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Late Cambrian trilobites from the Holy Cross Mountains, central Poland

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ABSTRACT:

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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* (ORŁOWSKI), *Leptoplastides irae* (ORŁOWSKI), *Peltura protopeltorum* ORŁOWSKI, and *Trilobagnostus rudis* (SALTER) are provided. Large morphological variation in cephala 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 argentina* (KAYSER) and *P.* (*N.*) *frequens finnmarchica* (NIKOLAISEN & HENNINGSMOEN), represent one taxon. *Parabolina* (*Neoparabolina?*) *lapponica* WESTERGÅRD is most probably related to *Parabolina* (*Neoparabolina*) *frequens* (BARRANDE). *Beltella* 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 clastic deposits of the Łysogóry 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 biogeographic 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 Doły 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-

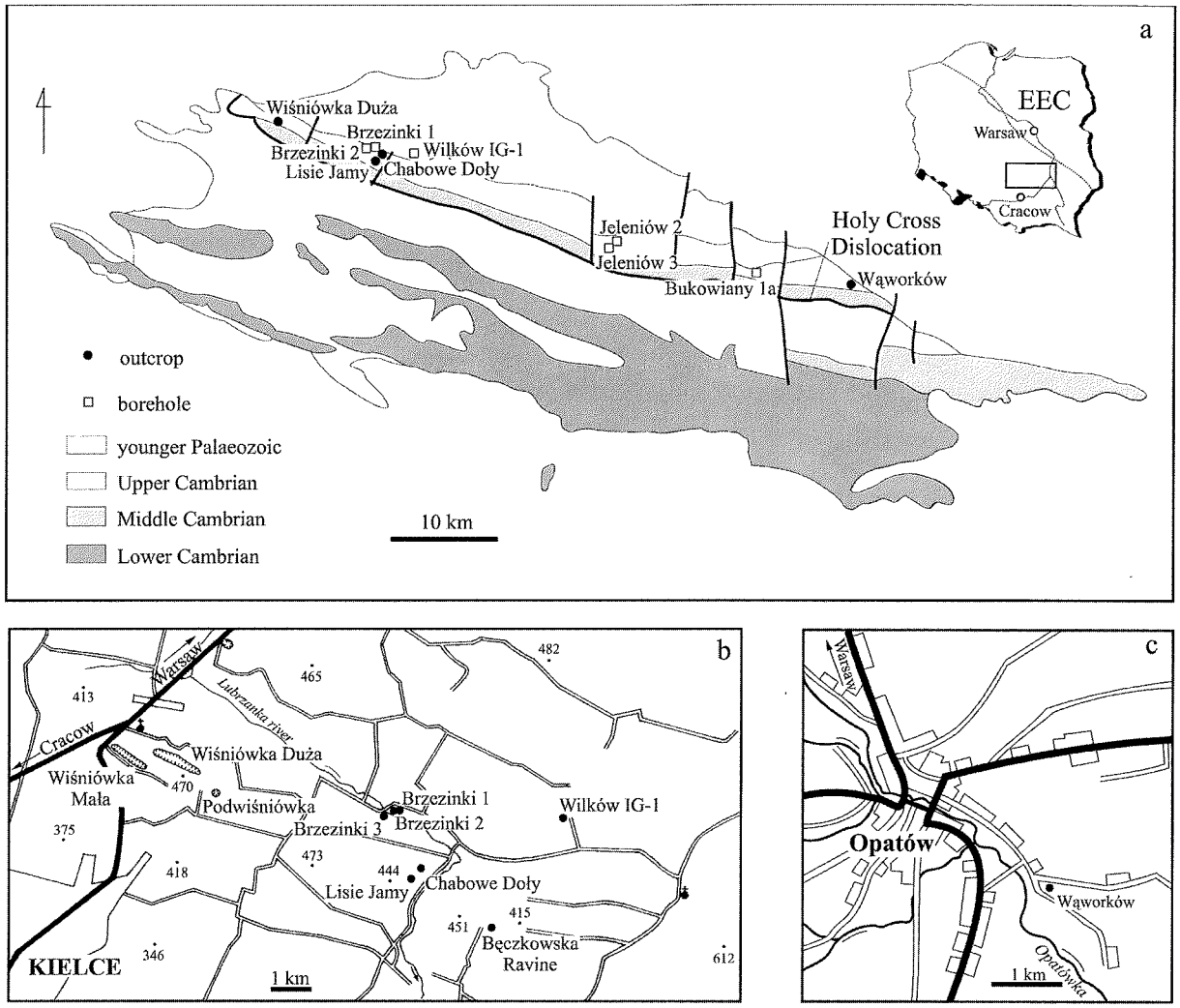

Fig. 1. a. Geological sketch-map of the Holy Cross Mountains, with Cambrian deposits, after ORŁOWSKI (1992), location of studied outcrops and boreholes after ORŁOWSKI (1968a) and TOMCZYKOWA (1968b); b. Sketch-map of the western part of the Łysogóry region; c. Sketch-map of the Wąworków region

mal palaeontological descriptions of the fauna. They merely noted the presence of various taxa in the succession, comparing the assemblages with those from Scandinavia. Most of their collections were destroyed during the Second World War, therefore the identifications cannot be verified, and most of their new taxa have to be treated as *nomina nuda*. The only existing collection is the fauna collected by Jan SAMSONOWICZ from the Wąworków Quarry, at present housed in the Museum of the Polish Geological Survey in Warsaw.

The topic was undertaken again in the late 1960s by Stanisław ORŁOWSKI and Ewa TOMCZYKOWA and resulted in formal description and illustration of Late Cambrian trilobites from exposures and boreholes of the Łysogóry region of the Holy Cross Mountains (ORŁOWSKI 1967, 1968a, b; TOMCZYKOWA 1964, 1968a, b). ORŁOWSKI (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 (ORŁOWSKI 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

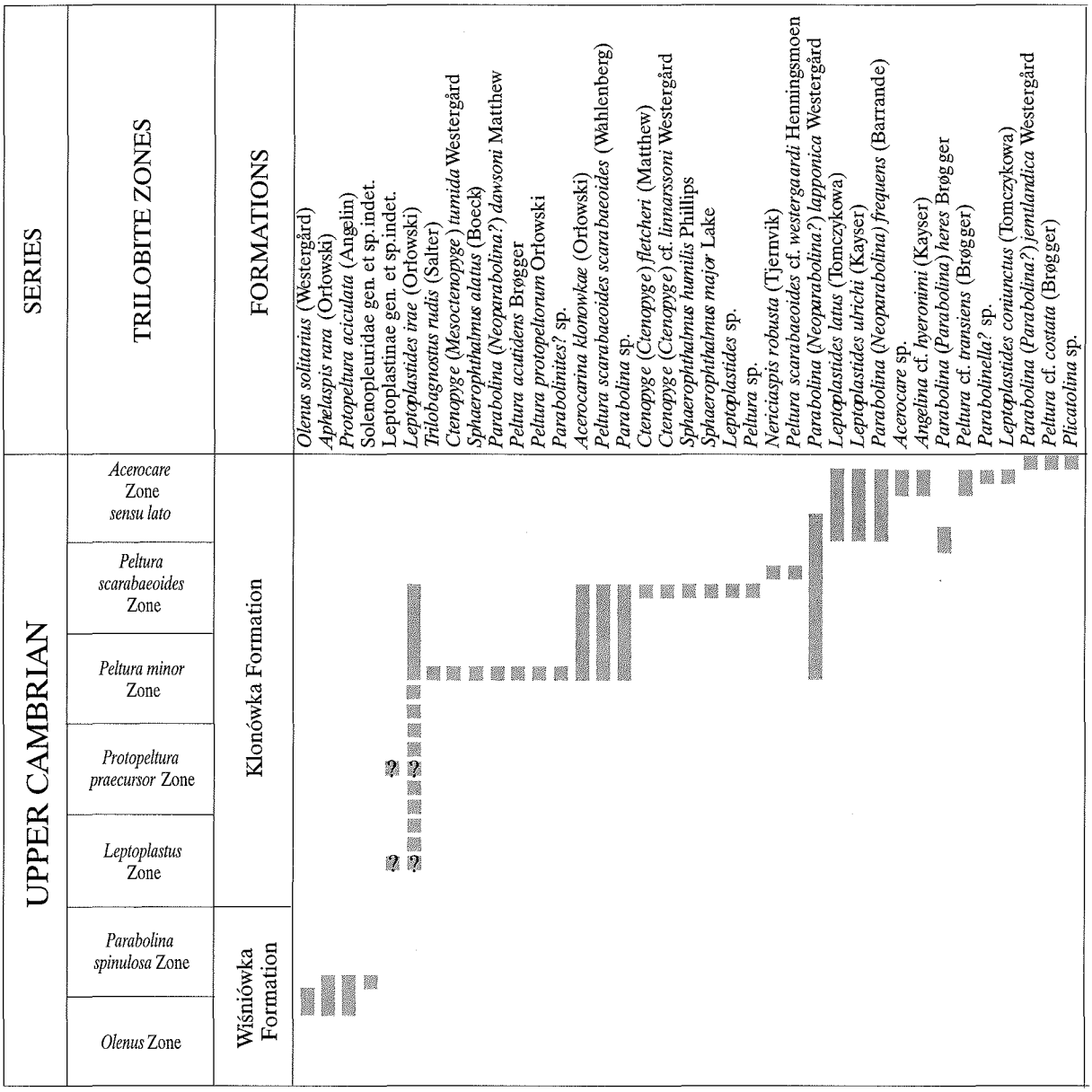

Fig. 2. Range chart of the Late Cambrian trilobites from the Holy Cross Mountains

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

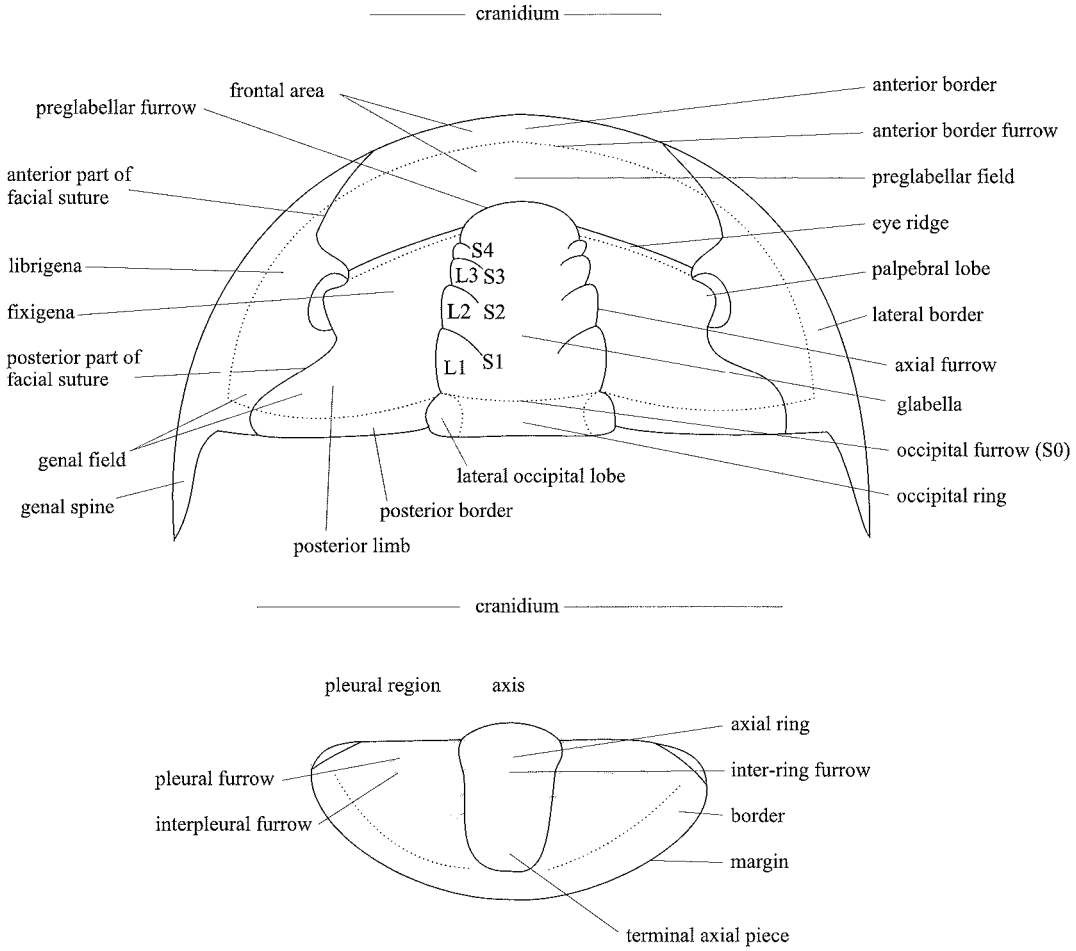

Fig. 3. Terminology of the morphologic features of the cephalon (top) and pygidium (bottom) of non-agnostidean trilobites as applied in this paper (modified after KAESLER 1997). S1-4 – lateral glabellar furrows, L1-3 – lateral glabellar lobes

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

a1	total cranidial length (sag.) - computed as b1 + f1
b	total glabellar length (sag.) - measured from the deepest point in the occipital furrow to the deepest point in the preglabellar furrow
b1	occipital glabellar length (sag.) - measured from the posterior margin of the occipital ring to the deepest part of the preglabellar furrow
c	palpebral length (exs.) - measured between the anterior and posterior tips of the palpebral lobe
d5	occipital post-palpebral distance (sag.) - measured from the posterior edge of the occipital ring to the projection of the posterior end of the palpebral lobe
f1	frontal area length (sag.) - measured from the deepest part of the preglabellar furrow to the anterior edge of the cranidium
g1	anterior border length (sag.) - computed as f1 – h
h	preglabellar area length (sag.) - measured from the deepest part of the preglabellar furrow to the deepest part of the anterior border furrow
j2	maximum width of the frontal area (tr.) - measured between the most widely extended points on the frontal area
j4	pre-palpebral cranidial width (tr.) - measured between angles generally formed at the intersection of palpebral lobes with anterior branches of facial sutures
k	occipital width (tr.) - measured between the deepest parts of the axial furrow opposite the widest part of the occipital ring
k1	palpebral glabellar width (tr.) - measured between the deepest parts of the axial furrow on opposite sides of the glabella at mid-palpebral level
k5	anterior glabellar width (tr.) - measured between anterior pits of the glabella
l	length of posterior limb (tr.) - measured between deepest part of the preglabellar furrow at the posterior edge of the cranidium and the outer tip of the posterior limb
w	maximum pygidial width (tr.) - measured between the outermost tips of the pygidium
y1	intra-articulating length of axis (sag.) - measured from the bottom of the furrow marking off the articulating ring to the bottom of the axial furrow behind the axis
z1	intra-articulating length of pygidium (sag.) - measured from the bottom of the furrow behind the articulating ring to the rear edge of the pygidium
z2	intramarginal pygidial length (sag.) - measured from the anterior edge of the articulating ring to the bottom of the marginal furrow

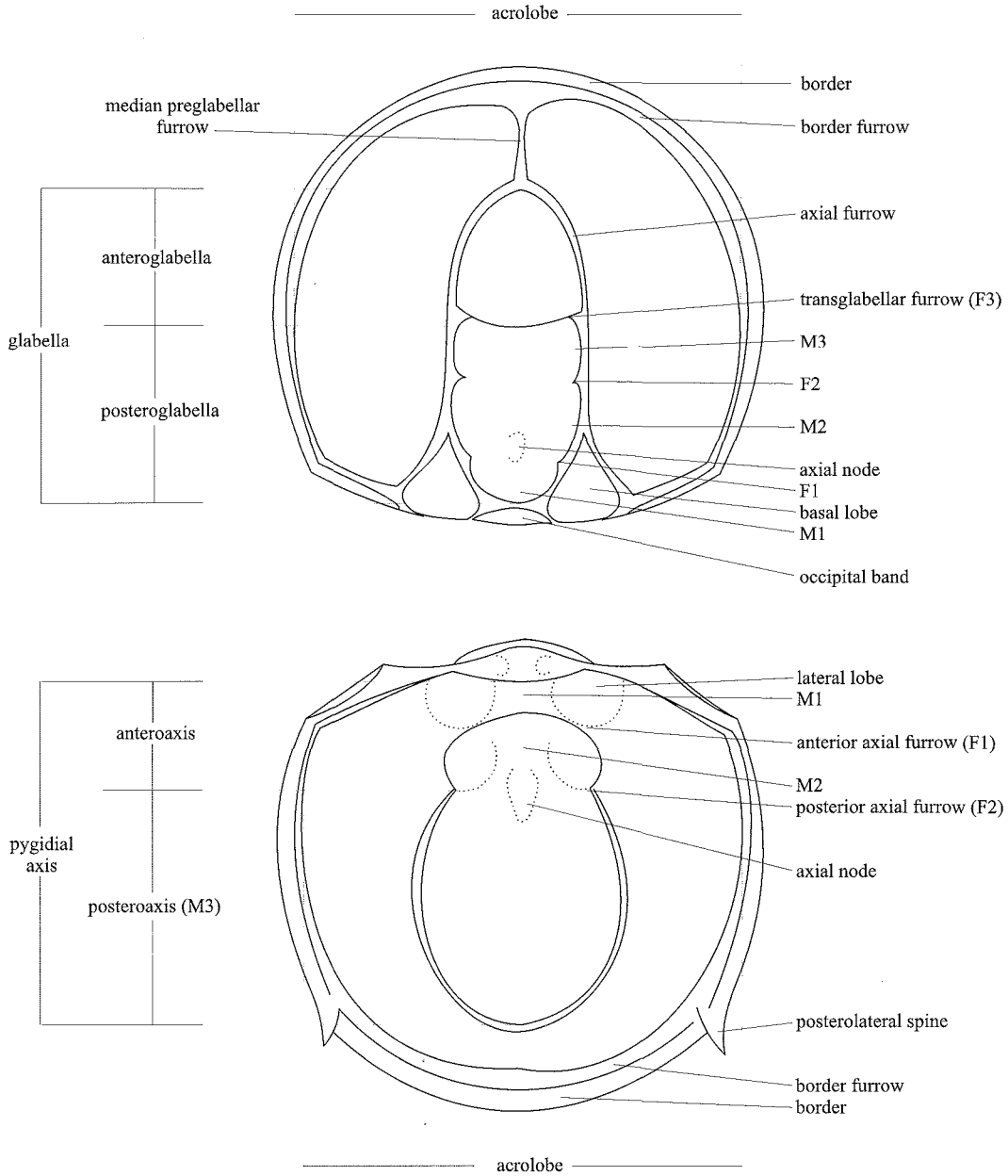

Fig. 4. Terminology of the morphologic features of the cephalon (top) and pygidium (bottom) of agnostidean trilobites as applied in this paper (modified after SHERGOLD & *al.* 1990)

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

Lc	length of cephalon (sag.) - measured from the posteriormost tip of glabella to anteriormost tip of cephalon
Lac	length of cephalic acrolobe (sag.) – measured from posteriormost tip of glabella to anteriormost tip of cephalic acrolobe
Lg	length (sag.) of glabella – measured from the posteriormost tip of glabella to anteriormost tip of glabella
Wc	maximum width of cephalon (tr.) – measured at the widest point of cephalon
Wg	maximum width of glabella (tr.) – measured at the widest point of glabella
Lp	length of pygidium (sag.) – measured from the anteriormost tip of the anteroaxis to the posteriormost tip of the pygidium
La	length of pygidial axis (sag.) – measured from the anteriormost tip of the anteroaxis to the posteriormost tip of the posteroaxis
Lpa	length of posteroaxis (sag.) – measured from the projection of the posterior axial furrow on the axis to the posteriormost tip of the posteroaxis
Wp	maximum width of pygidium (tr.) – measured at widest point of pygidium
Wa	maximum width of pygidial axis (tr.) – measured at widest point of posteroaxis

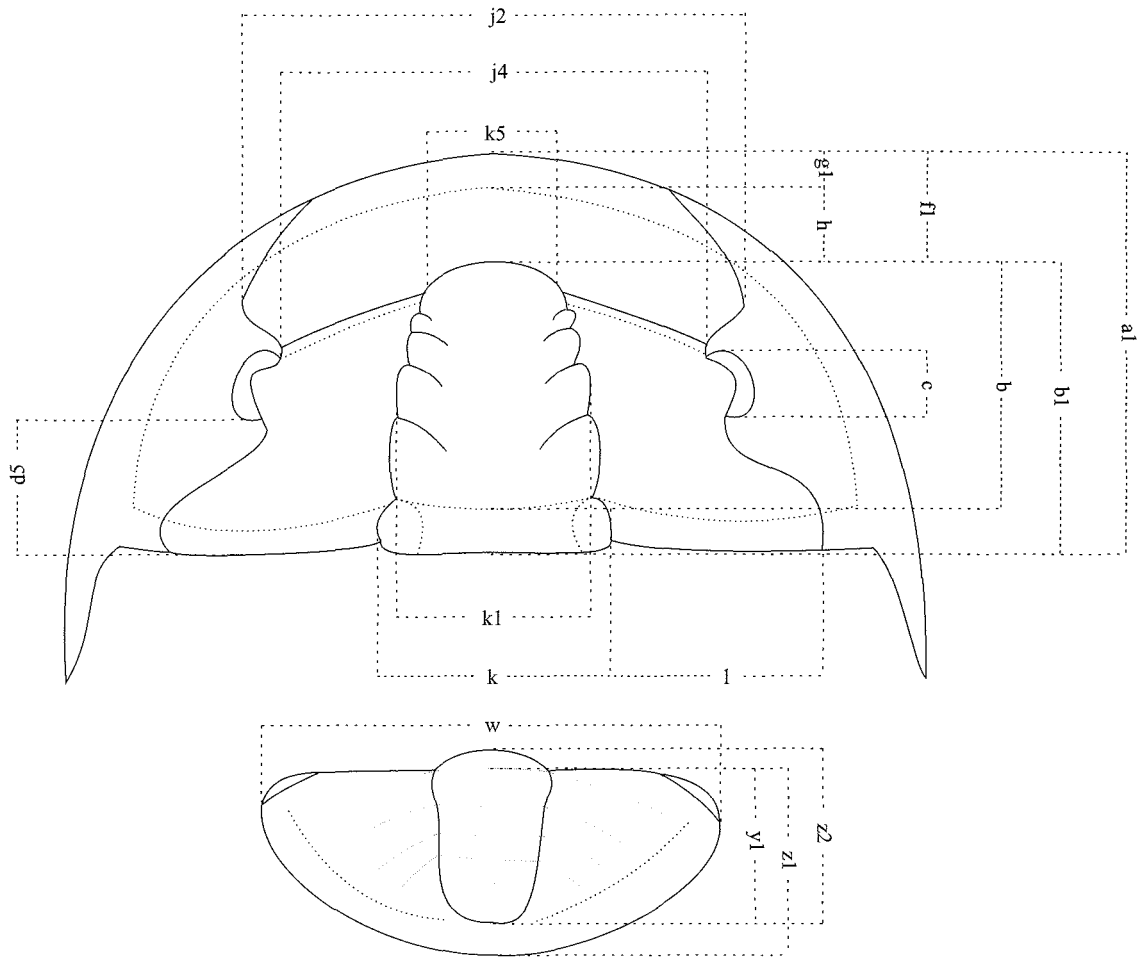

Fig. 5. Sclerite dimensions for the cephalon (top) and pygidium (bottom) of non-agnostidean trilobites as applied in this paper (after SHAW 1956, 1957 and TEMPLE 1975)

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 & SDZUY (1991). Linear dimensions along with the calculated parameters are available upon request.

Table 3. Parameters calculated for the exoskeleton of non-agnostidean trilobites; after STRUVE (1958) and SHERGOLD & SDZUY (1991)

b/a1	total glabellar length (sag.) to total cranidial length (sag.);
b1/a1	occipital glabellar length (sag.) to total cranidial length (sag.)
c/b	large eye index; palpebral lobe length (sag.) to total glabellar length (sag.)
c/b1	small eye index; palpebral lobe length (sag.) to occipital glabellar length (sag.)
f1/a1	frontal area length (sag.) to total cranidial length (sag.)
f1/b	frontal area length (sag.) to total glabellar length (sag.)
f1/b1	frontal area length (sag.) to occipital-glabellar length (sag.)
k/l	transverse occipital width (tr.) to transverse width of posterior limb (tr.)
c/d5	palpebral lobe length (sag.) to occipital post-palpebral distance (sag.)

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

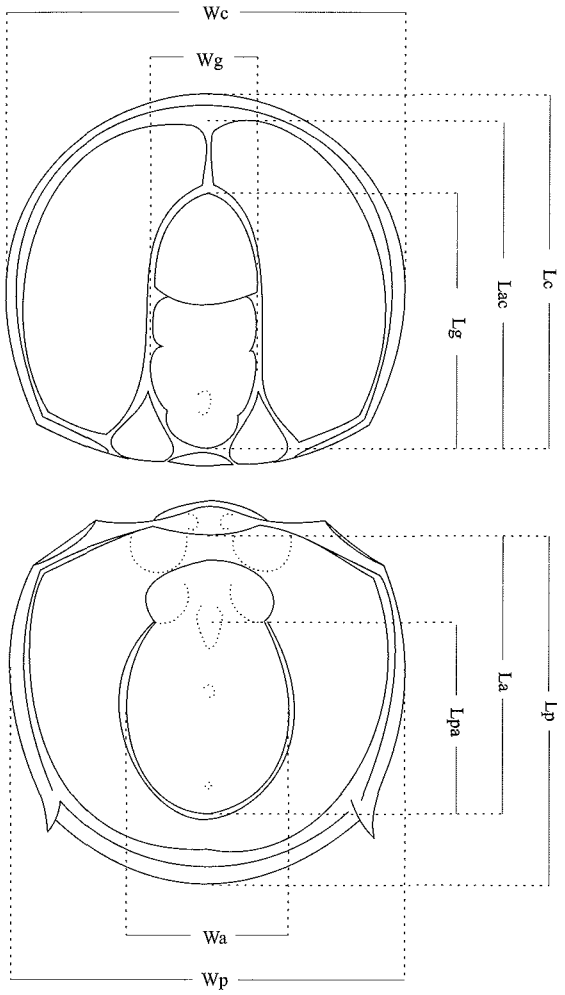

Fig. 6. Sclerite dimensions for agnostidean trilobites as applied in this paper (modified from AHLBERG & AHLGREN 1996)

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). KOBAYASHI (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. 1, 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 (PRATT 1992). According to SHERGOLD & *al.* (1990), SHERGOLD & LAURIE (1997) and NIELSEN (1997, 1999), species referred to *Trilobagnostus, Oncagnostus, Homagnostus, Strictagnostus* 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* LERMONTOVA, 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); LERMONTOVA, p. 7.
1954. *Geragnostus rudis*; WILSON, p. 254.
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.
1972. *Rudagnostus rudis* (SALTER); SHERGOLD, pp. 20-21.
1988. *Rudagnostus rudis* (SALTER); MORRIS, p. 205.
1990. *Agnostus* (*Homagnostus*) *pseudobesus* ORŁOWSKI; LENDZION & ORŁOWSKI, p. 48, Pl. 10, Fig. 3.
1996. *Trilobagnostus rudis* (SALTER); AHLBERG & AHLGREN, p. 133, Figs 3H-J.

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

BIOMETRIC DATA: Five parameters measured on 4 cephala, 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-deliquiate. 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 deliquiate, 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.

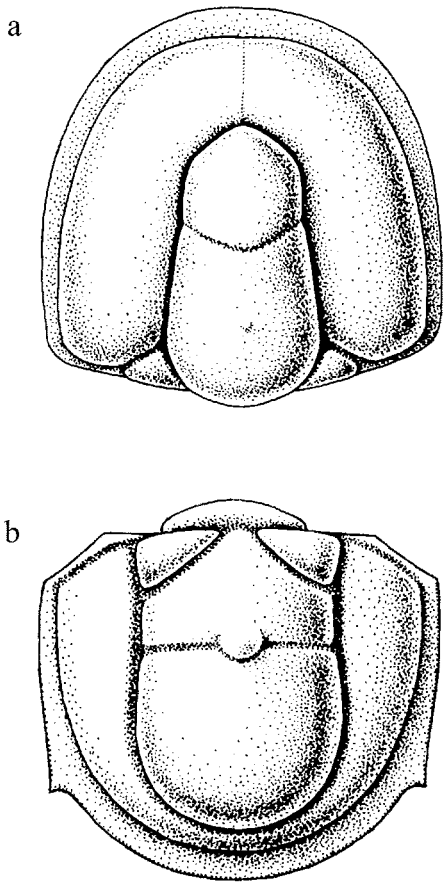

Fig. 7. *Trilobagnostus rudis* (SALTER) from the *Peltura minor* Zone, Klonówka Formation; restoration of cephalon (a) and pygidium (b). Scale bar represents 1 mm

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* sp. 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 cephala 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-

* I follow RUSHTON (1978), PRATT (1992) and AHLBERG & AHLGREN (1996) and consider *Homagnostus* as a separate genus, contrary to SHERGOLD & *al.* (1990) and SHERGOLD & LAURIE (1997).

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 *Trilobagnostus rudis* the development of the median preglabellar furrow is also variable. In the only specimen of the cephalon from Västergötland in Sweden, the median preglabellar furrow is preserved as a very short, narrow, almost indistinct furrow (AHLBERG & AHLGREN 1996, Fig. 3I). In the investigated specimens of *Trilobagnostus rudis*, 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 *Trilobagnostus* 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*.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation at Chabowe Doły Mill, *Peltura minor* Zone. In North Wales, UK: *Peltura minor* Zone. In Sweden: *Peltura minor* Zone.

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.II.93, 120-120a, 121.

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

REMARKS: The specimens are fragmentary, but resemble pygidial spines of genera assigned to Ceratopygidae LINNARSSON, i.e. of *Hysterolenus* MOBERG or *Ceratopyge* 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.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Lower? Tremadocian, Klonówka Formation in the Jeleniów 2 Borehole (183.5-185 m).

Order Ptychopariida SWINNERTON, 1915
Suborder Olenina SWINNERTON, 1915
Superfamily Olenacea BURMEISTER, 1844
Family Olenidae BURMEISTER, 1844
Subfamily Leptoplastinae ANGELIN, 1854

Ctenopyge LINNARSSON, 1880

TYPE SPECIES: *Olenus* (*Sphaerophthalmus*) *pecten* SALTER, 1864, from the Merioneth Series of Herefordshire and Worcestershire, England, UK, by subsequent designation of VOGDES (1890).

REMARKS: The genus is subdivided into three subgenera (HENNINGSMOEN 1957), e.g. *Eoctenopyge*, *Mesoctenopyge* and *Ctenopyge*, which appear stratigraphically in this order.

Subgenus *Mesoctenopyge* HENNINGSMOEN, 1957

TYPE SPECIES: *Ctenopyge spectabilis* BRØGGER, 1882, from the Upper Cambrian of Norway, by original designation.

Ctenopyge (*Mesoctenopyge*) *tumida* WESTERGÅRD, 1922
(Pl. 1, Figs 11-12)

part 1880. *Ctenopyge*? sp. indet.; LINNARSSON, p. 26, Pl. 2, Fig. 15 (*non* Pl. 2, Fig. 14 – *Ctenopyge* (*Ct.*) *fletcheri*).
part 1922. *Ctenopyge tumida* n. sp.; WESTERGÅRD, pp. 155-156, Pl. 11, Figs 15-18 (*non* Pl. 11, Figs 19-20 – *Ctenopyge* (*M.*) *tumidoides*).
part 1923. *Ctenopyge tumida* WESTERGÅRD; POULSEN, pp. 39-41, Pl. 1, Fig. 14 (*non* Text-fig. 16 – *Ctenopyge* (*M.*) *tumidoides*).
part 1947. *Ctenopyge tumida* WGÅRD; WESTERGÅRD, p. 24

(stratigraphic range including *Ctenopyge* (*M.*) *tumidoides*).

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

1972. *Ctenopyge* (*Mesoctenopyge*) *tumida* WESTERGÅRD; RUSHTON *in* TAYLOR & RUSHTON, p. 32, Fig. 8a.

1988. *Ctenopyge* (*Mesoctenopyge*) *tumida* WESTERGÅRD; MORRIS, p. 62.

1992. *Ctenopyge* (*Mesoctenopyge*) *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.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation at Chabowe Doły Mill, *Peltura minor* Zone. In Norway, Sweden, Denmark and the UK: *Peltura minor* Zone (*tumida* Subzone).

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*).

1901. *Ctenopyge* n. sp.; LINDSTRÖM, p. 29, Pl. 3, Figs 28-30.

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.

1947. *Ctenopyge laticornis* WESTERGÅRD; WESTERGÅRD, p. 17.

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

1957. *Ctenopyge* (*Ctenopyge*) *fletcheri* (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 fletcheri* (MATTHEW); MORRIS, p. 60.

1992. *Ctenopyge* (*Ctenopyge*) *fletcheri* (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. 22, Fig. 6).

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Shale Formation at Chabowe Doły 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* LAKE 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 Doły 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).

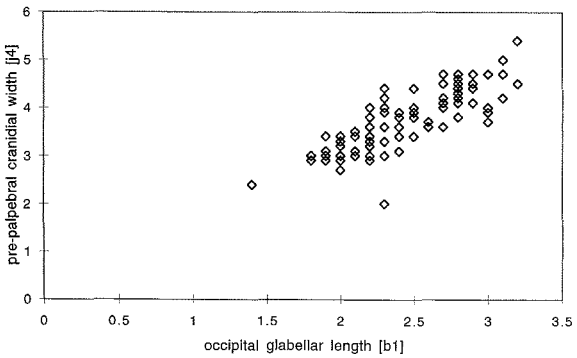

Fig. 8. Bivariate scatterplot showing relationship between occipital glabellar length and pre-palpebral cranidial width in *Sphaerophthalmus alatus* (BOECK) from Chabowe Doły Mill; n=94

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 cephala 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); STØRMER, pp. 144-145, Pl. 1, Figs 16-17.
1957. *Sphaerophthalmus alatus* (BOECK); HENNINGSMOEN, pp. 212-215, Pl. 2, Fig. 12, Pl. 5, Pl. 22, Figs 18-26.
part 1967. *Sphaerophthalmus alatus* (BOECK); ORŁOWSKI, p. 49 (including *S. humilis* and *S. major*).
part 1968b. *Sphaerophthalmus alatus* (BOECK); ORŁOWSKI, 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); BEDNARCZYK, Pl. 5, Figs 4-5, Pl. 6, Fig. 1.
1988. *Sphaerophthalmus alatus* (BOECK); MORRIS, p. 216.
1990. *Sphaerophthalmus alatus* (BOECK); LENDZION, ORŁOWSKI & TOMCZYKOWA, p. 65, Pl. 20, Fig. 2.
1992. *Sphaerophthalmus alatus* (BOECK); COPE & RUSHTON, Figs 4a-b, e-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).

MATERIAL: 292 cranidia, 1 librigena, in some cases with counterparts, MUZWG ZI/29/0128-0179, 0181-0230, 0232-0268, 0306-0307, 0313, 0318-0324, 0328, 0332, 0337-0338, 0341, 0345, 0350, 0353, 0356-0358, 0360, 0373, 0379, 0397, 0401-0403, 0411, 0415, 0417, 0420, 0428, 0438, 0452-0454, 0456-0457, 0463, 0466, 0469, 0471, 0479, 0482-0483, 0488-0489, 0493, 0498-0499, 0501, 0503, 0505-0506, 0510, 0520, 0528, 0554-0556, 0558, 0564, 0566, 0570, 0572-0574, 0618, 0637, 0639-0641, 0644, 0649, 0666, 0668, 0678-0679, 0681, 0683.

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 border short, distinct, slightly arched in anterior view. 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.

Librigena semicircular, with short, curved spine in anterior part, directed outwards. Posterior margin convex, longer than convex lateral margin. Inner spine angle acute. Border slightly widening anteriorly.

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 Doły Mill, *Peltura minor* Zone; within the Łeba Elevation, *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 sphaenopygus* 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.
part 1882. *Sphaerophthalmus alatus*, BOECK; BRØGGER, p. 119, Pl. 2, Figs 14-14a (according to HENNINGSMOEN (1957), some of BRØGGER's specimens are of *S. alatus*).
1890. *Sphaerophthalmus alatus* BOECK; POMPECKI, p. 89, Pl. 4, Figs 27-27a.
part 1894. *Sphaerophthalmus alatus*, BOECK, var. *Canadensis* n. var.; MATTHEW, p. 107, Pl. 17, Figs 11a-b (*non* Figs 12a-b – *Ctenopyge* (*Ct.*) *fletcheri*).
1901. *Sphaerophthalmus alatus* ANG. [sic!]; LINDSTRÖM, p. 29, Pl. 3, Figs 31-34.
part 1903. *Sphaerophthalmus Fletcheri*; MATTHEW, pp. 227-228, Pl. 17, Figs 7a-c, e-f (*non* Fig. 7d – *Ctenopyge* (*Ct.*) *fletcheri*).
1910. *Sphaerophthalmus alatus*; GOLDSCHMIDT, p. 5, Fig. 4.
part 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. *Sphaeroptalmus alatus* BAECK [sic!]; CZARNOCKI, p. 12.
?1927b. *Spherophtalmus alatus* BOECK; CZARNOCKI, pp. 199, 201.
1943. *Sphaerophthalmus alatus* (BOECK); WESTERGÅRD *in* JOHANSSON, SUNDIUS & WESTERGÅRD, p. 55, Text-figs 35a-e.
1952. *Sphaerophthalmus alatus* (BOECK); HUTCHINSON, pp. 88-90, Pl. 4, Figs 12a-c, 13-15.
1953. *Sphaerophthalmus alatus* ANGELIN [sic!]; HUPÉ, p. 78, Fig. 32:4.
part 1957. *Sphaerophthalmus humilis* (PHILLIPS); HENNINGSMOEN, pp. 215-217, Pl. 5, Pl. 22, Figs 12-14 (*non* Pl. 22, Figs 7, 11, 15 – *S. major*).
part 1967. *Sphaerophthalmus alatus* (BOECK); ORŁOWSKI, p. 49 (including *S. alatus* and *S. major*).

1968. *Sphaerophthalmus humilis* (PHILLIPS); RUSHTON, p. 415, Text-figs 2-3a, Pl. 78, Figs 11-15.

part 1968b. *Sphaerophthalmus alatus* (BOECK); ORŁOWSKI, 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* (*Ct.*) *fletcheri*).

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

1988. *Sphaerophthalmus humilis* (PHILLIPS); MORRIS, p. 216.

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

TYPES: The syntypes are cranidia nos. A348-353, Oxford University Museum, UK, and BGS GSM 10099, British Geological Survey, Keyworth, from the White-Leaved-Oak Shales, *Peltura scarabaeoides* Zone (Merioneth Series) of Raggedstone Hill near Malvern, Herefordshire and Worcestershire, England, UK.

MATERIAL: Two librigenae, three pygidia, MUZWG ZI/29/0269 - 0272, 0742.

DESCRIPTION: Librigena semicircular with short spine slightly curved backwards. Posterior margin convex and slightly longer than convex lateral margin. Border slightly widening in anterior part of librigena. Palpebral lobe situated far back, slightly in front of the border furrow.

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 Łeba Elevation (LENDZION 1976, 1982).

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation at Chabowe Doły Ravine, *Peltura scarabaeoides* Zone (*linnarssoni* Subzone); within the Łeba Elevation, *Peltura scarabaeoides* Zone. In Norway, Sweden, Denmark and the UK: *Peltura scarabaeoides* Zone. In eastern Canada: *Peltura* Zone.

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

part 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*).

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

1957. *Sphaerophthalmus major* LAKE; HENNINGSMOEN, pp. 217-218.

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

1957. *Sphaerophthalmus minor* [sic!]; HENNINGSMOEN, p. 218 (error for *S. major*).

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

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

part 1968b. *Sphaerophthalmus alatus* (BOECK); ORŁOWSKI, 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* (*Ct.*) *fletcheri*).

1988. *Sphaerophthalmus major* LAKE; MORRIS, p. 216.

TYPES: The lectotype is cranidium BGS GSM 8903, British Geological Survey, Keyworth, from the White-Leaved-Oak Shales (Merioneth Series) of 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 Chabowe Doły Ravine, *Peltura scarabaeoides* Zone (*linnarssoni* Subzone). In Norway, Sweden, Canada and the UK: *Peltura scarabaeoides* Zone.

Gen. et sp. indet.
(Pl. 3, Fig. 12)

MATERIAL: Two incomplete librigenae, MUZWG ZI/29/0588, 0595.

DESCRIPTION: Librigena with long spine curved inwards and deviating from course of lateral margin. Genal angle acute, inner spine angle acute. Anterior margin rather long, slightly convex, posterior margin shorter, straight.

REMARKS: The specimens are too poorly preserved to assign them with confidence to a genus or species, but the long spine, curved inwards and with a long anterior margin suggest early Leptoplastinae, i.e. *Leptoplastus* ANGELIN or *Eurycare* ANGELIN.

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

Subfamily Oleninae BURMEISTER, 1844

Angelina SALTER, 1859

TYPE SPECIES: *Angelina Sedgwickii* SALTER, 1859, from the Tremadoc Series of North Wales, UK, by subsequent designation of VOGDES (1890).

Angelina cf. *hyeronimi* (KAYSER, 1876)
(Pl. 4, Figs 1-3)

1968a. *Angelina* sp.; TOMCZYKOWA, p. 45.
1968b. *Angelina* sp. A; TOMCZYKOWA; pp. 41-42, Pl. 3, Figs ?23, 24-26.

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 *Parabolinella coelatifrons* HARRINGTON & LEANZA (1957, p. 109, Figs 3a-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 *Parabolinella 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), *Acerocare* 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).

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.).
1947. *Beltella solitaria* WGÅRD; WESTERGÅRD, p. 25.
1954. *Beltella solitaria* WESTERGÅRD; WILSON, p. 276.
1957. *Protopeltura? solitaria* (WESTERGÅRD); HENNINGSMOEN, pp. 230-231, Pl. 3.
part 1967. *Protopeltura olenusorum* n. sp.; ORŁOWSKI, p. 49 (including *Protopeltura aciculata*).
part 1968b. *Protopeltura olenusorum* sp. n.; ORŁOWSKI, pp. 275-276, Pl. 7, Fig. 12 (*non* Pl. 7, Figs 13-15, Pl. 8, Figs 1-3, Text-fig. 10 – *Protopeltura aciculata*).
1983. *Olenus* cf. *solitarius* (WESTERGÅRD); RUSHTON, p. 125, Pl. 18, Figs 3, 10-14, Text-figs 5e-f.
1985. *Olenus* cf. *solitarius*; NIKOLAISEN & HENNINGSMOEN, p. 13.
1985. *Leptoplastides solitarius*; NIKOLAISEN & HENNINGSMOEN, p. 13.
1990. *Protopeltura olenusorum* ORŁOWSKI; LENDZION, ORŁOWSKI & TOMCZYKOWA, p. 69, Pl. 20, Fig. 8.

TYPES: The lectotype is an axial shield without pygidium from Andrarum, Scania, Sweden, illustrated by WESTERGÅRD (1922, Pl. 14, Fig. 1), selected by HENNINGSMOEN (1957, p. 230).

MATERIAL: Negative of one axial shield without pygidium, MUZWG ZI/29/0684.

BIOMETRIC DATA: Nine parameters measured on one cranidium.

DESCRIPTION: Length of cranidium 7.4 mm (n=1). Glabella sub-rectangular, elongated, tapering forwards, truncate anteriorly. Length of glabella approximately 68% of cranidial length and approximately 80% if occipital ring is included. Glabella with rather low lateral profile, separated from occipital ring by distinct, straight occipital furrow. Occipital ring simple, with faint indication of node; its width does not exceed the pre-occipital glabellar width. Small palpebral lobes, the midpoints of which lie in advance of the middle of the glabella. Small eye index approximately 27%, large eye index approximately 32%. Eye-ridges poorly preserved. Two pairs of shallow, almost effaced lateral glabellar furrows. Frontal area poorly divided into flat preglabellar field and slightly shorter flat anterior border. Frontal area approximately 20% of total cranidial length, approximately 25% of occipital glabellar length and approximately 30% of total glabellar length. Fixigenae almost as wide as glabella posteriorly, approximately one-third width of glabella at mid-eye level, with shallow posterior border furrow, almost normal to axis. Posterior limbs about three-quarters width of occipital ring.

Librigenae preserved as faint impressions, with long slender spine reaching the sixth segment of the thorax. Spine in course of lateral margin of cephalon. Anterior part of facial suture parallel, then curved sharply adaxially. Posterior part of facial suture slightly convex.

Thorax of at least 12 segments. Axial part prominent, slightly wider than the pleurae. Median nodes not present.

* *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.

REMARKS: The specimen to hand is the holotype of *Protopeltura olenusorum* ORŁOWSKI. Although poorly preserved, it resembles the specimen figured by WESTERGÅRD (1922, Pl. 14, Fig. 1) and assigned to *Beltella solitaria*. The syntypes of *Protopeltura olenusorum* ORŁOWSKI differ from the holotype in the shape of the glabella, the size and position of the palpebral lobes as well in the different shape of the posterior limbs. They are assigned here to *Protopeltura aciculata* (ANGELIN). WESTERGÅRD (1922) also figured another specimen as *Beltella 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*. NIKOLAISEN & HENNINGSMOEN (1985, p. 13) considered RUSHTON's (1983) specimens as representatives of *Leptoplastides* RAW, because of two pygidial axial rings, whereas the contemporary species of *Olenus* (*Olenus veles* RUSHTON, *Olenus cataractes* SALTER and *Olenus micrurus* 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 *Leptoplastides*. The smaller number of axial rings in the pygidium recalls later olenines, e.g. *Protopeltura* BRØGGER.

Orygmaspis (*Parabolinoides*) *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).

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Wiśniówka Formation at Wiśniówka Duża Quarry, *Olenus scanicus* Subzone, and possibly also *Parabolina brevispina* Subzone; in Sweden: *Parabolina brevispina* Subzone of the *Parabolina spinulosa* Zone. In North Wales and England (UK): *Olenus cataractes* Subzone.

Parabolina SALTER, 1849

TYPE SPECIES: *Entomostracites spinulosus* WAHLENBERG, 1818, by monotypy. The specimen, from which WAHLENBERG made his drawing (p. 38, Pl. 1, Fig. 3), was figured by REYMENT (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 & LUDVIGSEN 1998). NIKOLAISEN & 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* BRØGGER, 1882 (Pl. 4, Figs 5-7)

part 1968b. *Parabolina lobata lobata* (BRØGGER); TOMCZYKOWA, pp. 31-32, Pl. 1, Fig. 5 (*non* Pl. 1, Fig. 4 – *Parabolina* (*N.*) *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, ?2 – *Peltura* cf. *transiens*).

REMARKS ON THE TYPES: The *Parabolina heres* group consists of:

- *Parabolina* (*Parabolina*) *heres heres* BRØGGER, 1882 (*Peltura transiens* to *Acerocare ecorne* Zones) - the lectotype is a pygidium, Palaeontological Museum of Oslo no. 19948, figured by BRØGGER (1882, Pl. 1, Fig. 13d), selected by HENNINGSMOEN (1957, p. 119);
- *Parabolina* (*Parabolina*) *heres lata* MATTHEW, 1892 (*Westergaardia* 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 paradoxa* Subzone) - the lectotype is a cranidium figured by MOBERG & MÖLLER (1898, Pl. 13, Fig. 2), reproduced by WESTERGÅRD (1922, Pl. 7, Fig. 17), selected and re-illustrated by WESTERGÅRD (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 & MÖLLER, *Parabolina* (*P.*) *heres heres* BRØGGER and *Parabolina* (*P.*) *heres lata* MATTHEW (see WESTERGÅRD 1909, Pl. 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)

1922. *Parabolina jemtlandica* n. sp.; WESTERGÅRD, p. 138, Pl. 7, Figs 35-38.
1947. *Parabolina jemtlandica* WESTERGÅRD; WESTERGÅRD, p. 24.
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.
?1981. *Parabolina jemtlandica?* WESTERGÅRD; ALLEN, JACKSON & RUSHTON, p. 317.
1985. *?Parabolina acanthura*; NIKOLAISEN & HENNINGSMOEN, pp. 4-5.
?1988. *Parabolina jemtlandica?* WESTERGÅRD; MORRIS, p. 164.
1990. *Parabolina acanthura* (ANGELIN); LENDZION, ORŁOWSKI & 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

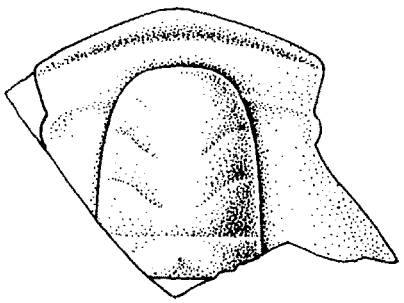

Fig. 9. *Parabolina* (*Parabolina?*) *jemtlandica* WESTERGÅRD, MUZPIG 1042.II.37, from the *Acerocare* Zone *sensu lato*, Klonówka Formation. Scale bar represents 10 mm

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 WESTERGÅRD (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.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation in the Jeleniów 2 Borehole (194.6 m), *Acerocare* Zone *sensu lato*. In Sweden, *?Acerocare* Zone *sensu lato*. In Wales (UK), *?Acerocare* Zone.

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 tergite, and a long macrospine on the last - twelfth - thoracic tergite). Glabella typically with one or two transglabellar furrows.

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.
1952. *Parabolina dawsoni* MATTHEW; HUTCHINSON, pp. 80-82, Pl. 3, Figs 11-13.
1957. *Parabolina dawsoni* MATTHEW; HENNINGSMOEN, p. 118.
part 1967. *Parabolina bella* n. sp.; ORŁOWSKI, p. 49 (including *Parabolina (N.?) lapponica*).
part 1968b. *Parabolina bella* sp. n.; ORŁOWSKI, pp. 269-270, Pl. 6, Fig. 18 (*non* Text-fig. 6, Pl. 6, Figs 16-17, 19-21 – *Parabolina (N.?) lapponica*).
1990. *Parabolina bella* ORŁOWSKI; LENDZION, ORŁOWSKI & 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.

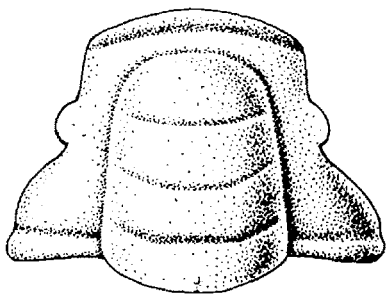

Fig. 10. *Parabolina (Neoparabolina?) dawsoni* MATTHEW, MUZWG ZI/29/0528, from the *Peltura minor* Zone, Klonówka Formation. Scale bar represents 5 mm

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 preoccipital 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 cranidial length, approximately 19% of occipital glabellar length and approximately 21% of total glabellar length. Width of fixigenae about one-quarter of glabellar width at mid-eye level, posterior limbs slightly narrower than glabella 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 eye-ridges are visible, and the occipital ring is also narrower (sag.). The paratypes of *Parabolina bella* are assigned here to *Parabolina (N.?) lapponica* WESTERGÅRD.

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* (BRØGGER) reveals variations in the shape of the palpebral ridges, position of palpebral lobes versus the glabella and width of the fixigenae posteriorly (WESTERGÅRD 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*.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation at Chabowe Doły Mill, *Peltura minor* Zone. In Canada (Nova Scotia): *Peltura* Zone.

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. *Parabolinella? Gümbeli*, BARR. (emend. BRØGG); BRØGGER, pp. 211-213.
1912. *Olenus* cf. *argentinus* KAYSER; HOEK *in* STEINMANN & HOEK, p. 209, Pl. 7, Fig. 10.
1912. *Parabolinella andina* n.sp.; HOEK *in* STEINMANN & HOEK, p. 214, Pl. 7, Figs 7-9.
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* (HOEK); KOBAYASHI, p. 477; Pl. 4, Figs 10-13.
1938. *"Olenus" argentinus* KAYSER; HARRINGTON, pp. 138, 267, 269, 256, 258.
1938. *Parabolina andina* (HOEK) KOBAYASHI; HARRINGTON, p. 198; Pl. 9, Figs 7, 9, 11.
1943. *Parabolina andina* (HOEK) KOBAYASHI; HARRINGTON & LEANZA, p. 347, Pl. 2, Figs 1, 6.
1955. *Parabolina frequens* (BARRANDE); SDZUY, 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* (BRØGGER); TOMCZYKOWA, p. 904.
1965. *Parabolina argentina* (KAYSER); BRANISA, Pl. 1, Fig. 5.
1965. *Parabolina* sp.; BRANISA, Pl. 1, Fig. 9.
1968. *Parabolina* cf. *P. argentina* (KAYSER); ROBISON & PANTOJA-ALOR; p. 788, Pl. 101, Figs 25-26.
1968a. *Parabolina parva* TOMCZYKOWA; TOMCZYKOWA, p. 45.
1968a. *Parabolina secreta* TOMCZYKOWA; TOMCZYKOWA, p. 45.
1968a. *Parabolina bukowiana* TOMCZYKOWA; TOMCZYKOWA, p. 45.

1968b. *Parabolina bukowiana* sp. n.; TOMCZYKOWA, pp. 30-31, Text-fig. 7, Pl. 1, Figs 14-15, ?16.

part 1968b. *Parabolina lobata lobata* (BRØGGER); TOMCZYKOWA, pp. 31-32, Pl. 1, Fig. 4 (*non* Pl. 1, Fig. 5 – *Parabolina* (*P.*) *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); PŘIBYL & VANĚK, 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*) *frequens* (BARRANDE) *finnmarchica* n. subgen., n. subsp.; NIKOLAISEN & HENNINGSMOEN, pp. 9-11, Figs 4, 11C-J, 12A-Ea.

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, ?8.

1990. *Parabolina lobata lobata* (BRØGGER); 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 SDZUY (1955, p. 16, Pl. 3, Fig. 58). SDZUY (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.II.34a, 38-38a, 44-44a, 46-46a, 47-51, 52-52a, 53, 54-54a, 55-58,

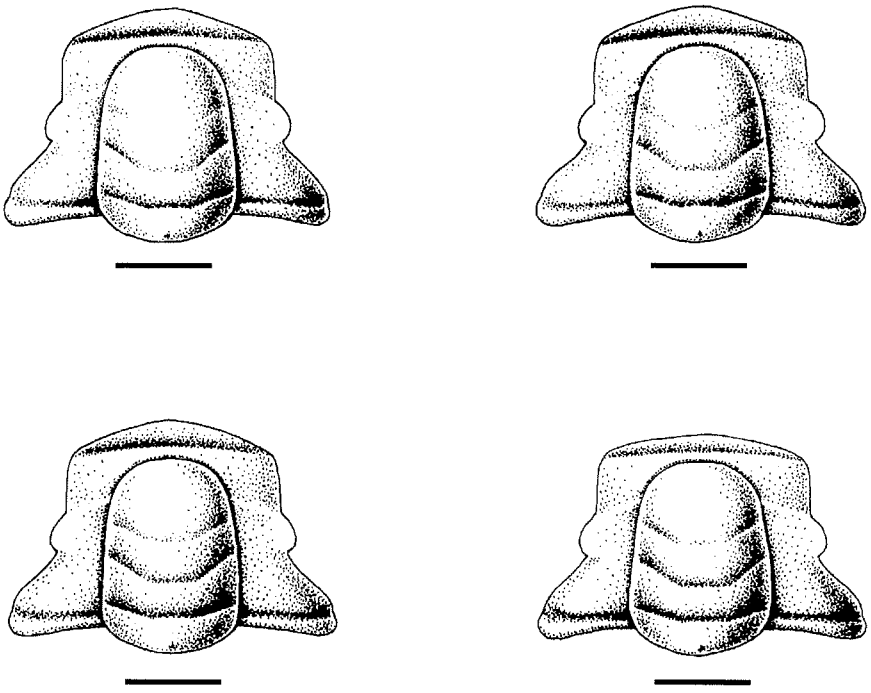

Fig. 11. Variability expressed in cranidia of *Parabolina* (*Neoparabolina*) *frequens* (BARRANDE), from the *Acerocare* Zone *sensu lato*, Klonówka Formation. Scale bar represents 10 mm

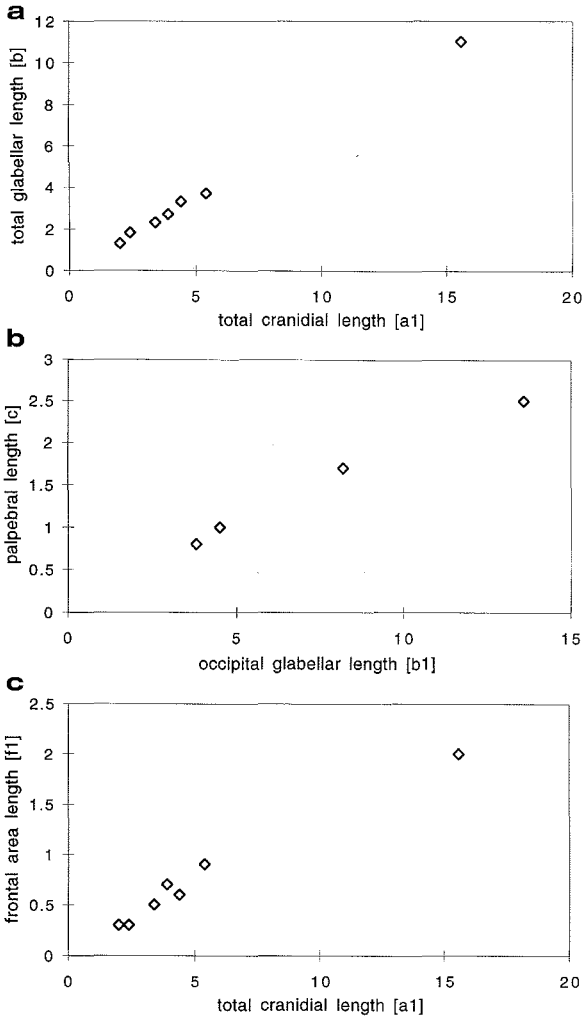

Fig. 12. Bivariate scatterplots showing relationship between a. total cranidial length and total glabellar length, b. occipital glabellar length and palpebral length, and c. total cranidial length and frontal area length in *Parabolina* (*Neoparabolina*) *frequens* (BARRANDE) from the Jeleniów 3 and Bukowiany 1a boreholes, n=7

59-59a, 62, 63, 64-64a, 65-65a, ?79, 101-101a, ?107, ?113 (counterpart of 107), 117 (counterpart of 53).

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 MUZPIG 1042.II.63).

REMARKS: Comparison of the illustrated collections of the subspecies of *Parabolina* (*Neoparabolina*) *frequens* [*P.* (*N.*) *frequens frequens* (BARRANDE) – SDZUY 1955, RUSHTON 1982; *P.* (*N.*) *frequens argentina* (KAYSER) – HARRINGTON & LEANZA 1957, PŘIBYL & VANĚK 1980; *P.* (*N.*) *frequens finnmarchica* – NIKOLAISEN & 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 (NIKOLAISEN & 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.*) *fre-*

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 effacement 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; PŘIBYL & VANĚK 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 MUZPIG 1042.II.44-44a (Pl. 5, Fig. 8), assigned by TOMCZYKOWA (1968b, pp. 31-32) to *Parabolina* (*N.*) *lobata lobata*, has also been included in *P.* (*N.*) *frequens*, as, although similar in many respects, it differs from *P.* (*N.*) *lobata lobata* (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 MUZPIG 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.*

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation in the Jeleniów 3 (109-160 m), Bukowiany 1a (226-243 m), and Brzezinki 1 (172 m) boreholes, *Acerocare* Zone *sensu lato*. In Germany: Lower Tremadocian of the Leimitz-Schiefer. In Wales (UK): Cwmhesgen Formation, *Acerocare* Zone. In Norway: Lower Tremadocian Berlogaissa Formation of the Digermul Peninsula. In Mexico: Upper Cambrian Tiñu Formation. In South America: Upper Cambrian and Lower Tremadocian *Parabolina argentina* Zone of Argentina and Bolivia. In Newfoundland, Canada: Lower Tremadocian Apsey Formation.

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.; ORŁOWSKI, p. 49 (including *Parabolina* (*N.?*) *dawsoni*).
part 1967. *Beltella irae* n. sp.; ORŁOWSKI, p. 49 (including *Leptoplastides irae*).
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.; ORŁOWSKI, pp. 269-270, Text-fig. 6, Pl. 6, Figs 16-17, 19-21 (*non* Pl. 6, Fig. 18 – *Parabolina* (*N.?*) *dawsoni*).
part 1968b. *Beltella irae* n. sp.; ORŁOWSKI, pp. 270-272, part Text-fig. 7 (librigena only), Pl. 5, Fig. 12 (*non* Pl. 5, Figs 1-11, 13-15 – *Leptoplastides irae*).
1990. *Parabolina latilimbata* TOMCZYKOWA, LENDZION, ORŁOWSKI & TOMCZYKOWA, p. 64, Pl. 19, Fig. 6.

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).

MATERIAL: 22 cranidia, 43 librigenae, in some cases with counterparts, MUZPIG 1042.II.39-40, 41 (negative of 40), 42, 43-43a, 86-86a; MUZWG ZI/29/0269, 0275, 0287, 0299, 0302, 0332, 0401, 0405-0406, 0410, 0414-0415, 0509, 0521-0524, 0526-0527, 0529-0531, 0533-0536, 0548, 0551, 0554, 0571, 0575, 0594, 0601, 0608, 0610, 0613-0614, 0622, 0628, 0630, 0659, 0734-0737, 0740-0741, 0743, 0749, 0751-0752, 0754, 0757-0759, 0764, 0771.

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.

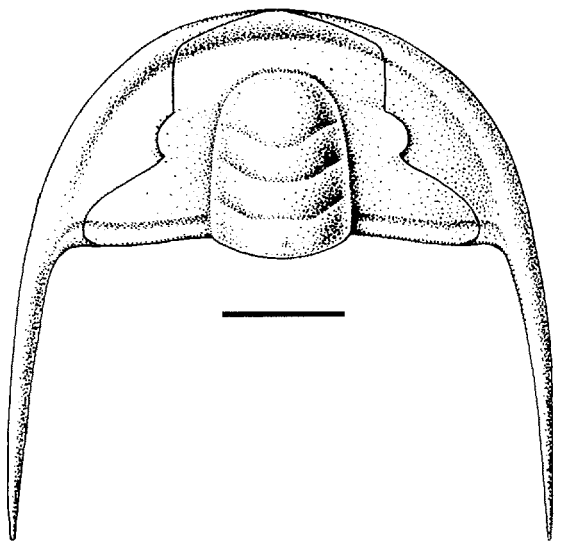

Fig. 13. *Parabolina* (*Neoparabolina?*) *lapponica* WESTERGÅRD, from the Upper Cambrian, Klonówka Formation; restoration of cephalon. Scale bar represents 10 mm

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 Doły Mill and Ravine, have also been assigned to this species. Their proportions and thick lateral border recall librigenae assigned to *Parabolina* (*N.*) *frequens* (SDZUY 1955; HARRINGTON & LEANZA 1957; PŘIBYL & VANĚK 1980; NIKOLAISEN & HENNINGSMOEN 1985), although large librigenae from Chabowe Doły 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* BRØGGER.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation at Chabowe Doły Mill, *Peltura minor* Zone; Chabowe

Doły Ravine, *Peltura scarabaeoides* Zone (*linnarssoni* Subzone); Jeleniów 3 (109-146 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)

part 1968b. *?Beltella* sp.; ORŁOWSKI, pp. 280-281, Pl. 8, Fig. 14 (*non* Pl. 8, Fig. 15 – *Peltura protopeltorum*).

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

DESCRIPTION: Pygidium sub-triangular, with three inter-ring furrows. Axis narrow, not reaching posterior margin. Border flattened, narrow. Margin with three broadly based pygidial spines, directed backwards.

REMARKS: The pygidia occur in the same beds as cranidia and librigenae of *Parabolina* (*N.?*) *lapponica* WESTERGÅRD, 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 Doły Mill, *Peltura minor* Zone; Chabowe Doły Ravine, *Peltura scarabaeoides* Zone (*linnarssoni* Subzone).

Parabolinella BRØGGER, 1882

TYPE SPECIES: *Parabolinella limitis* BRØGGER, 1882, from the Ceratopyge Shale, Oslo, Norway, designated by BASSLER (1915).

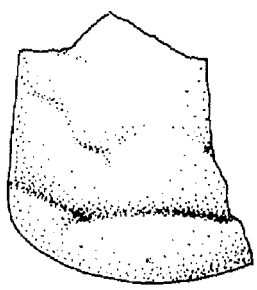

Fig. 14. *Parabolinella?* sp., MUZPIG 1042.II.79, from the *Acerocare* Zone *sensu lato*, Klonówka Formation. Scale bar represents 5 mm

Parabolinella? 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* BRØGGER 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* BRØGGER. *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).

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation in the Jeleniów 3 Borehole (109-116 m), *Acerocare* Zone *sensu lato*.

Parabolinites HENNINGSMOEN, 1957

TYPE SPECIES: *Parabolinella laticauda* WESTERGÅRD, 1922, from the Upper Cambrian, Andrarum, Scania, Sweden; by original designation.

Parabolinites? 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 Doły 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.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation at Chabowe Doły Mill, *Peltura minor* Zone. *Parabolinites* occurs in Scania, Sweden, in the *Leptoplastus?* and *Peltura* Zones and in the UK (Wales) in the *Peltura* Zone.

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)

1968b. *Parabolina* sp. B; TOMCZYKOWA, p. 34, Pl. 1, Figs 18-19.

MATERIAL: One incomplete cranidium with counterpart, 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 *Westergaardites* TROEDSSON or sixteen in *Wujiajiania* LU & LIN) by four distinct lateral glabellar furrows and a median indentation in the anterior part of the glabella.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation in the Brzezinki 2 Borehole (30-40 m), *Acerocare* Zone *sensu lato*. The genus is characteristic of the uppermost Upper Cambrian, e.g. in Wales, UK, within the *Acerocare* Zone (RUSHTON 1982) and in Vermont, USA, in the *Missisquoia* Zone (SHAW 1951).

Subfamily Pelturinae HAWLE & CORDA, 1847

Acerocare ANGELIN, 1854

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

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

1968a. *Acerocare* sp.; TOMCZYKOWA, p. 45.
1968b. *Acerocare* sp.; TOMCZYKOWA, p. 43, Pl. 3, Figs 5-9.

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

BIOMETRIC DATA: Six parameters measured on 3 cranidia.

DESCRIPTION: Length of cranidium 2.2-4.2 mm (n=3). Length of glabella 45-48% of cranidial length, 52-55% if occipital ring is included. Glabella rather flat, only slightly elevated above surface of fixigenae. Occipital ring simple, with small median node, separated from glabella by occipital furrow, which does not reach axial furrow abaxially. Palpebral lobes of medium size. Lateral glabellar furrows effaced. Frontal area convex, not differentiated into preglabellar field and anterior border. Frontal area 12-16% of total cranidial

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. MUZPIG 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 klonowkae (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? klonowkae* sp. n.; ORŁOWSKI, pp. 278-279, Text-fig. 12, Pl. 8, Figs 6-10 (*non* Pl. 8, Fig. 11 – *Peltura* sp.).

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

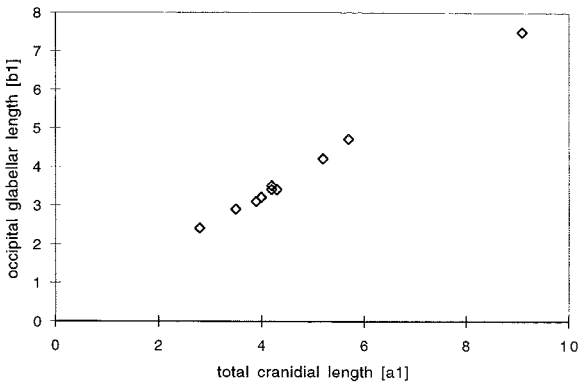

Fig. 15. Bivariate scatterplot showing relationship between total cranidial length and occipital glabellar length in *Acerocarina klonowkae* (ORŁOWSKI) from Chabowe Doły Mill and Ravine, n=10

TYPES: The holotype is cranidium MUZWG ZI/29/0545, from the Upper Cambrian, Chabowe Doły 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 forwards, 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

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 – Pl. 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 ecorne* 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. 7 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.

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

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 (FORTEY & OWENS 1991a, b).

The type species of *Beltella* and *Leptoplastides*, *Beltella depressa* (SALTER *in* MURCHINSON) 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

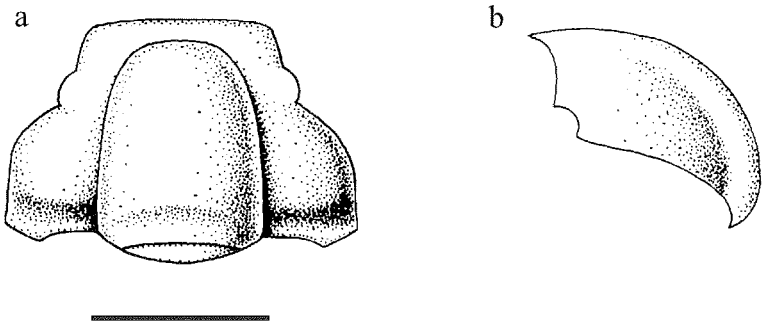

Fig. 16. *Acerocarina klonowkae* (ORŁOWSKI), from the *Peltura minor* and *Peltura scarabaeoides* Zones, Klonówka Formation; a. cranidium, b. flattened librigena. Scale bar represents 5 mm

Random Island, Newfoundland (Canada) (FORTEY & OWENS 1991a; WHITTINGTON 1996), and FORTEY & OWENS (1991b, Figs 8c-j) presented modern photographs of the lectotype and associated specimens of *Leptoplastides salteri*. Based on this, both type species were reconstructed (FORTEY & OWENS 1991a, Fig. 2 – *Beltella depressa*; FORTEY & 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 FORTEY & OWENS (1991a, b) retained both genera, include the median axial spines on the occipital ring and the thoracic segments, as well as blunt posterolateral 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 1-2, 4) or *Leptoplastides salteri* (FORTEY & OWENS 1991b, Fig. 9), compared to that in the reconstruction of FORTEY & OWENS (1991a, Fig. 2). The median axial spines and the blunt posterolateral pleural spines, considered of generic significance in distinguishing *Beltella* and *Leptoplastides* (FORTEY & OWENS 1991a, b), are not restricted to species of *Leptoplastides*. *Beltella nodifer* RUSHTON from the *Acerocare* Zone in North Wales bears distinct median axial nodes (RUSHTON 1982, Pl. 3, Fig. 9) and *Beltella verisimilis* (SALTER) (considered a synonym of *Beltella depressa* – WHITWORTH 1972; NIKOLAISEN & HENNINGSMOEN 1985) possesses falcate 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 FORTEY & 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, Pls 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 Oleninae (NIKOLAISEN & HENNINGSMOEN 1985; with regard to *Beltella* LAKE – also TOMCZYKOWA 1968b), and on the other hand to the Pelturinae (FORTEY & OWENS 1991a – with regard to *Beltella* LAKE; FORTEY & OWENS 1991b – with regard to *Leptoplastides sensu* HENNINGSMOEN 1957). I follow FORTEY & 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* (FORTEY & 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 Jeleniów 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-

tinct, 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-triangular 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.

Librigenae with short spine, deviating slightly from lateral border. Genal angle and inner spine angle slightly obtuse. Border rather wide.

REMARKS: *Leptoplastides coniunctus* is distinctive because of its transglabellar lateral glabellar furrows, uncommon in *Leptoplastides*. In general proportions, it greatly resembles the contemporary *Leptoplastides latus* (TOMCZYKOWA), but has much smaller palpebral lobes and the fixigenae are narrower, particularly posteriorly. The anterior part of the cranidium 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-1 Borehole in south-eastern Poland (TOMCZYKOWA & TOMCZYK 2000).

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

Leptoplastides irae (ORŁOWSKI, 1968)
(Text-fig. 18; Pl. 8, Fig. 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 (cranidium 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 protopeltorum*).

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 Doły 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, 0363, 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,

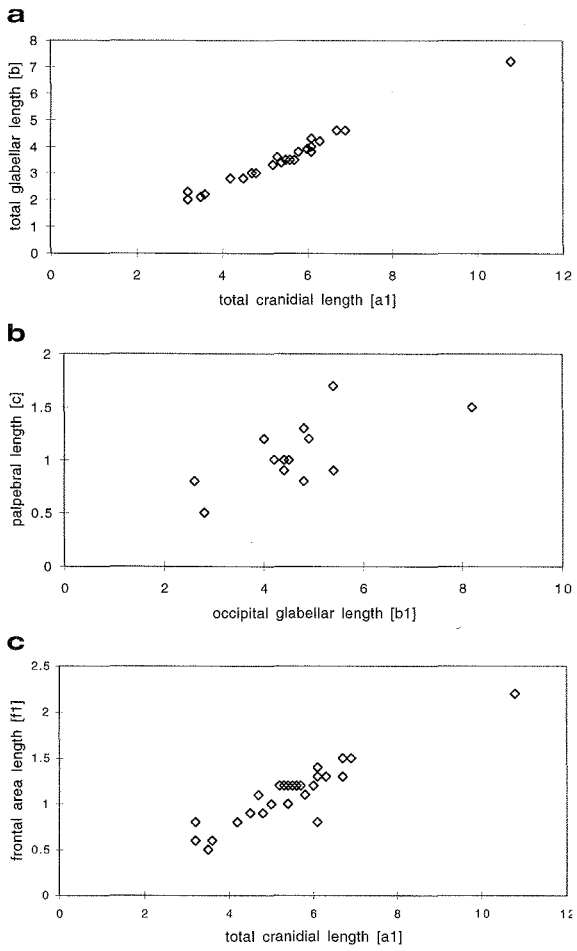

Fig. 17. Bivariate scatterplots showing relationship between a. total cranidial length and total glabellar length, b. occipital glabellar length and palpebral length, and c. total cranidial length and frontal area length in *Leptoplastides irae* (ORŁOWSKI) from Lisie Jamy, Chabowe Doły Mill and Ravine, n=29

0474, 0479, 0481, 0487, 0490, 0492-0493, 0501, 0505-0506, 0508, 0515, 0520, 0525, 0532, 0545, 0547, 0551, 0554, 0557-0558, 0560, 0568, 0572-0573, 0575-0593, 0596-0600, 0602-0607, 0610, 0612, 0615-0618, 0621, 0623, 0625-0629, 0631-0632, 0634-0635, 0638-0658, 0660, 0662-0665, 0667-0677, 0731, 0738-0739, 0745, 0750, 0753, 0755-0756, 0759-0761, 0765, 0767, 0772-0773, 0775-0776; AK 1-5.

BIOMETRIC DATA: Ten parameters measured on 41 cranidia.

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 preoccipital 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.

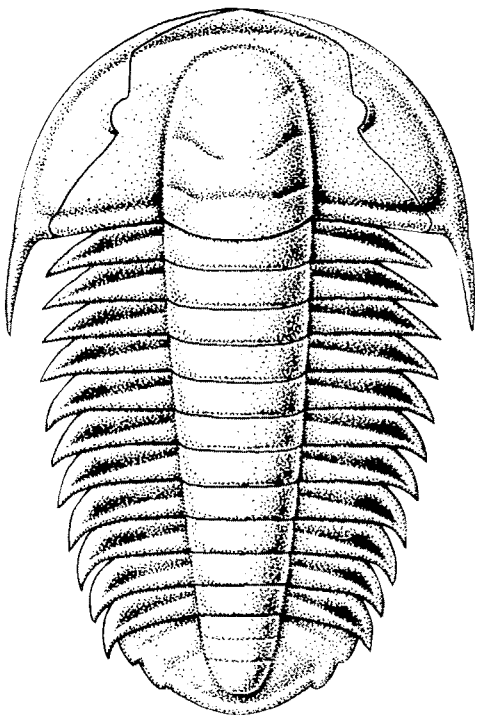

Fig. 18. *Leptoplastides irae* (ORŁOWSKI) from the Upper Cambrian, Klonówka Formation; tentative restoration of exoskeleton. Scale bar represents 10 mm

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: ORŁOWSKI (1968b) based *Beltella irae* on cranidia and librigenae with a long spine in line with the course of the lateral margin. The librigenae (illustrated by ORŁOWSKI 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 Doły

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/29/0599, 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 Doły 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 Doły Mill, *Peltura minor* Zone; Chabowe Doły Ravine, *Peltura scarabaeoides* Zone (*linnarssoni* Subzone).

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

1968a. *Beltella lata* TOMCZYKOWA; TOMCZYKOWA, p. 45.
1968a. *Beltella czarnockii* TOMCZYKOWA; TOMCZYKOWA, p. 45.
1968b. *Beltella czarnockii* sp. n.; TOMCZYKOWA, p. 39, Text-fig. 12c, Pl. 2, Figs 8-14.
1968b. *Beltella lata* sp. n.; TOMCZYKOWA, pp. 39-40, Text-fig. 12d, Pl. 2, Figs 15-27.
1968b. *Beltella* sp. A; TOMCZYKOWA, p. 41, Text-fig. 12f, Pl. 2, Fig. 41.
?1985. *Leptoplastides* cf. *latus* (TOMCZYKOWA); NIKOLAISEN & 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 sinuous 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 anterolateral corners of glabella, visible only on some specimens, slightly oblique backwards. 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

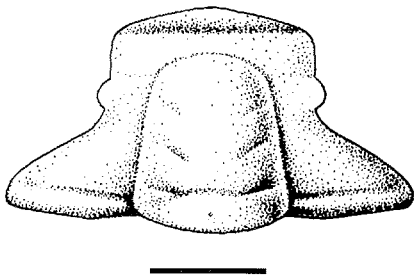

Fig. 19. *Leptoplastides latus* (TOMCZYKOWA) from the *Acerocare* Zone *sensu lato*, Klonówka Formation; restoration of cranidium. Scale bar represents 5 mm

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.

Librigena 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. Librigenae 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* (MUZPIG 1042.II.21; Pl. 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 Digermul Peninsula, Finnmark, Norway. The Norwegian form differs from the type specimens in possessing narrow posterior limbs, a narrower glabella posteriorly and less sinuous 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.
1957. *Beltella ulrichi* (KAYSER); HARRINGTON & LEANZA, pp. 88-89, Fig. 28,1.
1968a. *Beltella rotundata* TOMCZYKOWA; TOMCZYKOWA, p. 45.
1968a. *Beltella convexa* TOMCZYKOWA; TOMCZYKOWA, p. 45.
1968b. *Beltella ulrichi* (KAYSER); TOMCZYKOWA, pp. 36-37, Text-fig. 12h.
1968b. *Beltella convexa* sp. n.; TOMCZYKOWA, pp. 38-39, Text-fig. 12b, Pl. 2, Figs 28-30.
1968b. *Beltella rotundata* sp. n.; TOMCZYKOWA, pp. 40-41, Pl. 2, Figs 36-40, Pl. 3, Figs 18-22.
1968b. Olenidae gen., sp. indet.: TOMCZYKOWA, p. 44, Pl. 3, Fig. 27.
1980. *Beltella ulrichi* (KAYSER); PŘIBYL & VANĚK, Pl. 6, Figs 1-2, Pl. 7, Fig. 3.
?1985. *Leptoplastides* cf. *ulrichi* (KAYSER); NIKOLAISEN & HENNINGSMOEN, pp. 15-16, Figs 6, 14H-L.
1990. *Beltella convexa* TOMCZYKOWA; LENDZION, ORŁOWSKI & TOMCZYKOWA, p. 67, Pl. 21, Figs 7-8.
1990. *Beltella rotundata* TOMCZYKOWA; LENDZION, ORŁOWSKI & TOMCZYKOWA, p. 68, Pl. 21, Fig. 1.

TYPES: The lectotype is a cranidium no. 4335, Museo Argentino de Ciencias Naturales, Seccion Paleontologia (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 librigenae, two pygidia, in some cases with counterparts, MUZPIG 1042.II.1-1a, 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.

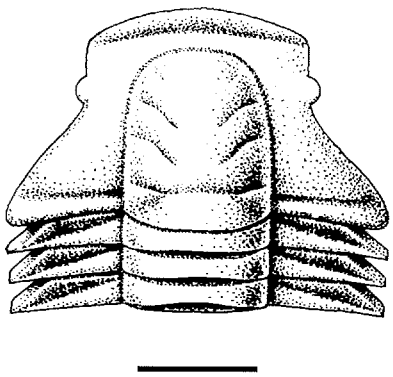

Fig. 20. *Leptoplastides ulrichi* (KAYSER) from the *Acerocare* Zone *sensu lato*, Klonówka Formation; restoration of anterior part of axial shield. Scale bar represents 10 mm

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 preoccipital 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 divergent, posterior part 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 PŘIBYL & VANĚK 1980, Pl. 6, Fig. 1).

NIKOLAISEN & HENNINGSMOEN (1985) described *Leptoplastides* cf. *ulrichi* from the Upper Cambrian of the Digermul Peninsula, Norway. Their form is poorly illustrated (NIKOLAISEN & HENNINGSMOEN 1985, Figs 14H-L), but the reconstruction (NIKOLAISEN & HENNINGSMOEN 1985, Fig. 6) is very close to the specimens of *Leptoplastides ulrichi* from South America (HARRINGTON & LEANZA 1957; PŘIBYL & 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

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) boreholes, *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 Kistedal 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 irae* (ORŁOWSKI) 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* cf. *spiniferus* by NIKOLAISEN & HENNINGSMOEN (1985, Fig. 15C).

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

Nericiaspis TJERNVIK, 1955

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

Nericiaspis robusta (TJERNVIK, 1953)
(Text-fig. 21; Pl. 13, Fig. 5)

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

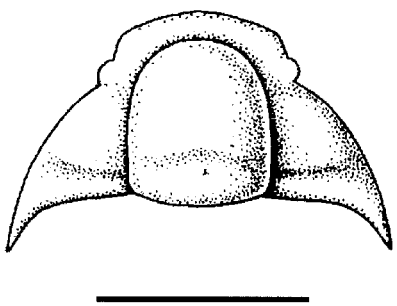

Fig. 21. *Nericiaspis robusta* (TJERNVIK), MUZPIG 1042.II.140, from the *Peltura scarabaeoides* Zone, Klonówka Formation. Scale bar represents 5 mm

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 *linnarssoni* Subzone or the *lobata* Subzone). In Sweden: lower part of the *Peltura scarabaeoides* Zone.

Peltura MILNE EDWARDS, 1840

TYPE SPECIES: *Entomostracites scarabœoides* 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 scarabœoides*, WAHLENB. var. *acutidens*; BRØGGER, p. 108, Pl. 2, Fig. 9.
1922. *Peltura scarabœoides acutidens* BRØGGER; WESTERGÅRD, p. 175, Pl. 15, Figs 14-17.
1957. *Peltura acutidens* BRØGGER; HENNINGSMOEN, pp. 233-234, Pl. 6, Pl. 25, Figs 1, 3-4, 7, 9, 11.
1976. *Peltura acutidens* BRØGGER; LENDZION, p. 73.
1982. *Peltura acutidens* BRØGG.; LENDZION, p. 218.
1990. *Peltura acutidens* BRØGGER; LENDZION, ORŁOWSKI & TOMCZYKOWA, pp. 65-66, Pl. 20, Figs 3a-c.

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

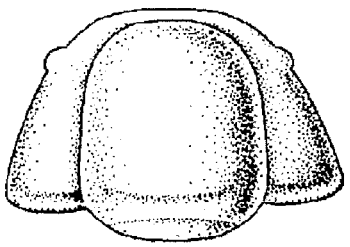

Fig. 22. *Peltura acutidens* BRØGGER, MUZWG ZI/29/0574, from the *Peltura minor* Zone, Klonówka Formation. Scale bar represents 5 mm

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-eigths 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* (BRØGGER) are typically rather shallow.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Shale Formation at Chabowe Doły Mill, *Peltura minor* Zone; Łeba Elevation: *Sphaerophthalmus alatus* Zone. In Norway and Sweden: *Peltura minor* Zone.

Peltura cf. *costata* (BRØGGER, 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 BRØGGER (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 posterior limbs with posterior parts of glabella preserved. Glabella with at least two pairs of almost effaced lateral glabellar furrows, directed inwards and then sharply curved backwards. Occipital furrow deep, not reaching axial furrows adaxially. Small palpebral lobes situated at level of L3, close to glabella. Eye-ridges almost effaced. Fixigenae pelturoid. Posterior limbs rather narrow. Posterior part of facial suture gently convex. Fulcrum close to axial furrow.

REMARKS: The specimens under discussion are too incomplete to be assigned with certainty, but their pelturoid fixigena and rather effaced lateral glabellar furrows recall late species of *Peltura*. The proportions of the fixigena are similar to that in *Peltura costata* (BRØGGER), but the lateral glabellar furrows are much more effaced in that species.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka 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 protopeltorum ORŁOWSKI, 1968
(Text-figs 24-25; Pl. 6, Fig. 10; Pl. 8, Fig. 11; Pl. 10, Fig. 1; Pl. 14, Figs 15-18; Pl. 15, Figs 1-13; Pl. 16, Figs 1-12)

1967. *Peltura (?) protopeltorum* n.sp.; ORŁOWSKI, p. 49.
1968b. *Peltura? protopeltorum* sp. n.; ORŁOWSKI, pp. 263-275, Text-fig. 9, Pl. 7, Figs 1-11.
part 1968b. *?Peltura* sp.; ORŁOWSKI, p. 280, Pl. 8, Figs 20-21, 23 (*non* Text-fig. 14, Pl. 8, Figs 22, 24 – *Leptoplastides irae*).
part 1968b. *?Beltella* sp.; ORŁOWSKI, pp. 280-281, Pl. 8, Fig. 15 (*non* Pl. 8, Fig. 14 – *Parabolina* sp.).
1968b. *?Parabolina* sp.; ORŁOWSKI, p. 281, Text-fig. 16, Pl. 8, Figs 12-13.
1990. *?Peltura protopeltorum* ORŁOWSKI; LENDZION, ORŁOWSKI & TOMCZYKOWA, p. 66, Pl. 20, Figs 4a-d.

TYPES: The holotype is cranidium MUZWG ZI/29/0570, figured by ORŁOWSKI (1968b, Pl. 7, Figs 1a-d), LENDZION & *al.* (1990, Pl. 20, Figs 4a-d), (Pl. 15, Figs 1-3 of this paper), from Chabowe Doły Mill. Paratypes are in the ORŁOWSKI collection, MUZWG ZI/29.

MATERIAL: 218 cranidia and their fragments; 55 librigenae; 33 pygidia; one thoracic segment; in some cases with counterparts, MUZWG 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.

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

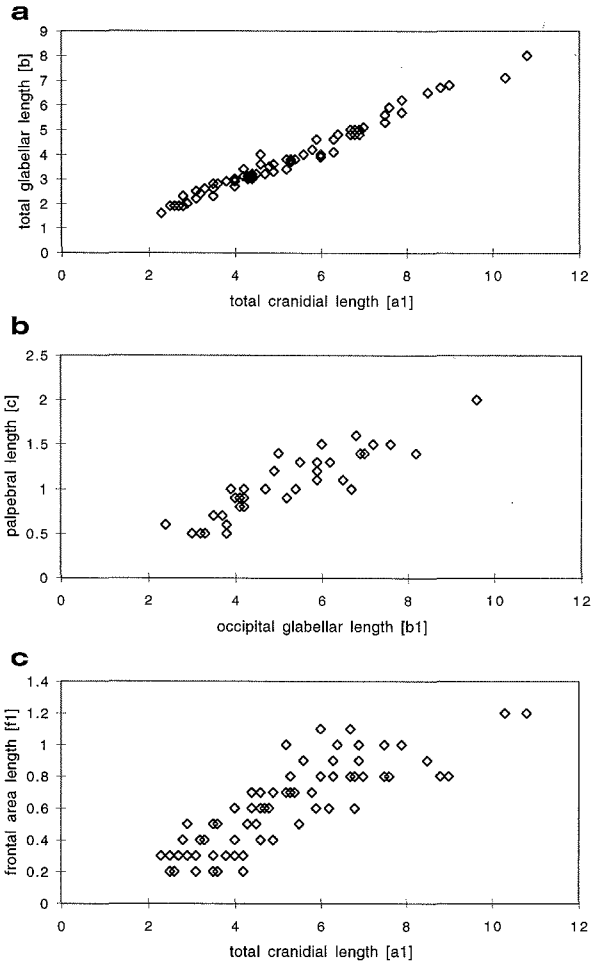

Fig. 23. Bivariate scatterplots showing relationship between a. total cranidial length and total glabellar length, b. occipital glabellar length and palpebral length, and c. total cranidial length and frontal area length in *Peltura protopeltorum* ORŁOWSKI from Chabowe Doły Mill, n=79

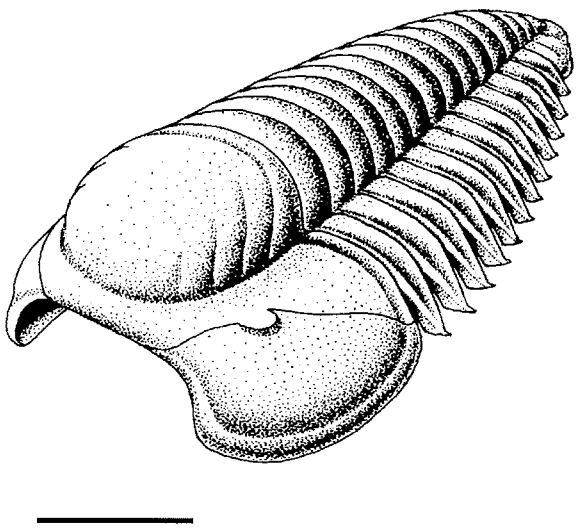

Fig. 24. *Peltura protopeltorum* ORŁOWSKI, from the *Peltura minor* Zone, Klonówka Formation; restoration of exoskeleton, antero-lateral view. Scale bar represents 10 mm

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

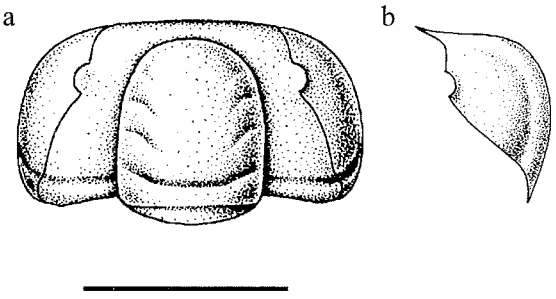

Fig. 25. *Peltura protopeltorum* ORŁOWSKI, from the *Peltura minor* Zone, Klonówka Formation; a. restoration of cephalon, b. flattened librigena. Scale bar represents 10 mm

posteriorly. Axis tapering strongly backwards, with two axial rings and a terminal piece.

REMARKS: When describing this species, ORŁOWSKI (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. paradoxa* 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. *Peltocare compactum* NIKOLAISEN & 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 (NIKOLAISEN & 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 subrectangular shape of the glabella in this species may be a result of flattening.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Klonówka Formation at Chabowe Doły Mill, *Peltura minor* Zone.

Peltura scarabaeoides scarabaeoides (WAHLENBERG, 1818)
(Pl. 14, Figs 4-14)

1818. *Entomostracites scarabœoides*; WAHLENBERG, p. 41, Pl. 1, Fig. 2.
1822. *Paradoxides scaraboides*; BRONGNIART, p. 34, Pl. 3, Fig. 5.
1827. *Trilobites scarabœoides*; BOECK, p. 36, Fig. 24.
1837. *Olenus scarabœoides*; HISINGER, p. 19, Pl. 4, Fig. 4.
1840. *Peltoura scaraboides*; MILNE EDWARDS, p. 344.
1847. *Peltura scarabœoides*; HAWLE & CORDA, p. 127, Pl. 6, Fig. 68.
1848. *Olenus spinulosus?*; PHILLIPS, pp. 55, 347, Fig. 3.
1864. *Olenus scarabœoides* var. *obesus;* SALTER, p. 5, Pl. 8, Figs 1-4.
1866. *Olenus scarabœoides*, WAHL.; SALTER, p. 301, Pl. 5, Figs 2-5.
1871. *Conocephalus Malverinus*, n. sp.; PHILLIPS, p. 68, Fig. 5.
1871. *Olenus scarabœoides* WAHLENBERG; PHILLIPS, p. 68, Fig. 6.
1878. *Peltura scarabœoides* WAHL.; ANGELIN, p. 45, Pl. 25, Fig. 8.
1880. *Peltura scarabœoides* WAHLENB. sp.; LINNARSSON, pp. 4-7, Pl. 1, Figs 1-4.
1880. *Peltura scarabœoides* var. *octacantha*; LINNARSSON, p. 6, Pl. 1, Fig. 5.
1882. *Peltura scarabœoides* WAHLENB.; BRØGGER, p. 107, Pl. 1, Figs 7-9, Pl. 2, Fig. 12.
1890. *Peltura scarabaeoides* WAHLENB.; HOLM, p. 264.
1892. *Peltura scarabeoides*, WAHL.; MATTHEW, p. 35, Pl. 13, Figs 9a-b.
1901. *Peltura scarabœoides*, WAHLENB.; LINDSTRÖM, pp. 29, 64, Pl. 3, Figs 35-42.
1903. *Peltura scarabeoides*, WAHLENB.; MATTHEW, p. 230.
1910. *Peltura scarabaeoides*; GOLDSCHMIDT, p. 4, Figs 1-2.
1919. *Peltura scarabœoides* (WAHLENBERG); LAKE, pp. 97-99, Pl. 11, Figs 9-12.
1922. *Peltura scarabœoides* (WAHLENBERG); WESTERGÅRD, p. 173, Pl. 15, Figs 12-13, 18.
1923. *Peltura scarabaeoides* WAHLENBERG; POULSEN, pp. 50, 58, Text-figs 18, 22, Pl. 2, Figs 6-7.
?1927a. *Peltura scarabaeoides* WAHLENB.; CZARNOCKI, p. 12.
?1927b. *Peltura scarabaeoides* WAHLENB.; CZARNOCKI, pp. 199, 201.
1929. *Peltura scarabœoides* (WAHLENB.); STRAND, p. 359.
1934. *Peltura scarabœoides*; STØRMER, p. 332.
1937. *Peltura scarabœoides* (WAHL.); RICHTER, p. 419, Text-fig. 2.
1942. *Peltura scarabœoides* (WAHLENBERG); STØRMER, p. 89.
1943. *Peltura scarabœoides* (WAHL.); WESTERGÅRD *in* JOHANNSON, SUNDIUS & WESTERGÅRD, p. 55, Figs 34a-b.
part 1947. *Peltura scarabaeoides* (WAHL.); WESTERGÅRD, p. 26 (some of the discussed specimens are of *Peltura scarabaeoides westergaardi*).
1952. *Peltura scarabaeoides* (WAHLENBERG); HUTCHINSON, p. 93, Pl. 5, Figs 1-6.
1953. *Peltura scarabœoides*; HOLTEDAHL, p. 182, Text-fig. 69, Figs 25-26.
1957. *Peltura scarabaeoides scarabaeoides* (WAHLENBERG); HENNINGSMOEN, pp. 237-239, Pl. 2, Fig. 1, Pl. 6, Pl. 25, Figs 6, 13-14, Pl. 26, Figs 1-2.
1957. *Peltura scarabaeoides*; STØRMER *in* HOLTEDAHL & DONS, p. 12, Figs 3:25-26 (copies of figures from HOLTEDAHL 1953).
1958. *Peltura scarabaeoides* (WAHLENBERG); WHITTINGTON, pp. 200-206, Pl. 38, Figs 1-18.

1967. *Peltura scarabeoides scarabeoides* (WAHLENBERG); ORŁOWSKI, p. 49.
1968b. *Peltura scarabeoides scarabeoides* (WAHLENBERG); ORŁOWSKI, pp. 279-280, Pl. 8, Figs 16-19.
1972. *Peltura scarabeoides scarabeoides* (WAHLENBERG); BEDNARCZYK, Pl. 2, Figs 3, 10, Pl. 4, Figs 3, 7.
1973. *Peltura scarabaeoides scarabaeoides* (WAHLENBERG); CLARKSON, 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.
1982. *Peltura scarabaeoides scarabaeoides* (WAHL.); LENDZION, p. 218.
1984. *Peltura scarabaeoides* (WAHLENBERG); BEDNARCZYK, Pl. 6, Fig. 4.
1988. *Peltura scarabaeoides* (WAHLENBERG); MORRIS, p. 170.
1990. *Peltura scarabaeoides scarabaeoides* (WAHLENBERG); LENDZION, ORŁOWSKI & 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 ZI/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.

Librigena pelturoid, rather narrow, without spine. Border moderately wide, slightly wider posteriorly. Border furrow well defined.

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 Doły Mill, *Peltura minor* Zone and Chabowe Doły Ravine, *Peltura scarabaeoides* Zone (*linnarssoni* Subzone); Łeba 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
(Pl. 13, Figs 11-12)

1964. *Peltura scarabaeoides* (WAHLENBERG); TOMCZYKOWA, p. 904.
1968a. *Peltura scarabaeoides* cf. *westergårdi* HENNINGSMOEN; TOMCZYKOWA, p. 44.
1968b. *Peltura scarabaeoides* cf. *westergårdi* HENNINGSMOEN; TOMCZYKOWA, p. 42, Pl. 3, Figs 14, ?15.
1990. *Peltura scarabaeoides* cf. *westergaardi* HENNINGSMOEN; LENDZION, ORŁOWSKI & 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 TOMCZYKOWA (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 westergaardi* 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* (BRØGGER, 1882)
(Pl. 13, Fig. 10; Pl. 14, Figs 1-3)

1968a. *Acerocarina* sp.; TOMCZYKOWA, p. 45.
part 1968b. *Peltura* sp. B; TOMCZYKOWA, p. 43, Pl. 3, Fig. 12 (*non* Pl. 3, Figs 10-11 – *Peltura* cf. *costata*).
part 1968b. *Peltura* sp. C; TOMCZYKOWA, p. 43, Pl. 3, Figs 1, ?2 (*non* Pl. 3, Figs 3-4 – *Parabolina* (*P.*) *heres*).
1968b. *Acerocarina* sp.; TOMCZYKOWA, p. 44, Pl. 3, Fig. 17.

TYPES OF *Peltura transiens*: The lectotype is a pygidium no. 19947a, Paleontological Museum of Oslo, figured by BRØGGER (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 cranidium 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* (BRØGGER) 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 ZI/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 ORŁOWSKI (1968b) as a librigena of a new species, *Acerocare? klonowkae*. The adaxial margin with the facial suture is not well preserved, and therefore it is not clear whether this librigena matches the cranidia of that species. The latter are associated with much narrower librigenae without a spine, which match the facial suture of the cranidia, and are here referred to *Acerocarina klonowkae*. The librigena under discussion rather recalls those of late *Peltura* 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 Klonówka Formation at Chabowe Doły Ravine, *Peltura scarabaeoides* Zone (*linnarssoni* Subzone).

Protopeltura BRØGGER, 1882

TYPE SPECIES: *Peltura præcursor* 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 rara*).

part 1967. *Protopeltura olenusorum* n. sp.; ORŁOWSKI, p. 49 (including *Olenus solitarius*).

part 1968b. *Protopeltura olenusorum* sp. n.; ORŁOWSKI, 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 Funäs, 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 olenusorum*, 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. MUZWG 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* WESTERGÅRD 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 fixigenae, recall *Protopeltura aciculata pusilla*. In turn, the associated librigena (MUZWG 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 scanicus* 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 SWINNERTON, 1915
Superfamily Ptychoparioidea SWINNERTON, 1915
Family Pterocephaliidae KOBAYASHI, 1935
Subfamily Aphelaspidinae 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 Aphelaspidinae 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, *Dicanthopyge* PALMER, *Litocephalus* RESSER, *Listroa* 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* WALCOTT, *Kujandaspis* 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

TYPE SPECIES: *Aphelaspis walcotti* RESSER, 1938, from the Upper Cambrian Nolichucky Formation, Virginia, USA, designated by PALMER (1953, p. 153).

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

1934. *Peltura*; SAMSONOWICZ, p. 7.
part 1934. *Parabolina*; SAMSONOWICZ, p. 7 (some of the specimens are of *Protopeltura aciculata*).
1967. *Olenus rarus* n. sp.; ORŁOWSKI, p. 49.
1968b. *Olenus rarus* n. sp.; ORŁOWSKI, pp. 268-269, Pl. 4, Figs 6-19.
1981. *Olentella rara* (ORŁOWSKI); ALLEN, JACKSON & RUSHTON, p. 308.
1983. *Olentella rara* (ORŁOWSKI); RUSHTON, p. 112.
1985. *Olentella rara* (ORŁOWSKI); RUSHTON *in* ALLEN & JACKSON, Pl. 4, Fig. 2.
1990. *Olenus rarus* ORŁOWSKI; LENDZION, ORŁOWSKI & TOMCZYKOWA, p. 62, Pl. 18, Fig. 8.
1997. *Pesaia? rara* (ORŁOWSKI); 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. Topotypes from the Upper Cambrian Wiśniówka Formation at Wąworków, Holy Cross Mountains, are in the SAMSONOWICZ collection, MUZPIG 8.II.159-160, 162a, 164-166.

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). 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).

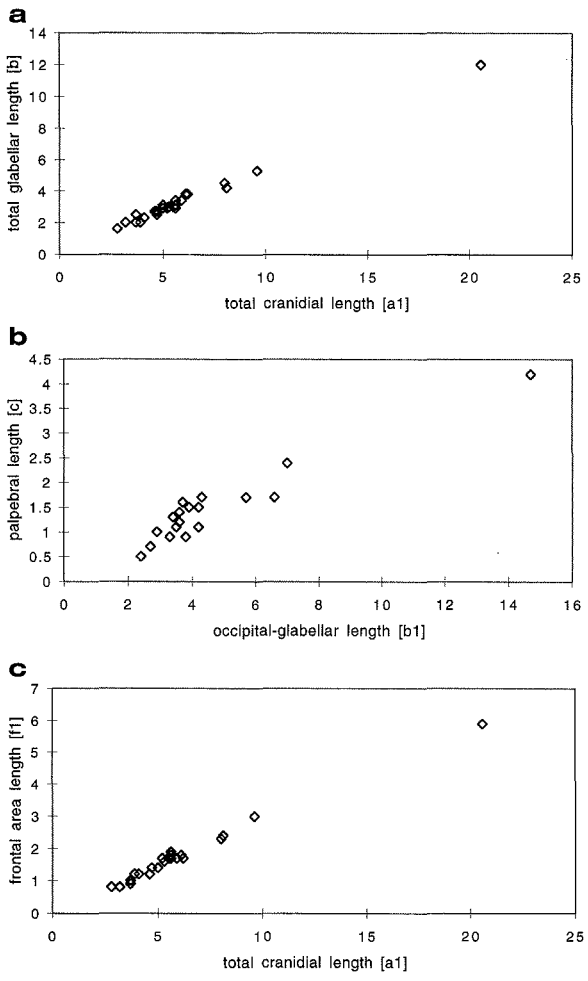

Fig. 26. Bivariate scatterplots showing relation between a. total cranidial length and total glabellar length, b. occipital glabellar length and palpebral length, and c. total cranidial length and frontal area length in *Aphelaspis rara* (ORŁOWSKI) from the Wiśniówka Duża and Wąworków quarries, n = 24

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-

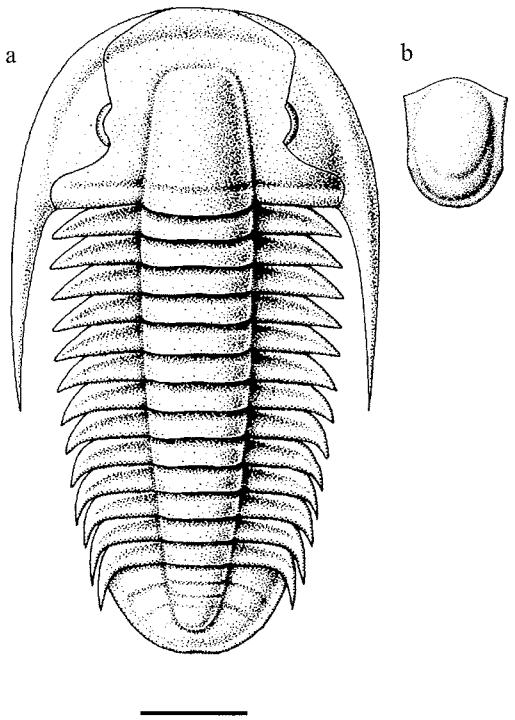

Fig. 27. *Aphelaspis rara* (ORŁOWSKI) from the *Olenus scanicus* and *Parabolina brevispina* Subzones, Wiśniówka Formation; a. restoration of exoskeleton; b. hypostome. Scale bar represents 10 mm

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 ORŁOWSKI (1968b) as *Olenus rarus* bear all of the characteristics of the genus *Aphelaspis* and should be transferred into it. Their affiliation to *Olenus* was already doubted by BERGSTRÖM (1973), according to whom "...the cephalic characters, including the blunt anterior end of the glabella, indicates that *"O." rarus* 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 & RESSER, from Novaya Zemlya), seems quite similar from the original illustrations (WALCOTT & RESSER 1924; MOORE 1959), but upon direct examination (see p. 212 in SHERGOLD & SDZUY 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.

RUSHTON (*in*: ALLEN & *al.* 1981; RUSHTON 1983), as well as SHERGOLD (SHERGOLD & COOPER 1985; SHERGOLD & SDZUY 1991; SHERGOLD & WEBERS 1992) also questioned the determinations of ORŁOWSKI (1968b). These doubts led RUSHTON (*in*: ALLEN & *al.* 1981; RUSHTON 1983) to transfer "*Olenus rarus*" to the genus *Olentella* IVSHIN, primarily known from the late Tuorian, *Aphelaspis - Kujandaspis* Zone, Tortuduk Suite, central Kazachstan, but now recognised to have a significant distribution (Siberian Platform, Antarctica, Montagne Noire – SHERGOLD & *al.* 1976; SHERGOLD & COOPER 1985; ROMANENKO 1988; SHERGOLD & WEBERS 1992; SHERGOLD & *al.* 2000).

According to SHERGOLD & COOPER (1985), SHERGOLD & SDZUY (1991), SHERGOLD & WEBERS (1992), and SHERGOLD & *al.* (2000), the species does not represent *Olenus* or *Olentella*, although from its cranidial characters it recalls representatives of the Aphelaspidinae mainly from the Siberian Platform and adjacent areas. On the other hand, the resemblance of *'Olenus' rarus* to the genus *Maladioidella* ENDO has often been pointed out (SHERGOLD & SDZUY 1991). This resemblance is of particular importance in the context of *Maladioidella* cf. *colcheni* 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 (FORTEY & 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 Wąworków 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 *Aphelasis rara* to 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 librigena 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.

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Wiśniówka Formation in the Wiśniówka Duża and Wąworków quarries, *Olenus scanicus* and *Parabolina brevispina* Subzones. In Wales, UK: Upper Cambrian Maentwrog Formation, *Olenus cataractes* Subzone, near Bronaber, Gwynedd, Wales.

Family Solenopleuridae ANGELIN, 1854

Gen. et sp. indet.
(Pl. 20, Figs 15-16)

1967. *Protopeltura* sp.; ORŁOWSKI, p. 49.
1968b. *Protopeltura* sp.; ORŁOWSKI, 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 ORŁOWSKI (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).

OCCURRENCE: In Poland: in the Holy Cross Mountains, Upper Cambrian Wiśniówka Formation in the Wąworków quarry, *Parabolina brevispina* Subzone.

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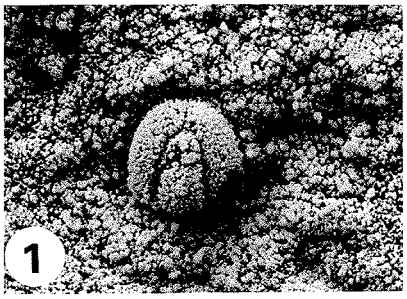
PLATE 1

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

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

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

13 – *Ctenopyge* (*Ctenopyge*) *fletcheri* (MATTHEW, 1901); *Peltura scarabaeoides* Zone, Chabowe Doły Ravine; MUZWG ZI/29/0605; librigena, × 2.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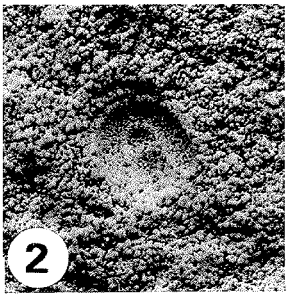
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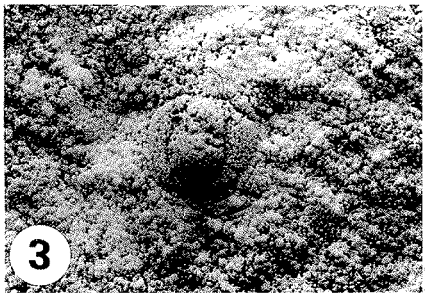
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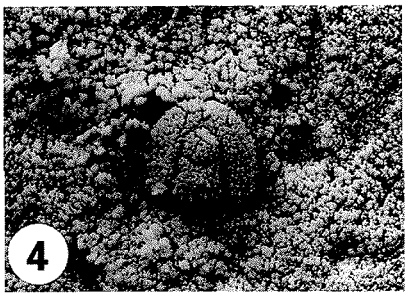
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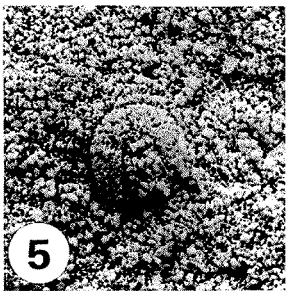
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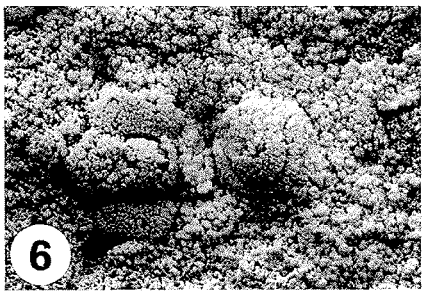
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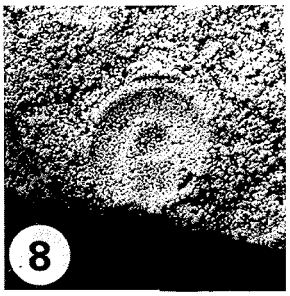
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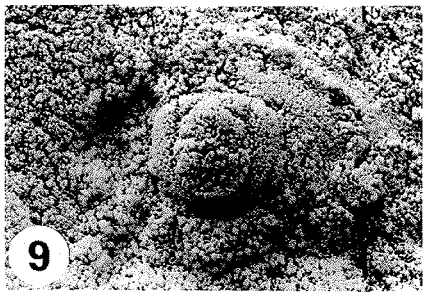
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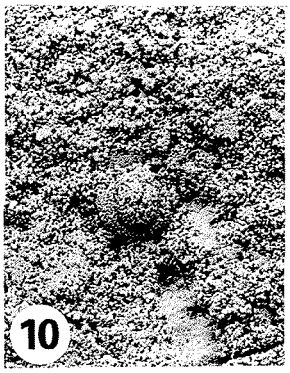
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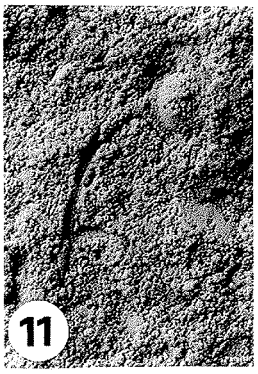
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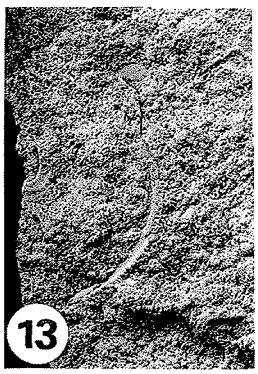
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PLATE 2

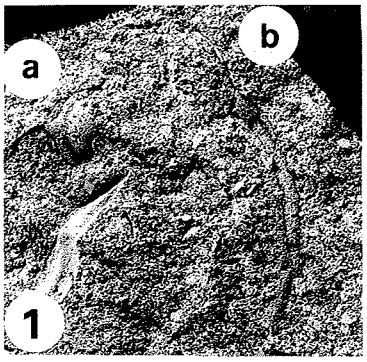
All specimens from the Upper Cambrian, Klonówka Formation, Holy Cross Mountains, Poland

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 Doły 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 Doły Ravine, × 3.

3-15 – *Sphaerophthalmus alatus* (BOECK, 1838); *Peltura minor* Zone, Chabowe Doły Mill, cephala, all × 4; 3 – MUZWG ZI/29/0266; 4 – MUZWG ZI/29/0263; 5 – MUZWG ZI/29/0224; 6 – MUZWG ZI/29/0159; 7 – MUZWG ZI/29/0223; 8 – MUZWG ZI/29/0197; 9 – MUZWG ZI/29/0142; 10 – MUZWG ZI/29/0152; 11 – MUZWG ZI/29/0146; 12 – MUZWG ZI/29/0262; 13 – MUZWG ZI/29/0157; 14 – MUZWG ZI/29/0151; 15 – MUZWG ZI/29/0158.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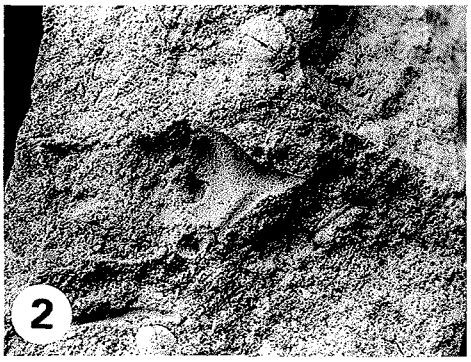
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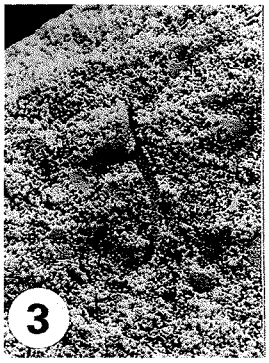
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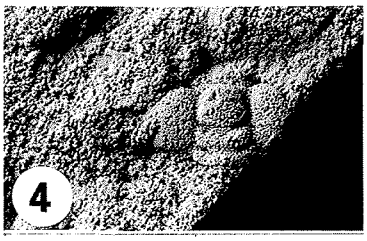
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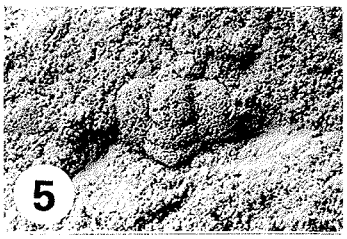
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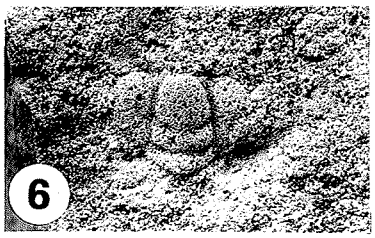
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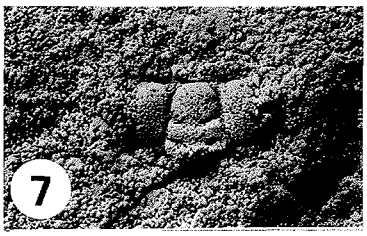
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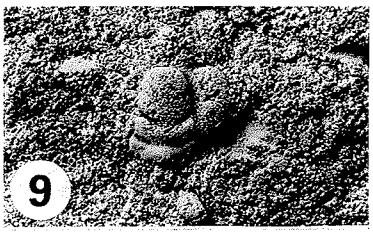
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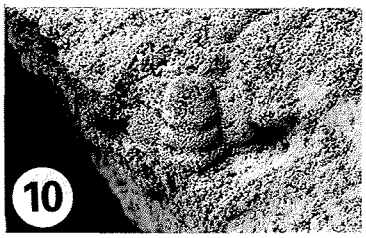
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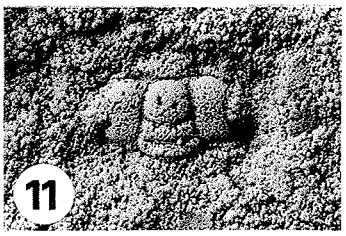
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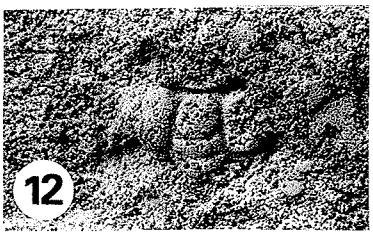
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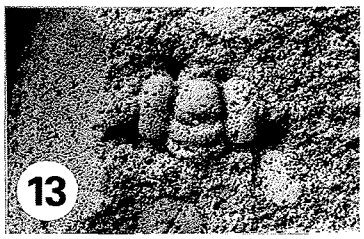
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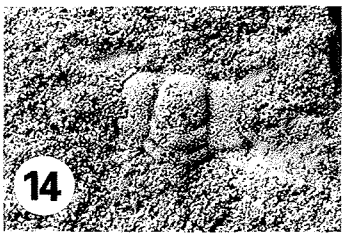
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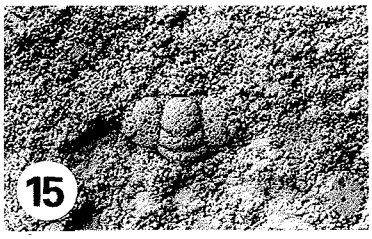
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PLATE 3

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

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

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


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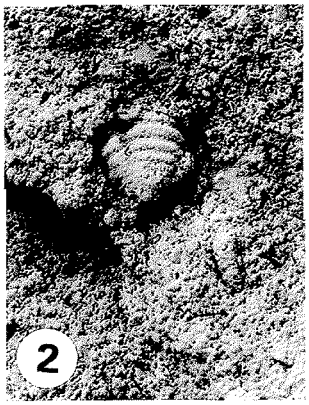
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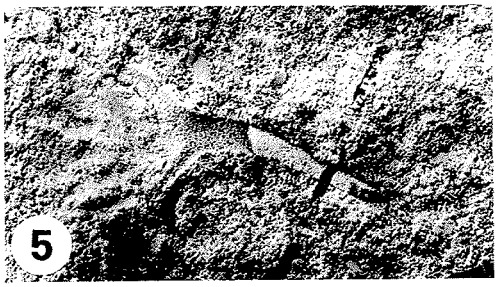
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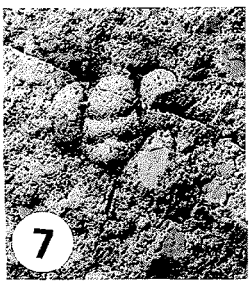
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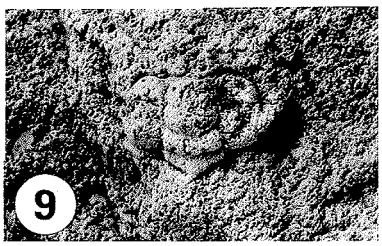
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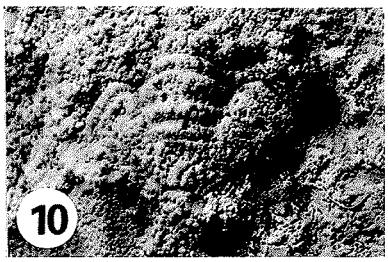
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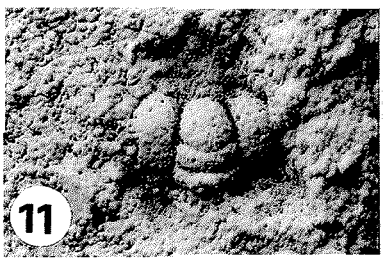
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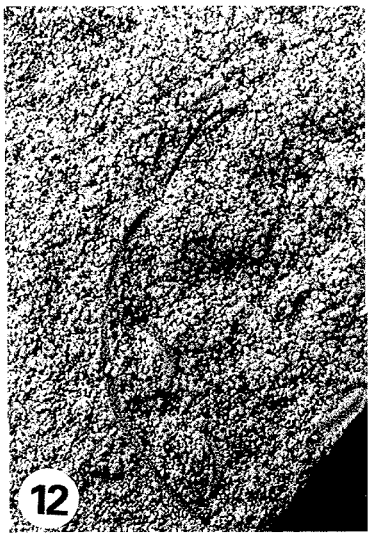
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PLATE 4

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 ORŁOWSKI (1968b, Pl. 7, Fig. 12b), *Olenus scanicus* and *?Parabolina brevispina* Subzones, Wiśniówka Duża Quarry, × 2.

5-7 – *Parabolina* (*Parabolina*) *heres* (BRØGGER, 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*, Brzezinki 2 Borehole, 30-40 m, × 3.

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


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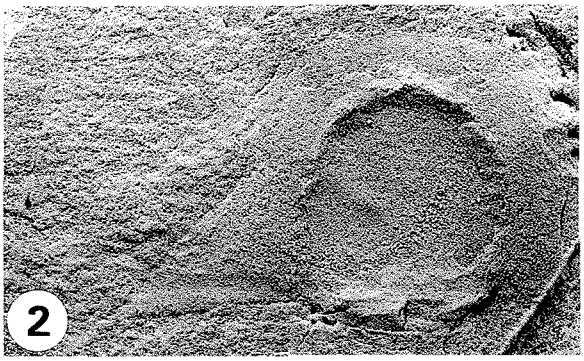
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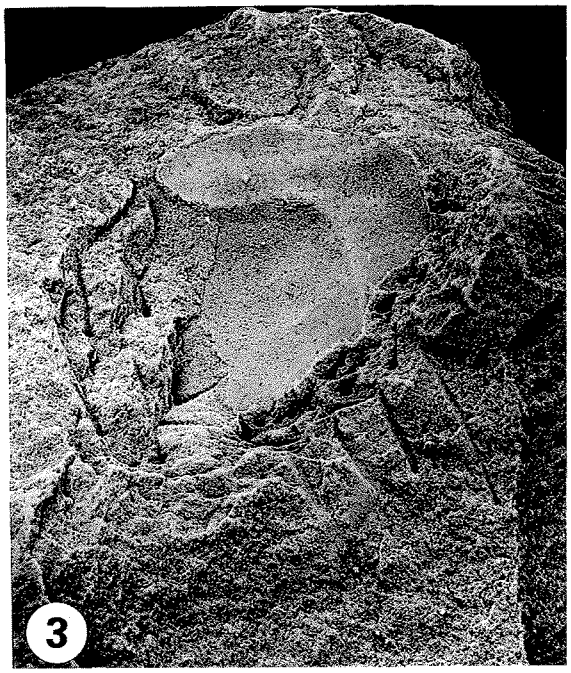
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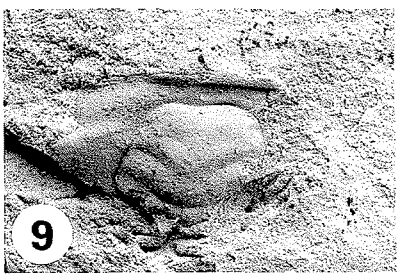
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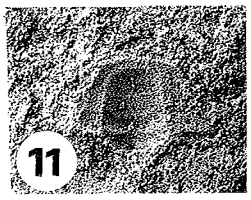
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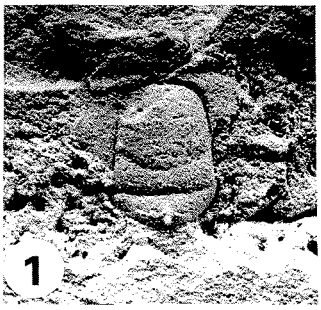
PLATE 5

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.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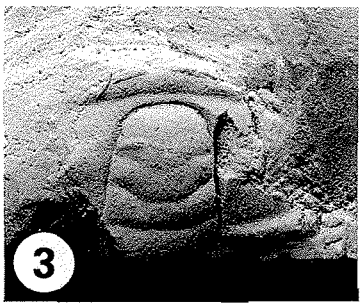
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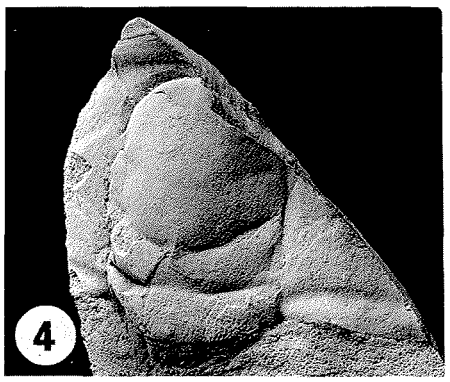
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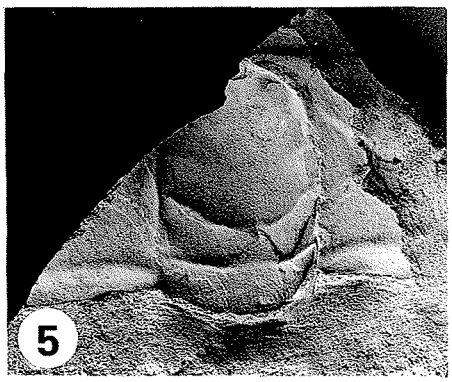
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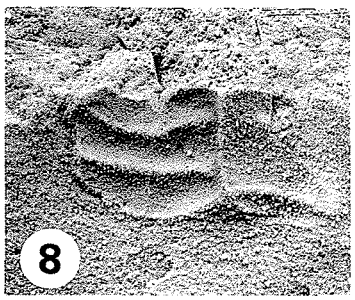
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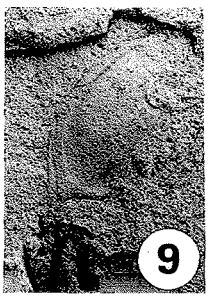
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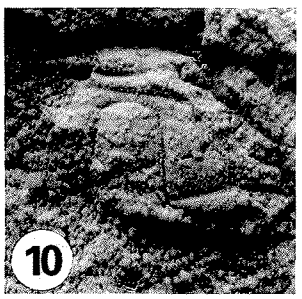
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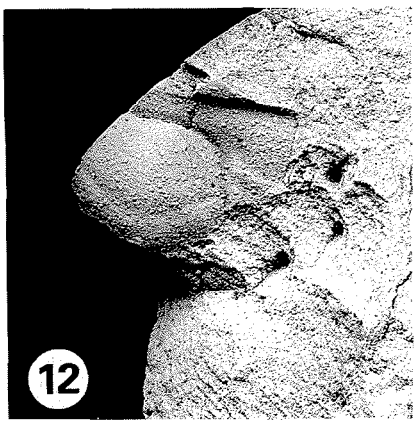
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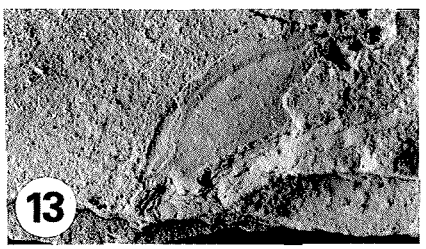
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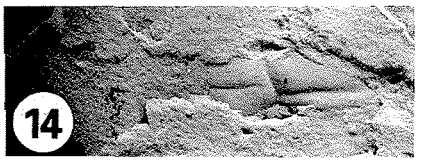
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PLATE 6

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 Doły Mill, × 3; 2 – MUZWG ZI/29/0535, cranidium, original of ORŁOWSKI (1968b, Pl. 6, Fig. 17), *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 6; 3 – MUZWG ZI/29/0610, librigena, *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 3; 4 – MUZWG ZI/29/0521, cranidium, original of ORŁOWSKI (1968b, Pl. 6, Fig. 19), *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 3; 5 – MUZWG ZI/29/0522, cranidium, *Peltura scarabaeoides* Zone, Chabowe Doły 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 Doły Ravine, × 3; 9 – MUZWG ZI/29/0533, cranidium, original of ORŁOWSKI (1968b, Pl. 6, Fig. 16), *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 4; 10 – MUZWG ZI/29/0529, cranidium, original of ORŁOWSKI (1968b, Pl. 6, Fig. 20), with *Peltura protopeltorum* ORŁOWSKI, *Peltura minor* Zone, Chabowe Doły Mill, × 3.

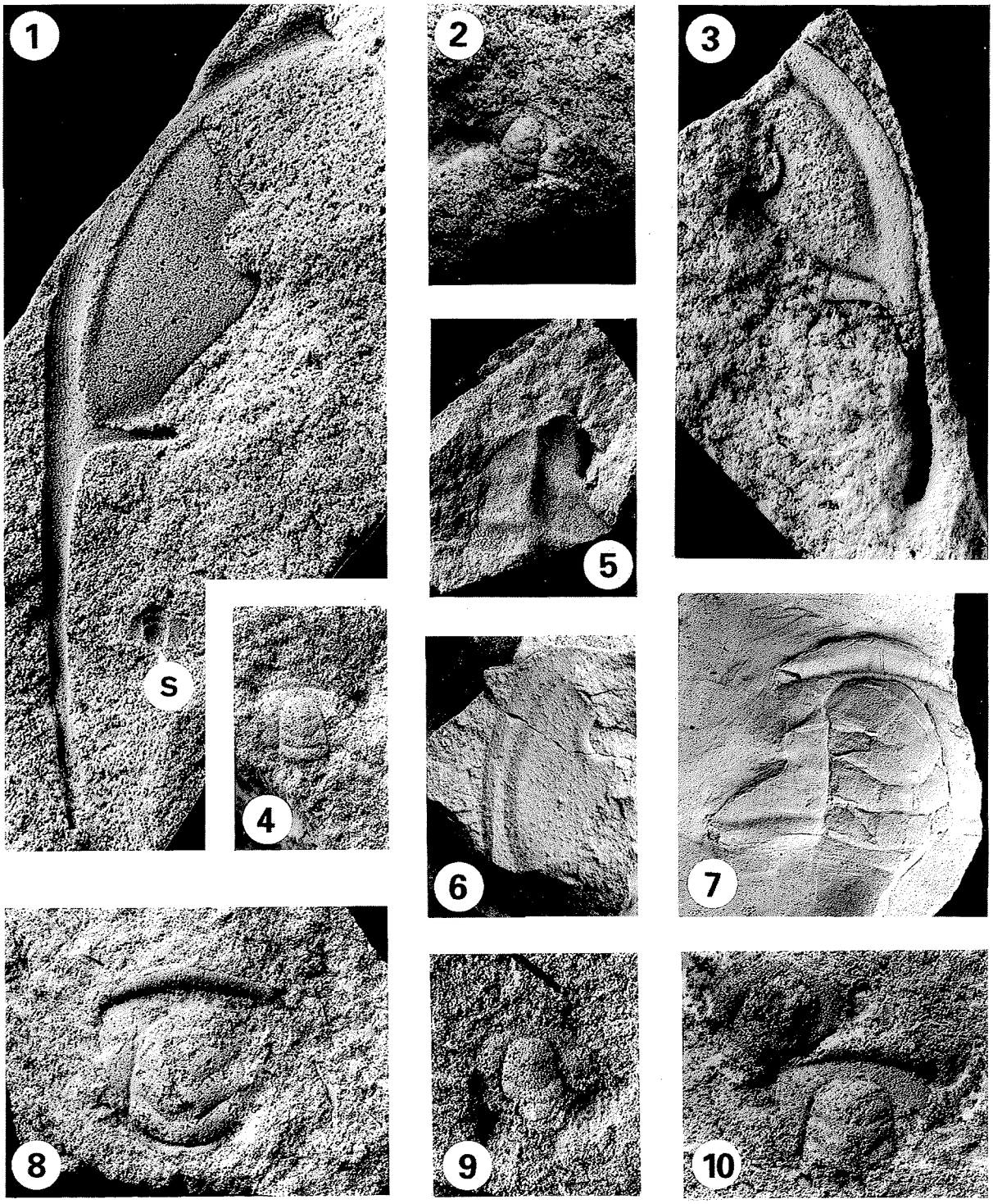
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PLATE 7

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

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

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

6 – *Parabolinites?* sp.; MUZWG ZI/29/0680, cranidium, *Peltura minor* Zone, Chabowe Doły Mill, × 3.

9-10 – *Acerocarina klonowkae* (ORŁOWSKI, 1968); *Peltura scarabaeoides* Zone, Chabowe Doły Ravine; 9 – MUZWG ZI/29/0768, cranidium, × 3; 10 – MUZWG ZI/29/0550, cranidium, × 4.


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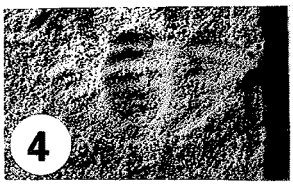
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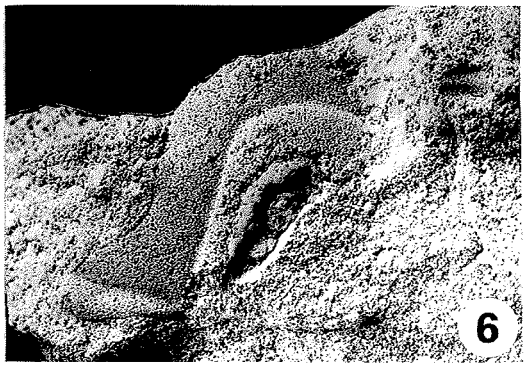
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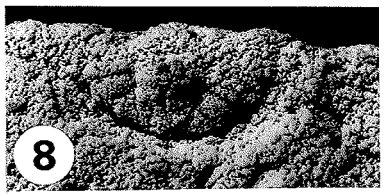
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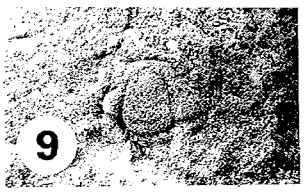
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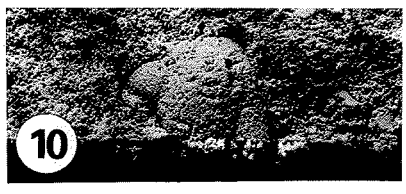
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PLATE 8

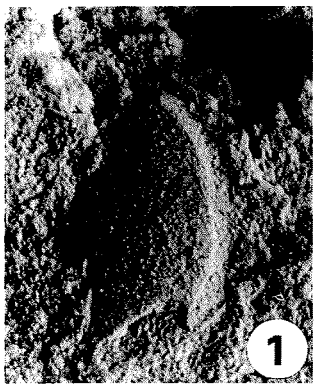
All specimens from the Upper Cambrian, Klonówka Shale Formation, Holy Cross Mountains, Poland

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), Brzezinki 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. 8), *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.

11 – MUZWG ZI/29/0573, *Peltura minor* Zone, Chabowe Doły Mill, × 2.

P – *Peltura protopeltorum* ORŁOWSKI, cranidium, ?thoracic segment; L – *Leptoplastides irae* (ORŁOWSKI), cranidia, librigenae.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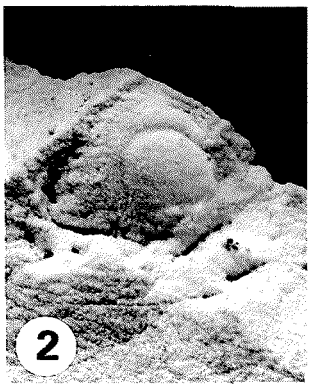
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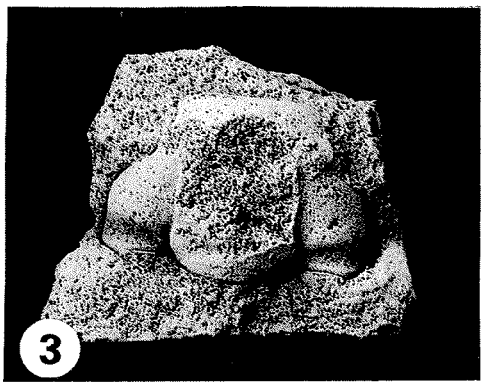
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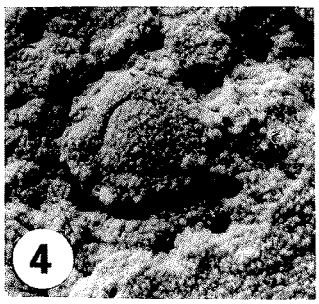
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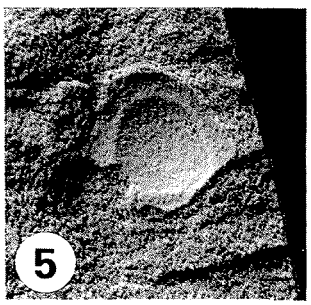
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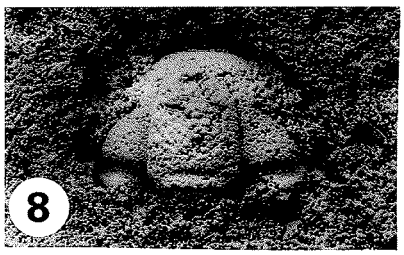
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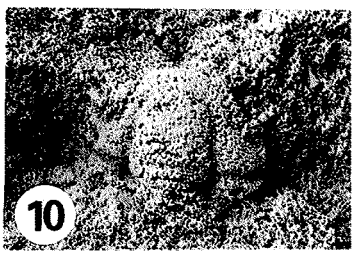
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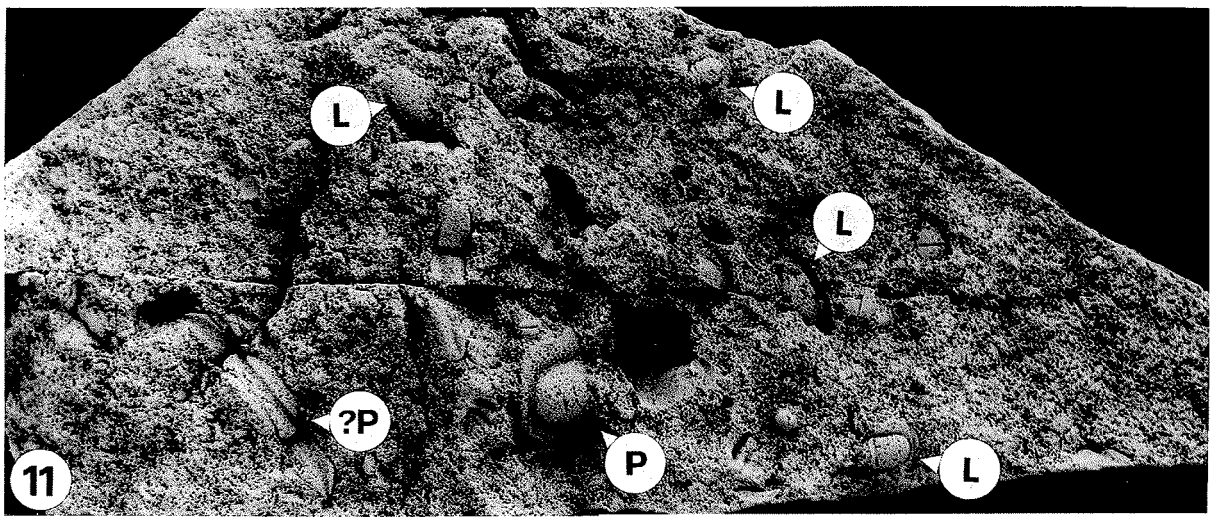
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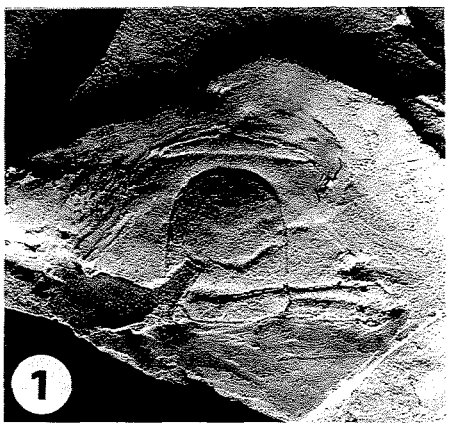
PLATE 9

All specimens from the Upper Cambrian, Klonówka 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* (ORŁOWSKI, 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 ORŁOWSKI (1968b, Pl. 5, Fig. 11), *Peltura minor* Zone, Chabowe Doły Mill, × 3; 8 – MUZWG ZI/29/0400, cranidium, original of ORŁOWSKI (1968b, Pl. 5, Fig. 2), *Peltura minor* Zone, Chabowe Doły Mill, × 3; 9 – MUZWG ZI/29/0598, sandy concretion with several effaced individuals of *Leptoplastides irae* (ORŁOWSKI) (the specimen enlarged on Fig. 6 is arrowed), *Leptoplastides* or *Protopeltura praecursor* Zone, Lisie Jamy, × 1.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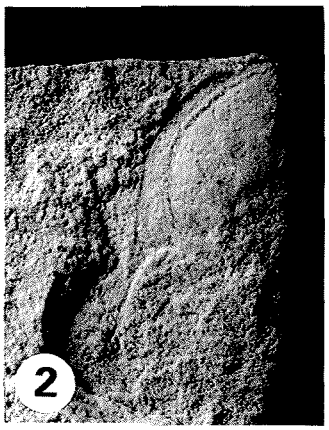
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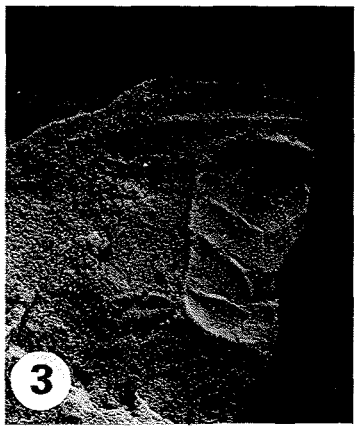
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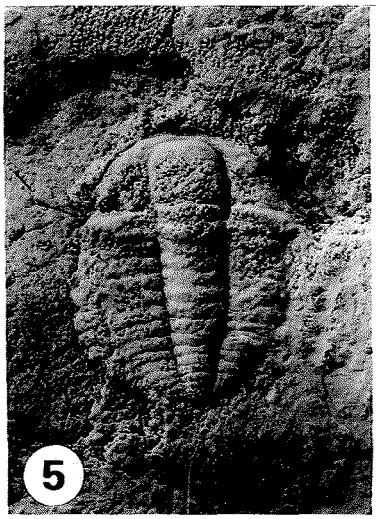
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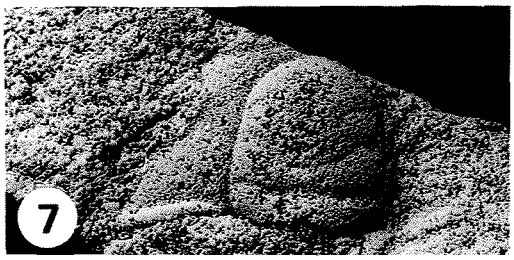
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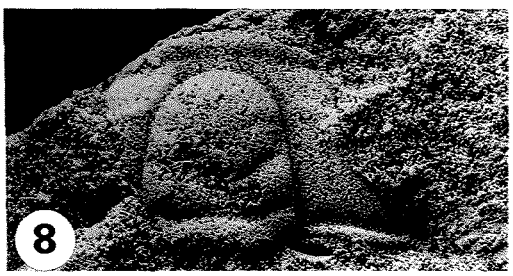
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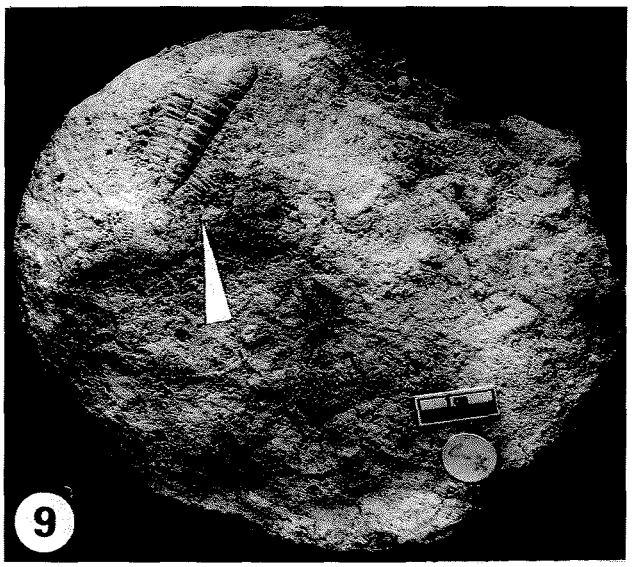
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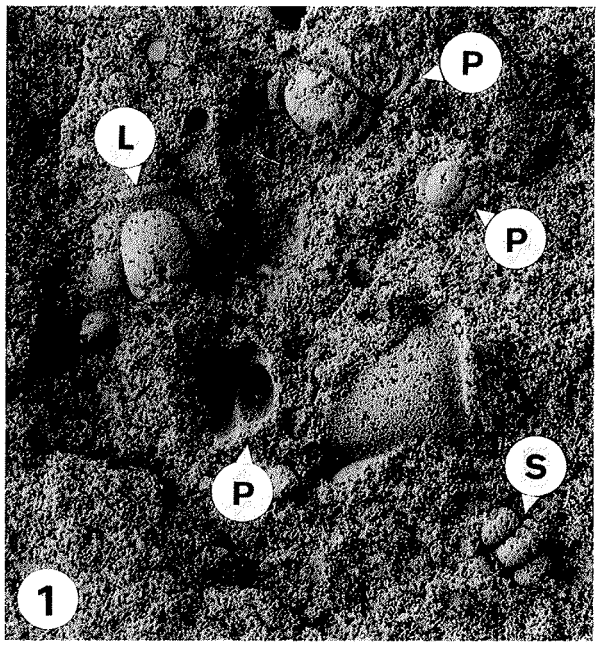
PLATE 10

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 *Sphaerophthalmus alatus* (BOECK) (S), *Peltura minor* Zone, Chabowe Doły Mill, × 3; 2 – MUZWG ZI/29/0396, cranidium, original of ORŁOWSKI (1968b, Pl. 5, Fig. 1), *Peltura minor* Zone, Chabowe Doły Mill, × 4; 3 – MUZWG ZI/29/0568, cranidium, *Peltura minor* Zone, Chabowe Doły Mill, × 4; 4 – MUZWG ZI/29/0648, cranidium, *Peltura minor* Zone, Chabowe Doły Mill, × 3; 5 – MUZWG ZI/29/0404, cranidium, original of ORŁOWSKI (1968b, Pl. 5, Fig. 8), *Peltura minor* Zone, Chabowe Doły Mill, × 4; 6 – MUZWG ZI/29/0402, cranidium, original of ORŁOWSKI (1968b, Pl. 5, Fig. 15), *Peltura minor* Zone, Chabowe Doły Mill, × 4; 7 – MUZWG ZI/29/0557, holotype cranidium, original of ORŁOWSKI (1968b, Pl. 5, Fig. 5), *Peltura minor* Zone, Chabowe Doły Mill, × 3; 8 – MUZWG ZI/29/0403, cranidium, original of ORŁOWSKI (1968b, Pl. 5, Fig. 7), *Peltura minor* Zone, Chabowe Doły Mill, × 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 Doły Mill, × 4; 12 – MUZWG ZI/29/0148, librigena, *Peltura minor* Zone, Chabowe Doły Mill, × 5.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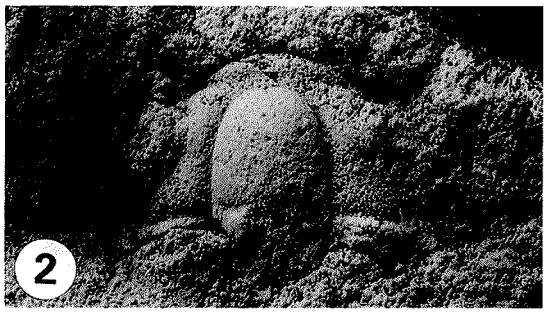
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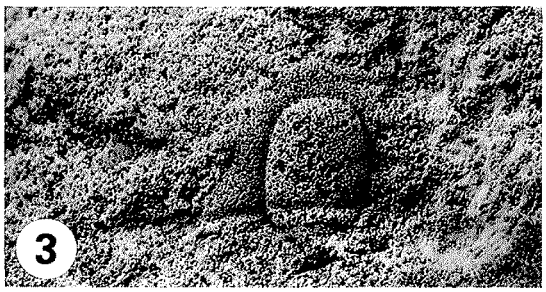
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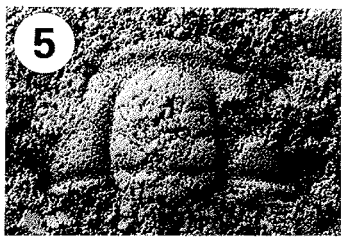
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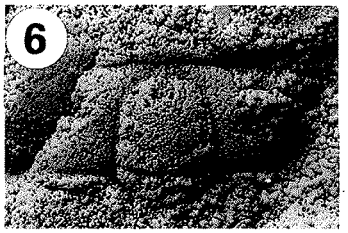
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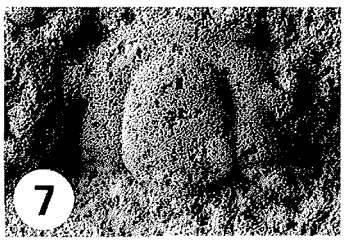
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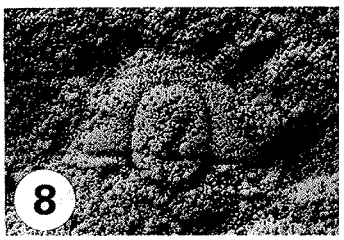
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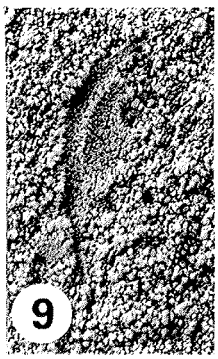
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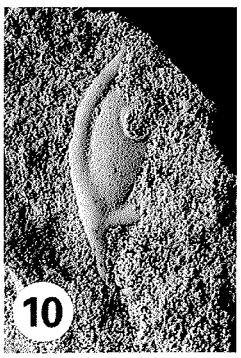
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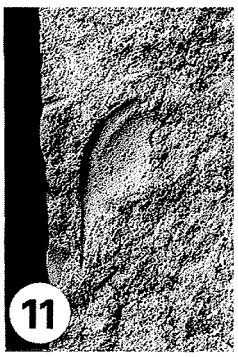
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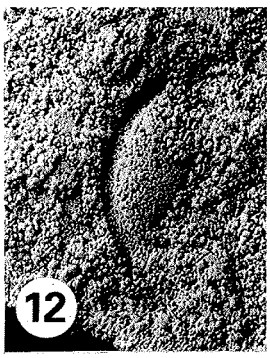
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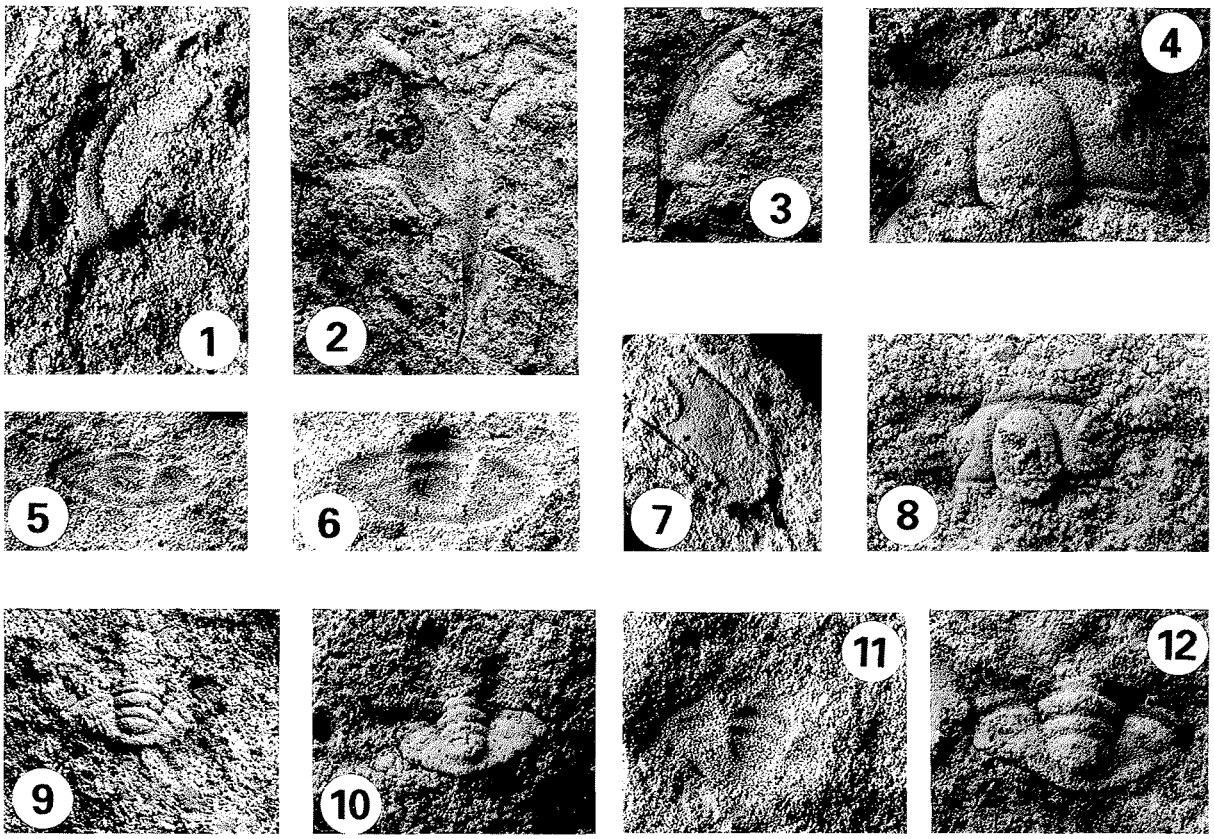
PLATE 11

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 Doły Mill, × 4; 2 – MUZWG ZI/29/0603, librigena, *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 3; 3 – MUZWG ZI/29/0606, librigena, *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 3; 4 – MUZWG ZI/29/0399, cranidium, original of ORŁOWSKI (1968b, Pl. 5, Fig. 3), *Peltura minor* Zone, Chabowe Doły Mill, × 4; 5 – MUZWG ZI/29/0424, pygidium, *Peltura minor* Zone, Chabowe Doły Mill, × 3; 6 – MUZWG ZI/29/0617, pygidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 15), *Peltura minor* Zone, Chabowe Doły 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 Doły Ravine, × 4; 9 – MUZWG ZI/29/0545, pygidium, *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 4; 10 – MUZWG ZI/29/0628, pygidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 24), *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 4; 11 – MUZWG ZI/29/0323, pygidium, original of ORŁOWSKI, (1968b, Pl. 8, Fig. 12), *Peltura minor* Zone, Chabowe Doły Mill, × 4; 12 – MUZWG ZI/29/0635, pygidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 22), *Peltura scarabaeoides* Zone, Chabowe Doły 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.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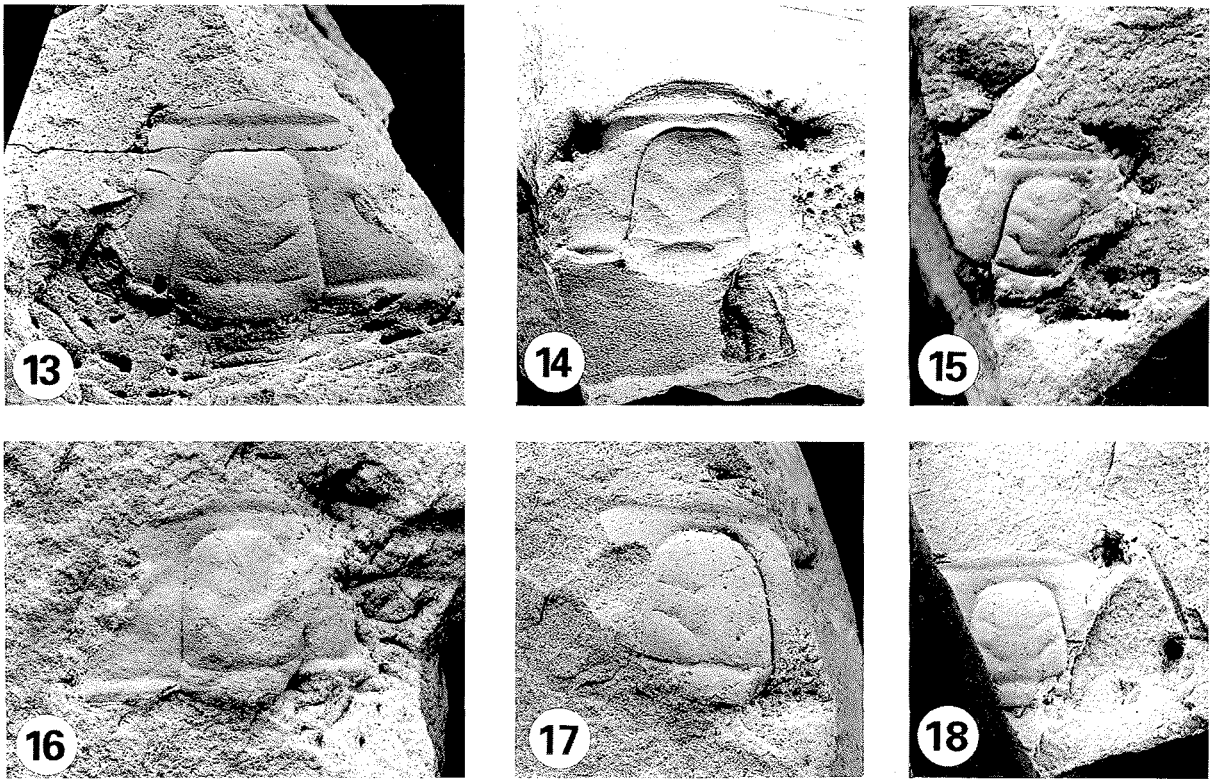
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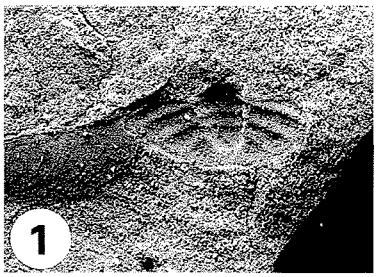
PLATE 12

All specimens from the Upper Cambrian, *Acerocare* Zone *sensu lato*, Klonówka 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, × 3; 2 – MUZPIG 1042.II.12, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 17), Jeleniów 3 Borehole, 113 m, × 4; 3 – MUZPIG 1042.II.12a, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 18), Jeleniów 3 Borehole, 113 m, × 4; 4 – MUZPIG 1042.II.16, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 25), Jeleniów 3 Borehole, 113.5-113.8 m, × 5; 5 – MUZPIG 1042.II.14, librigena, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 16), Jeleniów 3 Borehole, 113.8–114.8 m, × 4; 6 – MUZPIG 1042.II.17, librigena, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 26), Jeleniów 3 Borehole, 113.5-113.8 m, × 4; 7 – MUZPIG 1042.II.18, librigena, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 22), Jeleniów 3 Borehole, 113.8–114.8 m, × 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, × 3.5; 9 – MUZPIG 1042.II.5, librigena, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 37), Jeleniów 3 Borehole, 109-116 m, × 2; 10 – MUZPIG 1042.II.27, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 28), Jeleniów 3 Borehole, 152 m, × 1.5; 11 – MUZPIG 1042.II.10, cranidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 40), Jeleniów 3 Borehole, 113.5–113.8 m, × 3; 12 – MUZPIG 1042.II.28, pygidium, original of TOMCZYKOWA (1968b, Pl. 2, Fig. 29), Jeleniów 3 Borehole, 153.5 m, × 3; 13 – MUZPIG 1042.II.8, cranidium, original of TOMCZYKOWA (1968b, Pl. 3, Fig. 19), Bukowiany 1a Borehole, 238-243 m, × 3.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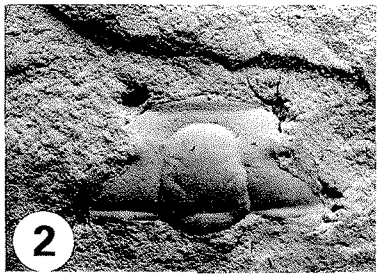
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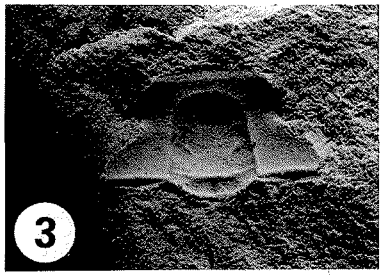
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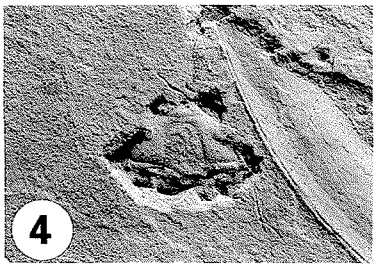
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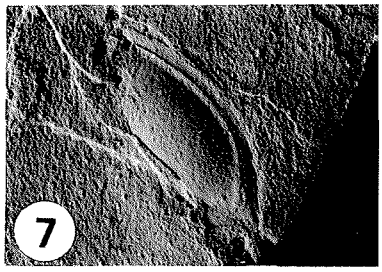
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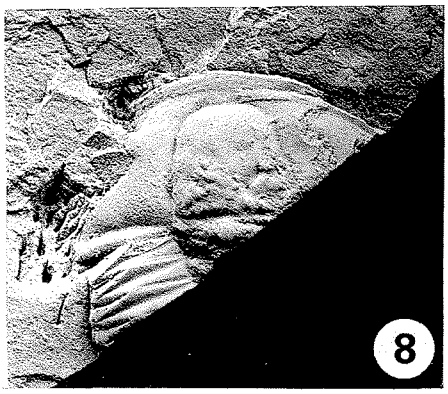
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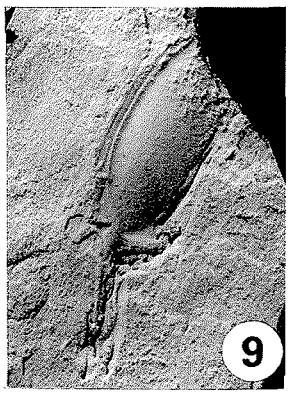
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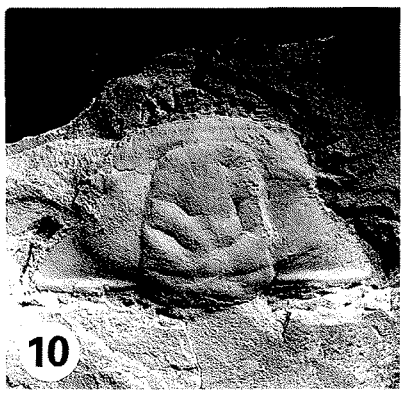
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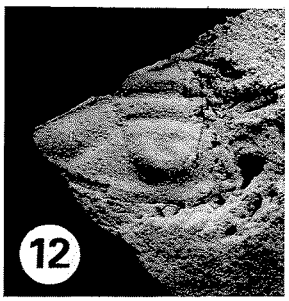
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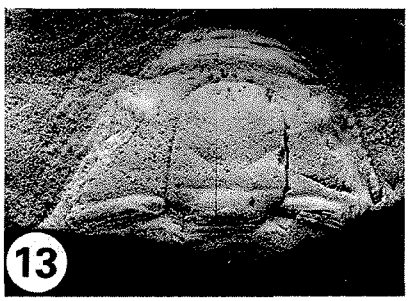
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PLATE 13

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 Doły Ravine; 3 – MUZWG ZI/29/0272, cranidium, × 4; 6 – MUZWG ZI/29/0180, cranidium, × 4.

4 – *Peltura acutidens* BRØGGER, 1882; MUZWG ZI/29/0574, cranidium, *Peltura minor* Zone, Chabowe Doły Mill, × 3.

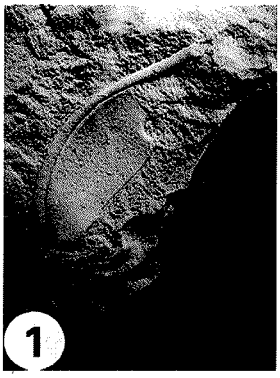
5 – *Nericiaspis robusta* (TJERNVIK, 1953); MUZPIG 1042.II.140, cranidium, *Peltura scarabaeoides* Zone, Wilków IG-1 Borehole, 847.8 m, × 3.

7 – *Peltura* sp.; MUZWG ZI/29/0553, librigena, original of ORŁOWSKI (1968b, Pl. 8, Fig. 11), *Peltura scarabaeoides* Zone, Chabowe Doły 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), Brzezinki 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*, Bukowiany 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.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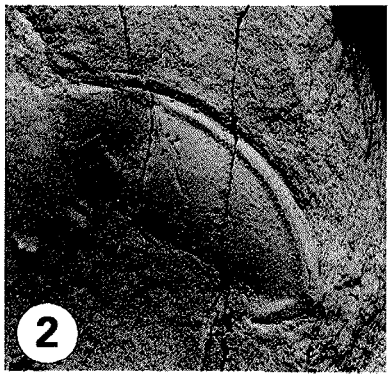
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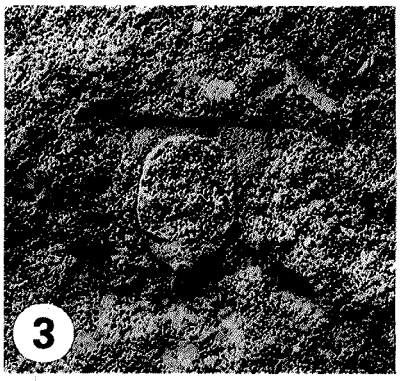
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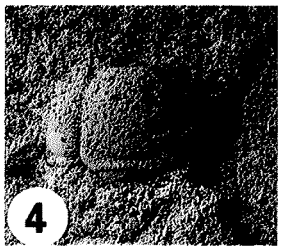
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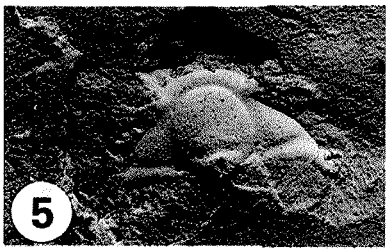
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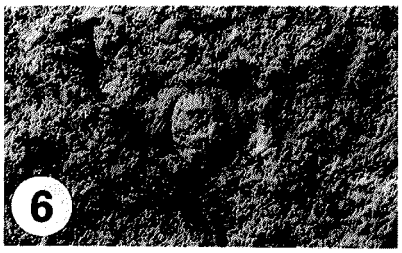
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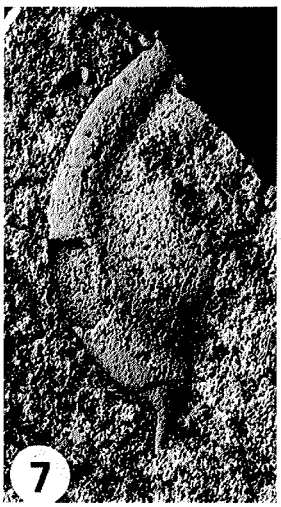
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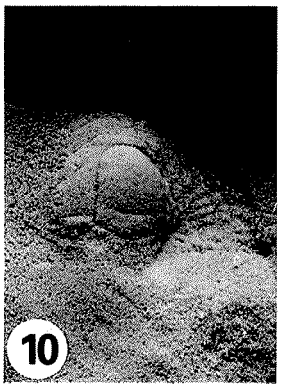
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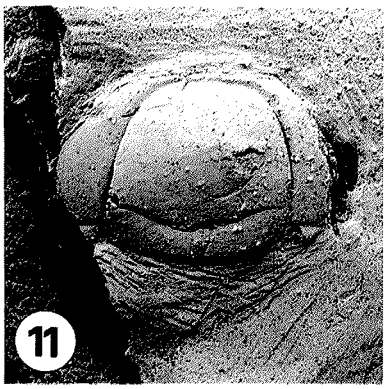
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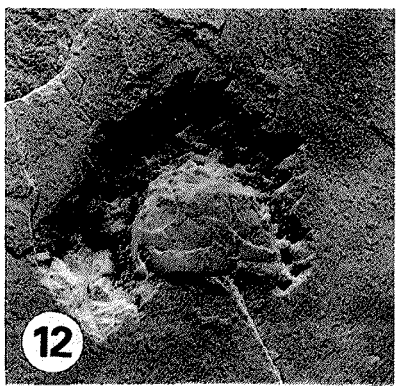
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PLATE 14

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

1-3 – *Peltura* cf. *transiens* (BRØGGER, 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 Doły Mill, × 4; 5 – MUZWG ZI/29/0575, *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 4; 6 – MUZWG ZI/29/0300, *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 4; 7 – MUZWG ZI/29/0299, *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 4; 8 – MUZWG ZI/29/0286, *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 3; 9 – MUZWG ZI/29/0619, *Peltura minor* Zone, Chabowe Doły Mill, × 4; 10 – MUZWG ZI/29/0619, negative of Fig. 9, × 4. 11 – MUZWG ZI/29/0296, *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 4; 12 – MUZWG ZI/29/0301, original of ORŁOWSKI (1968b, Pl. 8, Fig. 17), *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 3; 13 – MUZWG ZI/29/0303, original of ORŁOWSKI, (1968b, Pl. 8, Fig. 19), *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 4; 14 – MUZWG ZI/29/0304, original of ORŁOWSKI (1968b, Pl. 8, Fig. 16), *Peltura scarabaeoides* Zone, Chabowe Doły Ravine, × 4.

15-18 – *Peltura protopeltorum* ORŁOWSKI (P); *Peltura minor* Zone, Chabowe Doły 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.

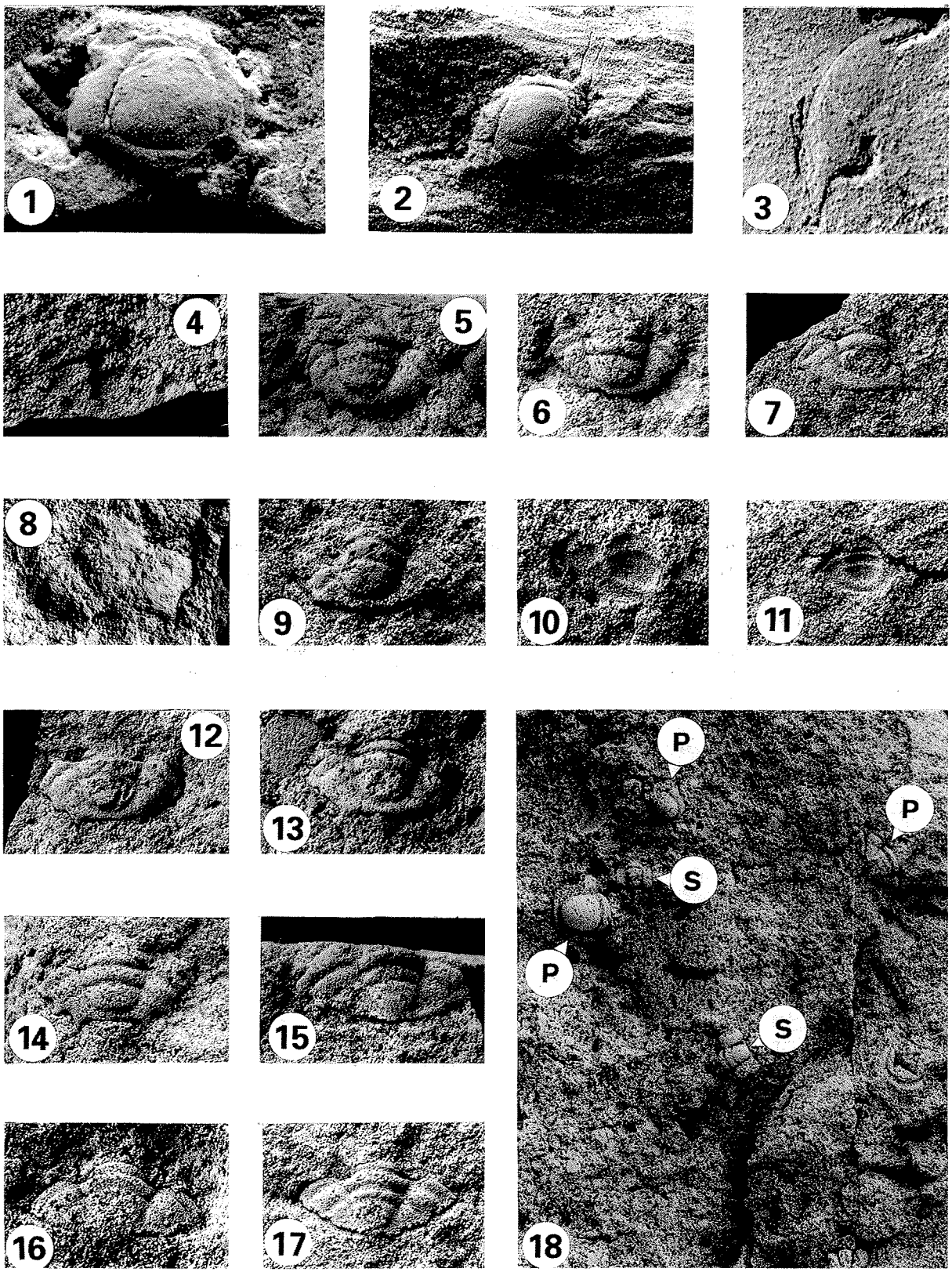
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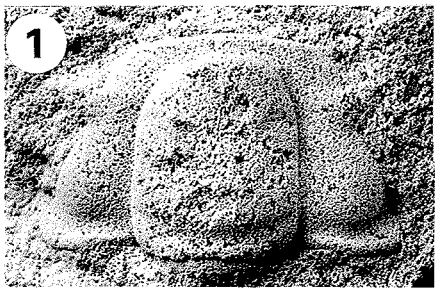
PLATE 15

All specimens from the Upper Cambrian, *Peltura minor* Zone, Klonówka Formation, Chabowe Doły 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.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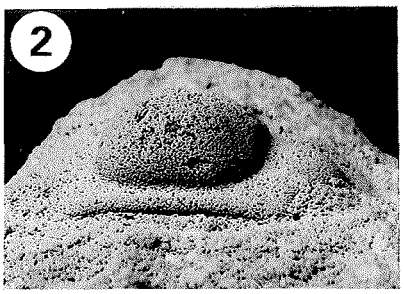
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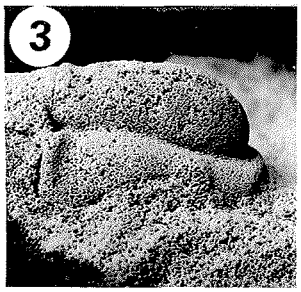
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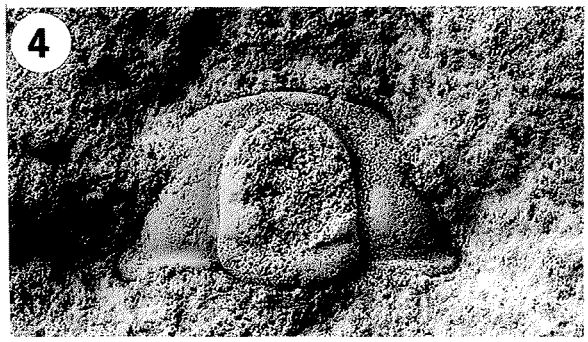
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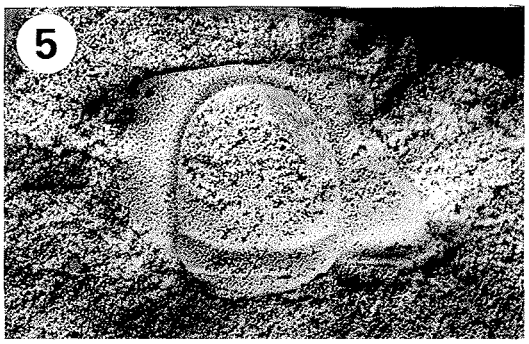
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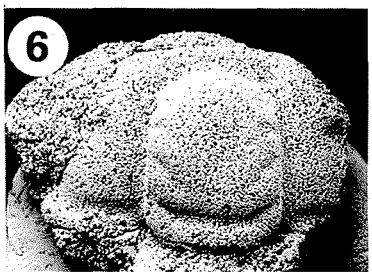
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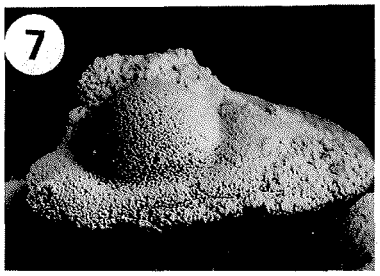
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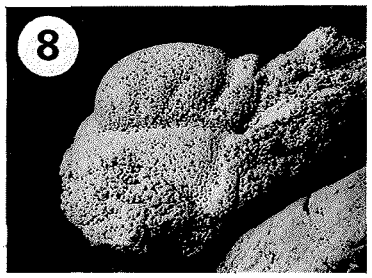
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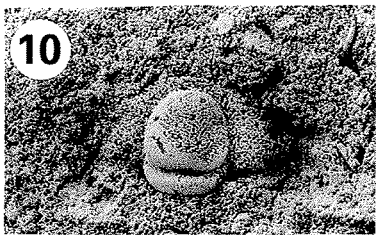
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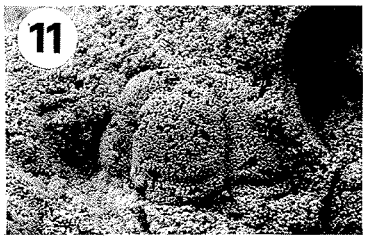
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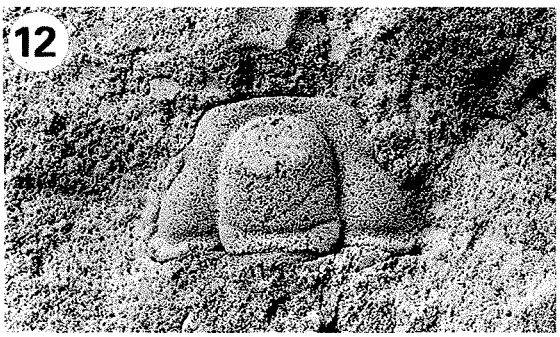
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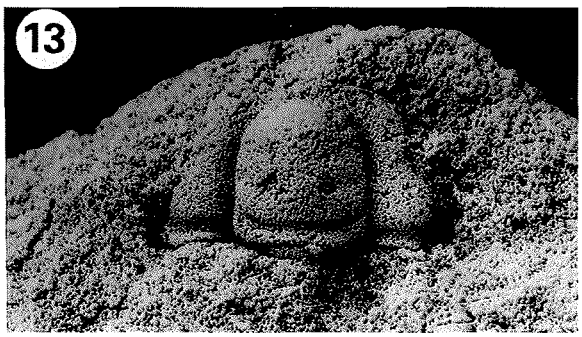
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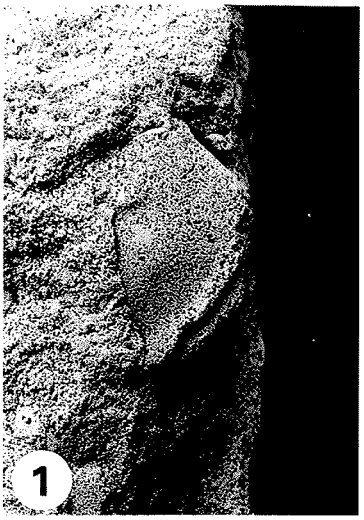
PLATE 16

All specimens from the Upper Cambrian, *Peltura minor* Zone, Klonówka Formation, Chabowe Doły 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.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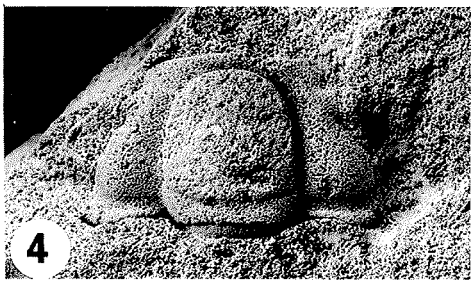
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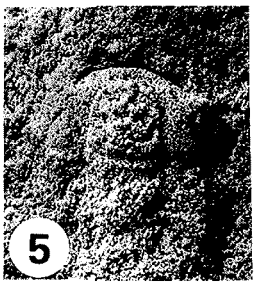
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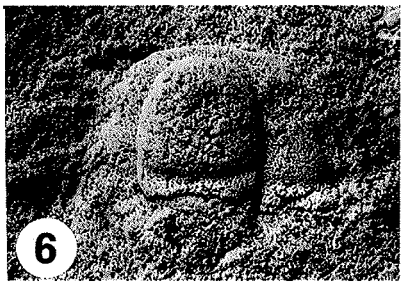
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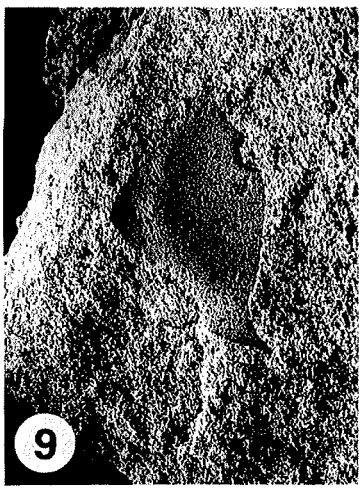
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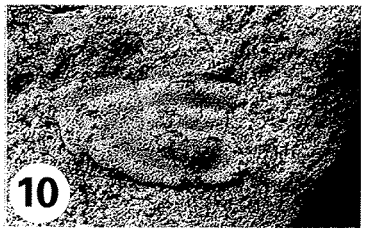
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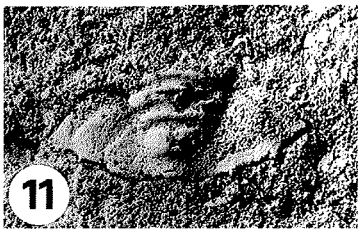
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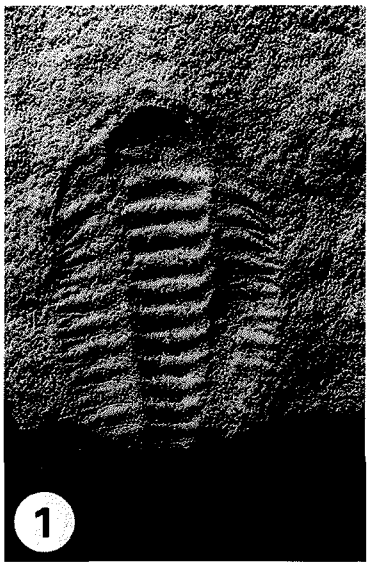
PLATE 17

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

1-18 – *Protopeltura aciculata* (ANGELIN, 1854). 1 – MUZWG ZI/29/0727, original of ORŁOWSKI (1968b, Pl. 7, Fig. 13), *Parabolina brevispina* Subzone, Wąworków 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, Wąworków Quarry, × 4; 4 – MUZWG ZI/29/0722, original of ORŁOWSKI (1968b, Pl. 8, Fig. 1), *Parabolina brevispina* Subzone, Wąworków Quarry, × 3; 5 – MUZWG ZI/29/0718, cranidium, original of ORŁOWSKI (1968b, Pl. 7, Fig. 15), *Parabolina brevispina* Subzone, Wąworków Quarry, × 4; 6 – MUZWG ZI/29/0005, cranidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 4; 7 – MUZWG ZI/29/0705, librigena, *Parabolina brevispina* Subzone, Wąworków Quarry, × 4; 8 – MUZWG ZI/29/0712, cranidium, original of ORŁOWSKI (1968b, Pl. 7, Fig. 14), *Parabolina brevispina* Subzone, Wąworków Quarry, × 4; 9 – MUZWG ZI/29/0715, cranidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 2), *Parabolina brevispina* Subzone, Wąworków Quarry, × 4; 10 – MUZWG ZI/29/0712, negative of Fig. 8, × 3; 11 – MUZWG ZI/29/0701, thorax, *Parabolina brevispina* Subzone, Wąworków Quarry, × 3; 12 – MUZWG ZI/29/0726, thorax with pygidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 2; 13 – MUZWG ZI/29/0702, part of thorax with pygidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 3; 14 – MUZPIG 8.II.163, (labelled *Parabolina*), cranidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 4; 15 – MUZWG ZI/29/0118, juvenile cranidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 10; 16 – MUZWG ZI/29/0719, cranidium, original of ORŁOWSKI (1968b, Pl. 8, Fig. 3), *Parabolina brevispina* Subzone, Wąworków Quarry, × 3; 17 – MUZWG ZI/29/0692, cranidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 4; 18 – MUZWG ZI/29/0709, cranidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 3.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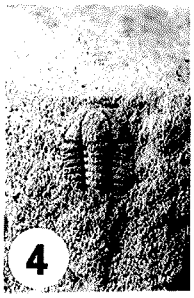
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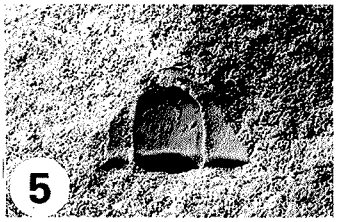
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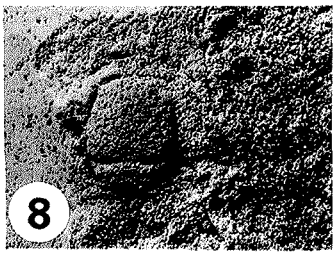
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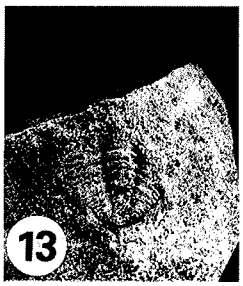
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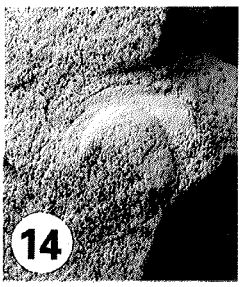
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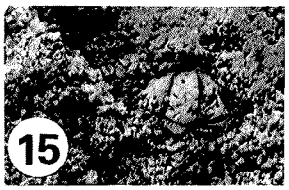
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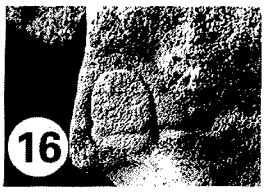
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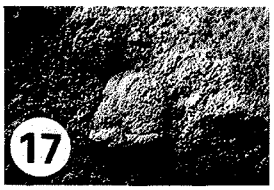
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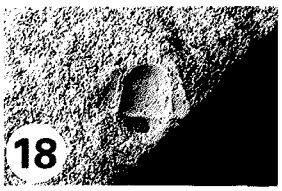
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PLATE 18

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, Wąworków Quarry, × 4; 2 – MUZWG ZI/29/0005; cranidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 4; 3 – MUZWG ZI/29/0036; cranidium, original of ORŁOWSKI (1968b, Pl. 4, Fig. 15); *Parabolina brevispina* Subzone, Wąworków 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, Wąworków Quarry, × 2; 6 – MUZPIG 8.II.162a; (labelled *Parabolina*), cranidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 4; 7 – MUZWG ZI/29/0061; cranidium, original of ORŁOWSKI (1968b, Pl. 4, Fig. 9); *Parabolina brevispina* Subzone, Wąworków Quarry, × 3; 8 – MUZWG ZI/29/0066; cranidium, *Parabolina brevispina* Subzone, Wąworków, × 3; 9 – MUZWG ZI/29/0057; cranidium, original of ORŁOWSKI (1968b, Pl. 4, Fig. 11); *Parabolina brevispina* Subzone, Wąworków Quarry, × 3; 10 – MUZWG ZI/29/0059; cranidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 3; 11 – MUZWG ZI/29/0019; pygidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 2; 12 – MUZWG ZI/29/0101; pygidium, *Parabolina brevispina* Subzone, Wąworków Quarry, × 2; 13 – MUZWG ZI/29/0067; cranidium with preglabellar boss, original of ORŁOWSKI (1968b, Pl. 4, Fig. 14); *Parabolina brevispina* Subzone, Wąworków Quarry, × 2.

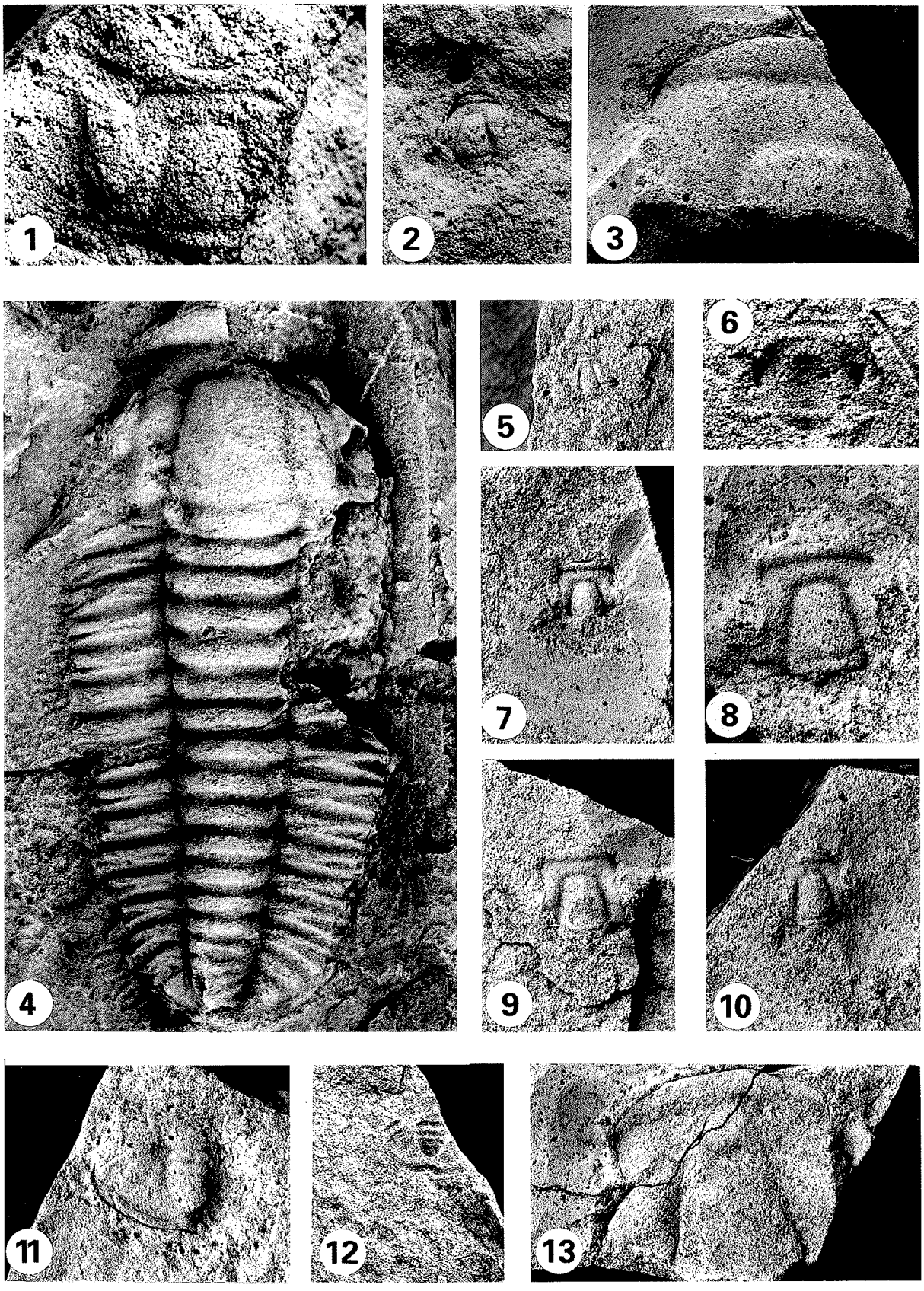
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PLATE 19

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 8.II.164, 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.

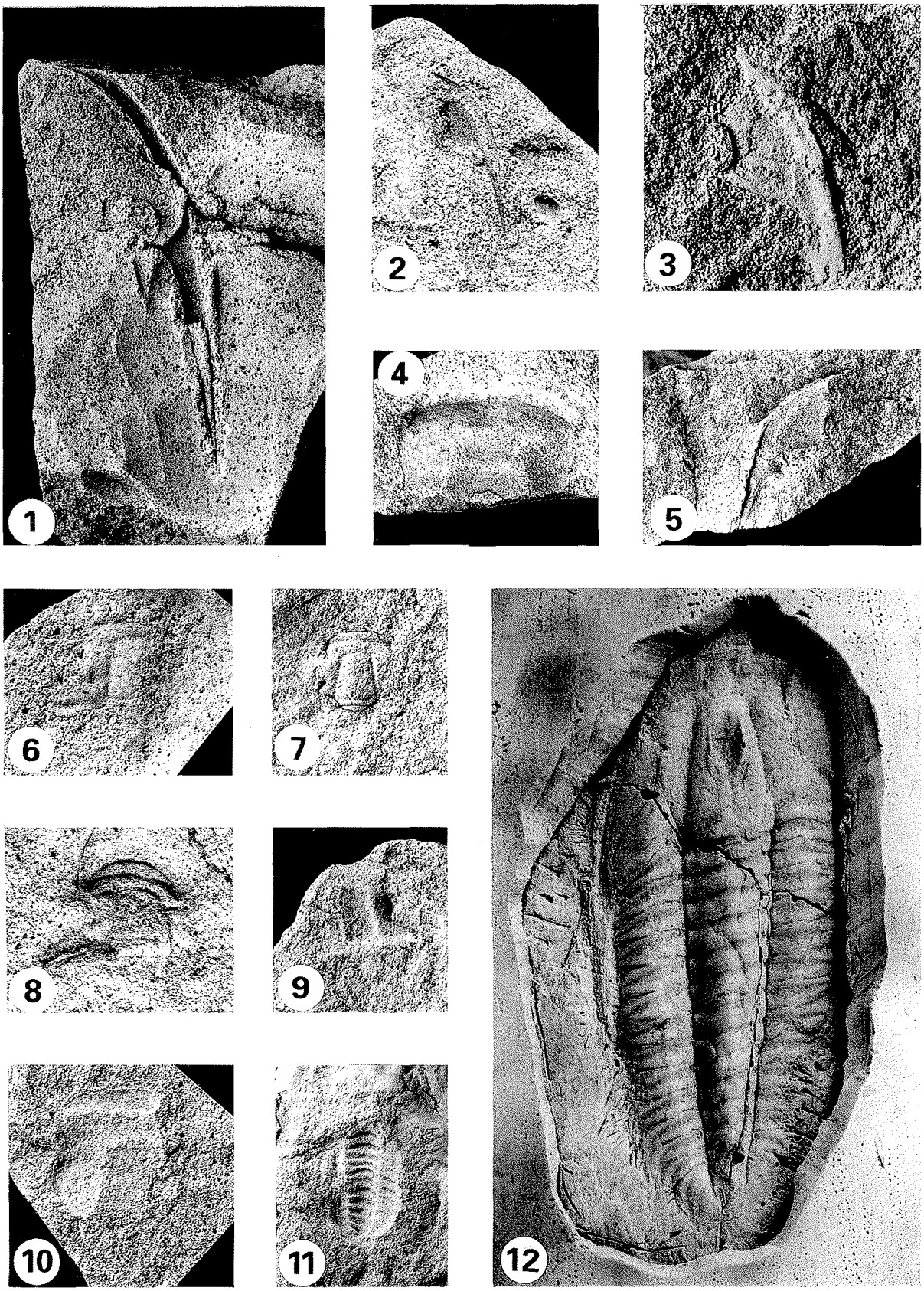
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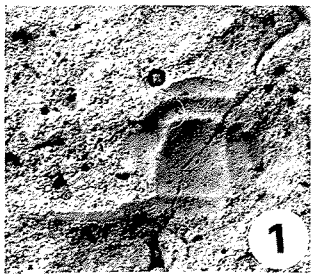
PLATE 20

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, × 3; 2 – MUZWG ZI/29/0074, librigena, × 2; 3 – MUZWG ZI/29/0078, librigena, × 2; 4 – MUZWG ZI/29/0095, pygidium, × 2; 5 – MUZWG ZI/29/0099, pygidium, × 2; 6 – MUZWG ZI/29/0100, pygidium, × 2; 7 – MUZWG ZI/29/0109, pygidium, × 2; 8 – MUZPIG 8.II.166a, (labelled *Olenidae*), pygidium, × 4; 9 – MUZWG ZI/29/0098, pygidium, × 2; 10 – MUZWG ZI/29/0089, pygidium, × 2; 11 – MUZPIG 8.II.160, (labelled *Peltura*), pygidium, × 3; 12 – MUZWG ZI/29/0085, pygidium, × 2; 13 – MUZWG ZI/29/0080, hypostome, × 2; 14 – MUZWG ZI/29/0079, hypostome, original of ORŁOWSKI (1968b, Pl. 4, Fig. 16), × 2.

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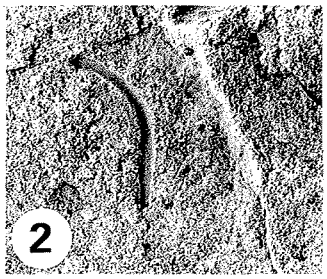
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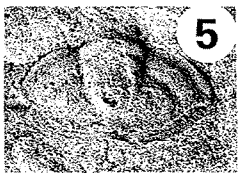
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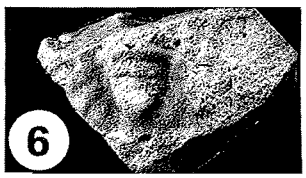
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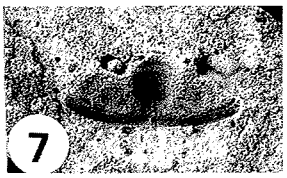
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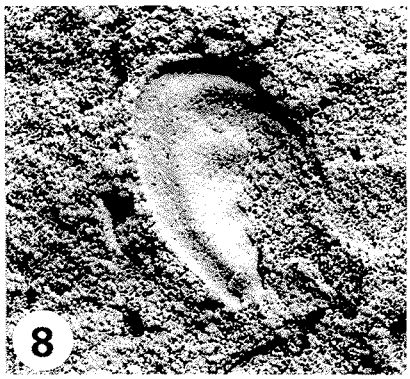
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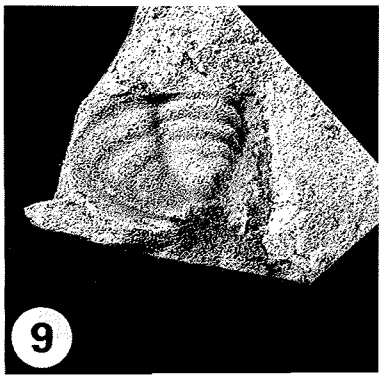
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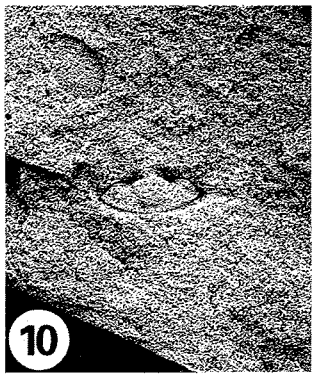
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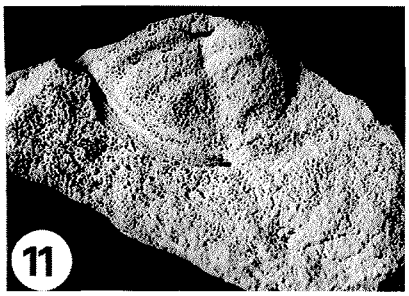
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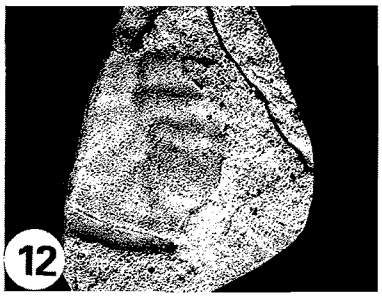
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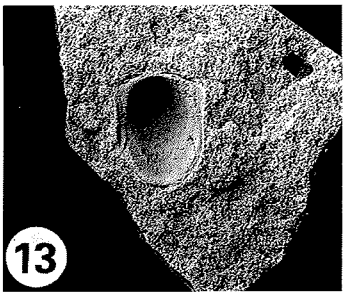
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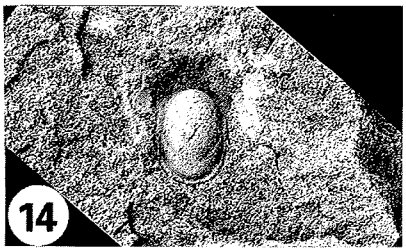
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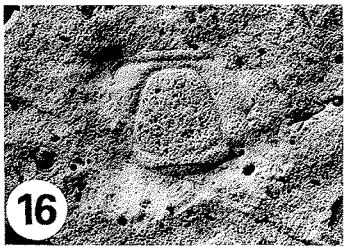
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