenus sp. belonged to one species and chose the name frequens as the most appropriate.

MATERIAL: 15 cranidia, 7 librigenae, one thoracic axial spine, tentatively assigned to this species, one pygidium, in some cases with counterparts, Muzpig 1042.I.34a, 38-38a, 44-44a, 46-46a, 47-51, 52-52a, 53, 54-54a, 55-58,

Fig. 11. Variability expressed in cranidia of Parabolina (Neoparabolina) frequens (Barrande), from the Acerocare Zone sensu lato, Klonówka Formation. Scale bar represents 10 mm.
Fig. 12. Bivariate scatterplots showing relationship between a. total cranidial length and total glabellar length, b. occipital glabellar length and palpebral length, and c. total cranidial length and frontal area length in Parabolina (Neoparabolina) frequens (Barrande) from the Jeleniów 3 and Bukowiany 1a boreholes, n=7

Biometric data: Thirteen parameters measured on ten cranidia.

Description: Length of cranidium 2.0-15.6 mm (n=7). Glabella sub-rectangular, slightly rounded anteriorly. Length of glabella 70±4% of total cranidial length (Text-fig. 12a), 85±2% if occipital ring is included. Glabella rather flat, only slightly elevated above surface of fixigenae, but distinctly outlined by deep axial, preglabellar and occipital furrows. Occipital ring simple, with small node in posterior part. Occipital furrow generally deep, although slightly shallower in some specimens. Occipital ring slightly wider than pre-occipital glabella. Palpebral lobes of medium size, situated at level of L2, connected by distinct, strongly oblique eye-ridges with points slightly below the anterolateral corners of glabella. Small eye index 18-22% (Text-fig. 12b), large eye index 23-27%. Lateral glabellar furrows of variable depth, depending on degree of flattening. S1 always transglabellar, sinuous; S2 typically transglabellar, slightly less sinuous than S1, although in some specimens much shallower medially, and in this case appearing as not connected across glabella. S3 nearly effaced, slightly oblique and not connected across glabella. Frontal area separated by deep anterior border furrow into flat preglabellar field and slightly longer, convex anterior border. Anterior border often sub-triangular. Frontal area 15±2% of total cranidial length (Text-fig. 12c), 17±3% of occipital glabellar length and 21±4% of total glabellar length. Fixigenae about 1/3 glabellar width at mid-palpebral level. Posterior limbs slightly narrower than glabellar width posteriorly. Anterior part of facial suture slightly divergent to slightly convergent, posterior part of facial suture almost straight, strongly divergent backwards.

Librigena with long spine, confluent or slightly divergent from lateral margin. Genal angle and inner spine angle close to a right angle. Border relatively wide. Librigenae fused by median suture.

Pygidium semi-elliptical. Axis with four inter-ring furrows. Margin with at least three pairs of spines.

Thorax not preserved, but the eleventh tergite possessed a macrospine (specimen MUZP1G 1042.II.63).

Remarks: Comparison of the illustrated collections of the subspecies of Parabolina (Neoparabolina) frequens [P. (N) frequens frequens (Barrande) - Szudy 1955, Rushton 1982; P. (N) frequens argentina (Kayser) - Harrington & Leanza 1957, Přibyl & Vaněk 1980; P. (N) frequens finnmarchica - Nikolaiesen & Henningsmoen 1985] shows a large morphologic variation within these subspecies. In the cranidium, the morphologic variation applies particularly to the length (sag., exs.) of the anterior border, length (sag.) of the preglabellar field, degree of effacement of the lateral glabellar furrows and degree of divergence of the anterior parts of facial sutures. For example, cranidia of P. (N) frequens argentina have rather broad cranidial and librigenal borders (Přibyl & Vaněk 1980), and thus differ from cranidia of P. (N) frequens finnmarchica. However, some cranidia of the latter form (Nikolaiesen & Henningsmoen 1985, p. 11) also have broad cranidial and librigenal borders. The anterior parts of facial sutures are convergent forwards in P. (N) frequens finnmarchica, convergent to divergent forwards in P. (N) frequ-
quens frequens and divergent to sub-parallel in P. (N.) frequens argentina. NIKOLAISEN & HENNINGSMOEN (1985) discussed some cranidia similar to P. (N.) frequens argentina with divergent anterior sutures from the same strata as P. (N.) frequens finnmarchica. These cranidia are distorted, and the anterior parts of the facial sutures thus appear more divergent than in reality. These forms are included here in Parabolina (N.) frequens. The degree of efiacement of the lateral glabellar furrows within the particular subspecies is also variable (cf. SDZUY 1955, Pl. 3, Figs 58-61; HARRINGTON & LEANZA 1957, Figs 26: 1-17; PRIHYL & VANEX 1980, Pls 2-4). The librigenae of the three subspecies have a spine, which is either confluent with the lateral margin [P. (N.) frequens finnmarchica], or deviates slightly outwards [P. (N.) frequens frequens and P. (N.) frequens argentina]. Again, in P. (N.) frequens frequens, some of the librigenae have spines confluent with the lateral margin (SDZUY 1955, Pl. 3, Fig. 64). The inner spine angle is also variable; generally obtuse in P. (N.) frequens argentina, obtuse or close to a right angle in P. (N.) frequens frequens, to acute in P. (N.) frequens finnmarchica as presumed from the reconstruction (NIKOLAISEN & HENNINGSMOEN 1985, Fig. 4). However, the holotype specimen of the latter species (illustrated by NIKOLAISEN & HENNINGSMOEN 1985, Figs 11C-D) shows an obtuse inner spine angle! The pygidia with the axis reaching near the posterior margin are identical in P. (N.) frequens argentina and P. (N.) frequens finnmarchica. To conclude, the three subspecies of P. (N.) frequens, frequens, argentina and finnmarchica fall into the variability of P. (N.) frequens and hence cannot be maintained.

The above analysis also largely applies to the material of Parabolina (N.) frequens from the Holy Cross Mountains (Text-fig. 11). On the base of this material, TOMCZYKOWA (1968a, b) erected four new species of Parabolina, P. bukowiana, P. minima, P. parva and P. secreta. The specimens, represented mainly by cranidia, are typically incomplete, in some cases distorted and flattened. Detailed analysis of biometric data (Text-fig. 12) and comparison with the illustrated collections of P. (N.) frequens allow assignation of this apparently diverse group to one species. Specimen MUZP1G 1042.II.44-44a (Pl. 5, Fig. 8), assigned by TOMCZYKOWA (1968b, pp. 31-32) to Parabolina (N.) lohata lohata, has also been included in P. (N.) frequens, as, although similar in many respects, it differs from P. (N.) lohata lohata (WESTERGÅRD 1922, Pl. 7, Figs 1-8, 18-20, 23; WESTERGÅRD 1944, Pl. 1, Figs 4-8; HENNINGSMOEN 1957, Pl. 9, Figs 9-11) in much narrower fixigenae at palpebral level and posteriorly.

Specimen MUZP1G 1042.II.38b (holotype pygidium of Parabolina bukowiana TOMCZYKOWA) has not been traced in the collection. From the original illustrations (TOMCZYKOWA 1968b, Pl. 1, Fig. 16), this fragmentary pygidium seems much narrower than the typical pygidia of P. (N.) frequens, and the pleural spines, although having the same number and position, are shorter and more broadly based.

As discussed below, Parabolina (N.) lapponica is probably a species closely related to Parabolina (N.) frequens.


**Parabolina (Neoparabolina?) lapponica** WESTERGÅRD, 1947

(Text-fig. 13; Pl. 6, Figs 1-10; Pl. 7, Figs 1-3, 7)

1890. Parabolina spinulosa; HOLM, p. 264.
1922. Parabolina spinulosa; WESTERGÅRD, p. 96.
1947. Parabolina lapponica sp. n.; WESTERGÅRD, p. 14, Pl. 3, Fig. 8.
1957. Parabolina lapponica WESTERGÅRD; HENNINGSMOEN, p. 122, Pl. 6.
part 1967. Parabolina bella n. sp.; ORLOWSKI, p. 49 (including Parabolina (N.) dawsoni).
1968a. Parabolina latilimbata TOMCZYKOWA; TOMCZYKOWA, p. 45.
1968b. Parabolina latilimbata sp. n.; TOMCZYKOWA, p. 31, Text-fig. 8, Pl. 1, Figs 6-10.
1968b. Olenidae gen., sp. indet.; TOMCZYKOWA, p. 44, Pl. 3, Fig. 31.
part 1968b. Parabolina bella sp. n.; ORLOWSKI, pp. 269-270, Text-fig. 6, Pl. 6, Figs 16-17, 19-21 (non Pl. 6, Fig. 18 – Parabolina (N.) dawsoni).
part 1968b. Beliella irae n. sp.; ORLOWSKI, pp. 270-272, part Text-fig. 7 (librigena only), Pl. 5, Fig. 12 (non Pl. 5, Figs 1-11, 13-15 – Leptoplastides ine).
1990. Parabolina latilimbata TOMCZYKOWA, LENDZION, ORLOWSKI & TOMCZYKOWA, p. 64, Pl. 19, Fig. 6.
LATE CAMBRIAN TRILOBITES FROM CENTRAL POLAND

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TYPES: The holotype (by monotypy) is cranidium No. Ar. 106, Paleozoological Department of the Swedish Museum of Natural History, Stockholm, from Southern Lapland, Sweden, illustrated by WESTERGÅRD (1947, Pl. 3, Fig. 8).


BIOMETRIC DATA: Thirteen parameters measured on nine cranidia.

DESCRIPTION: Length of cranidium 2.2-18.9 mm (n=5). Glabella sub-rectangular, slightly tapering forwards, bluntly rounded anteriorly. Length of glabella 61±2% of cranidial length, 77±2% if occipital ring is included. Glabella convex, moderately elevated above fixigenae. Glabella separated from occipital ring by shallow, distinct occipital furrow, reaching axial furrows abaxially. Occipital ring complex, with small median node situated posteriorly, occipital ring slightly wider than pre-occipital glabella. Palpebral lobes situated opposite L2, smaller in large specimens and larger in small specimens. Small eye index 19-29%, large eye index 24-36%. Eye-ridges distinct, but not prominent, strongly oblique, connecting anterior tips of palpebral lobes with axial furrows slightly below anterolateral corners of glabella. Three lateral glabellar furrows, S1 deep and strongly sinuous, transglabellar, S2 slightly shallower, transglabellar; S3 short, slightly oblique, faintly visible in some specimens. Frontal area with flat preglabellar field and strongly convex anterior border. In flattened specimens anterior border appears longer than in specimens with more or less original convexity. Frontal area 23±2% of total cranidial length, 29±3% of occipital glabellar length and 37±3% of total glabellar length. Anterior border furrow narrow, well incised. Fixigenae about one-third glabellar width at mid-palpebral level, posterior limbs narrower than glabella posteriorly, with distinct posterior border furrow.

Librigenae with long spine diverging only slightly from course of lateral margin. Genal angle slightly acute. Inner spine angle close to a right angle. Border wide, of equal width to doublure. Border covered with fine terrace lines, sub-parallel to librigenal margin. Librigenae separated by median suture. Surface finely pitted, both on cranidia and librigenae.

REMARKS: Until now, Parabolina (N?) lapponica was known only from a few cranidia, of which only the holotype was illustrated (WESTERGÅRD 1947, Pl. 3, Fig. 8). The Polish material, although incompletely preserved and distorted, resemble this type specimen in all respects. Analysis of a larger sample of cranidia reveals the variable length of the preglabellar field and the anterior border depending on the state of preservation. Librigenae, which commonly co-occur with cranidia of Parabolina (N?) lapponica in Chabowe Doly Mill and Ravine, have also been assigned to this species. Their proportions and thick lateral border recall librigenae assigned to Parabolina (N) frequens (SIDZUY 1955; HARRINGTON & LEANZA 1957; PRIEL & VANEK 1980; NIKOLAISEN & HENNINGSMOEN 1985), although large librigenae from Chabowe Doly Mill have the spine almost in line with the course of the lateral margin. It is also interesting to note that the cranidia of Parabolina (N) frequens also possess quite large palpebral lobes connected to the anterolateral corners of the glabella by strongly oblique eye-ridges and the glabella bears two transglabellar lateral furrows. The two taxa might be closely related. The rather long (sag.) preglabellar field of Parabolina (N?) lapponica also recalls the cranidia assigned to species of Parabolinites HENNINGSMOEN and Parabolinella BROGGER.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation at Chabowe Doly Mill, Peltura minor Zone; Chabowe
Doly Ravine, Peltura scarabaeoides Zone (linnarsoni Subzone); Jeleniów 3 (109-116 m) and Bukowiany 1a (238-243 m) boreholes, Acerocare Zone sensu lato. In Sweden: Peltura scarabaeoides Zone.

Parabolina sp.  
(Pl. 7, Figs 4-5, 7)

MATERIAL: 7 pygidia, generally incomplete, in some cases with counterparts, MUZWG ZI/29/0288, 0497, 0570, 0620, 0624, 0636, 0774.


REMARKS: The pygidia occur in the same beds as cranidia and librigenae of Parabolina (N?) lapponica WESTERGARD, and they might belong to this species. The pygidia recall those of species of the P. lobata group, e.g. Parabolina (N.) lobata and Parabolina (N.) frequens.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation at Chabowe Doly Mill, Peltura minor Zone; Chabowe Doly Ravine, Peltura scarabaeoides Zone (linnarsoni Subzone).

Parabolina BRÖGGER, 1882

TYPE SPECIES: Parabolina limitis BRÖGGER, 1882, from the Ceratopyge Shale, Oslo, Norway, designated by BASSLER (1915).

Parabolinellites? sp.  
(Text-fig. 14)

MATERIAL: Fragment of cranidium, MUZPIG 1042.II.79.

DESCRIPTION: Posterior part of glabella with one geniculate, oblique backwards, lateral glabellar furrow. Occipital furrow composite, occipital ring with very small median node.

REMARKS: The geniculate lateral glabellar furrow and the composite occipital furrow recall those of cranidia assigned to Parabolinella BRÖGGER or Hypermecaspis HARRINGTON & LEANZA. Both genera are related (HARRINGTON & LEANZA 1957; EBBESTAD 1999) and occur predominantly in Ordovician strata. Species of Parabolinella, however, rarely possess accessory lateral glabellar furrows between the occipital furrow and S1 (RUSHTON 1988), whereas in Hypermecaspis this feature is very common (EBBESTAD 1999). Therefore, due to lack of accessory lateral glabellar furrows, the specimen in question recalls specimens assigned to Parabolinella BRÖGGER, Parabolinella contracta? LU & ZHOU and Parabolinella? simplex (SALTER) as well as Parabolinella? sp. have been identified in the Upper Cambrian of North Wales (RUSHTON 1982; MORRIS 1988).


Parabolinellites HENNINGSMOEN, 1957

TYPE SPECIES: Parabolinellites laicatada WESTERGÅRD, 1922, from the Upper Cambrian, Andrarum, Scania, Sweden; by original designation.

Parabolinellites? sp.  
(Pl. 7, Fig. 6)

MATERIAL: One incomplete cranidium, MUZWG ZI/29/0680.

DESCRIPTION: Cranidium probably longer than wide. Glabella sub-parallel, rounded anteriorly, rather flat transversely. Lateral glabellar furrows not preserved. Palpebral lobe small, situated slightly in front of glabellar transverse mid-line. Frontal area very long, at least one-
quarter occipital-glabellar length, not differentiated into preglabellar field and anterior border. Fixigenae about one-third of glabellar width at mid-palpebral level, only slightly wider posteriorly. Posterior border widening abaxially. Anterior part of facial suture sub-parallel in front of palpebral lobes, posterior part of facial suture slightly sinuous.

REMARKS: The cranidium is too poorly preserved to allow unequivocal assignment to a genus. It differs from all of the other cranidia from Chabowe Doly Mill. The rather long (sag.) frontal area, and the position and size of the palpebral lobes recall cranidia assigned to *Parabolinites* HENNINGSMOEN, e.g. of *Parabolinites laticaudus* (WESTERGÅRD) (particularly of a specimen with effaced eye-ridges – WESTERGÅRD 1922, Pl. 8, Fig. 2), but a different generic assignment is also possible.


*Plicatolina* SHAW, 1951

TYPE SPECIES: *Plicatolina kindlei* SHAW, 1951, from the Upper Cambrian of Vermont, USA, by original designation.

*Plicatolina* sp.

(Pl. 4, Fig. 9)


MATERIAL: One incomplete cranidium with counter-part, MUZPIG 1042.II.60-60a.

DESCRIPTION: Only the anterior part of the cranidium is preserved. Glabella truncate anteriorly, anterior margin slightly rounded, with shallow median indentation. Palpebral lobes small, situated opposite L3, at a distance from glabella of less than half glabellar width at mid-palpebral level. Eye-ridges distinct, slightly oblique, connecting anterior tips of palpebral lobes with points slightly posterior to the anterolateral corners of glabella. S1 not preserved, S2 deep, sinuous, connected across glabella, S3 long, not connected across glabella, S4 shallow, slightly oblique. Frontal area with flat preglabellar field and slightly shorter, somewhat steep anterior border.

REMARKS: *Plicatolina* is closely related to *Parabolina* as well as to the Tremadocian *Bienvillia* CLARK. Characterised by a large number of thoracic segments (at least seventeen in the type species), the genus is distinguished from other olenids with a similar number of thoracic segments (i.e. nineteen in *Westelgaardites* TROEDSSON or sixteen in *Wujiajiania* LU & LIN) by four distinct lateral glabellar furrows and a median indentation in the anterior part of the glabella.


Subfamily Pelturinae HAWLE & CORDA, 1847

*Acerocare* ANGELIN, 1854

TYPE SPECIES: *Acerocare ecome* ANGELIN, 1854, by monotypy.

*Acerocare* sp.

(Pl. 8, Figs 1-2, 4-5)


MATERIAL: Four cranidia, one librigena, MUZPIG 1042.II.77-77a, 78-78a, 79, 79a, 109b.

BIOMETRIC DATA: Six parameters measured on 3 cranidia.

DESCRIPTION: Only the anterior part of the cranidium is preserved. Glabella truncate anteriorly, anterior margin slightly rounded, with shallow median indentation. Palpebral lobes small, situated opposite L3, at a distance from glabella of less than half glabellar width at mid-palpebral level. Eye-ridges distinct, slightly oblique, connecting anterior tips of palpebral lobes with points slightly posterior to the anterolateral corners of glabella. S1 not preserved, S2 deep, sinuous, connected across glabella, S3 long, not connected across glabella, S4 shallow, slightly oblique. Frontal area with flat preglabellar field and slightly shorter, somewhat steep anterior border.

REMARKS: The cranidium is too poorly preserved to allow unequivocal assignment to a genus. It differs from all of the other cranidia from Chabowe Doly Mill. The rather long (sag.) frontal area, and the position and size of the palpebral lobes recall cranidia assigned to *Parabolinites* HENNINGSMOEN, e.g. of *Parabolinites laticaudus* (WESTERGÅRD) (particularly of a specimen with effaced eye-ridges – WESTERGÅRD 1922, Pl. 8, Fig. 2), but a different generic assignment is also possible.


Subfamily Pelturinae HAWLE & CORDA, 1847

*Acerocare* ANGELIN, 1854

TYPE SPECIES: *Acerocare ecome* ANGELIN, 1854, by monotypy.
length, 23-30% of occipital glabellar length, 25-33% of total glabellar length. Fixigenae about one-quarter width of glabella at mid-palpebral level, posterior limbs slightly more than half as wide as glabella posteriorly. Anterior part of facial suture sub-parallel forwards, posterior part of facial suture strongly divergent outwards and backwards, posterior limbs rounded abaxially.

Librigena pelturoid, without spine. Lateral border of moderate width.

REMARKS: The specimens are rather poorly preserved, but the position of the palpebral lobes, the shape and proportions of the frontal area, and the shape of fixigenae as well as the proportions of the glabella confirm their assignment to Acerocare. The significant difference is in the lack of lateral glabellar furrows, which might be a result of preservation. MÜZPIG 1042.II.79a (Pl. 8, Fig. 4) resembles Pelturina HENNINGSMOEN, but the palpebral lobes are situated more anteriorly than in that genus. The fixigenae are also not completely preserved. This suggests that Acerocare may be related to late species of Peltura, from which Pelturina probably evolved. The analysed specimens do not bear the tubercles near the anterior corners of the cranidium that are characteristic of the two species assigned to Acerocare [A. ecorne ANGELIN, A. tullbergi (MOBERG & MÖLLER)].

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation in the Brzezinki 2 (30-40 m), Jeleniów 3 (109-116 m) and Bukowiany 1a (238-243 m) boreholes, Acerocare Zone sensu lato. Acerocare occurs in Norway and Sweden in the Acerocare ecorne Zone.

Acerocarina POUlsen, 1952

TYPE SPECIES: Cyclognathus micropygus LINNARSSON, 1875, by original designation.

Acerocarina klonówkae (ORŁOWSKI, 1968) (Text-fig. 16; Pl. 7, Figs 8-9; Pl. 8, Figs 3, 6-10)

part 1967, Acerocare (?) klonówkae n. sp.; ORŁOWSKI, p. 49 (including Peltura sp.).

part 1968b, Acerocare? klonówkae sp. n.; ORŁOWSKI, pp. 278-279; Text-fig. 12, Pl. 8, Figs 6-10 (non Pl. 8, Fig. 11 – Peltura sp.).

1990, ?Acerocare klonówkae ORŁOWSKI; LENDZION, ORŁOWSKI & TOMCZYKOWA, p. 67, Pl. 20, Fig. 7.

Fig. 15. Bivariate scatterplot showing relationship between total cranidial length and occipital glabellar length in Acerocarina klonówkae (ORŁOWSKI) from Chabowe Doly Mill and Ravine, n=10

TYPES: The holotype is cranidium MUZWG ZI/29/0545, from the Upper Cambrian, Chabowe Doly Ravine, Holy Cross Mountains, illustrated by ORŁOWSKI (1968b, Pl. 8, Fig. 6) and LENDZION & al. (1990, Pl. 20, Fig. 7) (Pl. 8, Fig. 8 of this paper). Paratypes are in the ORŁOWSKI collection, MUZWG ZI/29.

MATERIAL: 25 cranidia, 3 librigenae, often with counterparts, MUZWG ZI/29/0287, 0537-0552, 0611, 0615, 0744, 0747, 0762-0763, 0766, 0768-0770.

BIOMETRIC DATA: Eleven parameters measured on 13 cranidia.

EMENDED DIAGNOSIS: A species of Acerocarina with tapering glabella, palpebral lobes slightly posterior to the preglabellar furrow, effaced lateral glabellar furrows, convex posterior part of genal suture and librigenae without spine. Thorax and pygidium not known.

DESCRIPTION: Cranidium sloping downwards anteriorly. Length of cranidium 2.8-9.1 mm (n=10). Glabella sub-rectangular, tapering downwards, truncated or slightly rounded anteriorly. Length of glabella 68±6% of cranidial length, 82±2% if occipital ring is included (Text-fig. 15). Glabella only slightly elevated above surface of fixigenae, separated from occipital ring by rather shallow occipital furrow, not reaching axial furrows abaxially. Occipital ring smooth, but with small node in some smaller specimens. Width of occipital ring slightly exceeds pre-occipital glabellar width. Palpebral lobes small, situated rather close to glabella, slightly posterior to the preglabellar furrow. Large eye index 17±2%, small eye index 14±2%. Glabellar furrows effaced, only a faint indication of two pairs of short, oblique furrows present on specimen MUZWG
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ZI/29/0770. Frontal area sloping forwards and downwards, not separated into preglabellar field and anterior border. Frontal area 18±2% of total cranidial length, 22±3% of occipital glabellar length, 27±4% of total glabellar length. In larger specimens (e.g. MUZWG ZI/29/0546 – PI. 8, Fig. 3) anterior margin slightly convex backwards. Fixigenae about one-fifth of glabellar width at mid-palpebral level. Posterior limbs strongly convex, sloping downwards, width of posterior limb three-quarters width of occipital ring, in flattened specimens must have been much larger. Posterior margin with distinct fulcrum situated at its mid-point.

Librigena typically pelturoid, narrow, without spine. Borders narrow, of even width.

REMARKS: Although the anterior part of the cranidium, with its rather long (sag.) frontal area, recalls species assigned to Acerocare, particularly Acerocare ecome ANGELIN, the specimens differ from them in the tapering glabella, the palpebral lobes slightly posterior to the preglabellar furrow, the effaced lateral glabellar furrows, the convex posterior part of genal suture and the absence of a spine on the (newly recognised) librigenae. In these respects, the specimens are closer to Acerocarina, particularly Acerocarina micropyga (LINNARSSON) from the Peltura costata Zone in Scandinavia. Acerocarina klonowkae also resembles species of the Tremadocian genus Peltocare HENNINGSMOEN, e.g. Peltocare norvegicum (MOBERG & MÖLLER) and Peltocare compactum (NIKOLAISEN & HENNINGSMOEN 1985), but differs in its much narrower glabella (tr.) and longer (sag.) frontal area.

The librigena previously assigned to this species (ORŁOWSKI 1968b, Pl. 8, Fig. 11; Pl. 13, Fig. 17 of this paper) belongs neither to Acerocare nor to Acerocarina. It actually represents a species of Peltura (see below), but being incomplete, it cannot be assigned with confidence to any of the known species of that genus.


Leptoplastides RAW, 1908

SYNONYMS: Parabolinopsis HOEK in STEINMANN & HOEK, 1912; Beltella LAKE, 1919; Andesaspis KOBAYASHI, 1935.

TYPE SPECIES: Olenus salteri CALLAWAY, 1877, by original designation.

REMARKS: Andesaspis (type species Andesaspis argentinensis KOBAYASHI) was considered as a partial junior synonym of Parabolinopsis (type species Parabolinopsis mariana HOEK in STEINMANN & HOEK) (the pygidia associated with Andesaspis argentinensis belong to Pseudokainella lata (KOBAYASHI) – see HARRINGTON & LEANZA 1957; NIKOLAISEN & HENNINGSMOEN 1985). HENNINGSMOEN (1957) regarded Parabolinopsis as a synonym of Leptoplastides. These assignments can be accepted without question. On the other hand, the view that Beltella may be considered as a synonym of Leptoplastides (HENNINGSMOEN 1957; WHITWORTH 1972; NIKOLAISEN & HENNINGSMOEN 1985; MORRIS 1988) has often been rejected (FORTÉY & OWENS 1991a, b).

The type species of Beltella and Leptoplastides, Beltella depressa (SALTER in MURCHISON) and Leptoplastides salteri (CALLAWAY), were, until recently, known only from distorted specimens (LAKE 1919, STUBBLEFIELD 1933) or lacked good photographic documentation (CALLAWAY 1877; LAKE 1919; RAW 1925). Undistorted and only slightly flattened specimens of Beltella depressa were discovered in Gloucestershire, England (UK) and on

Fig. 16. Acerocarina klonowkae (ORŁOWSKI), from the Peltura minor and Peltura scarabaeoides Zones, Klónowka Formation; a. cranidium, b. flattened librigena. Scale bar represents 5 mm
with regard to Beltella as junior synonym of Beltella depressa. Based on this, both type species were reconstructed (Forte & Owens 1991a, Figs 2 - Beltella depressa; Forte & Owens 1991b, Fig. 9 - Leptoplastides salteri). These taxa have similar cephalic features, similar convexity of the axis and the entire exoskeleton, and the librigenae possess spines of medium length, which slightly deviate from the lateral margin. The main differences, on the basis of which Forte & Owens (1991a, b) retained both genera, include the median axial spines on the occipital ring and the thoracic spine, as well as blunt posteralateral pleural spines in Leptoplastides salteri. Whittington (1996) doubted the importance of such differences in generic classifications, and presented a slightly different reconstruction of Beltella depressa (Whittington 1996, Text-fig. 2), showing that the animal had a much more convex exoskeleton, similar to that of Peltura scarabaeoides scarabaeoides (Whittington 1996, Pl. 2, Figs 1-4) or Leptoplastides salteri (Forte & Owens 1991b, Fig. 9), compared to that in the reconstruction of Forte & Owens (1991a, Fig. 2).

The median axial spines and the blunt posteralateral pleural spines, considered of generic significance in distinguishing Beltella and Leptoplastides (Forte & Owens 1991a, b), are not restricted to species of Leptoplastides. Beltella nodifer Rushston from the Acrocara Zone in North Wales bears distinct median axial nodes (Rushston 1982, Pl 3, Fig. 9) and Beltella versimilla (Salter) (considered a synonym of Beltella depressa - Whitworth 1972; Nikolaisen & Henningsmoen 1985) possesses calcite pleural tips also on the posterior pleurae (Lake 1919, p. 108; Nikolaisen & Henningsmoen 1985, p. 12). Axial nodes are present on the thoracic segments of Beltella depressa from Gloucestershire, figured by Forte & Owens (1991a, Pl. 1, Fig. A) and Whittington (1996, Pl. 1, Fig. 4)! According to Whittington (1996, p. 386), pleural spines can be lost during the ontogenetic development in some olenids (i.e. Triarthrus beckii Green - see Whittington 1992, PIs 38b, 39c, 40).

Beltella Lake, 1919 should thus be referred to as a junior synonym of Leptoplastides Raw, 1908. An emended diagnosis of the latter genus was presented by Nikolaisen & Henningsmoen (1985, p. 12).

Leptoplastides (sensu Nikolaisen & Henningsmoen 1985) was assigned on the one hand to the Oleniniae (Nikolaisen & Henningsmoen 1985; with regard to Beltella Lake - also Tomczykowa 1968b), and on the other hand to the Pelturinae (Forte & Owens 1991a - with regard to Beltella Lake; Forte & Owens 1991b - with regard to Leptoplastides sensu Henningsmoen 1957). I follow Forte & Owens (1991a, b) in assigning Leptoplastides (sensu Nikolaisen & Henningsmoen 1985) to the Pelturinae, as the genus encompasses species with:

- a considerable convexity of the exoskeleton, similar to that of Peltura scarabaeoides scarabaeoides (Forte & Owens 1991b; Whittington 1996);
- a broadly arched anterior cephalic margin, as in Peltura or Peltocare;
- the glabella and fixigenae in the form of a broad arch about the midline in anterior view, as in most pelturines (other than Protopeltura);
- the glabella dominating on the cranidium;
- librigenae with moderately long genal spines, typically angular to the lateral margin; librigenal spines of pelturines can reach a moderate length, and usually deviate slightly from the course of the lateral margin.

Leptoplastides coniunctus (Tomczykowa, 1968)
(Pl. 9, Figs 1-4)

1968a. Beltella coniuncta Tomczykowa; Tomczykowa, p. 45.
1968b. Beltella coniuncta sp. n.; Tomczykowa, p. 38, Fig. 12, Pl. 2, Figs 31-35.
1990. Beltella coniuncta Tomczykowa, Lendzion, Orłowski & Tomczykowa, p. 67, Pl. 21, Fig. 6.

TYPES: The holotype is cranidium Muzpig 1042.II.29, figured by Tomczykowa (1968b, Pl. 2, Fig. 33), Lendzion & al. (1990, Pl. 21, Fig. 6), (Pl. 9, Fig. 1 in this paper) from the leleni6w 3 borehole, 143-144 m. Paratypes are in the Tomczykowa collection, Muzpig 1042.II.30-33.

MATERIAL: Three cranidia, two librigenae, in some cases with counterparts, Muzpig 1042.II.29-33, 34c (counterpart of 30).

BIOMETRIC DATA: Ten parameters measured on 3 cranidia.

EMENDED DIAGNOSIS: A species of Leptoplastides with transglabellar lateral glabellar furrows, small palpebral lobes situated opposite L3, no eye-ridges, narrow fixigenae and librigenae with short spine.

DESCRIPTION: Length of cranidium 9.3-10.1 mm (n=3). Glabella tapering slightly forwards, bluntly rounded anteriorly. Length of glabella 63-68% of total cranidial length, 79-81% if occipital ring is included. Glabella rather flat, only slightly elevated above surface of fixigenae. Occipital ring simple, occipital furrow dis-
distinct, reaching the axial furrows adaxially. Occipital ring only slightly wider than pre-occipital glabella. Palpebral lobes rather small, situated opposite L3. Small eye index 9-13%, large eye index 11-16%. Eye-ridges not distinguishable. Two transglabellar lateral glabellar furrows, bent strongly backwards. Frontal area separated by straight anterior border furrow into flat preglabellar field and slightly longer, convex, sub-angular anterior border. Frontal area 19-21% of total cranidial length, 24-26% of occipital glabellar length, 30-33% of total glabellar length. Fixigenae rather narrow, about one-third of glabellar width at mid-palpebral level, slightly more than half of occipital ring width posteriorly. Anterior part of facial suture slightly divergent in front of palpebral lobes, posterior part strongly oblique, rather straight.


REMARKS: Leptoplasisides coniunctus is distinctive because of its transglabellar lateral glabellar furrows, uncommon in Leptoplasisides. In general proportions, it greatly resembles the contemporary Leptoplasisides latus (Tomczykowa), but has much smaller palpebral lobes and the fixigenae are narrower, particularly posteriorly. The anterior part of the cranium also resembles late Parabolina species, particularly those of the Parabolina (P.) heres group, but differs in the transglabellar furrows and lack of palpebral ridges. The species was also noted from the Upper Cambrian of the Daromin IG-I Borehole in south-eastern Poland (Tomczykowa & Tomczyk 2000).

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonkówka Formation in the Jeleniów 3 Borehole (143-144 m), Acerocare Zone sensu lato.

**Leptoplasisides irae** (Orłowski, 1968)

(Text-fig. 18; Pl. 8, Figs 11, Pl. 9, Figs 5-9; Pl. 10, Figs 1-12; Pl. 11, Figs 1-12)

part 1967. Beltella irae n. sp.; Orłowski, p. 49 (including P (N?) lapponica).

part 1968b. Beltella irae sp. n.; Orłowski, pp. 270-272, part Text-fig. 7 (cranium only); Pl. 5, Figs 1-11, 13-15 (part Text-fig. 7 (librigena), non Pl. 5, Fig. 12 - P (N?) lapponica).

part 1968b. Peltura sp.; Orłowski, p. 280, Text-fig. 14, Pl. 8, Figs 22, 24 (non Pl. 8, Figs 20-21, 23 - Peltura protoperon).

1990. Beltella irae Orłowski; Lendzion, Orłowski & Tomczykowa, p. 68, Pl. 20, Fig. 6.

**TYPES:** The holotype is cranidium MUZWG ZI/29/0557, illustrated by Orłowski (1968b, Pl. 5, Fig. 5) and Lendzion & al. (1990, Pl. 20, Fig. 6) (Pl. 10, Fig. 7 of this paper), from Chabowe Doly Mill. Paratypes are in the Orłowski collection, MUZWG ZI/29.

**MATERIAL:** Three effaced complete specimens, 177 cranidia, 63 librigenae, 25 pygidia, in some cases with counterparts, MUZWG ZI/29/0148, 0152, 0157, 0164, 0167, 0204-0205, 0209, 0211, 0215-0217, 0235, 0240, 0246, 0251, 0260, 0263, 0267, 0273, 0280, 0286, 0295-0296, 0300, 0306, 0312, 0322-0323, 0327-0328, 0330, 0332, 0334-0335, 0340, 0360, 0365, 0378-0379, 0384, 0386, 0392, 0396-0400, 0402-0405, 0407-0409, 0411-0413, 0415-0421, 0424-0426, 0430, 0433, 0436, 0438, 0441, 0444-0445, 0447-0450, 0452-0464, 0468-0469.

![Fig. 17. Bivariate scatterplots showing relationship between a. total cranidial length and total glabellar length, b. occipital glabellar length and palpebral length, and c. total cranidial length and frontal area length in Leptoplasisides irae (Orłowski) from Lisie Jamy, Chabowe Doly Mill and Ravine, n=29](image-url)
EMENDED DIAGNOSIS: A species of *Leptoplastides* with palpebral lobes situated opposite L2, two sinuous lateral glabellar furrows, anterior part of facial suture sub-parallel to slightly divergent in front of palpebral lobes, librigenae with medium sized slender spine, thorax with at least 11 segments, pygidium with two axial rings and two pairs of short, broadly based spines.

DESCRIPTION: Length of cranidium 3.2-10.8 mm (n=26). Glabella sub-parallel, tapering slightly forwards, rounded anteriorly. Length of glabella 65±3% of total cranidial length (Text-fig. 17a), 80±3% if occipital ring is included. Glabella separated from them by deep axial and preglabellar furrows. Glabella and fixigenae form a gentle arch in anterior view. Glabella separated from complex occipital ring by distinct occipital furrow, slightly shallower than axial furrows. Occipital furrow slightly concave forwards, not reaching axial furrows adaxially. Small median node present on some specimens. Occipital ring only slightly wider than pre-occipital glabella. Palpebral lobes of medium size, situated opposite L2. Small eye index 28±6% (Text-fig. 17b), large eye index 23±3%. Fine eye-ridges present on some specimens, connecting anterior tip of palpebral lobe with points slightly posterior to anterolateral corners of glabella. Two slightly sinuous, shallow lateral glabellar furrows, in most specimens effaced. Frontal area separated into flat preglabellar field and slightly longer, convex, sub-triangular anterior border. Anterior border furrow distinct, slightly convex anteriorly. Frontal area 20±3% of total cranidial length (Text-fig. 17c), 26±5% of occipital glabellar length, 31±4% of total glabellar length. Fixigenae from one-quarter to one-third glabellar width at mid-palpebral level. Posterior limbs triangular, slightly curved backwards abaxially. Width of posterior limb about three-quarters of occipital ring width. Anterior part of facial suture sub-parallel to slightly diverging in front of palpebral lobes, then curved sharply adaxially to meet at midline.

Librigenae with slender spine of medium length, slightly diverging from lateral margin. Librigenae separated by median suture. Border narrow, slightly widening posteriorly. Genal spine angle slightly obtuse, inner spine angle close to a right angle.

Thorax with at least 11 segments (the only complete specimen, MUZWG ZI/29/0599, Pl. 9, Fig. 5, is of a juvenile individual), with the anteriormost pleurae pointed and with large facets. Axis without median knobs or spines. Pygidium sub-triangular, with two axial rings and end-lobe. Axis tapering gently backwards, not reaching poorly distinguishable border. Margin with two pairs of short, broadly-based spines.

REMARKS: ORLOWSKI (1968b) based *Belitella irae* on cranidia and librigenae with a long spine in line with the course of the lateral margin. The librigenae (illustrated by ORLOWSKI 1968b, Pl. 5, Fig. 12; Pl. 6, Fig. 1 in this paper) also possess a rather wide border and doublure. The anterior and posterior borders of the cranidia are not that wide, and the librigenae with rather wide borders and long spine are excluded here from *L. irae* and assigned to *Parabolina (N.?) lapponica*, the cranidia of which co-occur with *L. irae* (cranidia) in Chabowe Doly Formation.
Mill and Ravine. Librigenae possessing slender spines deviating slightly from the lateral margin and with narrow borders, commonly associated with cranidia of *L. irae*, are here considered conspecific. Moreover, such librigenae (apart from leptoplastine librigenae with a strongly curved spine, Pl. 3, Fig. 12) are associated with cranidia of *L. irae* in Lisie Jamy, where effaced but complete specimens are also present (MUZWG ZI/29/0598, Pl. 9, Fig. 5, MUZWG ZI/29/0598, Pl. 9, Fig. 6). The librigenae in MUZWG ZI/29/0598 are strongly bent down, as in the reconstruction of *Leptoplastides depressus* (Salter in Murchinson) presented by Whittington (1996, Text-fig. 2). The pygidia, tentatively assigned to this species, co-occur with cranidia and librigenae in the Chabowe Doly Mill and Ravine as well as in Lisie Jamy. They are similar to pygidia of *Leptoplastides marianus* (Hoek in Steinmann & Hoek), but their axis tapers less posteriorly, and the pygidium is rather sub-triangular and not semi-elliptical as in *Leptoplastides marianus* (Harrington & Leanza 1957, Fig. 29).

**OCCURRENCE:** In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation at Lisie Jamy, *Leptoplastides* or *Protopeltura praecursor* Zone; Bęczków Ravine, stratigraphic horizon unknown; Chabowe Doly Mill, *Peltura minor* Zone; Chabowe Doly Ravine, *Peltura scarabaeoides* Zone (Linnavsson Subzone).

*Leptoplastides latus* (Tomczykowa, 1968)
(Text-fig. 19; Pl. 11, Figs 13-18; Pl. 12, Figs 1-7)

1968b. *Beltella czarnockii* sp. n.; Tomczykowa, p. 39, Text-fig. 12c, Pl. 2, Figs 8-14.
1968b. *Beltella* sp. A; Tomczykowa, p. 41, Text-fig. 12f, Pl. 2, Fig. 41.

1985. *Leptoplastides cl. latus* (Tomczykowa); Nikolaesen & Henningsmoen, pp. 13-14, Figs 5, 14A-G.
1990. *Beltella czarnockii* Tomczykowa; Lendzion, Orłowski & Tomczykowa, pp. 67-68, Pl. 21, Fig. 5.
1990. *Beltella lata* Tomczykowa; Lendzion, Orłowski & Tomczykowa, p. 68, Pl. 21, Figs 2-4.
2000. *Beltella lata* Tomczykowa; Tomczykowa & Tomczyk, p. 175, Pl. 5, Fig. 9.

**TYPES:** The holotype is cranidium MUZPIG 1042.II.11, figured by Tomczykowa (1968b, Pl. 2, Fig. 23), Lendzion & al. (1990, Pl. 21, Fig. 2), (Pl. 11, Fig. 13 of this paper), from the Jeleniów 3 Borehole, 160 m. Despite the fact that *Beltella czarnockii* has page priority over *Beltella lata* (Tomczykowa 1968b, pp. 39-40), I suggest applying *latus* as the specific name for the specimens under discussion, as the holotype cranidium of *Beltella czarnockii* is deformed and its posterior limbs are not preserved. Paratypes of *Leptoplastides latus* are in the Tomczykowa collection, MUZPIG 1042.II.12-20.

**MATERIAL:** 16 cranidia, 3 librigenae, 1 pygidium, in many cases incomplete and in some cases with counterparts; MUZPIG 1042.II.11, 12-12a, 13-13a, 14-14a, 15-15a, 16, 17-17a, 17b (counterpart of 16), 18-18a, 19-19a, 20-20a, 21-21a, 22, 23-23a, 24-26, 34, 35-35a, 110 (counterpart of 34), ?100-100a, ?129-129a.

**BIOMETRIC DATA:** Eleven parameters measured on 10 cranidia.

**EMENDED DIAGNOSIS:** A species of *Leptoplastides* with small palpebral lobes situated opposite L3, three sinusous lateral glabellar furrows, sub-parallel anterior parts of facial suture, librigenae with short, slender spines, pygidium with two axial rings and at least two short, broadly-based pygidial spines.

**DESCRIPTION:** Length of cranidium 2.9-9.6 mm (n=8). Glabella tapering forwards, bluntly rounded anteriorly. Length of glabella 66±3% of total cranidial length, 82±2% if occipital ring is included. Glabella with rather low lateral profile, but distinctly elevated above surface of fixigenae. Glabella separated from occipital ring by distinct occipital furrow, slightly concave anteriorly and not reaching the axial furrows abaxially, shallower medially. Occipital ring complex, with small median node, and slightly wider than pre-occipital glabella. Palpebral lobes small, situated opposite L3. Small eye index 17±1%, large eye index 21±1%. Almost effaced narrow eye-ridges connecting anterior tip of palpebral lobes with axial furrows at points slightly posterior to the anterior lateral corners of glabella. Lateral glabellar furrows rather shallow, short, S1 slightly sinuous, S2 straight, oblique, shallower than S1, S3 shorter, oblique, faintly distinguishable on some specimens. Frontal area well developed, divided into flat preglabellar field and slightly shorter, convex, sub-triangular anterior border by straight, distinct anterior border furrow. Frontal area 19±2% of total cranidial length, 23±3% of occipital glabellar length and 29±3% of total glabellar length. Fixigenae moderately wide, about three-eights of glabellar width at mid-palpebral level. Posterior limbs triangular, about three-quarters
width of glabella posteriorly. Anterior parts of facial suture sub-parallel in front of palpebral lobes, then curved sharply abaxially and meeting at mid-point of anterior margin. Posterior parts of facial suture slightly sinuous, oblique.

Liberigena with slender, rather short spine deviating slightly from course of lateral margin. Border moderately wide. Genal angle obtuse, inner spine angle close to a right angle. Liberigenae separated by median suture.

Pygidium semi-elliptical, with at least two rather broadly-based spines. Pygidial axis with three inter-ring furrows, narrowing posteriorly, not reaching posterior margin. Border moderately wide, poorly discernible.

**REMARKS:** *Leptoplastides latus* (TOMCZYKOWA) encompasses *Beltella lata* TOMCZYKOWA and *Beltella czarnockii* TOMCZYKOWA, as well as *Beltella* sp. A (TOMCZYKOWA 1968b). *B. czarnockii* is considered conspecific because of similar cranidial proportions and shape of the glabella. The lateral glabellar furrows are slightly deeper in specimens of *B. czarnockii*, shallower in those assigned to *B. lata*, and almost effaced in the only cranidium of *Beltella* sp. A. Those cranidia where the lateral glabellar furrows are rather effaced, are flattened, whereas specimens of *B. czarnockii* retain much of their original convexity, therefore the lateral glabellar furrows are deeper in them. The frontal area in the holotype of *B. czarnockii* (MIZPIG 1042.II.21; PI. 11, Fig. 14) is deformed, and the preglabellar field appears shorter than it was originally.

NIKOLAISEN & HENNINGSMOEN (1985) described *Leptoplastides cf. latus* from the Upper Cambrian of the Digerum Peninsula, Finnmark, Norway. The Norwegian form differs from the type specimens in possessing narrow posterior limbs, a narrower glabella posteriorly and less sinusoid posterior branches of the facial sutures. NIKOLAISEN & HENNINGSMOEN (1985) considered this as resulting from differences in preservation.

**OCCURRENCE:** In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation in the Jeleniów 3 (109-160 m), Bukowiany 1a (238-243 m) and probably Brzezinki 2 (95-104 m) boreholes, Acerocare Zone sensu lato.

*Leptoplastides ulrichi* (KAYSER, 1897)
(_TEXT-FIG. 20; PL. 12, FIGS 8-13; PL. 13, FIGS 1-2)

1897. *Liostracus ulrichi* n. sp.; KAYSER, pp. 277-279, PL. 7, FIGS 1-1a, 4.
1938. *Beltella ulrichi* (KAYSER); HARRINGTON, p. 201, PL. 7, FIGS 9, 13-18.
1943. *Beltella ulrichi* (KAYSER); HARRINGTON & LEANZA, p. 351, PL. 2, FIG. 5.
1954. *Beltella ulrichi* (KAYSER); WILSON, p. 277.
1957. *Beltella ulrichi* (KAYSER); HENNINGSMOEN, p. 269.
1968b. *Beltella ulrichi* (KAYSER); TOMCZYKOWA, pp. 36-37, TEXT-FIG. 12h.
1980. *Beltella ulrichi* (KAYSER); PRIBYL & VANĚK, PL. 6, FIGS 1-2, PL. 7, FIG. 3.
1985. *Leptoplastides cf. ulrichi* (KAYSER); NIKOLAISEN & HENNINGSMOEN, pp. 15-16, FIGS 6, 14H-L.

**TYPES:** The lectotype is a cranidium no. 4335, Museo Argentino de Ciencias Naturales, Seccion Paleontología (Invertebrados), from Iruya, Salta, Argentina, figured by KAYSER (1897, PL. 7, FIGS 1-1a), subsequently selected by HARRINGTON (1938, p. 201).

**MATERIAL:** Four cranidia, of which one is preserved with three thoracic pleurae, six liberigenae, two pygidia, in some cases with counterparts, MIZPIG 1042.II.1a, 2-5, 6-6a, 7 (counterpart of 5), 8-10, 27, 28-28a, 83 (counterpart of 8), 85, 139 (counterpart of 85).

**BIOMETRIC DATA:** Eleven parameters measured on 4 cranidia.
DESCRIPTION: Length of cranidium 6.5-16.7 mm (n=4). Glabella sub-parallel, tapering slightly forwards, bluntly rounded anteriorly. Length of glabella 66-71% of cranidial length, 82-86% when occipital ring is included. Glabella slightly elevated above surface of fixigenae, separated from occipital ring by distinct occipital furrow, deeper medially and not reaching the axial furrows abaxially. Occipital ring composite, on some specimens with small median node situated posteriorly. Occipital ring slightly wider than pre-occipital glabella. Palpebral lobes of medium size, situated opposite L3. Small eye index 15-18%, large eye index 18-23%. Two pairs of lateral glabellar furrows oblique, slightly sinuous, short, not connected across glabella. S1 more distinct, S2 almost effaced, slightly less oblique. Eye-ridges almost effaced (visible on MUZPIG 1042.II.1, Pl. 12, Fig. 8), slightly oblique backwards. Frontal area separated into flat preglabellar field and slightly convex, slightly longer, sub-triangular anterior border. Anterior border furrow distinct, convex anteriorly. Frontal area 14-18% of total cranidial length, 16-22% of occipital glabellar length and 20-27% of total glabellar length. Fixigenae about one-third of glabellar width at mid-palpebral level. Posterior limbs about three-quarters glabellar width posteriorly, pointed slightly backwards. Fulcrum rather close to glabella. Anterior part of facial suture slightly sinuous.

Librigena wide, with moderately long spine, diverging faintly from course of lateral margin. Lateral border furrow and posterior border furrow well defined. Lateral border narrow, surface covered with terrace lines. Genal angle slightly obtuse, inner spine angle close to a right angle. Librigenae most probably connected by median suture.

Thorax preserved only as three anterior pleurae with rather large facets. Fulcrum situated slightly closer to the outer margin of pleura.

Pygidium semi-elliptical, wider than long, with three inter-ring furrows. Axis slightly convergent backwards, not reaching posterior border furrow. Border narrow, well defined.

REMARKS: Beltella rotundata Tomczykowa and Beltella convexa Tomczykowa, based on relatively incomplete and distorted cranidia, are probably conspecific. The holotype specimen of *B. rotundata* has rather effaced lateral glabellar furrows, but the paratypes of this taxon possess more distinct, slightly sinuous lateral glabellar furrows. In this respect they approach the holotype (and only) cranidium of *B. convexa*. The specimens have the same proportions, which can be compared to those of *Leptoplastides ulrichi* (see Wilson 1954, Tab. 4).

Tomczykowa (1968b) assigned the specimens analysed here to the new taxa *B. convexa* and *B. rotundata* on the basis of comparison with *Leptoplastides depressus*. The most important differences included lack of eye-ridges, larger fixigenae as well as an anteriorly narrower glabella. She based her comparison on the illustrations of *Leptoplastides depressus* (as *Beltella depressa*) in Stubblefield (1933). Since that time, more complete and less distorted material of *Leptoplastides depressus* has been illustrated (Fortey & Owens 1991a; Whittington 1996), thus giving a better idea of the species. Indeed, the eye-ridges are prominent on unflattened, typically smaller specimens, whereas they are subdued on larger ones. This is also the case with cranidia of *Leptoplastides ulrichi*, to which the analysed specimens can be assigned on the basis of glabellar and cranidial proportions. The anterior pleurae of the thorax in *L. ulrichi* are also similar, as well as the rather wide librigenae with wide border and the pygidium. The librigenae analysed here have the spine angle deflected less from the lateral margin than e.g. in the specimen illustrated by Harrington & Leanza (1957, Fig. 28) (re-illustrated by Pršyl & Vaněk 1980, Pl. 6, Fig. 1).

Nikolaïsen & Henningmoen (1985) described *Leptoplastides cf. ulrichi* from the Upper Cambrian of the Digeruå Peninsula, Norway. Their form is poorly illustrated (Nikolaïsen & Henningmoen 1985, Figs 14H-L), but the reconstruction (Nikolaïsen & Henningmoen 1985, Fig. 6) is very close to the specimens of *Leptoplastides ulrichi* from South America (Harrington & Leanza 1957; Pršyl & Vaněk 1980) and Poland (Tomczykowa 1968b; this paper). Bifurcate S1 furrows on the specimens from Norway have not been observed on specimens from South America or from Poland, but specimen MUZPIG 1042.II.27 (Pl. 12, Fig. 10) shows very

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**Fig. 20. Leptoplastides ulrichi (Kayser) from the Acorocare Zone sensu lato, Klonówka Formation; restoration of anterior part of axial shield.**

Scale bar represents 10 mm
faint bifurcation of S2, most probably caused by tectonic distortion. Slight differences in the cranidial and glabellar proportions of *Leptoplastides* cf. *ulrichi* from the Digermul Peninsula may result from preservation.

**OCCURRENCE:** In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation in the Jeleniów 3 (107-153.5 m) and Bukowiany 1a (220-243 m) borcholes, *Acerocare* Zone *sensu lato*. In South America: Argentina and Bolivia, Upper Cambrian and Lower Tremadocian *Parabolina argentina* Zone. *Leptoplastides* cf. *ulrichi* occurs in the Upper Cambrian of the Kisteadal Formation, Digermul Peninsula, Norway.

*Leptoplastides* sp.  
(Pl. 13, Figs 3, 6)

**MATERIAL:** Seven cranidia, two isolated thoracic segments with median spine, MUZWG ZI/29/0180, 0272, 0548, 0601, 0603, 0609, 0611, 0732.

**DESCRIPTION:** Cranidium trapezoidal in outline. Glabella sub-parallel, widest at transverse mid-point, rounded anteriorly, convex transversely and sagittally. Occipital ring with distinct median spine, directed backwards. Occipital furrow rather shallow. Palpebral lobes of medium size, situated in front of transverse mid-line of glabella. Lateral glabellar furrows not preserved. Frontal area rather long, about three-eights length of glabella, separated by distinct anterior border furrow into flat preglabellar field and strongly convex anterior border. Fixigenae narrow, about one-third of glabellar width at level of palpebral lobes, and slightly less than half occipital ring width posteriorly.

Thoracic segments with slender median spines, directed upwards. Pleurae moderately bent downwards.

**REMARKS:** The cranidia are too poorly preserved and incomplete to be assigned to any genus, but their distinct frontal area, the position of the palpebral lobes and the distinct occipital spine suggest assignment to *Leptoplastides* Raw. They differ from the contemporary *Leptoplastides* *incus* (Orelowski) in possessing an occipital spine, as well as median spines on the thorax, narrower fixigenae and a sub-parallel glabella, slightly wider at transverse mid-point. The associated thoracic segments with distinct median spines recall the segments of *Leptoplastides* *salteri* (Fortey & Owens 1991b, Fig. 9), as well as thoracic segments assigned to *Leptoplastides* *spinosus* by Nikolaisen & Henningsmoen (1985, Fig. 15C).

**OCCURRENCE:** In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation at Chabowe Doly Ravine, *Peltura scarabaeoides* Zone (linnarssonii Subzone).

*Neriacispis* Tiernvik, 1955

**TYPE SPECIES:** *Jujuyaspis (?) robusta* Tiernvik 1953, by original designation.

*Neriacispis robusta* (Tiernvik, 1953)  
(Text-fig. 21; Pl. 13, Fig. 5)

1953. *Jujuyaspis (?) robusta* sp. n.; Tiernvik, p. 75, Fig. 2.  
1955. *Neriacispis robusta* (Tiernvik); Tiernvik, pp. 209-212, Pl. 2, Figs 1-4, Text-fig. 1b.  
1957. *Neriacispis robusta* (Tiernvik); Henningsmoen, p. 242, Pl. 2, Fig. 6, Pl. 6.

**TYPES:** The holotype (by monotypy) is an incomplete cranidium from the Upper Cambrian at Lanna, Närke, Sweden, figured by Tiernvik (1953, Fig. 2).

**MATERIAL:** One cranidium with counterpart, MUZPIG 1042.II.140-140a.

**BIOMETRIC DATA:** Ten parameters measured on one cranidium.

**DESCRIPTION:** Length of cranidium 4.5 mm (n=1). Glabella sub-parallel, tapering forwards, rounded anteriorly. Length of glabella approximately 64% of cranidial length; approximately 80% if occipital ring is included. Axial furrows developed rather as a change in

Fig. 21. *Neriacispis robusta* (Tiernvik), MUZPIG 1042.II.140, from the *Peltura scarabaeoides* Zone, Klonówka Formation. Scale bar represents 5 mm
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convexity and not as distinct furrows. Glabella separated from occipital ring by a wide, shallow occipital furrow, which curves forward abaxially, not reaching axial furrows. Occipital ring composite, with small, but distinct median tubercle. Palpebral lobes rather small, situated far forwards and close to glabella. Small eye index approximately 11%, large eye index approximately 14%. Lateral glabellar furrows effaced. Frontal area moderately long, slightly convex, preglabellar field and anterior border not defined. Frontal area approximately 20% of total cranidial length, approximately 25% of occipital glabellar length and approximately 31% of total glabellar length. Eye-ridges not present. Fixigenae slightly narrower than glabella posteriorly, provided with prominent fixigenal spine, directed outwards and backwards. Facial suture of proparian type, anterior part convergent, convex, posterior part divergent, sinuous, passing onto fixigenal spine. Surface covered with fine pits.

REMARKS: Nericiaspis belongs to the proparian olenids, represented additionally by the genus Saltaspis HARRINGTON & LEANZA from the Lower Ordovician. A species of Acerocare, A. tullbergi, also possesses a small intergenal spine, but in that species it is situated at the midpoints of the posterior margins. According to TJERNVIK (1955), Nericiaspis probably developed from Peltura, with which it shares the shape of cranidium, the position of the small palpebral lobes and the shape of the posterior part of the facial suture.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation in the Wilków IG-1 borehole (847.8 m), Peltura scarabaeoides Zone (upper part of the linnarssonii Subzone or the lobata Subzone). In Sweden: lower part of the Peltura scarabaeoides Zone.

Peltura Milne Edwards, 1840

TYPE SPECIES: Entomostracites scarabaeoides WAHLENBERG, 1818, by subsequent designation of HALL (1859, p. 61).

REMARKS: Species of Peltura Milne Edwards are characterised by a prominent axis, and originally were quite convex (WHITTINGTON 1996). However, many of the illustrated specimens are flattened, and the glabella appears rather flat and bluntly rounded anteriorly on these specimens. In the case of poorly preserved specimens, this might cause confusion in the correct recognition of the particular species.

Peltura acutidens BRØGGER, 1882

(Text-fig. 22; Pl. 13, Fig. 4)

1882. Peltura scarabaeoides, WAHLENB. var. acutidens; BRØGGER, p. 108, Pl. 2, Fig. 9.
1922. Peltura scarabaeoides acutidens BRØGGER; WESTERGÅRD, p. 175, Pl. 15, Figs 14-17.
1957. Peltura acutidens BRØGGER; HENNINGSMOEN, pp. 233-234, Pl. 6, Pl. 25, Figs 1-5, 7, 9, 11.
1976. Peltura acutidens BRØGGER; LENDZION, p. 73.

TYPES: The lectotype is pygidium no. H 2720, Palaeontological Museum of the University of Oslo, from Slemmestad in Røyken, Norway, figured by BRØGGER (1882, Pl. 2, Fig. 9), selected and re-figured by HENNINGSMOEN (1957, Pl. 25, Fig. 11).

MATERIAL: One incomplete cranidium with counterpart, MUZWG ZI/29/0574; one incomplete cranidium with counterpart, tentatively assigned to this species, MUZWG ZI/29/0307.

BIOMETRIC DATA: Ten parameters measured on one cranidium.

DESCRIPTION: Length of cranidium 5.8 mm (n=1). Glabella sub-rectangular, tapering forwards, bluntly rounded anteriorly. Length of glabella approximately 90% of cranidial length, approximately 78% if occipital ring is included. Glabella prominent in lateral profile, fixigenae downsloping. Glabella separated from occipital ring by distinct occipital furrow, not reaching axial furrows and curved forwards abaxially. Occipital ring slightly wider than pre-occipital glabella. Palpebral lobes small, situated far forwards and close to glabella. Eye-ridges faintly indicated, oblique, connecting anterior tips.

Fig. 22. Peltura acutidens BRØGGER, MUZWG ZI/29/0574, from the Peltura minor Zone, Klonówka Formation. Scale bar represents 5 mm.
of palpebral lobes with axial furrows slightly below anterolateral corners of glabella. Small eye index approximately 10%, large eye index approximately 11%. Lateral glabellar furrows effaced. Frontal area very short, approximately 10% of total cranidial length, approximately 12% of occipital cranidial length and approximately 13% of total glabellar length, without preglabellar field. Fixigenae about one-quarter of glabellar width at mid-palpebral level. Posterior limbs about three-eighths of occipital ring width.

REMARKS: The cranidia, although incomplete, resemble the cranidia of *P. acutidens* figured by HENNINGSMOEN (1957, Pl. 25, Figs 1, 4). The significant difference is the lack of lateral glabellar furrows, although those of *P. acutidens* as well as of the contemporary species *Peltura minor* (BR0GGER) are typically rather shallow.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Kloneńka Formation in the Jeleniów 3 (47.5 m) and Brzezinki 1 (142 m) boreholes, *Acerocare Zone sensu lato*. *Peltura costata* occurs in Norway and Sweden in the *Peltura costata* Zone.

*Peltura cf. costata* (BR0GGER, 1882) (Pl. 13, Figs 8-9)

1968b. *Peltura* sp. A; TOMCZYKOWA, p. 42, Pl. 3, Fig. 13. part 1968b. *Peltura* sp. B; TOMCZYKOWA, p. 43, Pl. 3, Figs 10-11 (non Pl. 3, Fig. 12 – *Peltura cf. transiens*).

TYPES OF *Peltura costata*: The lectotype is pygidium no. 29017, Palaeontological Museum of Oslo, figured by BR0GGER (1882, Pl. 1, Figs 5c-d), selected and re-figured by HENNINGSMOEN (1957, p. 234, Pl. 27, Fig. 9), from Eiker, Norway.

MATERIAL: Two incomplete cranidia with counterparts, MUZPIG 1042.II.68-68a, 69-69a.

DESCRIPTION: Only from Eiker, Norway.

TYPES OF MATERIAL: Two incomplete cranidia with counterparts, MUZPIG 1042.II.68-68a, 69-69a.

DESCRIPTION: Only from Eiker, Norway.

MATERIAL: 218 cranidia and their fragments; 55 librigenae; 33 pygidia; one thoracic segment; in some cases with counterparts, MUZPIG ZI/29/0131, 0140, 0145-0146, 0149, 0155, 0195, 0206-0207, 0209, 0211, 0218, 0221, 0230-0231, 0233, 0235, 0240, 0246, 0252, 0257, 0259, 0264, 0266-0267, 0306, 0308, 0313, 0315, 0318, 0320-0334, 0336-0362, 0364-0377, 0379-0391, 0393-0395, 0401-0403, 0412, 0420, 0422-0423, 0425-0432, 0434-0435, 0437-0440, 0442-0443, 0446, 0450-0451, 0454, 0458, 0463, 0465-0480, 0482-0486, 0488-0492, 0494-0499, 0501-0507, 0509-0520, 0529, 0549, 0554-0559, 0561-0574, 0633, 0637, 0639-0642, 0652, 0657, 0661, 0667, 0677, 0680, 0682-0683, 0731.

BIOMETRIC DATA: Ten parameters measured on 117 cranidia.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Kloneńka Formation in the Jeleniów 3 (47.5 m) and Brzezinki 1 (142 m) boreholes, *Acerocare Zone sensu lato*. *Peltura costata* occurs in Norway and Sweden in the *Peltura costata* Zone.
DESCRIPTION: Length of cranidium 2.3-10.8 mm (n=73). Glabella sub-rectangular, rounded anteriorly, tapering slightly forwards. Length of glabella 73±4% of cranidial length (Text-fig. 23a), 88±3% if occipital ring is included. Glabella strongly convex sagittally and transversely, separated from composite occipital ring by rather deep occipital furrow, concave forwards and not reaching axial furrows abaxially. Occipital ring slightly wider than pre-occipital glabella. Palpebral lobes small, situated opposite L3 at a distance of about one-quarter of glabellar width at mid-palpebral level. Small eye index 20±3% (Text-fig. 23b), large eye index 24±4%. Two pairs of oblique glabellar furrows, situated far abaxially on glabella. Frontal area downsloping, poorly differentiated into preglabellar field and anterior border. Frontal area small, of variable length (Text-fig. 23c), 12±3% of total cranidial length, 14±4% of occipital-glabellar length and 16±5% of total glabellar length. Posterior lobes about three-quarters length of occipital ring. Anterior part of facial suture parallel or slightly convergent in front of palpebral lobes, posterior parts of facial sutures slightly convex. Posterior border long, posterior border furrow long and shallow, slightly concave forwards abaxially.

Librigena pelturoid, without spine. Border relatively wide, increasing in width and sharply downsloping anteriorly.

Pygidium twice as wide as long, with three broadly-based spines. Anteriormost spine directed backwards and longest, the remainder shorter and directed inwards. Border relatively wide, flattened, narrowing

Fig. 23. Bivariate scatterplots showing relationship between a. total cranidial length and total glabellar length, b. occipital glabellar length and palpebral length, and c. total cranidial length and frontal area length in Peltura protopeltorum ORLOWSKI from Chabowe Doly Mill, n=79

Fig. 24. Peltura protopeltorum ORLOWSKI, from the Peltura minor Zone, Klonówka Formation; restoration of exoskeleton, antero-lateral view. Scale bar represents 10 mm

Fig. 25. Peltura protopeltorum ORLOWSKI, from the Peltura minor Zone, Klonówka Formation; a. restoration of cephalon, b. flattened librigena. Scale bar represents 10 mm
posteriorly. Axis tapering strongly backwards, with two axial rings and a terminal piece.

REMARKS: When describing this species, ORLOWSKI (1968b) tentatively assigned it to the genus Peltura MILNE EDWARDS. Although the species is different from the contemporary Peltura species, P. minor and P. acutidens, particularly in the width of the fixigenae at mid-eye level and the length of the frontal area, it greatly resembles the later Peltura species, P. paradoxus and P. transiens. The latter species lack lateral glabellar furrows in adult cranidia. Peltura protopeltorum possesses lateral glabellar furrows even on large, adult cranidia, and the original convexity of the axis is retained. The transversely straight anterior margin and anterior downward curvature of the cephalon is similar in large cranidia of the probably related Acerocarina klonowkae, as well as in later pelturines, e.g. Pellocare compactum NICOLAISEN & HENNINGSMOEN from the Lower Tremadocian Berlogaissa Formation, Digermul Peninsula, Norway.

Pygidia associated with cranidia of Peltura protopeltorum recall the pygidia of Peltura acutidens with regard to the flattened border, as well as Peltura transiens with regard to the shape and size of the pygidial spines.

The cranidia of Peltura? sp. from the Upper Cambrian Kistedal Formation in the Digermul Peninsula, Norway (NICOLAISEN & HENNINGSMOEN 1985) are quite similar, particularly in the rather long frontal area, size and position of the palpebral lobes, but they differ in the width of the fixigenae at mid-palpebral level and the shape of the librigena. The sub-rectangular shape of the glabella in this species may be a result of flattening.


Peltura scarabaeoides scarabaeoides (WAHLB., 1918)
(Pl. 14, Figs 4-14)

1818. Entomostracites scarabaeoides; WAHLB., p. 41, Pl. 1, Fig. 2.
1822. Paradoxides scarabaeoides; BONGNAERT, p. 34, Pl. 3, Fig. 5.
1827. Triobolites scarabaeoides; BOECK, p. 36, Fig. 24.
1837. Olenus scarabaeoides; HISINGER, p. 19, Pl. 4, Fig. 4.
1840. Peltura scarabaeoides; MILNE EDWARDS, p. 344.
1847. Peltura scarabaeoides; HAWLE & CORBA, p. 127, Pl. 6, Fig. 68.
1848. Olenus spinulosus?; PHILLIPS, pp. 55, 347, Fig. 3.
1864. Olenus scarabaeoides var. obesus; SALTER, p. 5, Pl. 8, Figs 1-4.
1866. Olenus scarabaeoides, WAHL.; SALTER, p. 301, Pl. 5, Figs 2-5.
1871. Conocephalus Malherbius, n. sp.; PHILLIPS, p. 68, Fig. 5.
1871. Olenus scarabaeoides WAHL.; PHILLIPS, p. 68, Fig. 6.
1878. Peltura scarabaeoides WAHL.; ANGELIN, p. 45, Pl. 25, Fig. 8.
1880. Peltura scarabaeoides WAHL.; LINNARSSON, pp. 4-7, Pl. 1, Figs 1-4.
1880. Peltura scarabaeoides var. octacantha; LINNARSSON, p. 6, Pl. 1, Fig. 5.
1882. Peltura scarabaeoides WAHL; BRØGGER, p. 107, Pl. 1, Figs 7-9, Pl. 2, Fig. 12.
1890. Peltura scarabaeoides WAHL.; HOLM, p. 264.
1892. Peltura scarabaeoides, WAHL.; MATTHEW, p. 35, Pl. 13, Figs 9a-b.
1901. Peltura scarabaeoides, WAHL.; LINNARSSON, pp. 29, 64, Pl. 3, Figs 35-42.
1910. Peltura scarabaeoides; GOELDSCHMIDT, p. 4, Figs 1-2.
1919. Peltura scarabaeoides (WAHLB.); LAGE, pp. 97-99, Pl. 11, Figs 9-12.
1922. Peltura scarabaeoides (WAHLB.); WESTERGÅRD, p. 173, Pl. 15, Figs 12-13, 18.
1923. Peltura scarabaeoides WAHLB.; POULSEN, pp. 50, 58, Text-figs 15, 22, Pl. 2, Figs 6-7.
1927a. Peltura scarabaeoides WAHLB.; CZARNOWKI, p. 12.
1927b. Peltura scarabaeoides (WAHL.); STRAND, p. 359.
1934. Peltura scarabaeoides; STURMER, p. 332.
1937. Peltura scarabaeoides (WAHL.); RICHTER, p. 419, Text-fig. 2.
1942. Peltura scarabaeoides (WAHLB.); STURMER, p. 89.
1943. Peltura scarabaeoides (WAHL.); WESTERGÅRD in JOHANSSON, SUNDUS & WESTERGÅRD, p. 55, Figs 34a-b.
1947. Peltura scarabaeoides (WAHL.); WESTERGÅRD, p. 26 (some of the discussed specimens are of Peltura scarabaeoides westergardi).
1952. Peltura scarabaeoides (WAHLB.); HUTCHINSON, p. 93, Pl. 5, Figs 1-6.
1953. Peltura scarabaeoides; HOLTEDAHL, p. 182, Text-fig. 69, Figs 25-26.
1957. Peltura scarabaeoides scarabaeoides (WAHLB.); HENNINGSMOEN, pp. 237-239, Pl. 2, Fig. 1, Pl. 6, Pl. 25, Figs 6, 13-14, Pl. 26, Figs 1-2.
1957. Peltura scarabaeoides; STURMER in HOLTEDAHL & DONS, p. 12, Figs 3-25-26 (copies of figures from HOLTEDAHL 1953).
1958. Peltura scarabaeoides (WAHLB.); WHITTINGTON, pp. 200-206, Pl. 38, Figs 1-18.
1967. *Peltura scarabaeoides* scarabaeoides (WAHLENBERG); ORLOWSKI, p. 49.
1968b. *Peltura scarabaeoides* scarabaeoides (WAHLENBERG); ORLOWSKI, pp. 279-280, Pl. 8, Figs 16-19.
1972. *Peltura scarabaeoides* scarabaeoides (WAHLENBERG); BEDNARCZYK, PI. 2, Figs 3, 10, Pl. 4, Figs 3, 7.
1973. *Peltura scarabaeoides* scarabaeoides (WAHLENBERG); CLARKE, pp. 746-748, Text-figs 4a, c.
1976. *Peltura scarabaeoides* scarabaeoides (WAHLENBERG); LENDZION, p. 73.
1981. *Peltura scarabaeoides* scarabaeoides (WAHLENBERG); RUSHTON in ALLEN, JACKSON & RUSHTON, p. 315, Pl. 17, Fig. 4.
1984. *Peltura scarabaeoides* (WAHLENBERG); BEDNARCZYK, Pl. 6, Fig. 4.
1990. *Peltura scarabaeoides* scarabaeoides (WAHLENBERG); LENDZION, ORLOWSKI & TOMCZYKOWA, p. 66, Pl. 20, Fig. 5.
1996. *Peltura scarabaeoides* scarabaeoides (WAHLENBERG); WHITTINGTON, pp. 386-387, Pl. 2.

**TYPES:** Syntypes from the Upper Cambrian of Sweden are in the WAHLENBERG collection, Palaeontological Institute Museum, Uppsala.

**MATERIAL:** 1 fragmentary cranidium, 1 librigena, 17 pygidia, rarely with counterparts, MUZWG Z1/29/0173, 0240, 0286, 0296-0305, 0428, 0500, 0575, 0619, 0745-0746.

**BIOMETRIC DATA:** Four parameters measured on 14 pygidia.

**DESCRIPTION:** Glabella with two pairs of faintly preserved, oblique and short lateral glabellar furrows. Occipital ring simple, rather long. Occipital node not preserved.


Pygidia sub-elliptical in shape. Maximum length of pygidium 41±4% of maximum width. Length of axis 82±5% of maximum length of pygidium. Axis with two inter-ring furrows, tapering posteriorly, not reaching the posterior pygidial margin. Border not defined. Margin with three pairs of short, broadly-based marginal spines. Distance between posterior pair of spines slightly wider than width of anterior axial ring.

**REMARKS:** The presence of the species in the collection has been determined solely on pygidia, which are diagnostic for distinguishing the two subspecies of *Peltura scarabaeoides* (e.g. *scarabaeoides* and westergaardi) from one another.

**OCCURRENCE:** In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation at Chabowe Doly Mill, *Peltura minor Zone* and Chabowe Doly Ravine, *Peltura scarabaeoides Zone* (Innaranoni Subzone); Leba Elevation, *Peltura scarabaeoides Zone*. In Norway, Denmark, the UK and Canada: lower part of the *Peltura scarabaeoides Zone*. In Sweden: upper part of the *Peltura minor Zone* and lower part of the *Peltura scarabaeoides Zone*.

*Peltura scarabaeoides* cf. *westergaardi* HENNINGSMOEN, 1957

(PI. 13, Figs 11-12)

1964. *Peltura scarabaeoides* (WAHLENBERG); TOMCZYKOWA, p. 904.
1968a. *Peltura scarabaeoides* cf. *westergaardi* HENNINGSMOEN; TOMCZYKOWA, p. 44.
1990. *Peltura scarabaeoides* cf. *westergaardi* HENNINGSMOEN; LENDZION, ORLOWSKI & TOMCZYKOWA, p. 66, Pl. 21, Fig. 9.

**TYPES OF Peltura scarabaeoides westergaardi:** The holotype is a cranidium figured by WESTERGÅRD (1944, Pl. 3, Fig. 3) from a limestone boulder, *Peltura scarabaeoides Zone* (Upper Cambrian), Åkarpsmölla, Scania, Sweden, by original designation.

**MATERIAL:** One incomplete cranidium; MUZPIG 1042.II.66-66a, one incomplete cranidium tentatively assigned to the subspecies, MUZPIG 1042.II.67.

**BIOMETRIC DATA:** Nine parameters measured on one cranidium.

**DESCRIPTION:** Length of cranidium 7.2 mm (n=1). Glabella sub-quadrangular, tapering slightly forwards, truncate anteriorly. Length of glabella approximately 81% of cranidial length, approximately 96% if occipital ring is included. Glabella with low lateral profile, separated from occipital ring by shallow occipital furrow, which does not reach the axial furrows abaxially. Occipital ring simple, concave, with small node. Occipital ring slightly wider than pre-occipital glabella. Small palpebral lobes, situated far forwards and close to glabella, opposite S4. Small eye index approximately 12%,
large eye index approximately 10%. Lateral glabellar furrows very shallow, almost effaced, S1 - S3 sinuous, S4 short, oblique backwards, very close to S3. No preglabellar field, anterior border extremely narrow. Frontal area approximately 4% of total cranidial length. Eye-ridges not present. Fixigenae narrow, about one-quarter of glabellar width at mid-palpebral level, incompletely preserved. Anterior part of facial suture convergent forwards. Posterior part of facial suture divergent, convex.

REMARKS: The main difference distinguishing the two subspecies of *Peltura scarabaeoides* from one another is the length of the pygidial spines, which are short in *scarabaeoides* and long in *westergaardi*. As already pointed out by Tomiczkowa (1968b), on the basis of figures in Henningsmoen (1957), the main difference in the cranidia is the presence of more sinuous lateral glabellar furrows and a more prominent occipital node in *Peltura scarabaeoides westergaardi*. In the absence of pygidia, this subspecies cannot be positively determined.

**OCCURRENCE:** In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation in the Wilków IG-1 Borehole (855-856 m), *Peltura scarabaeoides Zone*. *Peltura scarabaeoides* Zone occurs in Norway and Sweden in the *Peltura scarabaeoides Zone* (upper part of linnarssoni Subzone and lobata Subzone) and in the UK in the *Peltura scarabaeoides Zone* (linnarssoni Subzone).

*Peltura cf. transiens* (Brögger, 1882)  
(Pl. 13, Fig. 10; Pl. 14, Figs 1-3)

part 1968b. *Peltura* sp. B; Tomiczkowa, p. 43, Pl. 3, Fig. 12  
(non Pl. 3, Figs 10-11 - *Peltura cf. costata*).  
part 1968b. *Peltura* sp. C; Tomiczkowa, p. 43, Pl. 3, Figs 1, 72  
(non Pl. 3, Figs 3-4 - *Pseudobolina (P.)* heres).  
1968b. Acerocarina sp.; Tomiczkowa, p. 44, Pl. 3, Fig. 17.  

**TYPES OF Peltura transiens:** The lectotype is a pygidium no. 19947a, Paleontological Museum of Oslo, figured by Brögger (1882, Pl. 1, Fig. 6), re-illustrated and selected by Henningsmoen (1957, p. 240, Pl. 26, Fig. 8).

**MATERIAL:** Four incomplete cranidia, one librigena, MUZPIG 1042.II.70-70a, 71-72, 80, ?108.

**BIOMETRIC DATA:** Nine parameters measured on 3 cranidia.

**DESCRIPTION:** Length of cranidium 2.8-3.7 mm (n=3). Glabella sub-rectangular, tapering slightly forwards, bluntly rounded anteriorly. Length of glabella 75-79% of cranidial length, 86-93% if occipital ring is included. Glabella slightly elevated above surface of fixigenae, separated from occipital ring by shallow, distinct occipital furrow, slightly curved forward abaxially. Occipital ring simple, with faint median node. Occipital ring slightly wider than pre-occipital glabella. Palpebral lobes small, situated almost in line with anterior glabellar furrow. Small eye index 12-13%, large eye index 14-15%. Eye-ridge poorly marked, slightly oblique backwards. Lateral glabellar furrows effaced. Frontal area short, with almost no preglabellar field and convex anterior border. Frontal area 7-8% of total cranidial length, 8-9% of occipital-glabellar length and 9-11% of total glabellar length. Fixigenae narrow, about one-quarter of glabellar width at mid-palpebral level, about one-third of glabellar width posteriorly. Posterior limbs strongly convex. Anterior part of facial suture divergent, posterior part pelturoid, convex.

Librigena with short, rather broadly-based spine, deviating slightly from course of lateral margin. Border narrow, widening posteriorly. Genal angle and inner spine angle slightly obtuse.

**REMARKS:** The cranidia differ from specimens assigned to *P. transiens* by Henningsmoen (1957, Pl. 26, Figs 7, 11) in lacking lateral glabellar furrows. Only adult cranidia of *P. transiens* have effaced lateral glabellar furrows, whereas the size of the analysed specimens is comparable to that of the small cranium illustrated by Henningsmoen (1957) on Pl. 26, Fig. 7. The librigena differs from those of *P. transiens* in possessing a stouter spine, which deviates less from the course of the lateral margin.

**OCCURRENCE:** In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation in the Jeleniów 3 (107-116 m) and Bukowiany 1a (238-243 m) boreholes, Acerocare Zone sensu lato. *Peltura transiens* (Brögger) is characteristic of the *Peltura transiens Zone* in Norway and Sweden.

*Peltura sp.*  
(Pl. 13, Fig. 7)

part 1968b. Acerocare klonowkae? sp. n.; Orłowski, pp. 278-279, Pl. 8, Fig. 11 only (non Pl. 8, Figs 6-10 - *Acerocarina klonowkae*).

**MATERIAL:** One librigena with counterpart, MUZWG Z1/29/0553.
DESCRIPTION: Librigena pelturoid, with short, slender spine deviating from lateral margin almost at a right angle. Genal angle acute. Border very wide, narrowing slightly anteriorly.

REMARKS: This specimen was considered by Orlowksi (1968b) as a librigena of a new species, Acerocara klonowke. The adaxial margin with the facial suture is not well preserved, and therefore it is not clear whether this librigena matches the cranidium of that species. The latter are associated with much narrower librigenae without a spine, which match the facial suture of the cranidium, and are here referred to Acerocarina klonowke. The librigena under discussion rather recalls those of late Protopeltura species, e.g. P. paradoxa and P. transiens, but is slightly wider, and being poorly preserved, cannot be assigned with confidence to any species.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonowka Formation at Chabowe Doly Ravine, Peltura scarabaeoides Zone (linnarsoni Subzone).

Protopeltura Brøgger, 1882

TYPE SPECIES: Peltura precursor Westergård, 1909 (= Protopeltura acanthura Brøgger, 1882 non Angelin, 1854) from the Upper Cambrian of Norway, by subsequent designation of Westergård (1922) (Henningsmoen 1956, 1957).

Protopeltura aciculata (Angelin, 1854)
(Pl. 17, Figs 1-18)

part 1934. Parabolina;Samsonowicz, p. 7 (some of the specimens are of Aphelaspis rana).
part 1954. Protopeltura olensorum n. sp.; Orlowksi, p. 49 (including Olenus solitarius).
part 1968b. Protopeltura olensorum sp. n.; Orlowksi, pp. 275-276, Text-fig. 10, Pl. 7, Figs 13-15, Pl. 8, Figs 1-3 (non Pl. 7, Fig. 12 – Olenus solitarius).

REMARKS ON THE TYPES: Protopeltura aciculata (Angelin, 1854) encompasses two subspecies:
- Protopeltura aciculata aciculata (Angelin, 1854), from the brevispina Subzone of the Parabolina spinulosa Zone; the lectotype is an axial shield from Andrarum, Scania, Sweden, figured by Westergård (1922, Pl. 14, Fig. 6), selected by Henningsmoen (1957, p. 222).
- Protopeltura aciculata pusilla Westergård, 1922, from the spinulosa Subzone of the Parabolina spinulosa Zone; the lectotype is a cranidium from the Upper Cambrian of Funä, Jämtland, Sweden, figured by Westergård (1922, Pl. 14, Fig. 14), selected by Henningsmoen (1957, p. 223).

MATERIAL: One effaced specimen, tentatively assigned to the species, three axial shields without pygidia, 30 cranidia, one librigena tentatively assigned to the species, two incomplete thoraces with pygidia, five thoracic fragments, in some cases with counterparts, MUZWG ZI/29/0005, 0118, 0685-0688, 0690, 0692-0702, 0705-0710, 0712-0715, 0717-0728, MUZPIG 8.II.162, 163.

BIOMETRIC DATA: Eleven parameters measured on 29 cranidia.

DESCRIPTION: Length of cranidium 3.1-7.0 mm (n=10). Glabella tapering slightly forward, rounded anteriorly. Length of glabella 66±4% of cranidial length, 81±2% when occipital ring is included. Glabella distinctly elevated above surface of fixigenae, separated from occipital ring by deep occipital furrow, slightly curved forward abaxially. Occipital ring with stout median node visible only on well preserved specimens. Occipital ring as wide as pre-occipital glabella. Palpebral lobes small, situated at level of anterior margin of glabella. Small eye index 14-20%, large eye index 17-24%. Lateral glabellar furrows generally effaced, S1 and S2 visible on a few well preserved specimens (e.g. MUZWG ZI/29/0712, Pl. 17, Fig. 10), oblique backwards, straight. Frontal area rather long, separated by shallow anterior border furrow into preglabellar field and anterior border of generally equal length. Frontal area 19±2% of total cranidial length, 24±3% of occipital glabellar length and 29±4% of total cranidial length. Fixigenae about one-third of glabellar width at mid-palpebral level. Posterior limbs about three-quarters of occipital ring width. Librigena with short, slender spine in line with lateral margin of librigena proper. Genal angle obtuse, inner spine angle acute. Border narrow.

Thorax with at least 10 segments, small pleural spines directed posteriorly and with axial spines (clearly visible on counterparts of small specimens) or knobs (in larger and poorly preserved specimens). Pygidium sub-triangular, entire, with three interring furrows. Axis narrows slightly posteriorly, almost reaching the pygidial border.

REMARKS: The specimens under discussion include paratypes of Protopeltura olensorum, the holotype of which is assigned in this paper to Olenus solitarius (Westergård). They differ from the holotype to a degree precluding inclusion into one taxon, the main
differences being expressed in the shape of the glabella and the size as well as position of the palpebral lobes. The specimens have undergone tectonic compression in many cases (e.g. MUZGW ZI/29/0727, Pl. 17, Fig. 1), but in the size of the cranidium, the shape of the glabella, the position and size of the palpebral lobes, as well as in the structure of the thorax with short pleural spines and distinct axial spines, they recall early species of Protopeltura. Those being represented by Protopeltura aciculata aciculata (ANGELIN) and P. aciculata pusilla WESTGÅRD differ only in minor details, e.g. in the size of the librigenae and the shape of the pygidium. According to HENNINGSMOEN (1957), another difference between these subspecies is the shape of the glabella - rounded in P. aciculata aciculata and rather truncate in P. aciculata pusilla. However, HENNINGSMOEN (1957, Pl. 23, Fig. 2) illustrates distorted axial shields assigned to P. aciculata pusilla showing both rounded and truncate glabellae on one slab. The shape of the glabella in this case cannot be considered a distinguishing feature between the subspecies. This can also be confirmed in the material under discussion, where compressed specimens possess more truncate glabellae. The pygidium, which is sub-triangular in shape and entire, as well as the proportions of the fissionae, recall Protopeltura aciculata pusilla. In turn, the associated librigenae (MUZGW ZI/29/0705, Pl. 17, Fig. 7) is more similar to P. aciculata aciculata with regard to its width and length of the librigenal spine. The overall features distinguished on the analysed specimens do not allow definite assignment to any of the subspecies of Protopeltura aciculata.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Wiśniówka Formation in the Wiśniówka Duża and Wąworków quarries, Olenus scanius and Parabolina brevispina Subzones. Protopeltura aciculata aciculata occurs in Sweden and the UK (England) in the brevispina Subzone of the Parabolina spinulosa Zone, whereas Protopeltura aciculata pusilla occurs in Norway and Sweden in the spinulosa Subzone of the Parabolina spinulosa Zone.

Suborder Ptychopariina SWINNEITON, 1915
Superfamily Ptychoparioidea SWINNEITON, 1915
Family Pterocephaliidae KORAYASHI, 1935
Subfamily Aphelaspidae PALMER, 1960

REMARKS: Following PALMER (1960, 1965), PRATT (1992) and SHERGOLD & al. (2000) the subfamily is accommodated in Pterocephaliidae. FORTEY & CHATTERTON (1988, and in the new Treatise - KAESLER 1997) suggested that Pterocephaliidae should be classified within the order Asaphida, but this view is not yet broadly accepted.

The concept of the subfamily Aphelaspidae was introduced by PALMER (1960, 1962, 1965) and subsequently discussed by various authors (SHERGOLD 1982; SHERGOLD & al. 1983; SHERGOLD & WEBERS 1992). The group is characterised by olenoideans, which have simple preglabellar morphology, possess a rostral plate and a narrow doublure as well as a natant hypostomal condition (FORTEY & CHATTERTON 1988; WHITTINGTON 1988; FORTEY 1990). On the basis of differences in preglabellar morphology, three groups can be identified (SHERGOLD & SDZUY 1991). The first one includes genera such as Aphelaspis RESSER, Dicanthoppyge PALMER, Litocephalus RESSER, Listera PALMER, Taenora PALMER, Eugonocare WHITEHOUSE and Olenaspella WILSON, which have a simple gently convex preglabellar area. The second group includes genera, which possess a preglabellar boss (e.g. Aphelaspis nobilis IVSHIN, Dunderbergia WALTOTT, Kajandaspis IVSHIN, and Ketyna ROSOVA), whereas the third includes genera, which have an incipient boss, modifying the course of the anterior cranidial border furrow (e.g. Olentella IVSHIN, Amorphella ROSOVA, and Apheloides IVSHIN).

Aphelaspis RESSER, 1935


Aphelaspis rara (ORLOWSKI, 1968)
(Text-fig. 27; Pl. 18, Figs 1-13; Pl. 19, Figs 1-12; Pl. 20, Figs 1-14)

1934. Pelura; SAMSONOWICZ, p. 7.
1934. part 1934. Parabolina; SAMSONOWICZ, p. 7 (some of the specimens are of Protopeltura aciculata).
1967. Olenus rarus n. sp.; ORLOWSKI, p. 49.
1981. Olentella rara (ORLOWSKI); ALLEN, JACKSON & RUSHTON, p. 308.
1983. Olentella rara (ORLOWSKI); RUSHTON, p. 112.
1985. Olentella rara (ORLOWSKI); RUSHTON in ALLEN & JACKSON, Pl. 4, Fig. 2.
1990. Olenus rarus ORLOWSKI; LENDZION, ORLOWSKI & TOMICZKOWA, p. 62, Pl. 18, Fig. 8.
1997. Pesutia? rara (ORLOWSKI); Dzik, Fig. 1.8F.
TYPES: The holotype is cranidium MUZWG ZI/29/0063, illustrated by Orłowski (1968b, Pl. 4, Fig. 6) and Lendzion & al. (1990, Pl. 18, Fig. 8) (Pl. 18, Fig. 1 of this paper), from the Upper Cambrian Wiśniówka Formation at Wąworków, Holy Cross Mountains, Poland. Paratypes are in the Orłowski collection, MUZWG ZI/29/0001-0117, 0119-0127, 0689, 0690, 0704, 0730, MUZPIG 8.II.159-160, 162a, 164-166; unnumbered specimen (Department of Geology, University of Vilnius, Lithuania). Plaster cast of complete but distorted specimen, BGS Zs 840 (British Geological Survey, Keyworth, UK), from the Maentwrog Formation, Wales (illustrated in Allen & Jackson 1985, Pl. 4, Fig. 2) (courtesy of A.W.A. Rushton).

MATERIAL: Two complete, although effaced specimens, 64 cranidia, 15 librigenae, 30 pygidia, 5 hypos­tomes, two incomplete thoraces and 20 single pleu­rae, all with a variable degree of effacement and typ­ically incomplete, occasionally with counterparts, MUZWG ZI/29/0001-0117, 0119-0127, 0689, 0690, 0704, 0730, MUZPIG 8.II.159-160, 162a, 164-166; unnumbered specimen (Department of Geology, University of Vilnius, Lithuania).

BIOMETRIC DATA: Thirteen parameters measured on 59 cranidia, four parameters measured on 25 pygidia.

EMENDED DIAGNOSIS: A species of Aphelaspis with indistinct lateral glabellar furrows; occipital node absent. Almost flat preglabellar field slightly longer than moderately short, convex anterior border, separated from it by well-incised anterior border furrow. Fixigena moderately wide, palpebral lobe moderately short, strongly convex transversely, situated slightly anteriorly from glabellar midlength. Librigena with long, slender spine reaching the sixth thoracic segment. Thorax with 13 segments. Pygidium sub-elliptical in outline, with a slight indentation in border at posterior midpoint, bearing three inter-ring furrows; border moderately narrow, of varying width, well defined.

DESCRIPTION: Length of cranidium 2.8-20.6 mm (n=24). Glabella sub-rectangular, tapering forwards, truncate or slightly rounded anteriorly. Length of glabel­la 57±4% of total cranidial length (Text-fig. 26a), 71±2% if occipital ring is included. Glabella with low lat­eral profile, separated from occipital ring by occipital furrow, which reaches the axial furrows abaxially. Occipital ring simple, without node. Occipital ring slight­ly wider than pre-occipital glabella. Moderately short, distinctly upsloping palpebral lobes, the mid-points of which lie anterior to the middle of the glabella. Small eye index 32±6% (Text-fig. 26b), large eye index 39±6%. Lateral glabellar furrows generally effaced, although two shallow lateral glabellar furrows, not connected across glabella and oblique backwards, are present on small specimens (e.g. MUZWG ZI/29/0005, Pl. 18, Fig. 2 and MUZWG ZI/29/0033, Pl. 19, Fig. 7). Frontal area with almost flat preglabellar field slightly longer than moder­ately short, convex anterior border. Frontal area 29±2% of total cranidial length (Text-fig. 26c), 41±5% of occip­ital glabellar length and 52±6% of total glabellar length. Well-incised, although quite shallow anterior border fur­row. Fixigenae moderately wide, three-eights width of glabella at mid-palpebral level, slightly wider in larger specimens, posterior limbs present only on some speci-
mens, slightly wider than glabella posteriorly, with shallow, distinct posterior border furrow.

Librigenae with long slender spine reaching the sixth thoracic segment. Lateral border furrow well defined, extending slightly onto genal spine. Posterior border furrow absent. Anterior part of facial suture parallel or slightly divergent forward from palpebral lobes to anterior border furrow, then curved sharply adaxially across anterior border to cut anterior margin at the level of anterolateral glabellar corners. Posterior part of facial suture divergent, sinuous, reaching almost the posterior lateral margin.

Hypostome elongate, oval, with strongly convex middle body. Anterior lobe of middle body ovate in outline, separated from posterior lobe by very shallow middle furrow. Lateral and posterior border narrow, anterior border flat, narrow, incomplete medially, passing into short, pointed anterior wings.

Total number of thoracic segments (13) visible only on MUZWG ZI/29/0001 (Pl. 18, Fig. 4) and on the plaster cast of BGS Zs 840 (Pl. 19, Fig. 12). Axial part elevated above slightly wider pleural parts. Anterior pleural tips pointed laterally, posterior pleural tips slightly curved, pointed posterolaterally, the posteriormost passing into stout short pleural spines.

Pygidium entire, wider than long. Maximum length of pygidium 2.3-7.9 mm (n=10). Maximum length 47±4% of maximum width. Pygidial axis 81±7% of maximum pygidial length, considerably elevated above surface of pygidium and with three inter-ring furrows, of which the most posterior one typically much shallower than the others. Axis slightly narrows posteriorly, but does not reach moderately narrow, well-defined pygidial border. Border varying in width within each specimen, being narrowest at axial line, and gradually broadening laterally. Pygidium with slight indentation at posterior midpoint.

REMARKS: The specimens described by ORLOWSKI (1968b) as Olenus rams bear all of the characteristics of the genus Aphelaspis and should be transferred into it. Their affiliation to Olenus was already doubted by BERGSTROM (1973), according to whom "...the cephalic characters, including the blunt anterior end of the glabellum, indicates that "O." rams belongs to the Acrocephalitinae, probably to one of the Upper Cambrian genera Pesaia, Cliffia or Paracrocephalites...". Pesaia (known from only one species Pesaia exculpta WALCOTT & RESER, from Novaya Zemlya), seems quite similar from the original illustrations (WALCOTT & RESER 1924; MOORE 1959), but upon direct examination (see p. 212 in SHERGOLD & SIZUZ 1991) differs in possessing an incipient preglabellar boss and a wide linguloid anterior cranidial border, as well as deeply impressed border furrow. Cliffia WILSON and Paracrocephalites POULSEN typically possess occipital spines or nodes, and have different proportions of the cranidial characters. Moreover, representatives of Acrocephalitinae have a strongly convex glabella and a swelling or boss on the preglabellar field, whereas the glabella of the specimens in question has a low profile and the boss is present only on the largest specimen (MUZWG ZI/29/0067, Pl. 18, Fig. 13). The latter feature might be characteristic for mature individuals only and might well represent a brood pouch, as suggested by FORTEY & HUGHES (1998), although there are insufficient data to confirm this interpretation.

According to Shergold & Cooper (1985), Shergold & Szuży (1991), Shergold & Webers (1992), and Shergold & al. (2000), the species does not represent Olenus or Olenella, although from its cranidial characters it recalls representatives of the Aphelaspidae mainly from the Siberian Platform and adjacent areas. On the other hand, the resemblance of 'Olenus' rara to the genus Maladioidella Endo has often been pointed out (Shergold & Szuży 1991). This resemblance is of particular importance in the context of Maladioidella cf. colchera Shergold (in: Shergold & al. 1983), which has been interpreted as being responsible for the creation of the trace fossil Cruziana semiplicata Salter, based on investigations in Oman (Forstey & Seilacher 1997). Cruziana semiplicata is common in the Upper Cambrian sandstones of the Wiśniówka Duża quarry, which yield few specimens of Aphelaspis rara, and can be correlated with the sandstones from the Wąwrock quarry, where A. rara is abundant. Cruziana semiplicata traces, however, could also have been made by trilobites with the same general outline as Maladioidella, e.g. by Aphelaspis rara (Żylińska 1999), which has very large librigenae with long spines, which created the longitudinal ridges in the Cruziana semiplicata traces.

The specimens of Aphelaspis rara hand are most similar to specimens described as A. quadrata Resser from north-eastern Tennessee (Rasetti 1965, Pl. 18, Figs 1-9). The proportions between the various parameters of the cranidium are comparable, particularly the small eye index (Text-fig. 26b), the ratio between the occipital width and the length of the posterior limb, and the ratio between the palpebral lobe length and the occipital post-palpebral distance. In Aphelaspis rara, however, the palpebral lobes are placed slightly more posteriorly than in A. quadrata, the frontal area is about 40% of the occipital glabellar length (compared to 50% of A. quadrata) and the preglabellar field is rather flat and not downsloping as in A. quadrata. The associated librigenae possess a longer spine, and the course of the posterior facial suture is different from that in the librigenae illustrated by Rasetti (1965, Pl. 18, Figs 4, 5). Such a course of the facial suture is present on a specimen of Aphelaspis cf. walcotti Resser from the Heritage Range in the Ellsworth Mountains, West Antarctica (Shergold & Webers 1992, Pl. 9, Fig. 1), but the librigenae possesses a much shorter spine in comparison to the spine of librigenae of Aphelaspis rara. The pygidium of A. rara is a typical Aphelaspis pygidium. The number of axial lobes as well as the indentation compares with these features in A. quadrata, but in comparison to the latter, the pygidium is slightly narrower.


Family Solenopleuridae Angelin, 1854

Gen. et sp. indet.

(Pl. 20, Figs 15-16)

1968b. Protopeltura sp.; Orlowski, pp. 276-277, Text-fig. 11, Pl. 8, Figs 4-5.

MATERIAL: 4 incomplete cranidia, occasionally with counterparts, MUZWG ZI/29/0703, 0711, 0716, 0729.

BIOMETRIC DATA: Twelve parameters measured on 4 cranidia.

DESCRIPTION: Length of cranidium 8.3-11.6 mm (n=2). Glabella tapering strongly forwards, truncated anteriorly. Length of glabella 67-71% of cranidial length, 83-84% if occipital ring is included. Cranidium widely convex in unflattened specimens. Glabella slightly elevated above surface of fixigenae, separated by deep axial and preglabellar furrows from fixigenae, and from occipital ring by deep, concave forwards occipital furrow, connected with glabella adaxially. Occipital ring composite, with median node (visible only on MUZWG ZI/29/0716). Occipital ring about 10% wider than pre-occipital glabella. Palpebral lobes rather long, situated at a distance from glabella of about half glabellar width at mid-palpebral level, slightly anteriorly than transverse mid-line of glabella. Small eye index 26-29%, large eye index 32-34%. Eye-ridges distinct, slightly oblique. Glabellar furrows effaced. Frontal area short, comprising rather flat preglabellar field and convex anterior border of similar width. Frontal area 16-17% of total cranidial length, 19-21% of occipital-glabellar length and 22-26% of total glabellar length. Anterior border furrow, distinct, slightly curved backwards abaxially. Anterior margin trapezoidal. Anterior part of facial suture slightly divergent in front of palpebral lobes, then turned sharply abaxially and crossing the anterior border at points more or less at level of anterolateral corners of glabella. Posterior part of facial suture and posterior lobes not preserved.

REMARKS: The specimens were assigned to Protopeltura by Orlowski (1968b). This genus is, how-
ever, characterised by a strongly or bluntly rounded glabella, tapering only slightly forwards, and the palpebral lobes are rather close to the glabella, whereas the fairly large palpebral lobes and trapezoidal glabella with effaced lateral glabellar furrows of the specimens under discussion do not permit this assignment. The specimens recall in some respects genera assigned to the Solenopleuridae.

Andrarina? pusilla (WESTERGÅRD) from the lower part of the Upper Cambrian in Scania is quite similar in the shape and proportions of the glabella as well as in the position of the palpebral lobes, but it bears lateral glabellar furrows, and the anterior border is quite wide (sag.) in comparison with the specimens under discussion (WESTERGÅRD 1922, Pl. 2, Figs 8-13).


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PLATE 1

All specimens from the Upper Cambrian, Klonówka Formation, Holy Cross Mountains, Poland

1-10 – *Trilobagnostus nudis* (Salter, 1864); *Peltura minor* Zone, Chabowe Doly Mill. 1 – MUZW ZI/29/0316; cephalon, original of Orłowski (1968b, Pl. 4, Fig. 3); × 5; 2 – MUZW ZI/29/0307; cephalon, original of Orłowski (1968b, Pl. 4, Fig. 2b); × 4; 3 – MUZW ZI/29/0311; pygidium, original of Orłowski (1968b, Pl. 4, Fig. 4); × 5; 4 – MUZW ZI/29/0314; cephalon, original of Orłowski (1968b, Pl. 4, Fig. 1); × 5; 5 – MUZW ZI/29/0307; cephalon, original of Orłowski (1968b, Pl. 4, Fig. 2a); × 4; 6 – MUZW ZI/29/0319; pygidium, original of Orłowski (1968b, Pl. 4, Fig. 5); with cranidium of *Sphaerophthalmus alatus*, × 5; 7 – MUZW ZI/29/0312; pygidium, × 4; 8 – MUZW ZI/29/0315; cephalon, × 5; 9 – MUZW ZI/29/0306; pygidium, × 6; 10 – MUZW ZI/29/0420; pygidium, × 5.

11-12 – *Ctenopyge* (*Mesoctenopyge*) *tumida* Westergård, 1922; *Peltura minor* Zone, Chabowe Doly Mill; 11 – MUZW ZI/29/0639; librigena, × 4; 12 – MUZW ZI/29/0682; librigena, × 4.

13 – *Ctenopyge* (*Ctenopyge*) *jletcheri* (Matthew, 1901); *Peltura scarabaeoides* Zone, Chabowe Doly Ravine; MUZW ZI/29/0605; librigena, × 2.
PLATE 2

All specimens from the Upper Cambrian, Klonówka Formation, Holy Cross Mountains, Poland

1a – *Sphaerophthalmus humilis* (PHILLIPS, 1848); librigena, original of ORŁOWSKI (1968b, Pl. 6, Fig. 7);
1b – *Ctenopyge (Ctenopyge) fletcheri* (MATTHEW, 1901); librigena, MUZWG ZI/29/0272; *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 3.
2 – *Ctenopyge (Ctenopyge) fletcheri* (MATTHEW, 1901); MUZWG ZI/29/0292, librigena, original of ORŁOWSKI (1968b, Pl. 6, Fig. 11), *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 3.
PLATE 3

1 from the Lower? Tremadocian, 2-12 from the Upper Cambrian, Klonówka Formation, Holy Cross Mountains, Poland

1 – Ceratopygidae gen. et sp. indet.; MUZPIG 1042.II.93; pygidial spine, Jeleniów 2 Borehole, 183.5 m, × 3.

2-3 – Sphaerophthalminus humilis (PHILLIPS, 1848); Peltura scarabaeoides Zone, Chabowe Doly Ravine; 2 – MUZWG ZI/29/0271, pygidium, original of ORLOWSKI (1968b, Pl. 6, Fig. 13), × 5; 3 – MUZWG ZI/29/0269, pygidium, × 3.

4-5 – Ctenopyge (Ctenopyge) cf. linnarssoni WESTERGARD, 1922; Peltura scarabaeoides Zone, Chabowe Doly Ravine; 4 – MUZWG ZI/29/0768, × 3; 5 – MUZWG ZI/29/0293, librigena, × 5.

6-11 – Sphaerophthalminus major LAKE, 1913; Peltura scarabaeoides Zone, Chabowe Doly Ravine; 6 – MUZWG ZI/29/0275, cranidium, × 6; 7 – MUZWG ZI/29/0286, cranidium, × 4; 8 – MUZWG ZI/29/0279, original of ORLOWSKI (1968b, Pl. 6, Fig. 6), cranidium, × 4; 9 – MUZWG ZI/29/0277, cranidium, original of ORLOWSKI (1968b, Pl. 6, Figs 1a-b), × 4; 10 – MUZWG ZI/29/0295, pygidium, original of ORLOWSKI (1968b, Pl. 6, Fig. 14), × 5; 11 – MUZWG ZI/29/0280, cranidium, × 6.

12 – Leptoplastinae gen. et sp. indet.; Leptoplastus or Protopeltura praecursor Zone, Lisie Jamy, MUZWG ZI/29/0588, librigena, × 4.
PLATE 4

Figs 1-3, 5-11 from the Upper Cambrian, Klonówka Formation, 4 from the Upper Cambrian, Wiśniówka Formation, Holy Cross Mountains, Poland

1-3 - Angelina cf. hyeronimi (KAYSER, 1876); Acerocare Zone sensu lato, all × 3; 1 - MUZPIG 1042.II.82, cranidium, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 24), Jeleniów 3 Borehole, 107.5-108.5 m; 2 - MUZPIG 1042.II.81, cranidium, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 26), Jeleniów 3 Borehole, 106-107 m; 3 - MUZPIG 1042.II.83, cranidium, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 23), Bukowiany 1a Borehole, 238.2-243 m.

4 - Olenus solitarius (WESTERGÅRD, 1922); MUZWG ZI/29/0684, original of ORLOWSKI (1968b, Pl. 7, Fig. 12b), Olenus scanicus and ?Parabolina brevispina Subzones, Wiśniówka Duża Quarry, × 2.

5-7 - Parabolina (Parabolina) heres (BROGER, 1882); Acerocare Zone sensu lato, all × 3; 5 - MUZPIG 1042.II.73, pygidium, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 3), Jeleniów 3 Borehole, 109-116 m; 6 - MUZPIG 1042.II.61, librigena, original of TOMCZYKOWA (1968b, Pl. 1, Fig. 20), Jeleniów 3 Borehole, 113.5-113.8 m; 7 - MUZPIG 1042.II.45, librigena, original of TOMCZYKOWA (1968b, Pl. 1, Fig. 5), Wilków IG-1 Borehole, 838 m.

8 - Parabolina (Parabolina?) jemtlandica WESTERGÅRD, 1922; MUZPIG 1042.II.37, cranidium, original of TOMCZYKOWA (1968b, Pl. 1, Fig. 1), Acerocare Zone sensu lato, Jeleniów 2 Borehole, 194.6 m × 2.

9 - Plicatolina sp.; MUZPIG 1042.II.60, cranidium, original of TOMCZYKOWA (1968b, Pl. 1, Fig. 18), Acerocare Zone sensu lato, Brześniki 2 Borehole, 30-40 m, × 3.

10-11 - Parabolina (Neoparabolina?) dawsoni (MATTHEW, 1901); Peltura minor Zone, Chabowe Doly Mill; 10 - MUZWG ZI/29/0528, cranidium, original of ORLOWSKI (1968b, Pl. 6, Fig. 18), × 3; 11 - MUZWG ZI/29/0319, negative of Fig. 10, × 2.5.
PLATE 5

All specimens from the Upper Cambrian, Acerocare Zone sensu lato, Klonówka Formation, Holy Cross Mountains, Poland.

1-14 – Parabolina (Neoparabolina) frequens (BARRANDE, 1868); 1 – MUZPIG 1042.II.47, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 3); Jeleniów 3 Borehole, 132 m, × 6.5; 2 – MUZPIG 1042.II.50, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 5); Jeleniów 3 Borehole, 158.1-158.5 m, × 6; 3 – MUZPIG 1042.II.54, cranidium, original of TOMCZYKOWA (1968b, Pl. 1, Fig. 11); Bukowiany 1a Borehole, 238-243 m, × 4; 4 – MUZPIG 1042.II.38, cranidium, original of TOMCZYKOWA (1968b, Pl. 1, Fig. 16), Bukowiany 1a Borehole, 226-227 m, × 2; 5 – MUZPIG 1042.II.38a, original of TOMCZYKOWA (1968b, Pl. 1, Fig. 15), negative of Fig. 4, × 2; 6 – MUZPIG 1042.II.101, librigena, Jeleniów 3 Borehole, 115-116 m, × 4; 7 – MUZPIG 1042.II.51, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 4), Jeleniów 3 Borehole, 153.5-154 m, × 4; 8 – MUZPIG 1042.II.44a, cranidium, Jeleniów 3 Borehole, 160 m, × 3; 9 – MUZPIG 1042.II.53, librigena, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 7), Jeleniów 3 Borehole, 153.5-154 m, × 3; 10 – MUZPIG 1042.II.49, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 2), Jeleniów 3 Borehole, 143-144 m, × 10; 11 – MUZPIG 1042.II.56, librigena, original of TOMCZYKOWA (1968b, Pl. 1, Fig. 12), Bukowiany 1a Borehole, 238-243 m, × 3; 12 – MUZPIG 1042.II.59, cranidium, original of TOMCZYKOWA (1968b, Pl. 1, Fig. 17), Jeleniów 3 Borehole, 154.5 m, × 3; 13 – MUZPIG 1042.II.52, librigena, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 6), Jeleniów 3 Borehole, 158.1-158.5 m, × 3; 14 – MUZPIG 1042.II.107, cranidium, Jeleniów 3 Borehole, 109.8 m, × 3.
PLATE 6

All specimens from the Upper Cambrian, Klonówka Formation, Holy Cross Mountains, Poland

1-10 – *Parabolina (Neoparabolina?)* lapponica WESTERGÅRD, 1947; 1 – MUZWG ZI/29/0401, librigena, original of ORŁOWSKI (1968b, Pl. 5, Fig. 12), with *Sphaerophthalmus alatus* (BOECK, 1838) (S); *Peltura minor* Zone, Chabowe Doly Mill, × 3; 2 – MUZWG ZI/29/0535, cranidium, original of ORŁOWSKI (1968b, Pl. 6, Fig. 17), *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 6; 3 – MUZWG ZI/29/0610, librigena, *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 3; 4 – MUZWG ZI/29/0521, cranidium, original of ORŁOWSKI (1968b, Pl. 6, Fig. 19), *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 3; 5 – MUZWG ZI/29/0522, cranidium, *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 2; 6 – MUZPIG 1042.II.43a, librigena, *Acerocare Zone sensu lato*, Jeleniów 3, 143-144 m, × 3; 7 – MUZPIG 1042.II.39, cranidium, original of TOMCZYKOWA (1968b, Pl. 1, Fig. 9), *Acerocare Zone sensu lato*, Jeleniów 3, 144 m, × 2; 8 – MUZWG ZI/29/0523, cranidium, original of ORŁOWSKI (1968b, Pl. 6, Fig. 21), *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 3; 9 – MUZWG ZI/29/0533, cranidium, original of ORŁOWSKI (1968b, Pl. 6, Fig. 16), *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 4; 10 – MUZWG ZI/29/0529, cranidium, original of ORŁOWSKI (1968b, Pl. 6, Fig. 20), with *Peltura protopeltorum* ORŁOWSKI, *Peltura minor* Zone, Chabowe Doly Mill, × 3.
PLATE 7

All specimens from the Upper Cambrian, Klonówka Formation, Holy Cross Mountains, Poland

1-3, 7 - Parabolina (Neoparabolina?) lapponica Westergard, 1947; 1 - MUZWG ZI/29/0415, librigena, Peltura minor Zone, Chabowe valley Mill, x 3; 2 - MUZFIG 1042.II.42, librigena, Acerocare Zone sensu lato, Jeleniów 3 Borehole, 109–116 m, x 3; 3 - MUZWG ZI/29/0527, cranidium, Peltura minor Zone, Chabowe valley Mill, x 3; 7 - MUZFIG 1042.II.40, cranidium, original of Tomczykowa (1968b, Pl. 1, Fig. 6), Acerocare Zone sensu lato, Jeleniów 3 Borehole, 140-146 m, x 3.

4-5, 8 - Parabolina sp.; 4 - MUZWG ZI/29/0636, pygidium, original of Orłowski (1968b, Pl. 8, Fig. 14), Peltura scarabaeoides Zone, Chabowe valley Ravine, x 4; 5 - MUZWG ZI/29/0620, pygidium, Peltura scarabaeoides Zone, Chabowe valley Ravine, x 4; 8 - MUZWG ZI/29/0570, pygidium, Peltura minor Zone, Chabowe valley Mill, x 4.

6 - Parabolinites sp.; MUZWG ZI/29/0680, cranidium, Peltura minor Zone, Chabowe valley Mill, x 3.

9-10 - Acerocarina klonowkae (Orłowski, 1968); Peltura scarabaeoides Zone, Chabowe valley Ravine; 9 - MUZWG ZI/29/0768, cranidium, x 3; 10 - MUZWG ZI/29/0550, cranidium, x 4.
PLATE 8

All specimens from the Upper Cambrian, Klonówka Shale Formation, Holy Cross Mountains, Poland

1-2, 4-5 - *Acerocare* sp.; *Acerocare Zone sensu lato*; 1 - MUZPIG 1042.II.79, librigena, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 9), Jeleniów 3 Borehole, 109-116 m, × 9; 2 - MUZPIG 1042.II.78, cranidium, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 5), Brzeźinki 2 Borehole, 30-40 m, × 4; 4 - MUZPIG 1042.II.79a, cranidium, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 6), Jeleniów 3 Borehole, 113-114 m, × 10; 5 - MUZPIG 1042.II.77a, cranidium, Bukowiany 1a Borehole, 238-243 m, × 7.

3, 6-10 - *Acerocarina klonowkae* (ORŁOWSKI, 1968); 3 - MUZWG ZI/29/0546, cranidium, *Peltura scarabaeoides Zone*, Chabowe Doły Ravine, × 3; 6 - MUZWG ZI/29/0763, librigena, *Peltura scarabaeoides Zone*, Chabowe Doły Ravine, × 3; 7 - MUZWG ZI/29/0549, cranidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 6), *Peltura minor Zone*, Chabowe Doły Mill, × 4; 8 - MUZWG ZI/29/0545, holotype cranidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 6), *Peltura scarabaeoides Zone*, Chabowe Doły Ravine, × 4; 9 - MUZWG ZI/29/0548, cranidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 7), *Peltura scarabaeoides Zone*, Chabowe Doły Ravine, × 4; 10 - MUZWG ZI/29/0547, cranidium, *Peltura scarabaeoides Zone*, Chabowe Doły Ravine, × 4.


P - *Peltura protopelorum* ORŁOWSKI, cranidium, ?thoracic segment;
L - *Leptoplastides trae* (ORŁOWSKI), cranidia, librigenae.
PLATE 9

All specimens from the Upper Cambrian, Kłonówka Formation, Holy Cross Mountains, Poland

1-4 - *Leptoplastides coniunctus* (TOMCZYKOWA, 1968); *Acerocare Zone sensu lato*; 1 - MUZPIG 1042.II.29, holotype cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 33), Jeleniów 3 Borehole, 143-144 m, × 3; 2 - MUZPIG 1042.II.32, librigena, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 31), Jeleniów 3 Borehole, 143-144 m, × 4; 3 - MUZPIG 1042.II.30, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 32), Jeleniów 3 Borehole, 143-144 m, × 3; 4 - MUZPIG 1042.II.31, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 34), Jeleniów 3 Borehole, 143-144 m, × 3.

5-9 - *Leptoplastides irae* (ORLOWSKI, 1968); 5 - MUZWG ZI/29/0599, *Leptoplastides* or *Protopeltura praecursor* Zone, Lisie Jamy, × 4; 6 - MUZWG ZI/29/0598, detail from Fig. 9, *Leptoplastides* or *Protopeltura praecursor* Zone, Lisie Jamy, × 2; 7 - MUZWG ZI/29/0407, cranidium, original of ORLOWSKI (1968b, Pl. 5, Fig. 11), *Peltura minor* Zone, Chabowe Doly Mill, × 3; 8 - MUZWG ZI/29/0400, cranidium, original of ORLOWSKI (1968b, Pl. 5, Fig. 2), *Peltura minor* Zone, Chabowe Doly Mill, × 3; 9 - MUZWG ZI/29/0598, sandy concretion with several effaced individuals of *Leptoplastides irae* (ORLOWSKI) (the specimen enlarged on Fig. 6 is arrowed), *Leptoplastides* or *Protopeltura praecursor* Zone, Lisie Jamy, × 1.
PLATE 10

All specimens from the Upper Cambrian, Klonówka Formation, Holy Cross Mountains, Poland

1-12 – Leptoplastides irae (Orłowski, 1968); 1 – MUZWG ZI/29/0209, cranidium (L), original of Orłowski (1968b, Pl. 5, Fig. 14), with cranidia of Peltura protopeltorum Orłowski (P) and Sphaeroophthalinus alatus (Boeck) (S), Peltura minor Zone, Chabowe Doly Mill, × 3; 2 – MUZWG ZI/29/0396, cranidium, original of Orłowski (1968b, Pl. 5, Fig. 1), Peltura minor Zone, Chabowe Doly Mill, × 4; 3 – MUZWG ZI/29/0568, cranidium, Peltura minor Zone, Chabowe Doly Mill, × 4; 4 – MUZWG ZI/29/0648, cranidium, Peltura minor Zone, Chabowe Doly Mill, × 3; 5 – MUZWG ZI/29/0404, cranidium, original of Orłowski (1968b, Pl. 5, Fig. 8), Peltura minor Zone, Chabowe Doly Mill, × 4; 6 – MUZWG ZI/29/0402, cranidium, original of Orłowski (1968b, Pl. 5, Fig. 15), Peltura minor Zone, Chabowe Doly Mill, × 4; 7 – MUZWG ZI/29/0557, holotype cranidium, original of Orłowski (1968b, Pl. 5, Fig. 5), Peltura minor Zone, Chabowe Doly Mill, × 3; 8 – MUZWG ZI/29/0582, librigena, Leptoplastides or Protopeltura praecursor Zone, Lisie Jamy, × 4; 9 – MUZWG ZI/29/0582, librigena, Leptoplastides or Protopeltura praecursor Zone, Lisie Jamy, × 4; 10 – AK-4, librigena, Leptoplastides or Protopeltura praecursor Zone, Lisie Jamy, × 4; 11 – MUZWG ZI/29/0413, librigena, Peltura minor Zone, Chabowe Doly Mill, × 4; 12 – MUZWG ZI/29/0148, librigena, Peltura minor Zone, Chabowe Doly Mill, × 5.
PLATE 11

All specimens from the Upper Cambrian, Klonówka Formation, Holy Cross Mountains, Poland

1-12 – *Leptoplastides irae* (ORŁOWSKI, 1968); 1 – MUZWG ZI/29/0327, librigena, *Peltura minor* Zone, Chabowe Doly Mill, × 4; 2 – MUZWG ZI/29/0603, librigena, *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 3; 3 – MUZWG ZI/29/0606, librigena, *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 3; 4 – MUZWG ZI/29/0399, cranidium, original of ORŁOWSKI (1968b, Pl. 5, Fig. 3), *Peltura minor* Zone, Chabowe Doly Mill, × 4; 5 – MUZWG ZI/29/0424, pygidium, *Peltura minor* Zone, Chabowe Doly Mill, × 3; 6 – MUZWG ZI/29/0617, pygidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 15), *Peltura minor* Zone, Chabowe Doly Mill, × 3; 7 – MUZWG ZI/29/0577, librigena, stratigraphic horizon unknown, Bęczków Ravine, × 2; 8 – MUZWG ZI/29/0605, cranidium, original of ORŁOWSKI (1968b, Pl. 5, Fig. 13), *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 4; 9 – MUZWG ZI/29/0545, pygidium, *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 4; 10 – MUZWG ZI/29/0628, pygidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 24), *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 4; 11 – MUZWG ZI/29/0323, pygidium, original of ORŁOWSKI, (1968b, Pl. 8, Fig. 12), *Peltura minor* Zone, Chabowe Doly Mill, × 4; 12 – MUZWG ZI/29/0635, pygidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 22), *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 4.

13-18 – *Leptoplastides latus* (TOMCZYKOWA, 1968); *Acerocare* Zone sensu lato; 13 – MUZPIG 1042.II.11, holotype cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 23), Jeleniów 3 Borehole, 160 m, × 3; 14 – MUZPIG 1042.II.21, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 9), Bukowiany 1a Borehole, 238-243 m, × 2.5; 15 – MUZPIG 1042.II.24, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 13), Jeleniów 3 Borehole, 113-114 m, × 7; 16 – MUZPIG 1042.II.35, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 41), Bukowiany 1a Borehole, 241.9 m, × 3; 17 – MUZPIG 1042.II.23, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 10), Jeleniów 3 Borehole, 143-144 m, × 3; 18 – MUZPIG 1042.II.26, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 12), Bukowiany 1a Borehole, 238-243 m, × 3.
PLATE 12

All specimens from the Upper Cambrian, *Acerocare Zone sensu lato*, Klоновка Formation, Holy Cross Mountains, Poland

1-7 - *Leptoplastides latus* (Tomczykowa, 1968); 1 - MUZPIG 1042.II.13, pygidium, original of Tomczykowa (1968b, Pl. 2, Fig. 20), Jeleniów 3 Borehole, 113-114 m, x 3; 2 - MUZPIG 1042.II.12, cranidium, original of Tomczykowa (1968b, Pl. 2, Fig. 17), Jeleniów 3 Borehole, 113 m, x 4; 3 - MUZPIG 1042.II.12a, cranidium, original of Tomczykowa (1968b, Pl. 2, Fig. 18), Jeleniów 3 Borehole, 113 m, x 4; 4 - MUZPIG 1042.II.16, cranidium, original of Tomczykowa (1968b, Pl. 2, Fig. 25), Jeleniów 3 Borehole, 113.5-113.8 m, x 4; 5 - MUZPIG 1042.II.14, librigena, original of Tomczykowa (1968b, Pl. 2, Fig. 16), Jeleniów 3 Borehole, 113.8-114.8 m, x 4; 6 - MUZPIG 1042.II.17, librigena, original of Tomczykowa (1968b, Pl. 2, Fig. 26), Jeleniów 3 Borehole, 113.5-113.8 m, x 4; 7 - MUZPIG 1042.II.18, librigena, original of Tomczykowa (1968b, Pl. 2, Fig. 22), Jeleniów 3 Borehole, 113.8-114.8 m, x 4.

8-13 - *Leptoplastides ulrichi* (Kayser, 1897); 8 - MUZPIG 1042.II.1, cranidium with three thoracic pleurae, original of Tomczykowa (1968b, Pl. 2, Fig. 36), Jeleniów 3 Borehole, 116 m, x 3.5; 9 - MUZPIG 1042.II.5, librigena, original of Tomczykowa (1968b, Pl. 2, Fig. 37), Jeleniów 3 Borehole, 109-116 m, x 2; 10 - MUZPIG 1042.II.27, cranidium, original of Tomczykowa (1968b, Pl. 2, Fig. 28), Jeleniów 3 Borehole, 152 m, x 1.5; 11 - MUZPIG 1042.II.10, cranidium, original of Tomczykowa (1968b, Pl. 2, Fig. 40), Jeleniów 3 Borehole, 113.5-113.8 m, x 3; 12 - MUZPIG 1042.II.28, pygidium, original of Tomczykowa (1968b, Pl. 2, Fig. 29), Jeleniów 3 Borehole, 153.5 m, x 3; 13 - MUZPIG 1042.II.8, cranidium, original of Tomczykowa (1968b, Pl. 3, Fig. 19), Bukowiany 1a Borehole, 238-243 m, x 3.
PLATE 13

All specimens from the Upper Cambrian, Klonówka Formation, Holy Cross Mountains, Poland

1-2 - *Leptoplastides ulrichi* (Kayser, 1897); *Acerocare Zone sensu lato*;
1 - MUZPIG 1042.II.6, librigena, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 38), Jeleniów 3 Borehole, 136 m, × 2; 2 - MUZPIG 1042.II.3, librigena, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 22), Jeleniów 3 Borehole, 107.6 m, × 3.

3, 6 - *Leptoplastides* sp.; *Peltura scarabaeoides* Zone, Chabowe Doly Ravine;
3 - MUZWG ZI/29/0272, cranidium, x 4; 6 - MUZWG ZI/29/0180, cranidium, x 4.


5 - *Nericiaspis robusta* (Tjernvik, 1953); MUZPIG 1042.II.140, cranidium, *Peltura scarabaeoides* Zone, Wilków IG-1 Borehole, 847.8 m, × 3.

7 - *Peltura* sp.; MUZWG ZI/29/0553, librigena, original of ORLOWSKI (1968b, Pl. 8, Fig. 11), *Peltura scarabaeoides* Zone, Chabowe Doly Ravine, × 4.

8-9 - *Peltura* cf. *costata* (Brøgger, 1882); *Acerocare Zone sensu lato*.
8 - MUZPIG 1042.II.68, cranidium, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 13), Jeleniów 3 Borehole, 47.5 m, × 3; 9 - MUZPIG 1042.II.69, cranidium, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 10), Brzeźniki 1 Borehole, 142 m, × 3.

10 - *Peltura* cf. *transiens* (Brøgger, 1882); MUZPIG 1042.II.70, cranidium, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 12), *Acerocare Zone sensu lato*, Bukowianny 1a Borehole, 238-243 m, × 3.

11-12 - *Peltura scarabaeoides* cf. *westergaardi* Henningsmoen, 1957; *Acerocare Zone sensu lato*;
11 - MUZPIG 1042.II.66, cranidium, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 14), Wilków IG-1 Borehole, 856 m, × 3; 12 - MUZPIG 1042.II.67, cranidium, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 15), Wilków IG-1 Borehole, 855 m, × 4.
PLATE 14

All specimens from the Upper Cambrian, Klonówka Formation, Holy Cross Mountains, Poland

1-3 – Peltura cf. transiens (BRÖGGER, 1882), Acerocare Zone sensu lato.  
1 – MUZPIG 1042.II.80, cranidium, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 17), Jeleniów 3 Borehole, 109-116 m, × 7; 2 – MUZPIG 1042.II.71, cranidium, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 1), Jeleniów 3 Borehole, 107.6 m, × 4; 3 – MUZPIG 1042.II.72, librigena, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 2), Jeleniów 3 Borehole, 113-114 m, × 3.

4-14 – Peltura scarabaeoides scarabaeoides (WAHLENBERG, 1818); pygidia;  
4 – MUZWG ZI/29/0173, Peltura minor Zone, Chabowe Doly Mill, × 4; 5 – MUZWG ZI/29/0575, Peltura scarabaeoides Zone, Chabowe Doly Ravine, × 4; 6 – MUZWG ZI/29/0300, Peltura scarabaeoides Zone, Chabowe Doly Ravine, × 4; 7 – MUZWG ZI/29/0299, Peltura scarabaeoides Zone, Chabowe Doly Ravine, × 4; 8 – MUZWG ZI/29/0286, Peltura scarabaeoides Zone, Chabowe Doly Ravine, × 4; 9 – MUZWG ZI/29/0619, Peltura minor Zone, Chabowe Doly Mill, × 4; 10 – MUZWG ZI/29/0619, negative of Fig. 9, × 4; 11 – MUZWG ZI/29/0296, Peltura scarabaeoides Zone, Chabowe Doly Ravine, × 3; 12 – MUZWG ZI/29/0301, original of ORŁOWSKI (1968b, Pl. 8, Fig. 17), Peltura scarabaeoides Zone, Chabowe Doly Ravine, × 3; 13 – MUZWG ZI/29/0303, original of ORŁOWSKI (1968b, Pl. 8, Fig. 19), Peltura scarabaeoides Zone, Chabowe Doly Ravine, × 4; 14 – MUZWG ZI/29/0304, original of ORŁOWSKI (1968b, Pl. 8, Fig. 16), Peltura scarabaeoides Zone, Chabowe Doly Ravine, × 4.

15-18 – Peltura protopeltorum ORŁOWSKI (P); Peltura minor Zone, Chabowe Doly Mill; 15 – MUZWG ZI/29/0429, pygidium, × 3; 16 – MUZWG ZI/29/0512, × 4; 17 – MUZWG ZI/29/0428, pygidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 20), × 3; 18 – MUZWG ZI/29/0337, cranidia and pygidium, with Sphaerophthalmus alatus (BOECK) (S), × 2.
PLATE 15

All specimens from the Upper Cambrian, *Peltura minor* Zone, Klonówka Formation, Chabowe Doly Mill, Holy Cross Mountains, Poland

1-13 – *Peltura protopeltorum* ORŁOWSKI, 1968; 1-3 – MUZWG ZI/29/0570, holotype cranidium, original of ORŁOWSKI (1968b, Pl. 7, Figs 1a-d), × 3; 4 – MUZWG ZI/29/0568, cranidium, × 4; 5 – MUZWG ZI/29/0325, cranidium, original of ORŁOWSKI (1968b, Pl. 7, Figs 3a-c), × 3; 6-8 – MUZWG ZI/29/0329, cranidium, × 4; 9 – MUZWG ZI/29/0315, cranidium, × 4; 10 – MUZWG ZI/29/0332, cranidium, × 4; 11 – MUZWG ZI/29/0327, cranidium, original of ORŁOWSKI (1968b, Pl. 7, Fig. 11), × 3; 12 – MUZWG ZI/29/0321, cranidium, × 3; 13 – MUZWG ZI/29/0266, cranidium, × 4.
PLATE 16

All specimens from the Upper Cambrian, *Peltura minor* Zone, Klonówka Formation, Chabowe Doly Mill, Holy Cross Mountains, Poland

1-12 - *Peltura protopeltorum* ORŁOWSKI, 1968; 1 - MUZWG ZI/29/0549, librigena, × 3; 2 - MUZWG ZI/29/0338, librigena, × 3; 3 - MUZWG ZI/29/0327, librigena, original of ORŁOWSKI (1968b, Pl. 7, Fig. 11), × 4; 4 - MUZWG ZI/29/0315, cranidium, original of ORŁOWSKI (1968b, Pl. 7, Fig. 4), × 4; 5 - MUZWG ZI/29/0561, cranidium, × 4; 6 - MUZWG ZI/29/0555, cranidium, original of ORŁOWSKI (1968b, Pl. 7, Fig. 2), × 3; 7 - MUZWG ZI/29/0677, librigena, × 3; 8 - MUZWG ZI/29/0571, librigena, original of ORŁOWSKI (1968b, Pl. 7, Fig. 6), × 3; 9 - MUZWG ZI/29/0569, librigena, original of ORŁOWSKI (1968b, Pl. 7, Fig. 9), × 3; 10 - MUZWG ZI/29/0422, pygidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 21), × 3; 11 - MUZWG ZI/29/0434, pygidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 23), × 3; 12 - MUZWG ZI/29/0520, pygidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 13), × 4.
PLATE 17

All specimens from the Upper Cambrian, Wiśniówka Formation, Holy Cross Mountains, Poland

1-18 - *Protopelta aciculata* (Angelin, 1854). 1 - MUZWG ZI/29/0727, original of Orłowski (1968b, Pl. 7, Fig. 13), *Parabolina brevispina* Subzone, Wąwózków Quarry, × 3; 2 - MUZWG ZI/29/0685, *Olenus scanicus* and *Parabolina brevispina* Subzones, Wiśniówka Duża Quarry, × 2; 3 - MUZPIG 8.II.162, (labelled *Parabolina*), *Parabolina brevispina* Subzone, Wąwózków Quarry, × 4; 4 - MUZWG ZI/29/0722, original of Orłowski (1968b, Pl. 8, Fig. 1), *Parabolina brevispina* Subzone, Wąwózków Quarry, × 3; 5 - MUZWG ZI/29/0718, cranidium, original of Orłowski (1968b, Pl. 7, Fig. 15), *Parabolina brevispina* Subzone, Wąwózków Quarry, × 4; 6 - MUZWG ZI/29/0005, cranidium, *Parabolina brevispina* Subzone, Wąwózków Quarry, × 4; 7 - MUZWG ZI/29/0705, librigena, *Parabolina brevispina* Subzone, Wąwózków Quarry, × 4; 8 - MUZWG ZI/29/0712, cranidium, original of Orłowski (1968b, Pl. 7, Fig. 14), *Parabolina brevispina* Subzone, Wąwózków Quarry, × 4; 9 - MUZWG ZI/29/0715, cranidium, original of Orłowski (1968b, Pl. 8, Fig. 2), *Parabolina brevispina* Subzone, Wąwózków Quarry, × 4; 10 - MUZWG ZI/29/0712, negative of Fig. 8, × 3; 11 - MUZWG ZI/29/0701, thorax, *Parabolina brevispina* Subzone, Wąwózków Quarry, × 3; 12 - MUZWG ZI/29/0726, thorax with pygidium, *Parabolina brevispina* Subzone, Wąwózków Quarry, × 2; 13 - MUZWG ZI/29/0702, part of thorax with pygidium, *Parabolina brevispina* Subzone, Wąwózków Quarry, × 3; 14 - MUZPIG 8.II.163, (labelled *Parabolina*), cranidium, *Parabolina brevispina* Subzone, Wąwózków Quarry, × 4; 15 - MUZWG ZI/29/0118, juvenile cranidium, *Parabolina brevispina* Subzone, Wąwózków Quarry, × 10; 16 - MUZWG ZI/29/0719, cranidium, original of Orłowski (1968b, Pl. 8, Fig. 3), *Parabolina brevispina* Subzone, Wąwózków Quarry, × 3; 17 - MUZWG ZI/29/0692, cranidium, *Parabolina brevispina* Subzone, Wąwózków Quarry, × 4; 18 - MUZWG ZI/29/0709, cranidium, *Parabolina brevispina* Subzone, Wąwózków Quarry, × 3.
All specimens from the Upper Cambrian, Wiśniówka Formation, Holy Cross Mountains, Poland

1-13 – *Aphelaspis rara* (Orłowski, 1968); 1 – MUZWG ZI/29/0063; holotype cranidium, original of Orłowski (1968b, Pl. 4, Fig. 6); *Parabolina brevispina* Subzone, Ważworków Quarry, × 4; 2 – MUZWG ZI/29/0005; cranidium, *Parabolina brevispina* Subzone, Ważworków Quarry, × 4; 3 – MUZWG ZI/29/0036; cranidium, original of Orłowski (1968b, Pl. 4, Fig. 15); *Parabolina brevispina* Subzone, Ważworków Quarry, × 2; 4 – MUZWG ZI/29/0001; *Olenus scanicus* and *Parabolina brevispina* Subzones, Wiśniówka Duża Quarry, × 1.5; 5 – MUZWG ZI/29/0022; cranidium, *Parabolina brevispina* Subzone, Ważworków Quarry, × 2; 6 – MUZPIG 8.11.162a; (labelled *Parabolina*), cranidium, *Parabolina brevispina* Subzone, Ważworków Quarry, × 4; 7 – MUZWG ZI/29/0061; cranidium, original of Orłowski (1968b, Pl. 4, Fig. 9); *Parabolina brevispina* Subzone, Ważworków Quarry, × 3; 8 – MUZWG ZI/29/0066; cranidium, *Parabolina brevispina* Subzone, Ważworków, × 3; 9 – MUZWG ZI/29/0057; cranidium, original of Orłowski (1968b, Pl. 4, Fig. 11); *Parabolina brevispina* Subzone, Ważworków Quarry, × 3; 10 – MUZWG ZI/29/0059; cranidium, *Parabolina brevispina* Subzone, Ważworków Quarry, × 3; 11 – MUZWG ZI/29/0019; pygidium, *Parabolina brevispina* Subzone, Ważworków Quarry, × 2; 12 – MUZWG ZI/29/0101; pygidium, *Parabolina brevispina* Subzone, Ważworków Quarry, × 2; 13 – MUZWG ZI/29/0067; cranidium with preglabellar boss, original of Orłowski (1968b, Pl. 4, Fig. 14); *Parabolina brevispina* Subzone, Ważworków Quarry, × 2.
PLATE 19

1-11 - *Aphelaspis rara* (Orłowski, 1968); Upper Cambrian, Wiśniówka Formation, Holy Cross Mountains, Poland; 1 - MUZWG ZI/29/0076, librigena, original of Orłowski (1968b, Pl. 4, Fig. 19), *Parabolina brevispina* Subzone, Wąworków Quarry, × 2; 2 - MUZWG ZI/29/0075, librigena, *Parabolina brevispina* Subzone, Wąworków Quarry, × 3; 3 - MUZPIG 81164, librigena, *Parabolina brevispina* Subzone, Wąworków Quarry, × 4; 4 - MUZWG ZI/29/0054, cranidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 3; 5 - MUZWG ZI/29/0073, librigena, *Parabolina brevispina* Subzone, Wąworków Quarry, × 3; 6 - MUZWG ZI/29/0032, cranidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 3; 7 - MUZWG ZI/29/0033, cranidium, original of Orłowski (1968b, Pl. 4, Fig. 7), *Parabolina brevispina* Subzone, Wąworków Quarry, × 3; 8 - MUZWG ZI/29/0026, cranidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 2; 9 - MUZWG ZI/29/0060, cranidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 3; 10 - MUZWG ZI/29/0048, cranidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 2; 11 - thorax, unnumbered specimen, Department of Geology, University of Vilnius, Lithuania; *Olenus scanicus* and *Parabolina brevispina* Subzone, Wiśniówka Duża Quarry, × 2.

12 - *Aphelaspis rara* (Orłowski, 1968b), plaster cast of specimen BGS Zs 840, Geological Survey Museum, original of Allen & Jackson (1985, Pl. 4, Fig. 2), *Olenus cataractes* Subzone, upper part of Maentwrog Formation, England, UK, × 2.
PLATE 20

All specimens from the Upper Cambrian, *Parabolina brevispina* Subzone, Wiśniówka Formation, Wąworków Quarry, Holy Cross Mountains, Poland

1-14 – *Aphelaspis rara* (Orłowski, 1968); 1 – MUZWG ZI/29/0058, cranidium, \( \times 3 \); 2 – MUZWG ZI/29/0074, librigena, \( \times 2 \); 3 – MUZWG ZI/29/0078, librigena, \( \times 2 \); 4 – MUZWG ZI/29/0095, pygidium, \( \times 2 \); 5 – MUZWG ZI/29/0099, pygidium, \( \times 2 \); 6 – MUZWG ZI/29/00100, pygidium, \( \times 2 \); 7 – MUZWG ZI/29/0109, pygidium, \( \times 2 \); 8 – MUZPIG 8.II.166a, (labelled *Olenidae*), pygidium, \( \times 4 \); 9 – MUZWG ZI/29/0098, pygidium, \( \times 2 \); 10 – MUZWG ZI/29/0089, pygidium, \( \times 2 \); 11 – MUZPIG 8.II.160, (labelled *Peltura*), pygidium, \( \times 3 \); 12 – MUZWG ZI/29/0085, pygidium, \( \times 2 \); 13 – MUZWG ZI/29/0080, hypostome, \( \times 2 \); 14 – MUZWG ZI/29/0079, hypostome, original of Orłowski (1968b, Pl. 4, Fig. 16), \( \times 2 \).

15-16 – Solenopleuridae gen. et sp. indet. 15 – MUZWG ZI/29/0703, cranidium, \( \times 3 \). 16 – MUZWG ZI/29/0729, cranidium, original of Orłowski (1968b, Pl. 8, Fig. 4), \( \times 2 \).