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VERSITA

The oldest Cambrian trilobites from the Holy Cross Mountains, Poland: taxonomic, stratigraphic and biogeographic reappraisal

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ABSTRACT:

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Authorship issues are clarified, new photographic documentation is provided and emended systematic descriptions are presented for the oldest Cambrian trilobite taxa from the Holy Cross Mountains (Poland). Biostratigraphic analysis of the fauna allows correlation with the traditional *Holmia kjerulfi*-group Zone of Scandinavia, the *Callavia* Zone of Britain and Newfoundland, the lower and middle part of the *Sectigena* Zone of Morocco and the Marianian Stage of Spain. The trilobites display a strong biogeographic signal linked with West Gondwana and Avalonia and a suggestion is made that the TESZ margin of Baltica with the Małopolska Massif was liable to currents from those areas that distributed planktonic trilobite larvae.

Keywords: Ellipsocephalidae; Holmiidae; Cambrian Series 2; Stratigraphy; Biogeography; Holy Cross Mountains; Trilobita.

INTRODUCTION

The oldest Cambrian trilobite faunas of the Holy Cross Mountains, Poland, have been known since 1917, when Jan Samsonowicz discovered fine-grained, fossiliferous sandstones along the Koprzywianka River in the vicinity of Gieraszowice in the far south-east of the area (Samsonowicz 1918, 1920); although some trilobites seem to have been found as early as in 1915 (see discussion under *Strenuella polonica* Czarnocki, 1926 in the systematic part). Subsequent papers provided lists of trilobites, even new species names, and tied associated fauna to particular lithologies (Czarnocki 1919, 1926, 1927a, b, 1932, 1933). Unfortunately, the taxa were never described or illustrated by their authors. Many of the trilobite names given in these reports must be treated as *nomina nuda* because of the loss of a large part of the original collections housed in the Museum of the Polish Geological Institute in Warsaw during the Warsaw Uprising in 1944. The first illustrations and descriptions, based partly on the original specimens, were presented by Samsonowicz (1959a, b, c, and in the posthumous paper, Samsonowicz 1962, prepared from his manuscripts). In these papers, a number of species mentioned by Czarnocki (*op. cit.*) were retained as valid because the original specimens were found with appropriate museum labels. This original authorship usually remained, however, unrecognized in later reports (Bergström 1973b; Orłowski 1974, 1985a; Geyer 1990b).

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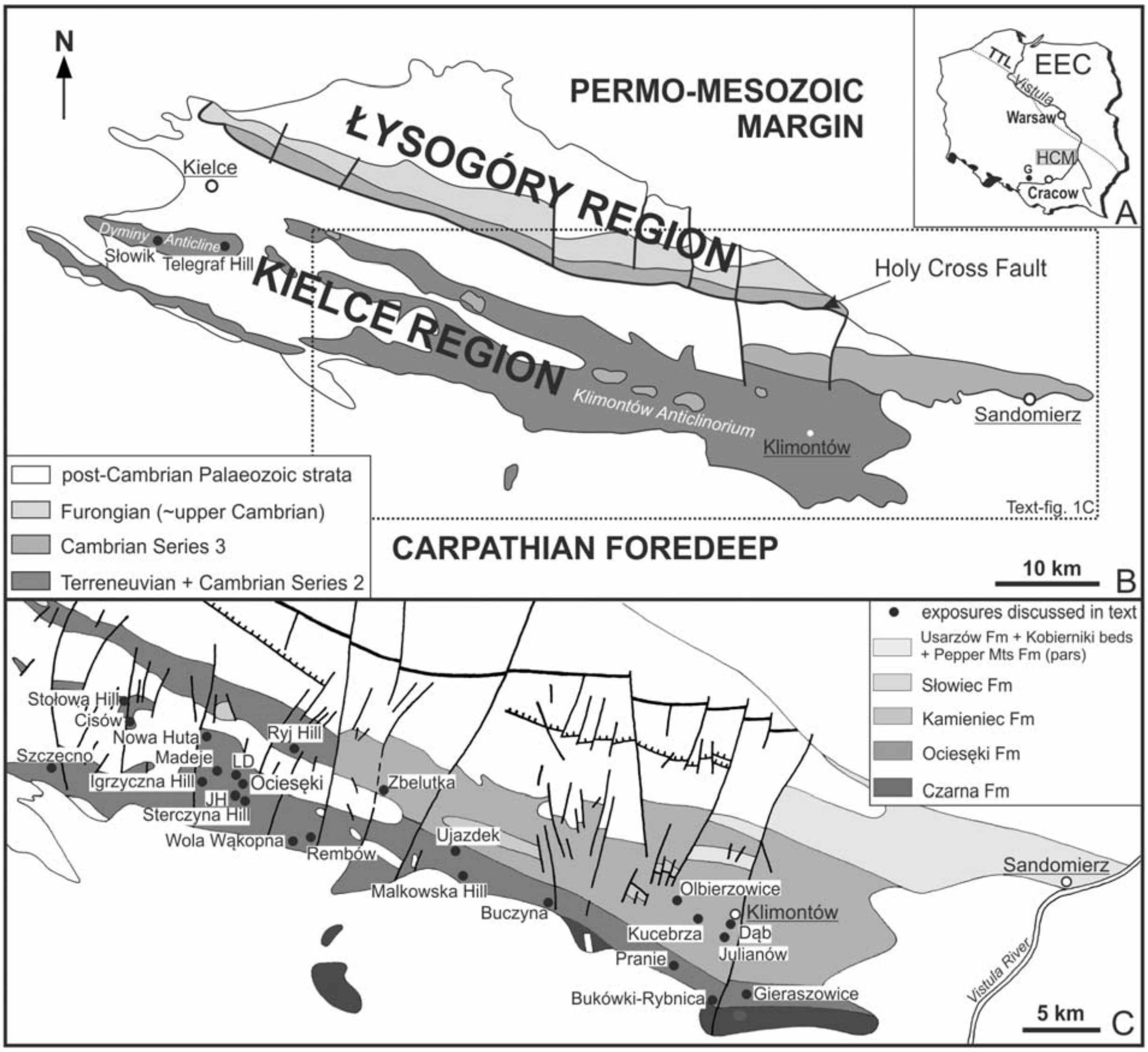
This paper clarifies the authorship issues for the oldest known Cambrian trilobite taxa from the Holy Cross Mountains, provides new photographic documentation and supplies emended systematic descriptions for some of them. Moreover, the stratigraphic significance of this fauna is discussed in detail as well as in terms of diversity and biogeographic significance, thus supplementing new stratigraphic and biogeographic conclusions on Cambrian trilobites in the southern part of the Holy Cross Mountains (Kielce Region) (Żylińska and Masiak 2007; Żylińska and Szczepanik 2009). Two ellipsocephalid species from this fauna have been recently revised and assigned to *Berabichia oratrix* (Orłowski, 1985a), based on bi- and multivariate analysis of morphometric parameters and graphic techniques (Żylińska *et al.* in press).

GEOLOGICAL SETTING

The Holy Cross Mountains (HCM) represent one of the very few areas in Europe that expose Palaeozoic rocks in the direct vicinity of the Teisseyre–Tornquist Line (Text-fig. 1A), with its basement forming a part of the Trans-European Suture Zone (TESZ; Berthelsen 1992), an important geotectonic domain separating the Precambrian East European Craton (EEC) from the Palaeozoic fold-belts of central and western Europe. This WNW–



Text-fig. 1. (A) Sketch-map of Poland with location of the Holy Cross Mountains (HCM) in relation to the East European Craton (EEC) and Teisseyre–Tornquist Line (TTL). Black dot with "G" marks the Goczałkowice IG-1 borehole. (B) Geological sketch-map of the HCM showing the distribution of Cambrian deposits, modified from Orłowski (1975b, 1992). (C) Geological sketch-map of the Klimontów Anticlinorium with the Cambrian lithostratigraphic formations and location of exposures yielding the oldest known trilobites, compiled and modified from Samsonowicz (1962) and Orłowski and Mizerski (1995). LD – Leśniakowa Dębina, JH – Jaźwina Hill

ESE-oriented, 70 km long and 50 km wide hilly area, is located in south-central Poland (Text-fig. 1B). The morphology follows the tectonic structure of the area, with the orientation of the particular hilly ranges corresponding closely to the orientation of the main anticlines and synclines in the Palaeozoic core of the Mountains. The area was subjected to multi-stage evolution, in which the Late Cretaceous–Early Palaeogene tectonic inversion and uplift that resulted in partial removal of Permian and Mesozoic strata and exposure of the Palaeozoic, was one of the last structural events (Kutek and Głazek 1972; Krzywiec *et al.* 2009). The latest marine influence in the HCM was in the Miocene, when the sea of the Carpathian Foreland basin encroached on the southern margins of the area (e.g., Radwański 1969).

Different facies development, stratigraphy and tectonic evolution have resulted in the subdivision of the Palaeozoic of the HCM into two regions: the southern, Kielce Region, located on the northern part of the Małopolska Block, and the northern, Łysogóry Region, located on the Łysogóry Block, separated by the WNW–ESE-oriented Holy Cross Fault (e.g., Czarnocki 1919). These regions were considered to be tectonostratigraphic units (e.g., Czarnocki 1919). Recent studies point to their palaeogeographic character (e.g., Belka *et al*. 2000, 2002; Nawrocki and Poprawa 2006 and publications referenced therein), with contrasting views on whether they are of proximal or exotic provenance with regard to the palaeocontinent of Baltica. These ambiguous views on the nature of both blocks result from inconsistent information on their composition, provenance of detrital material and the biogeographic signature of faunas in their sedimentary cover. Recent geophysical data indicate that both blocks have a similar crustal composition, comparable to that of the EEC (Malinowski *et al.* 2005); according to Nawrocki *et al.* (2007), they represent proximal terranes relocated along the TESZ margin of the Baltica palaeocontinent.

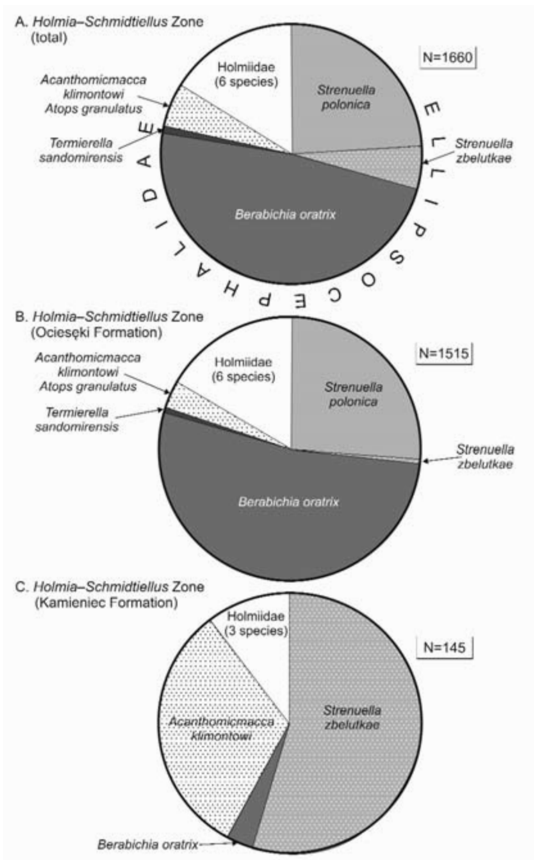
The Cambrian strata in the HCM are composed of siliciclastic facies with an estimated thickness of 2500–3500 m (e.g. Orłowski 1988). The trilobites studied come from the Kielce Region, where the source strata are exposed within the Klimontów Anticlinorium, a Variscan structural unit that covers almost half of the area (Text-fig. 1B, C). A few specimens come from two exposures within the Dyminy Anticline, in the western part of the Kielce Region (Text-fig. 1B). The fossils were encountered in two formations, i.e. the Ociesęki Sandstone, cropping out in the south-easternmost, southern and western part of the area, and the Kamieniec Shale, occurring in the central and eastern part of the unit (Text-fig. 1B, C). The Ociesęki Formation includes fine-grained sandstones and siltstones, often strongly bioturbated, with thin claystone intercalations (Orłowski 1975b; Kowalczewski *et al.* 2006), representing shallow-marine settings as indicated by sedimentary structures and ichnofossils (Studencki 1988; Orłowski 1989, 1992; Mizerski *et al.* 1999; Orłowski and Żylińska 2002). The Kamieniec Formation is clay- and siltstone-dominated with thin intercalations of fine-grained, non-bioturbated sandstones (Orłowski 1975b; Orłowski and Mizerski 1995); its sedimentary structures and the few ichnofossils point to an outer shelf setting below the storm wave base (Studencki 1988; Mizerski *et al.* 1991).

COMPOSITION OF THE FAUNAS

The fauna under discussion is composed of six taxa representing the Holmiidae [*Holmia marginata* Orłowski, 1974; *H. glabra* Orłowski, 1974; *Schmidtiellus panowi* (Samsonowicz, 1959a); *S. nodosus* Orłowski, 1985a; *Kjerulfia orcina* Orłowski, 1974; *Postfallotaspis spinatus* Orłowski, 1985a], four taxa representing the Ellipsocephalidae [*Strenuella polonica* Czarnocki, 1926; *S. zbelutkae* Orłowski, 1985a; *Berabichia oratrix* (Orłowski, 1985a); *Termierella sandomirensis* Samsonowicz, 1962], one taxon of the Chengkouiidae (*Acanthomicmacca klimontowi* Orłowski, 1985a), and one taxon of the Atopidae (*Atops granulatus* Orłowski, 1985c) (see Żylińska *et al.* in press, and systematic part below) (Text-fig. 2). The abundance of particular taxa in the material, reaching over 1600 specimens, varies considerably. The fauna is dominated by the Ellipsocephalidae, composing 78% of the material (Text-fig. 3A). Holmiids, including the zone-indicative genera, constitute only 16% of the material. Representatives of the chengkouiids and atopids comprise the remaining 6%. Of the four species of the Ellipsocephalidae, the dominant one is *Berabichia oratrix* (see Żylińska *et al.* in press, for an emended diagnosis of this species), with the Berger-Parker index of dominance for the whole material being 0.48 (Hammer and Harper 2006). The composition of faunas representing particular formations varies. The composition of the fauna from the Ociesęki Formation (1 in Text-fig. 4) more or less corresponds to that of all the material (Text-fig. 3B). However, the composition of the fauna from the Kamieniec Formation (2 in Text-fig. 4) differs considerably (Text-fig. 3C); represented by 145 specimens, it comprises only six species (Berger-Parker index of 0.55): *Strenuella zbelutkae* (55%), *Acanthomicmacca klimontowi* (32%), *Berabichia oratrix* (3%) and three species of Holmiidae (10%). The presence in the Kamieniec Formation of a different species of *Strenuella*, i.e.

family	taxa \ localities	Słowik	Telegraf Hill	Szczecno	Stołowa Hill	Cisów	Igrzyczna Hill	Nowa Huta	Madeje	Jaźwina Hill	Leśniakowa Dębina	Sterczyna Hill	Ociesęki	Ryj Hill	Wola Wąkopna	Rembów	Zbelutka	Ujazdek	Malkowska Hill	Buczyna	Pranie	Olbierzowice	Kucebrza	Bukówki-Rybnica	Julianów	Dąb	Gieraszowice
Ellipsocephalidae	*Berabichia oratrix*	+	+			+	+	+			+	+	+			+	+	+	+	+	+						
	Strenuella polonica						+		+	+	+	+				+	+				+						
	Strenuella zbelutkae										+		+				+									+	
	Termierella sandomirensis																										+
Holmiidae	*Holmia glabra*												+														
	Holmia marginata			+	+		+				+	+	+		+				+							+	
	Holmia sp.					+							+						+	+	+		+			+	+
	Kjerulfia orcina								+		+	+	+		+				+	+						+	
	Postfallotaspis spinatus						+																				
	Schmidtiellus nodosus						+				+	+							+		+						
	Schmidtiellus panowi										+					+										+	+
other	*Acanthomicmacca klimontowi*						+						+		+		+					+	+		+	+	
	Atops granulatus										+	+															

Text-fig. 2. Distribution of trilobite taxa (grouped into families) in the particular localities arranged from west to east. Localities in the Kamieniec formation are marked in grey



Text-fig. 3. Pie-chart showing the abundance of particular taxa in the *Holmia–Schmidtiellus* Assemblage Zone. A – total; B – Ociesęki formation, C – Kamieniec formation. Grey shades mark representatives of the Ellipsocephalidae

S. zbelutkae instead of *S. polonica*, which is very abundant in the Ociesęki Formation, as well as the extremely low representation of *Berabichia oratrix*, known from almost every exposure of the Ociesęki Formation in the studied interval, may suggest a common, e.g. environmental, factor influencing the distribution of particular trilobite species in both formations.

BIOSTRATIGRAPHIC ANALYSIS

Both formations with the oldest trilobite faunas are relatively well-constrained in the local zonal scheme for the HCM (Text-fig. 4). The Ociesęki Formation ranges from the lowermost *Holmia–Schmidtiellus* Assemblage Zone through the *Protolenus–Issafeniella* Zone of Cambrian Series 2 up to the *Eccaparadoxides insularis* Zone of Cambrian Series 3; and the Kamieniec Formation ranges from the *Holmia–Schmidtiellus* Assemblage Zone to the *Protolenus–Issafeniella* Zone of Cambrian Series 2 (Orłowski 1974, 1985a, b; Mizerski *et al.* 1986; Żylińska and Szczepanik 2009).

The *Holmia–Schmidtiellus* Assemblage Zone was established by Orłowski (1987); previously this interval was referred to the *Holmia* Zone (e.g. Samsonowicz 1962; Orłowski 1975b, 1985a). Its *Holmia* representatives, i.e. *H. marginata* and *H. glabra*, show great similarity to *H. kjerulfi* (Linnarsson, 1871), the index taxon of the traditional *Holmia kjerulfi*-group Zone of

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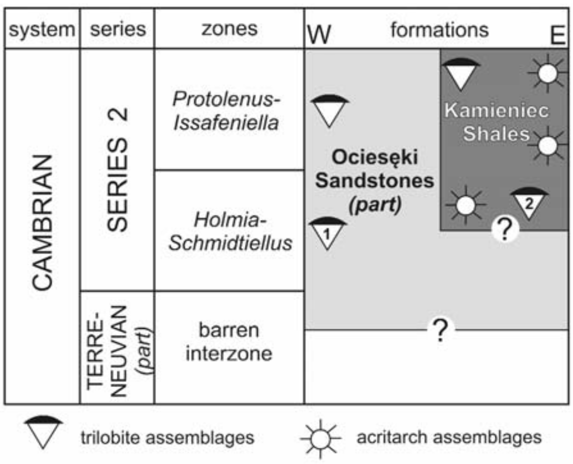
Scandinavia (Bergström and Ahlberg 1981; Ahlberg *et al*. 1986) or the upper part of the *Holmia kjerulfi* Assemblage Zone of Moczydłowska (1991), and it is commonly accepted that the *Holmia*-bearing beds of the HCM correspond to that part of Cambrian Series 2 in Scandinavia (Bergström 1973b; Bergström and Ahlberg 1981; Ahlberg *et al.* 1986; Ebbestad *et al.* 2003). Other holmiids that co-occur with *Holmia* include *Schmidtiellus panowi* and *S. nodosus*. In Scandinavia, *Schmidtiellus* Moberg (in Moberg and Segerberg 1906) appears in the oldest trilobite zone, i.e. in the traditional *Schmidtiellus mickwitzi* Zone (Bergström 1981; Ahlberg *et al.* 1986). However, based on sequence stratigraphy, the strata yielding this genus were shown to correlate with the traditional *Holmia kjerulfi*-group Zone (Nielsen and Schovsbo 2011). Species of *Kjerulfia* Kiær, 1917 occur in Scandinavia in the traditional *Holmia kjerulfi*-group Zone (Kiær 1917; Ahlberg *et al.* 1986; Ebbestad *et al.* 2003). In a recently proposed revised biostratigraphic scheme for the lower Cambrian of Scandinavia, based on sequence stratigraphy, the traditional *Holmia kjerulfi*-group Zone is now interpreted as the lower part of the *H. kjerulfi*–'*O.*' *linnarssoni* Zone (see discussion in Nielsen and Schovsbo 2011). A strange and still poorly known holmiid of the *Holmia*–*Schmidtiellus* Assemblage Zone is *Postfallotaspis spinatus.* It seems quite similar (see systematic part below) to the poorly known holmiid *Iyouella* Geyer and Palmer, 1995, from the *Sectigena* Zone of Morocco (Geyer and Palmer 1995), which corresponds to the upper part of the



Text-fig. 4. Stratigraphic occurrence of trilobite faunas and acritarch assemblages in Cambrian Series 2 strata of the Ociesęki and Kamieniec formations. Trilobite and acritarch assemblages from the *Protolenus*–*Issafeniella* Zone were defined and described in Żylińska and Szczepanik (2009); the acritarch assemblage from the *Holmia*–*Schmidtiellus* Assemblage Zone of the Kamieniec Formation is from Szczepanik and Żylińska (2012). The trilobite faunas from the Ociesęki and Kamieniec formations discussed herein are marked as 1 and 2, respectively

Callavia Zone in Avalonia and the traditional *Holmia kjerulfi*-group Zone of Scandinavia. Acritarch assemblages recognized recently in the Dąb exposure (Szczepanik and Żylińska 2012) contain such taxa as e.g. *Skiagia ciliosa*, *Solisphaeridium implicatum* and *Cymatiosphaera postii*, suggesting a position in the *Heliosphaeridium dissimilare* – *Skiagia ciliosa* Assemblage Zone (Moczydłowska 1991), which have also been recovered from the traditional *Holmia kjerulfi*-group Zone of Sweden (Vidal 1981; Vidal and Nystuen 1990; Moczydłowska 1991).

Trilobites accompanying the holmiids belong to the Ellipsocephalidae, a family with wide palaeogeographic distribution (Hupé 1953; Geyer 1990b). They are most common in West Gondwana, particularly in Morocco, where they provide a number of index taxa for the Banian and 'Tissafinian' zones (Geyer 1990a; Geyer and Landing 2004), and in Spain, where they are index fossils for the Marianian and Bilbilian (e.g. Gozalo *et al.* 2003). In Avalonia, ellipsocephalid species are used for biostratigraphic subdivisions of the upper Comley Series in Great Britain (e.g. Rushton *et al.* 2011) and in Newfoundland, Canada (e.g. Fletcher 2006). Individual species are used for defining the uppermost Cambrian Series 2 zones in Scandinavia (Baltica) (Kiær 1917; Bergström and Ahlberg 1981; Nielsen and Schovsbo 2011) and in the Holy Cross Mountains (Orłowski 1988; Żylińska and Masiak 2007; Żylińska and Szczepanik 2009).

Ellipsocephalids that accompany the holmiids in the *Holmia*–*Schmidtiellus* Assemblage Zone in the HCM are represented by *Berabichia* Geyer, 1990b, *Strenuella* Matthew, 1887 emend. Hupé, 1953, and *Termierella* Hupé, 1953 (Żylińska *et al.* in press, and systematic part below). The two recognized species of *Berabichia* from the Anti-Atlas and High Atlas of Morocco, *B. vertumnia* Geyer, 1990b and *B. stenometopa* Geyer, 1990b (see Żylińska *et al.* in press, for summary), and a number of morphotypes left in open nomenclature, are most abundant in the *Antatlasia guttapluviae* and *Sectigena* zones (Geyer 1990b). *Berabichia wilkesi* (Palmer and Gatehouse, 1972) and *Berabichia subdita* (Palmer and Gatehouse, 1972), from the Argentina Range in Antarctica, are known from erratic boulders that apparently correspond to the Banian of Morocco (Palmer and Gatehouse 1972; Palmer and Rowell 1995). *Berabichia milleri* Westrop (in Westrop and Landing, 2000) from southern New Brunswick, Canada, occurs in the *Kingaspidoides* cf. *K. obliquoculatus* Zone, thus indicating a younger level than its occurrences in Morocco (Westrop and Landing 2000). The faunule with *Berabichia erratica* Geyer, Popp, Weidner and Förster, 2004, from Pleistocene erratic boulders in a gravel pit in northern Germany is considered to correspond to the upper part of the traditional *Holmia kjerulfi*-group Zone of Sweden (Geyer *et al.* 2004). *Berabichia rotundata* (Kiær, 1917), from Scandinavia, is known from beds that yield also *Holmia kjerulfi* (Kiær 1917; Ahlberg and Bergström 1978). Sdzuy (1995) reported *Berabichia* from the Cantabrian Mountains (northern Spain), from the lower member of the Láncara Formation. Álvaro (2007) described *Berabichia eslanensis* Álvaro, 2007, from the same horizon. The age of these occurrences is early Bilbilian (Gozalo *et al.* 2007), i.e. they correlate with the upper part of the *Sectigena* Zone of Morocco and the *Protolenus*–*Issafeniella* Zone of the HCM in Poland (Żylińska and Szczepanik 2009). *Strenuella* is another ellipsocephalid from the study interval that has a relatively wide distribution. A number of *Strenuella* species have been recognized in Comley, Shropshire, in strata generally corresponding to the *Strenuella sabulosa* Zone of Newfoundland (Fletcher 2006; Rushton *et al.* 2011); however, *Strenuella*? *spinosa* (Cobbold, 1910) has been noted from the Ac2 horizon in the Comley Limestones (Morris 1988), thus, in slightly older strata, corresponding to the upper part of the *Callavia* Zone. Another *Strenuella* from the *Callavia* Zone mentioned by Morris (1988), *Strenuella comleyensis* Hupé, 1953, is considered by Geyer (1990b) to be a close relative of *Pruvostinoides angustilineatus* Hupé, 1953. In Massachusetts, USA, *Strenuella strenua* (Billings, 1874) is common in beds yielding *Serrodiscus bellimarginatus* (Shaler and Foerste, 1888), suggesting a younger age of these fossils, although Rushton (1966) noted *S. bellimarginatus* from the upper *Callavia* Zone in the Purley Shales of Nuneaton. The Moroccan *Strenuella* specimens of Hupé (1953), *S. rasetti* Hupé, 1953 and *S. howelli* Hupé, 1953, have been referred by Geyer (1990b) to *Pruvostinoides angustilineatus* and *Ornamentaspis triangularis* (Hupé, 1953), respectively. In Spain, the Marianian Stage commences with the first appearance of *Strenuella* (Liñán *et al.* 2002; Gozalo *et al.* 2003). Species of *Termierella* have been recognized in Morocco in the *Sectigena* and *Hupeolenus* zones (Hupé 1953; Geyer 1990b), and in Spain, in the Marianian Stage (Sdzuy 1961, 1962; Gozalo *et al.* 2003).

The species of *Acanthomicmacca* Hupé, 1953, are known from several localities in Avalonia and Gondwana. *Acanthomicmacca walcotti* (Matthew, 1899) has been noted from the *Callavia broeggeri* Zone of Newfoundland (Fletcher 2006) and the *Olenellus* Limestone (Ac2) at Comley (Cobbold 1931). *Acanthomicmacca* sp. aff. *A. ellipsocephaloides* (Cobbold, 1910) is known from the overlying *Dipharus attleborensis* Zone in Newfoundland (Fletcher 2006), and *A.* sp. cf. *A. ellipsocephaloides* (Cobbold, 1910) from the Branchian Series of New Brunswick (Landing *et al.* 2008). Hupé (1953) and Geyer and Malinky (1997) described *Acanthomicmacca neltneri* Hupé, 1953, from the *Marocconus notabilis* Zone of Morocco. Horizons Ac1 and Ac2 of the Comley Limestone at Comley yielded *Acanthomicmacca comleyensis* (Cobbold, 1931) and *A. ellipsocephaloides* (Cobbold, 1910), respectively (Cobbold 1931; Morris 1988), i.e. in strata corresponding to the *Callavia* Zone (Rushton *et al.* 2011). *Micmacca* (*Micmacca*) *coloi* Hupé, 1953 is also probably a representative of *Acanthomicmacca*; it was described from the *Sectigena* Zone of Morocco (Hupé 1953). *Micmacca* aff. *coloi* Hupé, 1953 has been noted in Spain (Sdzuy 1961).

The genus *Atops* Emmons, 1844 is essentially known from Laurentia. However, the *Atops*-group trilobites are also known from the successions of Avalonia and West Gondwana. In Britain, *Pseudatops reticulatus comleyensis* (Cobbold, 1936) was noted in horizon Ac3 of the Comley Limestone (Morris 1988). Fletcher (2006) illustrated *Pseudatops reticulatus* (Walcott, 1890) from the *Dipharus attleborensis* Zone of Newfoundland. Gozalo *et al.* (2003) reported *Atops* as one of the trilobites typical of the Marianian Stage; indeed, *Atops*? *calanus* Richter and Richter, 1941 and fragments doubtfuly assigned to this species, are known from southern Spain (Richter and Richter 1941; Sdzuy 1962).

In conclusion, all trilobites of the *Homia*–*Schmidtiellus* Assemblage Zone in the HCM indicate correlation with the traditional *Holmia kjerulfi*-group Zone of Scandinavia, the *Callavia* Zone of Britain and Newfoundland, the lower and middle parts of the *Sectigena* Zone of Morocco and the Marianian Stage of Spain.

BIOGEOGRAPHIC SIGNIFICANCE OF THE STUDIED FAUNA

The discussed fauna is composed of holmiids which allow direct correlation with the Scandinavian successions and thus show a strong Baltic biogeographic affinity, and of ellipsocephalids associated with a chengkouiid and an atopid, which indicate strong similarity to faunas of West Gondwana and Avalonia[1] (Text-fig. 5). Interestingly, the most abundant species (of *Berabichia* and *Strenuella*) are either common to Baltica, Avalonia and West Gondwana or only to Avalonia and West Gondwana. When compared to the time-

[1] Herein, Avalonia is treated as a microcontinent separate from Gondwana already during the Cambrian, following Landing (2005) and references therein.

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genus / biogeographic area	Baltica	Avalonia	West Gondwana	HCM
Holmia	+			+
Schmidtiellus	+			+
Kjerulfia	+		+	+
Postfallotaspis			?	+
Berabichia	+	+	+	+
Strenuella		+	+	+
Termierella			+	+
Acanthomicmacca		+	+	+
Atops		+	+	+

Text-fig. 5. Distribution of trilobite genera from the *Holmia–Schmidtiellus* Assemblage Zone in the HCM and in other biogeographic areas. See text for references

equivalent successions of Baltica or Avalonia/West Gondwana, the HCM assemblage completely lacks eodiscoids; these appear later, in the *Protolenus–Issafeniella* Zone (see Żylińska and Szczepanik 2009 and references therein).

The close proximity of the Małopolska Massif (basement of the Kielce Region of the HCM) to Baltica was discussed in a number of papers; the most recent conclusions were based on provenance of clastic material, palaeomagnetics and biogeography (Nawrocki and Poprawa 2006; Nawrocki *et al.* 2007). During the Cambrian, the HCM edge of the Małopolska Massif was apparently a passive continental margin and was in a position close to Baltica, as evidenced by its Baltic Apparent Polar Wander Path (Nawrocki 2006; Nawrocki *et al.* 2007). Muscovites from the clastic facies of the HCM have a signature suggesting late Neoproterozoic cooling ages, but contain also an igneous-metamorphic overprint of c. 0.8–0.9 and 1.5 Ga, interpreted by Nawrocki *et al.* (2007) as a Fennoscandian source. On the other hand, dextral relocation of the Małopolska Massif along the TESZ margin of Baltica resulted in its close proximity also to the margin of Gondwana (Belka *et al.* 2002; Nawrocki *et al.* 2007), as suggested for the boundary interval of Cambrian Series 2 and 3 by detailed analysis of trilobites and acritarchs (Żylińska and Szczepanik 2009). This study brings further support for this conclusion. The dominance of Avalonian and West Gondwanan trilobites in the succession, with the proliferation of single species over a large area suggest that the HCM margin of the Małopolska Massif belonged to a region with a mixed fauna and with an interchange of faunal types characteristic of both West Gondwana and Avalonia. This also suggests a continuous influence of ellipsocephalid larvae-carrying currents between Małopolska, West Gondwana and Avalonia. Therefore the TESZ margin of Baltica, along which the Małopolska Massif [together with other consituents of the Teisseyre Terrane Assemblage of Nawrocki and Poprawa (2006) and the Teisseyre-Tornquist Terrane Assemblage of Nawrocki *et al.* (2007)], must have faced West Gondwana and Avalonia during Cambrian epochs 2 and 3. This is a view different from that expressed by the recent palaeogeographic interpretations of Cocks and Torsvik (2005, 2006), in which the TESZ margin of Baltica faced Laurentia and was subjected to currents of the Iapetus Ocean and not of the Ægir Sea or Panthalassic Ocean as was Gondwana with Avalonia. Álvaro *et al.* (2003) proposed a pattern of currents along the margin of Gondwana. However, apart from their applied palaeogeographic reconstruction requiring emendation, the pattern of currents shown in their reconstruction does not explain the migration of faunas along the margin of Gondwana, a fact that was already brought up by Żylińska and Masiak (2007).

The dispersal potential of the holmiids and the ellipsocephalids must have been very different. The ellipsocephalids, with pandemic distribution (e.g. Geyer 1990b), could have been characterized by a long-lived planktonic early stage (i.e. all protaspid growth stages) (strategy I of Chatterton and Speyer 1989). In contrast, the holmiids were much more endemic, with *Holmia* and *Schmidtiellus* confined to Baltica; *Callavia* Matthew, 1897 to Avalonia; *Andalusiana* Sdzuy, 1961 and *Cambropallas* Geyer, 1993 to West Gondwana; and *Esmeraldina* Resser and Howell, 1938, *Holmiella* Fritz, 1972 and *Palmettaspis* Fritz, 1995 to Laurentia. Only *Kjerulfia* had a wider distribution, being known from Baltica, West Gondwana and Avalonia (Palmer and Repina 1993). Holmiids apparently had a much lower dispersal potential than ellipsocephalids, possibly with an early benthic strategy of the protaspids (e.g. Chatterton and Speyer 1989). Owing to the poorly known early growth stages of the Olenellina (see e.g. Chatterton and Speyer in Kaesler 1997), this hypothesis cannot be proved.

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CONCLUSIONS

The oldest Cambrian trilobite fauna from the Holy Cross Mountains, Poland, is composed of six species of Holmiidae, four species of Ellipsocephalidae, one chengkouiid and one atopid. It is dominated by the ellipsocephalids (78%), with the abundance of *Berabichia oratrix* exceeding half of the known specimens. Biostratigraphic analysis of the taxa indicate correlation with the traditional *Holmia kjerulfi*-group Zone of Scandinavia, the *Callavia* Zone of Britain and Newfoundland, the lower and middle part of the *Sectigena* Zone of Morocco, and the Marianian Stage of Spain. The taxa display strong biogeographic affinities with West Gondwana and Avalonia, suggesting that the TESZ margin of Baltica with the Małopolska Massif must have been subjected to planktonic larvae-carrying currents effectively dispersing ellipsocephalid trilobites from and to West Gondwana and Avalonia.

PALAEONTOLOGICAL NOTES

Material and methods

The specimens studied herein are preserved as internal moulds or external moulds and their imprints; composite moulds have also been noted. Fossils from fine siliciclastics are usually flattened and in this case the measurable dimensions may not be reliable. Disarticulated sclerites prevail, dominated by cranidia, but trilobites from both formations are represented by a relatively high number of complete exoskeletons compared to other Cambrian successions of the HCM.

Detailed systematic diagnoses and descriptions are supplied only for taxa whose taxonomic assignment is revised herein or required emendation. In the remaining cases synonymy lists have been supplemented and taxon authorships are discussed. Appendix 1 summarizes the distribution of trilobite specimens in particular exposures with their repository numbers.

The terms applied to the trilobite exoskeleton follow the Trilobite Treatise (Kaesler 1997). Measurements were made with digital callipers (0.1 mm accuracy). 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. Particular parameters were calculated with Microsoft Excel software. A value range is given for two to four measured specimens, whereas for five specimens or more the mean value together with the standard deviation is given; the number of measured specimens is given in parentheses (e.g. n=6). Before being photographed, the specimens were coated with ammonium chloride. In some cases several photographs of a single specimen were stacked into one with use of computer software (CombineZM or Helicon Focus 5.3).

Systematic descriptions

Class Trilobita Walch, 1771
Order Redlichiida Richter, 1932
Suborder Olenellina Walcott, 1890
Superfamily Olenelloidea Walcott, 1890
Family Holmiidae Hupé, 1953
Subfamily Holmiinae Hupé, 1953

Genus *Holmia* Matthew, 1890

TYPE SPECIES: *Paradoxides kjerulfi* Linnarsson, 1871 from Cambrian Series 2 in the Ringsaker district, Norway, by original designation.

REMARKS: Emended diagnoses of the genus were presented by Bergström (1973b), Ahlberg *et al.* (1986), Palmer and Repina (1993) and Palmer and Repina in Kaesler (1997). The most recent emendation is by Lieberman (1999) based on phylogenetic analyses; however, the Polish specimens of this genus were not included in the analysis (Lieberman 1999, p. 73).

Holmia marginata Orłowski, 1974
(Text-figs 6A–D, 13E)

?1918. *Holmia Kjerulfi* Linnarss.; Samsonowicz, pp. 702, 705.
?1919. *Olenellus* (*Holmia*) *Kjerulfi* Lns.; Czarnocki, pp. 94–96.
partim 1959*a*. *Holmia kjerulfi* (Lnrs.); Samsonowicz, pp. 447, 449, pl. 1, figs 1, 3, 5, 6, *non* pl. 1, fig. 2 (= *Kjerulfia orcina*), *non* pl. 1, fig. 4 and pl. 2, fig. 3 (= *Holmia glabra*), *non* pl. 1, figs 7–10 and pl. 2, figs 4–11.
1974. *Holmia kjerulfi marginata* subsp. n.; Orłowski, pp. 8–10, pl. 1, figs 1–4, pl. 2, figs 1–6.
1985a. *Holmia marginata* Orłowski; Orłowski, pp. 236, 237, text-fig. 4, pl. 1, figs 1–4.
1990. *Holmia kjerulfi marginata* Orłowski; Lendzion and Orłowski in Pajchlowa, p. 51, pl. 12, fig. 2.
1999. *Holmia kjerulfi marginata* Orłowski 1974; Lieberman, p. 75.
2003. *Holmia marginata*, Orłowski, 1974; Ebbestad, Ahlberg and Høyberget, pp. 1039, 1043.

HOLOTYPE: Cephalon MWG ZI/29/0991 (former number: IGP UW 55), illustrated by Orłowski (1974, pl. 1, fig. 1a, b) and Lendzion and Orłowski (in Pajchlowa 1990, pl. 12, fig. 2a, b) as *Holmia kjerulfi marginata*, and in Text-fig. 6A herein, from the *Holmia–Schmidtiellus* Assemblage Zone of the Ocieseki Formation at Igrzyczna Hill, HCM.

AVAILABLE MATERIAL: Over 100 cephala (incomplete in many cases), including the holotype, occasionally with incomplete thoraces, 7 hypostomata, 7 librigenae, 4 pygidia, 3 thoraces and a number of fragmentary specimens.

REMARKS: This well-known species from the HCM area is closely related to *Holmia kjerulfi* from the traditional lower Cambrian of Scandinavia, as noted in the diagnosis and detailed description by Orłowski (1974). Based on well-preserved specimens, Orłowski (1985a) treated it as a separate species of *Holmia*, instead of as a subspecies of *H. kjerulfi*. This conclusion was confirmed by Ebbestad *et al.* (2003). The species is diagnostic of the *Holmia–Schmidtiellus* Assemblage Zone (Orłowski 1987). New photographic documentation is provided herein.

OCCURRENCE: Cambrian Series 2, *Holmia–Schmidtiellus* Assemblage Zone; Ocieseki Formation at Igrzyczna Hill, Leśniakowa Dębina, Malkowska Hill, Ocieseki, Sterczyna Hill, Stołowa Hill, Szczecno and Wola Wąkopna; Kamieniec Formation at Dąb, HCM.

Holmia glabra Orłowski, 1974
(Text-fig. 6E)

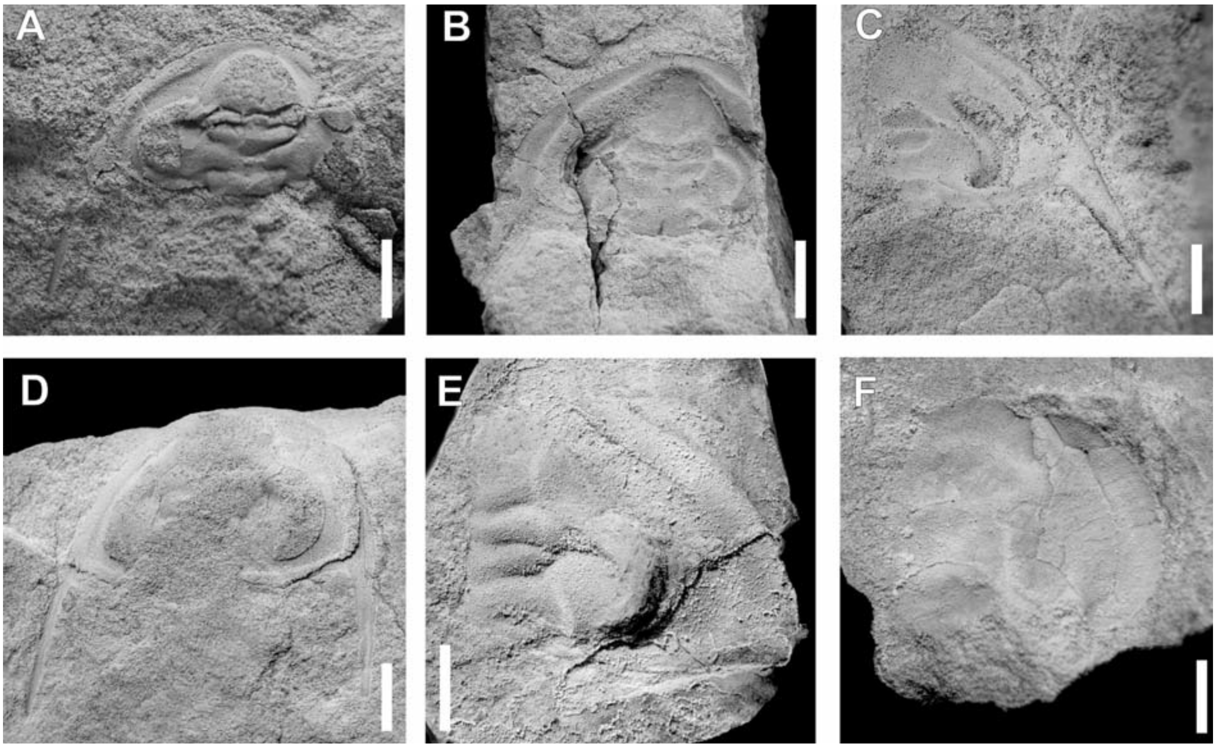
partim 1959a. *Holmia kjerulfi* (Lnrs.); Samsonowicz, pp. 447, 449, pl. 1, fig. 4; pl. 2, fig. 3, *non* pl. 1, figs 1, 3, 5, 6 (= *Holmia marginata*), *non* pl. 1, fig. 2 (= *Kjerulfia orcina*), *non* pl. 1, figs 7–10 and pl. 2, figs 4–11.

1974. *Holmia glabra* sp. n.; Orłowski, pp. 10–12, pl. 2, figs 7–9.

1990. *Holmia glabra* Orłowski, 1974; Lendzion and Orłowski in Pajchlowa, p. 51, pl. 11, fig. 5.

2003. *Holmia glabra* Orłowski, 1974; Ebbestad, Ahlberg and Høyberget, pp. 1039, 1043.

TYPES: Designated as holotype was specimen IGP UW 5 (a cephalon with incomplete thorax), illustrated in Orłowski (1974, pl. 2, fig. 7a–c) and Lendzion and



Text-fig. 6. Holmiinae from the *Holmia–Schmidtiellus* Assemblage Zone in the Ocieseki Formation, Holy Cross Mountains. **A–D**. *Holmia marginata* Orłowski, 1974 from Igrzyczna Hill. A – MWG ZI/29/0991, holotype, original of Orłowski (1974, pl. 1, fig. 1); B – MWG ZI/29/0993, original of Orłowski (1974, pl. 1, fig. 2); C – MWG ZI/29/1009; D – MWG ZI/29/1025, original of Orłowski (1985a, pl. 1, fig. 2). **E** – *Holmia glabra* Orłowski, 1974 from Ocieseki, neotype, latex cast of specimen MWG ZI/42/153, original of Samsonowicz (1959a, pl. 1, fig. 4). **F** – *Holmia* sp. from Gieraszowice, MWG ZI/42/292; original of Samsonowicz (1959a, pl. 1, fig. 7). Scale-bar represents 0.5 mm

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Orłowski (in Pajchlowa 1990, pl. 11, fig. 5), from the *Holmia–Schmidtiellus* Assemblage Zone in the Ociesęki Formation at Bukówki-Rybnica, HCM. However, the specimen is probably lost. Consequently, the fragmentary cephalon MWG ZI/42/153 (former number Os 84) (illustrated in Samsonowicz 1959a, pl. 1, fig. 4, and in Text-fig. 6E herein), from the *Holmia–Schmidtiellus* Assemblage Zone of the Ociesęki Formation, Ociesęki, HCM, is designated the neotype.

AVAILABLE MATERIAL: One cephalon (which is the neotype), one librigena.

REMARKS: The diagnosis of the species and features differentiating it from *H. marginata* were presented in the original description (Orłowski 1974, pp. 10–12). Ebbestad *et al.* (2003) also included this species in their definition of the genus *Holmia*.

OCCURRENCE: Cambrian Series 2, *Holmia–Schmidtiellus* Assemblage Zone; Ociesęki Formation at Ociesęki, HCM.

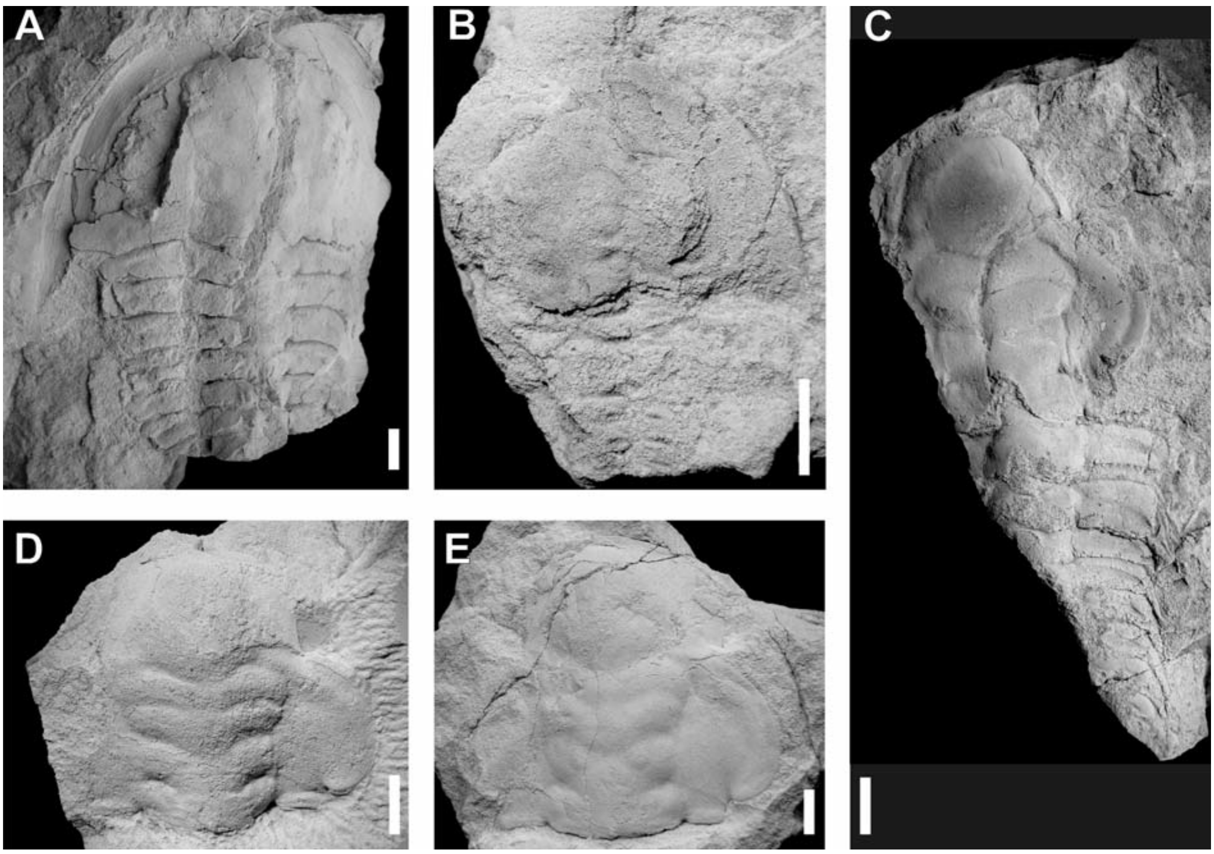
Genus *Schmidtiellus* Moberg in Moberg and Segerberg, 1906

TYPE SPECIES: *Olenellus mickwitzi* Schmidt, 1888, from the *Schmidtiellus mickwitzi* Zone of Cambrian Series 2 of Estonia; by original designation.

REMARKS: Emended diagnoses of the genus were given in Bergström (1973b), Ahlberg *et al.* (1986), Palmer and Repina (1993) and Palmer and Repina in Kaesler (1997). Based on phylogenetic analysis, Lieberman (1999) supplied the most recent emended diagnosis; the Polish specimens of this genus were not included in his analysis.

Schmidtiellus panowi (Samsonowicz, 1959a)
(Text-fig. 7B, C)

1959a. *Holmia panowi* nova species; Samsonowicz, pp. 449, 450, pl. 2, fig. 12a, b.
1973b. *Holmia panowi* Samsonowicz; Bergström, p. 295.



Text-fig. 7. Holmiinae from the *Holmia–Schmidtiellus* Assemblage Zone in the Ociesęki Formation, Holy Cross Mountains. **A**, **D**, **E** – *Schmidtiellus nodosus* Orłowski, 1985a. A – MWG ZI/29/1322, original of Orłowski (1985a, pl. 2, fig. 2a), Igrzyczna Hill; D – MWG ZI/29/1330, original of Orłowski (1985a, pl. 3, fig. 2), Leśniakowa Dębina; E – MWG ZI/29/1327, Sterczyna Hill. **B**, **C** – *Schmidtiellus panowi* (Samsonowicz, 1959a). B – MWG ZI/29/1338, original of Orłowski (1985a, pl. 3, fig. 4), Leśniakowa Dębina; C – MUZPIG 1.II.94, holotype, original of Samsonowicz (1959a, pl. 2, fig. 12a) and Orłowski (1974, pl. 1, fig. 5a), Ryj Hill. Scale-bar represents 0.5 mm

1973b. *Schmidtiellus panowi* (Samsonowicz); Bergström, pp. 301, 303.
1973. *Holmia grandis* Kiaer; Osmólska after Kotas, p. 37.
1974. *Schmidtiellus panowi* (Samsonowicz, 1959); Orłowski, pp. 7, 8, pl. 1, figs 5a, b, 6.
1975a. *Schmidtiellus panowi* (Samsonowicz, 1959); Orłowski, pp. 380, 381, pl. 1, fig. 1a, b.
1985a. *Schmidtiellus panowi* (Samsonowicz, 1959); Orłowski, p. 237, text-fig. 5, pl. 3, fig. 4.
1990. *Schmidtiellus panowi* (Samsonowicz, 1959); Lendzion and Orłowski in Pajchlowa, p. 52, pl. 13, figs 1, 2.
1999. *Schmidtiellus panowi* (Samsonowicz); Lieberman, p. 82.
2003. *Schmidtiellus panowi* (Samsonowicz, 1959); Ebbestad, Ahlberg and Høyberget, p. 1039.
2004. *Schmidtiellus panowi* (Samsonowicz); Żylińska in Nawrocki *et al*., text-fig. 6.

HOLOTYPE: The incomplete specimen, MUZPIG 1.II.94, illustrated in Samsonowicz (1959a, pl. 2, fig. 12a, b) as *Holmia panowi* nova species, Orłowski (1974, pl. 1, fig. 5a, b), Lendzion and Orłowski (in Pajchlowa 1990, pl. 13, fig. 1a, b) and Text-fig. 7C herein, from the *Holmia–Schmidtiellus* Assemblage Zone in the Ociesęki Formation at Ryj Hill near Bardo, HCM. This specimen was erroneously considered the lectotype by Orłowski (1974) and Lendzion and Orłowski (in Pajchlowa 1990).

AVAILABLE MATERIAL: Two almost complete exoskeletons (including the holotype), two cranidia, one pleura.

REMARKS: Diagnosis and detailed descriptions of the species are provided by Samsonowicz (1959a) and Orłowski (1974, 1985a). This rare species provides direct correlation between the HCM and Upper Silesia. New photographic documentation of the holotype and the other exoskeleton is provided herein.

OCCURRENCE: Cambrian Series 2, *Holmia* Zone; Goczałkowice Formation in the Goczałkowice IG-1 Borehole (depth 2793.0 m), Cracow–Silesia region; Cambrian Series 2, *Holmia–Schmidtiellus* Assemblage Zone; Ociesęki Formation at Gieraszowice, Leśniakowa Dębina and Ryj Hill; Kamieniec Formation at Dąb, HCM.

Schmidtiellus nodosus Orłowski, 1985a
(Text-fig. 7A, D, E)

1985a. *Schmidtiellus nodosus* sp. n.; Orłowski, pp. 237, 238, text-fig. 5, pl. 2, figs 1, 2, pl. 3, figs 2, 3.
1999. *Schmidtiellus nodosus* Orłowski; Lieberman, p. 82.
2003. *S. nodosus* Orłowski, 1985; Ebbestad, Ahlberg and Høyberget, pp. 1039, 1049.

HOLOTYPE: Cephalon MWG ZI/29/1318 (former number: IGP UW 1.349), illustrated in Orłowski (1985a, pl. 2, fig. 1), from the *Holmia–Schmidtiellus* Assemblage Zone, Ociesęki Formation at Malkowska Hill, HCM.

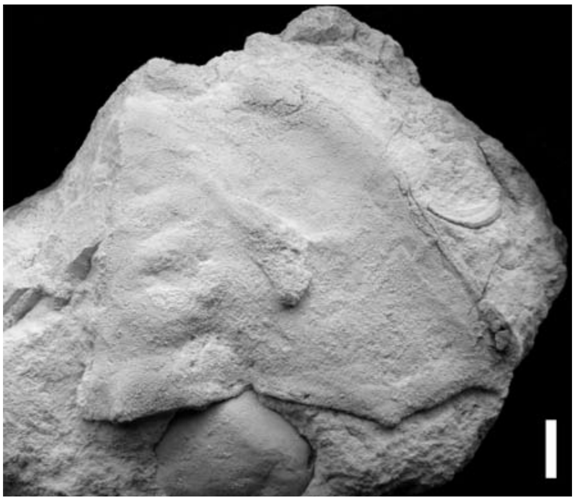
AVAILABLE MATERIAL: Thirteen cephala, including the holotype, two cephala with thoraces, one librigena, one hypostome, three pleurae, one pygidium tentatively assigned to the species.

REMARKS: The species differs from most of the representatives of *Schmidtiellus* in possessing only a short occipital spine instead of a prominent one (e.g. Orłowski 1985a; Ebbestad *et al.* 2003). The spine, visible only on imprints of external moulds, is round-based in smaller specimens and changes into a more prominent ridge on the occipital ring in larger specimens.

OCCURRENCE: Cambrian Series 2, *Holmia–Schmidtiellus* Assemblage Zone; Ociesęki Formation at Igrzyczna Hill, Leśniakowa Dębina, Malkowska Hill, Pranie and Sterczyna Hill, HCM.

Genus *Postfallotaspis* Orłowski, 1985a

TYPE SPECIES: *Postfallotaspis spinatus* Orłowski, 1985a, by monotypy.



Text-fig. 8. *Postfallotaspis spinatus* Orłowski, 1985a from the *Holmia–Schmidtiellus* Assemblage Zone in the Ociesęki Formation at Igrzyczna Hill, Holy Cross Mountains, MWG ZI/29/2130, holotype, original of Orłowski (1985a, pl. 3, fig. 5a–d). Scale-bar represents 0.5 mm

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Postfallotaspis spinatus Orłowski, 1985a
(Text-fig. 8)

1985a. *Postfallotaspis spinatus* sp. n.; Orłowski, p. 235, text-fig. 3, pl. 3, fig. 5.

HOLOTYPE: Cephalon MWG ZI/29/2130 (former number: IGP UW 1.496), illustrated in Orłowski (1985a, pl. 3, fig. 5) and in Text-fig. 8 herein, from the *Holmia*–*Schmidtiellus* Assemblage Zone in the Ocieseki Formation at Igrzyczna Hill, HCM.

AVAILABLE MATERIAL: One incomplete cephalon.

REMARKS: According to Palmer and Repina (1993, p. 32, and in Kaesler 1997, p. 428), it is impossible to ascertain a higher-level taxonomy of this genus and species; these authors placed it in the Superfamily Uncertain in the Suborder Olenellina. According to Jell and Adrain (2003, p. 429), the genus is a representative of the Holmiidae and this view is followed herein. The specimen at hand is distinguished from most of the other Holmiidae by a forwardly tapering glabella. In this respect it resembles specimens assigned to *Iyouella* Geyer and Palmer, 1995, represented so far by only one, incompletely preserved cephalon of *Iyouella contracta* Geyer and Palmer, 1995, from the *Sectigena* Zone, Issafen Formation in Morocco (Geyer and Palmer 1995). Due to the lack of other specimens, detailed comparison with other taxa is not possible.

OCCURRENCE: Cambrian Series 2, *Holmia*–*Schmidtiellus* Assemblage Zone; Ocieseki Formation at Igrzyczna Hill, HCM.

Subfamily Callaviinae Poulsen in Moore, 1959

Genus *Kjerulfia* Kiær, 1917

TYPE SPECIES: *Kjerulfia lata* Kiær, 1917 from Cambrian Series 2 of Tømten, Norway, by original designation.

REMARKS: Emended diagnoses presented by Ahlberg *et al.* (1986), Palmer and Repina (1993) and Lieberman (1999); the Polish species is excluded from the latter analysis.

Kjerulfia orcina Orłowski, 1974
(Text-fig. 9)

partim 1959a. *Holmia kjerulfi* (Lnrs.); Samsonowicz, pl. 1, fig. 2, *non* pl. 1, figs 1, 3, 5, 6 (= *Holmia marginata*), *non* pl. 1, fig. 4 and pl. 2, fig. 3 (= *Holmia glabra*), *non* pl. 1, figs 7–10 and pl. 2, figs 4–11.
partim 1959a. *Kjerulfia* sp.; Samsonowicz, p. 450, pl. 3, figs 1, 4, 5, *non* pl. 3, figs 2, 3, 6–9.
partim 1959a. *Kjerulfia? lagowiensis* Czarnocki; Samsonowicz, p. 450, pl. 3, fig. 11 (only).
1974. *Kjerulfia orcina* sp. n.; Orłowski, pp. 13–15, pl. 3, figs 4, 5, pl. 4, figs 1–8, pl. 5, figs 1–5.
1985a. *Kjerulfia orcina* Orłowski; Orłowski, p. 234, text-fig. 2, pl. 1, figs 5, 6.
1990. *Kjerulfia orcina* Orłowski; Lendzion and Orłowski in Pajchlowa, p. 50, pl. 11, figs 1, 2.

HOLOTYPE: Cephalon MWG ZI/29/1083 (former number: IGP UW 180), illustrated in Orłowski (1974, pl. 4, fig. 1a, b), Lendzion and Orłowski (in Pajchlowa 1990, pl. 11, fig. 1) and Text-fig. 9A herein, from the *Holmia*–*Schmidtiellus* Assemblage Zone, Ocieseki Formation at Ocieseki, HCM.

AVAILABLE MATERIAL: One complete exoskeleton, over sixty cephala (including the holotype), two cephala with thoraces, eight thoraces, 16 pleurae, 7 hypostomata, 25 librigenae and a number of fragmentary specimens.

EMENDED DIAGNOSIS: A species of *Kjerulfia* with a clavate glabella, large palpebral lobe and transversely narrow extraocular cheek with broad cephalic border; librigenae with short, broad-based spine; thorax with transversely wide pleurae and long, falcate pleural spines; axial spines present on all thoracic segments, on which they are posteriorly located; total number of segments reaches 17; pygidium small, posteriorly rounded (after Orłowski 1974, supplemented).

REMARKS: The record of a complete, posteriorly enrolled specimen (Text-fig. 9D–F) shows that *Kjerulfia orcina* was a micropygous trilobite with 17 segments in adults and a small, posteriorly rounded pygidium without marginal spines. *Kjerulfia*? *lagowiensis* Czarnocki (see Samsonowicz 1959a, pl. 3, figs 10–12) is represented only by single pleurae. According to Orłowski (1974, footnote on p. 14) the taxon should be treated as a *nomen nudum*. However, Czarnocki's collection at the Museum of the Polish Geological Institute in Warsaw (MUZPIG) yields several pleurae with labels indicating this name. Some of the pleurae resemble those typical of *Kjerulfia* (e.g. Samsonowicz 1959a, pl. 3, fig. 11).

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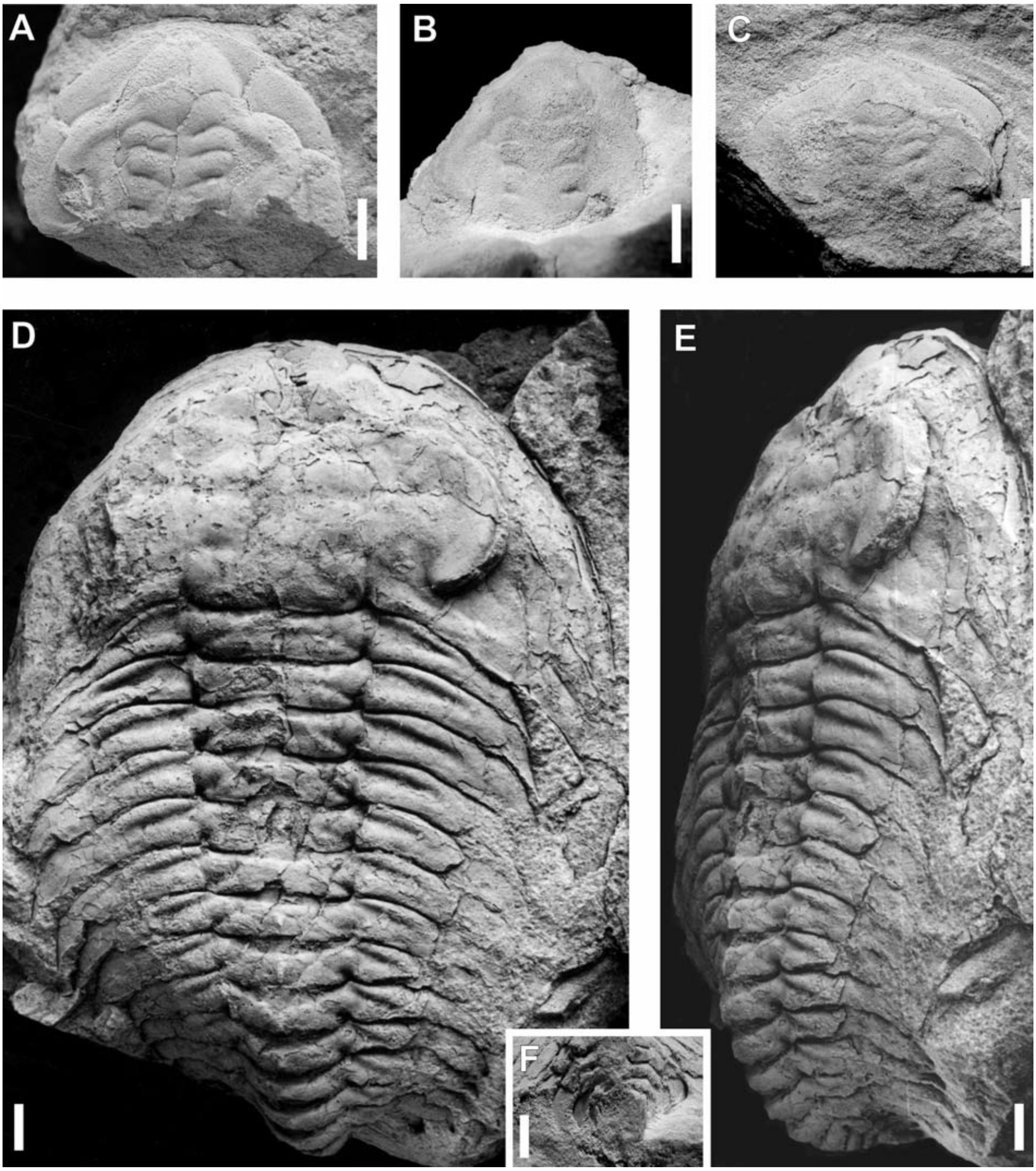

Text-fig. 9. *Kjerulfia orcina* Orłowski, 1974 from the *Holmia–Schmidtiellus* Assemblage Zone in the Ocieseki Formation, Holy Cross Mountains. **A** – MWG ZI/29/1083, holotype, original of Orłowski (1974, pl. 4, fig. 1), Ocieseki; **B** – MWG ZI/29/1101, Sterczyna Hill; **C** – MWG ZI/29/1118, Leśniakowa Dębina; **D–F** – MUZPIG 1689.II.41, Sterczyna Hill: D – frontal view, E – lateral view, F – posterior view. Scale-bar represents 0.5 mm

OCCURRENCE: Cambrian Series 2, *Holmia–Schmidtiellus* Assemblage Zone; Ocieseki Formation at Buczyna, Igrzyczna Hill, Leśniakowa Dębina, Madeje, Malkowska Hill, Ocieseki, Sterczyna Hill and Wola Wąkopna; Kamieniec Formation at Dąb, HCM.

Suborder Redlichiina Richter, 1932
Superfamily Ellipsocephaloidea Matthew, 1887
Family Ellipsocephalidae Matthew, 1887
Subfamily Strenuellinae Hupé, 1953 emend. Geyer, 1990b

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REMARKS: According to Geyer (1990b, p. 96), the family encompasses only six genera, *Strenuella* Matthew, 1887, *Myopsostrenua* Rushton, 1966, *Comluella* Hupé, 1953 (restricted to the type species *Anomocare platycephalus* Cobbold, 1910), *Pruvostinoides* Hupé, 1953, *Rinconia* Hupé, 1953 and *Limuolenus* Jago in Courtessole and Jago, 1980. Characteristic features of its representatives, considered relatively primitive in the ellipsocephalid stock, include a non-specialized, usually straight-sided and anteriorly rounded glabella with three lateral glabellar furrows, a narrow preglabellar field in the form of a depression and palpebral lobes passing into eye ridges without any discontinuity but only a slight change in angle.

Genus *Strenuella*
Matthew, 1887 emend. Hupé, 1953

TYPE SPECIES: *Agraulos strenuus* Billings, 1874, from Cambrian Series 2 of south-east Newfoundland; subsequent designation by Kiær (1917, p. 30).

Strenuella polonica Czarnocki, 1926
(Text-fig. 10)

?1919. *Protolenus* sp.; Czarnocki, pp. 96, 97.
1926. *Strenuella polonica* sp. n.; Czarnocki, p. 7.
1927a. *Strenuella polonica*; Czarnocki, p. 736.
1927b. *Strenuella polonica* sp. n.; Czarnocki, p. 190.
1932. *Strenuella polonica*; Czarnocki, p. 77.
1933. *Strenuella polonica*; Czarnocki, p. 81.
1959c. *Strenuella polonica* Czarnocki (nomen nudum); Samsonowicz, pp. 525, 526, pl. 1, figs 1–4, ?5, ?6, 7–12.
partim 1959c. *Strenuella* cf. *lakei* Hupé; Samsonowicz, pl. 2, fig. 3, *non* pl. 2 figs 1, 2 (= *Strenuella zbelutkae*).
non 1962. *Strenuella polonica* Czarnocki (nomen nudum) 1927, Samsonowicz 1959; Samsonowicz, p. 12, pl. 3, fig. 9 (= *Termierella sandomirensis*).
1985a. *Strenuella polonica* Samsonowicz; Orłowski, pp. 241, 242, text-fig. 11, pl. 4, figs 1–6, pl. 5, fig. 6, pl. 7, fig. 9.
1990. *Strenuella polonica* Samsonowicz; Lendzion and Orłowski in Pajchlowa, p. 55, pl. 15, fig. 4.
2010. *Strenuella polonica* Czarnocki; Żylińska and Kin, pp. 91–93, fig. 1.

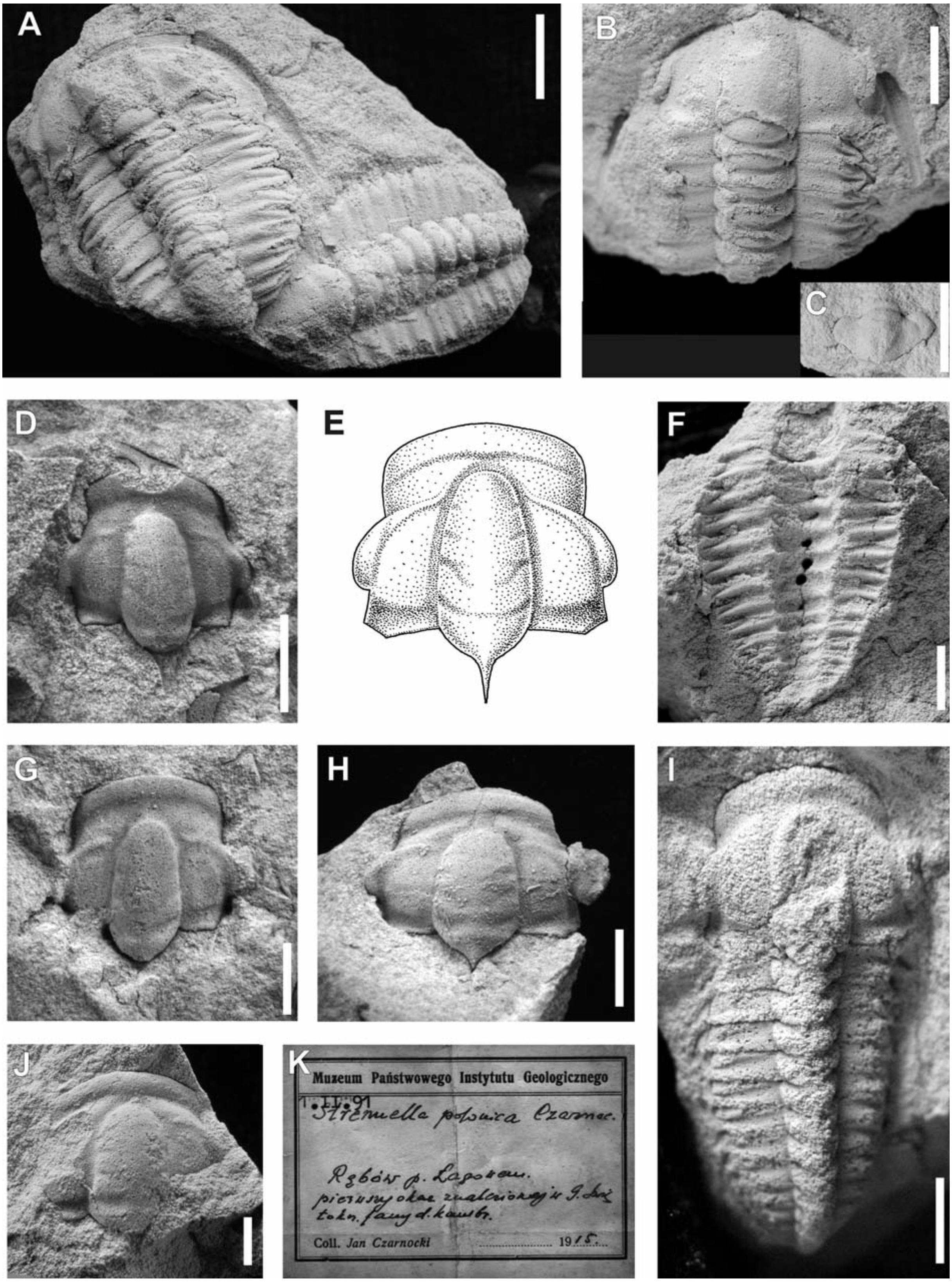
TYPES: According to Samsonowicz (1959c, p. 525), the holotype cannot be found and is most probably lost. The neotype is a partly enrolled imprint of a composite mould (MWG ZI/42/073; former number: IGP UW Os 60) and was selected by Samsonowicz (1959c, p. 525, pl. 1, fig. 1a–e); this specimen was also illustrated by Lendzion and Orłowski in Pajchlowa (1990, pl. 15, fig. 4a, b). Bergström (1973a, p. 27) and Geyer (1990b, p. 56) referred to this specimen as the holotype. The specimen is from the *Holmia–Schmidtiellus* Assemblage Zone of the Ociesęki Sandstone Formation at Ociesęki, HCM.

EMENDED DIAGNOSIS: A species of *Strenuella* with prominent glabella and anterior border; three distinct lateral glabellar furrows; anterior border furrow deflected rearwards at midline; occipital spine narrow-based, relatively short, deflected obliquely backwards; librigena with relatively long, slender, broad-based spine; thorax with median knobs, developed into backwardly-directed, curved spines on the 4th to 7th segments; pygidium small, with two pairs of small, inwardly directed marginal spines.

AVAILABLE MATERIAL: Twelve complete specimens, 5 axial shields, 32 cranidia with thoraces (including the neotype), 18 cranidia with libigenae and thoraces, 3 thoracopygons, 31 thoraces, 1 cranidium with librigenae, more than 275 cranidia, 8 librigenae, 11 pygidia, 2 hypostomata.

DESCRIPTION: Medium-sized micropygous trilobites, capable of spiral enrolment. Cranidium subquadrate, overall convexity fairly low, glabella and frontal border relatively strongly elevated above the fixigenae, length including occipital spine 95±11% of maximum width across centre of palpebral lobes when the occipital spine is preserved (n=18). Glabella strongly convex, distinctly elevated above the fixigenae, 80±3% of cranidial length including occipital spine (n=21) and 36±3% of cranidial width across occipital ring (n=18), slightly narrowing forwards. Frontal lobe evenly rounded anteriorly. Three pairs of lateral glabellar furrows, more distinct on internal moulds, shallow and narrow, decreasing in length towards the anterior; posteriormost furrow slightly bent backwards and vaguely bifurcating, the remaining two only slightly oblique with regard to the transverse line. Oc-

Text-fig. 10. *Strenuella polonica* Czarnocki, 1926 from the *Holmia–Schmidtiellus* Assemblage Zone in the Ociesęki Formation, Holy Cross Mountains. **A** – AK 300 CD 31-8, two slightly incomplete, outstretched exoskeletons, Sterczyna Hill; **B** – MWG ZI/29/1540, cephalon with incomplete, partly enrolled thorax, Sterczyna Hill; **C** – MUZPIG 1.II.56, incomplete cranidium (note imprint of internal mould of spine), Leśniakowa Dębina; **D** – MUZPIG 1.II.66, pygidium, Leśniakowa Dębina; **E** – reconstruction of cranidium; **F** – UJ 214P-T1, imprint of external mould of thorax (note holes after medial thoracic spines), Sterczyna Hill; **G** – MUZPIG 1.II.45, Leśniakowa Dębina; **H** – MUZPIG 1.II.79, Leśniakowa Dębina; **I** – MWG ZI/29/1488, axial shield with pygidium flex, Leśniakowa Dębina; **J** – MUZPIG 1.II.91, Rembów; **K** – original museum label for specimen MUZPIG 1.II.91 with the annotation: "*the first specimen of Lower Cambrian fauna found in the Holy Cross Mountains*". Scale-bar represents 0.5 mm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Coll. Jan Czarnocki
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cipital furrow shallow, wide, shallower at sagittal midline, slightly curved backward. Occipital ring 17±4% of cranidial length (n=48), 25±3% including occipital spine (n=21), evenly convex and undifferentiated. Occipital spine with relatively narrow base, rapidly narrowing backwards to reach approximately posterior margin of second thoracic segment, terminating in a fine, sharp tip; broken off or incomplete in most of the studied cranidia. Axial furrows shallow and wide. Fixigenae almost flat, at a distinctly lower level than glabella, their posterolateral corners slightly sloping downwards towards the margins, 76±10% of transverse occipital ring width (n=61). Palpebral lobes 27±3% of cranidial length including occipital spine (n=16), crescent-shaped and slightly elevated above the fixigenae, separated from them by wide and shallow palpebral furrow. Palpebral lobes separated by a very faint, almost exsagittal depression from slightly narrower eye ridges that run adaxially at a slightly changed angle. Eye ridges straight to slightly oblique, disconnected from glabella and curved adaxially close to anterior lobe of glabella. Anterior branch of facial suture almost parallel from palpebral lobes to frontal margin, then curving sharply adaxially. Posterior branch only slightly divergent, shorter than anterior branch. Frontal area 20±3% of total cranidial length including occipital spine (n=21), distinctly separated into strongly inflated anterior border and flat preglabellar field. Anterior border 63±9% of frontal area (n=61); anterior border furrow slightly deflected rearwards. Posterior border furrow wide and shallow, wider abaxially. Posterior border with fulcrum located at two-thirds of its length from axial furrow.

Librigena almost flat, transversely very narrow, with relatively wide border extending into prominent, broad-based spine that is almost as long as the exsagittal length of the librigenal field. Genal spine extending posteriorly to the level of the 4th thoracic segment. Lateral border furrow well defined. Librigenal doublure visible on internal or composite moulds, as wide as librigenal border. Librigenal spine following the curvature of the librigenal margin, extended slightly outwards.

Thorax with 13 segments. Thoracic pleurae wider than axial ring, bent strongly downwards (in unflattened specimens) from fulcral process that is located slightly closer to axial ring than half pleural length. Pleural furrows long, shallower close to the axial ring and becoming gradually narrower and more pronounced abaxially, extending from and connected with axial furrow almost up to the abaxial tip of the pleura. Pleural terminations extending into pleural spines that are slightly curved backwards except for the posteriormost pleurae in which the spines are either not curved backwards or not developed. Axial rings in the anterior half of the thorax with prominent median spine that is curved backwards and ends in a sharp tip. Subsequent spines overlap one another when thorax is outstretched. The most prominent spines present in the middle part of thorax, on the 4th to 7th segments, where they are broad-based, thick and long.

Pygidium small, nearly flat, almost twice as wide as long, with axis transversely wider than pleural region. Axis with two obsolescent axial rings, strongly tapering backward and with rounded terminal axial piece that does not reach the posterior margin of the pygidium. Articulating half-ring with lateral margins slightly convergent towards axis. Pleural regions subtriangular, almost undifferentiated except for two pleural furrows, the anterior one being more pronounced. Border flat, very poorly defined from pleural regions. Pygidial margin with two pairs of small, inwardly directed pygidial spines, of which the anterior one is relatively longer and more broad-based. Distance between posterior spines slightly wider transversely than anterior width of axis.

MEASUREMENTS: Cranidial length with occipital spine 5.2–18 mm; cranidial width across centre of palpebral lobes 6.7–18.8 mm (n=73). The largest, almost complete exoskeleton is longer than 30 mm (MWG ZI/29/1519).

REMARKS: *Strenuella polonica* differs from *S. zbelutkae* Orłowski, 1985a, another species of *Strenuella* from the HCM, in a more elevated glabella and a more prominent anterior margin, more distinct lateral glabellar furrows, slightly shorter palpebral lobes in relation to cranidial length, a less rounded anterior margin, an anterior border furrow deflected rearwards, and a shorter occipital spine that is less broad-based. From *Strenuella strenua* (Billings, 1874), the type species, it differs in a higher width to length ratio, a sagittally longer frontal area, an anterior border distinctly separated from preglabellar field, more distinct lateral glabellar furrows and a slightly longer occipital spine, as well as a more slender librigenal spine (see e.g., Shaw 1950, pl. 79, figs 2, 5, 14). The medially deflected anterior border furrow also seems to be a distinguishing feature in this case, although Shaw (1950, p. 580) noted a thickening of the border in *S. strenua* from Attleboro, Massachusetts, USA, as a feature of larger cranidia and ascribed it to maturity or geronticism. Thoraces of *S. polonica*, known from over 80 specimens, are very similar to the thorax assigned to *S. strenua*, illustrated originally by Shaler and Foerste (1888, pl. 2, fig. 21) and re-illustrated by Shaw (1950, pl. 79, figs 11–13), particularly in the arrangement of the thoracic spines (see description in Shaw 1950, p. 580). A distorted but complete specimen of *Strenuella* sp.

from Cierro del Hierro (southern Spain) (Mayoral *et al*. 2008, fig. 6g) shows the same arrangement of thoracic medial spines. Likewise, distorted thoraces of *Strenuella* (*Myopsostrenua*) *sabulosa* Rushton, 1966 (now considered a separate genus, see Geyer 1990b, p. 96), illustrated in Bullock *et al.* (2011), show the same, conservative thoracic morphology, seemingly characteristic of this group of trilobites.

Despite the lack of a formal description of the species by Czarnocki, the identity of the taxon was clear to Samsonowicz (1959c), so that he was able to identify the species in old museum collections (many specimens still have original museum labels from Czarnocki's times) and in exposures. Samsonowicz (1959c) referred to Czarnocki (1927a) as the original publication in which the species was mentioned for the first time. However, the first published report with the taxon name was by Czarnocki (1926), and this year should be used with the species name. This is supported also by the fact that the paper by Czarnocki (1927a) is an abstract from the International Geological Congress held in Madrid in 1926.

According to the original museum label for specimen MUZPIG 1.II.91, *Strenuella polonica* was the first Early Cambrian trilobite found in the HCM area already in 1915 (Text-fig. 10K). This very characteristic Cambrian trilobite from the HCM was capable of spiral enrolment, a feature that was noted already by Samsonowicz (1959c), Bergström (1973a), Orłowski (1985a) and Geyer (1990b). The exoskeleton was relatively spinose, with backwardly directed spines located on the occipital ring, librigenae, almost all thoracic axial segments and thoracic pleurae, and also on the pygidial margin. When enrolled, the animal could have posed a serious challenge for potential predators of the Cambrian sea (Żylińska and Kin 2010). The mechanism of enrolment in this species along with the possible causes of such behaviour will be discussed in detail in a separate paper.

OCCURRENCE: Cambrian Series 2, *Holmia*–*Schmidtiellus* Assemblage Zone; Ocieseki Formation at Igrzyczna Hill, Jaźwina Hill, Leśniakowa Dębina, Madeje, Ociesęki, Pranie, Rembów, Sterczyna Hill, HCM.

Strenuella zbelutkae Orłowski, 1985a
(Text-fig. 11)

partim 1959c. *Strenuella* cf. *lakei* Hupé; Samsonowicz, pp. 526, 527, pl. 2, figs 1, 2, *non* pl. 2, fig. 3 (= *Strenuella polonica*).

1985a. *Strenuella zbelutkae* sp. n.; Orłowski, pp. 243, 244, text-fig. 13, pl. 4, figs 7, 8.

HOLOTYPE: Cranidium MWG ZI/42/035 (former numbers: IGP UW Zb2, 1.436), illustrated in Samsonowicz (1959c, pl. 2, figs 1a–c) as *Strenuella* cf. *lakei*, Orłowski (1985a, pl. 4, fig. 7) and Text-fig. 11B herein, from the *Holmia*–*Schmidtiellus* Assemblage Zone, Kamieniec Formation at Zbelutka, HCM.

EMENDED DIAGNOSIS: A species of *Strenuella* with glabella and anterior border only slightly elevated above the fixigenae; two pairs of almost effaced, short lateral glabellar furrows; anterior border furrow slightly less pronounced medially; occipital furrow less pronounced medially; occipital spine broad-based and long, extending into sharp tip.

AVAILABLE MATERIAL: Over 90 cranidia, including the holotype, in variable states of preservation.

DESCRIPTION: Cranidium subquadrate, overall convexity low, glabella and anterior border only slightly elevated above the fixigenae, length including occipital spine 115±7% of maximum width across centre of palpebral lobes (n=10). Glabella slightly elevated above the fixigenae, 81±3% of cranidial length including occipital spine and 40±3% of cranidial width across occipital ring (n=10); only slightly narrowing forwards. Frontal lobe slightly rounded to acute anteriorly. Two pairs of short and shallow, obsolescent lateral glabellar furrows. Occipital furrow shallow and wide, less pronounced medially, and slightly curved rearwards. Occipital ring 20±3% of cranidial length (n=5), 29±4% of cranidial length including occipital spine (n=9), of similar transverse convexity as glabella, undifferentiated. Occipital spine with stout base, narrowing evenly backwards, relatively long and terminating in a sharp, broad-based tip. Axial furrows shallow and wide. Fixigenae nearly flat, at a slightly lower level than glabella, with posterior limbs slightly deflected abaxially, 70±8% of transverse occipital ring width (n=10). Palpebral lobes 25±2% of cranidial length including occipital spine (n=10), crescent-shaped and at a slightly higher level than the fixigenae but not upturned abaxially, separated from fixigenae by an obsolescent palpebral furrow. Palpebral lobes passing without any discontinuity but only slight change of angle into slightly elevated, very narrow eye ridges. Eye ridges slightly oblique, disconnected from glabella, passing into a vaguely marked parafrontal band. Anterior branch of facial suture almost parallel from palpebral lobes to frontal margin, then curving sharply adaxially. Posterior branch slightly divergent, short. Frontal area 19±3% of cranidial length including occipital spine (n=10), poorly separated into only slightly elevated anterior border and flat preglabel-

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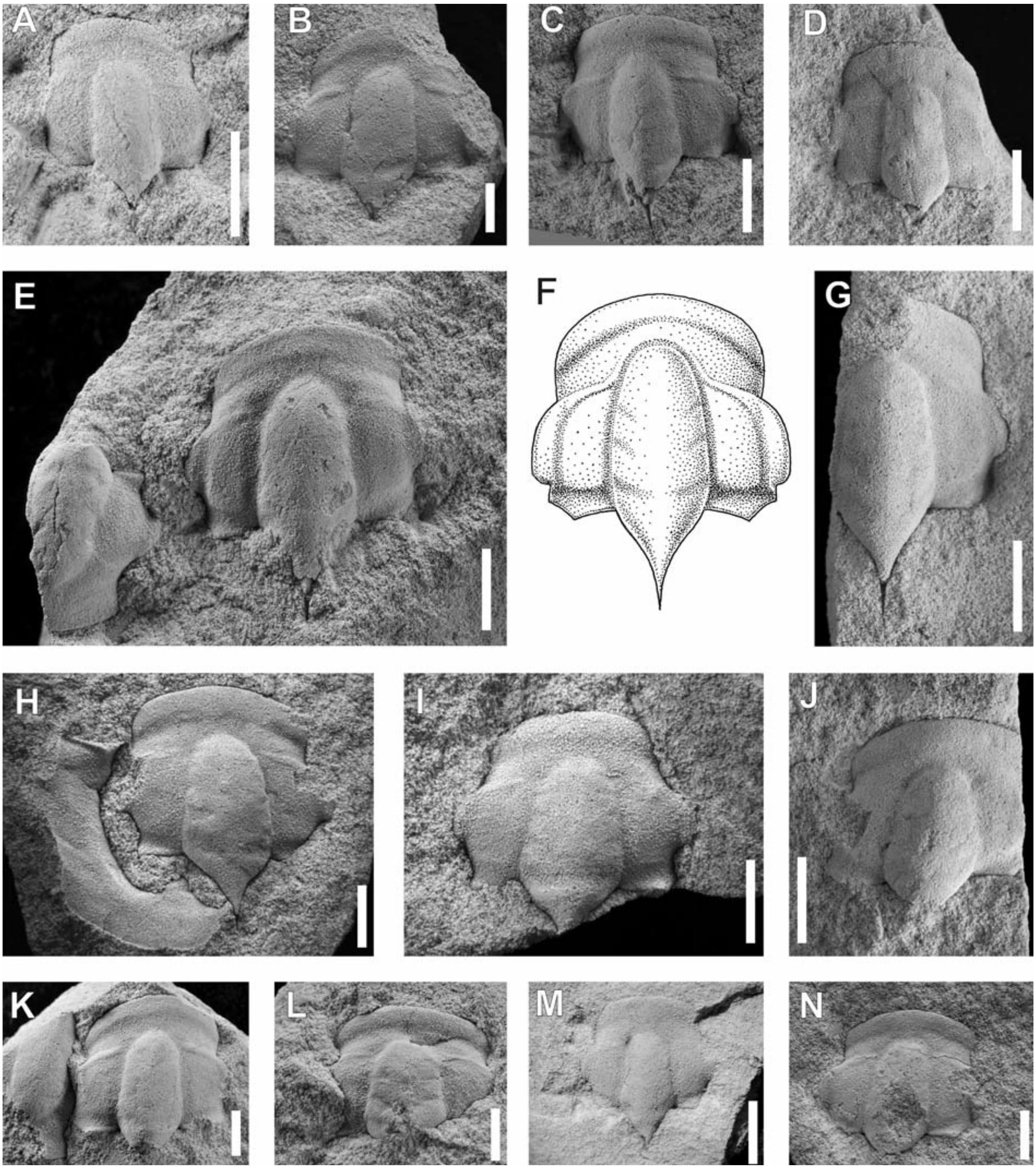
lar field. Anterior border about half of frontal area. Posterior furrow of medium width and shallow, becoming slightly wider abaxially. Posterior margin with fulcrum located at half width of posterior limb. Librigena, thorax and pygidium unknown.

MEASUREMENTS: Cranidial length including occipital spine 11.5–21 mm; cranidial width across centre of palpebral lobes 11.8–17.9 mm (n=10). Holotype cranidium with occipital spine is 16.5 mm long and 14 mm wide across centre of palpebral lobes.



Text-fig. 11. *Strenuella zbelutkae* Orłowski, 1985a from the *Holmia–Schmidtiellus* Assemblage Zone in the Kamieniec (K) or Ocieseki (O) formations, Holy Cross Mountains. **A** – MUZPIG 110.II.233, locality unknown (O); **B** – MWG ZI/42/035, holotype, original of Samsonowicz (1959c, pl. 2, fig. 1a–c) and Orłowski (1985a, pl. 4, fig. 7), Zbelutka (K); **C** – MUZPIG 113.II.2a, Zbelutka (K); **D** – MWG ZI/42/040, original of Orłowski (1985a, pl. 4, fig. 8); **E** – MUZPIG 113.II.2C, Zbelutka (K); **F** – reconstruction of the cranidium; **G** – MWG ZI/42/029, original of Samsonowicz (1959c, pl. 2, fig. 2), Zbelutka (K); **H** – MUZPIG 113.II.4A, Zbelutka (K); **I** – MUZPIG 110.II.168B, laterally deformed cranidium, locality unknown; **J** – MWG ZI/29/1286b, Zbelutka (K); **K** – MUZPIG 113.II.2B, Zbelutka (K); **L** – MUZPIG 110.II.168C, locality unknown; **M** – MUZPIG 110.II.160B, Ocieseki (O); **N** – MWG ZI/29/1289, Zbelutka (K). Scale-bar represents 0.5 mm

REMARKS: Comparison of *S. zbelutkae* with *S. polonica* is presented in the description of the latter species. From *S. strenua*, *S. zbelutkae* differs in a sagittally longer frontal area, longer palpebral lobes and a stout-based, long occipital spine. This species is one of the most abundant taxa in the Kamieniec Shales and seems to represent a species more adapted to the deeper environment of this formation.

OCCURRENCE: Cambrian Series 2, *Holmia–Schmidtiellus* Assemblage Zone; Ociesęki Formation at Leśniakowa Dębina and Ociesęki; Kamieniec Formation at Dąb and Zbelutka, HCM.

Subfamily Protoleninae Richter et Richter, 1948 emend. Geyer, 1990b

Termierella Hupé, 1953

TYPE SPECIES: *Termierella latifrons* Hupé, 1953 from the *Sectigena* and *Hupeolenus* zones of the Issafen Syncline, Anti-Atlas, Morocco, by original designation.

Termierella sandomirensis Samsonowicz, 1962 (Text-fig. 12)

partim 1962. *Termierella sandomiriensis* n. sp.; Samsonowicz, pp. 18, 19, pl. 1, figs 1–6, *non* fig. 7 (= *Berabichia oratrix*).

1962. *Strenuella polonica* Czarnocki (nomen nudum), 1927, Samsonowicz, 1959; Samsonowicz, p. 20, pl. 3, fig. 9.

1985a. *Strenuella sandomirensis* (Samsonowicz, 1962); Orłowski, pp. 242, 243, text-fig. 12, pl. 4, figs 9–11.

1990. *Termierella sandomirensis* Samsonowicz, 1962; Lendzion and Orłowski in Pajchlowa, p. 57, pl. 16, fig. 1.

HOLOTYPE: Cranidium MWG ZI/42/043 (former number: IGP UW Gr4) from the *Holmia–Schmidtiellus* Assemblage Zone at Gieraszowice, HCM, illustrated in Samsonowicz (1962, pl. 1, fig. 3), Orłowski (1985a, pl. 4, fig. 11), Lendzion and Orłowski (in Pajchlowa 1990, pl. 16, fig. 1) and Text-fig. 12A herein.

EMENDED DIAGNOSIS: A small species of *Termierella* with the anteriormost pair of lateral glabellar furrows obsolescent, eye ridges widening close to glabella and occipital ring with short, broad-based spine.

AVAILABLE MATERIAL: 12 cranidia, including the holotype.

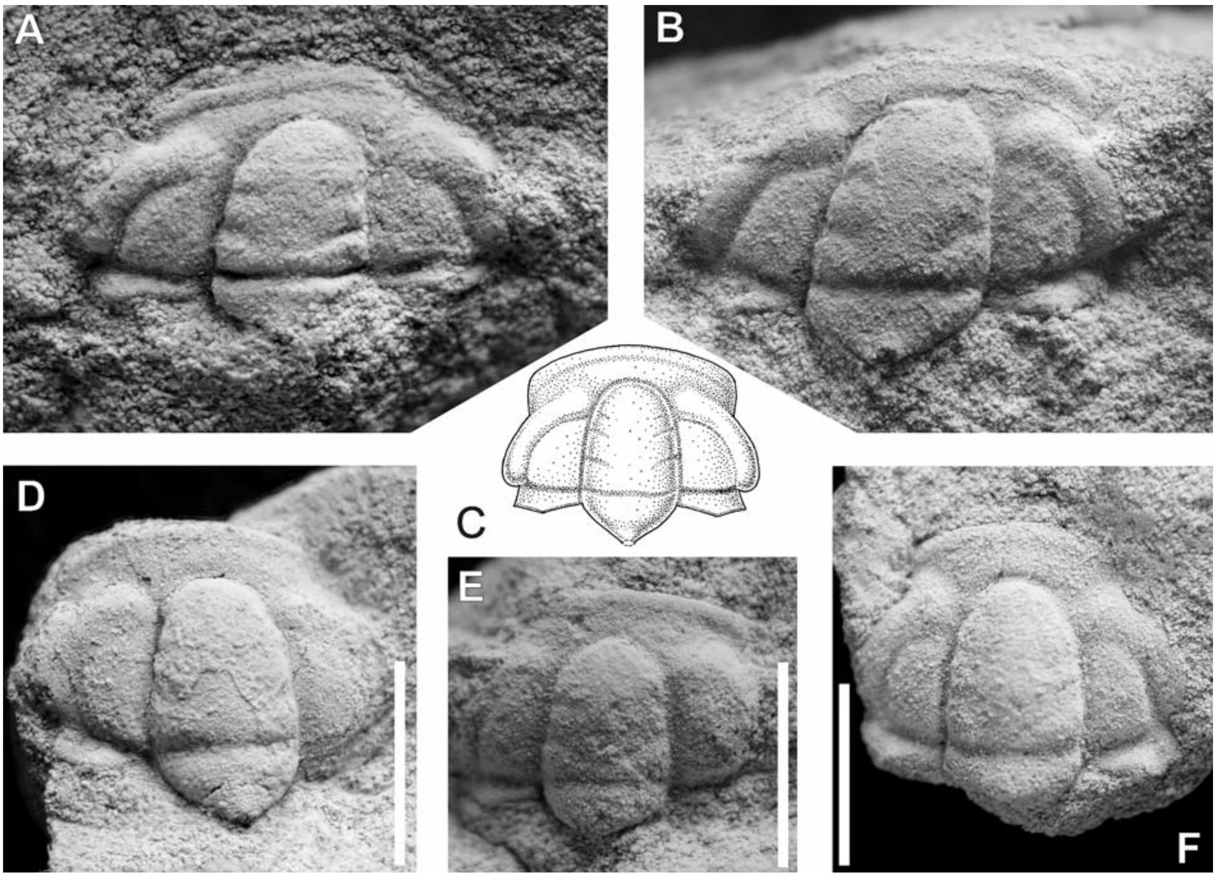
DESCRIPTION: Cranidium subtrapezoidal, overall convexity low, length 93–102% of maximum width across centre of palpebral lobes. Glabella distinctly elevated above the fixigenae, 81–88% of cranidial length and 46–47% of cranidial width across occipital ring; distinctly narrowing forwards. Frontal lobe bluntly rounded anteriorly. Three pairs of shallow, obliquely backward directed lateral glabellar furrows; the posteriormost furrow being the longest and relatively deepest, whereas the anteriormost is obsolescent, probably transverse and short. Occipital furrow transverse, relatively deep and narrow, slightly shallower and deflected forwards at mid-line. Occipital ring 26–29% of cranidial length, of similar transverse convexity as glabella, with triangular posterior margin extending into narrow and relatively short occipital spine. Axial furrows of moderate depth, narrow and distinct. Fixigenae flat, distinctly elevated above the surrounding furrows, located at slightly lower level than glabella, about 65% of transverse occipital ring width. Palpebral lobes 27–30% of cranidial length, crescent-shaped and slightly elevated above the fixigenae, separated from them by a palpebral furrow of almost the same depth as the axial furrows. Palpebral lobes passing evenly into elevated, almost transverse, wide eye ridges, generally of the same width as the palpebral lobes, then slightly broadening close to glabella and terminating at axial furrows at level of third lateral glabellar furrow. Anterior branch of facial suture only slightly divergent from palpebral lobes to frontal margin, then curving sharply adaxially, shortly anterior to the border furrow to meet the anterior margin anterior to the most elevated part of the preocular fields. Posterior branch divergent and distinctly ventrally deflected. Frontal area 12–19% of cranidial length, separated into slightly elevated anterior border and flat preglabellar field. Length of anterior border about one-third of frontal area. Posterior furrow deep and narrow, only slightly wider abaxially. Posterior margin with fulcrum located at approximately half width of posterior limb. Librigena, thorax and pygidium unknown.

MEASUREMENTS: Cranidial length with occipital spine 5.3–10.2 mm; cranidial width across centre of palpebral lobes 8–10 mm (n=2). The lower values are of the holotype cranidium.

REMARKS: This species is known from 12 cranidia, the original specimens of Jan Samsonowicz from Gieraszowice. They also display some degree of tectonic deformation (wide and narrow specimens) and the original width to length ratio is not clear. The reconstruction (Text-fig. 12C) is a compromise between sagittally and transversely distorted cranidia, taking into account that the illustrated specimens of other species of *Termierella* are generally wider than long (e.g. Hupé 1953, pl. 9, fig. 24, pl. 10, figs 1–4; Geyer 1990b, pl. 55, figs 4, 9, 11).

From the type species, *Termierella latifrons* Hupé, 1953, it differs in having a lower width to length ratio, a sagittally slightly longer and wider glabella, very short anteriormost lateral glabellar furrows and a longer occipital ring, an occipital spine, and in lacking grooves on the palpebral lobes. According to the footnote in Samsonowicz's posthumous paper (Samsonowicz 1962, p. 10), his manuscripts did not state to which of the subgenera of *Termierella* distinguished at that time this species belonged; an apparent comparison with Hupé's subgenera allowed assignment to *Brevitermierella* Hupé, 1953. At present, *Brevitermierella* is considered a separate genus (Geyer 1990b, p. 209), distinguished from *Termierella* by a sagittally narrow preglabellar field and a much longer posteriormost lateral glabellar furrow. The specimens at hand have a relatively long preglabellar field sagittally, distinct furrows separating the large palpebral lobes from the fixigenae and in general proportions resemble *Termierella* rather than *Brevitermierella*. In general proportions, the specimens at hand are close to *Termierella* sp. B from Guadalcanal in southern Spain (Sdzuy 1962), but differ in a slightly wider (tr.) glabella, lack of grooves on the palpebral lobes and the presence of an occipital spine. The discussed specimens differ from another species from Spain, *Termierella sevillana* Sdzuy, 1961, in a relatively wider (tr.) glabella, less pronounced lateral glabellar furrows, lack of grooves on the palpebral lobes and anterior facial sutures that are almost parallel and do not diverge abaxially as in *T. sevillana* (Sdzuy 1961).

Orłowski (1985a) attributed these specimens to *Strenuella*, based on the lack of grooves on the palpebral lobes and the presence of an occipital spine. The grooves on the palpebral lobes are generally not present in specimens of *T. latifrons* from Morocco illustrated by Geyer



Text-fig. 12. *Termierella sandomirensis* Samsonowicz, 1962 from the *Holmia*–*Schmidtiellus* Assemblage Zone in the Ociesęki Formation at Gieraszowice, Holy Cross Mountains. **A** – MWG ZI/42/043, holotype, slightly deformed cranidium, original of Samsonowicz (1962, pl. 1, fig. 3) and Orłowski (1985a, pl. 4, fig. 11); **B** – MWG ZI/42/034, original of Samsonowicz (1962, pl. 1, fig. 4) and Orłowski (1985a, pl. 4, fig. 10); **C** – reconstruction of the cranidium; **D** – MWG ZI/42/056, original of Samsonowicz (1962, pl. 1, fig. 1) and Orłowski (1985a, pl. 4, fig. 9); **E** – MWG ZI/42/032, original of Samsonowicz (1962, pl. 1, fig. 6); **F** – MWG ZI/42/053, original of Samsonowicz (1962, pl. 1, fig. 2). Scale-bar represents 0.5 mm

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(1990b, pl. 55, figs 1, 8, 9; pl. 56, fig. 4); moreover, the specimens at hand are poorly preserved and do not allow the recognition of all details. Specimens from the Montagne Noire, assigned by Courtessole and Jago (1980) to "cf. *Termierella* sp. no. 1" and "cf. *Termierella* sp. no. 2", are rather poorly preserved, but display the cranidial proportions, pattern of lateral glabellar furrows and shape of palpebral lobes as in *Termierella*. These specimens do not have grooves on the palpebral lobes and "cf. *Termierella* sp. no. 2" even may have had an occipital spine (Courtessole and Jago 1980, p. 18). A specimen of *T. latifrons* illustrated in Geyer (1990b, pl. 54, fig. 7a) has a small knob on the occipital ring.

OCCURRENCE: Cambrian Series 2, *Holmia–Schmidtiellus* Assemblage Zone; Ocieşęki Formation at Gieraszowice, HCM.

Order Corynexochida Kobayashi, 1935
Suborder Corynexochina Kobayashi, 1935
Family Chengkouiidae Zhu in Zhang *et al*., 1980

REMARKS: Geyer and Malinky (1997, pp. 627, 628) discussed the problems with higher-level classification of the family due to mixed ellipsocephalacean and corynexochoid features of the exoskeleton in its representatives. Landing *et al.* (2008) assigned the Chengkouiidae with doubt to Corynexochida. Allocation to the Corynexochida is also in Adrain (2011).

Acanthomicmacca Hupé, 1953

TYPE SPECIES: *Micmacca walcotti* Mathew, 1899, from the upper lower Cambrian basal Brigus Formation, south-east Newfoundland, Canada, by original designation.

REMARKS: The concept of the genus was discussed by Geyer and Malinky (1997). It encompasses also *Myopsomicmacca* Hupé, 1953, *Jaskovitchella* Repina in Repina *et al*., 1975 and *Chengkouia* Qian and Yao in Lu *et al*., 1974 (Geyer 1990b; Geyer and Malinky 1997; Jell and Adrain 2003).

Acanthomicmacca klimontowi Orłowski, 1985a
(Text-fig. 13)

partim 1962. *Strenuaeva primaeva* (Brögg.); Samsonowicz, p. 11, pl. 2, fig. 5, *non* pl. 2, figs 1–4, 6, 7 (= *Berabichia oratrix*).

1962. *Strenuella* cf. *lakei* Hupé; Samsonowicz, p. 12, pl. 3, figs 6–8.

1985a. *Ellipsocephalus simplex* sp. n.; Orłowski, p. 239; text-fig. 8, pl. 7, fig. 3.

1985a. *Micmacca* (*Acanthomicmacca*) *klimontowi* sp. n.; Orłowski, pp. 246, 247, text-fig. 16, pl. 7, figs 5–8.

HOLOTYPE: Cranidium MWG ZI/29/1297 (former number: IGP UW D6), illustrated in Samsonowicz (1962, pl. 3, fig. 7) as *Strenuella* cf. *lakei*, Orłowski (1985a, pl. 7, fig. 5) and Text-fig. 13A herein, from the *Holmia–Schmidtiellus* Assemblage Zone in the Kamieniec Formation at Dąb, HCM.

EMENDED DIAGNOSIS: A species of *Acanthomicmacca* with a parallel-sided glabella both in juveniles and adults; occipital ring with terminal occipital spine; relatively long, distinct eye ridges, relatively wide preocular fields, anterior border almost flat to slightly convex in sagittal section, elevated above the preglabellar field.

AVAILABLE MATERIAL: Over ninety cranidia, including the holotype, in various preservational state.

DESCRIPTION: Cranidium subquadrate, overall convexity modest, glabella distinctly elevated above the fixigenae, length excluding occipital spine 83±8% of maximum width across centre of palpebral lobes (n=8) and 100±9% including occipital spine (n=9). Glabella 77±6% of cranidial length including occipital spine (n=9) and 39±3% of cranidial width across occipital ring (n=17), with parallel sides both in juveniles and adults. Frontal lobe bluntly rounded anteriorly. Lateral glabellar furrows almost effaced; in some specimens two(?) backwardly directed furrows are faintly visible. Occipital furrow obsolescent, transverse. Occipital ring 15±2% of cranidial length (n=7), 26±7% including occipital spine (n=7), of similar transverse convexity as glabella, undifferentiated, slightly wider at sagittal midline, so that the occipital ring clearly tapers towards the axial furrows. Short, terminal occipital spine present, its length approximately the sagittal width of the occipital ring, narrowing backwards and terminating in a sharp tip. In smaller specimens the base of the spine is relatively broader than in adult individuals. Axial furrows shallow, wide, slightly shallower in front of anterior lobe. Fixigenae almost flat, their posterior limbs slightly sloping downwards abaxially, 78±11% of transverse occipital ring width (n=16). Palpebral lobes 26±4% of cranidial length including occipital spine (n=9), crescent-shaped and nearly flat, slightly elevated above the fixigenae, separated from them by a shallow and narrow palpebral fur-

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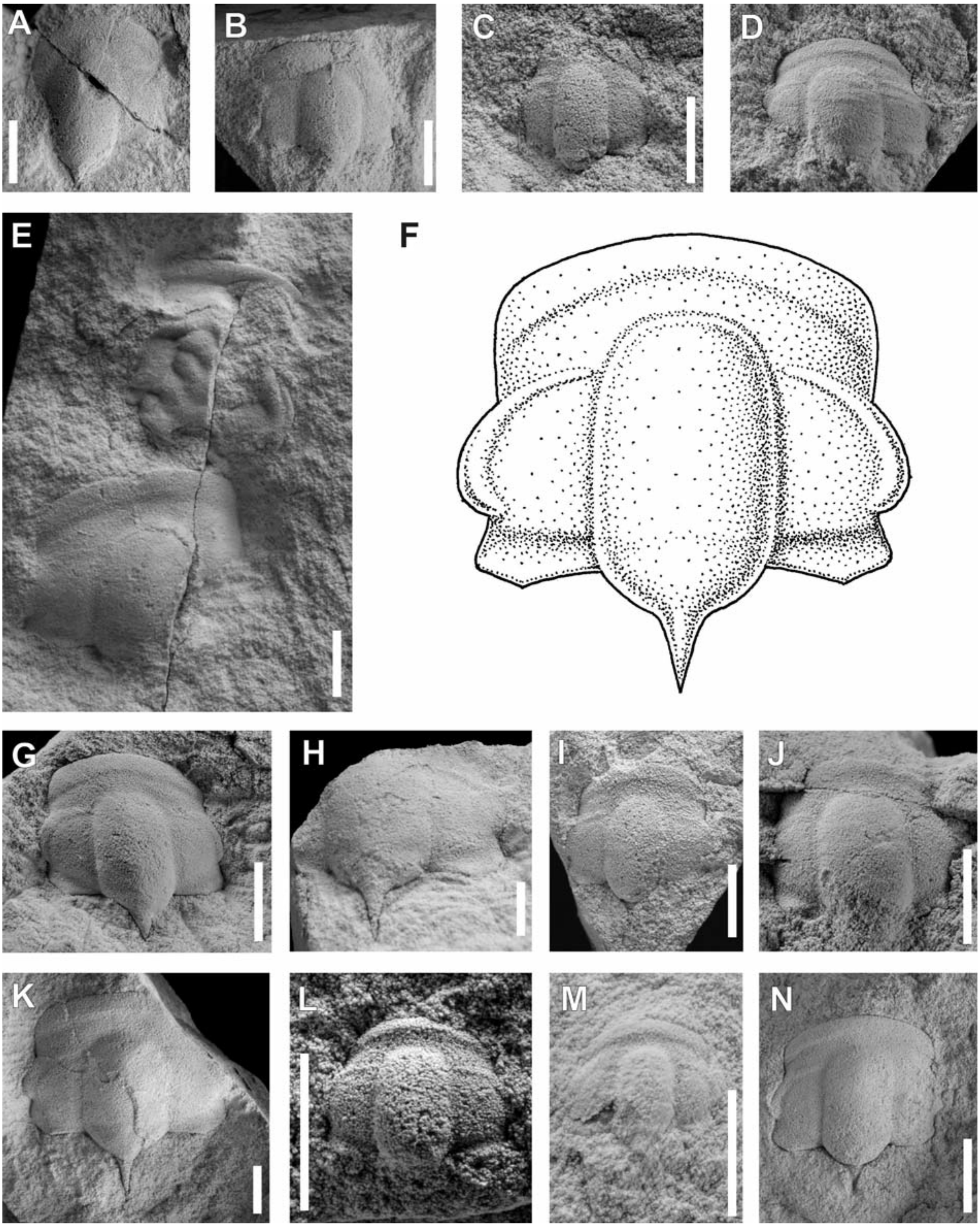


Text-fig. 13. *Acanthomicmacca klimontowi* Orłowski, 1985a from the *Holmia–Schmidtiellus* Assemblage Zone in the Kamieniec (K) or Ociesęki (O) formations, Holy Cross Mountains. **A** – MWG ZI/29/1297, holotype, original of Samsonowicz (1962, pl. 3, fig. 7) and Orłowski (1985a, pl. 7, fig. 5), Dąb (K); **B** – MWG ZI/42/037, original of Orłowski (1985a, pl. 7, fig. 8), Dąb (K); **C** – MWG ZI/42/042, original of Samsonowicz (1962, pl. 4, fig. 2), Dąb (K); **D** – MUZPIG 110.II.214, Igrzyczna Hill (O); **E** – MWG ZI/29/1309, with *Holmia marginata* Orłowski, 1974 (upper specimen), Dąb (K); **F** – reconstruction of the cranidium; **G** – MUZPIG 110.II.186, Ociesęki (O); **H** – MWG ZI/42/050, original of Orłowski (1985a, pl. 7, fig. 7), Dąb (K); **I** – MWG ZI/29/1305, Dąb (K); J – MUZPIG 8.II.3, Julianów (K); **K** – MWG ZI/29/1302, Dąb (K); **L** – MWG ZI/29/1299, Dąb (K); **M** – MUZPIG 1.II.8, Zbelutka (K); **N** – MWG ZI/29/1307, Wola Wąkopna (O). Scale-bar equals 0.5 mm row. Palpebral lobes evenly passing into oblique eye-ridges that are slightly elevated, cord-like and disconnected from glabella, terminating approximately slightly posterior to the anterior lobe. Anterior branch of facial suture slightly divergent from palpebral lobes to frontal margin, then curving sharply adaxially. Posterior branch divergent, moderately short. Frontal area 22±6% of cranidial length including occipital spine (n=9), poorly separated into only slightly elevated anterior border and flat preglabellar field. Anterior border about the sagittal length of the frontal area. Posterior furrow of medium width and very shallow, becoming slightly wider abaxially. Posterior margin with fulcrum located from axial furrows at about two-thirds width of posterior limb.

MEASUREMENTS: Cranidial length with occipital spine 5.8–19 mm; cranidial width across centre of palpebral lobes 5.6–20 mm (n=9). Holotype cranidium with occipital spine is 15.8 mm long and 16 mm wide across centre of palpebral lobes.

REMARKS: *Acanthomicmacca klimontowi* was introduced by Orłowski (1985a) based on two specimens assigned by Samsonowicz (1962) to *Strenuella* cf. *lakei* Hupé, 1953. At that time, *Acanthomicmacca* Hupé, 1953 was treated as a subgenus of *Micmacca* Matthew, 1895. The morphology and concept of *Micmacca* were discussed by Westrop and Landing (2000), who restricted that genus to its type species, *Micmacca matthevi* Matthew, 1895. *Acanthomicmacca* was treated as a distinct genus by Geyer and Malinky (1997), Westrop and Landing (2000) and Jell and Adrain (2003). The familial assignment of this species is still a matter of debate; the opinion of Geyer (1990b), Geyer and Malinky (1997) and Jell and Adrain (2003) including it in the Chengkouiidae is followed herein.

Acanthomicmacca klimontowi differs from the type species as well as other species of the genus (see overview in Geyer and Malinky 1997, p. 631) in a higher length to width ratio (which is equal almost to 1 when the occipital spine is included), a sagittally longer and relatively flat frontal area and relatively wider fixigenae posteriorly (about four-fifths of glabellar width). Similarly as in *A. neltneri* Hupé, 1953 (e.g. Geyer and Malinky 1997, figs 7.4, 7.6), the lateral glabellar furrows are almost effaced. Both the juvenile and adult forms of *A. klimontowi* have a glabella with parallel sides, in contrast to *A. neltneri*, which so far is the only species in *Acanthomicmacca* that possesses a glabella with constricted sides in adults and an anteriorly expanding glabella in juveniles.

A number of specimens representing this species have also been discovered in Samsonowicz's and Czarnocki's collections in the Museum of the Polish Geological Institute (MUZPIG); they were collected in Zbelutka, Olbierzowice, Julianów and Ocieseki, and assigned previously to *Strenuella* sp. or left undetermined, as is evident from the museum labels. Moreover, the holotype and only specimen of *Ellipsocephalus simplex* (Orłowski 1985a, pl. 7, fig. 3) from Kucebrza is an effaced individual of *A. klimontowi* with the occipital spine not preserved. The analyzed collections yield many effaced or spineless representatives of *A. klimontowi* whose overall appearance is very like this specimen.

OCCURRENCE: Cambrian Series 2, *Holmia–Schmidtiellus* Assemblage Zone; Ocieseki Formation at Ocieseki and Wola Wąkopna; Kamieniec Formation at Zbelutka, Dąb, Julianów, Kucebrza and Olbierzowice, HCM.

Order Uncertain
Family Atopidae Hupé, 1953

Genus *Atops* Emmons, 1844

TYPE SPECIES: *Atops trilineatus* Emmons, 1844 from Cambrian Series 2 of the New York State, by monotypy.

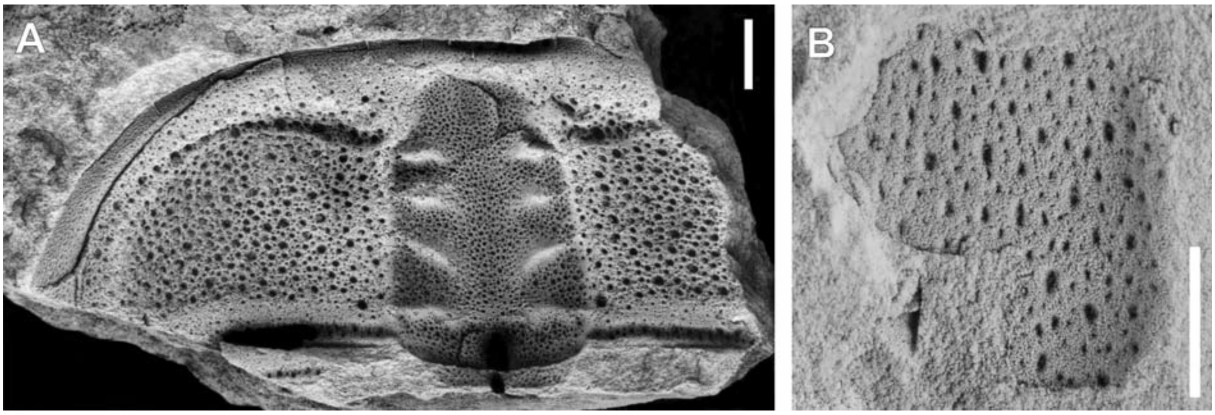
Atops granulatus Orłowski, 1985c
(Text-fig. 14)

1985c. *Atops granulatus* n. sp.; S. Orłowski, pp. 976, 977, fig. 2.

HOLOTYPE: Cephalon MWG ZI/29/3732 (former number: IGPUW/T/1), from the *Holmia–Schmidtiellus* Assemblage Zone in the Ocieseki Formation at Sterczyna Hill, HCM, illustrated in Orłowski (1985c, fig. 2) and Text-fig. 14A herein.

AVAILABLE MATERIAL: One incomplete cephalon, which is the holotype, one cephalic fragment with ornamentation tentatively assigned to the species, one pleura.

REMARKS: A fragmentary internal mould of the cephalon (Text-fig. 14B) from Czarnocki's collection in the Museum of the Polish Geological Institute (MUZPIG) shows an ornamentation composed of densely distributed larger and smaller pits. The holotype cephalon of *Atops granulatus* (Text-fig. 14A) is provided with large, fairly closely packed pits together with smaller ones on the genal fields, and smaller closely packed pits on the glabella. The small cephalic fragment shows the test with



Text-fig. 14. *Atops granulatus* Orłowski, 1985c from the *Holmia–Schmidtiellus* Assemblage Zone in the Ocieseki Formation, Holy Cross Mountains. **A** – MWG ZI/29/3732, holotype, Sterczyna Hill, original of Orłowski (1985c, fig. 2); **B** – MUZPIG 110.II.154, cephalic fragment with ornamentation, Leśniakowa Dębina. Scale-bar represents 0.5 mm

its characteristic ornamentation and is tentatively assigned to the species because the larger pits seem elongate in transverse section and not round.

OCCURRENCE: Cambrian Series 2, *Holmia–Schmidtiellus* Assemblage Zone; Ocieseki Formation at Sterczyna Hill, HCM.

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APPENDIX

Distribution of trilobites (in alphabetical order) in particular exposures (those within the Kamieniec Formation are underlined) with their repository numbers [MWG Museum of the Faculty of Geology, University of Warsaw (ZI/29/ collection of Stanisław Orłowski; ZI/42/ collection of Jan Samsonowicz); MUZPIG Museum of the Polish Geological Institute (1.II; 110.II and 113.II collections of Jan Czarnocki; 8.II collection of Jan Samsonowicz); AK collection of Adrian Kin, Museum of the Geoscience Friends Association "Phacops", Łódź; UJ 214P collection of Michał Stachacz, Institute of Geology, Jagiellonian University, Cracow. Abbreviations: ce – cephala, cr – cranidia, pl – pleurae, th – thoraces, pyg – pygidia; lib – librigenae; hyp – hypostomata; com – complete specimens; ax – axial shields; fr – various fragments. Type specimens are in **bold**.

Acanthomicmacca klimontowi Orłowski, 1985a – <u>Dąb</u>: cr [MWG ZI/29/1287, 1288, **1297**, 1298, 1300–1302, 1304–1306, 1309, 1310, 1313–1317, 1573; MWG ZI/42/031, 036–038, 042, 050, 054, 055, 064, 244, 245, 247, 249–251, 256]; Igrzyczna Hill: cr [MUZPIG 110.II.214]; <u>Julianów</u>: cr [MUZPIG 8.II.3]; <u>Kucebrza</u>: cr [MWG ZI/29/1292, 1296, 1311, 1312; MWG ZI/42/027, 028]; Ociesęki: cr [MWG ZI/42/234; MUZPIG 110.II.137, 142, 186]; <u>Olbierzowice</u>: cr [MUZPIG 8.II.7, 8]; Wola Wąkopna: cr [MWG ZI/29/1303, 1307, 1308]; <u>Zbelutka</u>: cr [MWG ZI/42/254; MUZPIG 1.II.8, 8a; MUZPIG 113.II.1A, 14]; unknown locality: cr [MUZPIG 110.II.176A].

Atops granulatus Orłowski, 1985c – Leśniakowa Dębina: fr [MUZPIG 110.II.154]; Sterczyna Hill: cr [MWG ZI/29/**3732**], pl [MWG ZI/29/3733].

Berabichia oratrix (Orłowski, 1985a) – Buczyna: com [MWG ZI/42/007], cr [MWG ZI/42/237]; Cisów: cr [AK 12/TA 1–9, 12–38], th [AK 12/TA 10, 11], ax [AK 12/TA 5-1]; Igrzyczna Hill: com [MWG ZI/29/**1340**, 1377, 1394, 1418, 1419], cr + th [MWG ZI/29/1395], cr [MWG ZI/29/1344–1347, 1351–1357, 1362–1368, 1398, 1421, 1431, 1435, 1440, 1441, 1447, 1454, 1455, 1458, 1459; MWG ZI/42/204, 209, 213, 233, 288]; Leśniakowa Dębina: com [MWG ZI/29/1434], cr [MUZPIG 1.II.23, 38, 42–44, 47, 57, 59, 63, 64, 68, 73, 80, 85–89; MUZPIG 110.II.29, 36, 37, 38, 56, 62, 68, 70–72, 77, 78, 82, 86, 93, 95–99, 102, 105, 108, 110, 115–123, 126, 130, 133, 135, 141–146, 150, 151, 155–159, 164, 182, 190, 219; MUZPIG 1716.II.2; MWG ZI/29/1103, 1105, 1263, 1341–1343, 1349, 1350, 1358–1360, 1378, 1380–1384 , 1386, 1388, 1389, 1391–1393, 1396, 1397, 1399–1409, 1417, 1420, 1422–1425, 1429, 1430, 1442, 1443, 1449, 1452, 1456, 1461, 1463, 1464, 1476, 1478, 1479, 1489, 1493, 1514, 1569; MWG ZI/42/068, 071, 086, 100, 188, 205, 207, 210, 212, 214, 218, 220, 223, 229–232, 236, 239–242, 269, 270, 276, 280–282, 284, 286; UJ 214P/T20, 23, 25], th [MWG ZI/42/205, 235], cr + lib [MWG ZI/29/1477]; Malkowska Hill: com [MWG ZI/29/1410], cr [MUZPIG 8.II.30, 31; MWG ZI/29/1368, 1372, 1373, 1451, 1457; MWG ZI/42/211, 216, 217, 267, 268, 271, 274, 277, 279], th [MWG ZI/42/287]; Nowa Huta: cr [MWG ZI/42/075]; Ociesęki: com [MWG ZI/29/1453; MUZPIG 1689.II.47], cr + th [MWG ZI/29/1439], cr [MUZPIG 110.II.166, 170–173, 183; MWG ZI/29/1260, 1361, 1371, 1385, 1413, 1415, 1416, 1427, 1432, 1433, 1444–1446, 1450, 1460, 1465, 1526, 1530; MWG ZI/42/021, 023, 070, 072, 077, 078, 081, 082, 084, 173, 178, 179, 182, 184–187, 190, 191, 193, 195–198, 200, 201, 224, 227, 228, 243, 272, 275, 278, 283, 285], th [AK 300/CD 20-1; MWG ZI/42/238]; Pranie: cr [MWG ZI/42/067, 069, 076, 085, 088, 089, 252, 264; MWG ZI/29/1376, 1436, 1437], lib [MWG ZI/42/083]; Rembów: cr [MWG ZI/29/1466, 1470]; Słowik: cr [MWG ZI/42/094; MWG ZI/29/1411, 1412]; Sterczyna Hill: com [MWG ZI/29/1438, 1471, 1472], cr + th [UJ 214P/T5, T6], cr + lib + th [AK 34/TA], cr [MWG ZI/29/1348, 1370, 1374, 1375, 1387, 1390, 1414, 1426, 1448, 1467, 1469, 1473, 1475, 1480–1483; UJ 214P/T11, T12], th [MWG ZI/29/1379, 1428, 1462, 1468, 1474]; Telegraf Hill: cr [MWG ZI/42/087]; Ujazdek: cr [MUZPIG 8.II.35; MWG ZI/42/074, 208]; <u>Zbelutka</u>: cr [MUZPIG 1.II.8B; MUZPIG 113.II.2, 4, 8]; unknown locality: cr [MUZPIG 110.II.174, 176A, 177, 180, 184, 189, 191–203, 205, 213, 229–231, 235], lib [MUZPIG 110.II.231].

Holmia glabra Orłowski, 1974 – Ociesęki: ce [MWG ZI/42/**153**], lib [MWG ZI/42/154].

Holmia marginata Orłowski, 1974 – <u>Dąb</u>: ce [MWG ZI/29/1052, 1075, 1309; MWG ZI/42/001–003, 008], hyp [MWG ZI/29/1068, 1076], lib [MWG ZI/42/014]; Igrzyczna Hill: ce + th [MWG ZI/29/3723], ce [MWG ZI/29/**0991**–0993, 0995–1002, 1004–1006, 1008–1023, 1025–1032, 1034–1036, 1038–1046, 1048, 1049, 1051, 1053, 1054, 1061, 1063–1065, 1070, 1073, 3722; MUZPIG 110.II.207, 214, 217], lib [MWG ZI/29/1070, 1074], hyp [MWG ZI/29/3725], th [MWG ZI/29/3728], pyg [MWG ZI/29/1062]; Leśniakowa Dębina: ce [MWG ZI/29/1007, 1059, 1066, 1067, 1071, 1077, MUZPIG 110.II.163], hyp [MWG ZI/29/1060, 1082], lib [MWG

ZI/29/1078], pyg [MWG ZI/29/3729, 3734], fr [MWG ZI/29/1079]; Malkowska Hill: ce [MWG ZI/29/1047]; Ociesęki: ce [MWG ZI/29/1050, 1055–1057, 1080; MWG ZI/42/004, 180], ce+lib [MUZPIG 110.II.221], hyp [MUZPIG 110.II.148], lib [MUZPIG 110.II.137, 144], pyg [MWG ZI/29/3730]; Sterczyna Hill: ce [MWG ZI/29/1024, 1058, 1081], hyp [MWG ZI/29/3724]; Stołowa Hill: ce [MWG ZI/29/1037]; Szczecno: ce [MWG ZI/29/1033]; Wola Wąkopna: ce [MWG ZI/29/0994, 1003, 1069], hyp [MWG ZI/29/1069], lib [MWG ZI/29/1072]; unknown locality: ce [MUZPIG 110.II.215, 220, 235], ce+lib [MUZPIG 110.II.160a, 169, 178, 229], lib [MUZPIG 110.II.234].

Holmia sp. – Buczyna: lib [MWG ZI/42/289]; Cisów: ce [MUZPIG 1.II.95]; Dąb: hyp [MWG ZI/42/005, 298], lib [MWG ZI/42/296]; Gieraszowice: ce [MWG ZI/42/292], hyp [MWG ZI/42/290], pl [MWG ZI/42/158, 294]; Malkowska Hill: lib [MWG ZI/42/155, 156, 159]; Kucebrza: lib [MWG ZI/42/160]; Ociesęki: ce [MWG ZI/42/197; MUZPIG 110.II.152], hyp [MWG ZI/42/202]; Pranie: lib [MWG ZI/42/006].

Kjerulfia orcina Orłowski, 1974 – Buczyna: ce [MWG ZI/42/016], lib [MWG ZI/42/010], pl [MWG ZI/42/015]; Dąb: th [MWG ZI/29/1153]; Igrzyczna Hill: ce [MWG ZI/29/1084, 1094, 1097, 1140, 1141, 1146, 1151, 1157], lib [MWG ZI/29/1061, 1095, 1142], hyp [MWG ZI/29/1180], pl [MWG ZI/29/1145, 1154, 1160, 1164, 1166, 1167]; Leśniakowa Dębina: ce [MWG ZI/29/1089, 1091–1093, 1107–1109, 1116, 1118, 1123, 1126, 1136, 1137, 1143, 1175, 1178; MWG ZI/42/025], lib [MWG ZI/29/1085, 1098, 1100, 1102, 1103, 1104, 1121, 1125, 1129, 1155, 1156, 1159, 1165, 1176], hyp [MWG ZI/29/1105, 1115, 1128, 1150, 1158], th [MWG ZI/29/1086, 1087, 1177], pl [MWG ZI/29/1117, 1148, 1149, 1161; MUZPIG 1.II.19, 20, 22–44]; Madeje: ce [MWG ZI/29/1106, 1119, 1120, 1130, 1134, 1138, 1152; MWG ZI/42/025], hyp [MWG ZI/29/1122], lib [MWG ZI/29/1146], pl [MWG ZI/42/026]; Malkowska Hill: lib [MWG ZI/42/157]; Ociesęki: ce [MWG ZI/29/**1083**, 1090, 1099, 1113, 1135; MWG ZI/42/021–023; MUZPIG 110.II.211], lib [MWG ZI/29/1112, 1114; MUZPIG 110.II.143], pl [MWG ZI/29/1110, 1111]; Sterczyna Hill: com [MUZPIG 1689.II.41], ce + th [MWG ZI/29/3727, 3735], ce [MWG ZI/29/1088, 1096, 1101, 1127, 1133, 1139, 1162, 1168, 1169, 1171, 1173, 1174, 1179, 1181–1184, 3731], lib [MWG ZI/29/1132, 1185], hyp [MWG ZI/29/3726], th [MWG ZI/29/1124, 1144, 1170], pl [MWG ZI/29/1163, 1172], fr [MWG ZI/29/1186]; Wola Wąkopna: th [MWG ZI/29/1187]; unknown locality: ce [MUZPIG 110.II.187].

Postfallotaspis spinatus Orłowski, 1985a – Igrzyczna Hill: ce [MWG ZI/29/**2130**].

Schmidtiellus nodosus Orłowski, 1985a – Igrzyczna Hill: ce + th [MWG ZI/29/1322], ce [MWG ZI/29/1321, 1324, 1326, 1329], pl [MWG ZI/29/1323, 1335]; Leśniakowa Dębina: ce [MWG ZI/29/1328, 1330]; Malkowska Hill: ce [MWG ZI/29/**1318**, 1325], pyg? [MWG ZI/29/1336], pl [MWG ZI/29/1337]; Pranie: lib [MWG ZI/42/066]; Sterczyna Hill: ce + th [MWG ZI/29/1320], ce [MWG ZI/29/1319, 1327, 1331, 1332, 1334], hyp [MWG ZI/29/1333].

Schmidtiellus panowi (Samsonowicz, 1959a) – Dąb: ce [MWG ZI/42/047]; Gieraszowice – pl [MWG ZI/42/033]; Leśniakowa Dębina: com [MWG ZI/29/1338], ce [MWG ZI/29/1339]; Ryj Hill: ce+ th [MUZPIG **1.II.94**].

Strenuella polonica Czarnocki, 1926 – Igrzyczna Hill: cr + th [MWG ZI/29/1491, 1551, 1553], cr [MWG ZI/29/1495, 1515, 1568; MUZPIG 110.II.13, 14, 16], lib [MUZPIG 110.II.14], th [MWG ZI/29/1552]; Jaźwina Hill: th [MUZPIG 110.II.42], th + pyg [MUZPIG 110.II.52]; Leśniakowa Dębina: com [MWG ZI/42/**073**, MWG ZI/29/1494, 1567, 1576], ax [MWG ZI/29/1487, 1488, 1559], cr + lib + th [MWG ZI/29/1486, 1519; MUZPIG 110.II.181], cr + th [MWG ZI/29/1516, 1560–1562, 1596; MWG ZI/42/103], cr [MWG ZI/29/1093, 1341, 1401, 1407, 1408, 1484, 1485, 1489, 1490, 1493, 1496, 1514, 1517, 1569, 1571, 1577, 1587–1589, 1592, 1593, 1595, 1597, 1600, 1601, 1603, 1610–1614, 3739; MWG ZI/42/096, 100, 192, 206, 212, 219, 221–223, 225, 226, 229, 232, 235, 269, 282; MUZPIG 1.II.20, 30, 32, 36–38, 43–48, 52–61, 63, 64, 68–89; MUZPIG 110.II.29, 35, 37, 56, 70–72, 75, 77–79, 82, 84, 86, 93, 95–97, 99, 102, 105, 108, 110, 115, 116, 119–121, 123, 125–127, 133, 137, 139, 145, 150, 151, 164, 181, 182], th [MWG ZI/II/1494, 1518, 1604; MWG ZI/42/174], hyp [MUZPIG 1.II.50; MWG ZI/42/199], lib [MUZPIG 1.II.57, 62, 63, 65, pyg [MUZPIG 1.II.49, 53, 57, 66, 84; MUZPIG 110.II.110]; Madeje: cr [MWG ZI/29/1521]; Ociesęki: com [MWG ZI/42/090], ax [MWG ZI/29/1537], cr + lib [MWG ZI/29/1498], cr + lib + th [MWG ZI/29/1513, 1540], cr + th [MWG ZI/29/1502, 1506, 1510, 1534], cr [MWG ZI/29/1427, 1499, 1500, 1503-1505, 1507-1509, 1511, 1523, 1525, 1526, 1529-1531, 1533, 1535, 1536, 1538, 1541, 1554, 1556, 1570, 1572, 1590, 1591; MWG ZI/42/072, 079, 080, 095, 101, 173, 175-177, 183, 189, 194, 215, 273, 283; MUZPIG 110.II.35, 166], th [MWG ZI/29/1501, 1507, 1522, 1524, 1528], th + pyg [MWG ZI/29/1532], lib [MWG ZI/29/1512], pl [MWG ZI/29/1527], hyp [MWG

ZI/29/1557]; Pranie: cr [MWG ZI/29/1594]; Rembów: cr [MUZPIG 1.II.91]; Sterczyna Hill: com [MWG ZI/29/1546, 1547, 1586, 1599, 1607; AK 300/CD 33-5 (1)], ax [AK 300/CD 33-5 (3)], cr + lib + th [AK 45/TA1, 100/AB 32-3, 100/AB 32-16, 300/CD 31-8 (2); MWG ZI/29/1558, 1566, 1579, 1582, 1584, 1598], cr + th [MWG ZI/29/1497, 1545, 1550, 1606; AK 45/TA2 (3), 100/AB 24-26, 300/BC 31-12, 300/CD 33-5 (2), 300/CD 33-5 (5); UJ 214P/T4, T5, T13, T14, T16, T17], cr [MWG ZI/29/1492, 1520, 1539, 1543, 1549, 1555, 1563-1565, 1574, 1578, 1581, 1583, 1585, 1602, 1609; UJ 214P/T6, T11; MUZPIG 1689.II. 44, 51], th [MWG ZI/29/1544, 1548, 1575, 1580, 1582, 1608; AK 300/CD 33-5 (4); UJ 214P/T9, T10, T15], th + pyg [MWG ZI/29/1574; AK 300/CD 20-1; UJ 214P/T1, T2], lib [AK 100/AB 25-1; MWG ZI/29/1542]; unknown locality: cr [MUZPIG 110.II.174, 180, 189, 192–194, 196, 198, 202, 203, 205, 235], cr + th [MUZPIG 113.II.5], th [MUZPIG 113.II.5], pyg [MUZPIG 110.II.235].

Strenuella zbelutkae Orłowski, 1985a – Dąb: cr [MWG ZI/29/1290, 1291]; Leśniakowa Dębina: cr [MUZPIG 1.II.34; MUZPIG 110.II.179A]; Ociesęki: cr [MUZPIG 110.II.160B]; Zbelutka: cr [MWG ZI/29/1286, 1289; MWG ZI/42/029, **035**, 040; MUZPIG 1.II.8b, 9a, 11; MUZPIG 113.II.1b–d, 2a–d, 4, 14, 18, 20, 23, 25, 26]; unknown locality: cr [MUZPIG 110.II.168A, B, C, 176B, C, 215, 233].

Termierella sandomirensis Samsonowicz, 1962 – Gieraszowice: cr [MWG ZI/42/030, 032, 034, 039, 041, **043**, 045, 051, 053, 056].