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New data on the Middle Cambrian trilobites and stratigraphy in the Holy Cross Mts

ABSTRACT: The new collection of the Middle Cambrian trilobites from the Holy Cross Mountains, Central Poland, is the basis for a revision of all previously recognized species of the area. For a few species either a supplementary description or a new taxonomical assignation is presented. Six species are established as new: *Comluella opatowi* sp. n., *Comluella usarzowi* sp. n., *Paradoxides socius* sp. n., *Kootenia enigmatica* sp. n., *Solenopleura minima* sp. n., and *Solenopleura trapezoides* sp. n. A new biostratigraphic zone is proposed, viz. the *Solenopleura canaliculata* Zone instead of the Barren Zone.

INTRODUCTION

The stratigraphy of the Middle Cambrian of the Holy Cross Mountains, Central Poland, was proposed by CZARNOCKI (1927). A new version of the stratigraphy with description of trilobites and some other fossils was offered by the author (ORŁOWSKI 1959a, b, 1964a, b, 1965). Additional description of trilobites was given by BEDNARCZYK (1970). The lithostratigraphic subdivision of the whole Cambrian sequence was also offered by the author (ORŁOWSKI 1975).

The trilobite collection was enlarged during last twenty years. The whole collection made an impulse to a new insight for trilobite species and genera described previously. Consequently, some new interpretations of some older species are given in this paper, the same as descriptions of several new species (*see* Text-fig. 1). All the investigated trilobites belong to the Baltic subprovince with some Bohemian influences.

STRATIGRAPHY

The four biostratigraphic Zones: *Insularis*, *Pinus*, *Polonicus*, and a Barren Zone at the top of the Middle Cambrian, were recognized in the Holy Cross Mountains (ORŁOWSKI 1964a, 1975). In this paper the youngest Zone, *Solenopleura canaliculata*, is proposed in place of the Barren Zone. The trilobites are very common in the three lower zones, but they are scarce in the youngest one.

The three lithostratigraphic formations were established in the Middle Cambrian of the investigated area (ORŁOWSKI 1975), as follows.

The *Usarzów Sandstone Formation* is exposed in the eastern part of the area and it comprises sandstones with subordinate clay and siltstone shale intercalations; the thickness of the formation is about 400 m. Trilobites are very common (see Text-fig.1), and they are represented by seven species of *Paradoxides* with *Paradoxides oelandicus* SJÖGREN, seven species of *Ellipsocephalus*, four species of *Comluella*, a species of *Kingaspis*, and a species of *Protolenus*. Associated are brachiopods, hyolithids, jellyfish, and archaeocyathids (ORŁOWSKI 1964a, 1975). Trace fossils are rare, and only *Planolites*, *Arcuatichnus*, and *Cruziana* were found.

The *Ślowiec Sandstone Formation* consists in the lower part of medium-grained, bedded sandstones, yellowish in color with many trilobites, especially: *Ellipsocephalus puschi* ORŁOWSKI, *E. guerichi* ORŁOWSKI, *E. hoffi* (SCHLOTHEIM), *Comluella opatowi* sp. n., and *C. usarzowi* sp. n. In the upper part of the formation there are poorly-sorted, often coarse-grained, thick-bedded sandstones with light-gray, light-yellow and reddish color. The trilobites are common, and the most characteristic are: *Paradoxides polonicus* ORŁOWSKI, *P. slowieensis* ORŁOWSKI, *P. socius* sp. n., *Solenopleurina linnarssoni* (BRÖGGER), *Solenopleura minima* sp. n., *S. trapezoides* sp. n., and *Kootenia enigmatica* sp. n. The trace fossils are unknown from this formation. The thickness of the formation is difficult to be established. but it attains at least 100 m.

The *Góry Pieprzowe Shale Formation* is represented by clay and siltstone shales and siltstones, black or dark-grey in color with thin sandstone intercalations, up to 400 m. The body fossils are not numerous: the trilobites *Solenopleurina linnarssoni* (BRÖGGER), *Solenopleura* cf. *canaliculata* (ANGELIN), *Solenopleura munsteri* (STRAND), and badly preserved agnostids are associated with the brachiopod *Lingulella vistulae* (GÜRICH).

PALEONTOLOGICAL REMARKS

The investigated Middle Cambrian trilobites are preserved mainly in sandstones as inner and outer casts; as a rule there is a lack of true carapace of trilobites. Generally, exoskeletons are segmented for parts, fortunately bigger parts of exoskeletons and whole exoskeletons are also found.

The systematic classification used in this paper is generally the same as in the *Treatise on Invertebrate Paleontology* (Part 0, Arthropoda 1, edited in 1959), but some ideas introduced by HUPÉ (1953) and WESTERGÅRD (1953) are also taken into account.

The collection of the investigated trilobites from the Middle Cambrian deposits of the Holy Cross Mountains counts about 1500 specimens, all of them being kept in the Institute of Geology, University of Warsaw.

The geological maps of the Middle Cambrian with location of the most important outcrops were presented formerly (ORŁOWSKI 1964a, 1975).

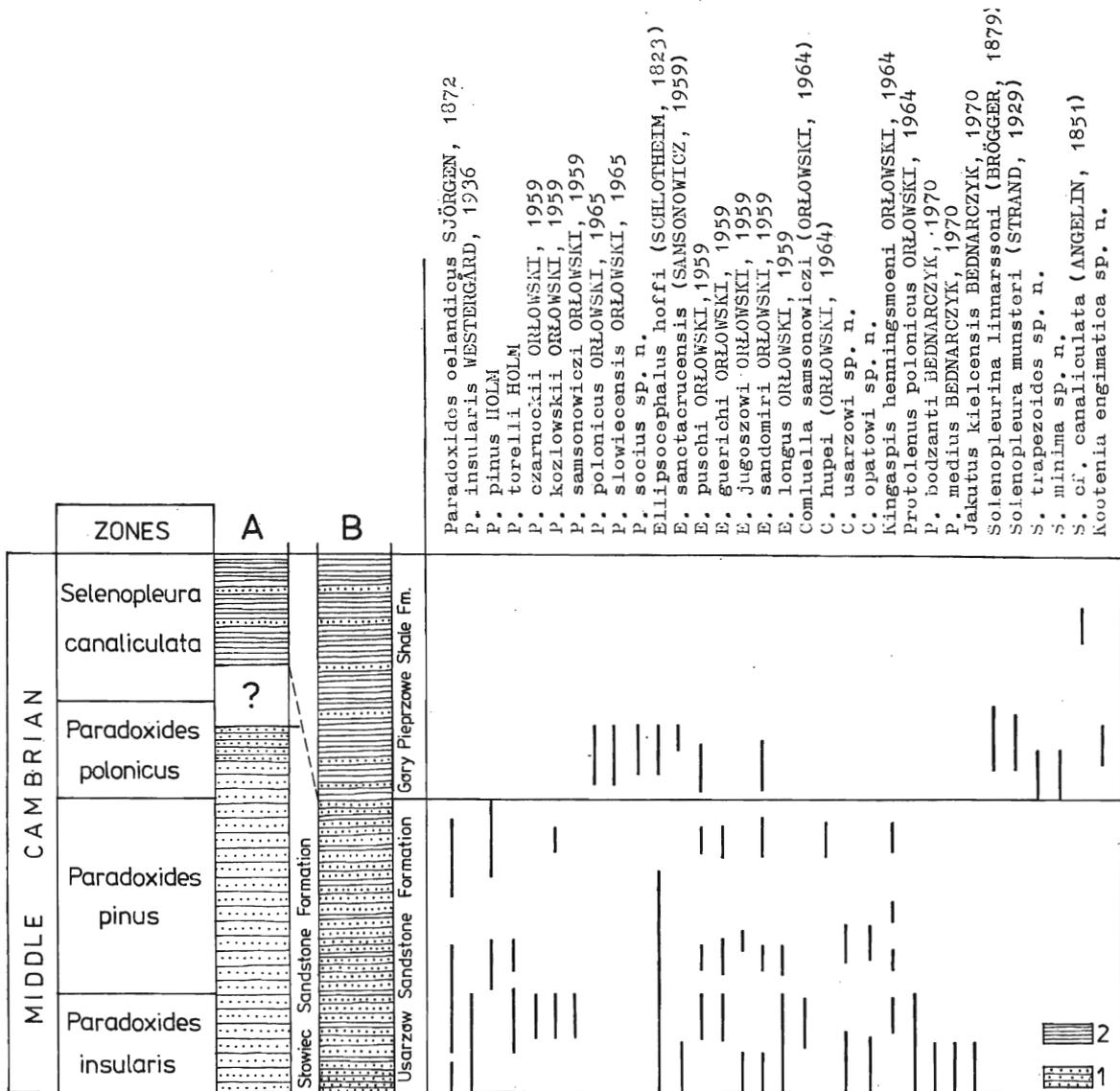
SYSTEMATIC ACCOUNT

Genus *Ellipsocephalus* ZENKER, 1833
Ellipsocephalus hoffi SCHLOTHEIM, 1823
 (Pl. 1, Figs 1—8)

1958. *Ellipsocephalus hoffi* SCHLOTHEIM, 1823; M. ŠNAJDR, pp. 88—92, Pl. 7, Figs 1—8, Pl. 8, Figs 1—7.
 1959b. *Ellipsocephalus polytomus* LINNARSSON; S. ORŁOWSKI, pp. 515—516, Pl. 1, Figs 1, 3 and 5.

MATERIAL: One whole specimen and over 40 cranidia.

Stratigraphy and trilobites of the Middle Cambrian in the Holy Cross Mountains



DESCRIPTION: Cephalon weakly convex, broader than long, rounded anteriorly, posterior margin straight. Glabella flat, often narrowing in the middle part; its frontal part triangular. Occipital ring short (*sag.*), occipital furrow straight, weakly marked. Preglabellar field separated from glabella and fixigenae by a long (*exsag.*) but shallow furrow. Eyes small, situated nearer the posterior margin furrow. Librigenae small, rounded laterally, without genal spine. Thorax narrowing posteriorly, with axial part convex; consists of 12 segments. Pygidium small, triangular, with convex axial part.

REMARKS: The species is very common in the Middle Cambrian of Bohemia, from where its detailed description and synonymy were presented by ŠNAJDR (1958). The Bohemian specimens come from shales and siltstones, but they often are deformed by tectonic factors. The Holy Cross specimens, embedded in sandstones, are more regularly preserved.

HORIZON and LOCALITY: The species is known from the sections Jugoszőw-Usarzőw and Słowiec Hill, where it is associated with many other trilobites. The species is reported from the Zones: Insularis, Pinus, and Polonicus.

Ellipsocephalus puschi ORŁOWSKI, 1959

(Pl. 2, Figs 5—8)

1959b. *Ellipsocephalus puschi* sp. n.; S. ORŁOWSKI, p. 517, Pl. 2, Fig. 1a—1c.

MATERIAL: Two almost complete specimens and over 100 cranidia.

ADDITIONAL DESCRIPTION: Cranidium convex, rounded anteriorly with short (*sag.*) duplicature. Glabella convex, narrowing slightly anteriorly; frontal part triangular. Occipital ring short (*sag.*), occipital furrow distinct. Preglabellar field short (*sag.*), smooth, strongly depressed antero-laterally. Thorax with 12 segments. Dorsal furrows broad (*tr.*), shallow; axial part evenly arched; pleural ends rounded. Pygidium small, triangular, with axial part evenly convex.

REMARKS: Description of this species was given by the author (ORŁOWSKI 1959b), but since that time many new cranidia were gathered, some of which very well preserved.

HORIZON and LOCALITY: The species is known from the sections Jugoszőw-Usarzőw and Słowiec Hill. The species is reported from the Insularis, Pinus, and Polonicus Zones.

Ellipsocephalus sandomiri ORŁOWSKI, 1959

(Pl. 1, Figs 9—13)

1959b. *Ellipsocephalus sandomiri* sp. n.; S. ORŁOWSKI, p. 518, Pl. 1, Fig. 2a—2b, Pl. 2, Figs 2—4.

MATERIAL: Five almost complete specimens and more than 90 cranidia.

ADDITIONAL DESCRIPTION: Cephalon oval, convex, with narrow (*sag.*) duplicature. Glabella convex, parallel-sided, smooth, frontal part triangular. Occipital ring short (*sag.*); occipital furrow straight, distinct. Eyes situated nearer the posterior margin furrow. Librigenae rounded without genal spine. Thorax narrowing slightly posteriorly, with 12 segments; axial part convex, axial furrows distinct, pleurae strongly bent downward, lateral parts of pleurae rounded. Pygidium unknown.

REMARKS: The species is similar to *Ellipsocephalus hoffi* (SCHLOTHEIM), but its glabella is much convex and parallel-sided, and occipital ring and furrow are more distinct.

HORIZON and LOCALITY: The species is very common in the upper part of the Jugoszőw-Usarzőw section, and it is also known from the Słowiec Hill. The species is reported from the Insularis, Pinus, and Polonicus Zones.

Ellipsocephalus guerichi ORŁOWSKI, 1959
(Pl. 2, Figs 9—15)

1959b. *Ellipsocephalus guerichi* sp. n.; S. ORŁOWSKI, pp. 516—517, Pl. 1, Figs 6—7 and 10.

MATERIAL: Almost 80 cranidia.

REMARKS: The species is still known only as cranidia, which are broad and short.

HORIZON and LOCALITY: The species is known from the sections Jugoszów-Usarzów and Słowiec Hill. The species occurs in the Insularis and Pinus Zones.

Ellipsocephalus jugoszowi ORŁOWSKI, 1959
(Pl. 2, Figs 1—4)

1959b. *Ellipsocephalus jugoszowi* sp. n.; S. ORŁOWSKI, pp. 518—519, Pl. 2, Figs 5, 6.

MATERIAL: Almost 40 cranidia.

REMARKS: Some new cranidia of this species were collected. The species characterizes by a flat cranidium, and a flat, long and parallel-sided glabella, triangular anteriorly.

HORIZON and LOCALITY: Insularis Zone in the Jugoszów-Usarzów section.

Ellipsocephalus longus ORŁOWSKI, 1959
(Pl. 3, Figs 1—3)

1959b. *Ellipsocephalus longus* sp. n.; S. ORŁOWSKI, p. 519, Pl. 2, Figs 7—9.

MATERIAL: 15 cranidia.

REMARKS: The species characterizes by an elongated cranidium and by a long, convex, parallel-sided glabella.

HORIZON and LOCALITY: Insularis and Pinus Zones in the Jugoszów-Usarzów section.

Genus *Comluella* HUPÉ, 1953
Comluella samsonowiczi (ORŁOWSKI, 1964)
(Text-fig. 2 and Pl. 3, Figs 7—13)

1964a. *Strenuella* (*Comluella*) *samsonowiczi* sp. n.; S. ORŁOWSKI, pp. 83—85, Text-fig. 16, Pl. 4, Figs 1—6.

MATERIAL: Two almost complete specimens, two partly preserved specimens and 70 cranidia.

PLATE 1

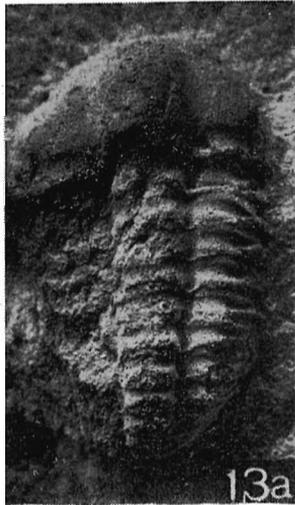
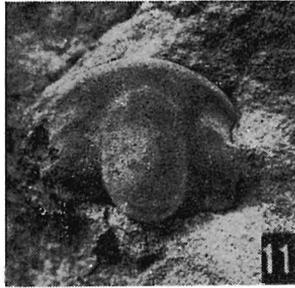
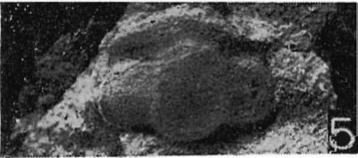
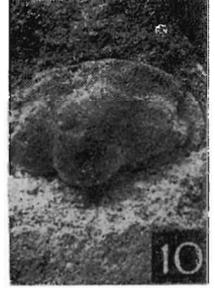
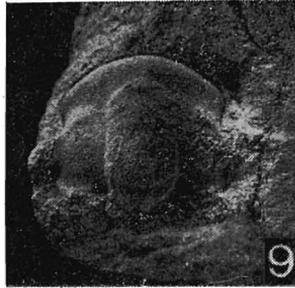
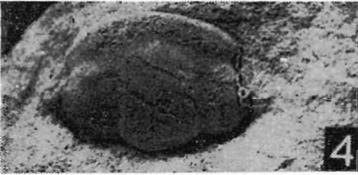
Ellipsocephalus hoffi SCHLOTHEIM, 1823

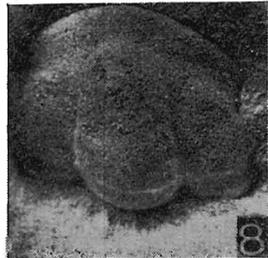
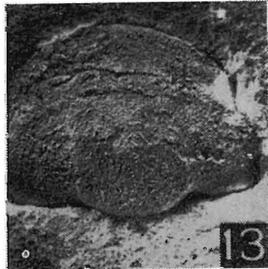
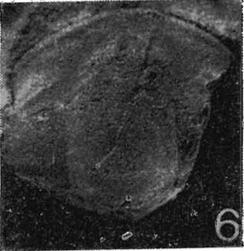
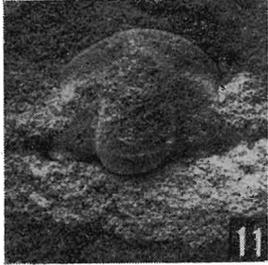
- 1 — Cranidium (No. 2.1576), Jugoszów 7a
2-7 — Cranidia (Nos 2.1374, 2.1377, 2.1315, 2.1310, 2.1603, 2.1806), Jugoszów 1a
8a-8b — Whole specimen (No. 2.1137); 8a top view, 8b lateral view; Jugoszów 1a

Ellipsocephalus sandomiri ORŁOWSKI, 1959

- 9 — Cranidium (No. 2.699), Jugoszów 19
10-11 — Cranidia (Nos 2.2852, 2.2844), Jugoszów 20
12 — Cranidium with 10 thoracic segments (No. 2.703), Jugoszów 19
13a-13b — Cephalon with 11 thoracic segments (No. 2.3532); 13a top view, 13b lateral view; Jugoszów 1

All photos × 2; taken by K. ZIELIŃSKA





REMARKS: This species was established on the basis of great collection composed primarily of cranidia, associated with some almost complete specimens. Critical analysis of the previous collection (*cf.* ORŁOWSKI 1964a) and new finds have convinced a separation of the three independent species, easily recognizable by their characteristic features. The genus *Comluella* is treated here as an independent genus as it was proposed by HUPÉ (1953); it differs from *Strenuella* by a lack of the occipital spine.

To the species *Comluella samsonowiczi* belong the specimens with a convex cranidium, broader than long, with glabella slightly narrowing anteriorly and frontal part of glabella rounded. Three pairs of lateral glabellar furrows are present. Occipital ring is rounded posteriorly, without occipital spine; occipital furrow composed. Fixigenae strongly convex, more convex laterally and lowering towards the glabella. Preglabellar field short (*sag.*), anterior border weakly marked (*see*

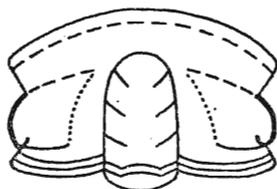


Fig. 2

Comluella samsonowiczi (ORŁOWSKI, 1964)

Text-fig. 2). Thorax narrowing posteriorly, consists of 13 segments. Pleurae strongly bent downward, with sharp spines directed backward. Pygidium small, triangular; axial part convex. The holotype is an almost complete specimen, although without librigenae (*see* Pl. 3, Fig. 12; specimen No. 2. 1 figured previously *in:* ORŁOWSKI 1964a, Pl. 6, Fig. 1).

HORIZON and LOCALITY: The species is common in the sections Jugoszów-Usarzów and Słowiec Hill. The species is known from the Insularis Zone.

Comluella opatowi sp. n.

(Text-fig. 3 and Pl. 4, Figs 6—14)

1964a. *Strenuella (Comluella) samsonowiczi* sp. n.; S. ORŁOWSKI, pp. 83—85, Pl. 7, Figs 1—4, 6—7, Pl. 8, Figs 1—3, 5—7.

HOLOTYPE: Cranidium (specimen No. 2. 1751) presented in Pl. 4, Fig. 12.

PLATE 2

Ellipsocephalus jugoszewi ORŁOWSKI, 1959

1-4 — Cranidia (Nos 2.1412, 2.1316, 2.1411, 2.1423), Jugoszów 7a except of Fig. 2 from Jugoszów 1a

Ellipsocephalus puschi ORŁOWSKI, 1959

5 — Cranidium (No. 2.3742), Słowiec Hill

6 — Cranidium (No. 2.551), Jugoszów 4

7 — Part of cranidium with at least 8 thoracic segments and pygidium (No. 2.2264), nat. size.; Jugoszów 3

8 — Cranidium (No. 2.3798), Słowiec Hill

Ellipsocephalus guerichi ORŁOWSKI, 1959

9-15 — Cranidia (Nos 2.953, 2.3131, 2.3768, 2.3766, 2.1534, 2.1964, 2.1488); 9 and 10 from Sternalice, 11 and 12 from Słowiec Hill, 13 and 15 from Jugoszów 7, 14 from Jugoszów 1

All photos $\times 2$ (except of Fig. 7); taken by K. ZIELIŃSKA

TYPE LOCALITY: Jugoszków-Usarzów section.

TYPE HORIZON: Middle Cambrian, Insularis Zone, Usarzów Sandstone Formation.

DERIVATION OF THE NAME: After the town Opatów, situated near the section.

MATERIAL: One complete specimen, two cephalae, 90 cranidia.

MEASUREMENTS: The smallest cranium is about 5 mm long and 6 mm broad; the biggest cranium is about 18 mm and 24 mm respectively.

DIAGNOSIS: A *Comluella* with cephalon broader than long, convex; glabella elongated, parallel-sided and rounded anteriorly, strongly convex; fixigenae moderately convex; librigenae with a short but sharp spine; thorax with 12 segments.

DESCRIPTION: Cephalon broader than long, convex, rounded anteriorly. Glabella long, very convex, parallel-sided, rounded anteriorly and reaching about 3/4 of cranium length. In younger specimens glabella is slightly conical. Three pairs of lateral glabellar furrows are present; the anterior pair is directed anteriorly. Occipital ring distinct, rounded posteriorly; occipital furrow long (*sag.*), distinct. Axial furrows deep, broad. Fixigenae evenly arched. Palpebral lobes distinct, palpebral lobe furrow distinct, both depressed below the level of fixigenae. Preglabellar field smooth, lowering laterally, without anterior border, separated from glabella and fixigenae by a shallow furrow. Posterior margin of cephalon almost straight; posterior margin furrow distinct. Librigenae rounded with a small but sharp spine situated laterally (*see* Text-fig. 3). Thorax with 12 segments,

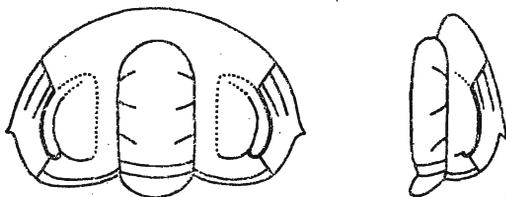


Fig. 3

Comluella opatowi sp. n.

narrowing posteriorly. Axial part convex without spine or nodes; axial furrows distinct. Pleurae with long and distinct pleural furrows; pleura spines small but sharp and directed backwards. Pygidium small, triangular with axial part convex.

DISCUSSION: The new species differs from *Comluella samsonowiczi* (ORŁOWSKI, 1964) in longer parallel-sided glabella, lack of anterior border, in convexity of fixigenae, and in number of thoracic segments.

PLATE 3

Ellipsocephalus langus ORŁOWSKI, 1959

- 1-3 — Cranidia (Nos 2.1252, 2.1307, 2.1314), Jugoszków *1a*

Comluella usarzowi sp. n.

- 4-6 — Cranidia (Nos 2.1734, 2.2561, 2.1644): 4 and 6 from Jugoszków *1a*, 5 from Jugoszków *4*

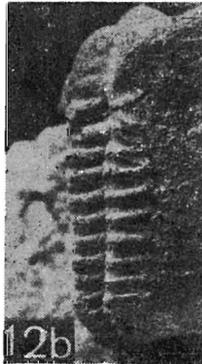
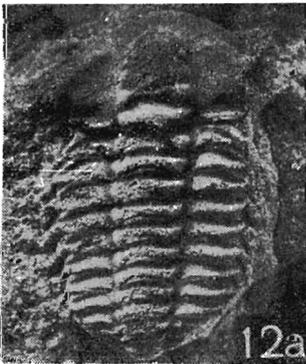
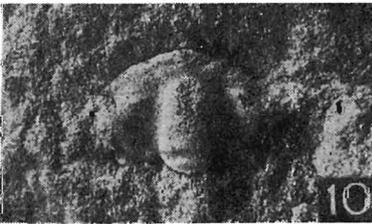
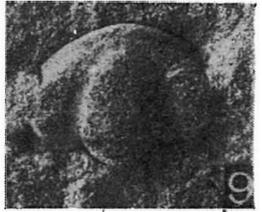
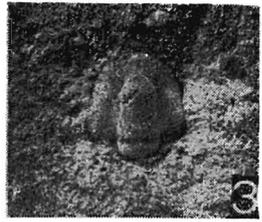
Comluella samsonowiczi (ORŁOWSKI, 1964)

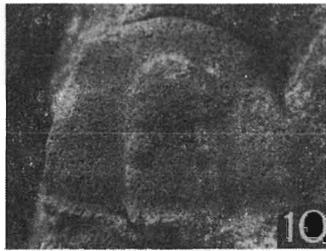
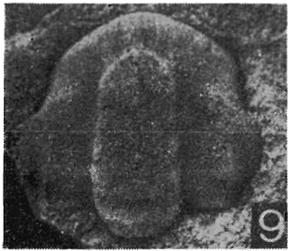
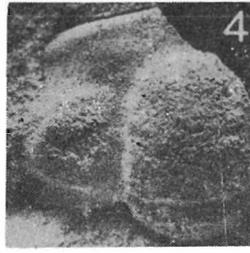
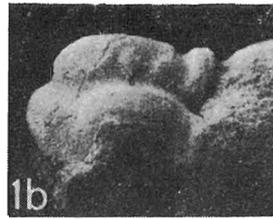
- 7-11 — Cranidia (Nos 2.3319, 2.3207, 2.3815, 2.448, 2.81): 7 and 8 from Sternalice, 9 from Helenów, 10 and 11 from Jugoszków *1*

- 12a-12b — Whole specimen with 13 thoracic segments (No. 2.17): 12a top view, 12b lateral view; Jugoszków *1a*

- 13 — Almost whole specimen (No. 2.1329), Jugoszków *1a*

All photos $\times 2$; taken by K. ZIELIŃSKA





From *C. hupei* (ORŁOWSKI, 1964) the new species differs in shorter and narrower but more convex and more parallel-sided glabella, in lateral glabellar furrows, longer occipital ring and different convexity of fixigenae.

Comluella usarzowi sp. n.

(Text-fig. 4 and Pl. 3, Figs 4—6, Pl. 4, Figs 1—5)

1964a. *Strenuella* (*Comluella*) *samsonowiczi* sp. n.; S. ORŁOWSKI, pp. 83—85, Pl. 8, Figs 8—9, Pl. 9, Figs 2—5.

HOLOTYPE: Cranium (specimen No. 2. 1166) presented in Pl. 4, Fig. 1.

TYPE LOCALITY: Jugoszków-Usarzów section.

TYPE HORIZON: Middle Cambrian, Insularis Zone, Usarzów Sandstone Formation.

DERIVATION OF THE NAME: After the village Usarzów.

MATERIAL: One partly preserved specimen, one cephalon, 25 crania.

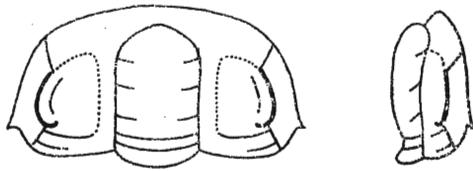
MEASUREMENTS: Small cranium is about 5 mm long and 9 mm broad; large cranium is about 13 mm and 21 mm respectively.

DIAGNOSIS: A *Comluella* with a short and broad cephalon, as well as a short and broad parallel-sided glabella.

DESCRIPTION: Cephalon about twice broad as long, strongly convex, rounded anteriorly. Posterior margin almost straight, posterior margin furrow distinct. Glabella parallel-sided, broad, rounded anteriorly, strongly convex, with three pairs of lateral glabellar furrows, reaching about 4/5 of cranium length. Occipital ring short (*sag.*), rounded posteriorly; occipital furrow distinct.

Fig. 4

Comluella usarzowi sp. n.



Fixigenae moderately convex, separated from glabella by broad (*tr.*) and deep axial furrows. Preglabellar field short, lowering strongly anteriorly. Palpebral lobes long (*exsag.*), palpebral lobe furrow distinct. Librigenae with short spine, situated posterolaterally (*see* Text-fig. 4). Only a part of the thorax with 10 segments is known. Axial part convex, axial furrows distinct. Pleurae with sharp pleural spines, directed backwards. Pygidium unknown.

PLATE 4

Comluella usarzowi sp. n.

1a-1b — Cranium (No. 2.1166 — holotype): 1a top view, 1b lateral view; Jugoszków 1a

2 — Half of cephalon (No. 2.2351), Jugoszków 3

3-5 — Crania (Nos 2.1673, 2.3520, 2.1517): 3 from Jugoszków 1a, 4 from Słowiec Hill, 5 from Jugoszków 7a

Comluella opatowi sp. n.

6-14 — Crania (Nos 2.1823, 2.72, 2.38/5, 2.1875, 2.3820, 2.1810, 2.1751 — holotype, 2.1379, 2.1184): 6, 9, 11-14 from Jugoszków 1a, 7 and 8 from Jugoszków 1, 10 from Słowiec Hill

All photos $\times 2$ (except of Figs 6, 8×4 and Fig. 9×3); taken by K. ZIELIŃSKA

DISCUSSION: The new species is similar to *C. opatowi* sp. n. in parallel-sided glabella, but its glabella is much broader, preglabellar field is shorter and often directed strongly downward, genal spines situated in another position.

From *C. samsonowiczi* (ORŁOWSKI, 1964) the new species differs in the shape of glabella, of occipital furrow, of fixigenae, and by a lack of anterior border on the preglabellar field.

From *C. hupei* (ORŁOWSKI, 1964) the new species differs in parallel-sided glabella and in convexity of fixigenae.

Genus *Paradoxides* BRONGNIART, 1822

Paradoxides polonicus ORŁOWSKI, 1965

(Text-fig. 5a and Pl. 5, Figs 1—5)

1965. *Paradoxides polonicus* (CZARNOCKI); S. ORŁOWSKI, pp. 138—139, Pl. 3, Figs 3—8, Pl. 4, Figs 1—6.

MATERIAL: About 80 cranidia.

REMARKS: Description of this species and its history were given formerly (ORŁOWSKI 1965). Since that time a new material has been collected, composed mainly of cranidia (see Text-fig. 5a). Other fragments of the exoskeleton, such as pygidia, hypostomata, librigenae, and pleurae, are enough common but it is difficult to point their proper specific position because of a lack the whole specimens.

STRATIGRAPHY: Middle Cambrian, Polonicus Zone, Słowiec Sandstone Formation.

Paradoxides slowieensis ORŁOWSKI, 1965

(Text-fig. 5c and Pl. 5, Figs 6—10)

1965. *Paradoxides slowieensis* (CZARNOCKI); S. ORŁOWSKI, pp. 139—140, Pl. 5, Figs 1—6.

MATERIAL: 25 cranidia.

REMARKS: Description of this species and its history were given formerly (ORŁOWSKI 1965). The new material contains mainly cranidia, some of which are very well preserved. On the glabella visible are in some specimens two additional pairs of weakly impressed lateral glabellar furrows (see Text-fig. 5c).

STRATIGRAPHY: Middle Cambrian, Polonicus Zone, Słowiec Sandstone Formation.

Paradoxides socius sp. n.

(Text-fig. 5b and Pl. 6, Figs 1—6)

1965. *Paradoxides* from the *oelandicus* group; S. ORŁOWSKI, pp. 137—138, Pl. 2, Figs 10—11, Pl. 3, Figs 1—2.

HOLOTYPE: Cranidium (specimen No. 2. 2473) presented in Pl. 6, Fig. 5.

TYPE LOCALITY: Słowiec Hill.

TYPE HORIZON: Middle Cambrian, Polonicus Zone, Słowiec Sandstone Formation.

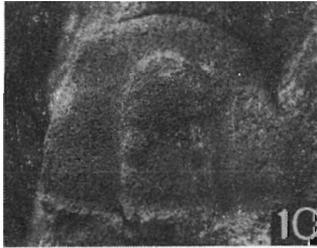
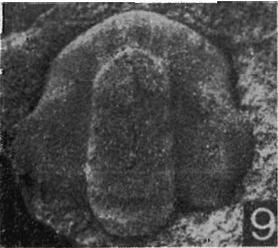
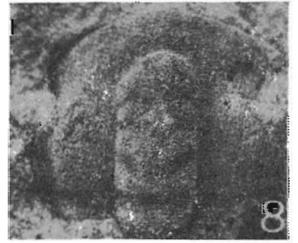
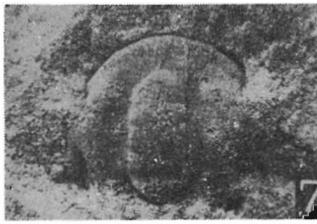
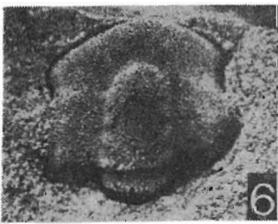
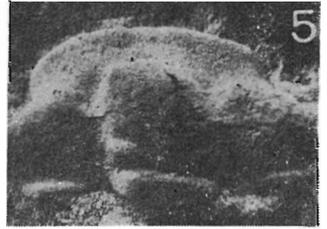
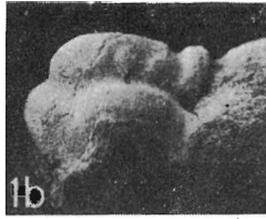
DERIVATION OF THE NAME: From Latin *socius* — together with other species of this genus.

MATERIAL: 15 cranidia, preserved as inner casts.

MEASUREMENTS: The biggest cranidium is 27 mm long and 36 broad.

DIAGNOSIS: A *Paradoxides* with a massive, pyriform glabella, narrow (*tr.*) but long and curved palberal lobes, distinct anterior border, with large anterior area opposite the anterior part of glabella.

DESCRIPTION: Cranidium convex, broader than long. Glabella long, reaching the anterior border furrow, pyriform, broad (*tr.*); its biggest broadness is across the anterior part. Two pairs of lateral glabellar furrows; first pair jointed or almost jointed across the glabella. Occipital ring



From *C. hupei* (ORŁOWSKI, 1964) the new species differs in shorter and narrower but more convex and more parallel-sided glabella, in lateral glabellar furrows, longer occipital ring and different convexity of fixigenae.

Comluella usarzowi sp. n.

(Text-fig. 4 and Pl. 3, Figs 4—6, Pl. 4, Figs 1—5)

1964a. *Strenuella (Comluella) samsonowiczi* sp. n.; S. ORŁOWSKI, pp. 83—85, Pl. 8, Figs 8—9, Pl. 9, Figs 2—5.

HOLOTYPE: Cranium (specimen No. 2. 1166) presented in Pl. 4, Fig. 1.

TYPE LOCALITY: Jugoszów-Usarzów section.

TYPE HORIZON: Middle Cambrian, Insularis Zone, Usarzów Sandstone Formation.

DERIVATION OF THE NAME: After the village Usarzów.

MATERIAL: One partly preserved specimen, one cephalon, 25 cranidia.

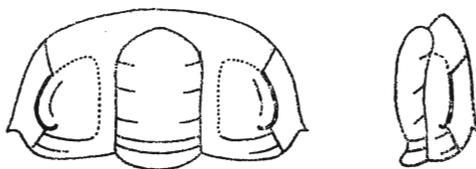
MEASUREMENTS: Small cranium is about 5 mm long and 9 mm broad; large cranium is about 13 mm and 21 mm respectively.

DIAGNOSIS: A *Comluella* with a short and broad cephalon, as well as a short and broad parallel-sided glabella.

DESCRIPTION: Cephalon about twice broad as long, strongly convex, rounded anteriorly. Posterior margin almost straight, posterior margin furrow distinct. Glabella parallel-sided, broad, rounded anteriorly, strongly convex, with three pairs of lateral glabellar furrows, reaching about 4/5 of cranium length. Occipital ring short (*sag.*), rounded posteriorly; occipital furrow distinct.

Fig. 4

Comluella usarzowi sp. n.



Fixigenae moderately convex, separated from glabella by broad (*tr.*) and deep axial furrows. Preglabellar field short, lowering strongly anteriorly. Palpebral lobes long (*exsag.*), palpebral lobe furrow distinct. Librigenae with short spine, situated posterolaterally (*see* Text-fig. 4). Only a part of the thorax with 10 segments is known. Axial part convex, axial furrows distinct. Pleurae with sharp pleural spines, directed backwards. Pygidium unknown.

PLATE 4

Comluella usarzowi sp. n.

1a-1b — Cranium (No. 2.1166 — holotype): 1a top view, 1b lateral view; Jugoszów 1a

2 — Half of cephalon (No. 2.2351), Jugoszów 3

3-5 — Cranidia (Nos 2.1673, 2.3520, 2.1517): 3 from Jugoszów 1a, 4 from Słowiec Hill, 5 from Jugoszów 7a

Comluella opatowi sp. n.

6-14 — Cranidia (Nos 2.1823, 2.72, 2.38/5, 2.1875, 2.3820, 2.1810, 2.1751 — holotype, 2.1379, 2.1184): 6, 9, 11-14 from Jugoszów 1a, 7 and 8 from Jugoszów 1, 10 from Słowiec Hill

All photos $\times 2$ (except of Figs 6, 8×4 and Fig. 9×3); taken by K. ZIELIŃSKA

DISCUSSION: The new species is similar to *C. opatowi* sp. n. in parallel-sided glabella, but its glabella is much broader, preglabellar field is shorter and often directed strongly downward, genal spines situated in another position.

From *C. samsonowiczi* (ORŁOWSKI, 1964) the new species differs in the shape of glabella, of occipital furrow, of fixigenae, and by a lack of anterior border on the preglabellar field.

From *C. hupei* (ORŁOWSKI, 1964) the new species differs in parallel-sided glabella and in convexity of fixigenae.

Genus *Paradoxides* BRONGNIART, 1822
***Paradoxides polonicus* ORŁOWSKI, 1965**
(Text-fig. 5a and Pl. 5, Figs 1—5)

1965. *Paradoxides polonicus* (CZARNOCKI); S. ORŁOWSKI, pp. 138—139, Pl. 3, Figs 3—8, Pl. 4, Figs 1—6.

MATERIAL: About 80 cranidia.

REMARKS: Description of this species and its history were given formerly (ORŁOWSKI 1965). Since that time a new material has been collected, composed mainly of cranidia (see Text-fig. 5a). Other fragments of the exoskeleton, such as pygidia, hypostomata, librigenae, and pleurae, are enough common but it is difficult to point their proper specific position because of a lack the whole specimens.

STRATIGRAPHY: Middle Cambrian, Polonicus Zone, Słowiec Sandstone Formation.

***Paradoxides slowiecensis* ORŁOWSKI, 1965**
(Text-fig. 5c and Pl. 5, Figs 6—10)

1965. *Paradoxides slowiecensis* (CZARNOCKI); S. ORŁOWSKI, pp. 139—140, Pl. 5, Figs 1—6.

MATERIAL: 25 cranidia.

REMARKS: Description of this species and its history were given formerly (ORŁOWSKI 1965). The new material contains mainly cranidia, some of which are very well preserved. On the glabella visible are in some specimens two additional pairs of weakly impressed lateral glabellar furrows (see Text-fig. 5c).

STRATIGRAPHY: Middle Cambrian, Polonicus Zone, Słowiec Sandstone Formation.

***Paradoxides socius* sp. n.**
(Text-fig. 5b and Pl. 6, Figs 1—6)

1965. *Paradoxides* from the *oelandicus* group; S. ORŁOWSKI, pp. 137—138, Pl. 2, Figs 10—11, Pl. 3, Figs 1—2.

HOLOTYPE: Cranidium (specimen No. 2. 2473) presented in Pl. 6, Fig. 5.

TYPE LOCALITY: Słowiec Hill.

TYPE HORIZON: Middle Cambrian, Polonicus Zone, Słowiec Sandstone Formation.

DERIVATION OF THE NAME: From Latin *socius* — together with other species of this genus.

MATERIAL: 15 cranidia, preserved as inner casts.

MEASUREMENTS: The biggest cranidium is 27 mm long and 36 broad.

DIAGNOSIS: A *Paradoxides* with a massive, pyriform glabella, narrow (*tr.*) but long and curved palberal lobes, distinct anterior border, with large anterior area opposite the anterior part of glabella.

DESCRIPTION: Cranidium convex, broader than long. Glabella long, reaching the anterior border furrow, pyriform, broad (*tr.*); its biggest broadness is across the anterior part. Two pairs of lateral glabellar furrows; first pair jointed or almost jointed across the glabella. Occipital ring



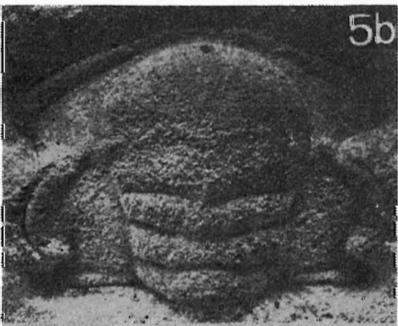
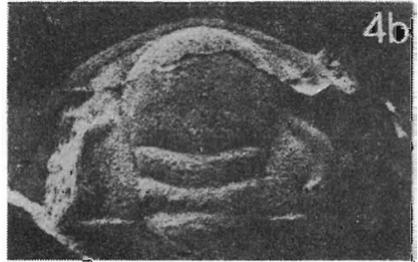
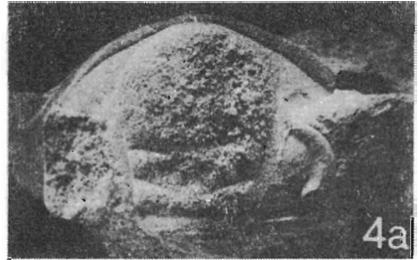
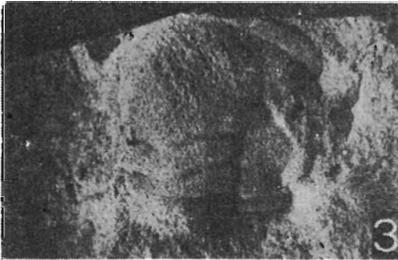
Paradoxides polonicus ORŁOWSKI, 1965

1-5 — Cranidia (Nos 2.3713, 2.222, 2.241, 2.3709, 2.3708), Słowiec Hill

Paradoxides slowiecensis ORŁOWSKI, 1965

6-10 — Cranidia (Nos 2.3698, 2.258, 2.268, 2.3691, 2.250), Słowiec Hill

All photos $\times 2$ (except of Fig. 6 — natural size); taken by K. ZIELIŃSKA



Paradoxides socius sp. n.

1-6 — Cranidia (Nos 2.3674, 2.317, 2.266, 2.3672, 2.2473 — holotype, 2.3681), Słowiec Hill;
4b latex cast

All photos in natural size (except of Figs 5b, 6×2); taken by K. ZIELIŃSKA

smooth, slightly rounded posteriorly; occipital furrow distinct, composed (*see* Text-fig. 5b). Fixigenae flat, narrower than glabella, across palpebral lobes. Palpebral lobes rather narrow (*tr.*), curved, anteriorly directed toward the glabella. Palpebral furrow distinct. Preglabellar area very short (*sag.*). Anterior border distinct, elevated, narrower before the glabella. Anterior border furrow distinct. Large anterior area is placed laterally to anterior part of glabella. Posterior branch of facial suture short, anterior branch much longer, directed antero-laterally from the eye.

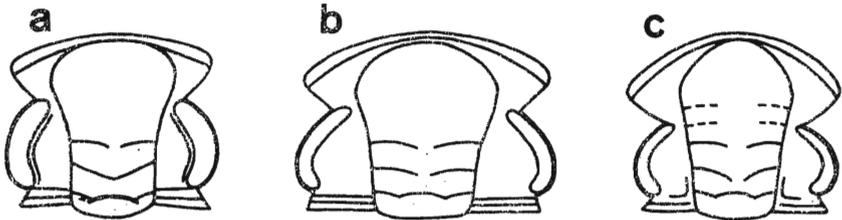


Fig. 5. Comparison of the three allied *Paradoxides* species:

- a — *Paradoxides polonicus* ORŁOWSKI, 1965
 b — *Paradoxides socius* sp. n.
 c — *Paradoxides slowieensis* ORŁOWSKI, 1965

DISCUSSION: The new species is similar (*see* ŠNAJDR 1958) to *Acadoparadoxides sacheri* (BARRANDE) in the shape of cranium, but it differs in narrower (*tr.*) palpebral lobes and longer posterior branch of facial suture, that is in the features upon which ŠNAJDR (1958) established the genus *Acadoparadoxides*.

The new species is also similar to *Paradoxides sacheri* var. *jacutica* SOLOVYEV, 1969, from the Amga Stage in Siberia, but it differs in shorter (*sag.*) and more inflated anterior border.

The new species differs very much from *P. polonicus* ORŁOWSKI, 1965; in the shape of glabella and cranium, narrower (*tr.*) and shorter palpebral lobes, broader (*tr.*) fixigenae, and in more distinct anterior border.

From *P. slowieensis* ORŁOWSKI, 1965, the new species differs in much broader (*tr.*) glabella, broader fixigenae, and in the shape of anterior border.

The new species is a bit similar to *P. mureoensis* SDZUY, 1958, but it differs in the shape of glabella, broader (*tr.*) fixigenae, longer palpebral lobes and in the shape of anterior border.

Genus *Kootenia* WALCOTT, 1888

Kootenia enigmatica sp. n.

(Text-fig. 6 and Pl. 7, Figs 14—15)

HOLOTYPE: Pygidium (specimen No. 2. 3590) presented in Pl. 7, Fig. 14.

TYPE LOCALITY: Slowiec Hill.

TYPE HORIZON: Middle Cambrian, Polonicus Zone, Slowiec Sandstone Formation.

DERIVATION OF THE NAME: From Latin *enigmatica* — known only as pygidia.

MATERIAL: Three pygidia.

DIAGNOSIS: Pygidium semioval with a narrow but well visible border, six pairs of marginal spines, five axial rings with short spines or nodes.

DESCRIPTION: Pygidium semioval, convex, with narrow but well marked border and six pairs of short but sharp marginal spines directed backwards, except of the anterior pair directed postero-laterally. Axial part convex, reaching the posterior border, slightly narrowing posteriorly;

its posterior part rounded. Width of axial part is slightly less than 1/3 of pygidium width. Five axial rings, the first four of which bear short spine or nodes. Articulating half-ring well marked. Axial furrows distinct. Pleural field with four broad and shallow furrows (see Text-fig. 6).

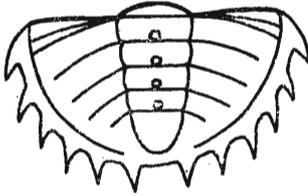


Fig. 6

Kootenia enigmatica sp. n.

DISCUSSION: The genus *Kootenia* is very rare in the Middle Cambrian of Europe but it is very common in the Cambrian of Asia and North America. In Europe, *Kootenia* sp. was mentioned by BERG-MODSEN (1981) from the Middle Cambrian of Bornholm.

The new species is near to *Kootenia florens* SUVOROVA, 1964, but it differs in slightly narrower axial part, smaller spines on axial rings, narrower border, and in longer marginal spines.

The new species is similar to *Kootenia sibirica* LERMONTOVA, 1940, but its axial part and border are narrower.

Genus *Solenopleura* ANGELIN, 1854

Solenopleura cf. *canaliculata* (ANGELIN, 1851)

(Pl. 7, Fig. 13)

REMARKS: Cranidium preserved as an internal cast, about 9 mm long, displays diagnostic features well comparable to those (see WESTERGÅRD 1953, pp. 19—21, Pl. 5, Figs 1—5) of *Solenopleura canaliculata* (ANGELIN). These are: the shape of cranidium and its convexity, the shape of anterior border and glabella, position of palpebral lobes and eye ridges, the shape of facial suture. The investigated specimen differs only in a little longer glabella. Lateral glabellar furrows and granulation of the test are not visible because of the absence of the exoskeleton.

HORIZON and LOCALITY: The species *Solenopleura canaliculata* is known from Sweden (Scania, Jämtland) and Denmark (Bornholm) from the *Solenopleura brachymetopa* (C_2) Zone of the *Paradoxides forchhammeri* Stage. In the Holy Cross Mountains, *Solenopleura* cf. *canaliculata* was found in sandstone intercalations of the alum shales at Pączek Hill.

Solenopleura minima sp. n.

(Text-fig. 7 and Pl. 7, Figs 1—8)

1965. *Agraulos* sp.; S. ORŁOWSKI, pp. 142—143, Pl. 1, Figs 13—17, Pl. 7. Fig. 5.

HOLOTYPE: Cranidium (specimen No. 2. 275) presented in Pl. 7, Fig. 1.

TYPE LOCALITY: Słowiec Hill.

TYPE HORIZON: Middle Cambrian, Polonicus Zone, Słowiec Sandstone Formation.

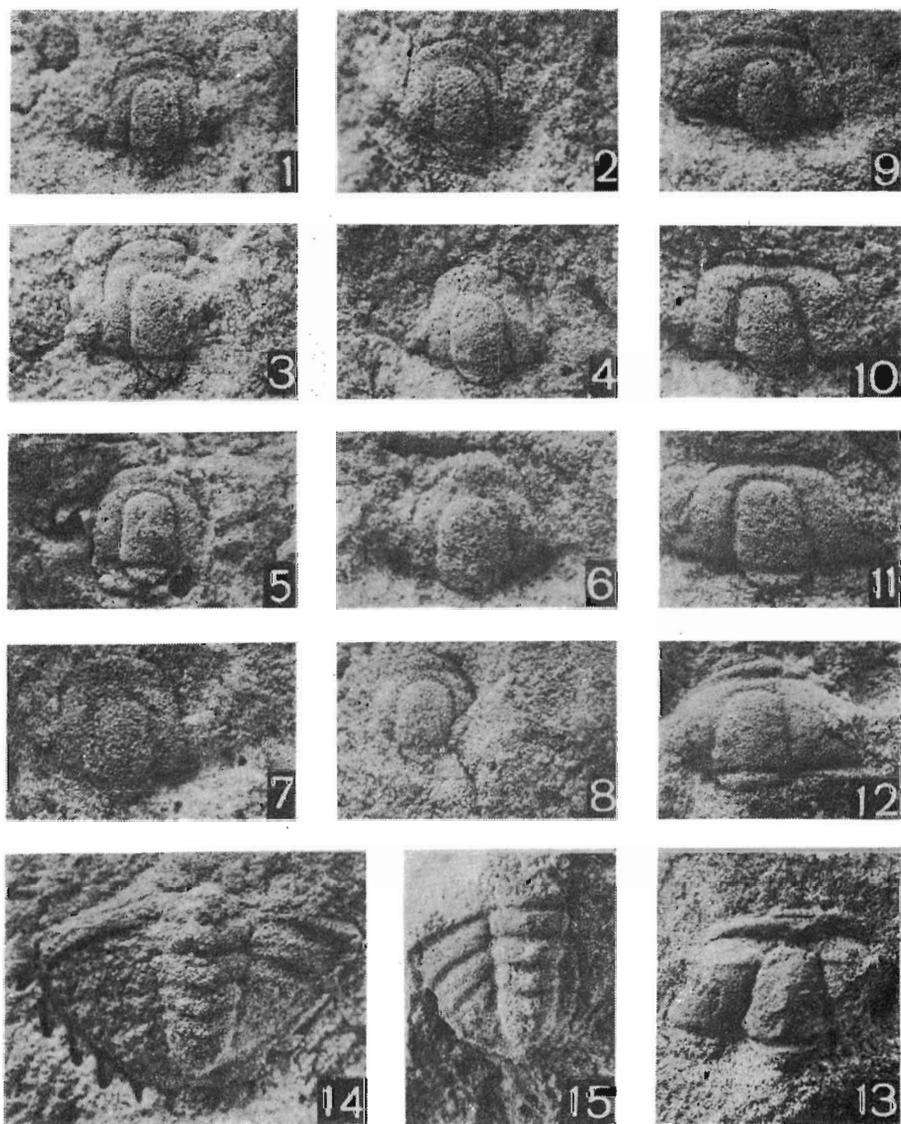
DERIVATION OF THE NAME: After a small size of cranidium.

MATERIAL: 29 cranidia.

MEASUREMENTS: Cranidium length of the holotype is about 4.5 mm, width along posterior border is about 4 mm; the largest specimen is about 5.5 mm long and 7 mm broad.

DIAGNOSIS: A *Solenopleura* with a very convex, anteriorly rounded cranidium, very convex parallel-sided to slightly tapering glabella, and the occipital ring triangular posteriorly.

DESCRIPTION: Cranidium small, strongly convex, slightly broader than long, rounded anteriorly. Glabella parallel-sided to slightly tapering, rounded anteriorly, convex, reaching about 2/3 of cranidium length. Axial furrows distinct. One pair of lateral glabellar furrows visible on



Solenopleura minima sp. n.

- 1-8 — Cranidia (Nos 2.275 — holotype, 2.3659, 2.3668, 2.3660, 2.3667, 2.3658, 2.3666, 2.3657), Słowiec Hill

Solenopleura trapezoides sp. n.

- 9-12 — Cranidia (Nos 2.3605, 2.3596, 2.3603 — holotype, 2.263), Słowiec Hill

Solenopleura cf. *canaliculata* (ANGELIN, 1851)

- 13 — Cranidium (No. 2.3593), Pączek Hill

Kootenia enigmatica sp. n.

- 14-15 — Pygidia (Nos 2.3590 — holotype, 2.3591), Słowiec Hill

All photos $\times 3$ (except of Figs 12—15 $\times 2$); taken by K. ZIELIŃSKA.

the posterior part of glabella. Occipital ring triangular posteriorly, occipital furrow distinct. Pre-glabellar field distinct, reaching about 1/3 of cranium length. Anterior border distinct, long (*sag.*), slightly convex; anterior border furrow distinct (*see* Text-fig. 7). Fixigenae strongly elevated on the level of palpebral lobes, posterior part strongly depressed. Palpebral lobe small (*exsag.*) situated

Fig. 7
Solenopleura minima sp. n.



opposite the middle of glabella. Eye ridges faintly marked, directed to the anterior part of glabella. Posterior margin straight, posterior margin furrow distinct. Posterior branch of facial suture long, straight and directed postero-laterally, anterior branch slightly convergent. Thorax, pygidium, and librigenae unknown.

DISCUSSION: The new species is similar to *Solenopleura limarssoni* (BRÖGGER) but its glabella is more convex and parallel-sided, preglabellar field is longer, and anterior branch of facial suture less convergent.

Solenopleura trapezoides sp. n.
(Text-fig. 8 and Pl. 7, Figs 9—12)

HOLOTYPE: Cranium (specimen No. 2. 3603) presented in Pl. 7, Fig. 11.

TYPE LOCALITY: Stowiec Hill.

TYPE HORIZON: Middle Cambrian, Polonicus Zone, Stowiec Sandstone Formation.

DERIVATION OF THE NAME: After a trapezoidal shape of the glabella.

MATERIAL: 16 cranidia preserved as internal and external casts.

MEASUREMENTS: Cranium length of the holotype is about 6 mm, width along posterior margin about 9 mm; the largest cranium is 11 mm long and about 16 mm broad.

DIAGNOSIS: A *Solenopleura* with a trapezoidal and strongly convex glabella, small eyes situated opposite the middle of glabella, and eye ridges directed to the anterior part of glabella.

DESCRIPTION: Cranium convex, trapezoidal; anterior margin slightly rounded. Glabella convex, slightly trapezoidal, truncate or slightly rounded in the front, reaching more than 2/3 of cranium length. Three pairs of lateral glabellar furrows. Occipital ring short (*sag.*), rounded posteriorly; occipital furrow distinct, straight. Axial furrows narrow, deep, joined in the front

Fig. 8
Solenopleura trapezoides sp. n.



of glabella. Preglabellar field lowering anteriorly. Anterior border convex, narrowing laterally, anterior border furrow distinct. Fixigenae convex, with anterior part strongly depressed. Palpebral lobes small, situated opposite the middle of glabella. Eye ridges well marked, directed to the anterior part of glabella. Posterior margin straight, posterior margin furrow distinct. Anterior branch of facial suture straight or slightly convergent, posterior branch directed postero-laterally, curved near the posterior margin (*see* Text-fig. 8). Thorax, pygidium, and librigenae unknown.

DISCUSSION: The new species is similar to *Solenopleura brachymetropa* (ANGELIN), in the outline of cranium, but it differs in trapezoidal glabella, which is more convex and longer,

and in axial furrows which are distinct in the front of glabella too. Eyes are situated more forwardly, and fixigenae are narrower.

From *S. minima* sp. n. the new species differs in the outline of cranium, in the shape of glabella and occipital ring, in the shape of preglabellar field, and in the course of posterior branch of facial suture.

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S. ORŁOWSKI

NOWE DANE O TRYLOBITACH I STRATYGRAFII KAMBRU ŚRODKOWEGO GÓR
ŚWIĘTOKRZYSKICH

(Streszczenie)

W pracy niniejszej dokonano krytycznego przeglądu rodzajów i gatunków trylobitów pochodzących z utworów kambru środkowego Gór Świętokrzyskich (patrz fig. 1), a opisanych wcześniej przez autora (ORŁOWSKI 1959a, b, 1964a, 1965) oraz przez BEDNARCZYKA (1970). Wśród badanego materiału ustanowiono 6 gatunków nowych (patrz fig. 2—8 oraz pl. 1—7): *Comluella opatowi* sp. n., *Comluella usarzowi* sp. n., *Paradoxides socius* sp. n., *Kootenia enigmatica* sp. n., *Solenopleura minima* sp. n., *Solenopleura trapezoides* sp. n.

Oznaczono także *Solenopleura* cf. *canaliculata*, oraz przez analogię z kambrem Szwecji gatunek ten uznano za przewodni dla najwyższego poziomu biostratygraficznego kambru środkowego Gór Świętokrzyskich.
