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Brachiopods and stratigraphy of the Upper Devonian (Frasnian) succession of the Radlin Syncline (Holy Cross Mountains, Poland)

In memory of our teacher Gertruda Biernat (1923–2016),
an eminent student of fossil brachiopods

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ABSTRACT:

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The lower part of the Frasnian succession in the Radlin Syncline (Kielce–Łagów Synclinorium, southern region of the Holy Cross Mountains), in the two studied successions: Józefka at Górno and (for the first time) Radlin, consists of the rhythmic marly Szydłówek Beds, the fossil-rich limestones of the Wietrznia Beds (locally) and the atypically developed, calcareous Kostomłoty Beds. The carbon isotope chemostratigraphic pattern overall corresponds well to the global Early–Middle Frasnian biogeochemical perturbation, even if the major *punctata* positive excursion is only fragmentarily recorded in the Kostomłoty intrashelf basin.

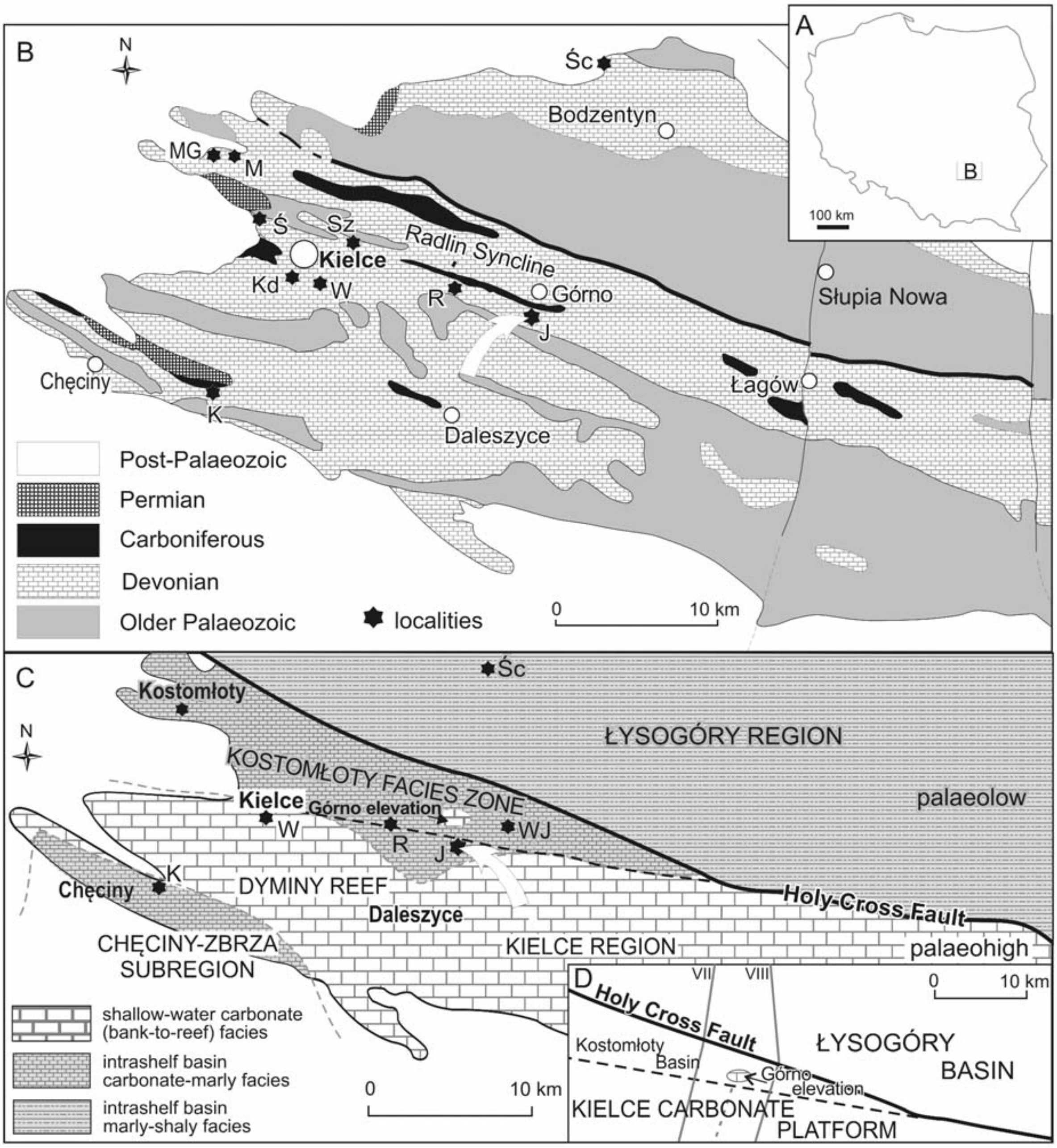
Two brachiopod assemblages are abundantly represented in both sections: the *Phlogoiderhynchus polonicus* Assemblage, typical of the Szydłówek Beds, and the *Biernatella lentiformis* Assemblage, limited to the middle part of the Wietrznia Beds. Both are highly dominated by the index species. Twenty nine lower Frasnian brachiopod species (Craniida – 1 species, Strophomenida – 1, Productida – 2, Protorthida – 1, Orthida – 5, Pentamerida – 1, Rhynchonellida – 4, Atrypida – 4, Athyridida – 3, Spiriferida – 4, Spiriferinida – 3) are described from the Szydłówek and Wietrznia Beds. Seven new species are introduced: *Skenidioides cretus* Halamski sp. nov., *Biernatium minus* Baliński sp. nov., *Monelasmina montisjosephi* Baliński sp. nov., *Atryparia* (*Costatrypa*) *agricolae* Halamski and Baliński sp. nov., *Davidsonia enmerkaris* Halamski sp. nov., *Leptathyris gornensis* Baliński sp. nov., and *Echinocoelia parva* Baliński sp. nov. *Davidsonia enmerkaris* Halamski sp. nov. is intermediate between *Davidsonia* Bouchard-Chantereaux, 1849 and *Rugodavidsonia* Copper, 1996 and is the youngest known representative of the suborder Davidsonioidea Copper, 1996. *Skenidioides cretus* Halamski sp. nov. is the last representative of the genus. Statistical investigation of a large sample of *Spinatrypina* (*Exatrypa*) *explanata* did not confirm the existence of two dimorphic forms, coarse- and fine-ribbed.

The high-diversity *Biernatella lentiformis* Assemblage is quite dissimilar to coeval brachiopod assemblages described heretofore from the Holy Cross Mountains region. It is interpreted as consisting of mostly parautochthonous dwellers of deep-slope muddy habitats and a local, occasionally storm-agitated, intra-basin brachiopod-crinoid-coral shoal. The fauna was adapted probably to cooler and nutrient-poor waters during an initial phase of the severe carbon cycle perturbation.

Key words: Devonian; Frasnian; stratigraphy; carbon isotope stratigraphy; *punctata* Event; brachiopods; Holy Cross Mountains.

INTRODUCTION

The Palaeozoic of the Holy Cross Mountains, central Poland, provides, among others, several Devonian sections with rich and well preserved faunas. The Devonian brachiopods of the Holy Cross Mountains have been intensely studied since the nineteenth century (e.g., Pusch 1837; Zejszner 1866; Gürich 1896; Sobolew 1909; Siemiradzki 1909; Biernat 1966; Baliński and Racki 1981; Racki 1993a; Halamski 2009); despite that, several faunas are known only imperfectly. During the Devonian the area of the present Holy



Text-fig. 1. The location of the Holy Cross Mountains against a geographical image of Poland (A) and of the studied outcrops in the Holy Cross Mountains (B); after Racki et al. (2004, fig. 2a). C – Palaeogeographic pattern of the late Givetian to middle Frasnian of Holy Cross Mountains (based on Racki 1993b, fig. 2), with the proposed situation of the Józefka and other key sites, and the Górno elevation (see Text-fig. 16); abbreviations for B and C: J – Józefka, R – Radlin, Śc – Ściegnia, W – Wietrznia, K – Kowala, MG – Małe Górki, M – Mogilki, Ś – Śluchowice, Kd – Kadzielnia, D – Szydłówek, WJ – Wola Jachowa. D – Tentative sketch of the Late Devonian synsedimentary tectonic framework of the Holy Cross region (based partly on fig. 1 in Kowalczewski 1963), as a block foundation of the main paleogeographic-facies units (see Szulczewski 1977; see also the Niewachlów Fault in Konon 2007, figs. 2–3), as well as the basin topography in the Górno area, where a localized shoal developed in a labile depressional structure (see the facies pattern in Text-figs 1C and 16), framed by transversal dislocation zones related to the VII and VIII primary elevations in the deeper Palaeozoic basement (sensu Kowalczewski 1963)

Text-fig. 2. Location of the studied sections at Józefka (A) and Radlin (B) near Górno (modified from Google Maps: http://maps.google.com). Trenches PR I, PR II, PR III and two outcrops are shown at Radlin, but only lower to middle Frasnian fragment of the succession (at PR I and PR III digs) is presented herein (Text-fig. 5)

Cross Mountains was situated on the southern shelf of Laurussia or, in other words, on the northern shore of a relatively narrow Rheic Ocean (= Variscan Sea; Scotese and McKerrow 1990; Golonka and Gawęda 2012; Halamski and Baliński 2013).

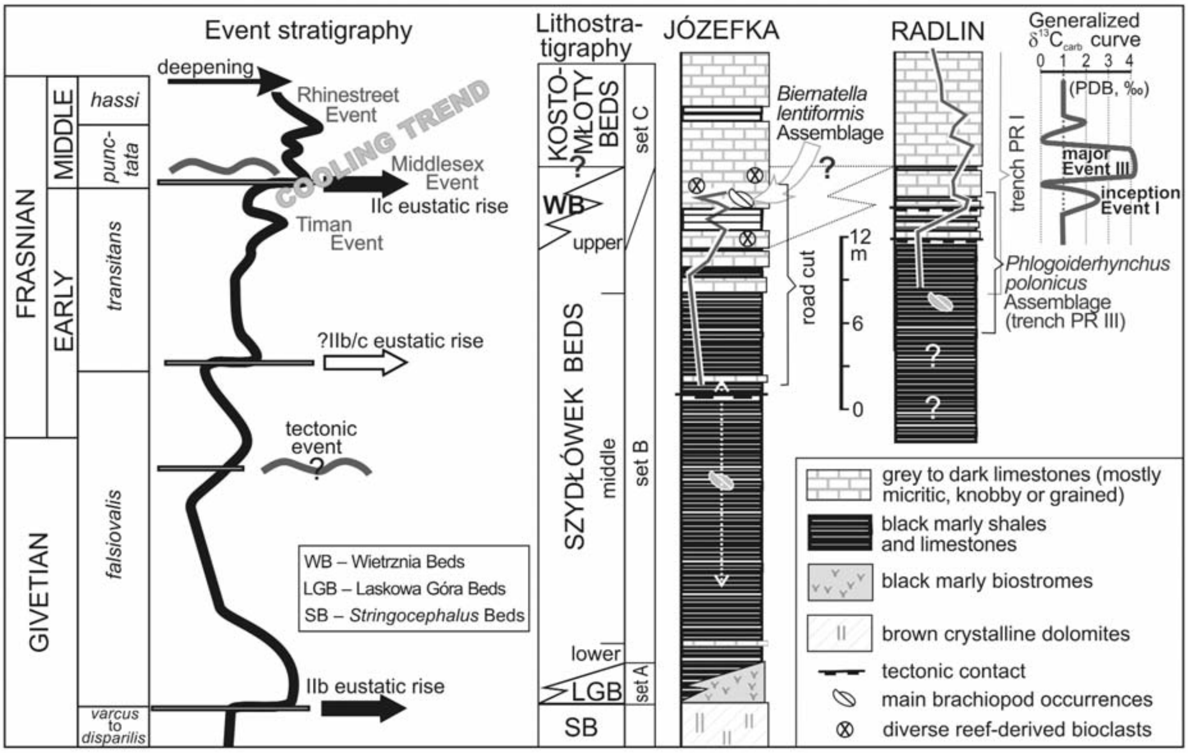
The brachiopods studied in the present paper come from the Radlin Syncline, a subordinate unit of the Kielce–Łagów Synclinorium, the latter being a major tectonic element of the southern (Kielce) region of the Holy Cross Mountains (Text-fig. 1). More precisely, the major part of the conodont-dated material, early Frasnian in age, has been collected in a roadcut situated on the eastern slope of Józefka hill along the Górno–Daleszyce road at 50°50’23”N 20°49’15”E and to a lesser extent from coeval strata exposed at the adjacent active Józefka Quarry (Plates 1–3). A minor part of the material studied comes from approximately coeval strata cropping out on the southern slope of a small hill, 1.3 km S of the Radlin village and 5.5 km W of the Józefka hill, at 50°51’17”N 20°44’50”E (Text-figs 1–2).

Górno and Radlin have been known as brachiopod-bearing sites since Gürich (1900, p. 379) listed “*Liorhynchus polonicus*” and “*Atrypa reticularis*” from Radlin, and “*Spirifer* sp. (?*elegans*)” from Górno. However, as shown by Siemiradzki (1903, p. 141–142), this spiriferide comes from outcrops in Górno village near the Kielce–Opatów road (Górno Brachyanticline; see Małkowski 1981), i.e., 1.4 km north of the section studied. The latter (Józefka site = section Górno-S) corresponds to the outcrop V sensu Małkowski (1981) belonging to his lowermost coral-bearing set A, from which a relatively diverse brachiopod fauna was reported (Filonowicz 1969, Małkowski 1981). As a matter of fact, these brachiopods were probably largely obtained from an older fossiliferous set, corresponding to the uppermost Givetian Laskowa Góra Beds (= set A; Text-fig. 3) sensu Racki (1993b, p. 171) and Racki and Bultynck (1993) and, subordinately, from stratigraphically younger deposits (*Cyrtospirifer tenticulum* sensu Filonowicz 1969, p. 36; 1980, p. 38). The atrypides dominating at Józefka (= Górno-S) were identified by Racki (1993a) as *Spinatrypina robusta*. Also a minor part of the collection of *Schizophoria schnuri prohibita* described by Halamski (2012) came rom the roadcut at Józefka as well, the holotype coming from slightly older strata cropping out in the nearby quarry (Pl. 1, Fig. 2).

Baliński (1995b) described *Biernatella lentiformis* from set C which was very poorly exposed in the roadcut (also diverse crinoids and non-pelmatozoan echinoderms were described from here by Głuchowski 1993 and Boczarowski 2001, respectively) and the main goal of the field work performed between 2006 and 2010 by the Department of Earth Sciences of the Silesian University (Sobstel and Borcuch 2011) was to elucidate the stratigraphic setting of this unique benthic association that includes several otherwise unknown species.

STRATIGRAPHIC SETTING

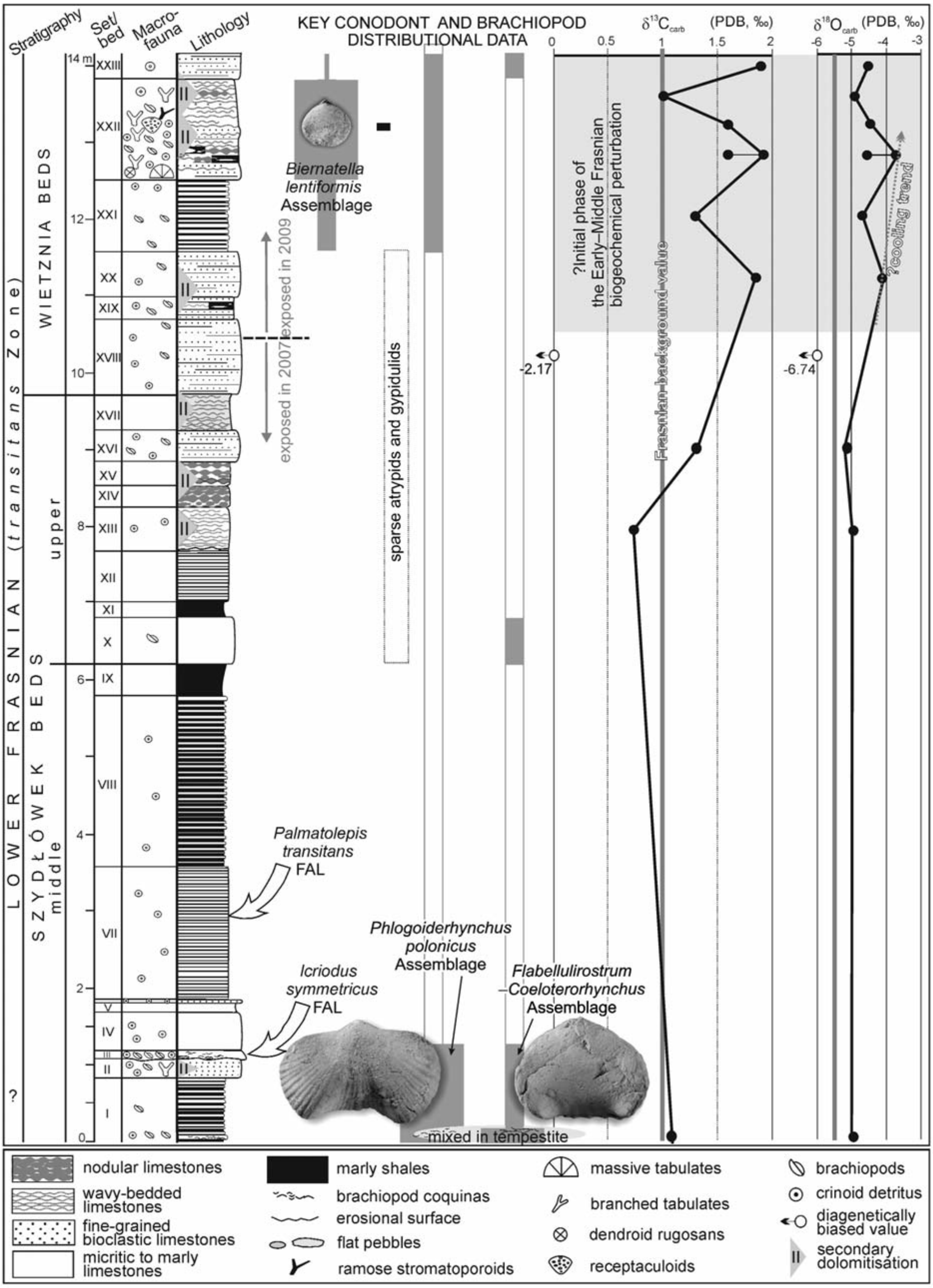
As shown by the conodont-based stratigraphical works of Małkowski (1981; collection erroneously published as ZPAL G.1–3, corrected number ZPAL C.24) and Racki and Bultynck (1993), and summarized in Racki (1993b), in this part of the Radlin Syncline the Givetian brownish-yellowish dolomitized *Stringocephalus* Beds are overlain by a dark marly-calcareous succession (Text-fig. 3). This lithological contact, a



Text-fig. 3. Generalized composite lithological sections of the upper Givetian to middle Frasnian strata exposed in the Górno–Radlin area (partly based on Małkowski 1981, fig. 2 and Racki and Bultynck 1993, fig. 2; see Text-figs 4–5 for details), showing the position of the key brachiopod faunas studied, against the global and regional event stratigraphy (modified from Racki 1993a, fig. 37; see Racki and Narkiewicz 2000, fig. 6, Pisarzowska *et al*. 2006, fig. 15, and also Becker *et al.* 2012 for updated conodont zonation) and the lithostratigraphical scheme of the Kostomłoty facies zone (Racki *et al.* 1985, 2004); carbon isotope chemostratigraphy scheme, corresponding to the global early-middle Frasnian biogeochemical *punctata* perturbation (Pisarzowska *et al.* 2006; Pisarzowska and Racki 2012), and carbon isotope curves from the studied sections are shown for comparison as an auxiliary reference to correlation of both the successions studied

sedimentary record of the two-step drowning of the undifferentiated stromatoporoid-coral biostromal bank (Racki *et al*. 1985; Racki 1993b), is well exposed in the southern part of Józefka Quarry (Pls 1–2). This zone of a frozen dolomitisation front (see Narkiewicz 1991) is also irregularly marked by de-dolomitisation and limonitisation, as a result of weathering processes altering the low-temperature hydrothermal hematite and ankerite mineralization, and by illitisation of the rock massif (see Nieć and Pawlikowski 2015).

The two oldest units of the post-dolomite succession compare well with the lithostratigraphic succession of the Kostomłoty Transitional Zone (Łysogóry facies; Racki 1993b), as established in the Laskowa, Małe Górki, and Mogiłki quarries (Racki *et al*. 1985), located at Kostomłoty ca. 20 km NW from the Radlin-Górno area. The highest part of the basal fossil-rich, biostromal/bioclastic Laskowa Góra Beds at Józefka (Pl. 3, Figs 5–6) are dated as possibly late *K. disparilis* Zone, while the basal Szydłówek Beds represent the early *M. falsiovalis* Zone (Racki and Bultynck 1993). This rhythmic argillaceous basin succession is succeeded at Józefka by varied Frasnian limestone strata assigned not only to the Kostomłoty Beds (Text-fig. 3), but also – in the basal part – to the Wietrznia Beds (Text-fig. 4) (Racki 1993b, p. 171), a unique situation in the facies zone (see below). This interval is dominated by micritic, platy, wavy-bedded, and knobby varieties, with the contribution of clayey and bioclastic fine-grained (crinoid- and brachiopod-rich) lithologies (see also Małkowski 1981). The Kostomłoty Beds seem to be developed atypically in both sections, insofar as they are almost devoid of intraformational conglomerates and breccias (Małkowski 1981), even if the latter are well known from the northern Górno sections (see Szulczewski 1968, 1971; Małkowski 1981; Górno-field locality of Vierek 2014). In a palaeogeographic context, the development of a tectonically-controlled transversal depression on the northern slope of the Kielce carbonate platform is suggested in the Górno-Daleszyce facies area (Racki 1993b, p. 94 and fig. 15D; see Text-fig. 1C–D), as indicated already for the Famennian strata by Czarnocki (1950, p. 48).



Text-fig. 4. Lithological succession of lower Frasnian strata at Józefka hill near Górno, based on the roadcut newly exposed in 2007–2008 (mostly after Sobstel and Borcuch 2011), jointly with conodont, brachiopod and stable isotope data (compare Text-fig. 3)

Sample Conodont taxa	G I (=JPD 0.2 m)	G III	G VII (= JPD 5.8 m)	G VIII (=JPD 10.8 m)	G XVII (=JPD 23.1 m)	G XVIII	G XIX	G XX	G XXI	G XXII	G XXIII
Platform elements	4	230	347	14	41	30	24	6	174	50	46
Polygnathus	4	190	260	11	38	29	24	6	167	42	33
Po. decorosus	+	+	+	+	+	+	+	+	+	+	+
Po. procerus	+	+	+						+	+	+
Po. alatus		+					+		+		+
Po. pollocki		+				+	+			+	
Po.pseudoxylus		+			+	+			+		
Po. webbi			+		+				+		
Po. dubius			+				+				
Po. rudkinensis			+								
Po. dengleri						+					
Po. foliatus									+	+	+
Icriodus		40	85	3	3	1			6	8	12
I. symmetricus		+	+	+	+					+	+
I. expansus		+	+						+	+	
I. subterminus			+			+			+		+
Palmatolepis			2								1
Pa. transitans			+								+
Mesotaxis									1		
M. falsiovalis									+		
BIOFACIES	?	Po	Po-I	iPo	Po		iPo	?	Po		Po-I
CONODONT ZONE	?Late *falsiovalis-transitans*		*transitans*								

Table 1. Conodont distribution and frequency at Górno – Józefka Hill road hill section (sample numbers correspond to the lithological set numbers in Text-fig. 4, after Borcuch in Sobstel and Borcuch 2011); for biofacies terminology see Sobstel *et al.* (2006) and Vierek and Racki (2011): Po – polygnathid, iPo – impoverished polygnathid, Po-I – polygnathid-icriodid. Samples JPD, GIII and GXVIII taken in 2007, GXIX–XXIII in 2011.

Józefka hill at Górno

The present paper is mostly devoted to the brachiopod faunas of the middle to upper Szydłówek Beds and overlying limestone strata (Wietrznia Beds) at the Józefka (= Górno-S) locality (Text-figs 2, 4). Notably, the Szydłówek Beds are characteristically reduced in thickness at Józefka in comparison to the reference Kostomłoty sections (up to 100 m thick; see Racki *et al.* 2004). Moreover, the study of the succession in all localities is seriously complicated by intensive fold tectonics, supplemented by the overthrusting which is displayed in the eastern wall of Józefka Quarry. Thus, the total thickness of the Szydłówek Beds is uncertain but less than 35 m (Racki and Bultynck 1993; compare Vierek 2008, 2014), probably ca. 25 m or even less (Text-fig. 3).

In addition, the Józefka section is marked by several unique characters in the basal Frasnian slice: (1) the occurrence of the small-sized variety only of the rhynchonellide *Phlogoiderhynchus polonicus*, typical of an upper part of the Szydłówek Beds (Sartenaer and Racki 1992), and therefore the absence of older members of the rhynchonellide succession at Kostomłoty, such as *Hadrotatorhynchus* (see Sartenaer and Racki 1992), (2) the abundance of storm-generated bioclastic layers, including atrypide and pugnacid coquinas (Vierek 2008, 2014), and (3) a rather continuous transition from rhythmic shaly-limestone couplets to more uniform and mostly micritic, partly dolomitized and limonitized lithologies (Text-fig. 3; Pl. 2, Figs 1–3).

Thus, the lithostratigraphic assignment of the *Biernatella*-bearing strata (beds XXI to XXIII; Text-fig. 4), the main goal of this study, remains somewhat ambiguous. Despite the generally subordinate occurrences of redeposited reef builders (with the exception of unit XXII; Pl. 2, Fig. 4, compare microfacies data below), as revealed in the recently improved exposure at the Józefka roadcut (in contrast to the time of field work by Małkowski 1981 and Racki 1993b; Pl. 4), benthos-enriched strata occur in the deep-slope fore-reef facies of the middle Wietrznia Beds (see Racki 1993b; also Baliński 1995b). This unit is characterized at Wietrznia by marly lithologies with many bioclastic, mostly brachiopod-crinoid tempestite layers (set C; Pisarzowska *et al*. 2006; Vierek and Racki 2011; Vierek 2014), and also by the localized storm-generated mass occurrence of the characteristic brachiopod, *Biernatella lentiformis*, in the more deep-water deposits (see below). Lack of intraformational varieties and the richness of fossils preclude assignment of these strata to the Kostomłoty Beds, whilst the domination of calcareous lithologies with diverse rock-forming fossils is unusual for the upper Szydłówek Beds (see Racki *et al*. 1985, 2004; Pisarzowska *et al*. 2006).

According to this interpretation, the present study is placed mainly in the the middle to upper Szydłówek Beds (ca. 10 m) and the locally developed, fossiliferous Wietrznia Beds (ca. 4.3 m). The open question in this interpretation is that the boundary between the Wietrznia and Kostomłoty Beds is not observed. In light of the ambiguous data of Małkowski (1981, figs 2–3 and p. 228) one may assume that abundant fossils, in particular crinoid debris, do not occur above the bottom part of the set B of this author, in the *Palmatolepis transitans* – *Palmatolepis punctata* zonal transition (formerly the lower and middle *Polygnathus asymmetricus* zones), whilst intraformational breccias appear locally in the overlying set C. In fact, unrecognized fault disturbances may partly obscure the succession, and several sets from the roadcut (at least XVI–XX; Text-fig. 4) are not observed in the eastern wall of quarry, most likely due to tectonic reasons.

The generally sparse conodont data from the almost exclusively non-diagnostic polygnathid biofacies (Table 1) has proved an early Frasnian date, e.g., due to the occurrence of *Icriodus symmetricus* in the coquina layer (set III) in the lowermost part of the succession (Racki and Bultynck 1993; Narkiewicz and Bultynck 2011). Furthermore, the first occurrence of the index species *Palmatolepis transitans* in the lower part of the Józefka section (Text-fig. 4), combined with the common occurrence of *Polygnathus decorosus* (see fig. 3 in Narkiewicz and Bultynck 2011) suggest strongly the assignment of the Józefka succession to the Lower Frasnian *transitans* Zone.

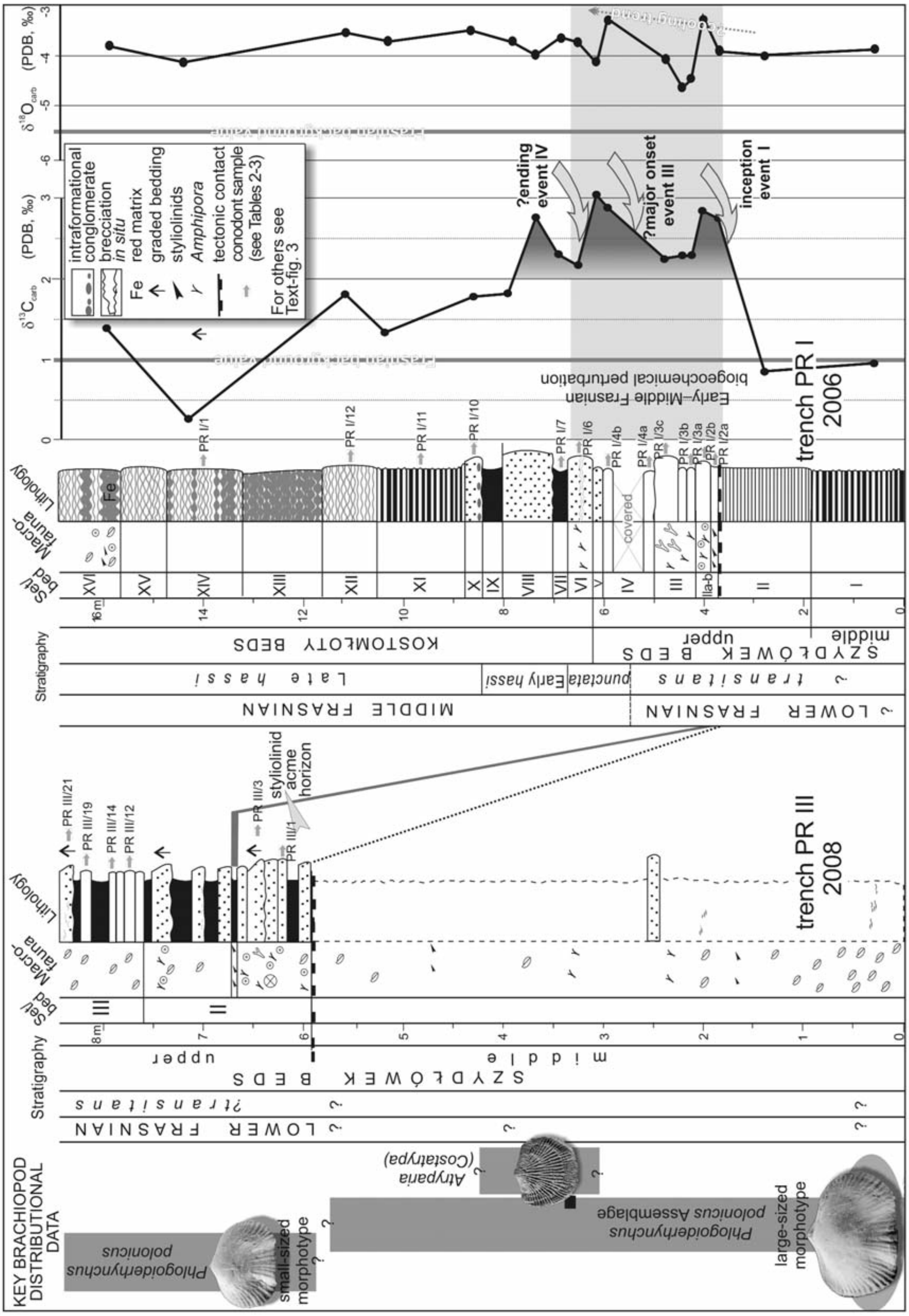
The stable isotope chemostratigraphic data in the dominantly micrite lithologies show reliable values (with exception of one sample), mostly close to the Frasnian background values. The $\delta^{13}C$ excursion up to 1.90‰ in the uppermost units (Text-fig. 4) suggests the assignment to an initial phase of the highly anomalous interval of the global Middle Frasnian *punctata* Isotopic Event (Pisarzowska *et al.* 2006; Pisarzowska and Racki 2012), erratically recorded in the *transitans* Zone in the Holy Cross Mts. This conclusion is supported by oxygen isotopic data exhibiting the commencement of the well-known cooling tendency in this Frasnian interval (see discussion in Pisarzowska and Racki 2012).

In microfacies terms, very diverse fossil constituents are characteristic of both the micrite (mostly bioturbated crinoid-brachiopod wackestones-packstones) and sparry (intraclastic-skeletal grainstones) varieties of the mostly stylonodular limestones of the *Biernatella*-bearing Wietrznia Beds (set XXII; Pl. 4). However, an admixture of unsorted reef and lagoonal bioclasts (stromatoporoids, including *Amphipora*; dendroid corals, calcispheroid microproblematics; see also Pl. 2, Fig. 4) is a constant feature of this unit in the Józefka succession. In addition, the secondary processes noted above, mostly dolomitization-related impregnative Fe-mineralization and probably illitisation, led subsequently to a friable rock character, which was a prerequisite to effective brachiopod sampling via washing of the softened sediment and waste.

Radlin

The Radlin section has been exposed recently for the first time in three research trenches on a low hill, in addition to the partly infilled small rural quarries (Text-fig. 2B; see Filonowicz 1969; Racki 1993b, p. 172). Surprisingly, despite its strong tectonic disturbance, this succession is easier to correlate with the reference Kostomłoty succession (Text-fig. 5). This is well exemplified by the middle member of the Szydłówek Beds, which is marked by a monotonous rhythmic marly lithology, with large-sized *Phlogoiderhynchus polonicus*, compared with the upper Szydłówek Beds, which contain mostly more varied lithologically *Amphipora*-bearing calcarenite layers and coquinas formed by a small variety of *P. polonicus* (see Sartenaer and Racki 1992). The occurrence of marly styliolinid micro-coquina in the upper Szydłówek Beds is also a feature comparable with the Kostomłoty sections (Racki *et al*. 2004; Pisarzowska *et al*. 2006). Far more diverse, mostly wavy-bedded and knobby fossil-barren micrite lithologies obviously represent the Kostomłoty Beds, even if these are almost devoid of coarse-grained intraclastic deposits in the lower part when cropping out in the trenches (PR I and PR II) and exposure I (Text-fig. 2B).

Both conodont and isotope stratigraphy data confirm perfectly the presence of the lower and middle Frasnian passage interval in the middle part of trench PR I (= *transitans* and *punctata* zonal transition; Text-fig. 5, Tables 2–3). In particular, the distinctive $\delta^{13}C$ positive excursion from perhaps ca. 1‰ (i.e., the Frasnian background level) to heavy values above 3‰, which starts already in the *transitans* Zone, corresponds well to the worldwide biogeochemical turnover pattern (Pisarzowska and Racki 2012). The coeval increase of $\delta^{18}O$ values is less clearly recorded and evidently more diagenetically biased. In addition, a positive $\delta^{13}C$ shift to ca. 2.75‰ is recognized in the



Text-fig. 5. Lithological succession of lower to middle Frasnian strata at the hill south of the village of Radlin, based on two of three research trenches PRI and PR III dug in 2007–2008 (see Text-fig. 2B; partly after Sobstel and Borcuch 2011), jointly with conodont, brachiopod and stable isotope data (compare Text-fig. 3). Note the different thickness scale in the two Radlin sections. Also note that intensive faulting of the Szydłówek Beds (combined with dysharmonical folding; compare e.g., fig. 3 in Racki *et al*. 2004) prevents a proper recognition of their succession and thickness

Sample PR III / Conodont taxa	1	3	8	10	19	21
Platform elements	49	30	26	37	35	588
Polygnathus	42	27	22	30	31	580
Icriodus	1	1				
Ancyrodella	6	1	3	7	4	5
A. rotundiloba early				1	2 aff.	
A. rotundiloba late	2			1		
A. alata early			?1 cf.	1 aff.		?1
A. pristina		?1				
A. sp.	4		2	4	2	4
Mesotaxis-Klapperina		?1	?1			?3
BIOFACIES	p o l y g n a t h i d					
CONODONT ZONE	?late *falsiovalis* - *transitans*					

Table 2. Conodont distribution and frequency in the Radlin hill section at trench PR III 2008 (for sample stratigraphic location see Text-fig. 5; after Sobstel in Sobstel and Borcuch 2011); for biofacies terminology see Sobstel *et al.* (2006) and Vierek and Racki (2011), for ancyrodellid taxonomy Pisarzowska *et al.* (2006)

Sample PR I / Conodont taxa	1	2a	2b	3a	3b	3c	4a	4b	6	7	10	11	12	14
Platform elements	30	247	226	95	118	28	430	155	61	421	1190	271	80	353
Polygnathus	10	165	175	67	84	26	350	144	23	360	1140	168	35	301
Icriodus	6	15	12	1	3	1	59	1	1	3	25	61	2	30
Ancyrodella		7	7	1	3		6	1	8	7	10	22	14	3
A. rotundiloba		3												
A. alata early							2							
A. alata late		1		1										
A. africana		2												
A. pramosica		1					1							
A. africana -> gigas									1					
A. gigas form I								1	5	6			4	
A. gigas form I										1				
A. gigas form III											5			
A. nodosa														
A. lobata												3	2	1
A. curvata early											2	6	3	
A. cf. *curvata*												2		
A. sp.									2		3	11	5	2
Palmatolepis	2	8	10	1			1	5	10	1	15	20	29	19
Pa. transitans		7	4	1				?1 aff.	1					
Pa. punctata									2	?1		2	?1 aff.	
Pa. punctata -> domanicensis												1		
Pa. aff. *domanicensis*											11			?17
Pa. hassi											3	2	1	1
Pa. aff. *proversa*											1			
Pa. gutta												1		
Pa. orbicularis														1
Pa. sp.	2	1	6	1			1	4	7			14	27	
Mesotaxis - Klapperina	12	52	22	15	28	1	14	4	19	50				
M. asymmetricus	5	6	3	1	1	1	5		1					
M. falsiovalis		8	4		4		1		2					
M. costalliformis			3						?1 aff.					
M. bogoslavskyi		1			1									
K. ovalis	1	6	2	1	1		1		2	11				
K. unilabius	4	16	3	4	5		3	3		22				
K. sp.	2	15	7	9	16		4	1	13	17				
Ozarkodina trepta											1	1		
BIOFACIES	mix	Po-M	Po						mix	Po		Po-I	Po-Pa	Po

Table 3. Conodont distribution and frequency in the Radlin hill section at trench PR I 2006 (sample numbers correspond to the lithological set numbers in Text-fig. 5, after Sobstel in Sobstel and Borcuch 2011); for conodont (mostly ancyrodellid) taxonomy and zonation see Pisarzowska *et al.* (2006). For biofacies terminology see Sobstel *et al.* (2006) and Vierek and Racki (2011): Po – polygnathid, Po-I – polygnathid-icriodid, Po-M – polygnathid-mesotaxid, Po-Pa – polygnathid-palmatolepid, mix – mixed

basal *Palmatolepis hassi* Zone, and this isotopic event needs verification as it may be a localized attribute present only in the Radlin hill succession.

Some of the brachiopod material under study was collected mostly, however, as loose specimens from the weathered Szydłówek Beds on the southern slope of Radlin hill (Text-figs 3, 5). Because of the very scarce conodont faunas in the middle Szydłówek Beds (see Racki and Bultynck 1993), their age assignment (also that of conodont-poor samples from the trench PR III) to the Frasnian is largely uncertain.

Brachiopod faunas and sampling

The brachiopods known from the Józefka quarry and roadcut may be considered as an overall coherent fauna in the sense that a large proportion of taxa (10 out of 29), are distributed from the bottom to the top of the section, across the Middle to Upper Devonian boundary. The precise fauna comprises: ?*Douvillinaria* sp., *Schizophoria schnuri prohibita*, *Fitzroyella alata*, *Coeloterorhynchus dillanus*, *Spinatrypina explanata, Davidsonia enmerkaris*, *Echinocoelia parva*, *Emanuella* aff. *takwanensis*, ?*Reticulariopsis* sp. and *Cyrtina* cf. *arkonensis*, counting only those identified certainly; moreover, if poorly preserved material from set A is included, also *Skenidioides cretus* and *Physemella* sp., this becomes 12 out of 29 species, slightly less than the half. More precisely, the stratigraphic assignment of the brachiopod fauna is as follows (Text-fig. 3):

Set C sensu Racki 1993b, comprising the Lower Frasnian Wietrznia Beds which have yielded the major part of the fauna (*Biernatella lentiformis* Assemblage) in terms of both species and specimens at Józefka (mainly roadcut, subordinately quarry; sets XVIII–XXIII; Pl. 2, Figs 2–4; Pl. 3); this unit is non-fossiliferous at Radlin.

Set B sensu Racki 1993b, comprising the probably lower Frasnian middle and upper Szydłówek Beds cropping out in the Józefka roadcut (sets I–XVII) and at Radlin (sets I-III in the trench PR-III only), characterized by the *Phlogoiderhynchus polonicus* Assemblage, but notably occurring mixed in a storm-generated layer with abundant pugnacids.

Set A of Racki 1993b, comprising the uppermost Givetian Laskowa Góra Beds to, probably, lower Frasnian middle Szydłówek Beds, cropping out at present only in the Józefka quarry (Pl. 2, Figs 5–6). This lower unit, available before 2005 in a near-road trench, in fact only as yellowish clayey waste, was previously reported also as 3 m thick fossil-rich grey-green marls by Filonowicz (1969), and partly as the set A of Małkowski (1981).

This fossiliferous interval, with a *Spinatrypina* fauna related to tabulate coral biostromes (compare Racki *et al*. 1985; Racki 1993a, p. 338; see the *Alveolitella fecunda* Assemblage in Racki 1993b), awaits more refined sampling. Brachiopods have been collected largely as loose specimens and have not received a detailed treatment in the systematic part of the present paper, except for comparison with the younger fauna. Likely, *P. polonicus* is solely derived from the overlying Szydłówek Beds (Pl. 2, Fig. 5; see below).

To sum up, the brachiopods described in the present paper come from the lower Frasnian sets B and C at Józefka, and from a lateral equivalent of the set B at Radlin. Among the brachiopods from the upper Givetian to lowermost Frasnian set A at Józefka, only those known also from sets B and C are taken into consideration if the samples are more numerous than those from younger strata, or if then allow a fuller appreciation of the intraspecific variability.

The stratigraphic distribution of the brachiopods studied is summarized in the Table 4.

SYSTEMATIC PALAEONTOLOGY

The material described (5840 specimens in total; see Table 4 and Text-fig. 17) is kept in the Institute of Paleobiology of the Polish Academy of Sciences in Warsaw under the collection number ZPAL Bp 73 (73/1, specimens coming from the Józefka section, both roadcut and quarry; 73/2, those from Radlin). The brachiopods have been collected by the present authors, but archival collections were reviewed for this paper as well. A minor part of the material is kept at the Silesian University in Sosnowiec (acronym GIUS).

The brachiopods were photographed mostly using a Fujifilm Finepix S2 pro camera with a Nikon micro 60 mm lens. Small specimens were photographed under a Nikon SMZ 1500 binocular microscope, equipped with a Nikon D800 digital camera or under the Phillips XL-20 scanning electron microscope at the Institute of Paleobiology. Shells to be photographed in visible light were coated with ammonium chloride, unless otherwise noted.

Biometric and statistic analyses were performed with MS Excel 2007 and PAST ver. 3.01 (Hammer *et al*. 2001) softwares. For sake of concision, width-to-length and thickness-to-length ratios are referred to as width and thickness indexes, respectively. Synonymy lists are briefly commented using special signs: *, valid

Givetian	Frasnian									Stratigraphy / Taxonomy	
Lower Szydłówek Beds and Laskowa Góra Beds	Szydłówek Beds					Wietrznia Beds					
	middle			upper							
unnumbered strata in the quarry	I	II–III	IV–IX	X	XI–XVII	XVIII–XIX	XXI	XXII	XXIII	Units at Józefka (roadcut and quarry)	
present					no identifiable brachiopods (mostly atrypids and gypidulids)			present		?*Douvillinaria* sp.	Strophomenida
	present							present		*Devonoproductus sericeus*	Productida
								present		Productida indet.	
?							frequent	frequent		*Skenidioides cretus*	Protorthida
							present	present	present	*Teichertina fitzroyensis*	Orthida
							frequent	frequent		*Biernatium minus*	
							present	present		*Aulacella* cf. *elliptica*	
							frequent	frequent		*Monelasmina montisjosephi*	
present	present	present		present			present	present	present	*Schizopho. schnuri prohibita*	
?							present	present	present	*Physemella* sp.	Pentamerida
present							present	present		*Fitzroyella alata*	Rhynchonellida
								present	present	*Flabellulirostrum* sp.	
	present	present				present	present	present	present	*Phlogoiderhynchus polonicus*	
present	present	present		present					present	*Coeloterorhynchus dillanus*	
				?						*Atryparia* (*Costatrypa*) *agricolae*	Atrypida
frequent		present					present	present	present	*Spinatrypina* (*Ex.*) *explanata*	
							present	present		*Desquamatia* sp.	
present							present	present		*Davidsonia enmerkaris*	
	present						present	present		?*Athyris* sp.	Athyridida
								present		*Leptathyris gornensis*	
							exceptionally frequent	exceptionally frequent	present	*Biernatella lentiformis*	
									present	*Cyrtospirifer* sp.	Spiriferida
present							present	present		*Echinocoelia parva*	
present							present	present	present	*Emanuella* aff. *takwanensis*	
present							present			?*Reticulariopsis* sp.	
present							present	present		*Cyrtina* cf. *arkonensis*	Spiriferinida
								present		*Cyrtina* sp. nov. A	
							frequent	frequent		*Komiella devonica*	

present (exceptional, rare, or moderately frequent) — frequent — exceptionally frequent

Table 4. Stratigraphic distribution of the studied brachiopods at Józefka (roadcut and quarry)

name introduced in the referred paper; v, material seen by the present authors; ., material assuredly conspecific.

In the systematic part the authorship of the descriptions is as follows: new species are described by their authors, as indicated; for the other taxa, descriptions of *Petrocrania*, *Devonoproductus*, *Schizophoria*, all Atrypida, and *Cyrtina* are by ATH, whereas the remaining ones are by AB.

Phylum Brachiopoda Duméril, 1805
Subphylum Craniiformea Popov, Bassett, Holmer and Laurie, 1993
Class Craniata Williams, Carlson, Brunton, Holmer and Popov, 1996
Order Craniida Waagen, 1885
Family Craniidae Menke, 1828
Genus *Petrocrania* Raymond, 1911

TYPE SPECIES: *Craniella meduanensis* Œhlert, 1888; Mayenne, western France; upper Lower Devonian.

REMARKS: It may be of interest to note that the type species of the genus *Petrocrania* Raymond, 1911 (= *Craniella* Œhlert, 1888 non von Schlotheim, 1820) comes from the Mayenne region in western France and not from the Boulonnais region in northern France, as stated erroneously by Holmer *et al.* (2013).

Petrocrania sp.
(Pl. 5, Fig. 1)

MATERIAL: a single poorly preserved shell ZPAL Bp 73/2/16/2A attached to the dorsal valve of *Atryparia* (*Costatrypa*) *agricolae* Halamski and Baliński sp. nov. from Radlin.

DESCRIPTION: Dorsal valve conical, relatively low, elliptic in outline, with maximal and minimal diameters 11.5 and 8.1 mm, respectively. Apex situated near the centre of the valve. Ornamentation mimicking that of the host (ribs ca. 4 per 5 mm).

REMARKS: The relatively flat shell of *Petrocrania* sp. described here is quite similar to that of *P. hamiltoniae* (Hall, 1860) from the Givetian Silica Shale in Ohio (Hoare and Steller 1969; see also Kesling and Chilman 1975, Sparks *et al.* 1980). However, poor preservation and the absence of diagnostic internal characters (Holmer *et al.* 2013) precludes the identification at the species level.

Subphyllum Rhynchonelliformea Williams, Carlson, Brunton, Holmer and Popov, 1996
Class Strophomenata Williams Williams, Carlson, Brunton, Holmer, and Popov, 1996
Order Strophomenida Öpik, 1934
Superfamily Strophomenoidea King, 1846
Family Douvillinidae Caster, 1939
Subfamily Douvillininae Caster, 1939
Douvillinaria Stainbrook, 1945

TYPE SPECIES: *Strophodonta variabilis* Calvin, 1878; Independence Shale, Middle Amana Beds, Frasnian; Iowa, USA.

?*Douvillinaria* sp.
(Pl. 5, Figs 2–12)

MATERIAL: Two complete and 18 incomplete shells, 8 fragmentary dorsal and ventral valves, collection number ZPAL Bp 73/1/1.

Dimensions of the two shells (in mm): length 6.8, 7.1; width 9.1, 9.8; thickness 1.9, 2.7.

DESCRIPTION: Shell medium-sized, concavoconvex, semi-elliptical in outline, wider than long; lateral margins weakly rounded, nearly straight near hinges; cardinal extremities poorly preserved, but growth lines indicating gently auriculate condition; anterior margin rounded, anterior commissure unisulcate to rectimarginate, hinge margin straight.

Ventral valve usually with very low, poorly marked median fold; interarea apsacline, weakly concave, vertically striated, with narrow delthyrium covered by convex pseudodeltidium; beak minute, pointed. Dorsal valve with poorly marked longitudinal median depression and nearly flat, vertically striated, hypercline interarea, approximately as high as the ventral one.

Ornamentation parvicostellate with costellae increasing by intercalation; intercostal spaces slightly convex on ventral valve (i.e., forming low radial plicae separated by costae) and concave on the dorsal valve; about 8–11 costellae between costae.

Internal structure observed in a single fragment of the dorsal valve: cardinal process lobes separated, posteroventrally directed; two lateral septa well developed, with deep circular depression between posterior half of them; short median ridge developed anteriorly from depression low, terminating anteriorly with slight swelling.

REMARKS: These rare and mostly fragmentary specimens are characterized by parvicostellate ornamentation, gently convex intercostal spaces on the ventral valve and concave on the dorsal, and by the presence of a weak ventral fold and dorsal sulcus. Externally, the specimens are most similar to *Douvillinaria*, but the former differs in having a concavoconvex profile instead of biconvex as observed in the latter genus. Thus, the assignment of the specimens from Józefka to *Douvillinaria* remains equivocal because they show some differences in external characters and because their internal shell structure remains insufficiently known.

OCCURRENCE: Józefka, quarry (Laskowa Góra – middle Szydłówek Beds) and roadcut (Wietrznia Beds, set XXII).

Order Productida Sarytcheva and Sokolskaya, 1959
Suborder Productidina Waagen, 1883
Superfamily Linoproductoidea Stehli, 1954
Family Monticuliferidae Muir-Wood and Cooper, 1960
Subfamily Devonoproductidae Muir-Wood and Cooper, 1960

Genus *Devonoproductus* Stainbrook, 1943

TYPE SPECIES: *Productella walcotti* Fenton and Fenton, 1924; Frasnian; Hackberry, Rockford, Iowa (see details in Muir-Wood and Cooper 1960, p. 177–179).

REMARKS: The stratigraphic range of *Devonoproductus* is reported as confined to the Frasnian by Brunton *et al*. (2000, p. 546). However, *D. primus* Crickmay, 1963 is found below a horizon with *Stringocephalus* and is thus Middle Devonian in age (Crickmay 1963). *D. minimus* Crickmay, 1963 is also probably Givetian in age. The range of *Devonoproductus* is therefore Givetian to Frasnian.

Devonoproductus sericeus (von Buch, 1838)
(Pl. 5, Figs 13–17)

*1838. *Orthis sericea*; von Buch, p. 68.
1868. *Productus sericeus* Buch sp.; Dames, p. 500–501, pl. 11, fig. 4.

MATERIAL: 13 ventral valves, collection number ZPAL Bp 73/1/2.

DESCRIPTION: Shell concavo-convex, wider than long, up to 16.9 mm (usually ca. 12 mm) in width. Ventral valve strongly convex, umbo moderately thick, beak strongly incurved; radial ornament of costae and costellae, 4–5 per mm; spines arranged quincuncially, distances between each pair ca. 3 mm. Dorsal valve concave; concentric ornament of dense, acute rugae continuous from one half of the hinge line to another, ca. 2 per mm. Interareas linear. Dorsal interior: cardinal process bifid, lobes divergent, each one posteriorly with a longitudinal incision; median septum thin and rather low, extending from ca. 1/6 to ca. 2/3 of the valve length. Ventral interior: umbonal cavity deep, with a median myophragm; teeth not observed; a slightly irregular shelf-like extension beginning at hinge line present on both sides of umbonal cavity.

REMARKS: This brachiopod is included in *Devonoproductus* on account of its regular dorsal rugae, ventral ribbing, and median septum not supporting the cardinal process (Muir-Wood and Cooper 1960; Brunton *et al.* 2000).

Devonoproductus sericeus (von Buch, 1838) was described on the basis of poorly preserved specimens from the late Frasnian (see Halamski 2013 and references therein) of Oberkunzendorf (now Mokrzeszów Górny) in Silesia (Schlesien, Śląsk). Better topotypic material was described more fully and illustrated by Dames (1868). Variability in Devonian Monticuliferidae can be important (Halamski and Baliński 2013, p. 253), wherefore samples from Józefka and Mokrzeszów are tentatively considered conspecific, despite the age difference (early vs. late Frasnian).

Devonoproductus aff. *leonensis* García-Alcalde nomen nudum sensu Rachebœuf (1983) from the upper Givetian of Brittany (France) is smaller (up to 10 mm), has denser spine bases (distances between pairs 1–2 mm) and denser dorsal lamellae (ca. 3 per mm).

Several representatives of *Devonoproductus* were reported (Crickmay 1963; Norris 1983) from the Frasnian of western Canada (Alberta, British Columbia, Northwest Territories). All of them differ from *D. sericeus* described herein. Middle Devonian (Pine Point Formation) *D. primus* Crickmay, 1963 possesses a relatively strong radial ornamentation on the dorsal valve. Middle Devonian (Presqu'ile Formation) *D. minimus* Crickmay, 1963 is very similar in overall shape to *D. sericeus* from Józefka but has weaker spines. Lower Frasnian (top of the Flume Formation; age after Uyeno 1991) *D. secundus* Crickmay, 1963 is longer than wide. Middle Frasnian (middle *asymmetricus* Zone) *D. tertius* Crickmay, 1963 has rarer spines on the ventral valve. Lower to middle Frasnian *D. reticulocostatus* Norris, 1983 differs in having a reticulate ornamentation of the ventral valve.

OCCURRENCE: *Devonoproductus sericeus* was originally described from the upper Frasnian of the Sudetes (von Buch 1838; Dames 1868). It was subsequently reported from a number of Frasnian localities in Germany (Klähn 1912) and Russia (Ljaschenko 1973; Bakulina and Minova 2010), although this is clearly an over-used name (see Mottequin 2008a, p. 465 for a revision of earlier reports of this species from Belgium). In the Holy Cross Mountains it was reported by Racki (1993a) from the late Givetian to early Frasnian Kowala Formation. At Józefka it is rare in set I and exceptionally rare in set XXII.

Productida fam., gen. et sp. indet.
(Pl. 5, Figs 18–20)

MATERIAL: A single poorly preserved dorsal valve ZPAL Bp 73/1/3/1.

REMARKS: The single dorsal valve is rather small-sized, attaining 4.3 mm in length and 5.1 mm in width, subrectangular in outline, with short ears and slightly emarginate anterior margin. Interarea is low, linear, but distinct. The valve is concave, with short trail. Internally the characteristic internal features include short, postero-ventrally directed, bilobed cardinal process, short breviseptum and deep sockets bordered anteriorly by high inner ridges forming a pair of well defined plates. Also characteristic is the presence of a subperipheral ridge which forms a pair of U-shaped loops separated medially by a deep trough. The general appearance of this ridge as well as a slight bilobation of the valve and very wide hinge margin resemble the condition observed in the strophalosiidine *Muhuarina* Baliński and Sun, 2005 described from the Tournaisian of southern China (Baliński and Sun 2005; Sun and Baliński 2008). The latter genus, however, differs significantly by the absence of a median septum, having trifid cardinal process and a much higher subperipheral ridge. From the co-occurring *Devonoproductus sericeus* the described specimen differs in having a subrectangular and wider outline, long hinge margin with short but distinct ears, bilobed subperipheral ridge, and different external ornamentation in the form of thick and irregular concentric rugae. The single valve from Józefka is too poorly preserved for satisfactory comparison with other forms and a formal species description.

OCCURRENCE: Józefka, Wietrznia Beds, set XXII.

Class Rhynchonellata Williams, Carlson, Brunton, Holmer and Popov, 1996

Order Protorthida Schuchert and Cooper, 1931
Superfamily Skenidioidea Kozłowski, 1929
Family Skenidiidae Kozłowski, 1929
Genus *Skenidioides* Schuchert and Cooper, 1931

TYPE SPECIES: *Skenidioides billingsi* Schuchert and Cooper, 1931; near the Ottawa River, Québec, Canada; Black River Formation, Sandbian, upper Ordovician.

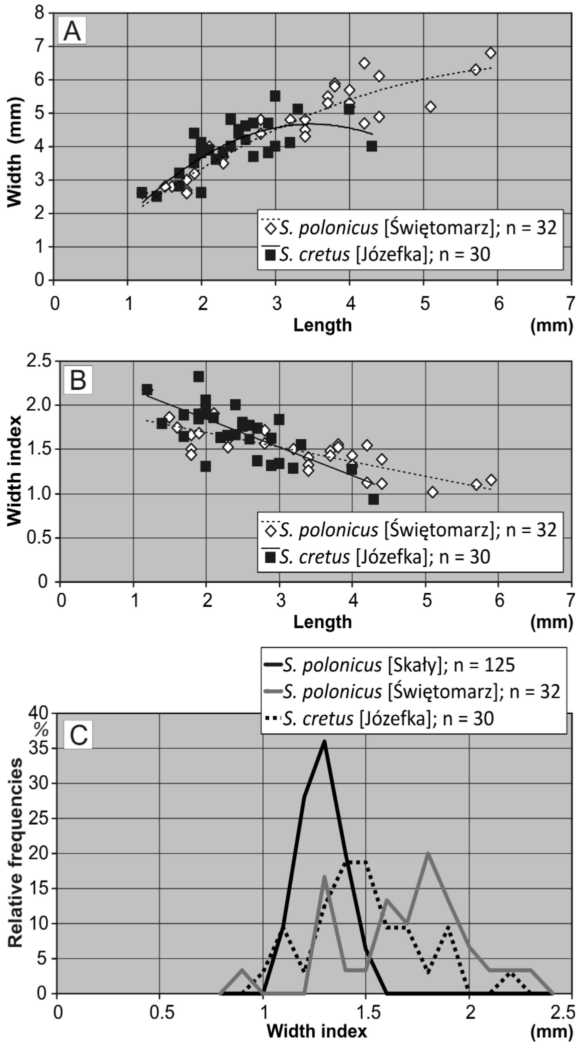
REMARKS: The upper range of the genus *Skenidioides* was given as 'Lower Devonian (Lochkovian)' by Williams and Harper (2000, p. 713). Younger representatives of the genus have been reported several times (Gürich 1896; Biernat 1959; Boucot *et al.* 1966; Havlíček 1977; Halamski 2009). A list of post-Lochkovian representatives of the genus as follows (in stratigraphic order).

Skenidioides suburbanus (Havliček, 1956); Praha-Barrandov, Barrandian; Řeporyje and Dvorce-Prokop limestones, Pragian;
Skenidioides fascinatus Havliček, 1977; Klukovice, Barrandian; Zlíchov Fm., lower Emsian;
Skenidioides boucoti Havliček, 1977; Praha-Hlubočepy, Barrandian; Zlíchov Fm., lower Emsian;
Skenidioides aff. *suburbanus* sensu Havliček, 1977; Holyně, Barrandian; Třebotov Limestone, upper Emsian;
Skenidioides cingulatus Havliček, 1977; Holyně, Barrandian; Choteč Limestone, Eifelian;
Skenidioides sp.; Liujing, Guangxi, South China; Mingtang Fm., upper Eifelian to lowermost Givetian (Sun 1992);
Skenidioides polonicus (Gürich, 1896); northern part of the Holy Cross Mountains; Skały Beds, upper Eifelian to lower Givetian;
Skenidioides cretus sp. nov., as below; lowermost Frasnian;
(See also Boucot *et al.* 1966 and below, Remarks, for discussion of *Skenidium moelleri* Tschernyschew, 1887 and *Skenidium uralicum* Tschernyschew, 1887, two alleged Givetian? representatives of *Skenidioides*).

Skenidioides cretus Halamski sp. nov.
(Text-fig. 6; Pl. 6, Figs 1–30)

ETYMOLOGY: *cretus*, past participle of *cerno*, 'I sift'; the material of the new species has been obtained by sieving rock samples.

TYPE LOCALITY: Józefka hill south of Górno, Holy



Text-fig. 6. Scatter diagrams of shell width (A) and shell width index (B) to shell length and of shell width index relative frequencies (C) in *Skenidioides cretus* Halamski sp. nov. and *S. polonicus* (Gürich, 1896). Data for the latter partly after Biernat (1959) and Halamski (2009); see also Table 5

Cross Mountains, roadcut on the east side of the hill along the road to Daleszyce.

TYPE HORIZON: Wietrznia Beds, sets XXI–XXII; lower Frasnian.

TYPE MATERIAL: Holotype ZPAL Bp 73/1/4/1 (Pl. 6, Figs 15–19); 48 articulated shells, 158 dorsal valves, and 196 ventral valves (paratypes, collection number ZPAL Bp 73/1/4).

DIAGNOSIS: *Skenidioides* with minute, strongly transverse adult shells (adult width 3–5 mm; width-to-length ratio 1.5–1.9).

DESCRIPTION: Shell up to 5.0 mm in width, transverse (see Table 5 for numerical data), strongly ventribiconvex to nearly planoconvex. Maximal width at hinge line; postero-lateral extremities sometimes mucronate. Anterior commissure nearly straight to broadly and lowly unisulcate. Interarea catacline, straight or moderately concave; delthyrium open, occupying (0.17–)0.32–0.43 of the interarea width, 1⅓ –1½ times as high as wide.

Ornamentation of radial costae and costellae, 5–12 per dorsal lateral flank, the median dorsal costa thicker than lateral ones. Growth lines fine.

Ventral interior: spondylium relatively shallow, flat-bottomed, posteriorly supported by a relatively thick median septum; teeth wide, plate-like. Dorsal interior: septalium deep; outer hinge plates wide; sockets triangular; cardinal process narrowly triangular, continuous with the median septum; the latter high, blade-like, reaching ⅔–⅘ of the valve length, triangular in lateral profile (Pl. 6, Fig. 30).

REMARKS: This species is included in *Skenidioides* on account of the cardinal process continuous with the median septum and the catacline ventral interarea. One may note the remarkable similarity to other species of the genus even in less important internal features like the form of the septum in lateral profile (compare Pl. 6, Fig. 30 and fig. 6O in Baliński 2012).

A detailed comparison with *S. polonicus* occurring in the same area and stratigraphically lower (arguably the evolutionary predecessor of the new species) is given in Table 5. To sum up, *S. cretus* sp. nov. is slightly smaller, more transverse (Text-fig. 6A; difference statistically significant tested by the Mann-Whitney test applied to the younger sample from Świętomarz: $U = 275$, $p < 0.01$), may have more costae, a wider delthyrium, and a strong dorsal median costa (lacking in *S. polonicus*). Given these differences and the stratigraphic gap between *S. polonicus* and *S. cretus* sp. nov., the latter is described as a new species. Eifelian *S. cingulatus* from Bohemia has "the median costella on each valve broader than the other" (according to the description by Havlíček 1977 but this is poorly visible on his figures) in the same way as in our species; however, it is less transverse than *S. cretus* sp. nov. (width to length ratio 1.25–1.44) and has much stronger growth lines. *Skenidium moelleri* Tschernyschew, 1887 from the Givetian? of the western slope of the Urals (possibly representing *Skenidioides*; Boucot *et al.* 1966) is also less transverse in shape. In contrast, *Skenidium uralicum* Tschernyschew, 1887 is unrelated to *Skenidioides* as it has a ventral septum (Tschernyschew 1887, p. 107). *Skenidioides* sp. from the Eifelian–Givetian

Taxon / Character	*Skenidioides cretus* sp. nov.	*Skenidioides polonicus* (Gürich, 1896)	
Locality	Górno	Świętomarz	Skały
Stratigraphy	early Frasnian	early Givetian	late Eifelian
Width to length ratio	(0.93–)1.50–1.88(–2.31) 1.69 [30] 0.183	(1.02–)1.32–1.67(–2.17) 1.50 [30] 0.173	(1.12–) 1.19–1.57(–1.6) 1.40 [4] 0.147
Maximum width	5.5 mm	6.8 mm	5.6 mm
Number of dorsal costae and costellae	5–12	8–10	

Table 5. Selected biometrical characteristics of *Skenidioides cretus* sp. nov. compared to those of its presumed evolutionary predecessor *S. polonicus*. Numerical data given in the following manner: (*a*–)*b*–*c*(–*d*), *e* [*N*], *V*, where *a* – absolute minimum (the lowest recorded value), *b* – lower quartile, *c* – upper quartile, *d* – absolute maximum (the highest recorded value), e – mean, *N* – sample size, *V* – variation coefficient. Data for the latter species after Biernat (1959) and Halamski (2009); stratigraphy after Halamski (2005), Halamski and Racki (2005), Halamski and Segit (2006), and references therein.

boundary beds in Guangxi, South China (Sun 1992) is too poorly preserved to allow a comparison.

The evolutionary sequence interpreted on the basis of the three samples of *Skenidioides* given in Table 5 shows that the younger stratigraphically the brachiopods are, the more transverse their shell is. In *Skenidioides* young individuals are more transverse than the adults (Halamski 2009; Text-fig. 6B herein). The Middle to Upper Devonian *Skenidioides* lineage may therefore be interpreted as a paedomorphic evolutionary sequence (see Gould 1977).

It may be also noted that the available material of this species consists largely of isolated valves with relatively few articulated specimens, unlike that of *S. polonicus* from both Skały and Świętomarz (Biernat 1959; Halamski 2009) composed mostly of articulated shells with few isolated valves. Given that no significant differences in articulation between both species can be observed, this phenomenon should be interpreted in terms of depositional environment, all the more that the ratio of shells to loose valves is different between lithologic sets (set XXI – 39 articulated shells vs. 181 loose valves; set XXII – 9 shells vs. 146 valves).

OCCURRENCE: The species is common in the Wietrznia Beds (sets XXI and XXII) of Józefka. Poorly preserved specimens from set A were tentatively included to this species.

Order Orthida Schuchert and Cooper, 1932
Suborder Dalmanellidina Moore, 1952
Superfamily Dalmanelloidea Schuchert, 1913
Family Dicoelosiidae Cloud, 1948
Genus *Teichertina* Veevers, 1959

TYPE SPECIES: *Teichertina fitzroyensis* Veevers, 1959; Sadler Formation, Frasnian; Fitzroy Basin, Western Australia.

Teichertina fitzroyensis Veevers, 1959
(Pl. 7, Figs 1–19)

*1959a. *Teichertina fitzroyensis* sp. nov.; Veevers, pp. 37–39, pl. 2, figs 1–16, text-figs 8, 9.
1972. *Teichertina fitzroyensis* Veevers; Johnson, pl. 1, figs 1–12, text-figs 1A, 2 (left), 3.
1978. *Teichertina fitzroyensis* Veevers 1959; Johnson, p. 123, pl. 1, figs 7–17.
1982. *Teichertina fitzroyensis* Veevers 1959; Johnson and Trojan, pp. 123–124, pl. 1, figs 1–13.
2000. *Teichertina fitzroyensis*; Harper, p. 800, fig. 579-3a–h.

MATERIAL: 51 complete to nearly complete and 25 fragmentary specimens with conjoined valves, 16 ventral and 17 dorsal valves, collection number ZPAL Bp 73/1/5.

DESCRIPTION: Shell small, rarely exceeding 7 mm in width, transverse, subtrapezoidal to semi-elliptical in outline, ventribiconvex; anterior commissure unisulcate, anterior margin emarginate, lateral margins arched, but slightly concave near long and straight hinge line; cardinal extremities acute.

Ventral valve subpyramidal with high, concave, apsacline (exceptionally catacline) interarea; delthyrium narrow, open except for apical thickened plate. Dorsal valve with sharply bounded and deep median sulcus and low but distinct, flat and anacline interarea.

Interior of ventral valve with strong dental ridges which forming frequently true albeit short dental plates posteriorly which confine, with their bases, a raised muscle field laterally (Pl. 7, Figs 17–19); cardinal process knob-like, slightly bilobed, settled on a transverse shelf-like plate (ancillary struts), anteriorly supported by sharp and high median ridge or septum; muscle area clearly marked, raised, reaching almost anterior valve margin (Pl. 7, Figs 12–14); sockets deep, elevated; brachiophores rod-like, antero-ventrally pointed. Interior of both valves radially ridged and with strong submarginal crenulations. Shell substance densely punctate.

Ornament relatively finely fascicostellate; growth lines sublamellose, well marked in the anterior half of adult shells.

REMARKS: The material from Poland can be confidently assigned to *Teichertina fitzroyensis* Veevers, 1959 on account of form, size, and ornamentation of the shell, curvature of the ventral interarea, and details of the internal structure. Examination of numerous specimens from Józefka shows that the ventral interarea is usually concave although rare shells may possess it almost flat. The Middle Devonian (Eifelian) *Teichertina americana* Johnson, 1970 from central Nevada (Johnson 1970, 1972) differs from the present material in attaining smaller shell dimensions, having a catacline ventral interarea, more distinct dental lamellae, and poorly developed, rudimentary fascicostellate ornamentation. The Early Devonian (Zlichovian) *Teichertina polyfrons* Havlíček, 1977 and *T. peregrina* Havlíček, 1977, as well as the Middle Devonian (Givetian) *T. minax* Havlíček, 1977 (see Havlíček 1977; Ficner and Havlíček 1978) are readily distinguished from the Polish specimens mainly by the shell ornamentation.

Veevers (1959a, p. 39) suggested that the shell of *T. fitzroyensis* might be impunctate, but it is obvious now that the pitting of the internal surface of the silicified valves observed by him reflects punctae. The shell punctation in *T. fitzroyensis* as well as in other species of the genus was acknowledged by Johnson (1972) and Havlíček (1977). The punctae are also well visible in the non-silicified material from Józefka.

OCCURRENCE: Originally, the species was described from the Frasnian Sadler Formation of the Fitzroy Basin, western Australia (Veevers 1959a). *T. fitzroyensis* was also reported from the Givetian *Hoperella* fauna in northern Roberts Mountains (Johnson 1978) and the Givetian beds with *Stringocephalus* and the lower *Tecnocyrtina* fauna in the Antelope Range in Nevada (Johnson *et al.* 1980; Johnson and Trojan 1982). At Józefka it was found in the Wietrznia Beds (sets XXI and XXII; a single corroded shell from set XXIII).

Family Mystrophoridae Schuchert and Cooper, 1931
Genus *Biernatium* Havlíček, 1975

TYPE SPECIES: *Skenidium fallax* Gürich, 1896; Middle Devonian, Lower Givetian; the Holy Cross Mountains, Poland.

Biernatium minus Baliński sp. nov.
(Text-fig. 7; Pl. 8, Figs 21–34; Pl. 9, Figs 13–23)

ETYMOLOGY: *minus*, smaller (neuter of the comparative); after small size of the shell in comparison to other species of the genus.

TYPE LOCALITY: Józefka hill south of Górno, Holy Cross Mountains, roadcut on the east side of the hill along the road to Daleszyce.

TYPE HORIZON: Wietrznia Beds, sets XXI–XXII; Lower Frasnian.

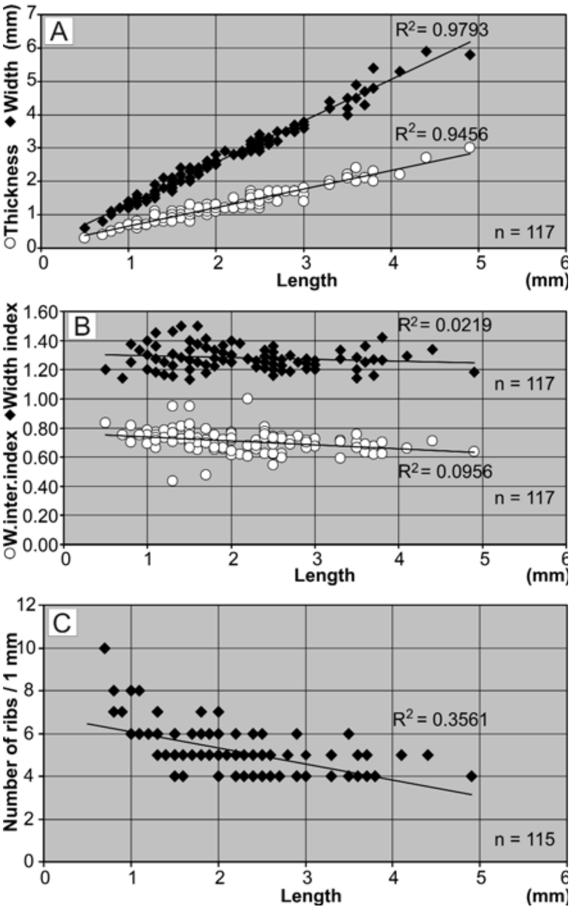
TYPE MATERIAL: Holotype (a complete articulated shell) ZPAL Bp 73/1/7/1 (Pl. 8, Figs 30–34; Pl. 9, Fig. 22) and about 180 articulated shells, 50 more or less damaged specimens, 12 ventral and 10 dorsal valves, collection number ZPAL Bp 73/1/7.

DIAGNOSIS: Shell small-sized, transverse in outline with width/length ratio 1.13–1.50; straight hingeline occupying about 60–80% of shell width; anterior commissure widely and weakly unisulcate; cruralium attaining about 46–56% of the valve length; 4–6 costae and costellae per 1 mm at the anterior margin.

DESCRIPTION: Shell small, rarely exceeding 4 mm in length, ventribiconvex, transversely elliptical in outline, with width/length ratio attaining usually 1.2–1.4 (total range 1.13–1.50); hingeline straight, occupying 62–76% of the total shell width in adults, but being slightly wider in juveniles (see Text-fig. 7 for full biometry); antero-lateral margins rounded, postero-lateral extremities rounded to slightly angular; anterior commissure widely and weakly unisulcate.

Ventral valve transversely elliptical in outline with well marked, projecting umbo; median fold not differentiated; interarea triangular, apsacline, concave; delthyrium open, with an apical angle of about 35–45°. Dorsal valve circular to transversely elliptical in outline, with wide and shallow sulcus appearing near umbo; dorsal interarea triangular, about half of the height of the ventral interarea, well marked, anacline, weakly curved, divided by wide and open notothyrium with an apical angle of about 60–87°.

Dorsal valve interior with long, rodlike, widely divergent brachiophores subparallel to hinge line; sockets without fulcral plates; cardinal process ridgelike, bilobed, with slender shaft continuous with median septum; cruralium triangular, narrowing anteriorly, attaining about 46–56% of the valve length, separated from brachiophores with the exception of the most posteromedian region; median septum high, highest at about mid-valve, thin anteriorly, extending forward to near anterior margin occupying 78–89% of the valve length. Ventral interior without dental plates, but with teeth supported by thickened ridges. Shell substance punctate.



Text-fig. 7. Scatter diagrams of shell width and shell thickness to shell length (A), shell width index and width of the ventral interarea index to shell length (B) and rib density per 1 mm to length (C) in *Biernatium minus* Baliński sp. nov.

Shell ornamented with costae and much thinner costellae arising by intercalation and bifurcation; 4–6 costae and costellae per 1 mm at the anterior margin of adult shells.

REMARKS: The genus *Biernatium* was founded by Havlíček (1975) with *Skenidium fallax* Gürich, 1896 as the type species. The internal structure of the dorsal valve described and illustrated by Havlíček (and repeated by Harper 2000, p. 810, fig. 586-5) was based on the material from the Givetian of Moravia, whereas Gürich (1896) established his species for specimens from the Holy Cross Mountains of Poland. According to Havlíček (1975) the cruralium in *Biernatium* is long, reaching almost the anterior margin of the valve. However, the type material of the species from the lower Givetian of the Holy Cross Mountains recently revised by Halamski (2009) clearly shows that the cruralium in *Biernatium fallax* is much shorter attaining about a half of the valve length. A similar condition is observed in the material described herein.

The specimens presently described display a close similarity to the type specimens of *B. fallax* (see Gürich 1896; Halamski 2009) especially in the general form of the shell, ornamentation, and internal structure. The present material is distinguished by clearly attaining smaller shell dimensions and by having a more transverse shell outline and finer shell ornamentation.

Orthis simplicior Barrande, 1879 (= *Biernatium simplicius*, according to Havlíček 1977) from the Koněprusy Limestone (Pragian, Lower Devonian) is a poorly known species based on a fragmentarily preserved type specimen (holotype) not adequate for comparison. Other specimens illustrated by Havlíček (1977, pl. 47, figs 4–8) resemble *Skenidioides* in their wide hinge margin, high ventral interarea, and character of shell ornamentation. From *Biernatium asiaticum* Alekseeva, 1992 described from the early Devonian of Mongolia (Alekseeva 1992) the new species differs by its much smaller shells, absence of fold on the ventral valve and dental plates inside the valve, wider hinge margin, and thinner radial costellation.

OCCURRENCE: The species is common in the Wietrznia Beds (sets XXI and XXII) of Józefka.

Family Rhipidomellidae Schuchert, 1913

Subfamily Rhipidomellinae Schuchert, 1913

Genus *Aulacella* Schuchert and Cooper, 1931

TYPE SPECIES: *Orthis eifeliensis* Schnur, 1853 (misspelling for *eifliensis*, = *Orthis prisca* Schnur, 1851); Eifelian, Middle Devonian; Germany.

Aulacella cf. *elliptica* Cooper and Dutro, 1982
(Pl. 10, Figs 1–20)

Compare
1982. *Aulacella elliptica* new species; Cooper and Dutro, pp. 38–39, pl. 2, figs 11–20, 31–59, 73–77, pl. 39, fig. 22.

MATERIAL: Three complete to slightly damaged shells (shell length 3.6, 9.5 and 11.6 mm respectively; 1.5–2 costellae per mm), 9 fragmentary specimens, and about twenty juvenile shells and single valves, collection number ZPAL Bp 73/1/8/1–3.

REMARKS: The main external characters of these uncommon shells in the studied section are: variable general shape, small to medium-size, biconvex, subtrapezoidal to transversally elliptical outline, wider than long, short hinge line, delicately paraplicate anterior commissure, and fascicostellate ornamentation. They are very similar to *Aulacella elliptica* Copper and Dutro, 1982 from the Sly Gap Formation (Frasnian) of New Mexico in having a comparable range of variability in general shell shape and ornamentation, although the present shells usually have slightly thicker costellae. The specimens from Józefka are also very similar to *Aulacella prisca* (Schnur, 1851) described by Halamski (2009; see also Biernat 1959, p. 26–35, pl. 1, figs 10–15, pl. 2, figs 1–15, pl. 3, figs 9–10, pl. 12, figs 1–2, text-figs. 9–10, text-pl. 3) from the Eifelian of the Eifel Mountains (Germany) and the Middle Devonian of the Holy Cross Mountains (Poland) in the shell dimensions and outline, but differ in having slightly coarser radial ornamentation and a slightly more distinct dorsal sulcus and anterior paraplication of the commissure. From the similar *Aulacella xinanensis* Chen, 1978 described from the lower part of the Frasnian of Sichuan (China) by Chen (1984, p. 108–110, pl. 2, figs 1–6, text-figs 8–10) the species from Józefka differs in coarser shell ornamentation and less inflated shell. *Aulacella* ex gr. *eifeliensis* from the Frasnian set A of Laskowa Hill Quarry (Racki *et al.* 1985, pl. 11, fig. 1) also seems similar to the specimens from Józefka, but the latter usually have coarser shell ornamentation. The Famennian *A. aggeris* from Belgium (Mottequin 2008a, pp. 470–474, text-figs 14F–Q, 15, 16) differs from the present material by its less developed sulcus on the dorsal valve and weaker ventral median fold.

OCCURRENCE: The taxon occurs rarely in the Wietrznia Beds (sets XXI and XXII) of Józefka.

Superfamily Enteletoidea Waagen, 1884
Family Draboviidae Havlíček, 1950
Subfamily Monelasmininae Harper, 2000
Genus *Monelasmina* Cooper, 1955

TYPE SPECIES: *Orthis deshayesi* Rigaux, 1873; Frasnian, Upper Devonian; Boulonnais, France.

Monelasmina montisjosephi Baliński sp. nov.
(Text-fig. 8; Pl. 8, Figs 1–20; Pl. 9, Figs 1–12)

ETYMOLOGY: From the type locality name (Józefka hill, latinized as Mons Josephi).

TYPE MATERIAL: Holotype (a complete articulated shell) ZPAL Bp 73/1/6/1 (Pl. 8, Figs 16–20) and about 380 complete and 44 incomplete shells, 19 ventral and 17 dorsal valves, collection number ZPAL Bp 73/1/6.

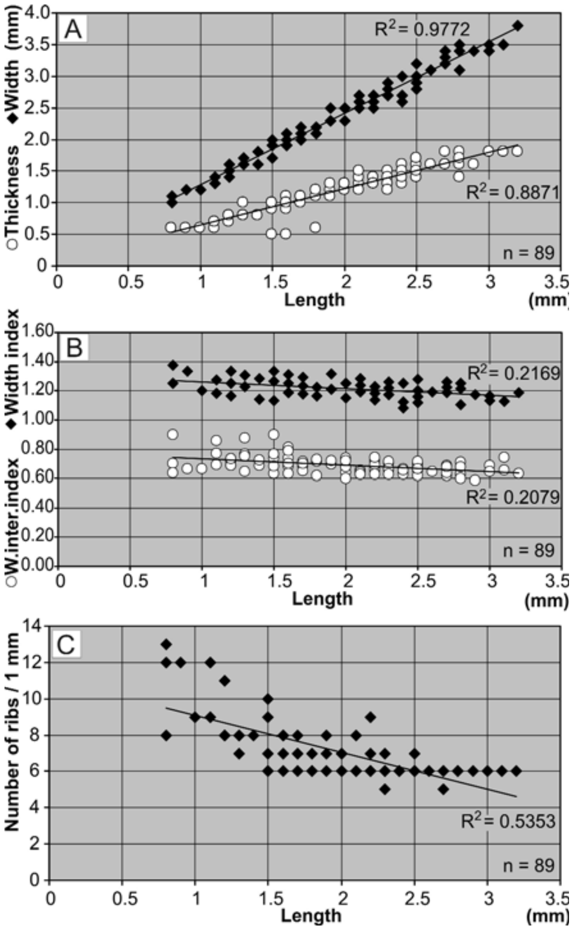
TYPE LOCALITY: Józefka hill south of Górno, Holy Cross Mountains, roadcut on the east side of the hill along the road to Daleszyce.

TYPE HORIZON: Wietrznia Beds, sets XXI–XXII; lower Frasnian.

DIAGNOSIS: Shell small-sized, transverse in outline with width/length ratio 1.08–1.38; straight hingeline occupying about 60–80% of shell width; anterior commissure widely and weakly unisulcate; median septum terminating at short distance from anterior margin; 6–9 costae and costellae per 1 mm at anterior margin of adult shells.

DESCRIPTION: Shell minute, exceptionally exceeding 3 mm in length, transversally elliptical in outline, with width/length ratio ranging 1.08–1.38 (Text-fig. 8), ventribiconvex; hinge line straight occupying about 60–80% of the shell width; anterior and lateral margins well rounded, postero-lateral extremities slightly angular; anterior commissure widely and weakly unisulcate.

Ventral valve rounded with thick umbo; median fold not developed; interarea triangular, apsacline, concave; delthyrium open, narrow, with an apical angle of about 20–33°. Dorsal valve well rounded in outline, with wide and very shallow sulcus appearing



Text-fig. 8. Scatter diagrams of shell width and shell thickness to shell length (A), shell width index and width of the ventral interarea index to shell length (B) and rib density per 1 mm to length (C) in *Monelasmina montisjosephi* Baliński sp. nov.

near umbo; dorsal interarea triangular, slightly concave, about half of the height of the ventral interarea, anacline, divided by relatively narrow and open notothyrium with an apical angle of about 45°.

In dorsal interior the fulcral plates usually not developed or very weakly marked as a ridge-like structure supporting sockets. Dorsal adductor scars shallowly impressed, laterally bordered by slightly anteriorly divergent ridges. Medial septum appearing short distance anteriorly from to the cardinal process and at about posterior limits of adductor muscle field; septum rising gradually anteriorly reaching maximum height at about the midlength of the valve, then terminates steeply a short distance from the anterior valve margin. The summit of the posterior half of the septum slightly expanded and flattened or with weak longitudinal concavity or furrow; anteriorly the median septum extends to the bottom of the opposite valve (Pl. 9, Fig. 11). Cardinal process bilobed, triangular, filling greater part of the notothyrial cavity. Brachiophore plates widely divergent, subvertical, confining posterior areas of adductor muscle scars.

Ventral interior with distinct, well developed crural fossettes supported by short dental plates. Shell substance punctate.

Shell ornamented with costae and much thinner costellae arising by intercalation; 6–9 costae and costellae per 1 mm at the anterior margin of adult shells.

REMARKS: These small-sized shells are characterized by persistently transversally expanded shells. Although the present collection contains several hundreds of specimens there are no shells exceeding 3.7 mm in length whereas the majority of the specimens attain less then 3 mm. Externally, they are similar to *Monelasmina deshayesi* (Rigaux, 1873) from the Frasnian of Ferques (Boulonnais, France; Cooper 1955; Brice 1981), but differ in their smaller and wider shells, less carinate ventral and less sulcate dorsal valves. In respect to the proportions of the shell dimensions the present specimens are identical with *M.* cf. *deshayesi* described by Mottequin (2008a) from the Grands Breux Formation of the Dinant Synclinorium and the Les Valisettes Formation of the Dinant Synclinorium, Belgium, but the former are smaller and have a slightly thinner radial ornament. *Monelasmina* sp. A described by Mottequin (2008a) from the Les Valisettes Formation of the Dinant Synclinorium is about 2.5 times larger than *M. montisjosephi* sp. nov. and has higher and slightly wider interareas. The Polish specimens are close to *Monelasmina wenjukovi* Ljaschenko, 1959 from the lower Frasnian of the Russian Platform (Ljaschenko 1959), but the latter is almost two times larger, more rounded and less transversally expanded in outline, and has rather parallel adductor scars in the dorsal valve whereas those in the former are divergent anteriorly. *Monelasmina besti* Pedder, 1959 from the Hey River Formation (Frasnian) of Western Canada (Pedder 1959) is distinguished from the present species by the shell being about twice as large, more circular in outline, with a proportionally shorter hinge line.

OCCURRENCE: The species is common in the Wietrznia Beds (sets XXI and XXII) of Józefka.

Family Schizophoriidae Schuchert and LeVene, 1929
Genus *Schizophoria* King, 1850

TYPE SPECIES: *Conchyliolithes Anomites resupinatus* Martin, 1809; Lower Carboniferous; Derbyshire, England, United Kingdom.

Schizophoria schnuri prohibita Halamski, 2012
(Pl. 10, Figs 21–22)

v* 2012 *Schizophoria schnuri prohibita* ssp. n.; Halamski, p. 356–359, figs 4A–C, E, M, Q, V–Y, BB–EE, 7A–II, 8C, E.

MATERIAL: Over 25 fragmentary shells embedded in limestone from set I; one fragment from set II–III; one incomplete shell from set X; 2 fragments from set XXI; 4 incomplete articulated shells, 3 dorsal valves, and several fragments from set XXII; 5 fragments from set XXIII, collection number ZPAL Bp 73/1/9; moreover upper Givetian and lower Frasnian material from the Józefka quarry and roadcut described by Halamski (2012), collection number ZPAL Bp 64.

DESCRIPTION: See Halamski (2012).

REMARKS: The material from set XXII, despite its fragmentation, is identifiable at subspecies level thanks to its characteristic wide dorsal muscle fields (see Halamski 2012). The material from other sets is too poorly preserved to allow such an identification; nonetheless, the available characters show no significant differences compared with those of shells from set XXII; as a consequence, the entire collection of *Schizophoria* is considered as belonging to the same taxon.

OCCURRENCE: This subspecies is known from three upper Givetian to lower Frasnian sections in the Holy Cross Mountains: Józefka (quarry and sets I–III, X, and XXI–XXIII), Laskowa (= Laskowa Góra), and Nieczulice (Halamski 2012). A number of other subspecies of the species *Schizophoria schnuri* are known from the Middle Devonian of the Eifel (Struve 1965), Ardennes (Struve 1965; Hubert *et al.* 2007), Holy Cross Mts. (Halamski 2009, 2012), Moravia (Havlíček 1977), and Burma (Anderson *et al.* 1969).

Order Pentamerida Schuchert and Cooper, 1931
Suborder Pentameridina Schuchert and Cooper, 1931
Superfamily Gypiduloidea Schuchert and Levene, 1929
Family Gypidulidae Schuchert and Levene, 1929
Subfamily Gypidulinae Schuchert and Levene, 1929
Genus *Physemella* Godefroid, 1974

TYPE SPECIES: *Physemella maillieuxi* Godefroid, 1974; Upper Devonian, Middle Frasnian; Frasnes-lez-Couvin, Belgium.

Physemella sp.
(Pl. 10, Figs 23–25)

1990. *Novozemelia*? sp. W.; Godefroid and Racki, p. 47–50, pl. 3, figs 1–3, text-fig. 3.

MATERIAL: About 70 fragmentary single valves (collection number ZPAL Bp 73/1/10) with worn external surface. Almost all are ventral valves.

REMARKS: The present collection is very fragmentary and poorly preserved and does not permit detailed description and accurate identification. The specimens are characterized by a medium to large, strongly convex ventral valve and smooth external surface. The interior of the ventral valve is distinguished by the presence of a pseudospondylium and the absence of a median septum. These characters indicate that the specimens described represent a species of the genus *Physemella*.

The species from Józefka are readily distinguishable from *Physemella christianae* Godefroid, 1990 described by Godefroid and Racki (1990) from the Late Frasnian of Tudorów (eastern part of the Holy Cross Mountains). The latter species is distinctly ribbed and has a ventral fold whereas the present form has a smooth surface without a clearly marked ventral fold. The specimens from Józefka are more similar to the type species of the genus, i.e., *P. maillieuxi* from the Middle Frasnian of Belgium (see Godefroid 1974). However, the latter species possesses radial ribs, which although weakly developed, are absent altogether in the former. Four fragmentary gypidulid specimens coming from Józefka Hill were described by Godefroid and Racki (1990) as *Novozemelia*? sp. W.

OCCURRENCE: Józefka, Wietrznia Beds (sets XXI and XXII, not uncommon; set XXIII, very rare); undeterminable gypidulids occur in upper Szydłówek Beds and Wietrznia Beds (X–XX). Poorly preserved specimens from the set A were tentatively included to this species.

Order Rhynchonellida Kuhn, 1949
Superfamily Uncinuloidea Rzhonsnitskaya, 1956
Family Uncinulidae Rzhonsnitskaya, 1956
Genus *Fitzroyella* Veevers, 1959

TYPE SPECIES: *Fitzroyella primula* Veevers, 1959; Frasnian, Upper Devonian; Fitzroy Basin, Australia.

Fitzroyella alata Biernat, 1969
(Pl. 11, fig 31, Pl. 12, figs 1–10)

*1969. *Fitzroyella alata* n. sp.; Biernat, pp. 377–386, pl. 1, figs 1–9, pl. 2, figs 1–4, pl. 3, figs 1–12, text-figs 1–5.
1971. *Fitzroyella alata* Biernat, 1969; Biernat, p. 144, pl. 2, fig 5.
1978. *Fitzroyella alata* Biernat, 1969; Struve, pp. 344–45, pl. 1, figs 1–5.
1981. *Fitzroyella alata* Biernat, 1969; Szulczewski and Racki, pl. 2, fig. 4.
v. 2006. *Fitzroyella alata* Biernat, 1969; Baliński, pp. 655–656, fig. 7C.

MATERIAL: Nine complete and 14 fragmentarily preserved shells and single valves, collection number ZPAL Bp 73/1/14.

Dimensions of two complete and illustrated specimens (in mm): length: 6.0, 6.9, 7.5; width: 6.5, 8.5, 8.8; thickness: 4.5, 5.4, 5.3.

REMARKS: The species was described in detail from the Early Frasnian of Kowala, Kadzielnia, and Wietrznia (Biernat 1969, 1971; Baliński 2006). The specimens now recovered at Józefka are characterized by small shell dimensions most often not exceeding 8 mm in length, pentagonal shell outline, long and slightly auriculate hinge margin, and strong, simple, and thick radial ribs. It should be noted that, although the present collection is small, the specimens display quite a broad range of intraspecific variability, especially in shell ribbing and development of median sulcation. For example, the number of ribs in the ventral sulcus range from one to four. The cardinal angles in the specimens from Józefka range from angular to slightly auriculate, but not as alate as in some of the type series of specimens of the species from Kadzielnia described by Biernat (1969).

OCCURRENCE: At Józefka section the specimens were found in the most fossiliferous sets XXI and XXII. Two shells were found in the older collecton coming from the now unexposed Givetian set A (Laskowa Hill Beds) in the road-cut at Józefka. The species was described by Biernat (1969, 1971) from the Lower Frasnian biohermal Kadzielnia Member of Kowala and Kadzielnia (Holy Cross Mountains), Szulczewski and Racki (1981) from the Early Frasnian bioherm of the Gałęzice syncline and by Baliński (2006) from the *Palmatolepis transitans* conodont Zone (Lower Frasnian) of the Wietrznia quarry. It is unknown outside the Holy Cross Mountains (Struve 1978) and confined to the uppermost Givetian and Lower Frasnian.

Genus *Flabellulirostrum* Sartenaer, 1971

TYPE SPECIES: *Uncinulus wolmericus* Veevers, 1959; Sadler Formation, Frasnian, Upper Devonian; Fitzroy basin, Western Australia.

Flabellulirostrum sp.
(Pl. 12, figs 11–15)

MATERIAL: Three complete and slightly damaged shells and 3 fragmentary specimens, collection number ZPAL Bp 73/1/15.

Dimensions of two complete and illustrated specimens (in mm): length: 10.1, 11.3; width: 11.0, 13.1; thickness: 7.2, 7.4.

REMARKS: This small and poorly representative collection includes specimens showing external and internal similarity to the Givetian–Frasnian genus *Flabellulirostrum*. The shells from Józefka are medium sized, up to 12.5 mm in length, uniplicate, subpentagonal in outline, and anteriorly costate. Costae are simple, round-top, separated by narrow grooves. Although interior of the single sectioned specimen is recrystalized, the absence of dental plates and presence of a septalium and a large cardinal process was revealed. The specimens studied differ from *F. kielcense* Baliński, 2006 and *F. rackii* Baliński, 2006 described from approximately coeval strata at Wietrznia (Baliński 2006) by having a less laterally expanded shell and attaining much smaller shell dimensions. The specimens from Józefka are most similar externally to the type species of the genus, i.e. *F. wolmericum* Veevers, 1959 described by Veevers (1959a) from the Sadler Formation of western Australia.

OCCURRENCE: The species occurs rarely in the Wietrznia Beds (sets XXII and XXIII), of Józefka.

Superfamily Camarotoechioidea Schuchert, 1929
Family Septalariidae Havliček, 1960
Genus *Phlogoiderhynchus* Sartenaer, 1970

TYPE SPECIES: *Uncinulus arefactus* Veevers, 1959; Lower Frasnian, Upper Devonian; Australia.

Phlogoiderhynchus polonicus (Roemer, 1866)
(Pl. 11, figs 1–5)

*1866. *Camarotoechia*? *polonica*; Roemer, p. 676, pl. 13, figs 9, 10.
1896. *Camarotoechia polonica* F. Roemer; Gürich, p. 280, pl. 7, fig. 8.
1975. *Phlogoiderhynchus polonicus* (Roemer, 1866); Biernat and Szulczewski, pp. 203–215, pls 21–28, text-fig. 2.
1988. *Phlogoiderhynchus polonicus* (Roemer); Makowski, pl. 10, figs 8, 9.
1993. *Phlogoiderhynchus polonicus*; Makowski in Racki *et al.*, pl. 18, fig. 3.
v. 2006. *Phlogoiderhynchus polonicus* (Roemer, 1866); Baliński, p. 663, figs 5A, 7H.

MATERIAL: One complete and 6 slightly damaged shells and 53 fragmentary specimens from Józefka, collection number ZPAL Bp 73/1/11; 20 complete shells and 53 fragmentary specimens from Radlin, collection number ZPAL Bp 73/2/11.

REMARKS: Biernat and Szulczewski (1975) revised the species and gave detailed description of its morphology, internal structure and the range of intraspecific variability.

The present material is conspecific with *Phlogoiderhynchus polonicus*, a highly characteristic and widely distributed species in several Lower–Middle Frasnian sections of the Holy Cross Mountains (Biernat and Szulczewski 1975; Racki 1993a; Racki *et al.* 1993). Although Sartenaer and Racki (1992) and Racki (1993a) noted some diachronism in the distribution of *P. polonicus* between the north and south basinal regions of the Holy Cross Mountains, the species can be regarded as a useful fossil for a local correlation of the Lower–Middle Frasnian deposits.

OCCURRENCE: The species has been reported from several localities in the Holy Cross Mountains: Jaźwica, Kowala, Sosnówka, Śluchowice-Czarnów, Kostomłoty, Szydłówek, Józefka, Radlin, Chęciny, Kawczyn, and Wietrznia. It is confined to the Lower and lower Middle Frasnian marls, marly limestones, and limestones (Biernat and Szulczewski 1975; Racki 1993a; Racki *et al.* 1993). At Józefka it is common in sets I–III (middle Szydłówek Beds) and uncommon in sets XIX, XXI–XXIII (Wietrznia Beds). It is frequent in the Szydłówek Beds at Radlin hill.

Superfamily Pugnacoidea Rzhonsnitskaya, 1956
Family Pugnacidae Rzhonsnitskaya, 1956
Genus *Coeloterorhynchus* Sartenaer, 1966

TYPE SPECIES: *Coeloterorhynchus tabasensis* Sartenaer, 1966; Middle and Upper Frasnian, Upper Devonian; Iran.

Coeloterorhynchus dillanus (Schmidt, 1941)
(Text-figs 9, 10; Pl. 11, Figs 6–30, 32)

*1941. *Pugnax acuminatus dillanus* n. subsp.; Schmidt, pp. 284–285, pl. 1, figs 2–4.
1982. *Coeloterorhynchus dillanus* (Herta Schmidt, 1941); Drot, p. 75, pl. 1, fig. 5.
1988. "*Parapugnax*" sp.; Makowski, pl. 12, figs 3, 4, 6, 13, 14.
1990. *Coeloterorhynchus dillanus* (Schmidt, 1941); Budziszewska, pp. 32–33, pl. 5, figs 1, 2.
1990. *Coeloterorhynchus magnificum* Cooper and Dutro, 1982; Budziszewska, pp. 33–35, pl. 6, figs 1–4.
1993. "*Parapugnax*" sp.; Makowski in Racki *et al.*, pl. 8, fig. 5.
v. 2006. *Coeloterorhynchus dillanus* (Schmidt, 1941); Baliński, pp 663–666, figs 13, 14D–F.

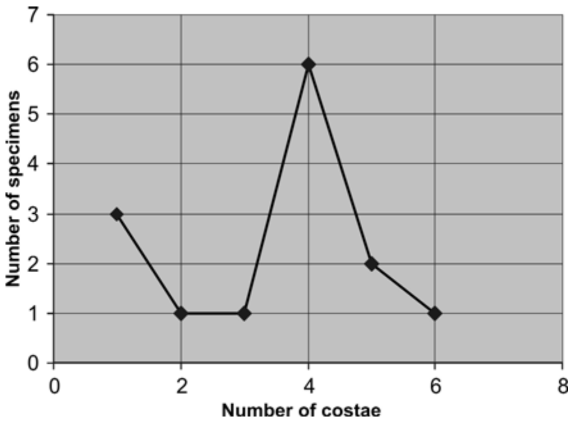
MATERIAL: 16 complete articulated and 3 incomplete shells, 13 fragments of shells and single valves, collection number ZPAL Bp 73/1/12. Dimensions of two complete specimens (in mm): length: 17.5, 25.4; width: 21.4, 30.3; thickness: 18.5, 16.9.

DESCRIPTION: Shell medium- to large-sized, attaining over 37.8 mm in width, wider than long, with the greatest width at about midlength to more anteriorly, strongly dorsibiconvex, transversely elliptical in outline; cardinal margin angular forming an angle of 111–118º, lateral margins rounded, anterior margin truncated, anterior commissure strongly uniplicate. Ventral valve with flattened to gently convex flanks, medially deeply excavated by wide sulcus; tongue prominent, triangular to subtrapezoidal with rounded and serrate top. Dorsal valve rounded to highly domed in anterior view, with poorly demarcated fold and convex flanks.

Shell surface smooth posteriorly, costate in anterior half; 3 rather weak costae on flanks, 1–6 (most commonly 4, see Text-fig. 9) costae in fold, and 0–5 costae in sulcus; costae most pronounced at anterior margin. Microornamentation consists of fine radial striae (Pl. 11, Figs 30, 32) and concentric growth lines.

Ventral valve interior with short, vertical dental plates. Dorsal interior with horizontal, divided hinge plates; median septum absent.

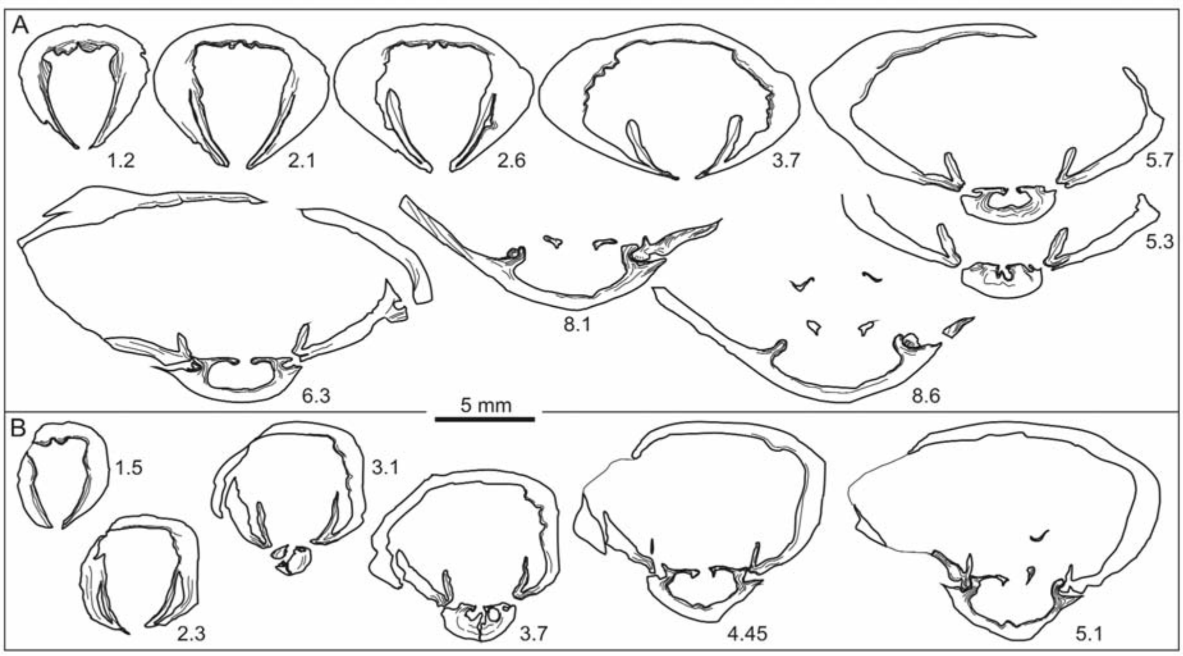
REMARKS: The available specimens from Józefka display a close similarity to *C. dillanus* described originally



Text-fig. 9. Histogram of absolute frequencies of number of costae on the fold in *Coeloterorhynchus dillanus* from the Józefka roadcut (set A); N = 14

by Schmidt (1941) from Langenaubach and Winterberg (Germany). The Polish specimens of *C. dillanus* have the same shell shape, development of sulcus, tongue, and ornamentation. They also show a similar variation pattern with the shells high (Pl. 11, Fig. 25 herein; Schmidt 1941, pl. 1, fig. 3), moderately high (Pl. 11, Fig. 15 herein; Schmidt 1941, pl. 1, fig. 4), and flattened (Pl. 11, Fig. 29 herein; Schmidt 1941, pl. 1, fig. 2) shells. The minor difference between the two samples consists in the slightly greater shell dimensions attained by the specimens from Józefka (the maximal recorded width in the type sample from Langenaubach is 26 mm; Schmidt 1941, p. 285). The variability of the costation in the Józefka sample is strong, the shells having from 1 to 6 costae on the fold (Text-fig. 9); those from Germany figured by Schmidt (1941, pl. 1, figs 2–4) have 3 or 4 costae but no more detailed data on the variability of German material are provided.

OCCURRENCE: *Coeloterorhynchus dillanus* was originally described from the Frasnian blocks contained in the Famennian breccia at Langenaubach (type locality situated in the Lahn-Dill Syncline). The age of *Archoceras varicosum* and *Pseudogruenewaldtia* contained in the same breccias is probably late Frasnian (Korn *et al*. 2013, p. 118; Halamski 2013, p. 300), but it is uncertain whether this age identification can be extended to the entire assemblage. *C. dillanus* was also reported from two Frasnian localities in the Harz, Winterberg (Schmidt 1941) and Elbingerode (Baliński 2006) as well as from Tafilalt (Northern Africa, eastern Anti-Atlas; Drot 1982). Recently the discussed species was reported from the middle part of the Wietrznia Beds (*Palmatolepis transitans* conodont Zone) of the Wietrznia quarry, Holy Cross Mountains (Budziszewska 1990; Baliński 2006). At Józefka the main occurrence of the species is in the uppermost Givetian set A (14 specimens). It is also known from set I (middle Szydłówek Beds) and single specimens were also found in the quarry (Laskowa Góra Beds) and in the roadcut (sets II, III, X, and XXIII; middle and upper Szydłówek and Wietrznia Beds). It remains uncertain



Text-fig. 10. Transverse serial sections of *Coeloterorhynchus dillanus* (Schmidt, 1941) through the shells ZPAL Bp 73/1/12/4, 5 from Józefka roadcut (middle Szydłówek Beds). Numbers refer to distances in mm from ventral umbo whether *Pugnax mesogona* (Phillips, 1836) sensu Filonowicz (1969, p. 36) from Józefka Hill represents the same species.

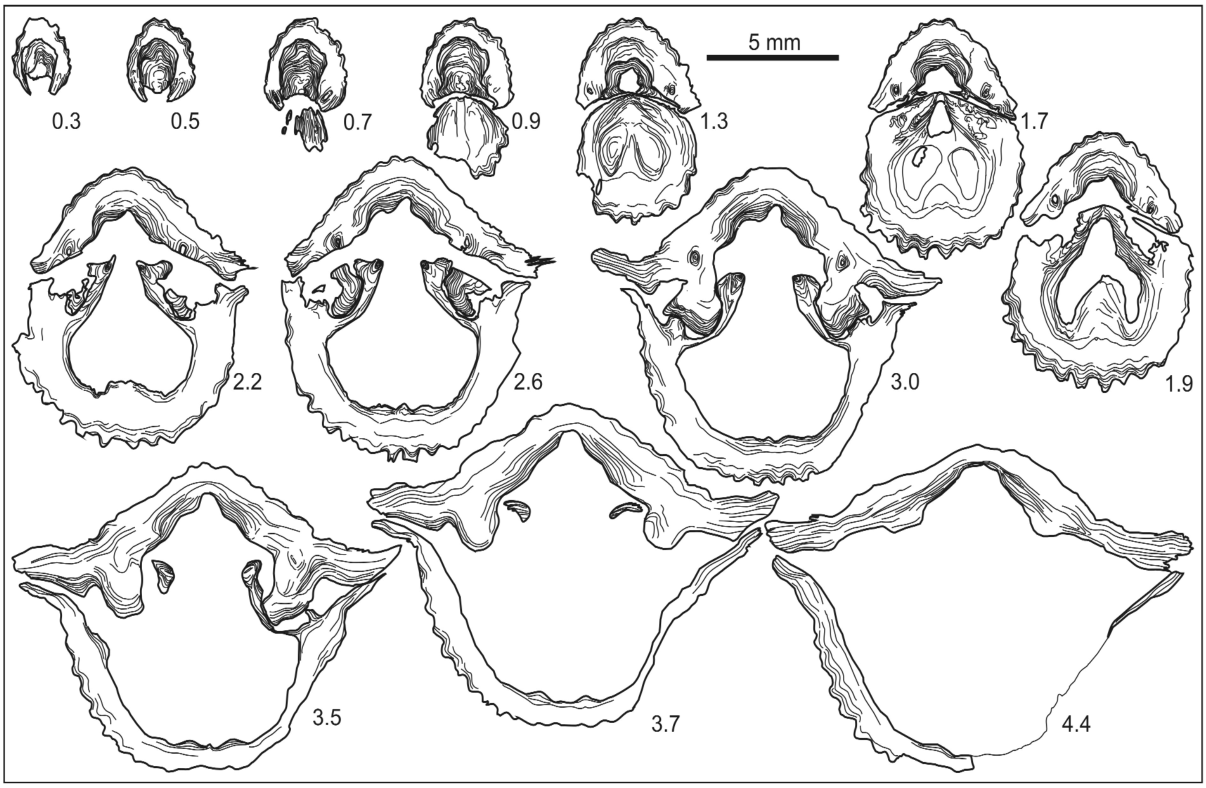
Order Atrypida Rzhonsnitskaya, 1960
Family Atrypidae Gill, 1871
Genus *Atryparia* Copper, 1966

TYPE SPECIES: *Atryparia instita* Copper, 1966; Eifelian, Middle Devonian; Eifel, Germany.

Subgenus *Atryparia* (*Costatrypa*) Copper, 1973

TYPE SPECIES: *Atrypa varicostata* Stainbrook, 1945; Independence Shale, Upper Frasnian, Upper Devonian; Iowa, USA.

SPECIES ASSIGNED:
Atryparia (*Costatrypa*) *agricolae* sp. n., as below; Radlin, Holy Cross Mountains; lowermost Frasnian;
Atryparia (*Costatrypa*) *dushanensis* Ma, Copper, Sun, and Liao, 2005; Guizhou; lowermost Frasnian;
Costatrypa eremitae Godefroid, 1998; Ardennes; lower Frasnian (*transitans* Zone, perhaps also the upper part of the *falsiovalis* Zone; Godefroid 1998);
Costatrypa traonliorsensis Copper and Racheboeuf, 1985; Goasquellou, Brittany, France; lower Frasnian ("probably F2a", Copper and Racheboeuf 1985);
Costatrypa fossae Godefroid, 1998; Dinant Synclinorium (Belgium); middle Frasnian (*punctata* Zone; Godefroid 1998);
Costatrypa lecomptei Godefroid, 1998; Dinant Synclinorium (Belgium); middle Frasnian (*punctata* Zone, perhaps also lower part of the *hassi* Zone; Godefroid 1998);
Costatrypa sp. A sensu Godefroid (1998); Dinant Synclinorium (Belgium); middle Frasnian (*punctata* Zone);
Atrypa (*Costatrypa*) sp. B sensu Godefroid (1988); Boulonnais, France; Ferques Fm., Upper *asymmetricus* Zone, Middle Frasnian.
Atryparia? *variabilis* Godefroid, 1970; Namur-Dinant Basin (Belgium) – middle to upper Frasnian (possibly upper part of the *punctata* Zone, *hassi*, *jamieae*, and *rhenana* zones; Godefroid 1970, 1998; Mottequin 2008b); Eifel, (late?) Frasnian (Godefroid and Hauser 2003);
Atrypa varicostata Stainbrook, 1945; Iowa and New Mexico – late Frasnian (incl. *Costatrypa extensa* Cooper and Dutro, 1982; see Stainbrook 1945, Cooper and Dutro 1982, Day and Copper 1998);



Text-fig. 11. Transverse serial sections of *Atryparia* (*Costatrypa*) *agricolae* sp. nov. through the shell ZPAL Bp 73/2/16/9 from Radlin (middle Szydłówek Beds). Numbers refer to distances in mm from ventral umbo

Holy Cross Mountains, late Frasnian (Racki and Baliński 1998).

REMARKS: Two species of *Atryparia* (*Costatrypa*) from Brittany have been reported under open nomenclature by Copper and Racheboeuf (1985, p. 85). *Costatrypa*? sp. A is worth mentioning as it comes from the Givetian Kergarvan Formation and thus would be the oldest representative of the discussed subgenus. However, according to Copper (2002, p. 1394) *Atryparia* (*Costatrypa*) is limited to the Frasnian.

Two additional species, *Atrypa uralica* Nalivkin, 1930 from the Semiluki horizon of the East European Platform (Nalivkin 1930, p. 74, pl. 6.10) and *Atrypa posturalica* (Markovskii *in* Mikryukov, 1955) from the Late Frasnian of the Urals (Mikryukov 1955, p. 239, pl. 4.5; reported also from the Middle Frasnian of the Kuzbass, Rzhonsnitskaya *et al.* 1998) have been considered as problematic representatives of the discussed subgenus [*Costatrypa*(?) *uralica* and *Costatrypa*(?) *posturalica* sensu Rzhonsnitskaya *et al.* 1998, respectively]. *Atryparia* (*Costatrypa*) cf. *uralica* was reported from the Frasnian of the Dębnik Anticline (Middle and Upper *asymmetricus* Zones; Baliński 1979: p. 56–57).

Atryparia (*Costatrypa*) *agricolae* Halamski and Baliński sp. nov.
(Text-fig. 11; Pl. 13, figs 1–30; Pl. 14, figs 1–10)

ETYMOLOGY: In honour of Georgius Agricola (24.03.1494–21.11.1555), geologist and mineralogist.

TYPE LOCALITY: Radlin, southern slope of a small hill 1.3 km S of the village, 50°51’17”N 20°44’50”E.

TYPE HORIZON: Middle part of the Szydłówek Beds; probably Lower Frasnian.

TYPE MATERIAL: Holotype, complete articulated shell ZPAL Bp 37/2/16/1 (Pl. 13, Figs 11–15); eight complete adult articulated shells (one sectioned), one juvenile shell, and four incomplete or fragmentary ones (paratypes), all from the type outcrop, collection number ZPAL Bp 73/2/16.

Dimensions of figured specimens (in mm), holotype in boldface:

Coll. number	Width	Length	Thickness	Ribs per 5 mm
ZPAL Bp 37/2/16/1	**30.4**	**27.6**	**19.3**	**(3–)4(–5)**
ZPAL Bp 37/2/16/2	28.9	27.2	21.8	(4–)5–6
ZPAL Bp 37/2/16/3	24.1	23.3	16.1	4–5
ZPAL Bp 37/2/16/4	28.2	26.4	16.6	4–5
ZPAL Bp 37/2/16/5	32.0	30.8	21.7	4
ZPAL Bp 37/2/16/6	23.3	24.2	13.4	4
ZPAL Bp 37/2/16/7	26.8	25.5	17.3	(4–)5
ZPAL Bp 37/2/16/8	29.3	26.1	16.6	4–5

DIAGNOSIS: *Atryparia* (*Costatrypa*) with weakly transverse, strongly dorsibiconvex to convexoplane shells usually 25–30 mm in width and 4–4.5 ribs per 5 mm at anterior margin.

DESCRIPTION: Shell usually 25–30 mm in width (maximal recorded width 32.0 mm), in larger specimens shield-shaped in outline, slightly wider than long, strongly dorsibiconvex to convexoplane; in smaller specimens rounded in outline, slightly longer than wide, moderately to strongly dorsibiconvex. Shoulder angle 120–140° in younger individuals, 150–170° in adults. Interareas not exposed, adpressed against the dorsal umbo. Ventral beak fine, incurved. Anterior commissure weakly to moderately uniplicate.

Ornamentation of strong ribs, 4–4.5(–5.5) per 5 mm at anterior margin; growth lines strong, densely packed in anterior region.

Ventral interior with extensive pedicle callist, almost completely filling the pedicle cavity; teeth large and strong, with small dental nuclei. Dorsal interior with deep sockets and relatively thin socket plates; crura fibrous, spiralium not preserved.

REMARKS: These brachiopods are assigned to *Atryparia* (*Costatrypa*) on account of their strongly dorsibiconvex to convexoplane shells, imbricate ribs crossed by numerous growth lamellae, adpressed ventral umbo, presence of dental nuclei and extensive pedicle callist. This subgenus is represented by several species (see above), often having wide geographic distribution but showing restricted stratigraphic ranges.

Among the representatives of this subgenus, *Atryparia* (*Costatrypa*) *agricolae* sp. n. is most similar to the coeval *A.* (*C.*) *dushanensis* Ma *et al.*, 2005 from the lowermost Frasnian of southern China (Ma *et al.* 2005). The strongly biconvex shells of the two species are nearly identical in form, but the Chinese brachiopods are somewhat smaller (usual size 20–25 mm in width, not exceeding 30 mm) and their ornamentation is finer (usually 12–13 costae per cm at anterior margin). *A.* (*C.*) *eremitae* Godefroid, 1998 from the lower Frasnian of the Ardennes (Godefroid 1998) has a more convex ventral valve and finer ornamentation. On the contrary, *A.* (*C.*) *traonliorsensis* Copper and Racheboeuf, 1985 from the (lower) Frasnian of southern Belgium, has a coarse ornamentation (4–5 ribs per 5 mm) like *A.* (*C.*) *agricolae* sp. nov. but is elongate. The other species of *Atryparia* (*Costatrypa*) are even more different in shape and without exception all have finer ornamentation.

Four shells (out of eight) in the studied material are encrusted by epizoans on their dorsal valves, three by auloporid tabulates and one by *Petrocrania* sp. (see above). It may be supposed that the life position of *Atryparia* (*Costatrypa*) *agricolae* sp. nov. was with ventral valve lying on the substrate. The environment at Radlin was therefore more quiet than that at Józefka (see remarks on *Skenidioides cretus* and *Davidsonia enmerkaris*).

Two decorticated shells from set X at Józefka may probably be referable to the same species. *Atryparia* (*Costatrypa*) sp. described by Baliński (2006) from the approximately coeval (*Palmatolepis transitans* Zone, Lower Frasnian) middle Wietrznia Beds at Wietrznia is similar in shape but smaller than the described material and with finer ornamentation (5–9 ribs per 5 mm).

OCCURRENCE: The species is known from the Middle Szydłówek Beds at the type locality (set I; Text-fig. 5) and probably from set X at Józefka (two damaged shells referred tentatively to the discussed species).

Genus *Spinatrypina* Rzhonsnitskaya, 1964

TYPE SPECIES: *Spinatrypina margaritoides* Rzhonsnitskaya, 1964; Pragian, Lower Devonian; Siberia, Russia.

Subgenus *Spinatrypina* (*Exatrypa*) Copper, 1967

TYPE SPECIES: *Terebratulites explanatus* von Schlotheim, 1820; Refrath beds, Frasnian, Upper Devonian; Refrath, Paffrath Syncline, Bergisches Land, Germany.

Spinatrypina (*Exatrypa*) *explanata* (von Schlotheim, 1820)
(Text-fig. 12; Pl. 15, figs 1–33)

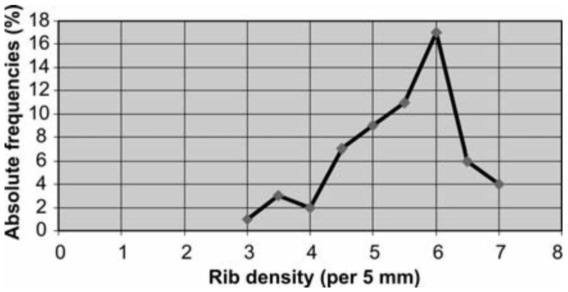
* 1820. *Terebratulites explanatus*; Schlotheim, p. 263.
1967a. *Spinatrypina* (*Exatrypa*) *explanata* (Schlotheim 1820); Copper, pp. 125–127, text-figs 7, 8, pl. 20, figs 1–4 [ubi syn.].
1988. *Spinatrypina* cf. *explanata* (von Schlotheim 1820); Godefroid, pp. 425–427; pl. 49, figs 7–8.
1998. *Spinatrypina (Exatrypa) explanata*; Racki and Baliński, pp. 285–286, fig. 11.
2006. *Spinatrypina* (*Exatrypa*) cf. *explanata* (Schlotheim, 1820); Baliński, pp. 668–669, fig. 18C, D.
2015. *Spinatrypina* (*Exatrypa*) *explanata* (Schlotheim, 1820); Ma *et al.*, p. 62, fig. 2K–L.

MATERIAL: Over eighty adult shells and several juveniles, one isolated dorsal valve; collection number ZPAL Bp 73/1/18.

DESCRIPTION: Shell elliptic in outline, usually about 24 to 29 mm wide (maximum recorded width 33.1 mm), moderately to markedly transverse in adults, approximately as wide as long to transverse in smaller shells [width-to-length ratio (1.02–)1.17–1.27(–1.40), N=50]. Shell usually weakly to moderately dorsibiconvex, more seldom aequibiconvex or weakly ventribiconvex [width-to-thickness ratio (1.65–)1.94–2.36(–2.77), N=50]. Shoulder angle 150–180°. Dorsal valve subtrapezoidal in anterior view, with a shallow and rather narrow U-shaped median sulcus beginning in umbonal region. Ventral valve lowly subtriangular in anterior view; interarea apsacline, its width about half of that of the shell; beak fine, foramen (seldom preserved) submesothyrid (Pl. 15, Fig. 26). Anterior commissure straight to uniplicate, rarely weakly sulciplicate. Ornamentation of tubular, bifurcating ribs, (3–)5–6(–7) per 5 mm at anterior commissure, interrupted by relatively rarely spaced growth lines (Pl. 15, Fig. 25). Dorsal interior with strong hinge plates and wide sockets, cardinal process none, adductor scars separated by a low and wide myophragm (Pl. 15, Figs 32–33); ventral interior unknown.

REMARKS: The agreement of biometric characters of the studied sample with that from the Paffrath Syncline is perfect as to the mean width-to-length ratio (1.22 in both cases). The sample from Józefka is, however, less flat than that from Paffrath (mean width-to-thickness ratios 2.12 and 2.78, respectively; data for comparison after Copper 1967a, p. 126).

Three species of the genus *Spinatrypina* have been reported as dimorphic, i.e. represented by a coarse-ribbed and a fine-ribbed variant. These are: *Spinatrypina soetenica* (Struve, 1964) (Eifel Mts, Lower Givetian; Copper 1967b), *Spinatrypina* (*Exatrypa*) *relicta* Racki and Baliński, 1998 (Łgawa Hill, Holy Cross Mts, Late Frasnian; Racki and Baliński 1998, p. 284), and *Spinatrypa mariaetheresiae* Halamski, 2013 (Mokrzeszów, late Frasnian; Halamski 2013, p. 302). Field observations of *Spinatrypina* (*E.*) *explanata*



Text-fig. 12. Histogram of absolute frequencies of rib density per 5 mm at anterior margin in *Spinatrypina* (*Exatrypa*) *explanata* (von Schlotheim, 1820) from the Józefka quarry (Laskowa Góra Beds or lower-middle Szydłówek Beds).

seemed to confirm such a pattern as well. However, the statistic examination of a larger sample (N = 60; Text-fig. 12) showed that the histogram of rib densities is unimodal (left-skewed). The alleged dimorphism might be explained by a psychological artefact due to the unusual aspect of the coarse-ribbed individuals (compare Pl. 15, Figs 21 and 23).

Copper (1967a, p. 126) reported the unpublished observations of von Schlotheim on the remarkable flatness of the shell of *S.* (*E.*) *explanata* and interpreted this feature as an adaptation to a strong current. This is in line with our observations on disarticulated shells of *Skenidioides cretus* indicating a high energy environment. It should, however, be stressed, that shells in the studied sample are much less flat than those from the Rhenish Slate Mts. (the mean value of the width-to-thickness in the latter is outside the variation range of the former).

OCCURRENCE: *S.* (*E.*) *explanata* is limited to the lower Frasnian of Europe (Copper 1967a) and has been reported from the Steinbreche horizon of the Refrath beds in the Paffrath Syncline (Copper 1967a; Ma *et al.* 2015) and from a few localities in the Holy Cross Mountains (Racki and Baliński 1998; Baliński 2006). At Józefka the species was found in the Laskowa Góra to middle Szydłówek beds in the quarry and in the now unexposed set A at the roadcut, in the middle Szydłówek Beds (sets II, III, roadcut), and in the Wietrznia Beds (sets XXI–XXIII, roadcut). A limited collection (four specimens) from the bed c of the Membre des Noces of the Beaulieu Formation (Ferques, Boulonnais, France; lowermost part of the Middle *asymmetricus* Zone) was reported under open nomenclature by Godefroid (1988). In view of the variability of the discussed species shown above, the samples from the Boulonnais are considered as belonging to the same species as those from the Paffrath Syncline and Józefka.

Genus *Desquamatia* Alekseeva, 1960

TYPE SPECIES: *Atrypa* (*Desquamatia*) *khavae* Alekseeva, 1960; lower Eifelian, Middle Devonian; Urals, Russia.

Desquamatia sp.
(Pl. 14, Figs 11–20)

MATERIAL: Three articulated shells, one damaged shell and a single ventral valve; collection number ZPAL Bp 73/1/17.

DESCRIPTION: Shell up to 27.2 mm long, rounded to shield-shaped (shoulder angle 130–150°), approximately as long as wide, markedly dorsibiconvex. Maximal width at midlength. Anterior commissure weakly plicate with a low and wide tongue. Dorsal valve strongly convex, somewhat flattened medially. Ventral valve subtriangular, beak not preserved. Ornamentation of tubular costae and costellae, 6–7 per 5 mm at anterior commissure. Interior not studied.

REMARKS: The two figured shells are included into the genus *Desquamatia* on account of their characteristic ornamentation. Scarcity of material precludes specific identification. In comparison with *Atryparia* (*Costatrypa*) cf. *agricolae* sp. nov. from set X, *Desquamatia* sp. is more rounded (smaller shoulder angle) and has finer ornamentation.

OCCURRENCE: The taxon occurs rarely in the Wietrznia Beds (sets XXI and XXII) of Józefka.

Suborder Davidsoniidina Copper, 1996

REMARKS: The early Frasnian species *Davidsonia enmerkaris* Halamski sp. nov. represents the youngest known occurrence of the suborder Davidsoniidina, which was known up to now from the Silurian to the Middle Devonian (Copper 2002, p. 1444).

Superfamily Davidsonioidea King, 1850
Family Davidsoniidae King, 1850

Genus *Davidsonia* Bouchard-Chantereaux, 1849

TYPE SPECIES: *Davidsonia verneuillii* Bouchard-Chantereaux, 1849; upper Eifelian, Middle Devonian; Germany.

SPECIES ASSIGNED:
Davidsonia septata Copper, 1996; Bangqao, eastern Yunnan, China; Bangqao Fm., upper Givetian?
Davidsonia enmerkaris Halamski sp. nov., as below.

REMARKS: The often reported species *D. bouchardiana* de Koninck, 1853 is at most a subspecific variant of *D. verneuillii* with which it often co-occurs (Copper 1996, p. 596). *Davidsonia woodwardiana* de Koninck, 1855 described originally from the Middle Devonian (upper Eifelian or lower Givetian) of Chimay (de Koninck, 1855, p. 285; Copper 1996, p. 599) is the type species of the genus *Rugodavidsonia* Copper, 1996, the validity of which is uncertain (see below).

Davidsonia enmerkaris Halamski sp. nov.
(Pl. 12, Figs 16–26)

ETYMOLOGY: In honour of Enmerkar, king of Sumer (4th or 3rd millennium B.C.), credited with the invention of the cuneiform script, one of the two oldest writing systems in the world.

TYPE LOCALITY: Józefka hill south of Górno, Holy Cross Mountains, roadcut on the east side of the hill along the road to Daleszyce; corresponding to outcrop V sensu Małkowski (1981) and to the type outcrop of *Biernatella lentiformis* Baliński, 1995 (Baliński 1995b).

TYPE HORIZON: Wietrznia Beds, sets XXI–XXII; lower Frasnian.

TYPE MATERIAL: About twenty articulated shells and isolated ventral valves (including the holotype ZPAL Bp 73/1/19/1; Pl. 12, Fig. 26), a single dorsal valve; four individuals still attached to alveolitid tabulates; several fragments; collection number ZPAL Bp 73/1/19.

DIAGNOSIS: *Davidsonia* with lateral flanks of the dorsal valve costate near the margin. Ventral cones with 2–3 spiralial grooves, ventral median septum none.

DESCRIPTION: Shell weakly to moderately transverse, up to ca. 15 mm in width; maximal width either at hinge line or in the posterior half, rarely anteriorly; anterior commissure straight. Ventral valve moderately convex, attached most frequently in apical region, in which case radial costae are present in marginal region; more seldom valve attached on its entire surface. Interarea up to 3 mm high, apsacline, delthyrium closed by two conjunct deltidial plates. Dorsal valve flat to weakly concave (post mortem?); tubular costae, 3–4 per 5 mm can be observed near anterior and lateral margins.

Ventral interior: Teeth short, stubby, located at the extremities of the delthyrium. Muscle scars flabellate, extending for 0.25–0.4 of the valve length. Ventral septum absent. Spiralia accommodated by thickened ventral cones with 2–3 grooves on their lateral slopes.

Dorsal interior: Hinge plate small and only moderately raised above the valve floor; cardinal process small. Sockets on both sides of the hinge plate. Adductor scars bilobed, rounded, shallow. Spiralia accommodated by faint depressions.

REMARKS: The described brachiopods are included within *Davidsonia* Bouchard-Chantereaux, 1849 on account of presence of spiralial grooves (although weaker than in the type species *D. verneuillii*; spiralial grooves absent in *Rugodavidsonia woodwardiana*). The costation is developed as in *Rugodavidsonia* Copper, 1996 (both species of *Davidsonia* known up to now, *D. verneullii* and *D. septata*, are smooth). The shell shape is most often transverse with maximal width posteriorly, as in *Davidsonia*, although rounded specimens reminiscent of *Rugodavidsonia* are also present in the studied material. The ventral valve shows a large spectrum of variation in cementation: some individuals are attached only in the apical region (as in *Rugodavidsonia*; Copper 1996), whereas in some a large portion of the valve is adherent to the substrate (as in *Davidsonia*). In view of the intrapopulational variability of characters of supposedly systematic value at genus level it is uncertain whether *Rugodavidsonia* should be retained as a separate genus.

OCCURRENCE: Type locality only; besides the type horizon, poorly preserved specimens attached to *Spinatrypina* (*Exatrypa*) *explanata* and referred with doubt to the discussed species were found in the quarry (most probably Laskowa Góra Beds). A single tentatively identified fragmentary ventral valve comes from the now unexposed set A at the roadcut. It is also uncertain whether *Davidsonia* sp. sensu Racki *et al.* (1985, pl. 11, fig. 4) from the Givetian of Laskowa represents the same species.

Order Athyridida Boucot, Johnson and Staton, 1964
Suborder Athyrididina, Johnson and Staton, 1964
Superfamily Athyridoidea Davidson, 1881
Family Athyrididae Davidson, 1881
Subfamily Athyridinae Davidson, 1881
Genus *Athyris* M'Coy, 1844

TYPE SPECIES: *Terebratula concentrica* von Buch, 1834; Eifelian, Middle Devonian; Gerolstein Syncline, Eifel, Germany.

?*Athyris* sp.
(Pl. 18, Figs 32–36)

MATERIAL: Six subcomplete to damaged shells and a single dorsal valve; collection number ZPAL Bp 73/1/21.

REMARKS: The studied collection is represented almost exclusively by small to very small individuals ranging from 2 to 6.5 mm in length. A single incomplete shell found at the bottom of the section (bed 1) represents the adult stage and measures 13 mm in length. However, due to the poor preservation of the specimen, its specific identity with the rest of the collection (coming from sets XXI and XXII) remains somewhat tentative. The best preserved, almost complete shell (Pl. 18, Figs 32–36) revealed from set XXII, attains 6.5 mm in length, being transversally elliptical in outline, strongly biconvex, and having a markedly uniplicate anterior commissure and distinct concentric lamellose ornamentation. Generally, the studied material is inadequate in quality and quantity to provide a basis for a detailed description and taxonomic determination. It shows some external similarity to *A. bayeti* Rigaux, 1908 as redescribed by Brice (1988) from the Frasnian Ferques Formation of the Ferques area (Boulonnais, France).

OCCURRENCE: The species occurs rarely in the middle Szydłówek Beds (set I) and Wietrznia Beds (sets XXI and XXII) of the Józefka roadcut.

Subfamily Didymothyridinae Modzalevskaya, 1979
Genus *Leptathyris* Siehl, 1962

TYPE SPECIES: *Leptathyris gryphis* Siehl, 1962; upper Eifelian, Middle Devonian; the Rhenish Slate Mountains, Eifel, Germany.

Leptathyris gornensis Baliński sp. nov.
(Text-fig. 13; Pl. 16, Figs 16–27)

TYPE MATERIAL: Holotype (a complete articulated shell) ZPAL Bp 73/1/22/1 (Pl. 16, Figs 16–20, 26), and three complete articulated shells, one incomplete specimen (paratypes); collection number ZPAL Bp 73/1/22.

TYPE LOCALITY: Józefka hill south of Górno, Holy Cross Mountains, trench on the east side of the hill along the road to Daleszyce; corresponding to outcrop V sensu Małkowski (1981) and to the type outcrop of *Biernatella lentiformis* Baliński, 1995 (Baliński 1995b).

TYPE HORIZON: Wietrznia Beds, set XXII; lower Frasnian.

ETYMOLOGY: After Górno, a village near the type locality.

DIAGNOSIS: Medium-sized for the genus, subpyriform to subpentagonal in outline, as wide as long, slightly uniplicate, ventral sulcus shallow, wide, developed on anterior half of valve, dorsal fold at anterior margin, poorly defined; interior with long dental plates, slightly divergent ventrally in umbonal region to subparallel anteriorly; ventral muscle field deeply impressed, cardinal plate deeply concave, with median longitudinal undulation.

DESCRIPTION: Shell subpyriform to subpentagonal in outline, subequally biconvex, generally as wide as long, with maximum width anterior to midlength; hinge margin angular, attaining 140–145°; lateral margins rounded, anterior margin straight, anterior commissure gently uniplicate.

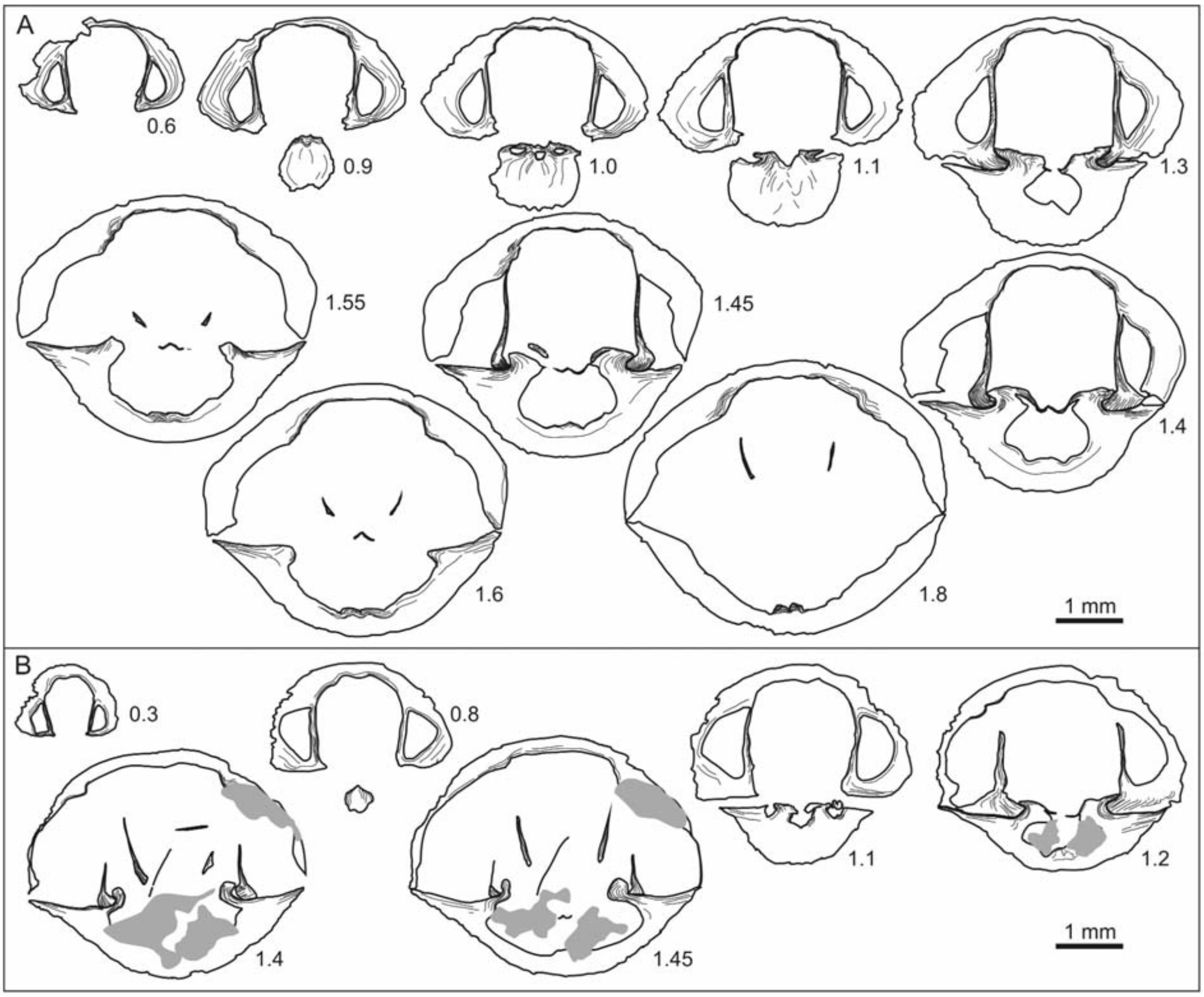
Ventral valve with suberect beak, prominent, orthocline palintrope without beak ridges; delthyrium narrow, open, enclosing 37–51°, pedicle foramen submesothyrid; sulcus poorly defined, shallow, wide, discernible on anterior half of the valve. Dorsal valve evenly curved or with very low, poorly defined fold appearing near the anterior margin.

Ventral interior with well-developed, thin and long dental plates, slightly divergent ventrally in the umbonal region to subparallel anteriorly (Text-fig. 13); teeth strong, short; muscle field deeply impressed, in umbonal region limited laterally by dental plates.

Dorsal interior with subhorizontal, well developed inner socket ridges; cardinal plate deeply concave, U-shaped, thin and delicate, with high median longitudinal undulation; axial part of the cardinal plate stretching anteriorly; crura bent ventrally.

Shell surface smooth with poorly preserved growth lines.

REMARKS: This is a very rare species in the brachiopod fauna from Józefka. Its general external appearance as well as the internal shell structure with well developed dental plates and U-shaped cardinal plate with longitudinal undulation or crest suggest that



Text-fig. 13. Transverse serial sections of *Leptathyris gornensis* Baliński sp. nov. through the shells ZPAL Bp 73/1/22/3, 4 from Józefka roadcut, set XXII (Wietrznia Beds). Numbers refer to distances in mm from ventral umbo

the species represents the genus *Leptathyris*. The stratigraphic range of the genus is basically confined to the Middle Devonian although there are rare records from the Early Devonian (Yazikov 1988; Soja 1988b). The Famennian record of *L. cardiothyriformis* Biernat, 1983 from Poland (Biernat 1983) should remain as doubtful (Alvarez and Rong 2002, p. 1519) until the internal structure of its shell is revealed. Thus, the present material from Józefka represents the youngest reliable occurrence of the genus.

The present specimens are generally similar in size and outline of the shell to the type species of the genus, *L. gryphis* Siehl, 1962 described from the upper Eifelian of the Rhenish Slate Mountains (Siehl 1962). The former differs in having wider, less inflated, non-bisulcate shell and a non-indented anterior commissure. Compared to *L.* n. sp. A described by Siehl (1962) from the same locality as the type species, the present specimens are proportionally longer and non-bisulcate, with a higher ventral palintrope. *L.* n. sp. B described by Siehl (1962) is a much smaller form and does not have developed dental plates.

The species from Józefka is similar in shell size to *L. circula* (Walcott, 1884) from the Eifelian of the Roberts Mountains, Nevada (Johnson 1966, 1968), but the former differs in having consistently better developed median sulcation and more medially situated dental plates. The Polish specimens are readily distinguished from *L. index* Johnson, 1971 described by Johnson (1971) from the *Warrenella kirki* Zone (lower Givetian) of the Roberts Mountains by their shell size being twice as great and their markedly transverse shell outline. *L. gornensis* sp. nov. differs from *L. deino* Havlíček and Kukal, 1990 from Daleian–Eifelian of Bohemia (Havlíček and Kukal 1990) by having a more subpyriform shell outline with the greatest shell width situated more anteriorly, and a more elongated and pointed umbonal region. *L. salairica* Yazikov, 1988 from the Emsian of the Salair Ridge (Russia; Yazikov 1988) differs from the new species being two–three times larger and by having a radially striated shell surface.

L. borki Soja, 1988 from the Emsian of southeastern Alaska (Soja 1988a) is much more elongated than *L. gornensis* and has considerably shorter dental plates and a less concave cardinal plate. Soja (1988b) recorded the *Leptathyris* Community within the Early Devonian benthic faunas of Alaska and suggested a shallow, quiet-water environment of the Benthic Assemblage 2.

OCCURRENCE: The species is known only from the type locality and horizon where it is confined to set XXII of the Wietrznia Beds.

Subfamiy Helenathyridinae Dagys, 1974
Genus *Biernatella* Baliński, 1977

TYPE SPECIES: *Biernatella polonica* Baliński, 1977; Frasnian, Upper Devonian; Dębnik anticline, southern Poland.

Biernatella lentiformis Baliński, 1995b
(Pl. 16, Figs 1–15, 28–29; Pl. 17, Figs 1–7, 9)

v*1995b. *Biernatella lentiformis* sp. n.; Baliński, pp. 142–144, figs 8A–C, 9–11.
v. 2003. *Biernatella lentiformis* Baliński, 1995b; Baliński in Baliński *et al.*, p. 221, pl. 157, fig. 2.
v. 2006. *Biernatella lentiformis* Baliński, 1995b; Baliński, p. 670, fig. 18A.

MATERIAL: About 3600 complete shells and 250 incomplete shells and single valves; collection number ZPAL Bp 73/1/20. Additionally, over 1600 specimens from the same locality (collection number ZPAL Bp XXXVIII) described previously by Baliński (1995b).

DESCRIPTION AND REMARKS: Although the external shell morphology and internal shell structure of the species based on several sectioned specimens was described in detail earlier (Baliński 1995b), the rich more recently recovered material, including free valves showing internal structures, allows for some additional comments.

Ventral valve. Commonly, the interior of the valve is without dental plates. However, there are a few specimens showing variable development of the dental ridges which exceptionally may form very short and thin dental lamellae. In these specimens the dental cavities are very narrow and shallow, slit-like (Pl. 17, Fig. 3). It should be noted that dental lamellae are well developed in *Eobiernatella* Baliński, 1995b, i.e., in the Givetian forerunner of the mainly Frasnian *Biernatella*, as well as in the Late Frasnian *Neptunathyris* Mottequin, 2008.

Dorsal valve. The inner socket ridges, outer hinge plates and the crural bases poorly differentiated, forming thickened ridges, distinctly elevated above the inner hinge plates (Pl. 17, Figs 4–6); inner hinge plates very thin and narrow and do not unite to form a single cardinal plate. The crural bases thin, circular in cross-section, straight and run ventrally, i.e., more or less perpendicularly to the commisural plane and hinge plates. The distal tips of the crural bases virtually touch the bottom of the ventral valve and then turn rapidly anteriorly at the right angle, thus giving the basal part of the brachidium an elbow-shaped appearance. The structure of the rest of the brachidium (diplospiralium) in the species was described and illustrated in Baliński (1995b).

REMARKS: The new material here described includes several free valves showing various development of cardinalia and structure of the brachidium. Although in *Eobiernatella* and *Neptunathyris* the cardinal plate is present (Baliński 1995b, pp. 138, 140, fig. 5; Mottequin 2008a, pp. 469–492, figs 33, 34), in serial sections through shells of *Biernatella* species (including *B. lentiformis*) the plate was not differentiated (Baliński 1977, 1995b; Mottequin 2004). The specimens now available show that the inner hinge plates are developed as very thin, delicate and fragile structures, very susceptible to breakage. When preserved they show various stage of development being usually narrow, but occasionally they form wide, sub-horizontal pair of plates, very narrow to lacking posteriorly, and wide, with a tendency to converge slightly towards the midline (but they never meet), anteriorly. Thus, the inner hinge plates do not form a true cardinal plate. However, the large, posteriorly located suboval free space between the plates is clearly homologous with the cardinal pit (dorsal foramen) in the cardinal plate of other athyridoids.

This is by far the dominant species in the assemblages from sets XXI and XXII. A few illustrations (Pl. 16, Figs 1–15, 28, 29, Pl. 17, Figs 1–7, 9) in addition to those in Baliński (1995b) show the main morphological variations within the species.

OCCURRENCE: The species is very numerous at the type locality (Józefka) in the Wietrznia Beds (sets XXI and XXII, two specimens in the set XXIII). It has been also found in coeval strata in the Wietrznia quarry (about 13 km west of the former site; Baliński 2006) as well as in a few other localities of the Holy Cross Mountains (see Baliński 1995b, p. 144). Two poorly preserved shells from the now unexposed set A (uppermost Givetian Laskowa Góra Beds) at the roadcut may represent *B. ovalis* Baliński, 1995b.

Order Spiriferida Waagen, 1883
Suborder Spiriferidina Waagen, 1883
Superfamily Cyrtospiriferoidea Termier and Termier, 1949
Family Cyrtospiriferidae Termier and Termier, 1949
Subfamily Cyrtospiriferinae Termier and Termier, 1949
Genus *Cyrtospirifer* Nalivkin in Fredericks, 1929

TYPE SPECIES: *Spirifer verneuili* Murchison, 1840; Frasnian, Ferques, Boulonnais, France.

Cyrtospirifer sp.
(Pl. 17, fig. 18)

MATERIAL: One fragmentary ventral valve ZPAL Bp 73/1/26/1.

REMARKS: The single poorly preserved ventral valve is not specifically definable although its occurrence in the assemblage seems important to note.

OCCURRENCE: Józefka, Wietrznia Beds, set XXIII.

Superfamily Ambocoelioidea George, 1931
Family Ambocoeliidae George, 1931
Subfamily Ambocoeliinae George, 1931
Genus *Echinocoelia* Cooper and Williams, 1935

TYPE SPECIES: *Echinocoelia ambocoelioides* Cooper and Williams, 1935; Tully Formation, Middle Devonian; New York, USA.

Echinocoelia parva Baliński sp. nov.
(Pl. 17, figs 8, 10–17; Pl. 18, figs 1–16)

ETYMOLOGY: *parvus* – small, little; after small size of the shell in comparison to other species of the genus.

TYPE MATERIAL: Holotype (a complete articulated shell) ZPAL Bp 73/1/23/1 (Pl. 18, Figs 12–16), 220 complete and 63 fragmentary shells, 27 ventral and 9 dorsal valves (paratypes); collection number ZPAL Bp 73/1/23.

TYPE LOCALITY: Józefka hill south of Górno, Holy Cross Mountains, trench on the east side of the hill along the road to Daleszyce; corresponding to outcrop V sensu Małkowski (1981) and to the type outcrop of *Biernatella lentiformis* Baliński, 1995 (Baliński 1995b).

TYPE HORIZON: Wietrznia Beds, sets XXI–XXII; Lower Frasnian.

DIAGNOSIS: Shell up to 3 mm in length, slightly transverse to subequal in outline; hingeline about 62–70% of shell width; anterior commissure widely and weakly unisulcate; dorsal valve with wide and very shallow sulcus in the anterior half of valve; shell exterior with very delicate and dense concentric bands (20 per 1 mm) of very fine spine bases (40 per 1 mm); spine bases aligned in radial micro-capillae.

DESCRIPTION: Shell small, usually attaining up to 3 mm in length, slightly wider than long to subequal, circular to subpentagonal in outline, strongly unequally ventribiconvex; hinge line straight occupying about 62–70% of the shell width; anterior margin weakly rounded to straight, lateral margins rounded, posterolateral extremities slightly angular; anterior commissure widely and weakly unisulcate.

Ventral valve strongly convex with massive ubonal region; neither sulcus nor fold, but median flattening developed on some valves; interarea concave, apsacline, beak suberect; delthyrium open, with an apical angle of 33–45°. Dorsal valve subrectangular to transversally elliptical in outline, with wide and very shallow sulcus developed in the anterior half of the valve; dorsal interarea triangular, nearly flat, about 30–40% of the height of the ventral interarea, anacline, divided by open notothyrium with an apical angle of 90–102°.

Interior of ventral valve without dental plates, with thickened dental ridges (Pl. 17, Figs 13, 16); teeth rather small, projecting dorso-medially; apical region of the delthyrium closed by triangular, anteriorly indented apical plate; low and long median myophragm dividing weakly impressed elongated muscle scars developed only on large individuals (Pl. 17, Fig. 16). Dorsal valve with small, knob-like cardinal process supported anteriorly by low median myophragm which divides weakly impressed muscle scars (Pl. 17, Fig. 14); crura long, subparallel; crural bases fused posteriorly with the valve floor (Pl. 17, Figs 11, 12, 14).

Shell surface smooth except for very delicate and densely spaced (20 per 1 mm) concentric bands of very fine and closely spaced spine bases (40 per 1 mm width) aligned in well marked radial micro-capillae (Pl. 17, Figs 15, 17).

REMARKS: The present material is attributed to the genus *Echinocoelia* on account of small, strongly unequally ventribiconvex shell, absence of dental plates, presence of apical plate in the ventral valve and characteristic shell microornamentaion. The species is readily distinguishable from the North American Eifelian–Early Givetian *Echinocoelia denayensis* Johnson, 1966, Eifelian–Givetian *E. septata* Johnson, 1980, and the Givetian *E. careocamera* Johnson, 1978 by the general shell form which in the former is subcircular with a rather narrow hinge margin instead of subtriangular to subpentagonal with a wide megathyrid posterior margin in the three latter forms (see Johnson 1966, 1971, 1978; Johnson *et al.* 1980). Moreover, *E. septata* differs from the Polish and all other species of the genus by having a ventral median septum supporting a slender conical tube close to the valve umbo (Johnson in Johnson *et al.*1980). The Eifelian–Givetian *E. septata* Johnson, 1980 from Nevada (Johnson *et al.* 1980; see also Goldman and Mitchell 1990) and the Middle Devonian *E. guangsiensis* Sun, 1992 from southern China (Sun 1992; Xian 1998) in fact represent the genus *Cyrtinoides* Iudina and Rzhonsnitskaya, 1985.

The new species differs from the late Givetian *E. pretiosa* Cooper and Dutro, 1982 by having a narrower hinge margin, broadly unisulcate anterior commissure, and attaining less than half the size of the latter. *E.* cf. *incurva* from the late Givetian of Morocco (Drot 1964) differs from *E. parva* sp. nov. from Józefka by having a rectimarginate commissure and the shell dimensions about three times larger. From the Givetian *E. tikhiensis* Baranov and Alhovik, 2006 of northeastern Russia (Baranov and Alhovik 2006) the new species differs by having a smaller shell, narrower hinge margin, more concave ventral interarea, and a more curved ventral beak. *E. ambocoelioides* described from the Givetian of Pennsylvania (Ellison 1965) is larger, much wider, and has a wide megathyrid cardinal margin. *E. similior* Vogel, Xu and Langenstrassen, 1989 from the Early Devonian of Guangxi, China (Vogel *et al.* 1989) attains similar shell dimensions as the species here described, but differs in having a median furrow on the ventral valve; more detailed comparison is not possible as the Chinese material is inadequately represented. The species from Józefka is readily distinguishable from the early Givetian *Echinocoelia dorsoplana* (Gürich, 1896) described by Halamski (2004) from the Świętomarz section in the Holy Cross Mountains by attaining shell dimensions twice as small, and by having the greatest width of the shell situated much more anteriorly.

OCCURRENCE: The species is known from the Wietrznia Beds (sets XXI and XXII) of Józefka. A few specimens, which may also represent this species, have been found in an older collection coming from the now unexposed set A at the roadcut (the Laskowa Góra Beds).

Subfamily Rhynchospiriferinae Paulus, 1957
Genus *Emanuella* Grabau, 1923

TYPE SPECIES: *Nucleospira takwanensis* Kayser, 1883; Givetian, Middle Devonian; Takwan, Yunnan Province, southern China.

Emanuella aff. *takwanensis* (Kayser, 1883)
(Text-fig. 14; Pl. 18, Figs 17–31)

aff. 1931. *Emanuella takwanensis* (Kayser, 1883); Grabau, pp. 410–413, pl. 43, figs 1–3, pl. 44, figs 1, 2, text-figs 46, 47.
aff. 1959b. *Emanuella takwanensis* (Kayser); Veevers, pp. 903–906, text-figs 3, 4A, 5.
aff. 1970. *Emanuella takwanensis* (Kayser, 1883); Dürkoop, p. 200, pl. 17, fig. 1.

MATERIAL: Twenty two complete articulated and 18 damaged shells; In addition, 150 juvenile to subadult specimens measuring 0.8–5.0 mm in length; collection number ZPAL Bp 73/1/24.

DESCRIPTION: Shell rather small-sized, up to 13 mm in length, ventribiconvex, rounded subpentagonal to transversally elliptical in outline, wider than long (width index 1.06–1.28), widest at about midlength; hinge margin attains 64–72% of the shell width, cardinal extremities well rounded; anterior margin weakly rounded to nearly straight, lateral margins well rounded, anterior commissure rectimarginate to weakly uniplicate. Ventral valve with rather massive umbo and incurved beak; interarea catacline to apsacline near the hinge margin, occasionally orthocline, but rather strongly curved, delthyrium presumably open; sulcus very shallow near anterior margin or absent. Dorsal valve gently convex, widely subelliptical to rounded subpentagonal in outline, without fold, but frequently with delicate median groove; interarea low, anacline, weakly concave to almost flat.

Ventral interior with poorly developed dental ridges, without dental plates; apex of delthyrium closed by flat to slightly convex delthyrial plate, on some specimens with median, protruding externally ridge. Interior of dorsal valve with wide and raised ctenophoridium, wide outer hinge plates, and thin, discrete crural plates (Text-fig. 14); dental sockets slightly elevated above the shell wall; crural bases situated near the valve floor.

Shell surface smooth except rare growth lamellae; microornament of very fine spinules.

REMARKS: The shells described here are very close externally to the stratigraphically slightly younger *Emanuella* sp. from the Grands Breux Formation of Belgium (Mottequin 2008a). The former differ in having a slightly wider shell and more rounded cardinal angles. The present material is also close to *Emanuella* sp. A described by Johnson (1978) from the Givetian of central Nevada. Our specimens differ in their less rounded lateral and anterior margins, by having a weakly unisulcate anterior commissure, contrary to the rectimarginate commissure in the latter. From the early Givetian *E. russelli* Johnson, 1978 from central Nevada the present shells are smaller, have a weakly unisulcate anterior commissure, and apparently less converging crural plates.

Externally, the form described here is closest to the lectotype of the type species of the genus, i.e., *E. takwanensis* from the Givetian of Yunnan Province, China, as illustrated by Dürkoop (1970, pl. 17, fig. 1). The former shows also noticeable similarity to other specimens of *E. takwanensis* from the Givetian of Yunnan Province described by Grabau (1931, pp. 410–413, pl. 43, figs 1–3, pl. 44, figs 1, 2, text-figs 46, 47). The specimens from Józefka are similar to *E. takwanensis* in the general outline and convexity of the shell, broadly rounded cardinal margins, poorly developed sulcation, and similarly structured dental sockets. The former attain slightly smaller shell dimensions and have more or less randomly distributed spinules in comparison with the concentric bands in *E. takwanensis* as noted by Veevers (1959b, pp. 903–904, text-fig. 3).

Majority of species of the genus *Emanuella* are known from Eifelian–Givetian deposits. Only a few species have been recorded in the Frasnian, i.e., from Australia (Veevers 1959a), Russia (Ljaschenko 1973), China (Ma *et al.* 2006), and Belgium (Mottequin 2008a). Thus, the species from Józefka which occurs in the earliest Frasnian, represents one of the youngest species of the genus.

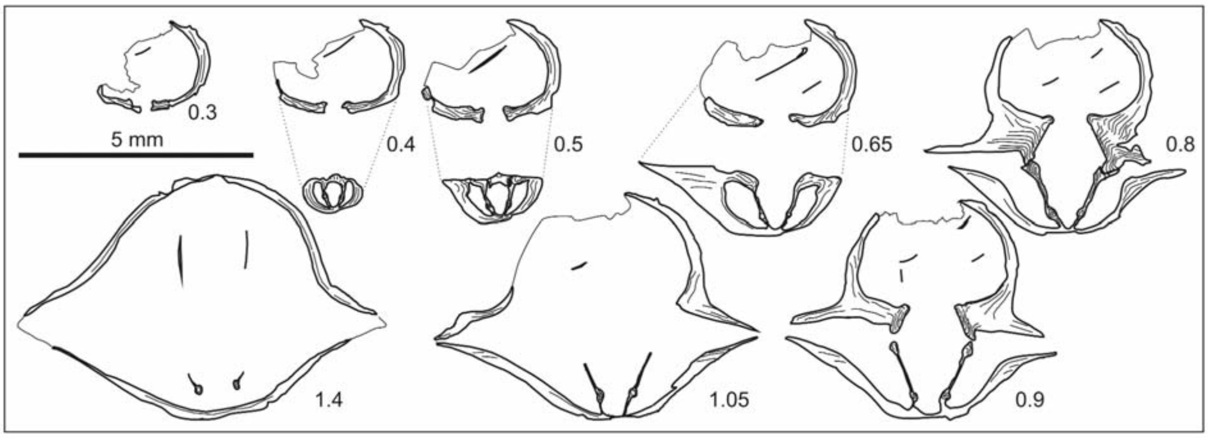
OCCURRENCE: The species is known from the Wietrznia Beds (sets XXI and XXII, and sporadically set XXIII) at Józefka. A few probably conspecific specimens were found in the now unexposed set A at the roadcut revealing the Laskowa Góra Beds.

Superfamily Reticularioidea Waagen, 1883
Family Reticulariidae Waagen, 1883
Subfamily Reticulariopsinae Gourvennec, 1994
Genus *Reticulariopsis* Fredericks, 1916

TYPE SPECIES: *Spirifer* (*Reticularia*) *dereimsi* Œhlert, 1901; Emsian, Early Devonian; Santa Lucia, León province, Spain.

?*Reticulariopsis* sp.
(Pl. 14, Figs 21–33)

MATERIAL: Three articulated shells (one subcomplete, two damaged); collection number ZPAL Bp 73/1/25.



Text-fig. 14. Transverse serial sections of *Emanuella* aff. *takwanensis* (Kayser, 1883) through the shell ZPAL Bp 73/1/24/4 from Józefka roadcut (Wietrznia Beds). Numbers refer to distances in mm from ventral umbo

Dimensions (in mm):

	length	width	thickness	sulcus width
ZPAL Bp 73/1/25/1	15.0	18.1	9.5	6.8
ZPAL Bp 73/1/25/2	32.5	48.3	28.7	20.1

DESCRIPTION: Shell transverse, ventribiconvex, dorsal valve subrectangular in shape with markedly rounded angles; maximal width at midlength of the dorsal valve. Ventral interarea catacline near hinge margin, of medium height, and concave; beak strongly incurved in large shell. Ventral sulcus originating at or near umbo, moderately deep, U-shaped. Anterior commissure uniplicate, tongue rounded. Shell largely smooth, very low and rounded plications developed on lateral flanks near the anterior commissure (4–5 observed on a single flank); microornamentation consisting of spine bases sometimes disposed in regular bands (Pl. 14, Fig. 32) and sometimes distributed irregularly (Pl. 14, Fig. 31). Microspines in two distinct sizes, although transitional ones also occurring. Small-sized microspines often arranged between a pair of larger ones (Pl. 14, Fig. 33).

Internal characters unknown; except for traces of dental plates visible on a partly decorticated umbo.

REMARKS: The external characters of the specimen studied and the presence of dental plates suggest that it represents the subfamily Reticulariopsinae. However, more precise determination is difficult and therefore the shell is tentatively assigned to *Reticulariopsis* Fredericks, 1916.

OCCURRENCE: The taxon is known from the Laskowa Góra to middle Szydłówek beds (quarry) and Wietrznia Beds, set XXI (roadcut) of Józefka; one incomplete specimen comes from the Szydłówek Beds at Radlin.

Order Spiriferinida Ivanova, 1972
Suborder Cyrtinidina Carter and Johnson, 1994
Superfamily Cyrtinoidea Fredericks, 1912
Family Cyrtinidae Fredericks, 1911

Genus *Cyrtina* Davidson, 1858

TYPE SPECIES: *Cyrtina heteroclita* Defrance, 1828; Lower Devonian; Néhou, Normandy, France.

REMARKS: Species-level taxonomy of *Cyrtina* is unclear. Its intrapopulational variation is often limited whereas interpopulational variation is strong; without a global scale revision it is uncertain whether the genus is represented by a small number of variable and widely distributed species or by a large number of local taxa (see Halamski and Baliński 2013).

Both forms described below are included into *Cyrtina* on account of their shell microstructure, closed delthyrium, smooth fold, and characteristic external form.

Cyrtina cf. *arkonensis* Ehlers and Wright, 1975
(Pl. 19, Figs 1–19)

cf. 1975 *Cyrtina arkonensis* sp. nov.; Ehlers and Wright, p. 160, pl. 2, figs 1–10, pl. 3, figs 1–20.

MATERIAL: Twenty two articulated shells, a single fragmentary dorsal valve, and several fragments; collection number ZPAL Bp 73/1/27.

DESCRIPTION: Shell up to 12.0 mm in width, wider than long (width to length ratio 1.32–1.80, mean 1.48, N=8), very strongly ventribiconvex. Maximal width and thickness at hinge line. Ventral valve high, pyramidal; interarea procline to catacline, high, transversely striate, flat or concave. Delthyrium occupying 1/10 to 1/6 of the shell width, deltidium usually not preserved (traces in a single specimen). Dorsal valve slightly to moderately convex. Ornamentation of rounded costae, 7–9 on each flank. Wide median dorsal fold with flattened top, most often with a distinct median groove on it. Ventral sulcus V-shaped.

Ventral interior: median septum with tichorhinum; otherwise unknown. Dorsal interior: cardinal process not observed; crural plates subparallel, supported at their anterior margins both laterally and medially; muscle scars small, limited to the area between the crural plates, separated by a faint median myophragm.

REMARKS: This species is tentatively compared to *Cyrtina arkonensis* Ehlers and Wright, 1975 from the Middle Devonian (Givetian?) Arkona Shale of Ontario (Ehlers and Wright 1975) on account of its similarity in shape and ornamentation; it differs from *C. arkonensis* in its stronger sulcus and median groove on the fold and in its smaller general size. The Eifelian to Givetian *Cyrtina sauvagei* Rigaux, 1908 present in the Łysogóry Region is similar in shape but has fewer costae (Halamski 2004).

Nearly constant preservational destruction of the deltidium is a curious taphonomic feature of the studied material; nonetheless, an analogous situations may be found for *Tecnocyrtina billingsi* described by Johnson and Norris (1972, pl. 2, figs 3, 12).

OCCURRENCE: *Cyrtina arkonensis* was described from the Middle Devonian Arkona Shale of southwestern Ontario (Ehlers and Wright 1975) and is apparently unknown elsewhere. *Cyrtina* cf. *arkonensis* was found at Józefka in the Lower Frasnian Wietrznia Beds (sets XXI and XXII). A few fragmentary specimens coming from the now unexposed set A at the roadcut (the Laskowa Hill Beds) may also represent this species.

Cyrtina sp. nov. A
(Pl. 19, Figs 20–24)

MATERIAL: A single subcomplete articulated shell ZPAL Bp 73/1/28/1 from set XXII.

DESCRIPTION: The single available shell is slightly asymmetric, 19.0 mm wide, 9.0 mm long, and 9.6 mm thick, with maximum width and thickness at hinge line. The ventral valve is high, pyramidal, with a strongly procline, high, transversely striate interarea, which is weakly convex except in the umbonal region where it is concave. The delthyrium is 2.5 mm wide and 8 mm high and closed by a strongly convex deltidium with a rather small apical foramen 1 mm long; in the foramen the apical part of the tichorhinum is visible. The dorsal valve is moderately convex with a linear, anacline interarea. The shell substance is punctate.

The ornamentation consists of fine, rounded costae, about 14 per dorsal flank. The median dorsal fold is smooth, low and flat, 3.5 mm wide, with a marked median furrow 1.4 mm wide. The ventral valve has a shallow, V-shaped sulcus; the costae are poorly preserved.

Traces of a tichorhinum are visible in the apical foramen; otherwise internal structures have not been studied.

REMARKS: The strongly transverse shape as well as the fine and dense costation of the described single available shell suggest it may be a new taxon which is not named for lack of sufficient material.

Family Komiellidae Johnson and Blodgett, 1993
Genus *Komiella* Ljaschenko, 1985

TYPE SPECIES: *Komiella devonica* Ljaschenko, 1985; Frasnian, Upper Devonian; Timan, Russia.

REMARKS: A short comment on a nomenclatorial matter is necessary here. The name *Komiella* was introduced twice, first by Barchatova (1970, p. 62) for a Permian chonetide, then by Ljaschenko (1985, p. 14) for a Devonian spiriferide. The revised *Treatise on Invertebrate Paleontology* is inconsistent on that matter: the former is considered as valid (and the latter, implicitly, as invalid) by Racheboeuf (2000, p. 417), whereas the latter is considered as valid and the former as a *nomen nudum* by Johnson (2006, p. 1883), beyond doubt an unusual situation requiring correction. In the former description (Barchatova 1970) only an indication of the type species, i.e. *Chonetes omolonensis* Licharev, 1934, was given without either diagnosis or description. It appears therefore that this publication does not fulfil the requirements of the Art. 13. of the ICZN, namely "To be available, every new name published after 1930 must (...) be accompanied by a description or definition that states in words characters that are purported to differentiate the taxon". *Komiella* Barchatova, 1970 is thus invalid, as indicated by Carter *et al*. (1994, p. 361) and contrary to the opinion of Racheboeuf (2000). *Komiella* Ljaschenko, 1985 does not require any amendment.

Within cyrtinoideans the genus *Komiella* is unique in the absence of a tichorhinum and in its having a smooth, bisulcate shell and a sessile jugum (Johnson and Blodgett 1993). The presence of punctate shell in silicified material of *Komiella* was reported by Johnson and Blodgett (1993). However, the present SEM study of non-silicified specimens from Poland does not confirm this assumption: no reliable punctae have been revealed on the exterior of decorticated shells (with primary shell layer removed) and on polished and etched sections. On the other hand, one of the shells studied shows characteristic reddish-brown spots suggesting the presence of punctae infilled with oxidized iron minerals. Thus, it seems very probable that the lack of evidence of punctation in shells studied by SEM is caused mainly by the preservational characteristic of the studied material. It is worth to note that Erlanger and Solomina (1989, p. 103) revealed significant variability in density of punctae among some spiriferinide genera. Also, Carter and Gourvennec (2006, p. 1877) remarked that in some spiriferinides the punctae are fine and very difficult to detect. Thus, *Komiella* is distinguished by a combination of the cyrtinoidean (mainly jugum) and non-cyrtinoidean (absence of tichorhinum, equivocal shell punctation) characters.

Komiella devonica Ljaschenko, 1985
(Text-fig. 15; Pl. 7, Figs 20–26; Pl. 19, Figs 25–32; Pl. 20, Figs 1–35)

*1985. *Komiella devonica* gen. et sp. nov.; Ljaschenko, pp. 14–15, pl. 2, figs 5, 6.

MATERIAL: 155 complete to nearly complete and 50 fragmentary shells, 10 ventral and 11 dorsal valves; collection number ZPAL Bp 73/1/29.

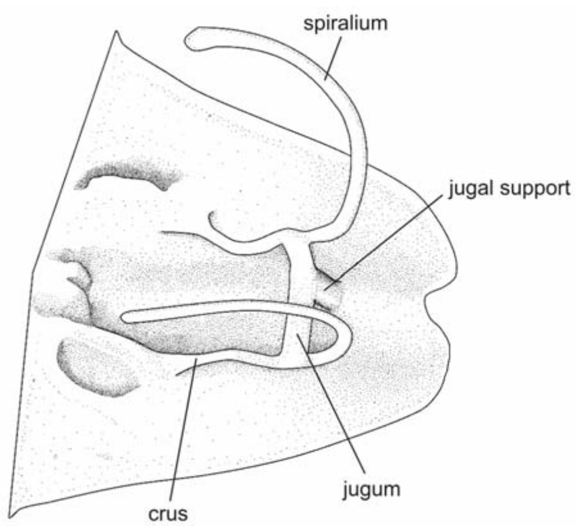
DESCRIPTION: Shell small, up to 4 mm in width, hemipyramidal, trapezoidal in outline, bisulcate, strongly ventribiconvex; anterior commissure rectimarginate, anterior margin medially angularly indented, lateral margins weakly convex anteriorly to weakly concave near the hinge margin; cardinal margin straight, cardinal angles slightly pointed.

Ventral valve hemipyramidal; interarea very high, triangular, flat to rarely concave, sometimes asymmetrically distorted, procline to infrequently catacline; delthyrium narrow, with an apical angle ranging from 12 to 28.4°, open, but markedly narrowed in the posterior half by thickened dental flanges (Pl. 20, Figs 10, 15, 20, 25, 30) which in gerontic specimens reduce the delthyrial opening to a narrow slit (Pl. 19, Figs 26, 27, Pl. 20, Fig 30); sulcus narrow and deep begins at or close to the umbo.

Dorsal valve subtrapezoidal in outline, weakly convex, with two gentle and wide folds separated by deep and narrow sulcus; interarea ill-defined to obsolescent.

Interior of ventral valve with strong, crescent-shape teeth (Pl. 19, Figs 26, 27) and thick dental flanges which umbonally join short and low median septum to form rudimentary spondylium (Pl. 19, Fig. 27). Dorsal interior with deeply excavated sockets causing frequent damage of the thin-shelled sockets' bottom (Pl. 7, Figs 23–25); inner socket ridges thick, elevated, outer socket ridges weak; cardinal process thin, high, knoblike, anteriorly supported by low median myophragm; crura thin, arise from the anteromedian region of the inner socket ridges (Pl. 7, Figs 20–25), anteriorly connected by wide transverse jugal blade; jugum wide, T-shaped, sessile, supported medially by stout stem fused with the valve bottom at about two-third of the valve length anteriorly (Pl. 20, Fig. 33, Text-fig. 15); spiral lamellae run antero-ventrally from the jugum in direct prolongation of crura, then turn gently posteriorly toward umbonal cavity of the ventral valve where they terminate attaining about a half of a single spiral whorl (Pl. 20, Fig. 32, Text-fig. 15). The shell substance does not show a presence of endopuctae in SEM examination (see comments above).

External shell surface smooth except faint concentric growth lines and fine pustules (Pl. 7, Fig. 26).



Text-fig. 15. Reconstruction of dorsal valve interior of *Komiella devonica* Ljaschenko, 1985 showing details of the structure of the spiralium

REMARKS: Although the type specimens of *Komiella devonica* from the upper part of the Lyajol' complex in the Timan Range (Russia) are not adequately illustrated by Ljaschenko (1985, pl. 2, figs 5, 6) it appears that our specimens are very close to and most probably conspecific with the Russian form. With our present limited knowledge of Ljaschenko's species it is not possible to delineate distinguishing characters between both forms. The Polish specimens are also very close to *Komiella gilberti* Johnson and Blodgett, 1993 from the early Eifelian Cheeneetnuk limestone of west-central Alaska (Johnson and Blodgett 1993). The former differ having stronger sulcation and by not having a ventrally deflected anterior commissure and the bisected upper surface of the spondylium. The specimens from Józefka differ from *Komiella magnasulcata* from the Eifelian of the northern Antelope Range of Nevada (Johnson and Blodgett 1993) by not having a deflected anterior commissure and less transverse shell outline. *Komiella stenoparva* Johnson and Blodgett, 1993 from the Upper Givetian of the Roberts Mountains and the Antelope Range of Nevada (Johnson and Blodgett 1993) differs from other species of the genus by its minute size.

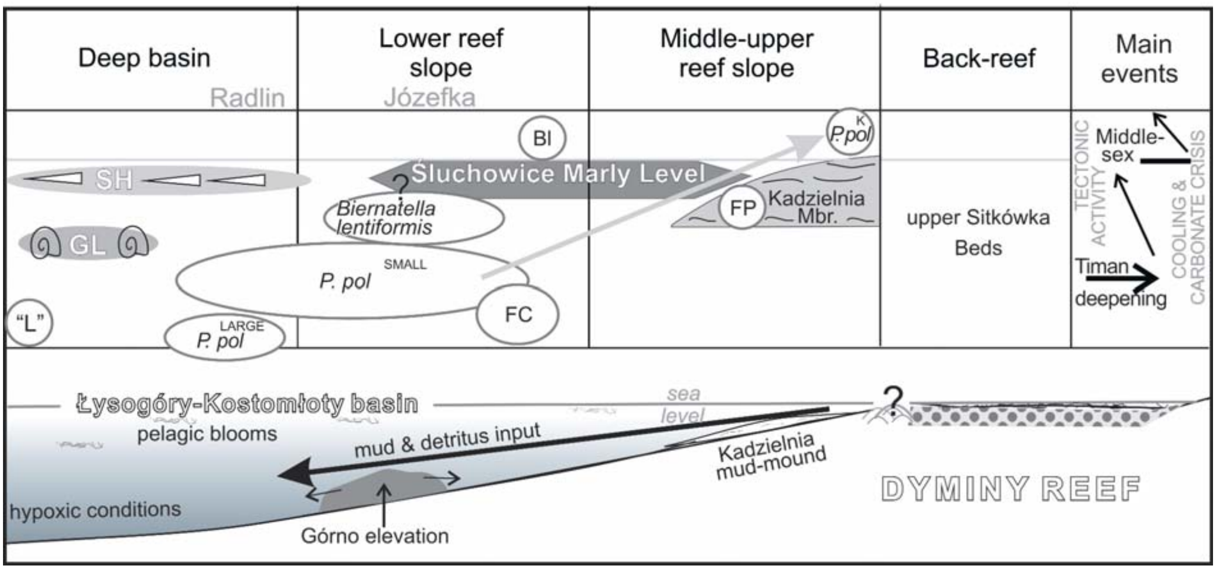
Noteworthy is the presence of fine pustules on well preserved shells from Józefka (Pl. 7, Fig. 26), the feature of microornament recognized for the first time in the genus.

OCCURRENCE: *Komiella devonica* was described originally from the middle part of the Frasnian of the southern Timan Range, Russia (Ljaschenko 1985). At Józefka it is common in the Lower Frasnian Wietrznia Beds (sets XXI and XXII).

PALAEOECOLOGY

It may be asked to what extent the described brachiopod faunas from the Radlin Syncline are similar to coeval Early Frasnian assemblages from the Holy Cross Mountains. As noted above, the low-diversity *Phlogoiderhynchus polonicus* Assemblage (with minor participation of other brachiopods, mostly atrypides) is relatively widely distributed in the stagnant and mostly hypoxic deep-water habitats of the region. The Górno site is close to the eastward range limit of the community, as it is known also only from the Szydłówek Beds at Wola Jachowa, ca. 4 km NE of Józefka hill (Gürich 1900, p. 379; Racki and Bultynck 1993). This is a prominent example of the basin-type "Rhynchonellid Biofacies" of Racki *et al.* (1993), dominated by "euryoxic" species partly self-buried in fluid muddy substrate with their commissure inclined to the substrate (compare e.g., Fürsich and Hurst 1974; Vogel 1980; Halamski and Baliński 2009). The succession of at least three distinctive morphotypes of the index species has been recognized previously (Biernat and Szulczewski 1975; Sartenaer and Racki 1992), but essentially only the small-sized Śluchowice-type variety occurs at Józefka. Probably, this is an ecologic response to more stressed conditions for the rhynchonellides in a shallower-water setting, because the matching phenomenon occurs also in the well-known Wietrznia faunas (Makowski in Racki *et al.* 1993; Baliński 2006). Similar ecologically mixed, probably storm-generated coquinas with *P. polonicus*, pugnacids, and schizophoriids are known from the Givetian–Frasnian boundary beds at Wietrznia (set A; Makowski in Racki *et al.* 1993, p. 82; see also Vierek 2008, 2014). In the context, a habitat assignment of rock-forming species *Coeloterorhynchus dillanus* (a leading part of *Flabellulirostrum–Coeloterorhynchus* Assemblage; the middle Wietrznia Beds) from the middle Szydłówek Beds at Józefka is uncertain, nonetheless obviously related to a deeper-water but still intermittently agitated fore-reef setting (see Racki *et al*. 1993; Baliński 2006).

An Early Frasnian brachiopod fauna from the Wietrznia section at Kielce (Kielce Syncline, ca. 13 km west from Górno) was described by Baliński (2006), from the same lithostratigraphic unit, i.e., middle Wietrznia Beds (set C therein). It consists of 21 species, five of them certainly shared with the section studied (*Biernatella lentiformis*, *Fitzroyella alata*, *Coeloterorhynchus dillanus*, *Phlogoiderhynchus polonicus*, *Spinatrypina* (*E.*) *explanata*). Shared genera are *Schizophoria*, *Devonoproductus*, *Emanuella*, *Flabellulirostrum*, and *Atryparia* (*Costatrypa*), but at least for the last two the species are most probably different. Overall, given the geographic and palaeogeographic proximity of the two sections, the similarity between the two partly diachronous faunas,



Text-fig. 16. Early–Middle Frasnian brachiopod faunas against a simplified facies scheme during the transient reef retreat interval in the Holy Cross Mts, related to the Timan and Middlesex transgressive events and the subsequent eustatic sea-level falls (arrowed), and regional synsedimentary tectonism (recorded also in an uplifted localized elevation in the Górno area; see Text-fig. 1C–D); a simplified reconstruction of the depositional environments and biotic events (GL – Goniatite Level; SH – Styliolinid Horizon) corresponds principally to the northern ramp-style slope of the Dyminy Reef (based on fig. 17 in Pisarzowska *et al*. 2006, and references therein). Brachiopod faunas: FP – *Fitzroyella–Parapugnax* Association (from Kadzielnia-type microbial-stromatoporoid-coral mud mounds; Szulczewski and Racki 1981), *P. pol* – *Phlogoiderhynchus polonicus*, in three variants (in stratigraphic order): LARGE – large-sized, SMALL – small-sized, K – Kowala-type (see Biernat and Szulczewski 1974; Sartenaer and Racki 1992), Bl – *Biernatella lentiformis* (see Baliński 2006), FC – *Flabellulirostrum–Coeloterorhynchus* Assemblage (see Racki *et al*. 1993; Baliński 2006), "L" – undescribed "leiorhynchid" assemblage from Ściegnia (formerly Wzdół) near Bodzentyn [two species of "*Camarotoechia (Liorhynchus)*" from the pyrite-rich fossiliferous horizon; Kościelniakowska 1967, table 6 and pl. IV, fig, 6 therein; Yazykova *et al*. 2006] (see Text-fig. 16), may be characterized as relatively low.

The Frasnian brachiopod assemblage relationships within the Kostomłoty–Łysogóry basin are poorly known, because on the localized impoverished faunas have been reported; see Text-fig. 16). Some affinities with older Middle Devonian brachiopod faunas from the Łysogóry Region (Skały beds) are, however, recognizable, especially in the protorthide and orthide association from Józefka (*Skenidioides, Biernatium, Aulacella;* see Biernat 1959; Halamski 2009).

One should also note that the brachiopods from the *transitans* Zone of the Dębnik Anticline, a small area of Devonian and Carboniferous outcrops situated in southern Poland near Cracow, representing the southern facies of the same Laurussian carbonate shelf located near the stable, elevated Sub-Carpathian Arch (Narkiewicz 1988), belong to the genera *Lingula*, *Douvillina*, *Corbicularia*, *Pseudoatrypa* (originally described as *Desquamatia*), *Spinatrypina* (*S.*), *Spinatrypa*, *Eleutherokomma*, and *Cyrtospirifer* (Zaręczny 1889; Gürich 1903; Baliński 1979, 1995a, 2006; Baliński and Racki 1981). The coeval Dębnik fauna (*Cyrtospirifer bisellatus* assemblage) is thus very unlike that studied even at genus level.

Biernatella lentiformis Assemblage

In the Kostomłoty facies zone, the latest Givetian fauna from Szydłówek (= the Bocianek suburb of Kielce; Racki and Bultynck 1993), with typical *Phlogoiderhynchus polonicus* (i.e., as originally described by Gürich 1896), is associated with a diverse benthos, including biernatellids (Baliński 1995b) and chonetids, as well as trilobites and *Haplocrinites* (see Głuchowski 1993). However, far more unique is the very diverse early Frasnian *Biernatella lentiformis* Assemblage from Józefka (Text-fig. 17; see Baliński 1995b). Such a dissimilarity is to be explained mostly by ecological factors. The brachiopod fauna from Józefka may be thought of as composed of two groups of species having different ecological requirements. On one hand, *Spinatrypa* (*Exatrypa*) *explanata* (von Schlotheim, 1820) is a typical peri-reefal brachiopod, its flattened shell being an adaptation to strong currents (Copper 1967c). *Davidsonia* is an epizoan on tabulate corals and other brachiopods (*Schizophoria*, *Spinatrypina*; see above). Other redeposited reefal organisms (stromatoporoids, tabulates, dendroid rugosans, receptaculitids; the latter briefly mentioned by Mierzejewska and Mierzejewski 1973, p. 180) are also quite common at Józefka, and rare in the presumably coeval strata at Radlin hill. Distal tempestite intercalations, with many reworked bioclasts originated from lagoonal environments (including *Amphipora* meadows; Pl. 4, Figs 1 and 3–4) of the Dyminy Reef, situated south- and westwards from the localities studied, evidence occasional large-scale storm-generated ecological mixing in the brachiopod habitats. However, this redeposited shelly admixture could be relatively insignificant for the benthos in the dominantly micrite lithofacies (Pl. 4, Figs 1–2), even if transported *Amphipora* branches occur in the low-energy facies, as well known from the hemipelagic Szydłówek Beds (Racki *et al.* 2004; Yazykova *et al.* 2006).

Allochtonous elements are difficult to unequivocal recognition in the assemblage also from a preservational viewpoint (?some atrypides and gypidulids), because, for example, the high ratio of disarticulated shells of *Skenidioides* is interpretable as resulting from post mortem disarticulation in a high energy off-reef niche (see above). Only one species (*Fitzroyella alata*) is common with a specific diverse association dwelling the upslope Kadzielnia mud-mound (Biernat 1971; Szulczewski and Racki 1981; Text-fig. 17). Elimination of reef-related ancyrodellid conodonts in the Górno habitat (but not at Radlin; Tables 1–3; see Sobstel *et al*. 2006; Vierek and Racki 2011) is notable in this context as well.

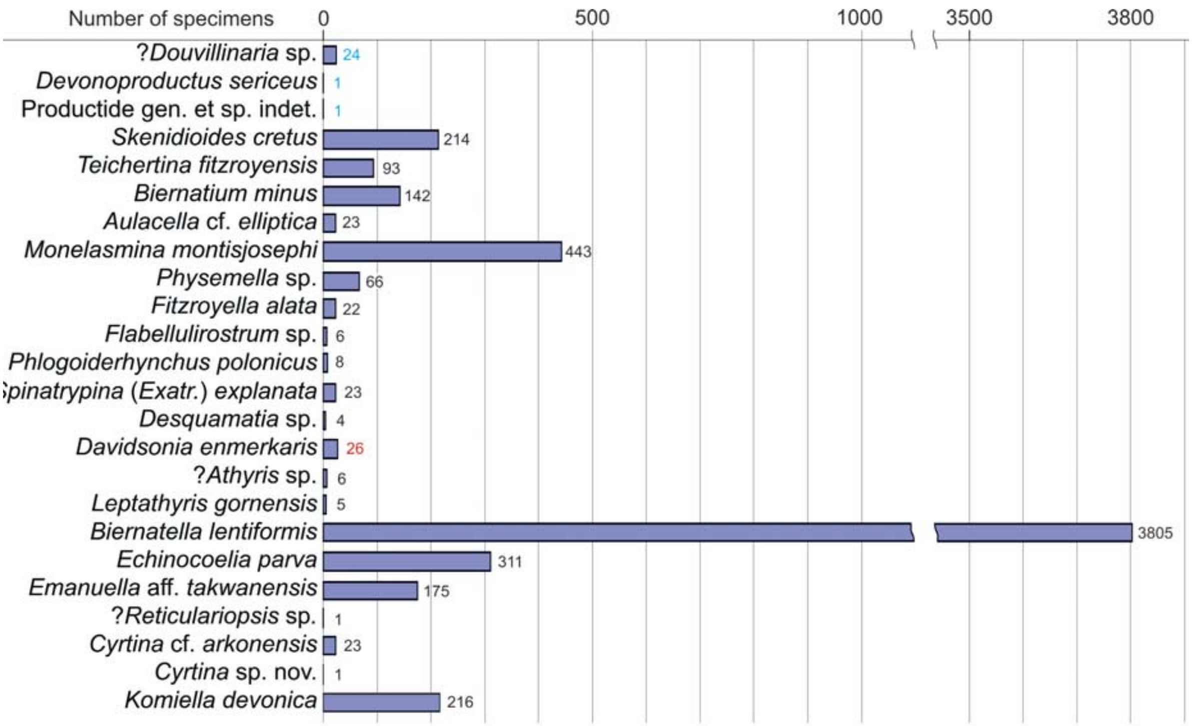
Notably, the assemblage studied is dominated by the small (less than 8 mm in size), lens-like, and unornamented *Biernatella lentiformis* Baliński, 1995, a double-spired athyridide brachiopod regarded as probably "well adapted to environments with a poor supply of food" (Baliński 1995b, p. 129). Most populations of this widely distributed Frasnian species in the Holy Cross region are known from shelly intercalations in bioclastic limestones of the Detrital Facies (sensu Szulczewski 1971), corresponding to upslope, "quite vigorous, well-aerated environments" (Baliński 1995b, p. 135; see also Racki *et al.* 1993). This inference is discussed in detail for the late Frasnian *Biernatella polonica* by Baliński (1977, p. 177), because this species "occupied probably shallow parts of the basin from several down to some tens of meters characterized by periodical strong currents". So, even high dominance of minute species in the Józefka fauna can be assumed as an adaptation to "increased water mobility". Most probably, however, *B. lentiformis* and the associated biota dwelt also in an environment overall calm, but punctuated by storm episodes from time to time (see its distribution in the Wietrznia sections; Baliński 2006, figs. 2–3). This biota developed as a result of successful early Frasnian colonization of the Kielce platform habitats by a Łysogóry-type benthic biota (see Racki *et al.* 1985;

Racki 1993a, 1993b). In fact, the species is known from micritic lithofacies as well, and its ancestor Givetian species *B. ovalis* is restricted to the marly Szydłówek Beds (Baliński 1995b). These pedunculate species are therefore interpreted either to have attached to firm bottom objects (skeletal fragments?) or to have anchored directly in more muddy substratum (compare e.g., Fürsich and Hurst 1974). In this context, the rarity of brachiopod species characterized by free-lying, semi-infaunal habit ("snowshoe life strategy"; Thayer 1975), such as productellids and strophomenides, strongly suggests a limited extent of truly soft substrata.

Indeed, the majority of brachiopod species examined in this report, regardless of their shell size, lived attached by their pedicle (Text-fig. 17). This mode of life was characteristic for virtually all small sized species of protorthides, orthides, and spiriferides which possessed large pedicle opening, e.g., *Skenidioides cretus*, *Teichertina fitzroyensis*, *Biernatium minus*, *Monelasmina montisjosephi*, *Leptathyris gornensis* and *Echinocoelia parva*. Small- and medium-sized spiriferinides *Komiella devonica* and *Cyrtina* species were also pedunculate, but the extremely high and often assymetricaly "twisted" or incurved ventral interarea of these forms (see Pl. 19, Figs 7–9, 21–24, 28, 29, 32, Pl. 20, Figs 1–31) suggests that they had very short pedicle and lived with the ventral interarea adpressed or resting very close to the substrate (e.g., Ivanova 1962; Rudwick 1970). Large, generally biconvex *Schizophoria schnuri prohibita, Physemella* sp., *Phlogoiderhynchus polonicus*, *Coeloterorhynchus dillanus*, *Atryparia* (*Costatrypa*) *agricolae*, *Desquamatia* sp., and *Spinatrypina* (*Ex.*) *explanata* lived attached by their pedicle, but most probably supported some of their weight by resting with a thick-shelled umbonal region against the substrate. Additionally, the last two mentioned atrypide species stabilized their shell on the muddy sea bottom with imbricate or frilly projections of the growth lamellae (e.g., Copper 1967c; Bassett 1984). Only one species of the described brachiopod fauna, the atrypide *Davidsonia enmerkaris*, was characterized by a fixosessile mode of life during whole its post-larval ontogeny. It remained cemented with a ventral valve to hard substrate as exemplified by colonies of tabulate corals or brachiopod shells.

Facies and habitat model

In the Kostomłoty–Łysogóry basin, synsedimentary tectonic uplifts are recorded in the surprisingly shallow-water structures locally populated by crinoid-brachiopod and algal communities, with the subordinate participation



Text-fig. 17. Quantitative taxonomic composition of the *Biernatella lentiformis* Assemblage (sets XXI–XXII; Text-fig. 4). Numbers denote the sum of specimens represented by conjoined valves and the more numerous specimens represented by either a dorsal or a ventral valve. The colour of the numbers indicates one of the main three ecological groups: blue – free-lying, black – penduculate, red – encrusting by cementation of major reef-building groups (see Kościelniakowska 1967; Szulczewski 1971; Racki *et al*. 1993, p. 97; Casier *et al*. 2000). As a consequence, additional fossil redistribution was probably promoted by seismically-generated gravity slump displacements in the tectonically active region near the Holy Cross Fault (Text-fig. 1C-D; see more data in Szulczewski 1968, 1971; Racki and Narkiewicz 2000; Vierek and Racki 2011).

As concluded by Małkowski (1981, p. 229) for the Górno area, a ridge developed probably also northwards from Józefka, i.e., within the Kostomłoty basin, as indicated by the increased frequency of coarse-grained, also coarse-intraclastic deposits in this direction. Therefore, a development of a fault-controlled elevation in the submerged part of the ramp-type slope of the Dyminy Reef (see Text-fig. 1C–D), occupied by distinctive and diverse brachiopod-crinoid-coral (and perhaps also receptaculitid) biotas, is suggested as a prime explanation of the amalgamated ecological features which are observed. As indicated by microfacies data (Pl. 4), in addition to a complex benthic community (brachiopods, echinoderms, receptaculitids, trilobites, gastropods, bryozoans, infaunal soft-bodied bioturbators, ?some corals), a pelagic component was also significant (styliolinids, entomozoid ostracodes, ?ammonoids), supplemented by rich fish association (placoderms, ?holocephalian chondrichthyans, osteolepidids and/or porolepidids, palaeoniscoids; Liszkowski and Racki 1993). On the other hand, even a transient development of a ‘lagoonal’ *Amphipora*-calcispheroid biota in the most restricted, uplifted parts of the fault-controlled shoal is probable, which would largely limit the significance of long-distance bioclast shedding from the Dyminy Reef to the site studied.

To sum up, the ecologically coherent *B. lentiformis* Assemblage studied consists largely of parautochthonous inhabitants of an at least 50 m deep toe of the reef slope (see fig. 14 in Racki *et al.* 1993) and of the adjacent intra-basin shoal (Text-figs 1C and 16); only a minor contribution of truly allochthonous dwellers of the shallow Dyminy reefal habitats is predicted. The very diverse, dominantly sessile community was comprized largely of different-level filter-feeders, with brachiopods and crinoids (including *Haplocrinites*; Głuchowski 1993) in a leading synecological role. This amazing habitat was probably also paired with a distinct initial interval of the Early to Middle Frasnian biogeochemical perturbation (see Text-figs 3–4), characterized by rapid sea-level changes, onset of climatic cooling, and the resultant carbonate crisis recorded regionally in the fossil-impoverished Marly Śluchowice Level (Text-fig. 16; see Pisarzowska *et al*. 2006; Pisarzowska and Racki 2012). However, the chemostratigraphic data (Text-fig. 4) suggest that the main brachiopod acme was associated with an initial positive C-isotope shift (Event 1) of the global *punctata* perturbation, and that it preceded the allegedly nutrient-poor environments of the Śluchowice Level (linked with the negative C-isotope excursion; Event 2). Because *B. lentiformis* re-appeared in the middle Frasnian of Wietrznia (Baliński 2006) its taxonomic uniqueness seems to be determined mostly by a successful development in cooler and nutrient-poor waters, in the distinguishing palaeogeographic-facies setting (Text-fig. 16). This is in contrast with the *Flabellisinurostrum*–*Coeloterorhynchus* Assemblage at Wietrznia, and, partly, at Józefka, paired with pre-pertubation biotic stagnation phase (see text-fig. 18 in Pisarzowska and Racki 2012).

The *B. lentiformis* Assemblage is distinctive in its composition also in a supraregional scale. A detailed discussion on the palaeobiogeographic affinities and the evolutionary character of the unique fauna from Józefka will be given elsewhere.

CONCLUSIONS

1. The lower part of the Frasnian succession in the Radlin Syncline (Kielce-Łagów Synclinorium, southern region of the Holy Cross Mountains), investigated in the Józefka roadcut and quarry and (for the first time) at Radlin hill, consists of the mostly rhythmic marly Szydłówek Beds, the fossil-rich limestones of the Wietrznia Beds (locally) and the atypically developed, calcareous Kostomłoty Beds.
2. An early Frasnian (*transitans* Zone) dating of the strata in both localities is based on rather rare conodont faunas (polygnathid biofacies), but also on the carbon isotope chemostratigraphic pattern which overall corresponds well to the global Early–Middle Frasnian biogeochemical perturbation. However, the major *punctata* positive excursion is only fragmentarily recorded in the Kostomłoty intrashelf basin.
3. Twenty nine brachiopod species are recorded (Craniida – 1 species, Strophomenida – 1, Productida – 2, Protorthida – 1, Orthida – 5, Pentamerida – 1, Rhynchonellida – 4, Atrypida – 4, Athyridida – 3, Spiriferida – 4, Spiriferinida – 3) from lower Frasnian Szydłówek and Wietrznia Beds.
4. The richest assemblage is recorded from the the middle Wietrznia Beds at Józefka (sets XXI–XXII). It is quite dissimilar to coeval brachiopod faunas from the Holy Cross region, and even to the most stratigraphically related assemblage from Wietrznia.

5. The *Biernatella lentiformis* Assemblage, dominated by small pedunculate species, is interpreted as consisting of the parautochthonous inhabitants of deep-slope habitats and of an episodically storm-agitated elevation in a fault-controlled basin (Text-fig. 16). This local shoal was populated by a unique crinoid-brachiopod-coral community may likely adapted to cooler and nutrient-poor conditions during the severe carbon cycling perturbation.
6. Seven new species are described.
a. *Skenidioides cretus* Halamski sp. nov. is a small, paedomorphic descendant of *Skenidioides polonicus* (Gürich, 1896) and the stratigraphically youngest representative of the genus.
b. *Biernatium minus* Baliński sp. nov. is a small-sized, widely and weakly unisulcate form, transverse in outline. Its cruralium attains about 46–56% of the valve length.
c. *Monelasmina montisjosephi* Baliński sp. nov. is also a small-sized form (usually attaining less than 3 mm in length), persistently transverse in outline. It possesses a widely and a weakly unisulcate anterior commissure, and a very long dorsal median septum anteriorly almost touching the bottom of the ventral valve.
d. *Atryparia* (*Costatrypa*) *agricolae* Halamski and Baliński sp. nov. differs from *A.* (*C.*) *traonliorsensis* Copper and Rachebœuf, 1985 in its transverse shape and from other representatives of the subgenus in its coarser ornamentation.
e. *Davidsonia enmerkaris* Halamski sp. nov. is intermediate between *Davidsonia* Bouchard-Chantereaux, 1849 and *Rugodavidsonia* Copper, 1996. It has the spiralial grooves of the former genus but its costation is developed as in the latter. Sometimes a large portion of the ventral valve is adherent to the substrate as in *Davidsonia*, whereas sometimes the valve is attached only in the apical region as in *Rugodavidsonia*. It is the youngest known representative of the suborder Davidsoniidina Copper, 1996.
f. *Leptathyris gornensis* Baliński sp. nov. represents the youngest reliable occurrence of the genus. It is medium-sized for the genus, subpyriform to subpentagonal in outline and has a poorly defined dorsal fold.
g. *Echinocoelia parva* Baliński sp. nov. does not exceed 3 mm in length. Its shell is subcircular with a rather narrow hinge margin and a broadly unisulcate anterior commissure.
h. Finally, *Cyrtina* sp. nov. A is reported under open nomenclature.
7. Several authors have reported dimorphism in *Spinatrypina* with a coarse-ribbed and a fine-ribbed form. Statistic analysis of a large sample of *Spinatrypina* (*Exatrypa*) *explanata* did not confirm such a phenomenon, the rib density distribution being clearly unimodal.
8. Within the investigated sample of *Davidsonia enmerkaris* Halamski sp. nov., features judged diagnostic for *Rugodavidsonia* Copper, 1996, namely a costate dorsal valve and weak cementation, show continuous variation from the character states of representatives of *Davidsonia* Bouchard-Chantereaux, 1849. The validity of *Rugodavidsonia* as a separate genus is thus uncertain.
9. *Komiella* Ljaschenko, 1985 (Spiriferida) is valid and *Komiella* Barchatova, 1970 (Productida) is invalid, as shown by Johnson (2006) and contrary to the opinion of Racheboeuf (2000).

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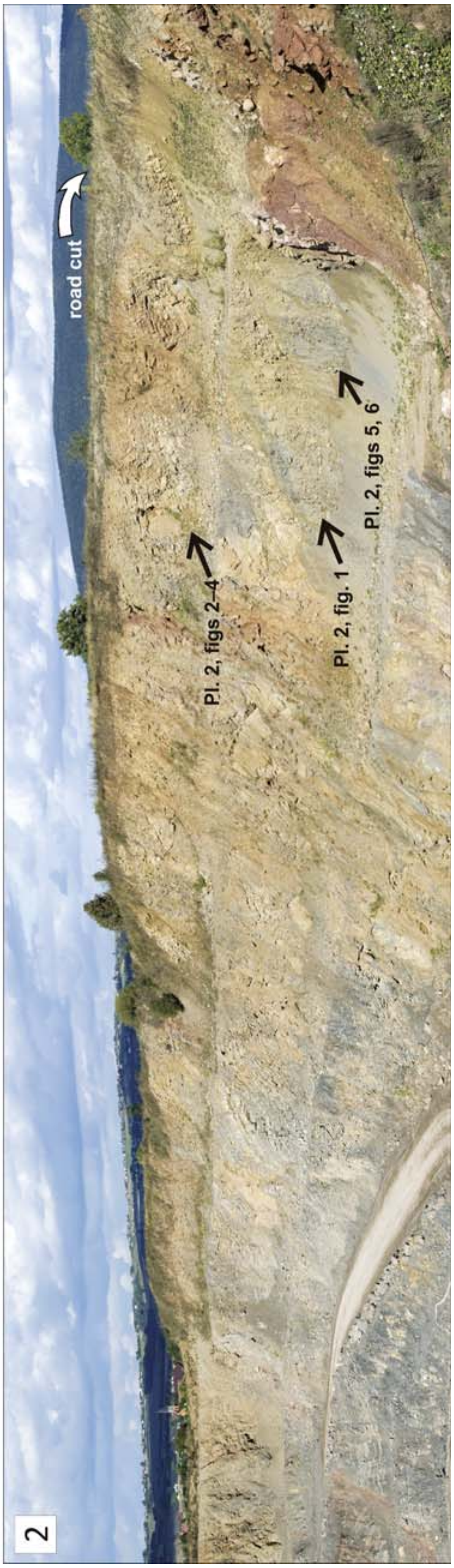
PLATES 1–20

PLATE 1

Active Józefka Quarry, south of Górno, in autumn 2009. Panoramic views on western (Fig. 1) and eastern (Fig. 2) parts to show a spectacular lithological contact between the brownish Givetian *Stringocephalus* dolomites and mostly Upper Devonian, dark marly-limestone strata (see Text-fig. 3).


1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Pl. 2, figs 2–4
Pl. 2, fig. 1
Pl. 2, figs 5, 6

PLATE 2

Active Józefka Quarry, south of Górno – fragments of the eastern wall (see Pl. 1, Fig. 2)

1 – Rhythmic succession of the middle Szydłówek Beds in September 2006 (courtesy of Wojciech Krawczyński).

2–4 – Brachiopod-bearing strata of the Lower Frasnian Wietrznia Beds (set XXII; Text-fig. 4) in April 2015, note irregular dolomite occurrences (brownish parts, mostly altered, with hematite and illite) and abundant rugose coral accumulation.

5, 6 – Transitional interval between the Laskowa Góra Beds and the Szydłówek Beds (5), and closeup of the tabulate marly biostrome (6) of the Laskowa Góra Beds in September 2006 (courtesy of Wojciech Krawczyński).

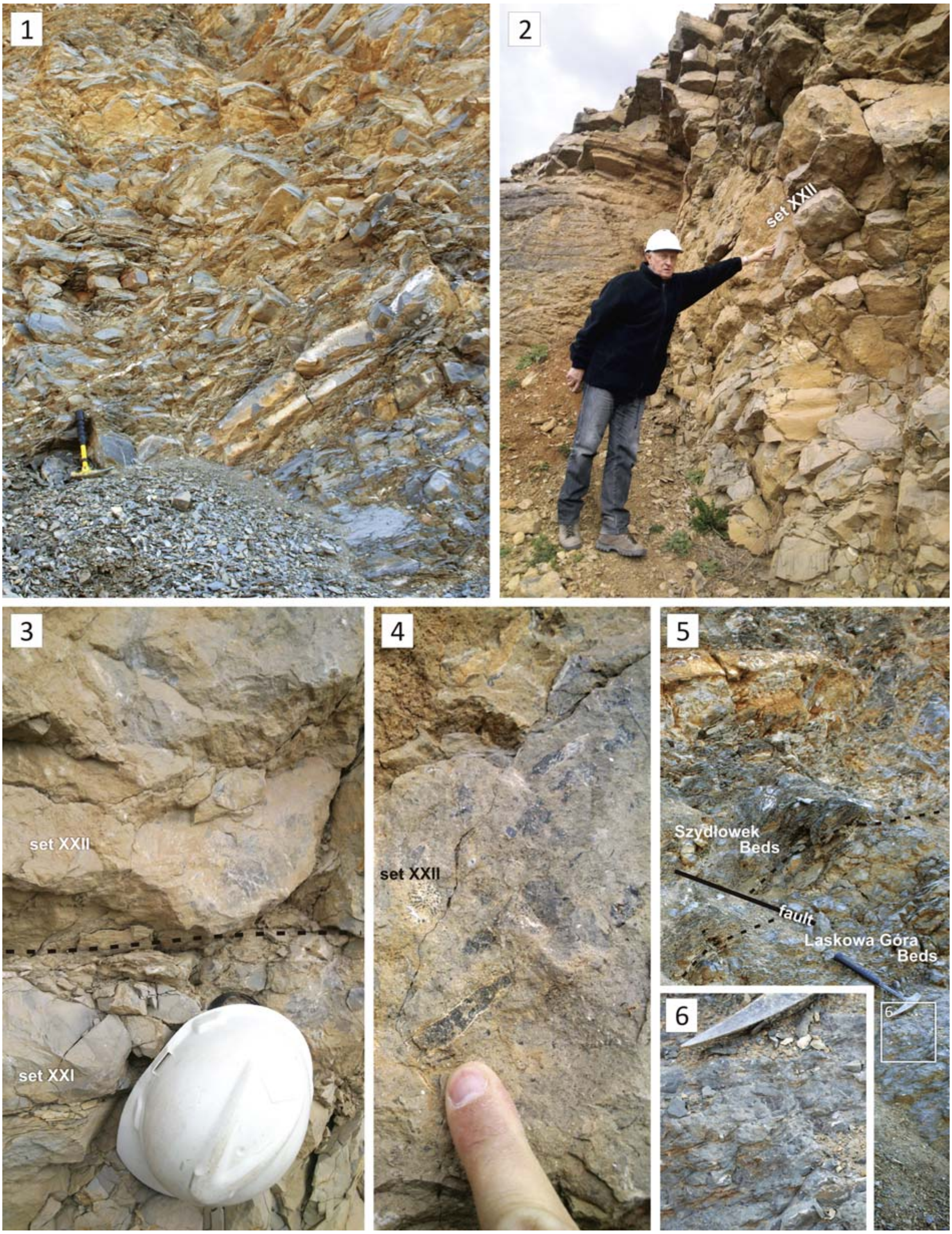
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PLATE 3

Renewed roadcut on the east side of the Józefka hill, south of Górno, along the road Daleszyce in August 2009. **1** – Panoramic view. **2** – Close-up of the most brachiopod-rich set XXII (see Text-fig. 4).


1
set I
set XXII


2

PLATE 4

Microfacies of the brachiopod-rich set XXII of the Lower Frasnian Wietrznia Beds of Józefka hill, showing a distinctive differentiation between bioturbated bioclastic wackestones-packstones (Figs 1–2; sample Gc from the quarry) and fine-grained skeletal intraclastic grainstones (Figs 3–5; sample Gb from the roadcut). Note the variously developed pressure-solution stylonodular structure (see Flügel 2004, pp. 318–319), either incipient (Figs 1–2) or fully developed (Figs 3–4), where cemented lime sands in nodules are sharply delineated by dark, Fe-oxide enriched and partly dolomitized partings, with residual seams due to partial dissolution of the original matrix. Fossil constituents include mostly fragmented crinoids (c), brachiopods (br, ?*Biernatella* – Bl), massive stromatoporoids (s), *Amphipora* (a), tabulate corals (t), trilobites (tr), receptaculitids (r), gastropods (g), bryozoans (by), echinoids (e), ostracodes (os; entomozoids – eo), calcareous microproblematics ("unilocular foraminifers"; mp), styliolinids (st) and ammonoids (am); note the different preservation of stromatoporoid skeletons, strongly recrystallized in Fig. 2 (lower part).

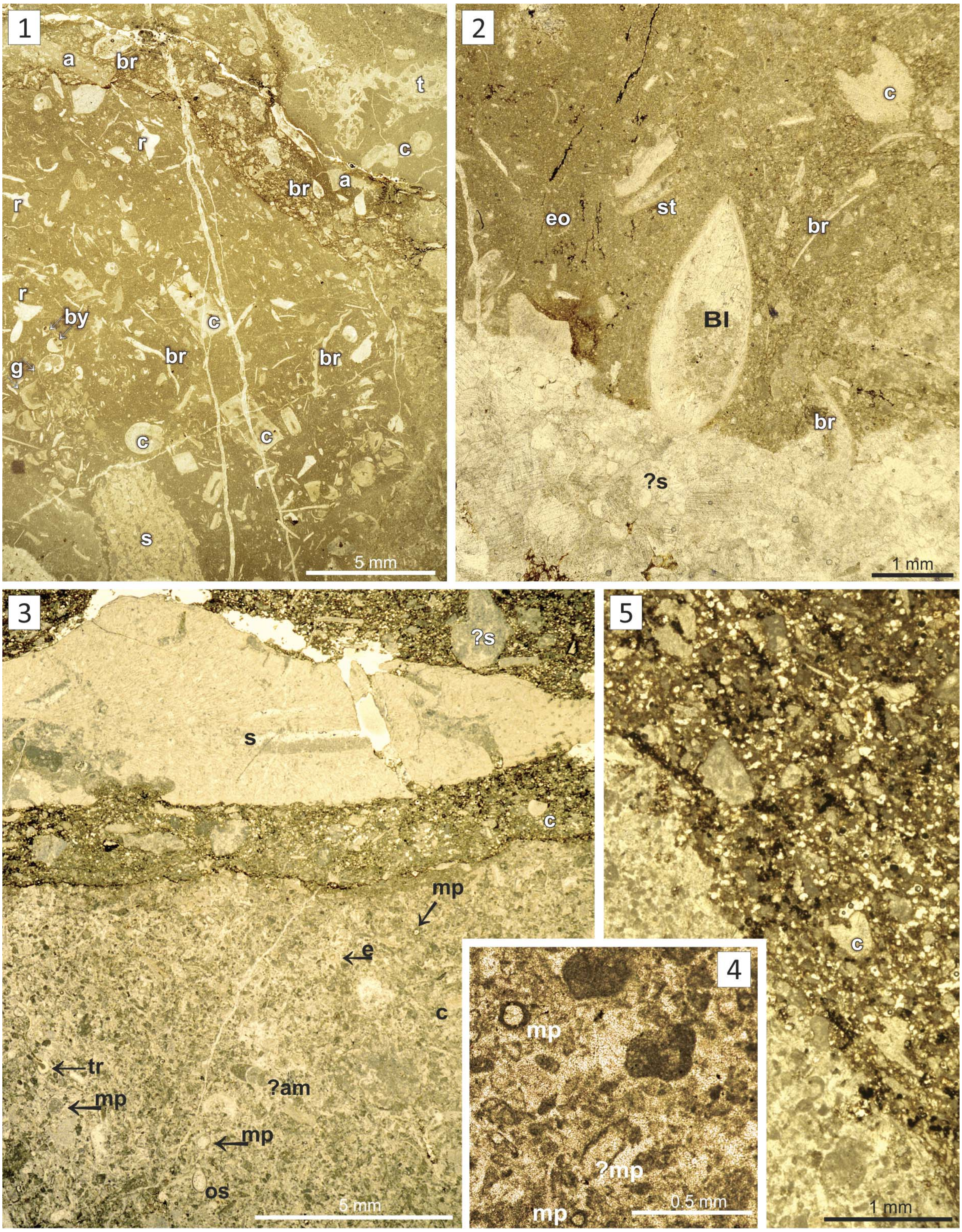
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PLATE 5

Craniida, Strophomenida, Productida

1 – *Petrocrania* sp. Shell ZPAL Bp 73/2/16/2A attached onto the dorsal valve of *Atryparia* (*Costatrypa*) *agricolae* Halamski and Baliński sp. nov. (the host shown also in Plate 13, Figs 21–25). Radlin, Szydłówek Beds.

2–12 – ?*Douvillinaria* sp. Józefka, Wietrznia Beds, set XXII. 2–4 – Juvenile articulated shell ZPAL Bp 73/1/1/3 in dorsal, ventral, and lateral views. 5, 6 – Articulated shell ZPAL Bp 73/1/1/2 in dorsal and ventral views. 7 – Incomplete dorsal interior ZPAL Bp 73/1/1/4. 8–12 – Articulated shell ZPAL Bp 73/1/1/1 in dorsal, ventral, lateral, posterior, and anterior views.

13–17 – *Devonoproductus sericeus* (von Buch, 1838). Józefka, set XXII. 13, 14 – Ventral valve ZPAL Bp 73/1/2/3 embedded in limestone in lateral and ventral views. 15, 16 – Articulated shell ZPAL Bp 73/1/2/1 in ventral and dorsal views. 17 – Incomplete dorsal interior ZPAL Bp 73/1/2/2.

18–20 – Productida fam., gen. et sp. indet. Dorsal valve ZPAL Bp 73/1/3/1. Józefka, Wietrznia Beds, set XXII. Internal (18) and external (19) view and enlargement of the cardinalia (20).

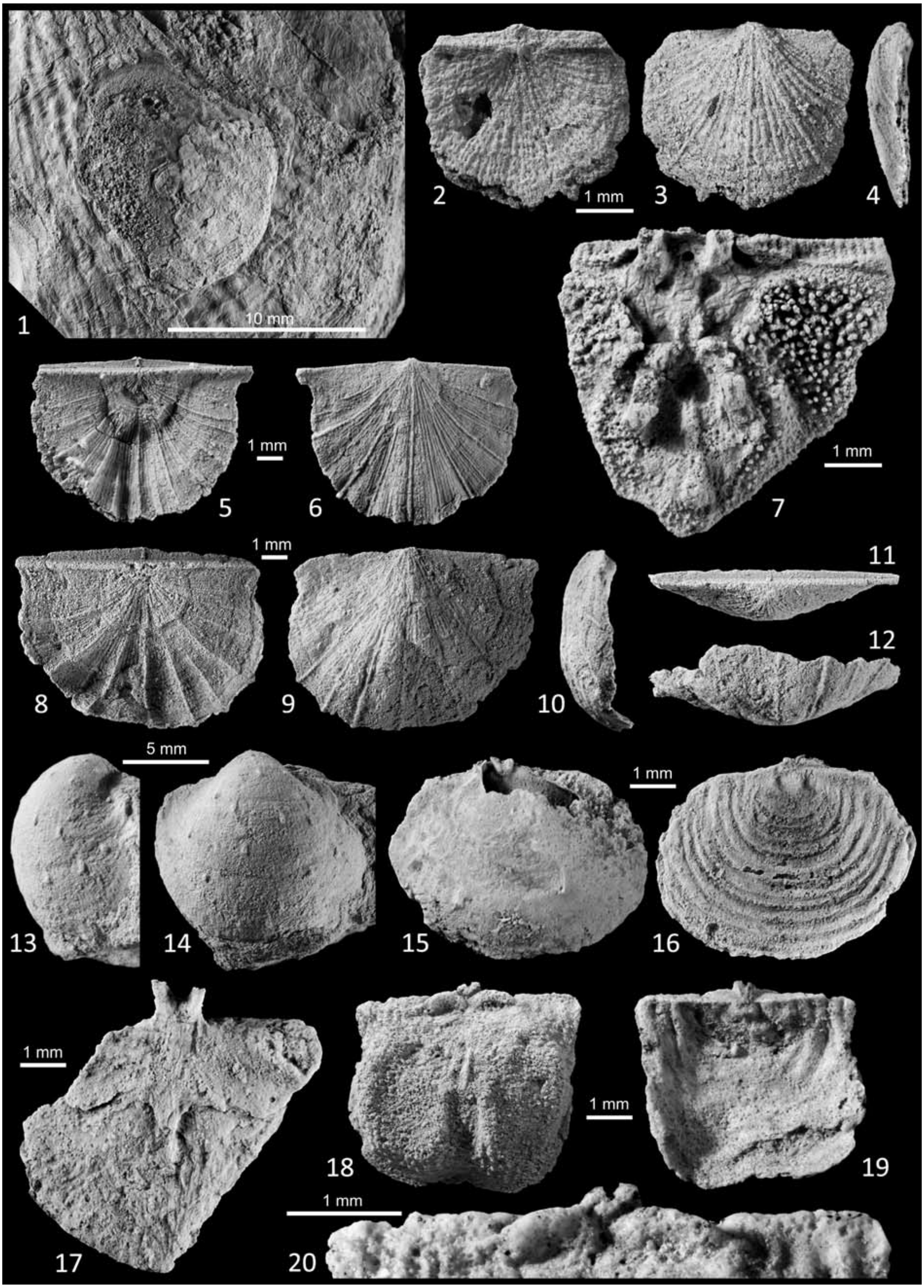
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PLATE 6

Protorthida

Skenidioides cretus Halamski sp. nov. Józefka, Wietrznia Beds. The specimens ZPAL Bp 73/1/4/2, 3, 5, 7–10, 12 are from the set XXI whereas ZPAL Bp 73/1/4/1, 4, 6, 11 are from set XXII. 3–4, 20–23 are SEM micrographs, the other have been taken in visible light.

1, 2 – Articulated shell ZPAL Bp 73/1/4/5 in dorsal and posterior views. 3, 4 – Subcomplete articulated shell ZPAL Bp 73/1/4/6 in posterior and dorsal views. 5–9, 10–14 – Articulated shells ZPAL Bp 73/1/4/2, 3 in dorsal, ventral, lateral, posterior, and anterior views. 15–19 – Articulated shell ZPAL Bp 73/1/4/1 (holotype) in dorsal, ventral, lateral, posterior, and anterior views. 20–22 – Articulated shell ZPAL Bp 73/1/4/4 in dorsal, lateral, and posterior views. 23 – Broken shell ZPAL Bp 73/1/4/7 in lateral view showing the dorsal septum in place. 24, 25 – Ventral interiors ZPAL Bp 73/1/4/8, 9. 26, 27 – Dorsal interiors ZPAL Bp 73/1/4/10, 11. 28–30 – Dorsal interior ZPAL Bp 73/1/4/12 in interior and oblique views and an enlargement of the latter showing the median septum.

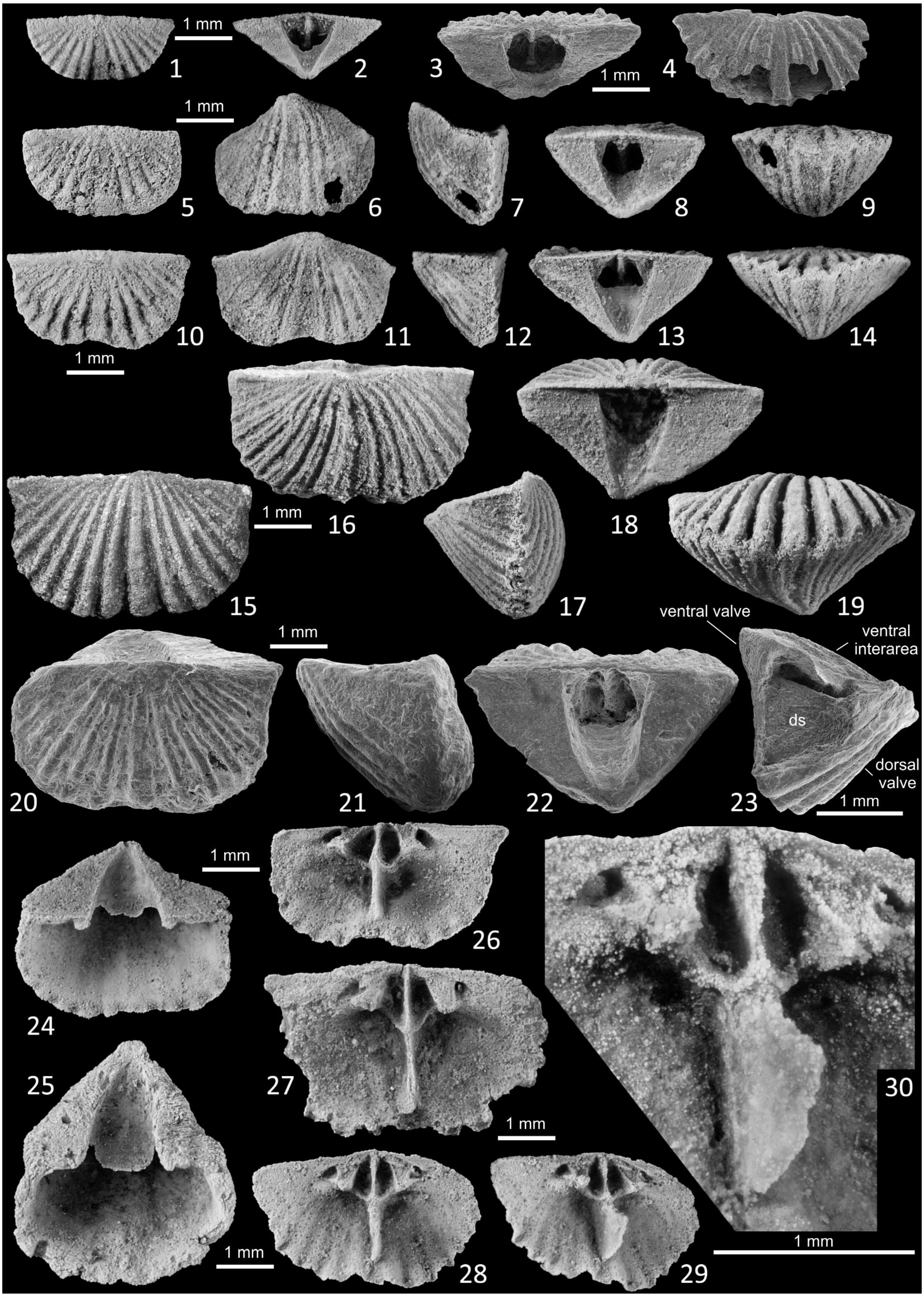
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PLATE 7

Orthida, Spiriferinida

1–19 – *Teichertina fitzroyensis* Veevers, 1959. Józefka, Wietrznia Beds. The specimens ZPAL Bp 73/1/5/1, 4 are from the set XXI whereas ZPAL Bp 73/1/5/2, 3, 5–7 are from set XXII. 11 is a SEM micrograph, the other have been taken in visible light. 1–5, 6–10 – Articulated shells ZPAL Bp 73/1/5/1, 2 in dorsal, ventral, lateral, posterior, and anterior views. 11, 13 – Dorsal interiors ZPAL Bp 73/1/5/6, 7. 12, 14 – Dorsal interior ZPAL Bp 73/1/5/5 and enlargement of a part thereof showing cardinalia. 15–17 – Ventral interior ZPAL Bp 73/1/5/3, general views in dorsal and dorso-anterior views, and enlargement of a part of the latter showing cardinalia. 18, 19 – Fragmentary ventral interior ZPAL Bp 73/1/5/4 and enlargement of a part thereof showing cardinalia.

20–26 – *Komiella devonica* Ljaschenko, 1985. Józefka, Wietrznia Beds, set XXI. 26 is a SEM micrograph, the other have been taken in visible light. See also Plate 19, Figs 25–32 and Plate 20, Figs 1–35. 20–25 – Three dorsal valves ZPAL Bp 73/1/29/8, 9, 10 in ventral (21, 23, 25) and various oblique (20, 22, 24) views. 26 – Microornamentation of the dorsal valve ZPAL Bp 73/1/29/11.

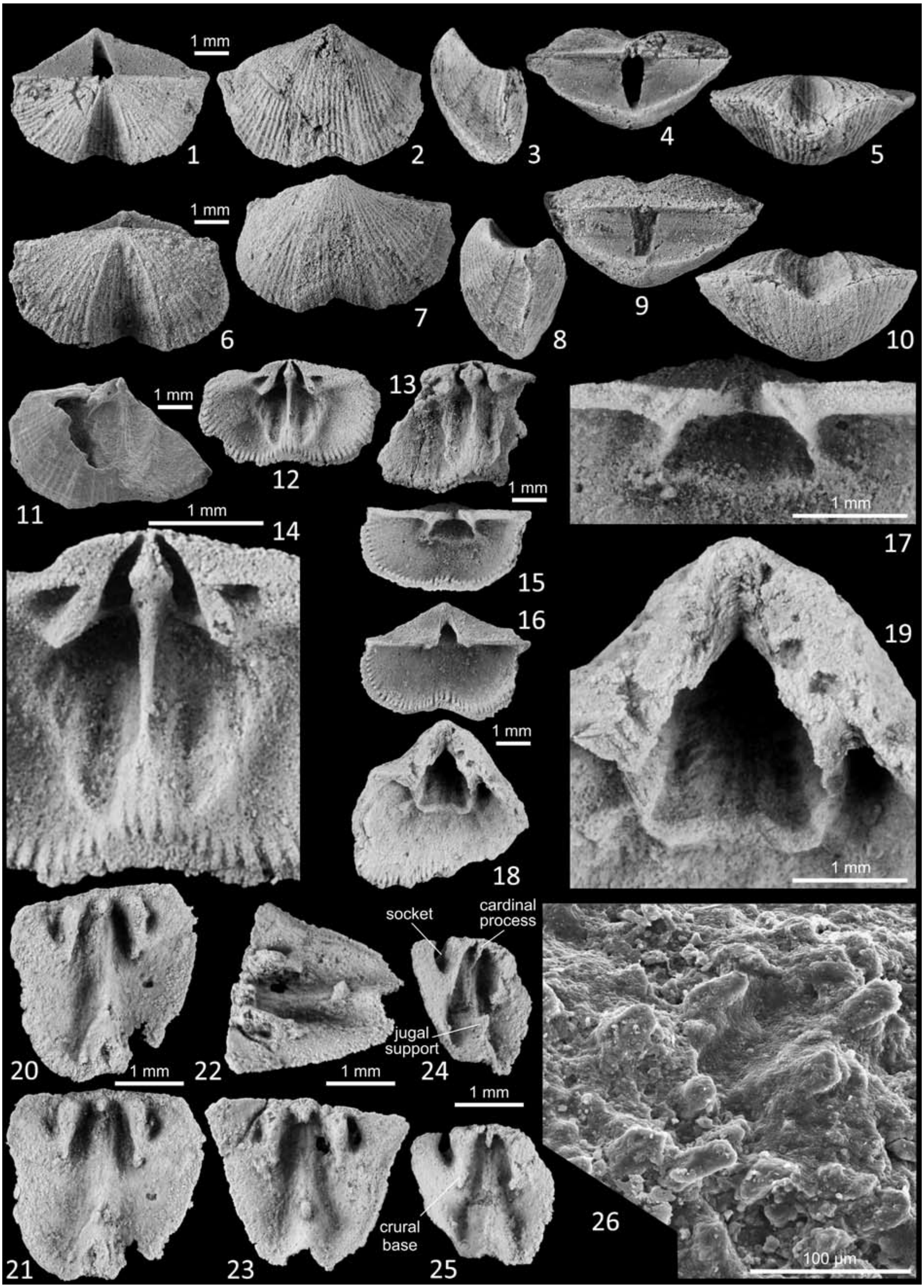
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PLATE 8

Orthida

1–20 – *Monelasmina montisjosephi* Baliński sp. nov. Józefka, Wietrznia Beds. The specimens ZPAL Bp 73/1/6/2, 3 are from the set XXI whereas ZPAL Bp 73/1/6/1, 4 are from set XXII. See also Plate 9, Figs 1–12. 1–5, 6–10, 11–15, 16–20 – Articulated shells ZPAL Bp 73/1/6/3, 4, 2, 1 in dorsal, ventral, lateral, posterior, and anterior views.

21–34 – *Biernatium minus* Baliński sp. nov. Józefka, Wietrznia Beds, sets XXI–XXII. 27–29 are SEM micrographs, the other have been taken in visible light. See also Plate 9, Figs 13–23. 21–25 – Articulated shell ZPAL Bp 73/1/7/2 in dorsal, ventral, lateral, posterior, and anterior views. 26 – Articulated shell ZPAL Bp 73/1/7/3 in dorsal view. 27–29 – Articulated shell ZPAL Bp 73/1/7/4 in dorsal, lateral, and posterior views. 30–34 – Articulated shell (holotype) ZPAL Bp 73/1/7/1 in dorsal, ventral, lateral, posterior, and anterior views (same specimen shown also in Plate 9, Figs 21–23).

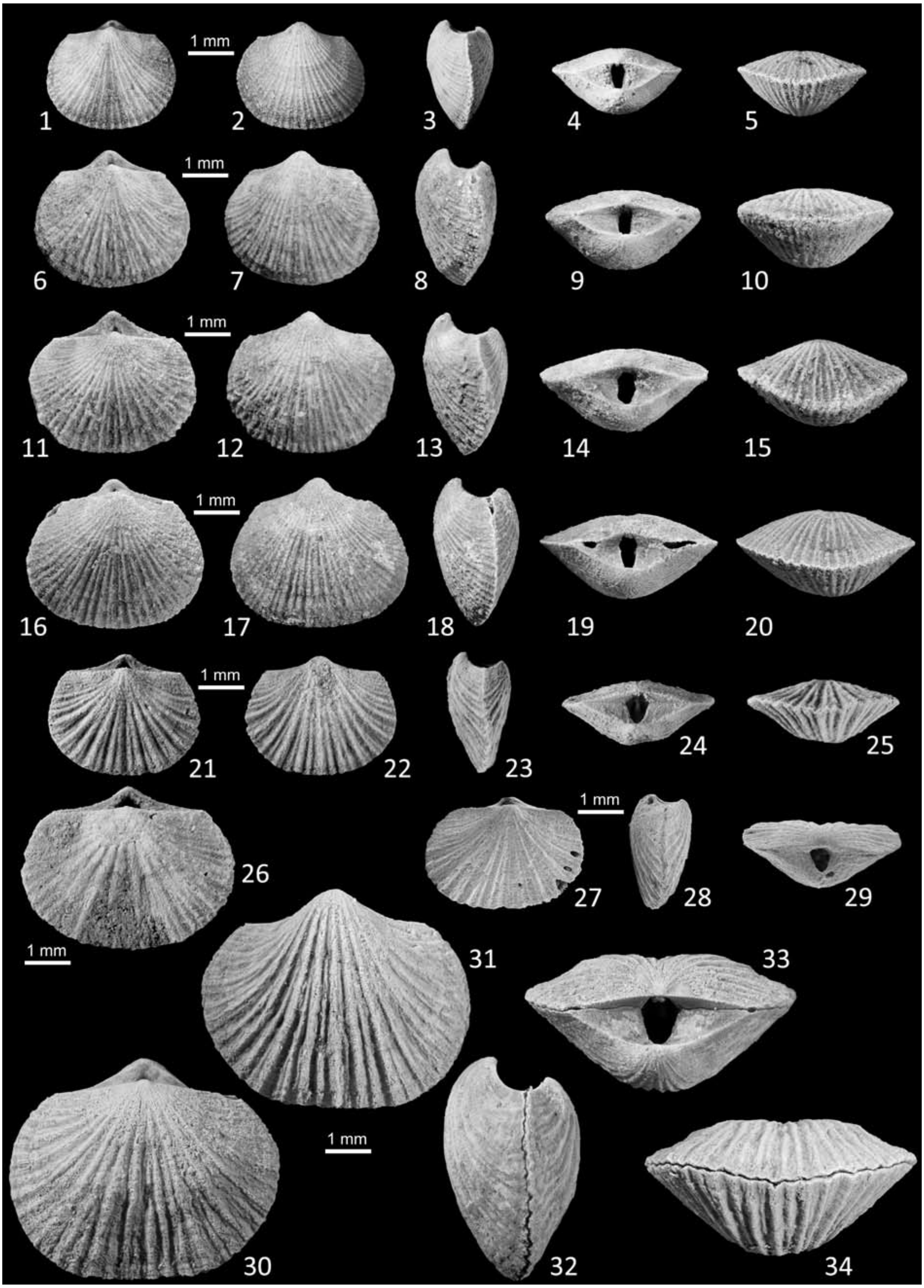
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PLATE 9

Orthida

1–12 – *Monelasmina montisjosephi* Baliński sp. nov. Józefka, Wietrznia Beds, set XXII. 4–5 are SEM micrographs, the other have been taken in visible light. See also Plate 8, Figs 1–20. 1, 6 – Ventral interior ZPAL Bp 73/1/6/9 in dorsal and dorso-anterior views. 2, 7, 12 – Ventral interior ZPAL Bp 73/1/6/10 in dorsal and dorso-anterior views and enlargement of a fragment of the latter showing cardinalia. 3 – Dorsal interior ZPAL Bp 73/1/6/6. 4, 5 – Dorsal interior ZPAL Bp 73/1/6/7 in ventral and oblique views. 8, 9 – Dorsal interior ZPAL Bp 73/1/6/8 in ventral and oblique views. 10 – Dorsal interior ZPAL Bp 73/1/6/5 in oblique view. 11 – Lateral view of the broken shell ZPAL Bp 73/1/6/11 showing the dorsal median septum *in situ*.

13–23 – *Biernatium minus* Baliński sp. nov. Józefka, Wietrznia Beds, sets XXI–XXII. 13–14 are SEM micrographs, the other have been taken in visible light. See also Plate 8, Figs 21–34. 13, 14 – Fragmentary dorsal valve ZPAL Bp 73/1/7/5 showing cardinalia in ventral and oblique views. 15, 16 – Lateral views of broken shells ZPAL Bp 73/1/7/6, 7 showing dorsal median septa *in situ*. 17–19 – Incomplete dorsal valve ZPAL Bp 73/1/7/8, ventral view (19) and two enlargements of the cardinalia (stereopair, 17–18). 20, 21 – Ventral valve of the holotype ZPAL Bp 73/1/7/1 in dorsal view and the posterior region thereof in dorso-anterior view (same specimen shown also in Plate 8, Figs 30–34). 22 – Dorsal valve of the holotype ZPAL Bp 73/1/7/1 (same specimen shown also in Plate 8, Figs 30–34).

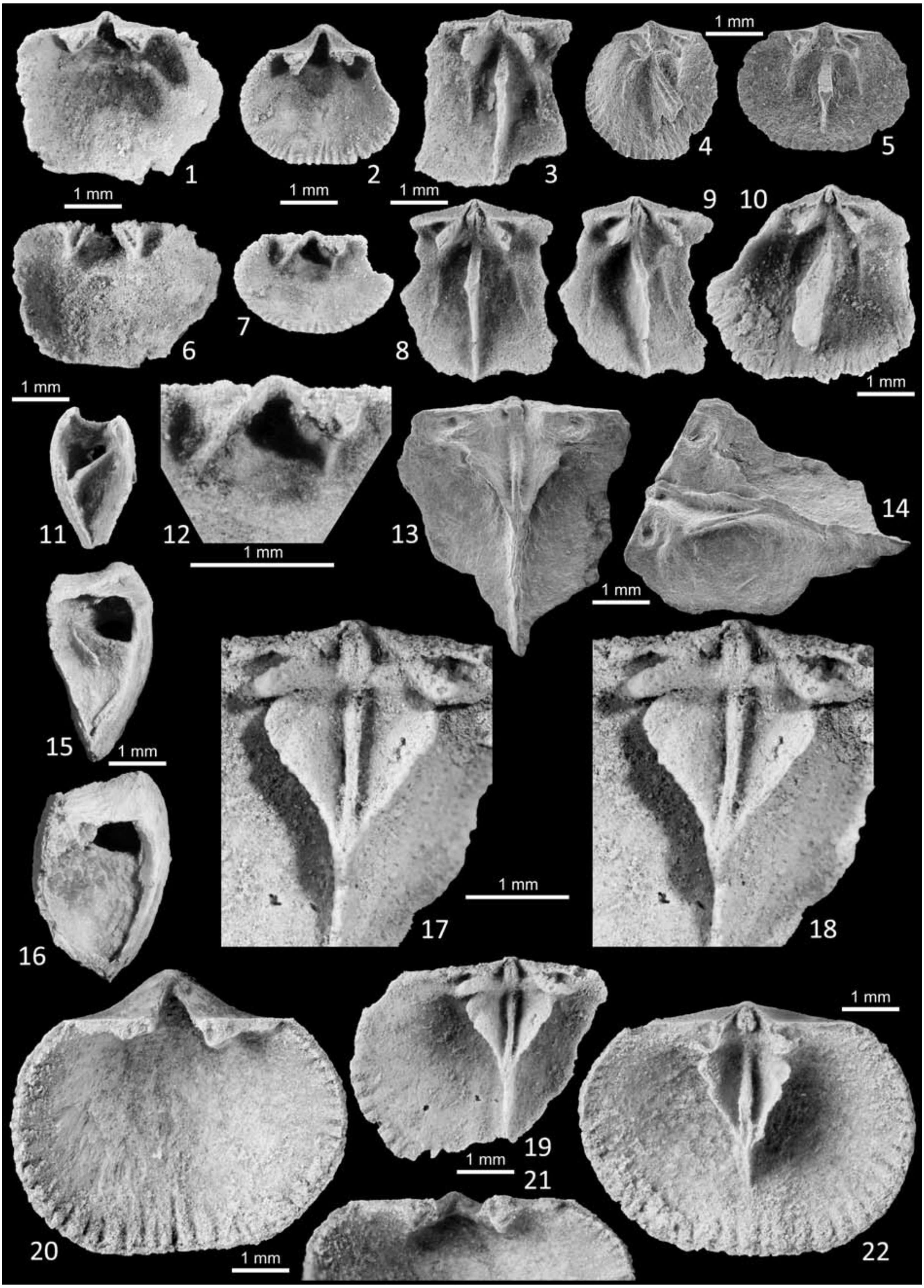
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PLATE 10

Orthida, Pentamerida

1–20 – *Aulacella* cf. *elliptica* Cooper and Dutro, 1982. Józefka, Wietrznia Beds, sets XXI–XXII. The specimens ZPAL Bp 73/1/8/1, 3–5 are from the set XXI whereas ZPAL Bp 73/1/8/2 is from set XXII. 1– 8 – Articulated shell ZPAL Bp 73/1/8/1 in dorsal (4, 2), ventral (5), lateral (6), posterior (7), and anterior (8) views and enlargements of the ventral interior (1) and dorsal exterior (2) and interior (3). 9 – Dorsal interior ZPAL Bp 73/1/8/2. 10–14, 15–19 – Articulated shells ZPAL Bp 73/1/8/3, 4 in dorsal, ventral, lateral, posterior, and anterior views. 20 – The largest articulated shell found ZPAL Bp 73/1/8/5 in ventral view.

21–22 – *Schizophoria schnuri prohibita* Halamski, 2012. Dorsal valve ZPAL Bp 73/1/9/1 embedded in limestone in dorsal and lateral view. Józefka**,** Szydłówek Beds**,** set I.

23–25 – *Physemella* sp. Józefka, Wietrznia Beds. The specimen ZPAL Bp 73/1/10/1 is from the set XXI whereas ZPAL Bp 73/1/10/2 is from set XXII. 23 – Ventral valve ZPAL Bp 73/1/10/1 in exterior view. 24, 25 – Ventral valve ZPAL Bp 73/1/10/2 in interior view and enlargement of the spondylium.

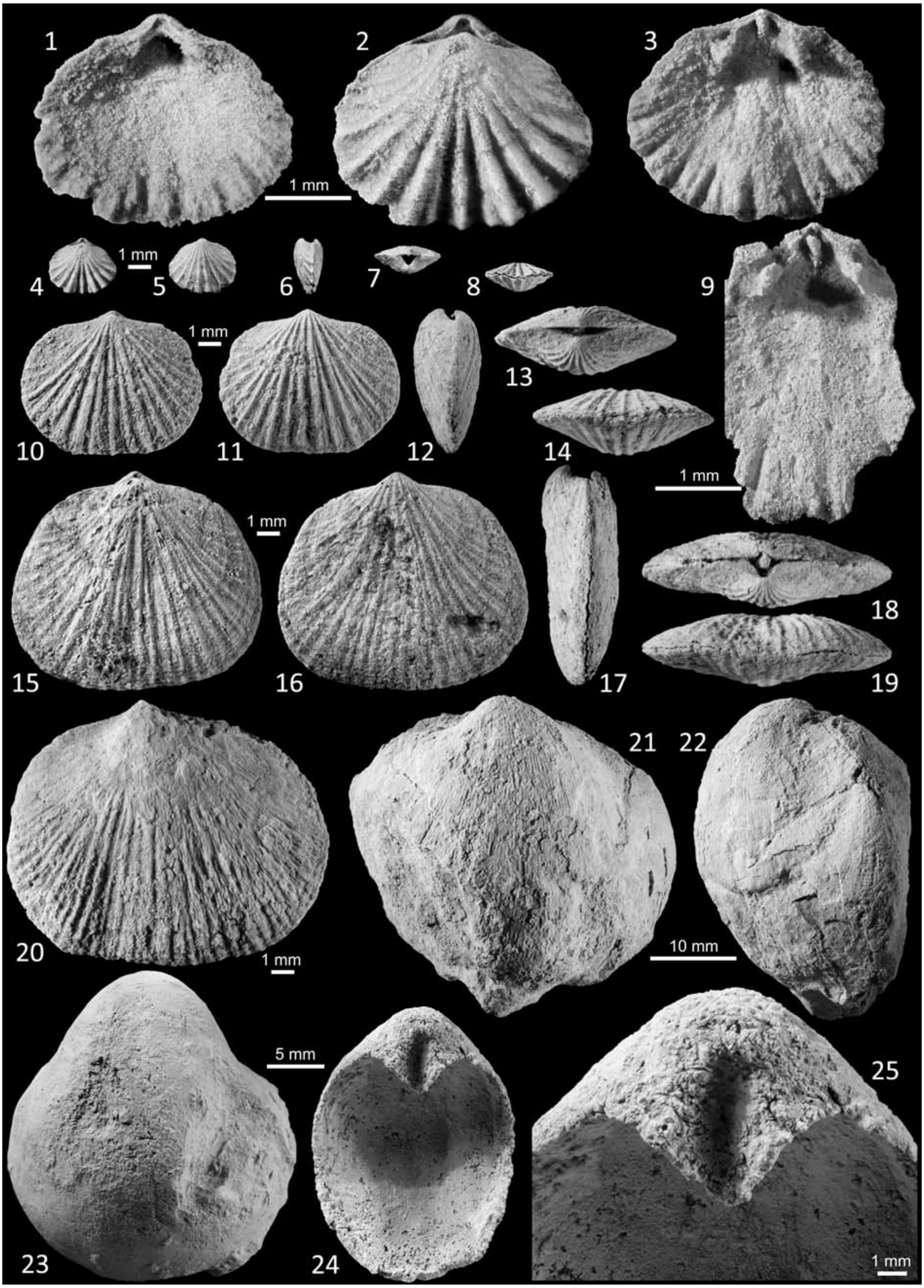
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PLATE 11

Rhynchonellida

1–5 – *Phlogoiderhynchus polonicus* (Roemer, 1866). Józefka**,** Wietrznia Beds, set XXII. Articulated shell ZPAL Bp 73/1/11/1 in dorsal, ventral, lateral, posterior, and anterior views.

6–30, 32 – *Coeloterorhynchus dillanus* (Schmidt, 1941). Józefka**,** roadcut (Szydłówek Beds, set I; collection numbers 73/1A/12, and set A, collection numbers GIUS 4-295a–c). 6–10, 30 – Articulated shell ZPAL Bp 73/1/12/1 in dorsal, ventral, lateral, posterior, and anterior views; an enlargement of a fragment of the latter (30) showing striae. 11–15, 16–20, 21–25. Articulated shells ZPAL Bp 73/1/12/2, GIUS 4-295a, and GIUS 4-295b in dorsal, ventral, lateral, posterior, and anterior views. 17–19, 32 – Articulated shell ZPAL Bp 73/1/12/3 in dorsal, lateral, and anterior views; an enlargement of a fragment of the latter (32) showing striae. 29 – Articulated shell GIUS 4-295c in anterior view.

31 – *Fitzroyella alata* Biernat, 1969. Józefka, Wietrznia Beds, set XXII. Shell ZPAL Bp 73/1/14/4 with broken ventral umbo in ventral view showing cardinalia. See also Plate 12, Figs 1–10.

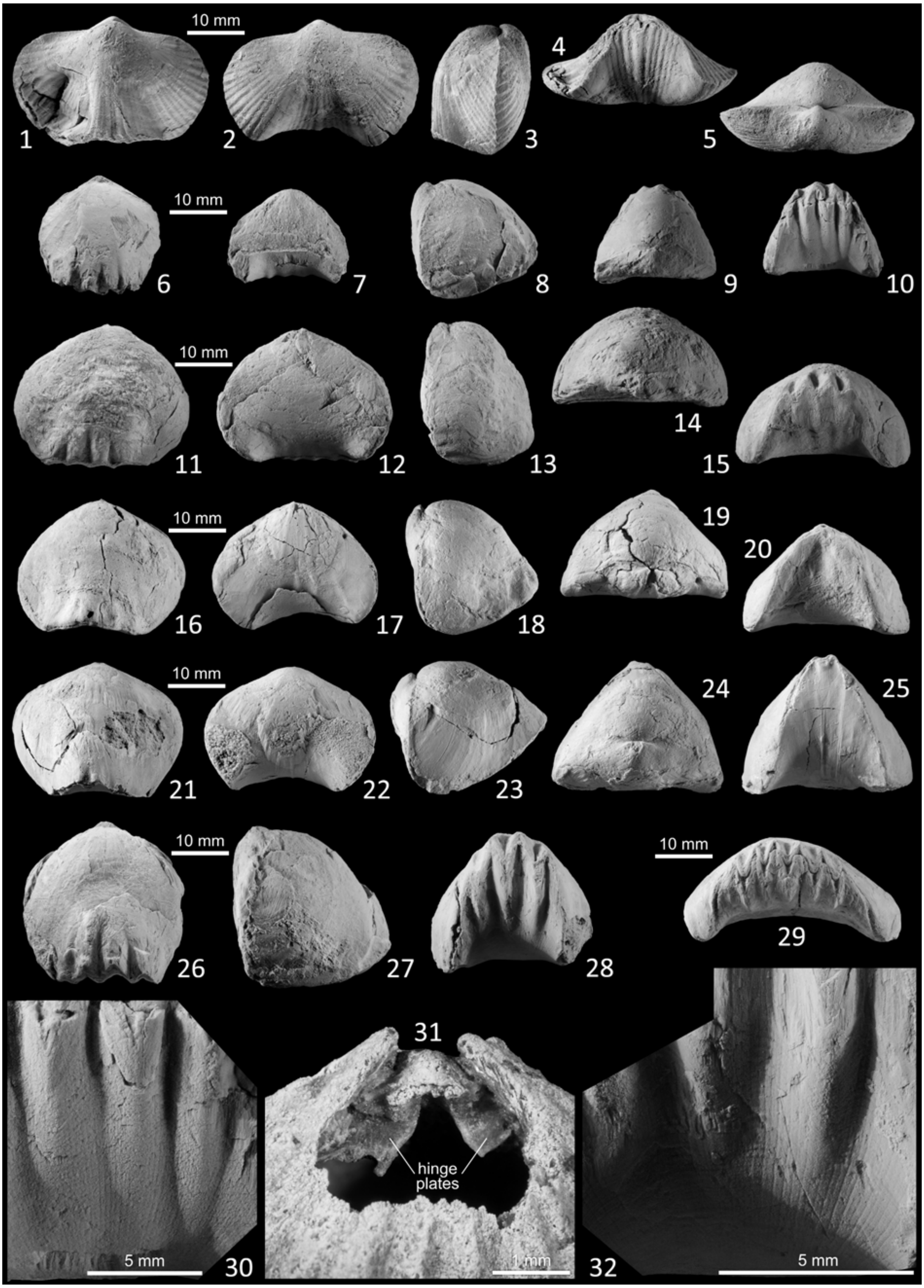
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PLATE 12

Rhynchonellida, Atrypida

1–10 – *Fitzroyella alata* Biernat, 1969. Józefka, Wietrznia Beds, sets XXI–XXII. The specimens ZPAL Bp 73/1/14/1, 2 are from the set XXI whereas specimen ZPAL Bp 73/1/14/3 is from set XXII. See also Plate 11, Fig. 31. 1–3. Articulated shell ZPAL Bp 73/1/14/3 in dorsal, ventral, and anterior views. 4, 5 – Articulated shell ZPAL Bp 73/1/14/2 in dorsal and ventral views. 6–10 – Articulated shell ZPAL Bp 73/1/14/1 in dorsal, ventral, lateral, posterior, and anterior views.

11–15 – *Flabellulirostrum* sp. Józefka, Wietrznia Beds, set XXII. Articulated shell ZPAL Bp 73/1/15/1 in dorsal, ventral, lateral, posterior, and anterior views.

16–26 – *Davidsonia enmerkaris* Halamski sp. nov. Józefka, Wietrznia Beds. The specimen ZPAL Bp 73/1/19/6 is from the set XXI whereas specimens ZPAL Bp 73/1/19/1–5 are from set XXII. 16, 17 – Articulated shell ZPAL Bp 73/1/19/6 in dorsal and ventral views. 18, 19 – Dorsal interior ZPAL Bp 73/1/19/5, general view (19) and enlargement showing cardinalia (18). 20–23. Articulated shell ZPAL Bp 73/1/19/2 in dorsal, ventral, lateral, and posterior views. 24, 25 – Ventral interiors ZPAL Bp 73/1/19/3, 4. 26 – Holotype, ventral interior ZPAL Bp 73/1/19/1.

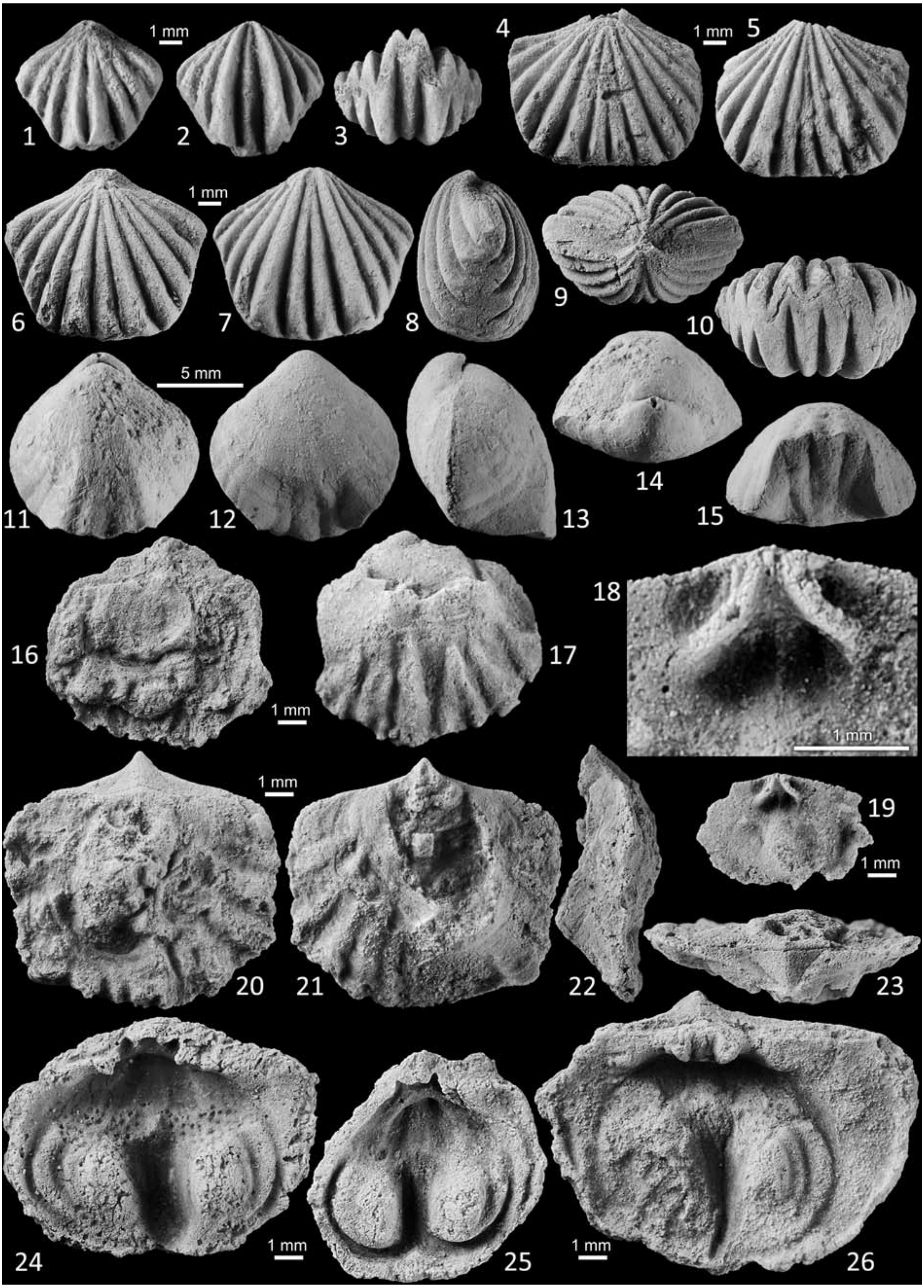
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PLATE 13

Atrypida

1–30 – *Atryparia* (*Costatrypa*) *agricolae* Halamski and Baliński sp. nov. Radlin, Szydłówek Beds. See also Plate 14, Figs 1–10. 1–5, 6–10, 11–15, 16–20, 21–25, 26–30. Articulated shells ZPAL Bp 73/2/16/5, 3, 4, 1 (holotype), 2, 6 in dorsal, ventral, lateral, posterior, and anterior views.

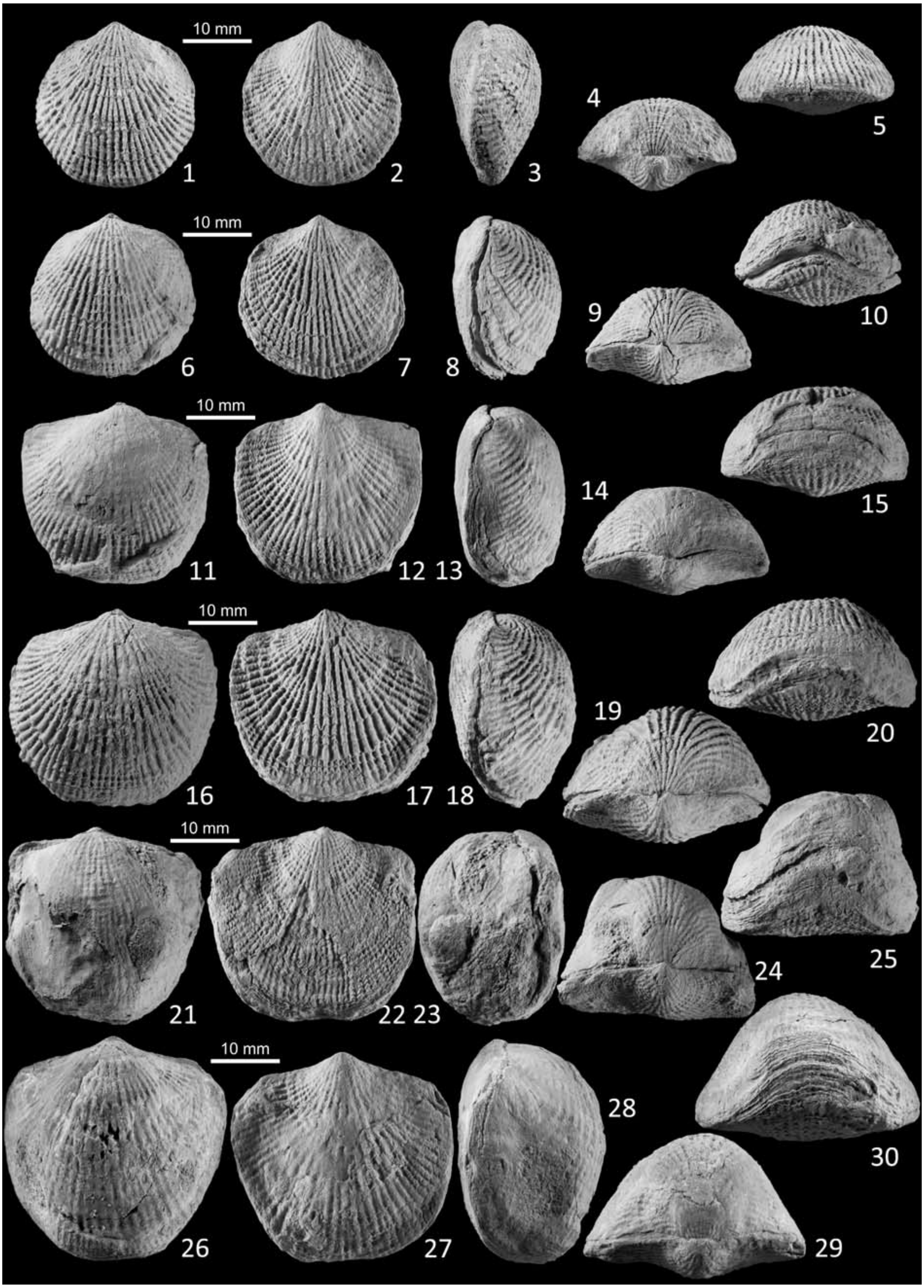
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PLATE 14

Atrypida, Spiriferida

1–10 – *Atryparia* (*Costatrypa*) *agricolae* Halamski and Baliński sp. nov. Radlin, Szydłówek Beds. See also Plate 13, Figs 1–30. 1–5, 6–10. Articulated shells ZPAL Bp 73/2/16/7, 8 in dorsal, ventral, lateral, posterior, and anterior views.

11–20 – *Desquamatia* sp. Józefka, Wietrznia Beds, set XXII. 11–15, 16–20 –Articulated shell ZPAL Bp 73/1/17/1 in dorsal, ventral, lateral, posterior, and anterior views.

21–33 – ?*Reticulariopsis* sp. Józefka. 21–25 – Articulated shell ZPAL Bp 73/1/25/1 from the Wietrznia Beds (set XXI) in dorsal, ventral, lateral, posterior, and anterior views. 26–34 – Articulated shell ZPAL Bp 73/1/25/2 from the Laskowa Góra / lower Szydłówek Beds in dorsal, ventral, lateral, posterior, and anterior views (26–30) and enlargements of ornamentation showing two ways of spine disposition, irregular in the ventral sulcus (31, 34) and regular along the growth lines near the anterior margin of the dorsal valve (32, 33) as well as the form of the spines (33, 34). The images 31–33 are of the uncoated specimen.

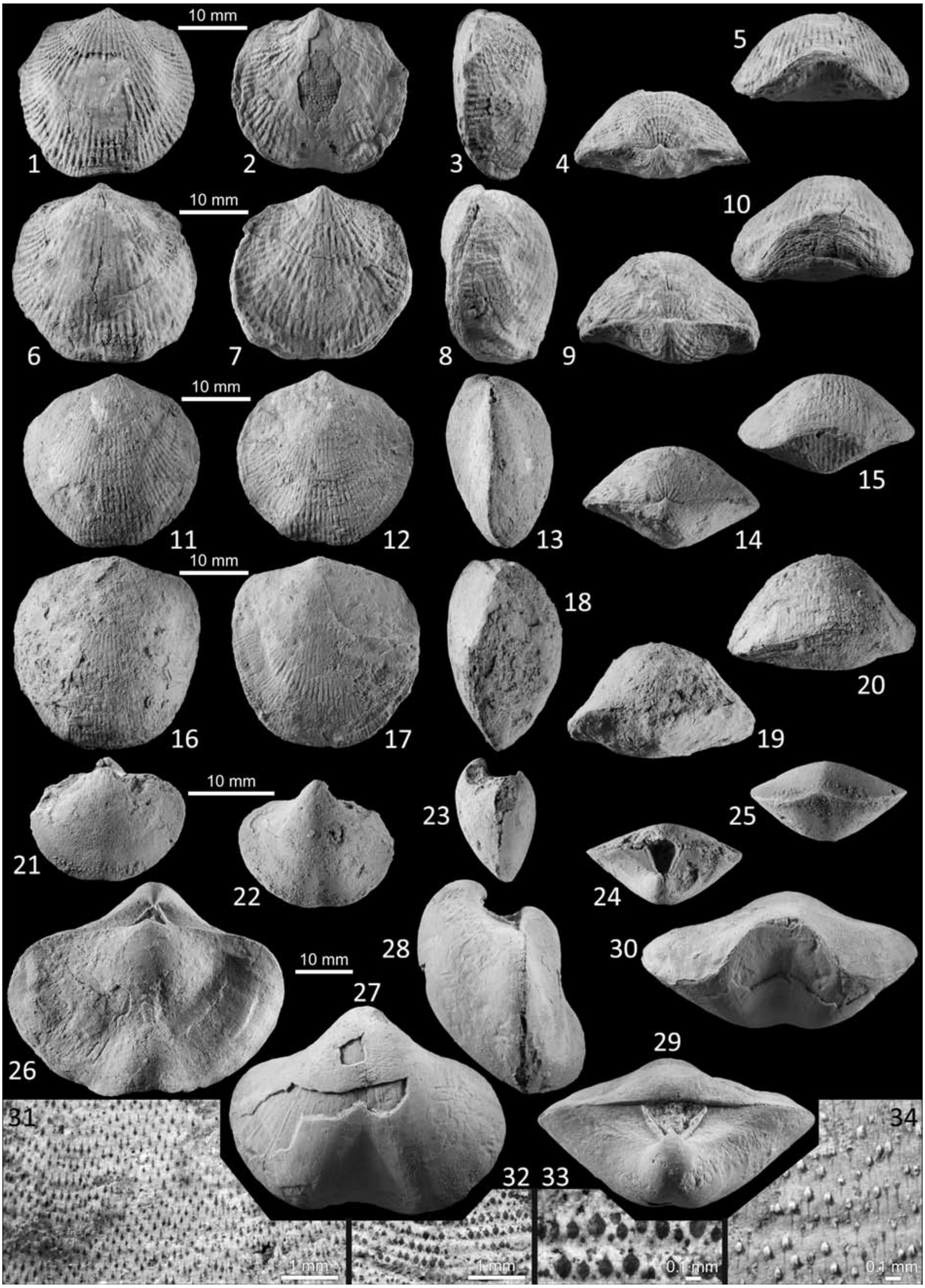
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PLATE 15

Atrypida

Spinatrypina (*Exatrypa*) *explanata* (von Schlotheim, 1820). Józefka. The specimens ZPAL Bp 73/1/18/3, 5, 6, 9 are from the sets XXI–XXII cropping out in the roadcut, whereas ZPAL Bp 73/1/18/1, 2, 4, 7, 8 are from the Laskowa Góra or lower to middle Szydłówek Beds cropping out in the quarry.

1–5 – Articulated shell ZPAL Bp 73/1/18/3 in dorsal, ventral, lateral, posterior, and anterior views. 6–10, 25, 26 – Articulated shell ZPAL Bp 73/1/18/1 in dorsal, ventral, lateral, posterior, and anterior views; enlargements of the dorsal view showing details of the ornamentation pattern (25) and the foramen (26). 11–15, 16–20 – Articulated shells ZPAL Bp 73/1/18/6, 7 in dorsal, ventral, lateral, posterior, and anterior views. 21–24, 27–30 – Articulated shells ZPAL Bp 73/1/18/9, 2, 8, 4 in dorsal and anterior views. 31–33 – Dorsal valve ZPAL Bp 73/1/18/5 in exterior and interior views, and enlargement of a fragment of the latter showing cardinalia.

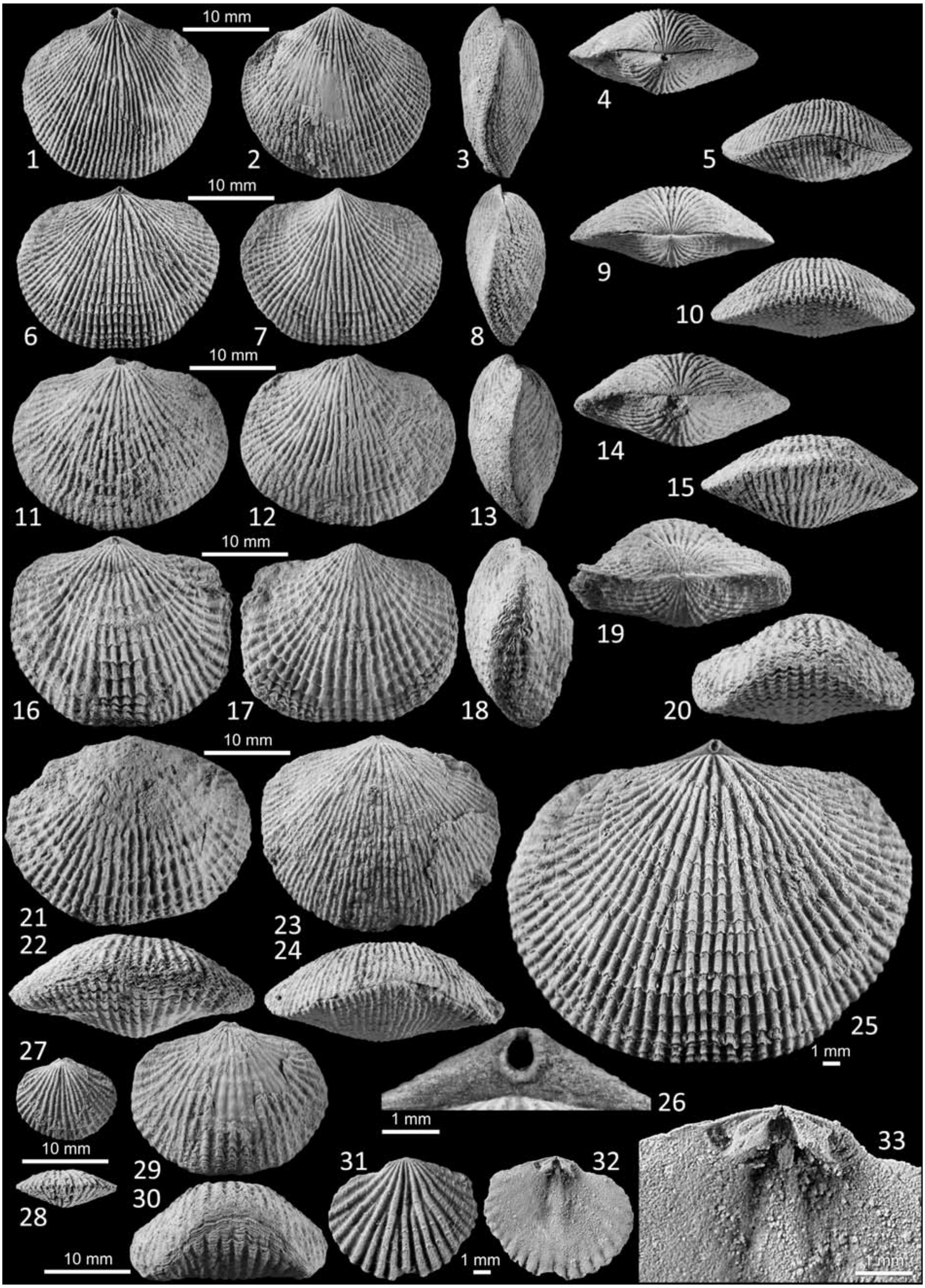
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PLATE 16

Athyridida

1–15, **28–29** – *Biernatella lentiformis* Baliński, 1995. Józefka, Wietrznia, set XXI. See also Plate 17, Figs 1–7, 9. 1–5, 29 – Articulated shell ZPAL Bp 73/1/20/1 in dorsal, ventral, lateral, posterior, and anterior views; enlargement of the beak in dorsal view. 60–10, 28 – Articulated shell ZPAL Bp 73/1/20/2 in dorsal, ventral, lateral, posterior, and anterior views; enlargement of the beak in dorsal view. 11–15 – Articulated shell ZPAL Bp 73/1/20/3 in dorsal, ventral, lateral, posterior, and anterior views.

16–27 – *Leptathyris gornensis* Baliński sp. nov. Józefka, Wietrznia set XXII. 16–20, 26. Holotype, articulated shell ZPAL Bp 73/1/22/1 in dorsal, ventral, lateral, posterior, and anterior views; enlargement of the beak in dorsal view. 21–25, 27. Articulated shell ZPAL Bp 73/1/22/2 in dorsal, ventral, lateral, posterior, and anterior views; enlargement of the beak in dorsal view.

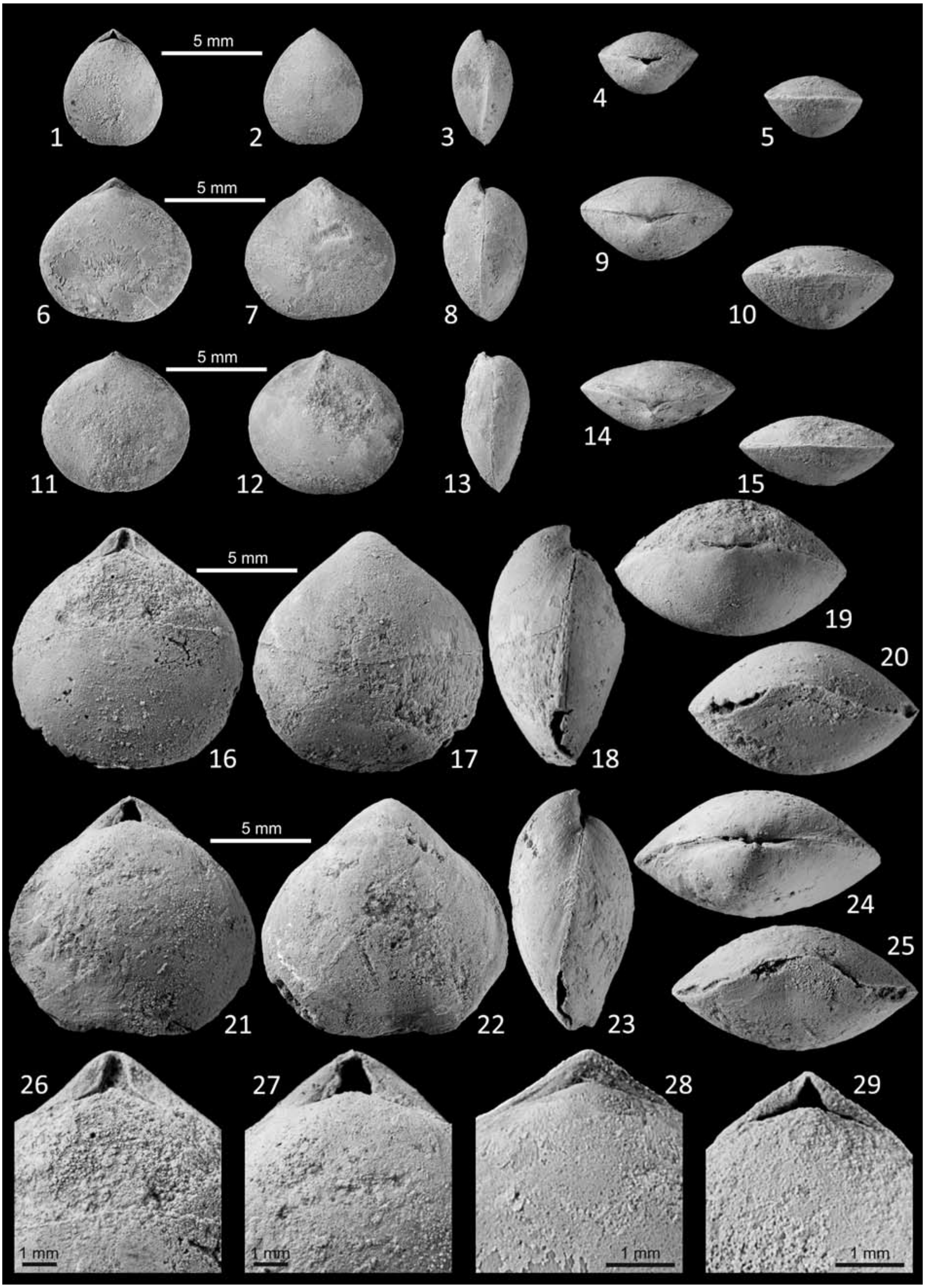

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PLATE 17

Athyridida, Spiriferida

1–7, **9** – *Biernatella lentiformis* Baliński, 1995. Józefka, Wietrznia Beds. The specimens ZPAL Bp 73/1/23/6,7, 10 are from the set XXI whereas ZPAL Bp 73/1/23/8,9 is from set XXII. 1–3 and 9 are SEM micrographs, the other have been taken in visible light. See also Plate 16, Figs 1–15, 28–29. 1 – Incomplete articulated shell ZPAL Bp 73/1/20/5, beak lacking, in posterior view, showing crural bases. 2 – Ventral interior ZPAL Bp 73/1/20/9 in dorsal view. 3 –Ventral interior ZPAL Bp 73/1/20/10 in dorso-anterior view. 4, 5 – Enlargements of the cardinalia of two dorsal valves ZPAL Bp 73/1/20/6, 7. 6, 7 – Incomplete dorsal valve ZPAL Bp 73/1/20/8, general view (7) and enlargement of the cardinalia (6). 9 – Fragmentary specimen ZPAL Bp 73/1/20/4, shell lacking, showing partly preserved diplospiralium.

8, **10–17** – *Echinocoelia parva* Baliński sp. nov. Józefka, Wietrznia Beds. The specimens ZPAL Bp 73/1/23/4–8, 10 are from the set XXI whereas ZPAL Bp 73/1/23/9 is from set XXII. See also Plate 18, Figs 1–16. 8, 12 – Dorsal interior ZPAL Bp 73/1/23/6 and enlargement of the cardinalia. 10 – Articulated shell ZPAL Bp 73/1/23/9 with dorsal valve partly broken, showing spiralium. 11, 14 – Dorsal interior ZPAL Bp 73/1/23/7 and enlargement of the cardinalia. 13, 16 – Ventral interior ZPAL Bp 73/1/23/8 and enlargement of the cardinalia. 15, 17 – ZPAL Bp 73/1/23/10, 4 microornamentation.

18 – *Cyrtospirifer* sp. indet. Józefka, Wietrznia Beds, set XXIII. Incomplete ventral valve embedded in limestone.

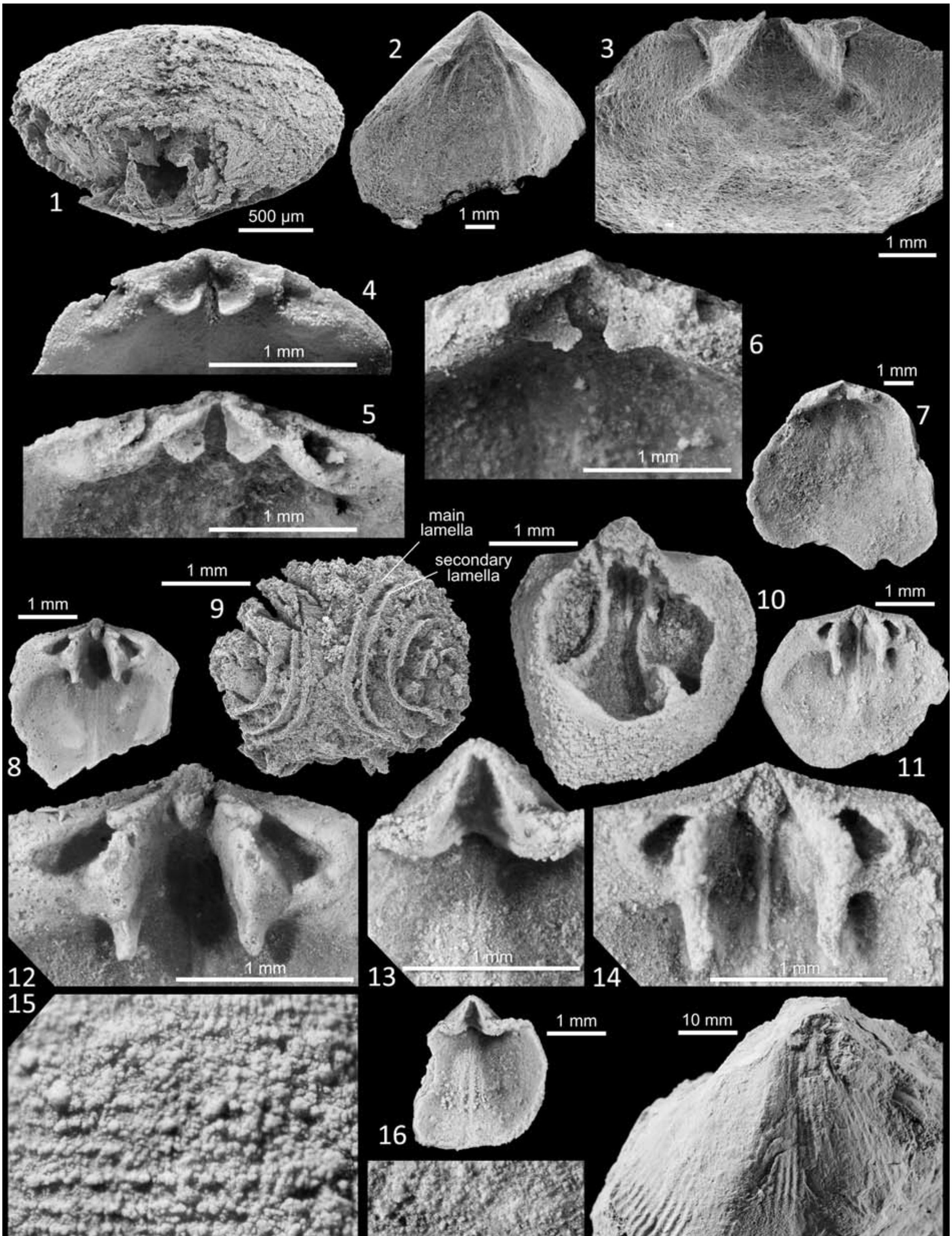
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PLATE 18

Spiriferida

1–16 – *Echinocoelia parva* Baliński sp. nov. Józefka, Wietrznia Beds . The specimens ZPAL Bp 73/1/23/1–3 are from the set XXI whereas ZPAL Bp 73/1/23/4, 5 are from set XXII. 1 is a SEM micrograph, the other have been taken in visible light. See also Plate 17, Figs 8–10, 17. 1 – Articulated shell ZPAL Bp 73/1/23/5 in oblique view. 2–5 – Articulated shell ZPAL Bp 73/1/23/3 in dorsal, ventral, lateral, and posterior views. 6 – Articulated shell ZPAL Bp 73/1/23/4 in dorsal view. 7–11 – Articulated shell ZPAL Bp 73/1/23/2 in dorsal, ventral, lateral, posterior, and anterior views. 12–16 – Articulated shell ZPAL Bp 73/1/23/1 (holotype) in dorsal, ventral, lateral, posterior, and anterior views.

17–31 – *Emanuella* aff. *takwanensis* (Kayser, 1883). Józefka, Wietrznia Beds , set XXII. 17–21, 22–26, 27–31 – Articulated shells ZPAL Bp 73/1/24/1, 2, 3 in dorsal, ventral, lateral, posterior, and anterior views.

32–36 – ?*Athyris* sp. Józefka, Wietrznia Beds set XXII. Articulated shell ZPAL Bp 73/1/21/1 in dorsal, ventral, lateral, posterior, and anterior views.

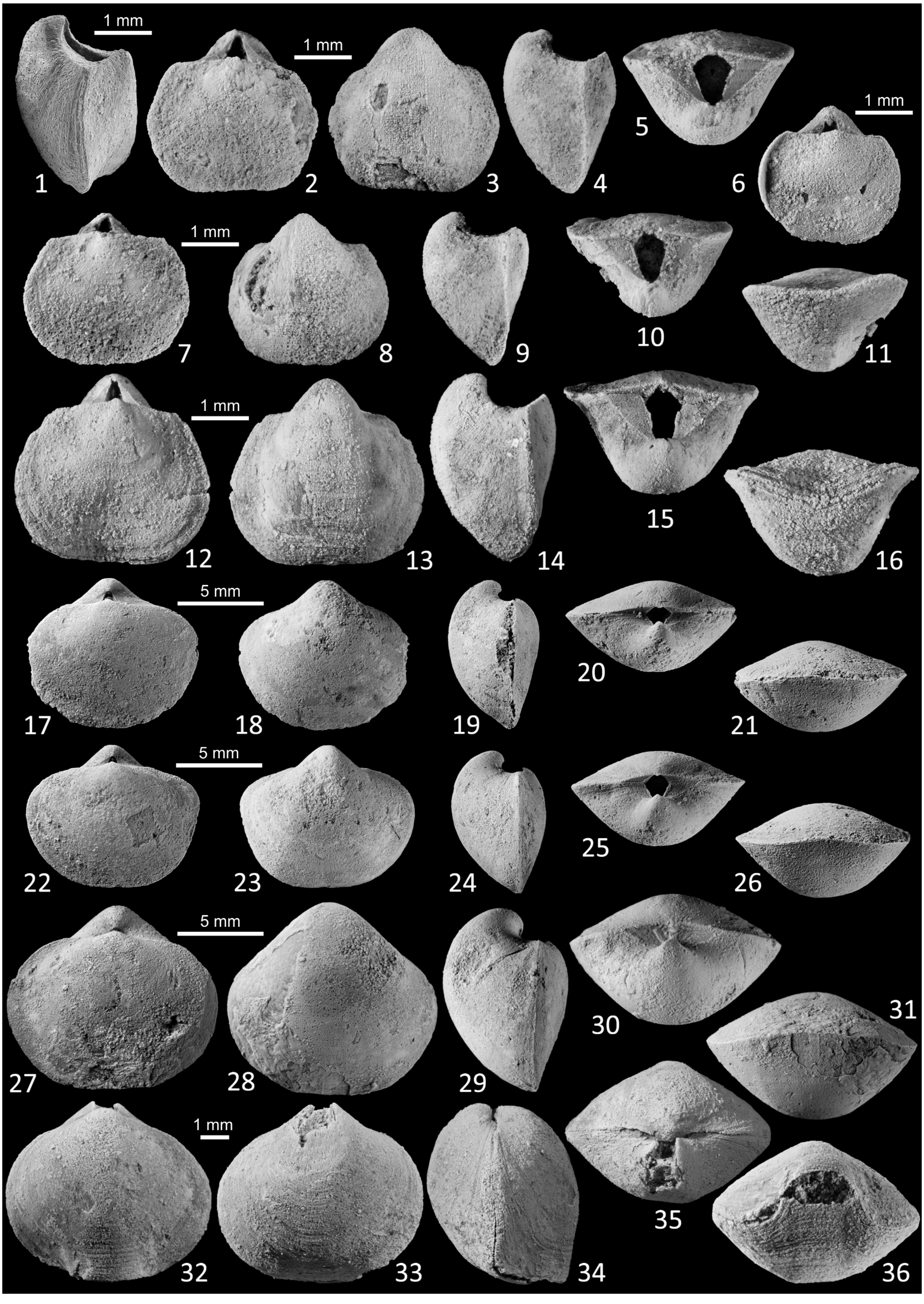
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PLATE 19

Spiriferinida

1–19 – *Cyrtina* cf. *arkonensis* Ehlers & Wright, 1975. Józefka, Wietrznia Beds. The specimens ZPAL Bp 73/1/27/1, 2, 4–7 are from the set XXI whereas ZPAL Bp 73/1/27/3 is from set XXII. 1–5, 6–10, 11–15 – Articulated shells ZPAL Bp 3/1/27/1, 2, 3 in dorsal, ventral, lateral, posterior, and anterior views. 16, 19 – Dorsal interiors ZPAL Bp 73/1/27/4, 5. 17, 18 – Ventral interiors ZPAL Bp 73/1/27/6, 7 in dorsal and oblique views.

20–24 – *Cyrtina* sp. nov. A. Józefka, Wietrznia Beds, set XXII. Articulated shell ZPAL Bp 73/1/28/1 in dorsal, ventral, lateral, posterior, and anterior views.

25–32 – *Komiella devonica* Ljaschenko, 1985. Józefka Wietrznia Beds. The specimens ZPAL Bp 73/1/29/14–16 are from the set XXI whereas ZPAL Bp 73/1/29/12, 13 are from set XXII. 25–27 are SEM micrographs, the other have been taken in visible light. See also Plate 7, Figs 20–26 and Plate 20, Figs 1–35. 25 –Ventral interior ZPAL Bp 73/1/29/12 in dorsal view. 26, 27 – Ventral interior ZPAL Bp 73/1/29/13 in postero-dorsal and dorsal views. 28, 29 – Articulated shells ZPAL Bp 73/1/29/14, 15 in posterior views. 30–32 – Ventral valve ZPAL Bp 73/1/29/16 in dorsal, antero-ventral and posterior views.

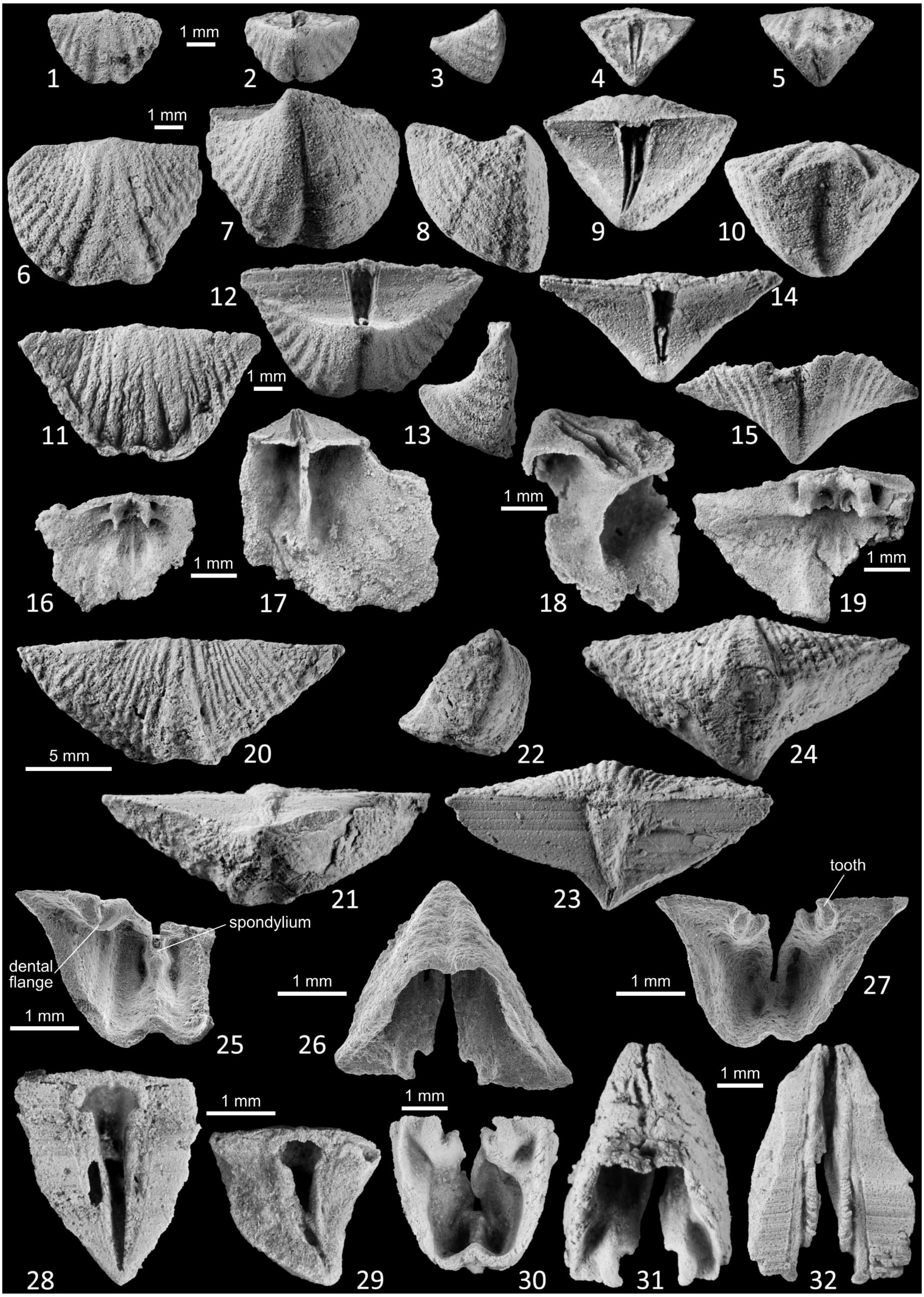
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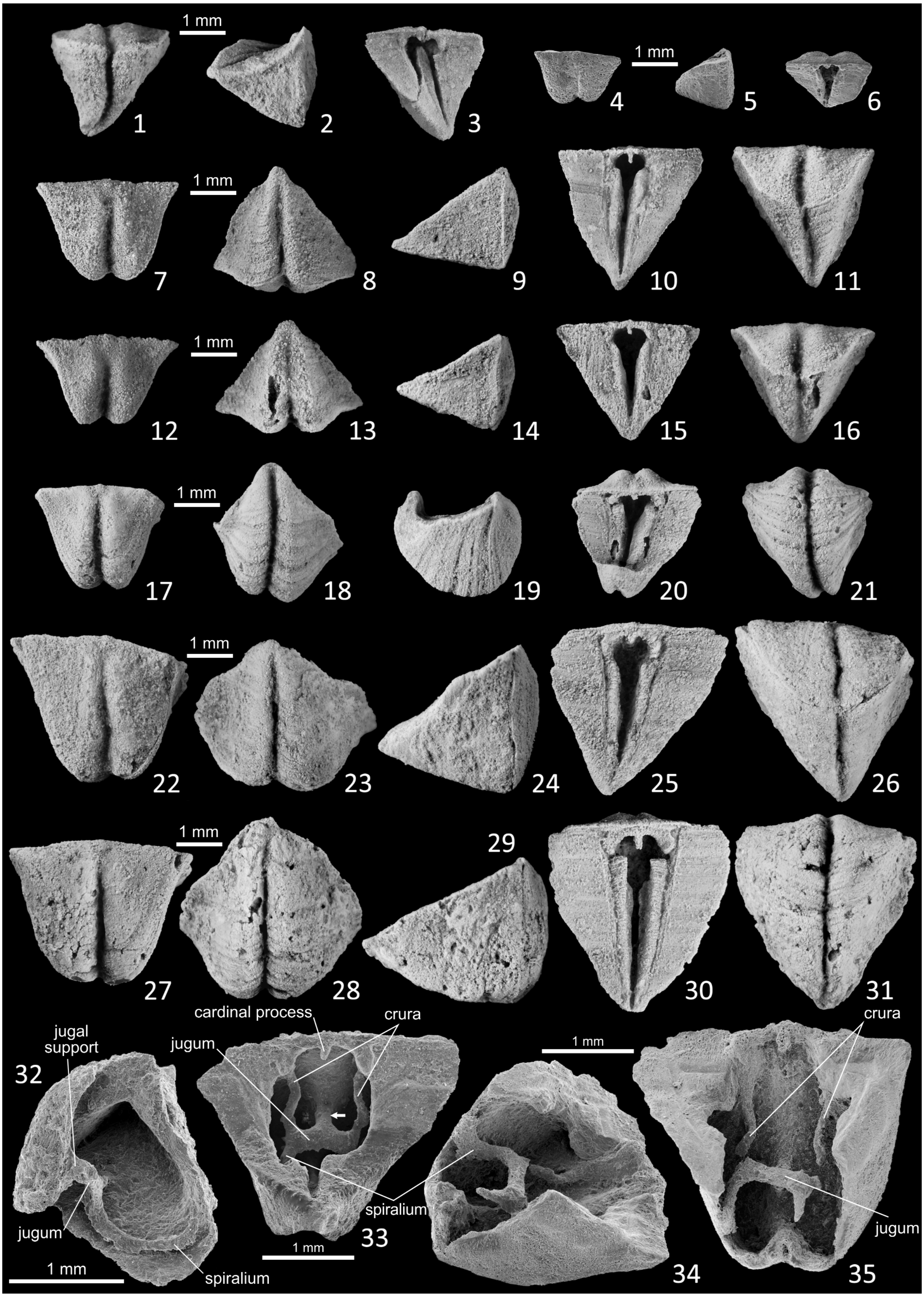
PLATE 20

Spiriferinida

Komiella devonica Ljaschenko, 1985. Józefka, Wietrznia Beds. The specimens ZPAL Bp 73/1/29/1, 2, 5, 19 are from the set XXI whereas ZPAL Bp 73/1/29/6, 7, 3, 4, 18 are from set XXII. 4–6 and 32–35 are SEM micrographs, the other have been taken in visible light. See also Plate 7, Figs 20–26 and Plate 19, Figs 25–32.

1–3 – Articulated shell ZPAL Bp 73/1/29/6 in ventral, lateral, and posterior views. 4–6 – Articulated shell ZPAL Bp 73/1/29/7 in dorsal, lateral, and posterior views. 7–11, 12–16, 17–21, 22–26, 27–31 – Articulated shells ZPAL Bp 73/1/29/3, 4, 5, 1, 2 in dorsal, ventral, lateral, posterior, and anterior views. 32 – Fragmentarily preserved shell ZPAL Bp 73/1/29/19 showing a part of the spiralium. 33 – Articulated shell ZPAL Bp 73/1/29/17 with ventral valve partly broken to show spiralium (posterior view). 34, 35 – Articulated shell ZPAL Bp 73/1/29/18 with ventral valve broken in major part to show spiralium (ventral and oblique views).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