

# UPPER DEVONIAN GONIATITES AND CO-OCCURRING CONODONTS FROM THE HOLY CROSS MOUNTAINS: STUDIES OF THE POLISH GEOLOGICAL INSTITUTE COLLECTIONS

Tatiana WORONCOWA-MARCINOWSKA

*Polish Geological Institute, ul. Rakowiecka St., 4, 00-975 Warsaw, Poland,  
e-mail: tatiana.woroncowa-marcinowska@pgi.gov.pl*

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**Abstract:** A revision of a major part of the old collections of Upper Devonian goniatites from the Holy Cross Mts., collected by J. Czarnocki, H. Makowski and M. Rózkowska, is presented. Described and illustrated are 26 species and subspecies belonging to 20 genera and subgenera and 9 families. Studied and illustrated for the first time are 35 suture lines and 15 growth lines. Conodonts, mostly collected from the parent rocks of the studied goniatites, allow for a more precise correlation of these goniatites with standard ammonoid and conodont zonations. The museum collections studied include specimens mostly of all standard Upper Frasnian through Famennian ammonoid zonations, but the precise zonal boundaries could not be established. Goniatite assemblages from the Płucki and Janczyce sections correspond to the *linguiformis* and Upper *crepida* conodont zones, respectively. Moreover, four conodont zones have been distinguished in the Łągów (Dule) section: Upper *crepida/rhomboides*, Lower *marginifera*, Lower/Upper *marginifera* and *trachytera* zones. This last zone has been recognised here for the first time.

**Key words:** Holy Cross Mts., Devonian, Frasnian, Famennian, goniatites, conodonts, biostratigraphy, taxonomy, correlation.

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## INTRODUCTION

Cephalopods, especially ammonites, are a group of fossils of orthostratigraphic value, from upper Palaeozoic to the top of Mesozoic. Fundamental papers on Devonian goniatites from Poland were published at the end of the 19<sup>th</sup> and the beginning of the 20<sup>th</sup> centuries (Gürich, 1896, 1903; Dybczyński, 1913; Sobolew, 1912, 1914). Most later regional stratigraphic papers include lists of Devonian goniatites without their palaeontological characteristics. The few modern studies include the papers by Lewowicki (1959), Gunia (1968), Makowski (1962, 1971, 1991), and Dzik (2002).

Three collections that include goniatites from the Holy Cross Mountains are stored in the PGI Geological Museum, Warsaw for more than half of a century. The oldest and the most numerous is that registered as “Clymeniidae of the Holy Cross Mts. area”, collected by J. Czarnocki, coming from years 1905–1950 and registered under number 284.II. Of the 822 numbered specimens (items), 766 were identified, most as belonging to the order Clymeniida, and 98 items – to the order Goniatiida. The goniatite collections come

from the following localities: Łągów, Gałęzice (Ostrówka, Besówka and Stokówka hills), Kowala and the now extinct “Sieklucki’s brickyard”.

The second collection in size, assembled by J. Czarnocki, H. Makowski and M. Rózkowska (acquisition year – 1949), consists of 129 specimens – representatives of orders Agoniatitida and Goniatiida. The collection is registered as “Stratigraphical Devonian material from Janczyce near Opatów – Cephalopod fauna from *Cheiloceras* Beds” and it includes also specimens of Frasnian age from locality Płucki near Łągów. All specimens classified by H. Makowski; collection number 175.II.

The third and smallest collection, catalogued in 1949 under number 176.II, contains goniatites from the “*Clymenia* Beds” at Łągów (Dule), and was assembled by H. Makowski and J. Czarnocki; the specimens were identified by H. Makowski. Names of species from the discussed collections were published in *Catalogue of Fossils* (Pajchłowa, 1972) and in the *Catalogue of Geological Collections PGI* (Zwierż, 1974). The fauna from these collections was listed

by Czarnocki in his stratigraphical papers (1928, 1948), and, with outcrop descriptions, in his posthumous monograph of Clymeniae (Czarnocki, 1989). H. Makowski presents descriptions of a few species, including two new ones, in his papers on dimorphism (Makowski, 1962, 1991) and on goniatites from Płucki (Makowski, 1971). Woroncowa-Marcinowska (2003a) verified these attributions for the *Atlas skamieniałości – Dewon*.

Palaeontological and stratigraphical study of the goniatites from the mentioned collections as well as co-occurring conodonts for more precise location of these specimens within well known Upper Devonian strata of the Holy Cross Mountains, it is a main purpose of present paper.

## METHODS

The uniqueness of the collection consists not only in the number of specimens but also in the fact that some exposures from which they were collected do not exist any more (e.g. the Sieklucki's brickyard), are hardly accessible (Łagów-Dule – intense development), or were exploited by fossil hunters (Janczyce). A significant drawback in this work was the lack of precise location of the studied specimens in sections. Conodonts were separated from host sediments of the studied goniatites, for precise determination of their stratigraphical position. Small samples (50–200 g) of the goniatite host rocks were dissolved in formic acid at PGI Geological Preparation Laboratory to obtain conodonts. Conodont determinations and frequencies are shown in tables, separately for each outcrop.

The goniatite study includes synonymy, detailed descriptions of the taxa, taking into account suture lines and growth lines, and a detailed photographic documentation of the fauna, made at PGI Photographic Laboratory.

The methods used allowed for the first presentation of an integrated goniatite/conodont biostratigraphy of the Frasnian and Famennian strata of the Holy Cross Mountains.

## STATE OF KNOWLEDGE ON UPPER DEVONIAN GONIATITES OF THE HOLY CROSS MOUNTAINS

Devonian goniatites (here understood jointly as representatives of the orders Agoniatitida and Goniatitida) occur in Poland mainly in the Holy Cross Mountains and in the Sudetes, while individual finds are known from the Cracovian – Silesian area, Radom – Lublin area and Pomerania. The greatest taxonomical diversity is present among the goniatites from the Holy Cross Mountains. They are mostly found in carbonate (platy and nodular limestones) and siliciclastic (marly shales) deposits of basinal facies. Goniatites are mostly accompanied by brachiopods, thin-shelled bivalves, trilobites, conodonts and other fauna.

Frasnian goniatites are known in the Holy Cross Mountains from three horizons and they belong mainly to order Agoniatitida. The Lower Frasnian goniatite assemblage collected by J. Malec (Racki *et al.*, 1985) from the upper part of

the Szydłówek Beds and identified by J. Dzik (2002) included: *Koenenites lamellosus* (G. et F. Sandberger), *Acanthoclymenia genundewa* (Clarke), *Linguatornoceras compressum* (Clarke) and *Epitornoceras mithracoides* (Frech). Conodonts described from these beds indicate the upper part of the Lower *asymmetricus* Zone (Racki, 1985), which corresponds to the *transitans* Zone of conodont zonation (Racki & Bultynck, 1993). A goniatite assemblage of similar age was described by Kościelniakowska (1967) from the Trzcianka and Wzdół sections in the Łysogóry region. This assemblage includes: *Manticoceras cordatum* (G. et F. Sandberger), *M. adorfense* Wedekind, *Ponticeras prumiense* (Steininger), *Crickites expectatus* Wedekind, *Tornoceras (T.) simplex* (v. Buch), *T. (T.) frechi* Wedekind, *T. (Aulatornoceras) paucistriatum* (Archiac et Verneuil) and *T. ausavense ausavense* (Steininger). These species may indicate the Iγ Goniatite Zone in the present author's opinion. Determinations of the same species by Dzik (2002) allow us to suggest that this assemblage is related to the Lower Frasnian assemblage from Kostomłoty.

In Upper Frasnian, related goniatite assemblages are found in two conodont zones: *rhenana* and *linguiformis* (Wolska, 1967; Szulczewski, 1971). The best known goniatite assemblage from the *rhenana* Zone was described by many authors from the so called “beds with *Manticoceras intumescens*” (= Cephalopoden Schichten, = Intumescens Kalk) of the Kadzielnia section at Kielce (Gürich, 1896, 1901; Sobolew, 1912; Czarnocki, 1989). This assemblage includes: *Manticoceras intumescens* (Beyrich), *M. calculiforme* (Beyrich), *Beloceras multilobatum* (Beyrich) [= *B. sagittarium* (G. et F. Sandberger)]. Goniatites with *Manticoceras* also belong to the *linguiformis* Zone. They have been described from many sections in the Holy Cross Mountains (Płucki near Łagów – Makowski, 1962, 1971; Dzik, 2002, Woroncowa-Marcinowska, 2002, 2003b; Kowala – Racki & Baliński, 1998; Dzik, 2002; Wietrzna – Dzik, 2002) and the Cracow – Silesia area (Dół Łączany and Dół Żarnówczany sections – Gürich, 1903; Jarosz, 1926; Baliński, 1979; Narkiewicz & Racki, 1984).

The most recent papers on Frasnian goniatites from the Holy Cross Mountains are related to the revision of the fauna from the Płucki section in the Kellwasser horizon. The goniatite assemblage is there richer than earlier described. The assemblage includes (Woroncowa-Marcinowska, 2002, 2003b): *Manticoceras lamed* (G. et F. Sandberger), *M. drevermanni* Wedekind, *Crickites holzapfeli* (Wedekind), *Linguatornoceras* aff. *clausum* (Glenister) and *Phoenixites frechi* (Wedekind), belonging to the Upper Kellwasser horizon. The present author suggested also that *M. intumescens* (Beyrich) and *M. ammon* (Keyserling) are not a dimorphic pair, as was suggested by Makowski (1962). Dzik (2002) has distinguished two goniatite zones in the same section, corresponding to the Lower and Upper Kellwasser horizon, respectively. The lower assemblage includes: *M. intumescens* (Beyrich), *M. lamed* (G. et F. Sandberger), *Linguatornoceras* sp. and *Aulatornoceras* cf. *auris* (Quenstedt), and the upper: *A. varicosum*, *Manticoceras drevermanni*, *M. adorfense* (Wedekind), *Linguatornoceras* sp., *Aulatornoceras belgicum* (Matern) and *Crickites holzapfeli* (Wedekind). However, Dzik's opinion was based

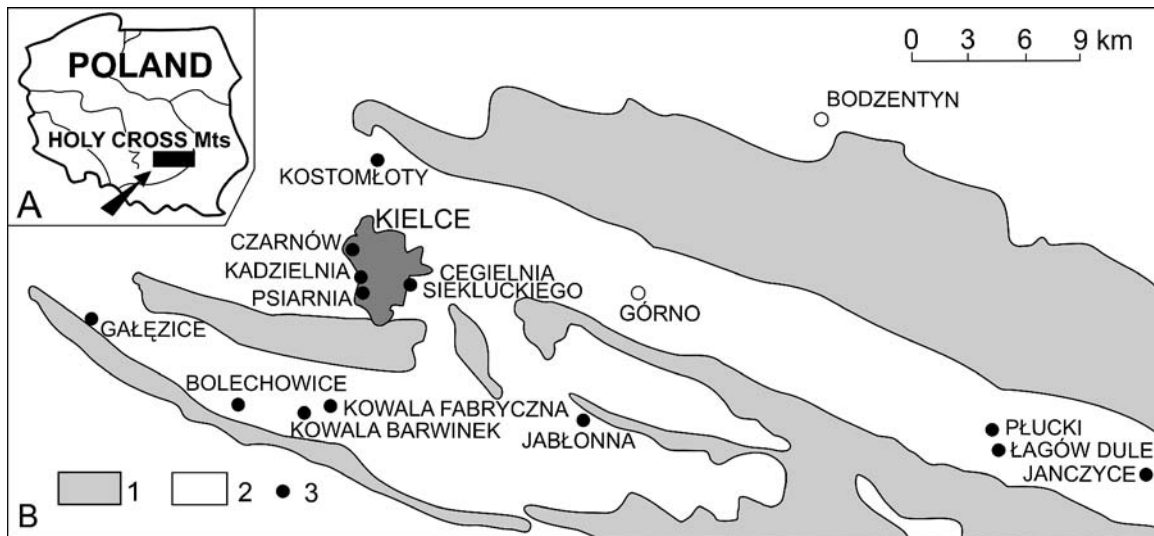


Fig. 1. A. General map of Poland with location of the Holy Cross Mountains. B. Occurrence of goniatites in the Holy Cross Mountains: 1 – lower Palaeozoic rocks, 2 – Devonian rocks, 3 – localities where goniatites were collected (after Czarnocki, 1989)

on observation in two different outcrops. In my opinion both the cephalopod limestone horizons at Płucki certainly represent only one horizon, which corresponds to the German Upper Kellwasserkalk horizon. It seems that the different position of these outcrops is caused by the fault.

The Famennian goniatites are more diversified taxonomically than the Frasnian forms belonging mainly to the genera from order Goniatitida. Their monographic study, initiated by Gürich (1896), who first described and illustrated new species in the Holy Cross Mountains, were continued by Sobolew (1911, 1912, 1914) and Dybczyński (1913). The D. Sobolew's works, based on specimens collected in the vicinities of Łągów and Kielce, involve 60 new species and subspecies of genera *Cheiloceras*, *Dimeroceras* and *Sporadoceras*. This material provided base for elaboration of a new systematics and a phylogeny (Sobolew, 1914), which, however, has never been accepted at the genus level as not complying to the rules of the International Code of Zoological Nomenclature, though most species have been commonly accepted. Dybczyński (1913) collected in Kielce (Sieklucki's brickyard), "a total of 452 specimens in 27 varieties and species, 12 genera and 3 families", among which he described and illustrated two new genera (*Protornoceras* and *Polonoceras*) and 15 new species. It should be stressed here that most species described by D. Sobolew and T. Dybczyński have been recognized in lower Famennian sections in other parts of Europe and North Africa.

Makowski (1962, 1991), in his papers on dimorphism presents descriptions of two new forms: *T. frechi parvum* Makowski and *T. subacutum* Makowski, besides the earlier known *Cheiloceras subpartitum* (Münster), "*Ch.*" *globosum* (Münster), *Tornoceras frechi* Wedekind, *T. sublentiforme* (Sobolew).

Famennian goniatites from the northern part of the Holy Cross Mountains are also mentioned by Kościelniakowska (1962, 1967), who lists species of genera *Cheiloceras* and *Tornoceras*. Goniatites of the Holy Cross Mountains were also mentioned and quoted in the papers by Samsonowicz

(1934), Pajchłowa (1962), Rózkowska (1969), Szulczewski (1971), Narkiewicz & Olkiewicz-Paprocka (1983), Żakowa *et al.* (1983) – the goniatites in the last paper mentioned were identified by H. Makowski and J. Dzik.

A marked part of the Famennian goniatite species listed in the papers mentioned above have been revised by foreign workers (Bogoslovsky, 1969, 1971; House, 1970; Becker, 1993). House (1970), basing on material from the H. Makowski's collection, distinguished a new genus *Tornia* with neotype *T. mirabile* (Dybczyński) which he considered as a precursor of clymenids. House (1970), after studying the collections of D. Sobolew and T. Dybczyński and his own collection from the area of Kielce (Sieklucki's brickyard), presented a suggestion on the age of this fauna, placing it within the *Sporadoceras pompeckji* – *Pseudoclymenia sandbergeri* zones.

#### DISTRIBUTION OF CONODONTS IN PARTICULAR SECTIONS AND STRATIGRAPHIC POSITION OF THE INVESTIGATED GONIATITES

The studied collections come from the Upper Devonian of the Holy Cross Mountains (Fig. 1): the eastern part – sections at Płucki, Łągów, Janczyce and the western part – sections at Gałęzice (Ostrówka and Besówka hills), Kowala and Kielce (Kadzielnia and Sieklucki's brickyard). The descriptions of the Famennian sections are based on Czarnocki (1989), and those of the Frasnian and Famennian sections near Łągów and Janczyce – on the papers by Wolska (1967) and Makowski (1971, 1991). Regional distribution of the Devonian facies in the Holy Cross Mountains is presented in Szulczewski (1995).

Conodonts have been isolated from both, the host rocks of the specimens hold in the studied collections and from samples collected in the outcrops. The obtained data, combined with the published data (Wolska, 1967; Szulczewski,

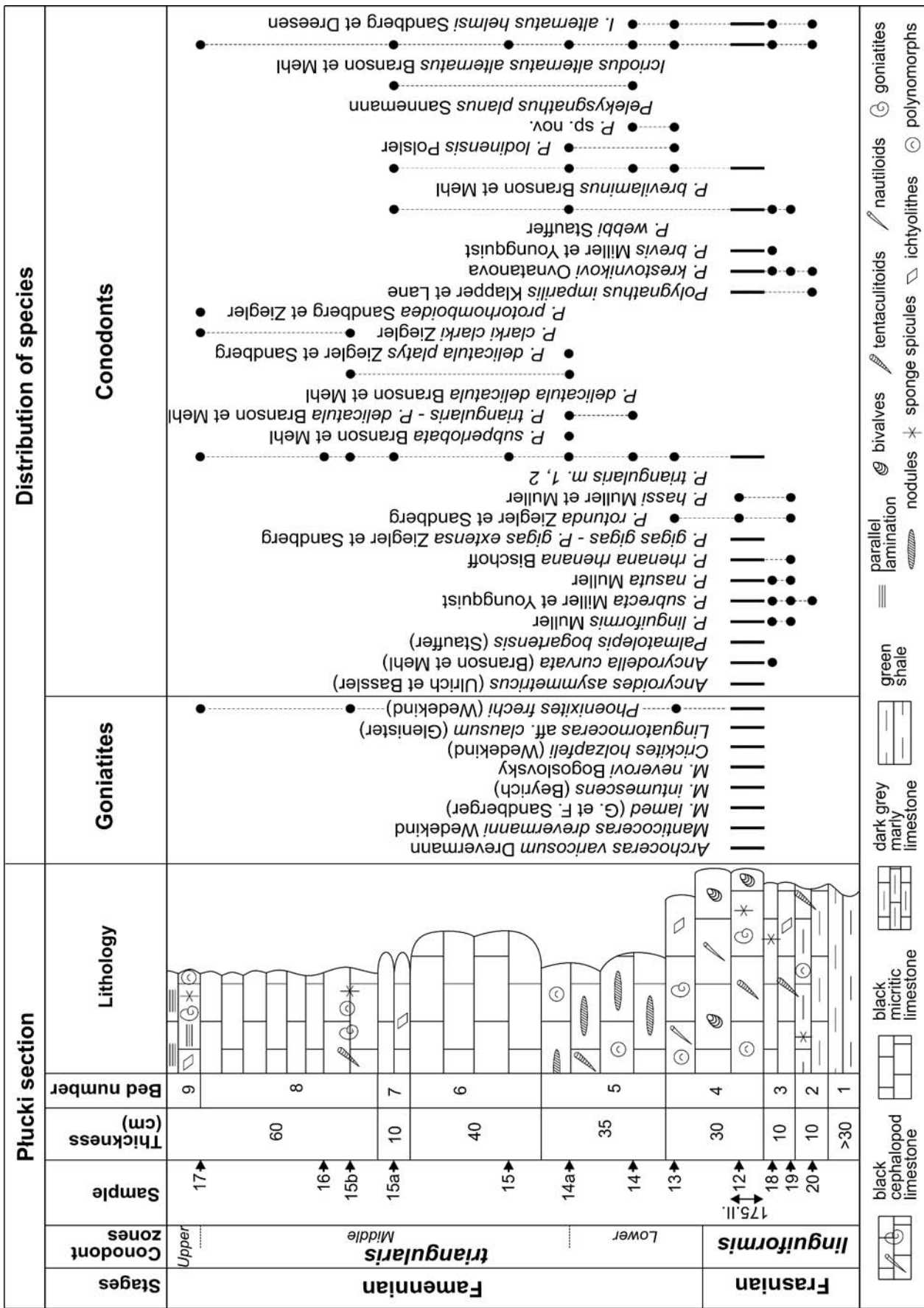


Fig. 2. Distribution of goniatites and conodonts across the Frasnian-Famennian boundary in the Plucki section

Table 1

Distribution of the Frasnian conodonts in samples from the Museum collection (175.II.); Plucki section (j – juvenile forms)

Conodont zones	<i>linguiformis</i>							
	175.II.42	175.II.46	175.II.48	175.II.49	175.II.50	175.II.51	175.II.52	175.II.125
<i>Palmatolepis bogartensis</i> (Stauffer)						5	1	
<i>P. gigas gigas</i> Miller et Youngquist		2			1			
<i>P. linguiformis</i> Müller						3		
<i>P. nasuta</i> Müller	1		6+5 j					
<i>P. rhenana rhenana</i> Bischoff	1	1						
<i>P. rotunda</i> Ziegler et Sandberg	1+1 j						4	
<i>P. subrecta</i> Miller et Youngquist	76+50 j	18		12+21 j	10+34 j	14+16 j	10+11 j	2
<i>P. triangularis</i> Sannemann morph. 1			1					
<i>Polygnathus brevilaminus</i> Branson et Mehl			12					
<i>P. imparilis</i> Klapper et Lane	2	1						
<i>P. krestovnikovi</i> Ovnatanova	42			18	17+20 j			
<i>Polygnathus</i> sp.	1							
<i>P. webbi</i> Stauffer	7	9		2	5			3
<i>Icriodus alternatus alternatus</i> Branson et Mehl	29	16	19	7	6	27	7	
<i>Icriodus alternatus helmsi</i> Sandberg et Dreesen	3		9		2	5	1	
<i>Ancyrodella curvata</i> (Branson et Mehl)					1	5+1 j	2	
<i>Ancyroides asymmetricus</i> (Ulrich et Bassler)	1	1						
" <i>Nothognathella</i> " sp.	2					3		

1971; Szulczewski *et al.*, 1996; Dzik, 2002; Racki *et al.*, 2002) provided base for precise location of the revised goniatites within the goniatite-bearing strata.

### Plucki section

The section is located at Plucki, at the junction of the Złota Woda and Łagowica streams. Frasnian strata exposed there are dark-grey bituminous limestones with goniatites (Fig. 2). My study of the conodont assemblage isolated from the goniatite specimens stored in the collections from this section (Fig. 2) allowed to distinguish the *linguiformis* Zone (Table 1, Figs 3, 4, 5A–H), which corresponds to the cephalopod Ið Zone of the Wedekind's (1913) scheme. The conodont assemblage from the rock samples in the collection and the assemblage from the exposure at Plucki (Tab. 2; Figs 2, 5I–L, 6) indicate that the revised goniatites (collection 175.II.) have been collected by Makowski from the lower part of layer 4 and possibly from layer 3 (Fig. 2). The most common among conodonts in this part of the section are: *Palmatolepis subrecta*, *P. bogartensis*, *P. rhenana*, *P. linguiformis*, *P. hassi*, *P. triangularis*, *Polygnathus krestovnikovi*, *P. webbi*, *P. brevilaminus*, *P. imparilis*, *Ancyrodella curvata*, *Ancyroides asymmetricus*, *Icriodus alternatus alternatus*, *I. alternatus helmsi*.

Goniatites from the mentioned layers belong mostly to families Gephuroceratidae and Tornoceratidae: *Manticoceras lamed* (G. et F. Sandberger) – in collection *M. ammon* (Keyserling), specimens 175.II.42, 43, 46; *M. drevermanni* Wedekind – in collection *M. acutilobatum* Bogoslovsky, specimens 175.II.38–40; *M. intumescens* (Beyrich), speci-

men 175.II.51; *Archoceras varicosum* Drevermann – in collection *Manticoceras bickense* (Wedekind), specimens 175.II.48–50; *Crickites neverovi* (Bogoslovsky) – in collection *Manticoceras neverovi* Bogoslovsky, specimen 175.II.52; *Cr. holzapheli* Wedekind – in collection *Manticoceras ammon* (Keyserling), specimens 175.II.33, 45, IG-PUW 003393; *Phoenixites frechi* (Wedekind) – in collection *Tornoceras simplex* (v. Buch) and new determined by myself *Linguatornoceras* aff. *clausum* (Glenister), specimen 175.II.42. The goniatite-bearing layer may be correlated with the cephalopod-tentaculite coquina in the section Janczyce 1 (Matyja & Narkiewicz, 1995), corresponding to the Upper Kellwasser horizon and *Crickites* Zone.

Residuum left after dissolution of most samples from these layers included tentaculites, spicules of siliceous sponges, fish scales, goniatite protoconchs and a large number of leiosferids (*Leiospheridia*) (Fig. 8I, K–R), these are especially numerous in samples 20 and 15b (Fig. 2). Similar leiosferids from this section were described by Filipiak (2002).

The conodont assemblages in the lower part of the section consist mostly of Frasnian species with rare (2 specimens) *Palmatolepis triangularis*. This taxon increases in frequency higher in the section (sample 13, Fig. 2), where specimens of genus *Icriodus* also become more numerous. The first Famennian conodonts *P. delicatula* and forms affine to *P. subperlobata* (Fig. 7A–I) have been found in sample 14 (Fig. 2) and they indicate the Famennian Lower *triangularis* Zone.

On the other hand, among palmatolepids in sample 13 predominate *P. triangularis* of both morphotypes and a

Table 2

Distribution of conodonts in samples from the Frasnian–Famennian section at Plucki (see Fig. 2)

Conodont zones	<i>linguiformis</i>				<i>triangularis</i>							
	20	19	18	12	13	14	14a	15	15a	15b	16	17
<i>Palmatolepis rotunda</i> Ziegler et Sandberg		3		1	1							
<i>P. hassi</i> Müller et Müller		3										
<i>P. subrecta</i> Miller et Youngquist	10+25 j	5+ 40 j	15+16 j	45+30 j						9+ 20 j		
<i>P. gigas extensa</i> Ziegler et Sandberg				2								
<i>P. nasuta</i> Müller		1	2									
<i>P. linguiformis</i> Müller		4										
<i>P. triangularis</i> Sannemann m.1					23 j	2+ 10 j	7	1+1j	1+2 j			1+2 j
<i>P. triangularis</i> Sannem. m.2					4	2	2				1	
<i>P. triangularis</i> <i>P. delicatula</i> Branson et Mehl						3	2 j					
<i>P. delicatula</i> Branson et Mehl										2		
<i>P. delicatula platys</i> Ziegler et Sandberg							1					
<i>P. subperlobata</i> Br. et Mehl							1					
<i>P. clarki</i> Ziegler										1		5
<i>P. protorhomboidea</i> Sandberg et Ziegler												5
" <i>Nothognatella</i> " (Pb-element)	2			1			1	2				
<i>Polygnathus brevis</i> Miller et Youngquist			1	3								
<i>P. webbi</i> Stauffer				16	2	3+3 j	2+3 j		2			
<i>P. krestovnikovi</i> Ovnatanova	4+2 j	4	5+2 j	25						7+2 j		
<i>P. lodinensis</i> Pölsler					3		2					
<i>P. brevilaminus</i> Branson et Mehl							3					
<i>Polygnathus</i> sp.					1	2						
<i>Icriodus alternatus alternatus</i> Branson et Mehl	2+10 j		12	10	12+18 j	3+14 j	8 j	4	1			1
<i>I. alternatus helmsi</i> Sandberg et Dreesen	1		8	11	3	4						
<i>Pelekysgnathus planus</i> Sannemann						1			5			
<i>Ancyrodella curvata</i> (Branson et Mehl)			1	5						1		

large number of icriodids. At the level of sample 14 appear the first Famennian forms – *P. delicatula* and forms affined to *P. subperlobata*, corresponding to the Lower *triangularis* Zone (Fig. 7A–I). Thus, the Frasnian–Famennian boundary lies within the bituminous limestones, between samples 12 and 13. It was similarly placed by Racki *et al.* (2002). The Middle *triangularis* Zone is marked by the appearance of *Palmatolepis delicatula platys* (Fig. 7J–R, 8A–G), and the Upper *triangularis* (Schülke, 1995) – by the appearance of *Palmatolepis protorhomboidea* (Fig. 8G, H). Conodont frequencies in the section (Tables 1 and 2) indicate that at the Frasnian–Famennian boundary suddenly decreases the number of representatives of genus *Palmatolepis* and increases the number of representatives of genus *Icriodus*. A similar succession of conodont assemblages has been found in the Sessaker section of the Rheinische Schiefergebirge (Schülke, 1998) as well as in Holy Cross Mountains (Dziki, 2002; Racki *et al.*, 2002).

#### Janczyce section

The section is located 0.5 km south of Janczyce (Fig. 1) in arable fields. Makowski (1991) exploited dark-grey

thin-bedded platy limestones with abundant cephalopods (Fig. 9). The limestones formed a lens 1.5 m thick among laminated marly limestones. Wolska (1967) identified from this lens a rich conodont assemblage indicative of the *crepida* Zone. This goniatite-bearing horizon from borehole Janczyce IG has been included to the Middle *crepida* Zone by Matyja and Narkiewicz (1995), on the base of the presence of numerous representatives of *Palmatolepis termini*.

Conodonts isolated from the host rocks of the studied goniatites (Table 3, Figs 10–12) are similar to the assemblage described earlier by Wolska (1967). The predominance of specimens of *Palmatolepis glabra glabra*, *P. glabra prima* and *P. minuta wolskae* indicates that they belong here to the Upper *crepida* Zone (cf., Szulczewski, 1971; Ziegler & Sandberg, 1990).

The goniatites from this section belong to families Tornoceratidae and Cheiloceratidae. Makowski in collection (175.II.) identified from this section *Cheiloceras subpartitum* (Münster), *Tornoceras acutum* Frech and *T. simplex* (V. Buch). Later, Makowski (1991) again elaborated Janczyce section and distinguished here *T. frechi* Wedekind, *T. sublentiforme* Sobolev and a new species *T. subacutum* among the mentioned above representatives of genus *Tor-*

Table 3

Distribution of conodonts in samples from the Famennian section at Janczyce

Conodont Zone	Upper <i>crepida</i>						
	175.II.77	175.II.80	175.II.91	175.II.100	175.II.105	175.II.107	175.II.88-Kadzielnia
<i>Palmatolepis minuta wolskae</i> Szulczewski	9+5 j	2+4 j		4	8	14	
<i>P. minuta minuta</i> Branson et Mehl	9+3 j	34	30	27	19	9+3 j	
<i>P. delicatula loba</i> Helms	5	26	12	13	3	3	2
<i>P. quadrantinodosalobata</i> Sannemann	10	20	8	35	32	8+6 j	
<i>P. tenuipunctata</i> Sannemann	8	3	18	66	21	16	
<i>P. termini</i> Sannemann	11	23	8	30	10	20	
<i>P. circularis</i> Szulczewski				17		8	
<i>P. perlobata perlobata</i> Ulrich et Bassler					2		
<i>P. crepida</i> Sannemann	10	13	2	2	2		
<i>P. subperlobata P. regularis</i> Cooper		3	1	1			
<i>P. regularis</i> Cooper	2	6	2	6	9	2	
<i>P. lobicornis</i> Schülke	1			2		2	
<i>P. glabra glabra</i> Ulrich et Bassler	1				1		1
<i>P. glabra prima</i> Ziegler et Huddle	8	7	21	38	30	5	
<i>P. tenuipunctata P. glabra prima</i>	6					9	
<i>Polygnathus pomeranicus</i> Matyja			8			2	
<i>P. subnormalis</i> Vorontzova et Kuzmin			4			1	
<i>P. nodocostatus</i> Branson et Mehl					4	1	
<i>P. glaber glaber</i> Ulrich et Bassler				5			
<i>Polylophodonta linguiformis</i> Branson et Mehl	1	3 j		2	2+1 j	1	
<i>Icriodus cornutus</i> Sannemann		1		4			

*noceras*. Actually, these species are *Oxytornoceras acutum* (Frech), *Phoenixites frechi* (Wedekind) and *Tornoceras sublentiforme* sensu Sobolew (1914) non Makowski (1991). The goniatite assemblage corresponds to the *Cheiloceras* (*Cheiloceras*) *subpartitum* (IIá) Zone.

### Łagów section

This section is located in the Niwy ravine at Łagów (Fig. 1). The section exposes folded, bedded Famennian limestones and shales (Fig. 13), described by Gürich (1896), Sobolew (1912, 1914), Wolska (1967) and Czarnocki (1989). The section is now hardly accessible because of dense buildings of the area at the lower end of the ravine. The authors mentioned above distinguished within the section the *Cheiloceras*, *Prolobites* and *Platyclymenia* genus zones (Table 4).

The conodont assemblage described by Wolska (1967) shows a stratigraphically mixed fauna. It may correspond to the zones *rhomboidea* – *quadrantinodosa* (*marginifera*). It has been impossible to determine from which part of the section come the conodonts.

The conodonts isolated from goniatite-bearing specimens in the studied collection (Table 5, Figs 14, 15) allowed to identify four conodont assemblages: the Upper *crepida/rhomboidea* Zone, Lower *marginifera* Zone, Lower/Upper *marginifera* Zone and *trachytera* Zone. The

Table 4

Lithology and stratigraphy of Famennian deposits at Łagów (Niwa ravine) after Czarnocki (1989)

Ammonoid zonation	Layer numbers	Layer descriptions
<i>Prolobites</i> and <i>Platyclymenia</i> genera zones	7, 8	Black shales and black argillaceous limestones, several metres thick, imprints of <i>Clymenia</i>
	6	Black argillaceous limestones, thick-bedded or nodular, 0.15–0.50 m thick, fauna of <i>Clymenia</i>
	5	Black shales, 0.15–0.20 m thick
	4	Black argillaceous limestones, locally bituminous, thick-bedded, 0.20–0.50 m thick, fauna of <i>Clymenia</i>
	3	Black shales, up to 0.15 m thick
<i>Cheiloceras</i> genus zone	2	Light-grey limestones, thick-bedded, locally massive, 1–1.50 m thick, goniatite fauna
	1	Grey argillaceous limestones, thin-bedded, with intercalations of dark-grey shales, goniatite fauna

Table 5

Distribution of conodonts in samples from the Famennian section at Łagów

Conodont zones	Upper <i>crepida/rhomboidea</i>			Lower <i>marginifera</i>			Lower/Upper <i>marginifera</i>		<i>trachytera</i>
	176.II.44	176.II.4	176.II.32	176.II.20	176.II.24	176.II.71	176.II.27	176.II.79	
<i>Palmatolepis glabra glabra</i> Ul. et Bassler			2		8		2		
<i>P. glabra prima</i> Ziegler et Huddle	3	1	6	3			5		
<i>P. glabra acuta</i> Helms			1		4	1	1		
<i>P. delicatula loba</i> Helms			2						
<i>P. minuta minuta</i> Branson et Mehl		2			16	6	9	1	2
<i>Polygnathus glaber glaber</i> Ul. et Bassler	2				4				
<i>P. nodocostatus</i> Branson et Mehl			1						
<i>Icriodus cornutus</i> Sannemann			2						2
<i>Palmatolepis rhomboidea</i> Sannemann					2				
<i>P. glabra lepta</i> Ziegler et Huddle				3	34	11	8	10	109
<i>P. glabra pectinata</i> Ziegler				1		3			
<i>P. stoppeli</i> Sandberg et Ziegler				1	1				
<i>P. inflexoidea</i> Ziegler					1	2			
<i>P. marginifera marginifera</i> Helms					3		2		
<i>P. perlobata sigmoidea</i> Ziegler						2			1
<i>Polygnathus glaber medius</i> Helms et Wolska					7	1			
<i>P. fallax</i> Helms et Wolska						1			
<i>P. triphyllatus</i> (Ziegler)					2				
<i>Palmatolepis perlobata helmsi</i> Ziegler									2
<i>P. rugosa trachytera</i> Ziegler									3
<i>P. schleizia</i> Helms									3
<i>Polygnathus lauriformis</i> Dreesen et Duser									2
<i>P. planirostratus</i> Dreesen et Duser									4
<i>P. granulatus</i> Branson et Mehl									2
<i>P. glaber bilobatus</i> Ziegler									2
<i>Scaphignathus velifer leptus</i> Ziegler et Sandberg									1
<i>Brammehla bohlenana</i> (Helms)									10

last zone – *trachytera* – has been not earlier found in this exposure.

Among the goniatite fauna, specimen 175.II.32, determined in the collection as *Cheiloceras verneuli* (Münster), corresponds to the Upper *crepida* Zone. Specimen 176.II.4, identified as *Cheiloceras curvispina* (Sandberger), corresponds to the Upper *crepida/rhomboidea* Zone. Both species belong to the cephalopod *Paratorleoceras globosum* (II $\alpha$ ) Zone and probably come from layer 1 of the section (Fig. 13) described by Czarnocki in 1936 (Czarnocki, 1989).

*Paratornoceras polonicum* (Gürich) [in collection *Cheiloceras lagowiense* Gürich (specimen 176.II.20) and *Ch. lentiforme* Gürich (specimen 176.II.24)], *Dimeroceras globosum* (Sobolew) [in collection *Ch. globosum* (Münster), specimens 176.II.8a, b, 11a] and *Praemeroceras globosoides* (Sobolew) [in collection *Ch. globosum* (Münster), specimens 176.II.9–11b, 12–16 and *Ch. verneuli* (Münster), specimen 176.II.40] correspond to the conodont zone Lower *marginifera* (Table 5) and the upper part of the cephalopod zone II $\alpha$  (*Paratornoceras acutum*). These

goniatites may come from the upper part of layer 1 or from the lower part of layer 2 (Fig. 13). The presence of the Lower *marginifera* Zone is indicated by the characteristic species *Palmatolepis stoppeli* Sandberg et Ziegler and *P. inflexoidea* Ziegler (Table 5, Fig. 14F, G, O). This zone may be correlated with the upper part of the laminated marly limestone unit in borehole Janczyce IG 1 (depth 89.5 m; Matyja & Narkiewicz, 1995).

The conodonts occurring with the goniatites *Cheiloceras subpartitum* (Münster) and *Sporadoceras* sp. (176.II.27 and 79) belong to the upper part of the *marginifera* Zone. The goniatite specimens mentioned above come most likely from the upper part of layer 2 in this section (Fig. 13), which belongs probably to the *Cheiloceras* genus zone (II $\beta$ ), as is shown by the presence of *Sporadoceras*. The appearance of genus *Sporadoceras* is correlated with the boundary of the Lower and Upper *marginifera* Zones (Becker, 1993).

Another specimen in this collection, *Sporadoceras varicatum* Wedekind (176.II.56), described in Germany in III $\beta$  Zone, corresponds to the goniatite zone *Prolobites*



Table 6

Lithology and stratigraphy of Famennian deposits at Ostrówka, after Czarnocki (1989)

Ammonoid zonation	Layer number	Layer description
<i>Clymenia</i> and <i>Woclumeria</i> genera zones	10-11	Limestones, in colour and lithology similar as below, locally reddish. A bed varying in thickness – 0.10–0.20 m. Top of the layer bulbous, <i>Clymenia</i> present in the bulbs, moreover numerous trilobites of genus <i>Phacops</i> Emmrich
	9	Grey-green limestones, with bluish spots, firmly cemented, divided in two beds 0.20 m each, in the lower part joined, with <i>Kosmoclymenia</i> and <i>Clymenia</i>
	8	Grey, grey-green marly limestones, compact, densely fractured, split in 2-3 layers up to 0.15 m thick, locally joined in one; fauna includes large <i>Clymenia</i> of genus <i>Clymenia</i>
<i>Platyclymenia</i> genus Zone	6-7	Grey-green limestones, forming irregular layers in structureless green-grey, marly crinoid mass: the limestone beds are 0.40–0.50 m thick. Fauna is accumulated in calcareous nodulus: <i>Platyclymenia</i> Hyatt, <i>Cymaclymenia striata</i> (Münster), <i>Sporadoceras muensteri</i> (Buch)
	5	Grey-black limestones, forming flat lenses in loose marly crinoid mass. Fauna in the limestone lenses is represented, similarly as in layer 4, by platyclymenids and <i>Genuclymenia polonica</i> sp. n.
	4	Black bituminous limestones, divided in three layers, of total thickness 0.20 m, including rich fauna, with particularly numerous <i>Platyclymenia</i> with index form <i>Platyclymenia annulata</i> (Münster) and <i>P. inflata</i> sp. n., <i>P. glabra</i> sp. n., <i>P. laticostata</i> sp. n., <i>P. quadrata</i> sp. n., <i>P. limata</i> sp. n., <i>P. unisulcata</i> sp. n., <i>P. walcotti</i> Wedekind and <i>P. biptycha</i> Lange
<i>Prolobites</i> genus Zone	3	Dark-grey limestones, slightly marly, wedging out, with rich fauna in swells of layers. Abundant <i>Sporadoceras</i> , <i>Prolobites</i> and <i>Clymenia</i>
	2	Compact reddish, crinoid limestones, 0.20–0.30 m thick, divided in 2-3 beds. One bed is full of cephalopods: <i>Sporadoceras</i> , <i>Prolobites delphinus</i> (Sandberger). <i>Gyroclymenia</i> are characteristic for this zone, beginning with the lowest beds ( <i>Gyroclymenia angulata</i> sp. n. in grey and red limestones). From grey limestones come <i>Gyroclymenia cyclocostata</i> sp. n. and <i>Rectoclymenia intermedia</i> sp. n.
	1	Grey compact limestones, 0.10–0.15 m thick, adjacent to and filling relief of upper Givetian <i>Amphipora</i> limestone, in full angular conformity with it. Fauna in this bed is poor: <i>Tornoceras</i> sp., <i>T. sandbergeri</i> (Gümbel), <i>Leiorhynchus kielcensis</i> Sobolew, <i>Gyroclymenia cyclocostata</i> sp. n.

*delphinus*, and in the conodont biostratigraphy to the Upper *trachytera* Zone (Becker, 1993). *Prolobites delphinus* (Sandberger) was described from layer 4 of the Czarnocki's section (Fig. 13, Table 4), which may be correlated with the basal part of the black shale and limestone unit from borehole Janczyce 1 (Matyja & Narkiewicz, 1995).

### Kadzielnia section

The section is located in the SE part of Kielce and was studied by Gürich (1896), Sobolew (1912), Wolska (1967), Szulczewski (1971) and Czarnocki (1989). The results of conodont studies by Wolska and Szulczewski show that deposition of the limestones with *Cheiloceras* began in the middle or younger part of the *crepida* Chronozone. Makowski (in: Szulczewski, 1971) identified from these limestones *Tornoceras acutum* Frech, noting that this is the oldest species of *Cheiloceras* genus zone (II $\alpha$ ) in this section.

The revised goniatite fauna includes *Tornoceras acutum* Frech (specimen 175.II.88), identified in this paper as *Oxytornoceras acutum*. The conodont assemblage shows that this specimen belongs to the Upper *crepida* Zone (Table 3) and possibly comes from layer 2, within the thin-bedded marly limestones described by Czarnocki (1989). Specimens 175.II.6,7, identified as *Cheiloceras (Staffites) curvispina curvispina* (G. et F. Sandberger) probably come from the same horizon. Both goniatite species represent the *Cheiloceras (Cheiloceras) subpartitum* Zone.

Table 7

Distribution of the Famennian conodonts in sample 284.II.323 from Ostrówka

Conodont Zone	Middle <i>expansa</i>
<i>Palmatolepis gracilis gracilis</i> Branson et Mehl	6
<i>P. gracilis sigmoidalis</i> Ziegler	14
<i>P. gracilis expansa</i> Sandberg et Ziegler	5
<i>P. rugosa ampla</i> Müller	2
<i>P. rugosa rugosa</i> Branson et Mehl	1
<i>P. perlobata schindewolfi</i> Müller	1
<i>P. perlobata helmsi</i> Ziegler	1
<i>Polygnathus parapetus</i> Druce	1
<i>P. znepolensis</i> Spasov	4
<i>P. experplexus</i> Sandberg et Ziegler	8
<i>P. exstralobatus</i> Schäfer	2
<i>P. hassi</i> Helms	1
<i>Pseudopolygnathus</i> aff. <i>micropunctatus</i> Bischoff et Ziegler	1
<i>P. brevipennatus</i> Ziegler	2
<i>Bispathodus costatus sulciferus</i> (Branson et Mehl)	14
<i>B. stabilis</i> (Branson et Mehl)	8
<i>Branmehla suprema</i> (Ziegler)	2
<i>B. fissilis</i> (Branson et Mehl)	5
<i>Mehlina crassidentata</i> (Branson et Mehl)	1

Table 8

Distribution of studied goniatites in the Frasnian and Famennian sections in the Holy Cross Mountains

Section	Plucki		Jan- czyce	Kadziel- nia	Sieklucki brickyard Kowala	Łagów				Ostrówka		
	<i>lingui- formis</i>	<i>triangu- laris</i>	Upper <i>crepida</i>	Upper <i>crepida</i>	Upper <i>marginifera- trachyt.</i>	Upper <i>crepida</i> <i>/rhom- boidea</i>	Lower <i>marginifera</i>	Lower/ Upper <i>marginifera</i>	<i>trachy- tera</i>	<i>trachy- tera</i>	<i>expansa</i>	
											Lower	Middle
<i>Archoceras varicosum</i> (Drevermann)												
<i>Manticoceras drevermanni</i> Wedekind												
<i>M. lamed</i> (G. et F. Sandberger)												
<i>M. intumescens</i> (Beyrich)												
<i>Crickites neverovi</i> (Bogoslovsky)												
<i>Crickites holzapfeli</i> Wedekind												
<i>Linguatornoceras aff. clausum</i> (Glenister)												
<i>Tornoceras sublentiforme</i> (Sobolew)												
<i>Oxytornoceras acutum</i> (Frech)												
<i>Phoenixites frechi</i> (Wedekind)												
<i>Falcitornoceras bilobatum</i> (Wedekind)												
<i>Tornia mirabile</i> (Dybczyński)												
<i>Posttornoceras contiguum</i> (Sobolew)												
<i>Cheiloceras (Ch.) s. subpartitum</i> (Münster)												
<i>Ch. (Ch.) longilobum</i> (Sobolew)												
<i>Ch. (Staffites) curvispina</i> (G. et F. Sandberger)												
<i>Ch. (Raymondiceras) verneuili</i> (Münster)												
<i>Dimeroceras globosum</i> Sobolew												
<i>Paratornoceras polonicum</i> (Gürich)												
<i>Praemeroceras globosoides</i> (Sobolew)												
<i>Prolobites</i> sp.												
<i>Sporadoceras muensteri</i> (v. Buch)												
<i>Sporadoceras posthumum</i> Wedekind												
<i>Sporadoceras varicatum</i> Wedekind												
<i>Praeglyphioceras kielcense</i> (Sobolew)												
<i>Prionoceras sulcatum</i> (Münster)												
<i>Prionoceras divisum</i> (Münster)												

### Ostrówka and Besówka sections near Gałęzice

Devonian and Carboniferous deposits, monoclinally dipping to the north, are exposed in the vicinities of Gałęzice. Famennian bioclastic limestones (more than 2 m thick) are here in contact with Frasnian amphipore limestones. Czarnocki (1928, 1948) has distinguished cephalopod genus zones from *Prolobites* (III) to *Wocklumeria* (VI) in the Famennian deposits. The richest collection of clymeniids from the Holy Cross Mountains, studied by Czarnocki (1989), comes from the Ostrówka Hill. Goniatites from the Ostrówka section were identified by H. Makowski (in: Rózkowska, 1969), and they include: *Sporadoceras varicatum* Wedekind and *S. humile* Lange. They belong to the conodont zones *velifer* and *costatus* (Wolska in: Rózkowska, 1969). The conodont microfauna studied in this section (Wolska, 1967; Szulczewski, 1971, 1978) indicates the presence of all zones of the upper Famennian, beginning with the *quadrantinodosa* Zone through the *costatus* Zone. Recently, Szulczewski *et al.* (1996), during a complex study of this area found that the section at the Ostrówka Hill (200 m east of Todowa Grząba) is not continuous. Its lower part belongs to the upper part of the *marginifera*

*Zone*, while the *postera* and Middle and Upper *prae-sulcata* Zones are missing.

It may be thus suggested, taking into account the results of studies by the mentioned authors and my own results, that layers 1–3 in the Czarnocki's section (1989; see Fig. 16, Table 6 in this paper) belong to the Upper *marginifera* – *trachytera* conodont Zones. According to Czarnocki, these layers belong to the *Prolobites* genus Zone, and especially numerous *Sporadoceras* and *Prolobites delphinus* (Sandberger) occur in layers 2 and 3.

The goniatite specimens from the revised collection – *Prolobites* sp. (specimen 284.II.85, 87), *Praeglyphioceras kielcense* (Sobolew) – in collection *P. pseudosphaericum* Frech (specimen 284.II.732), *Sporadoceras varicatum* Wedekind (specimens 284.II.69, 70) indicate the conodont zone *trachytera* and may come from layers 2 and 3 belonging to the *Prolobites delphinus* Zone.

Other goniatites from collection 284.II, determined as *Falcitornoceras bilobatum* (Wedekind) [in collection *Tornoceras bilobatum*, specimen 284.II.288], *Sporadoceras muensteri* (V. Buch) (specimen 284.II.275), *Prionoceras sulcatum* (Münster) (specimen 284.II.296) and *P. divisum* (Münster) (specimen 284.II.295), according to Czarnocki

Table 9

Stratigraphic position of the studied goniatic species in the conodont and cephalopod zonations (cf. Weddige, 1996)

Stage	Standard Conodont Zonation. Ziegler, in: Weddige (1996)	Standard Ammonoid Zonation. Becker, in: Weddige (1996)	Stratigraphic position of studied goniatic species (from PGI Geological Museum, Warsaw)	
F A M E N N I A N	<i>expansa</i> Upper Middle Lower	<i>Sphenoclymenia brevispina</i> <i>Ornatoclymenia ornata</i> <i>Kalloclymenia subarmata</i> <i>Clymenia laevigata</i> <i>Franconicyclomenia serpentina</i>	<i>Sporadoceras posthumum</i> <i>Falcitornoceras bilobatum</i>	
	<i>postera</i> Upper Lower	<i>Prot. (Protoxyclymenia) dunkeri</i> <i>P. (Platyclymenia) annulata</i> <i>Prolobites delphinus</i>	<i>Sporadoceras muensteri</i>	
	<i>trachytera</i> Upper Lower	<i>Pseudoclymenia pseudogoniatites</i> <i>Pernoceras „dorsatum”</i> <i>Dimeroceras mamilliferum</i> <i>Posttornoceras contiguum</i> <i>Maenoceras biferum</i> <i>Paratornoceras acutum</i> <i>Praemeroceras petterae</i>	<i>Sporadoceras varicatum</i>	
	<i>marginifera</i> Uppermost Upper Lower		<i>Dimeroceras globosum</i> <i>Posttornoceras contiguum</i> <i>Paratornoceras polonicum</i> <i>Praemeroceras globosoides</i>	
	<i>rhomboidea</i> Upper Lower	<i>Paratorleyoceras globosum</i>	<i>Paratorleyoceras globosum - Cheiloceras (Staffites) curvispina</i> <i>Ch. (Cheiloceras) subpartitum</i>	
	<i>crepida</i> Uppermost Upper Middle Lower	<i>Ch. (Cheiloceras) subpartitum</i> <i>Cheiloceras (Raymondiceras) verneuli</i>		
	<i>triangularis</i> Upper Middle Lower	<i>Phoenixites frechi</i>	<i>Phoenixites frechi</i>	
	FRAS-NIAN	<i>linguiformis</i>	<i>Crickites holzapfeli</i>	<i>Crickites holzapfeli</i>
		<i>rhenana</i>		

come from the “Lower *Lewigites* Beds” (V $\alpha$ ), probably layer 8 (Fig. 16), in which already genus *Clymenia* appears. This goniatic assemblage and the conodont assemblage in the Gałęzice area (Szulczewski *et al.*, 1996) indicate the Lower *expansa* conodont Zone.

*Sporadoceras posthumum* Wedekind [in collection *Sporadoceras contignum* var. *postuma* Wedekind, specimen 284.II. 323] comes from the “*Gonioclymenia* Beds”. The rich conodont assemblage isolated from the sample of this specimen’s host rock (*Palmatolepis gracilis expansa*, *P. gracilis sigmoidalis*, *P. perlobata helmsi*, *Polygnathus znepolenzsis*, *P. exsralobatus* among others) indicates that the “*Gonioclymenia* Beds” belong to the Middle *expansa* Zone (Table 7, Figs 17–19). Most conodont species in this assemblage have wider stratigraphical ranges, but *Polygnathus experplexus* Sandberg et Ziegler and *Palmatolepis perlobata helmsi* Ziegler are not known from sediments younger than the Middle *expansa* Zone (Ziegler, 1962; Sandberg & Ziegler, 1979; Perri & Spalletta, 1991). This conodont assemblage corresponds to the upper part of the *Clymenia* genus Zone (V $\beta$ ) of the cephalopod zonation.

An integral part of this chapter is Table 8 showing stra-

tigraphical ranges of the identified goniatic species in the studied sections as referred to the conodont zonation.

#### POSITION OF THE REVISED GONIATIC FAUNA IN THE STANDARD CEPHALOPOD AND CONODONT ZONATIONS

The revision of the goniatic fauna and the study of accompanying conodonts allowed to recognize faunal assemblages within the Frasnian and Famennian deposits of the Holy Cross Mountains and established their position (Table 9) in standard ammonoid/conodont zonations (Becker in: Weddige, 1996).

##### Frasnian zones

The youngest Frasnian goniatic zone – *Crickites holzapfeli* (Becker in: Weddige, 1996) – was found in the Płucki section near Łagów. It corresponds to the conodont zone *linguiformis* (Becker *et al.*, 1993; Becker & House,

1994). The most common goniatite species in this part of the section is *Archoceras varicosum* (Drevermann), which is rare in the revised collections. The goniatite assemblage in the studied collections includes: *Manticoceras drevermanni*, *M. lamed*, *Crickites neverovi*, *C. holzapfeli*, *Lingua-tornoceras* aff. *clausum*, *Phoenixites frechi* and *Manticoceras intumescens*.

#### amennian zones

The oldest Famennian goniatite zone in the Płucki section is represented by the index species *Phoenixites frechi*. This zone corresponds to the *triangularis* conodont Zone (Table 8; cf. Becker, 1993).

No goniatites representing the next younger zone, *Cheiloceras* (*Raymondiceras*) *verneuli*, are present in the PGI collection.

The *Cheiloceras* (*Cheiloceras*) *subpartitum* Zone is represented in the studied collection by *Tornoceras sublentiforme*, *Oxytornoceras acutum*, *Phoenixites frechi* and the index species. These goniatites come from the limestone lens in the Janczyce section. The mentioned goniatite zone corresponds to the Upper *crepida* conodont Zone (cf. Becker, 1993).

The *Paratorleyoceras globosum* Zone, correlated with the conodont zones from the Upper *crepida* through the Lower *rhomboidea* (cf. Becker, 1993), was distinguished in the Kadzielnia and Łągów-Dule sections. Among the goniatites from the revised collections, the occurrence of *Cheiloceras* (*Raymondiceras*) *verneuli*, *Ch. (Staffites) curvispina* and *Paratorleyoceras globosum* (determined by Sobolew (1914, pl. 8, figs 6, 7) in the Łągów section as *Oma-monomeroceras* (*Cheiloceras*) *umbilicatum* (Sandberg), may be correlated with the vicinity of the boundary between the *crepida* and *rhomboidea* Zones.

The standard goniatite *Praemeroceras peterae* Zone is marked by the appearance of representatives of genus *Praemeroceras* and correlated with the conodont Upper *rhomboidea* Zone (Becker in: Weddige, 1996). It is represented by specimens from Łągów in the studied material, that is *Pr. globosoides* and *Cheiloceras* (*Staffites*) *curvispina*.

The successive younger standard goniatite zones, *Paratorleyoceras acutum* – *Posttornoceras contiguum* correspond in the conodont zonation to the Lower and Upper *marginifera* Zones. The museum collection studied includes specimens of practically all the index species of the standard cephalopod zones mentioned above, but the order of their first occurrences could not be established. The assemblage in the studied collections includes *Paratorleyoceras polonicum*, *Dimeroceras globosum*, *Praemeroceras globosoides* and *Posttornoceras contiguum* (Table 9).

The *Prolobites delphinus* Zone, correlated with the Upper *trachytera* conodont Zone, is present in the Łągów and Ostrówka sections at Gałęzice. This zone is represented by *Prolobites* sp., *Praeglyphioceras kielcense* and *Sporadoceras varicatum*.

The standard cephalopod zones above the *Prolobites delphinus* Zone are based on the species of order Clymeniida. The studied material from the Ostrówka section includes two assemblages. The older one includes *Falcitor-*

*noceras bilobatum* and *Sporadoceras muensteri*, and the younger – specimens of *Prionoceras* – *P. divisum*, *P. sulcatum* collected in the “Lower *Lewigites* Beds” and *Sporadoceras posthumum* from the “*Gonioclymenia* Beds”. Both cephalopod assemblages may be correlated with the Lower and Middle *expansa* conodont Zones and the lower (V $\alpha$ ) and upper (V $\beta$ ) parts of *Clymenia* genus zones.

#### SYSTEMATIC PALAEOLOGY

The terms used in the systematic part come mostly from the *Treatise on Invertebrate Paleontology* (Miller *et al.*, 1957). This concerns mainly the conventional orientation of shells accepted in the descriptions (Fig. 20A). The shell side with hyponomic sinus is the ventral or outer side and the opposite side is the dorsal (inner) side. The more detailed terminology, e.g. that concerning the suture or growth lines is present, besides the *Treatise*, in Kullmann and Wiedmann (1970), Becker (1993), in the J. Kullmann’s computer program “Goniat, v. 2.90” (Kullmann *et al.*, 2000) and in Korn *et al.* (2003), which includes the most recent terminology.

The terms describing the individual parts and dimensions of shells are shown in Fig. 20B, C. The linear dimensions of shell parameters in the species descriptions are shown in millimetres. Proportions of shell parameters (whorl height and whorl width among others) to its diameter, besides the importance for species comparison, indicate also the variable nature of anatomy of various parts of the shell, while the ratio of the umbilical width to the shell diameter demonstrates degree of involution. Dimensions in tables, for larger numbers of specimens, take into account up to four specimens of the given species.

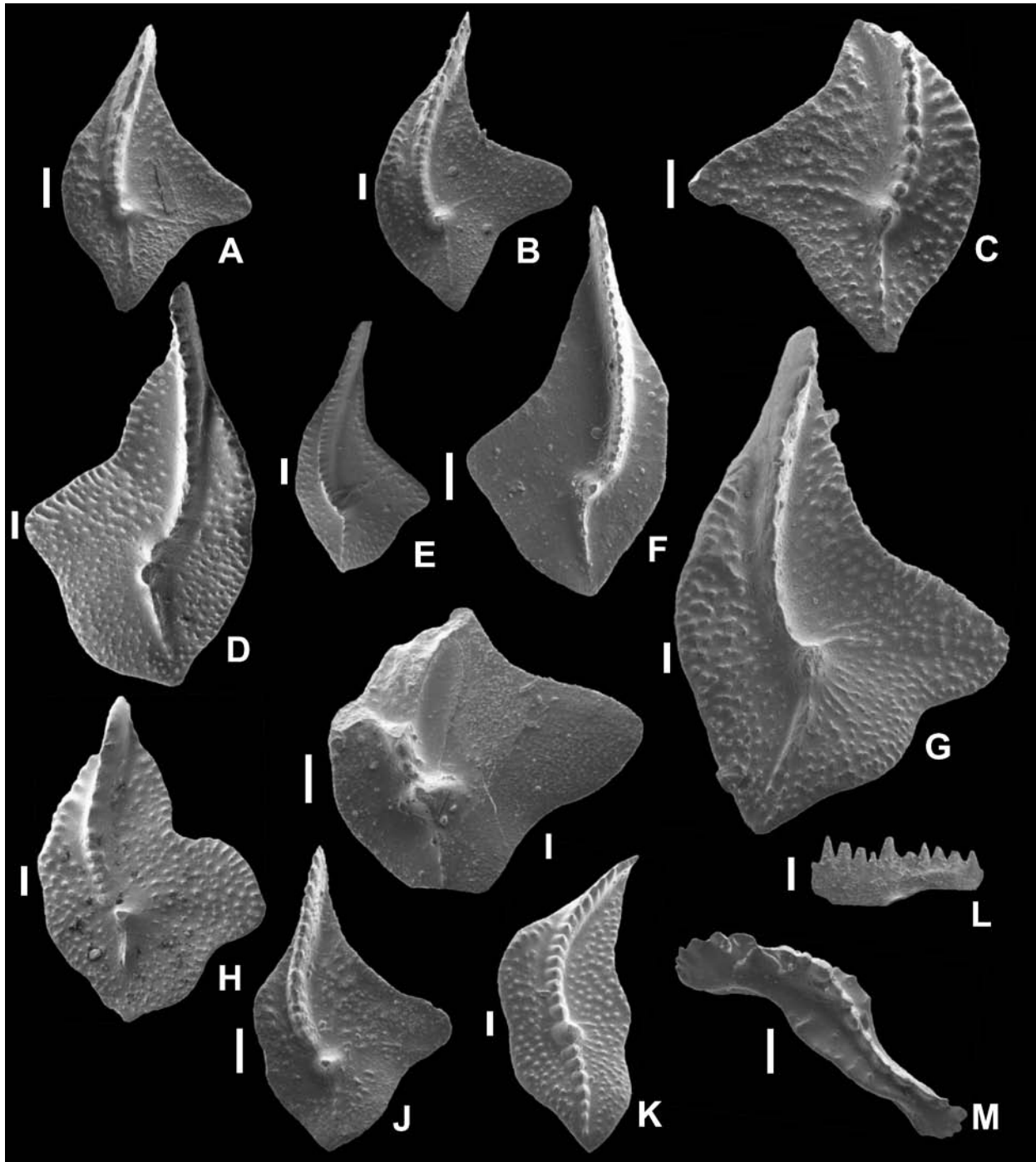
The goniatite descriptions are arranged according to the following pattern: (1) general form of shell, its maximum dimensions, (2) form of whorl cross-section, in various growth stages, as far as possible, (3) nature of umbilicus, (4) shell ornamentation; for most specimens form and density of growth lines and nature of constrictions, (5) structure of suture line from the centre of the ventral side through the whorl side to the umbilical part.

The descriptions of umbilici use the terminology of Kemper (1961), who distinguished ten types of umbilici in Lower Cretaceous Platylenticeras, taking into account their shape and inclination of umbilicus walls relative to the plane of symmetry, e.g., a high, low, flat, concave and steep umbilicus.

The uniqueness of the collection, and in some cases low representativeness (single specimen of a species), did not allow to destroy specimens for examination of the hidden part of the suture line. The suture line is an important indicator of phylogeny and ontogeny in ammonites. The lobe names, used in the descriptions, from the ventral to the dorsal one, are given below:

– ventral (outer) lobe – is present in bactrids and almost all ammonites; it is situated near the siphon, on the outer side of whorl, between the two outer saddles;

– lateral lobe – is located on the lateral side of shell; in cases when only ventral and lateral lobes are present, the



**Fig. 3.** Upper Frasnian conodonts from the Płucki section, *linguiformis* Zone. **A–C.** *Palmatolepis triangularis* Sannemann morphotype 1, sample 175.II.48; **D–G.** *Palmatolepis subrecta* Müller et Joungquist, D–F – sample 175.II.52, G – 175.II.42; **H.** *Palmatolepis bogartensis* (Stauffer), sample 175.II.52; **I, J.** *Palmatolepis rotunda* Ziegler et Sandberg, sample 175.II.48; **K.** *Palmatolepis linguiformis* Müller, sample 175.II.51; **L.** *Mehlina gradata* Youngquist, sample 175.II.48; **M.** “*Nothognathella*” sp. (oz element), sample 175.II.42. A–K, M – upper views, L – lateral view. Length of scale bars – 100  $\mu$ m

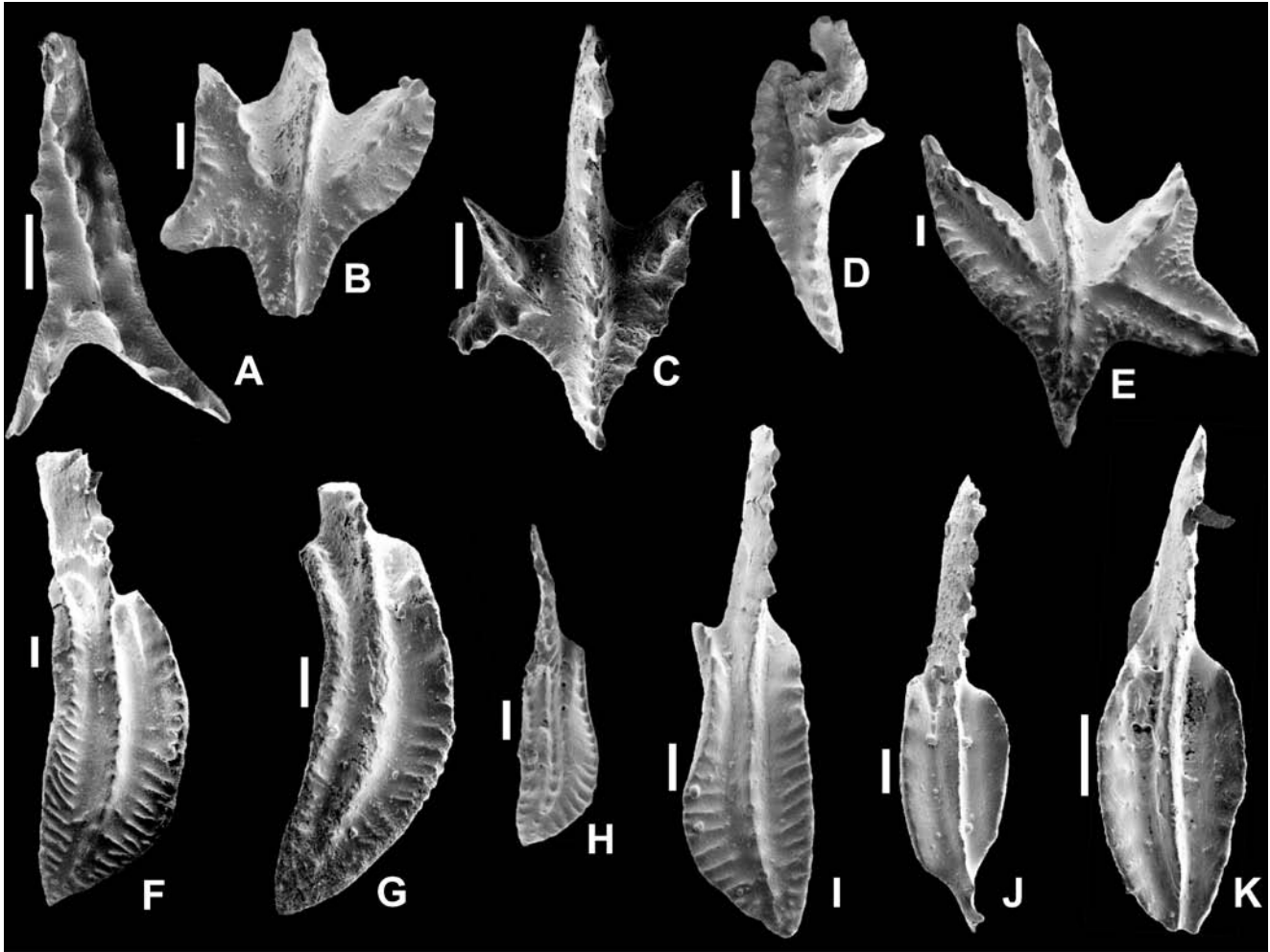
latter is wide and occupies the area between the ventral and dorsal lobes;

– umbilical lobe begins at the saddle, in the area between the dorsal and lateral lobes; it is present near umbilicus on the inner and outer side of shell.

Adventitious lobe has developed in some genera, between the ventral and lateral lobes. It is referred in this paper as the first lateral lobe. The development of this lobe, in

case of underdeveloped umbilical lobe, caused shifting of the lateral lobe to the umbilical position.

The structure of the suture line is shown for each genus, as drawn from observations under optical binocular microscope equipped with a drawing projector magnifying up to 3.8 times. The so drawn suture lines of large specimens were reduced in size and then shown against the whorl height in this part of the shell where the line is present. For



**Fig. 4.** Upper Frasnian conodonts from the Płucki section, *linguiformis* Zone, upper views. **A.** *Ancyroides asymmetricus* (Ulrich et Basler), sample 175.II.42; **B, C, E.** *Ancyrodella curvata* (Branson et Mehl), B – sample 175.II.42, C, E – 175.II.52; **D.** *Ancyroides?* sp., sample 175.II.42; **F, G.** *Polygnathus imparilis* Klapper et Lane, F – sample 175.II.42, G – 175.II.52; **H.** *Polygnathus webbi* Stauffer, sample 175. II.52; **I.** *Polygnathus krestovnikovi* Ovnatanova, sample 175.II.42; **J, K.** *Polygnathus brevilaminus* Branson et Mehl, sample 175.II.48. Length of scale bars – 100  $\mu$ m

some specimens, the suture lines are shown at various growth stages, when available. In specimens of genus *Archoceras*, because of the growth of calcite crystals inside the whorls, only the last suture line before the living chamber is preserved, and even this in very few cases. The same method was used to draw the growth lines.

Most specimens were coated with ammonium chloride before photographing. In those cases where this was not necessary, for instance where growth lines were losing visibility, the photographs were taken without coating and this fact is noted in figure captions.

Following abbreviations were used in the descriptions of goniatites: dm – shell diameter; ww – whorl width; wh – whorl height; ah – aperture height; uw – umbilicus width (Fig. 20).

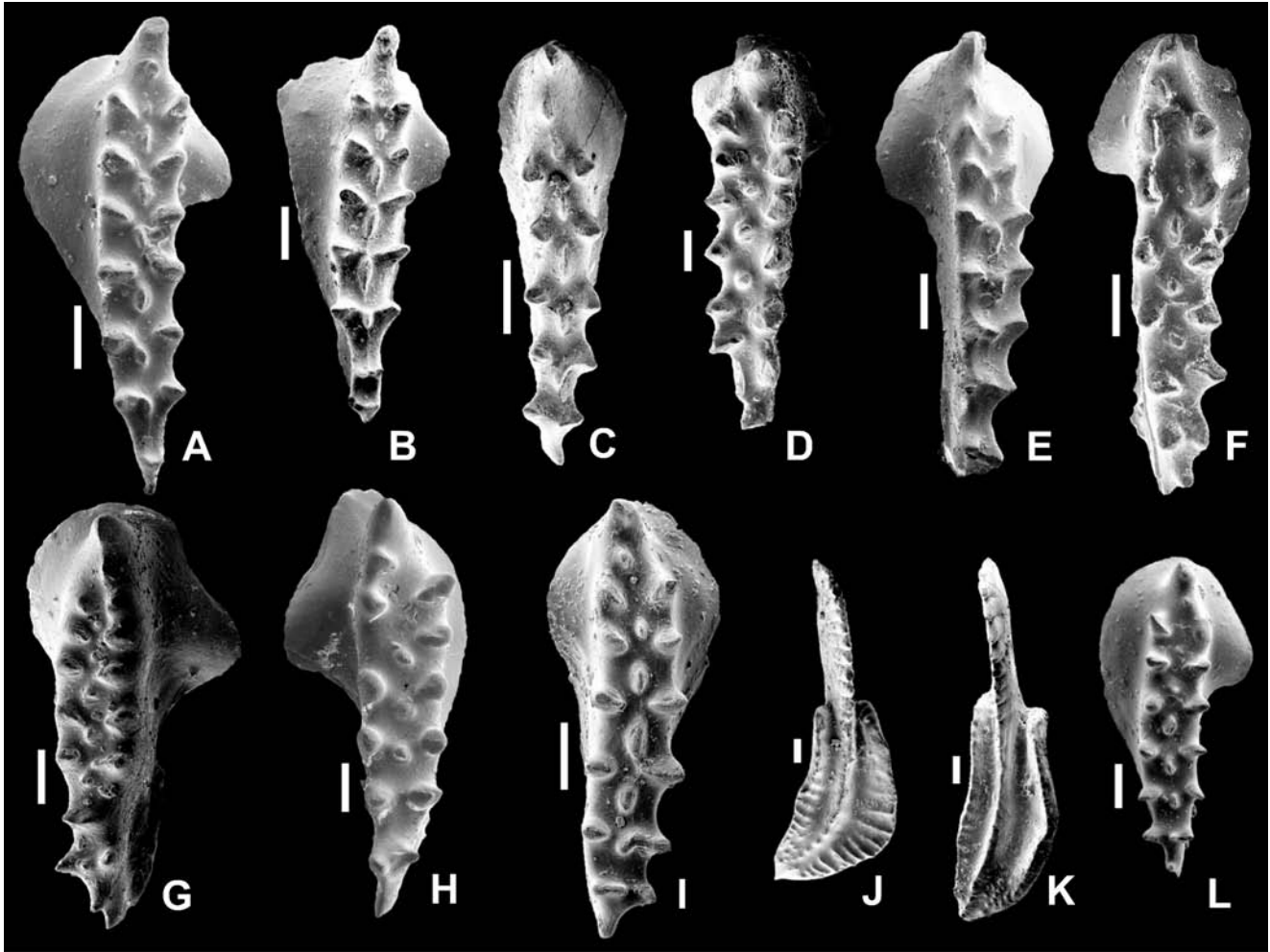
Subclass AMMONOIDEA Zittel 1884  
Order AGONIATITIDA Ruzhencev 1957  
Suborder ANARCESTINA Miller et Furnish 1954  
Superfamily ANARCESTACEAE Steinmann 1890

Family ANARCESTIDAE Steinmann 1890  
Genus *Archoceras* Schindewolf 1937  
Type species: *Euomphalus varicosum* Drevermann 1901

*Archoceras varicosum* (Drevermann 1901)  
Figs 21, 22 (A–G)

1901. *Euomphalus varicosus* Drevermann: p. 140–141, pl. 14, figs 10, 10a.  
1913. *Gephyroceras bickense* Wedekind: p. 69, pl. 6, fig. 6.  
1931. *Manticoceras bickense* (Wedekind): Matern, p. 68.  
1937. *Archoceras varicosum* (Drevermann): Schindewolf, pl. 19, fig. 5.  
1938. *Archoceras varicosum* (Drevermann) nov. em.: Gallwitz, p. 377–379, text-fig. 1.  
1963. *Archoceras varicosum* (Drevermann): House, pl. 4, figs e–g.  
1971. *Manticoceras bickense* (Wedekind): Makowski, p. 132–133, pl. 1, figs 1–3.  
1994. *Archoceras varicosum* (Drevermann): Becker & House, pl. 1, figs 1–2.

**Material:** MUZ PIG 175.II.48, 49, 50; in collection as *Manticoceras bickense* Wedekind; Płucki – 12a, b (Fig. 2).



**Fig. 5.** Upper Frasnian conodonts from the Plucki section, *linguiformis* Zone, upper views. **A–D.** *Icriodus alternatus alternatus* Branson et Mehl, A – sample 175.II.42, B, C – 175.II.52, D – 175.II.48; **E–H.** *Icriodus alternatus helmsi* Sandberg et Dreesen, E – sample 175.II.42, F – 175.II.52, G, H – 175.II.48; **I, L.** *Icriodus alternatus helmsi* Sandberg et Dreesen, I – sample Pl-12, L – sample Pl-13 (Fig. 2); **J, K.** *Polygnathus webbi* Stauffer, Pl-12. Length of scale bars – 100  $\mu$ m

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
175.II.50	9.8	2.3	2.3	3.2	5.7	0.23	0.23	0.32	0.58
175.II.48	11.5	2.9	-	3.0	6.2	0.25	-	0.26	0.53
175.II.49	13.2	3.2	2.8	3.7	6.0	0.24	0.21	0.21	0.45

**Description:** Evolute shell with slightly flattened, very slowly enlarging whorls, whose width slightly exceeds height. Cross section of the last whorl nearly circular. Umbilicus wide, with inner whorls visible. Body chamber occupies more than 3/4 of the whorl. A distinct constriction is visible on the ventral side of the body chamber, near aperture. The last whorl covers the earlier one in 3/4. Ventral lobe deep, in form of a funnel with round bottom. A broad, rounded saddle and a round lateral lobe are visible on whorl flanks. Growth lines distinct: with a deep sinus on the ventral side and a shallow one on the flank.

**Remarks:** Septa destroyed by calcite recrystallisation in most specimens, the last suture line seldom preserved. The specimens differ from representatives of *Manticoceras* in their long body chamber, the presence of constriction and a primitive suture line – rounded ventral and lateral lobes.

**Distribution:** Poland: Holy Cross Mountains, Plucki section (upper Frasnian, conodont zone: *linguiformis*); Germany (Frasnian, zones: I $\gamma$ –I $\delta$ ).

Suborder GEPHUROCERATINA Ruzhencev 1957  
Superfamily GEPHUROCERATACEAE Frech 1897  
Family GEPHUROCERATIDAE Frech 1897

Genus *Manticoceras* Hyatt 1894  
Type species: *Goniatites simulator* Hall 1874

*Manticoceras drevermanni* Wedekind 1913  
Figs 22 (H, I), 24 (A–E), 23 (A, E–G, I)

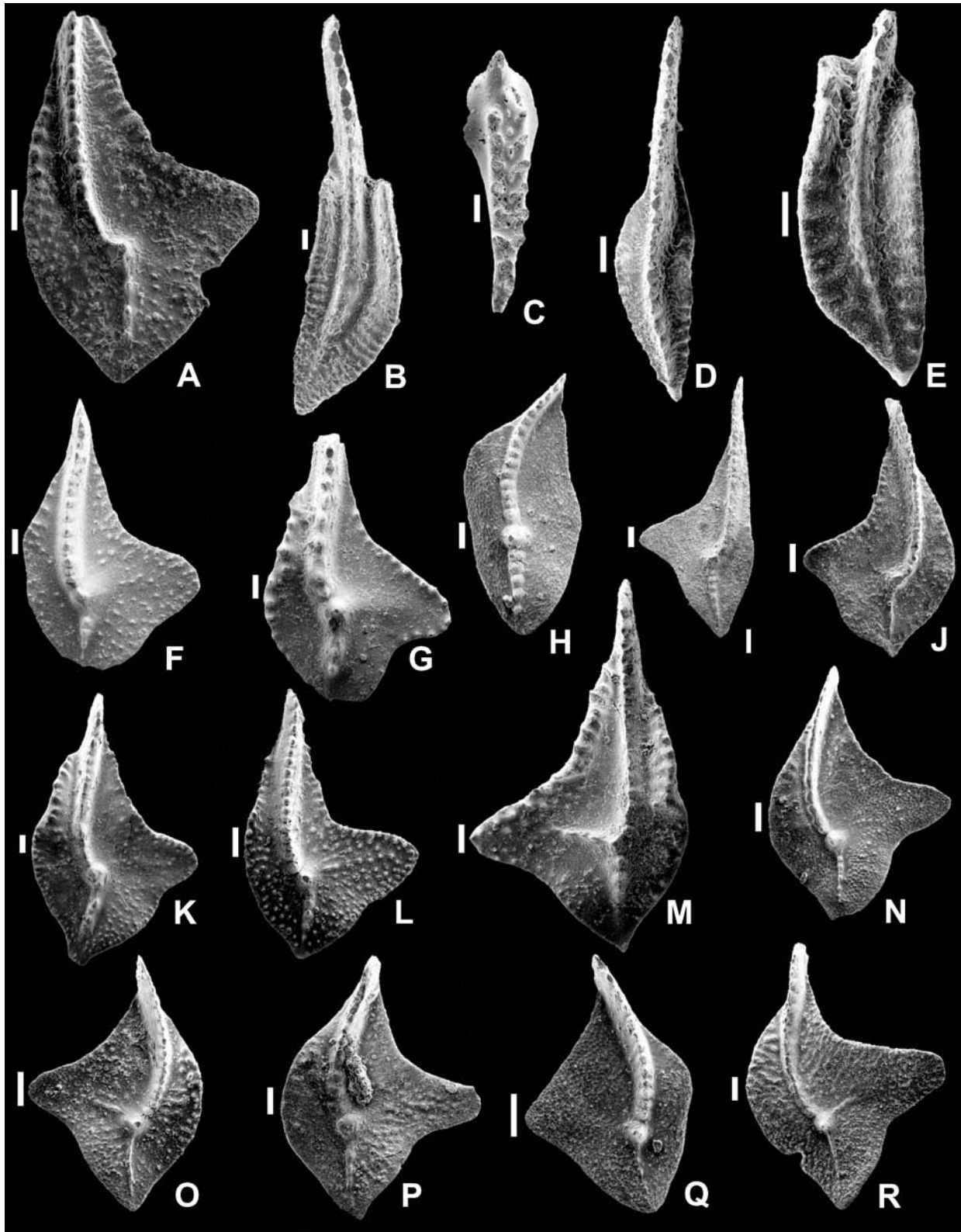
1913. *Manticoceras drevermanni* Wedekind: p. 61, text-fig. 11b, pl. 5, figs 5, 6.

1918. *Manticoceras drevermanni* Wedekind: text-fig. 34b, pl. 22, fig. 11.

1977. *Manticoceras drevermanni* Wedekind: House & Zieger, p. 83, pl. 2, figs 18–20.

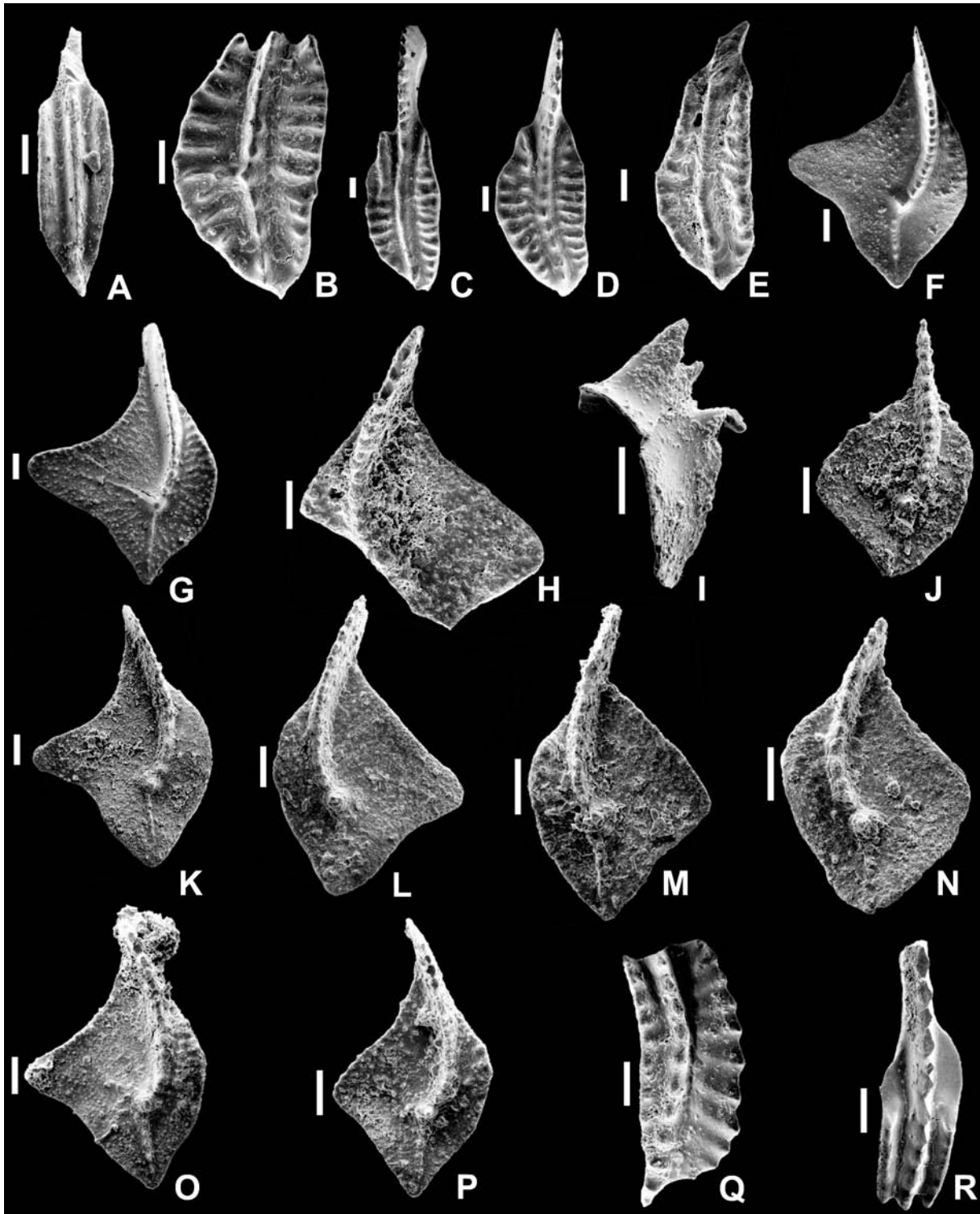
1994. *Manticoceras drevermanni* Wedekind: Becker & House, text-fig. 15b.

**Material:** MUZ PIG 175.II.35, 37, 38, 39, 40; in collection

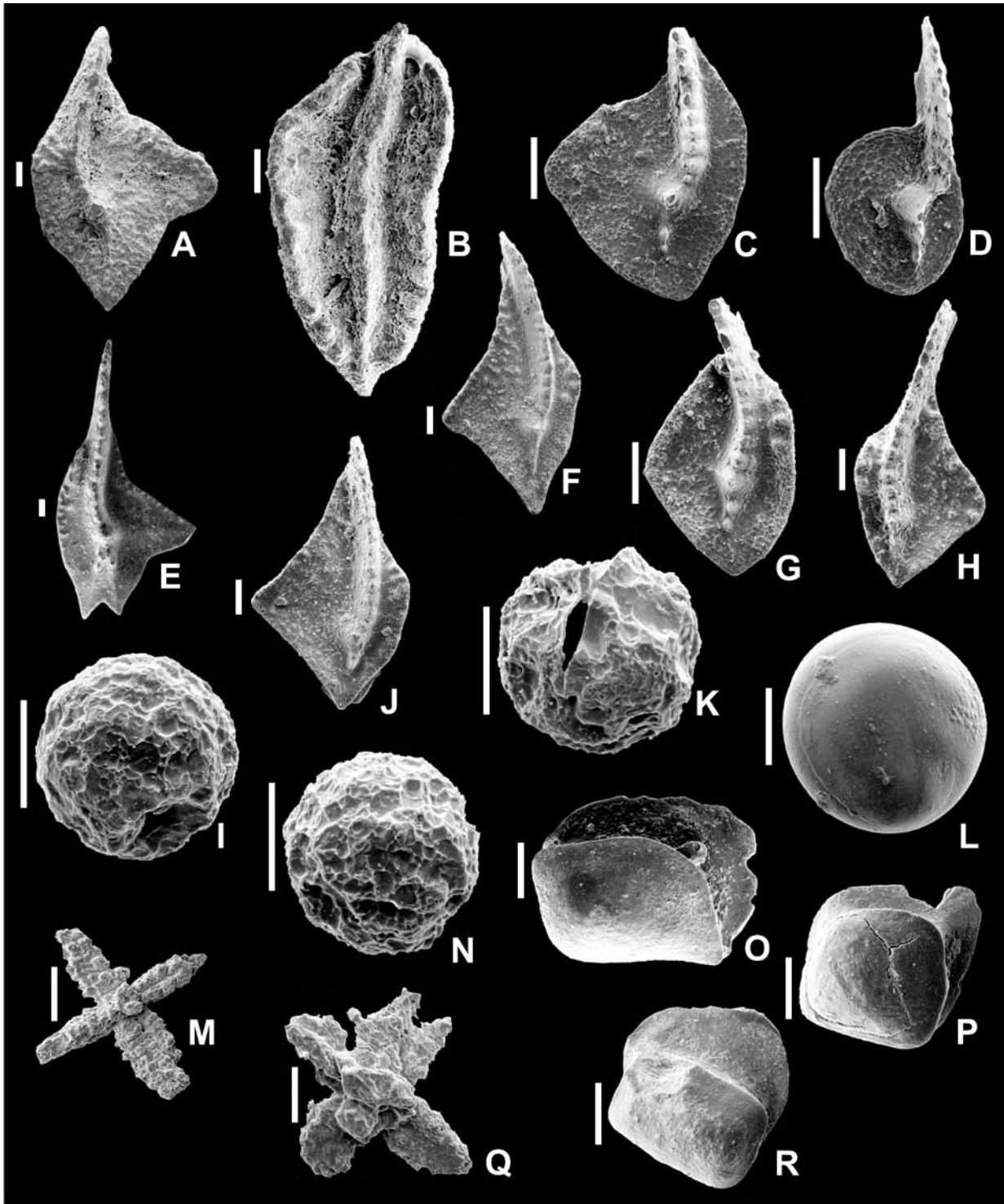


**Fig. 6.** Upper Frasnian conodonts from the Plucki section: A–M – *linguiformis* Zone, N–R – Lower *triangularis* Zone; upper views. **A.** *Palmatolepis subrecta* Müller et Joungquist; **B.** *Polygnathus imparilis* Klapper et Lane; **C.** *Icriodus alternatus alternatus* Branson et Mehl; A–C – sample P1-20; **D.** *Polygnathus lodinensis* Pölsler; **F, G.** *Palmatolepis rotunda* Ziegler et Sandberg; **H.** *Palmatolepis linguiformis* Müller; **I.** *Palmatolepis rhenana rhenana* Bischoff; D–I – sample P1-19. **J, K.** *Palmatolepis hassi* Müller et Müller; **L, M.** *Palmatolepis gigas extensa* Ziegler et Sandberg; J–M – sample P1-12; **N.** *Palmatolepis hassi* → *P. triangularis* Sannemann; **O, Q, R.** *Palmatolepis triangularis* Sannemann morphotype 2; **P.** *Palmatolepis triangularis* Sannemann, morphotype 1; N–R – sample P1-13. Length of scale bars – 100 µm





**Fig. 7.** Lower Famennian conodonts from the Plucki section: A–I – Lower *triangularis* Zone, J–R – Middle *triangularis* Zone; **A.** *Polygnathus brevilaminus* Branson et Mehl; **B, E.** *Polygnathus praecursor* Matyja, E – sample Pl-14; **C.** *Polygnathus* sp. A; A–C – sample Pl-13; **D.** *Polygnathus* sp. A; **F.** *Palmatolepis triangularis* Sannemann morphotype 2; **G.** *Palmatolepis triangularis* → *P. spatula* Schülke; **H.** *Palmatolepis delicatula* Branson et Mehl; **I.** *Pelekysgnathus planus* Sannemann; D, F–I – sample Pl-14; **J.** *Palmatolepis delicatula platys* Ziegler et Sandberg; **K.** *Palmatolepis subperlobata* Branson et Mehl; **L, M.** *Palmatolepis subperlobata* → *P. delicatula* Branson et Mehl; **N.** *Palmatolepis subperlobata* → *P. regularis* Cooper; **O, P.** *Palmatolepis triangularis* Sannemann morphotype 1; **Q.** *Polygnathus semicostatus* Branson et Mehl; **R.** *Polygnathus* cf. *lodinensis* Pölsler; J–R – sample Pl-14a. A–H, J–R – upper views, I – lateral view. Length of scale bars – 100  $\mu$ m



**Fig. 8.** Lower Famennian conodonts, upper views (A–H, J), leiospheres (I, K, L, N), sponge spicules (M, Q) and acanthodian scales (O, P, R) from the Plucki section. **A.** *Palmatolepis triangularis* → *P. perlobata* Ulrich et Bassler; **B.** *Polygnathus praecursor* Matyja; A, B – sample Pl-15a; **C, D.** *Palmatolepis delicatula delicatula* Branson et Mehl, D – junior form; **E.** *Palmatolepis clarki clarki* Ziegler, pathological specimen with bifurcate carina; C–E – sample 15b; **F, J.** *Palmatolepis clarki clarki* Ziegler; **G, H.** *Palmatolepis protoromboidea* Sandberg et Ziegler; F–H, J – sample Pl-17; **I, K, L, N.** *Leiosphaeridia* sp.; I, N – sample Pl-20; K, L – sample Pl-15b, L – mould of specimen. **M, Q.** Sponge spicules, sample Pl-15b; **O, P, R.** Acanthodian scale, basal view, sample Pl-17. Length of scale bars – 100  $\mu$ m

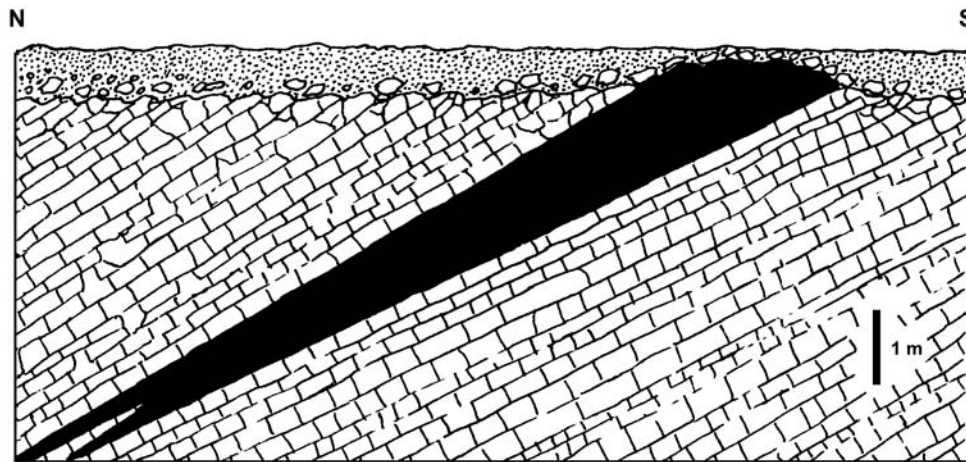


Fig. 9. Lens of the cephalopod limestone (black) within the Lower Famennian limestones at Janczyce (after Makowski, 1991)

175.II.38-40 as *Manticoceras acutilobatum* Bogoslovsky;  
175.II.35 as *Manticoceras* sp.

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
175.II.35	56.7	26.7	23.5	17.8	11.7	0.47	0.41	0.31	0.21
175.II.38	61.0	30.0	-	19.0	13.0	0.49	-	0.31	0.21
175.II.39	49.5	23.0	19.4	15.0	11.5	0.46	0.39	0.30	0.23
175.II.40	41.0	20.0	17.0	12.8	9.0	0.48	0.41	0.31	0.22

**Description:** Discoid, flattened, slightly involute shell. Whorl section high subtrapezoid. Ventral side narrow and slightly rounded. Umbilicus relatively wide, with high and rounded margin, with inner whorls visible. The last whorl covers 3/5 of the earlier whorl. Smooth shell preserved in fragments. Growth lines in form of a deep sinus on the ventral side and a shallow one on the flank. Ventral lobe wide, divided by a high median saddle into two secondary lobes with sharp ends, whose apices are directed towards the flanks. Lateral saddle asymmetric, with broad base and sharp apex, while the adjacent subumbilical lobe has a sharpened bottom.

**Remarks:** It differs from *M. lamed* (G. et F. Sandberger) by having flanks more flattened and a high subtrapezoid whorl section.

**Distribution:** Poland: Holy Cross Mountains, Płucki section (upper Frasnian, conodont zone *linguiformis*); Germany, Bicken; France, Montagne Noire (upper Frasnian, zone Ið).

*Manticoceras lamed* (G. et F. Sandberger 1850)

Figs 23 (B, C, H), 24 (F–H)

1850. *Goniatites lamed* var. *complanatus* G. et F. Sandberger: p. 90, pl. 8, figs 5, 5a.

1913. *Goniatites lamed* var. *complanata* G. et F. Sandberger: R. Wedekind, pl. 6, fig. 3.

1977. *Manticoceras lamed* (G. et F. Sandberger): House & Ziegler, p. 83, pl. 2, figs 15–17, 23, 24.

1993. *Manticoceras lamed* (G. et F. Sandberger): Becker, pp. 58–60.

1994. *Manticoceras lamed* (G. et F. Sandberger): Becker & House, text-fig. 15a.

2000. *Manticoceras lamed* (G. et F. Sandberger): Becker *et al.*, pl. 3, figs 15, 16.

**Material:** MUZ PIG 175.II.42, 43, 44, 46; in collection as *Manticoceras ammon* (Keyserling).

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
175.II.46	18.0	10.5	-	7.5	-	0.58	-	0.41	-
175.II.42	35.0	20.0	-	17.0	8.0	0.57	-	0.48	0.22
175.II.43	36.5	21.5	14.0	17.4	9?	0.58	0.38	0.47	0.24
175.II.44	49.0	27.5	-	23.0	9.0	0.56	-	0.46	0.18

**Description:** Shell up to 50 mm in diameter, discoid, nearly involute, with rapidly expanding whorls. Maximum whorl thickness near the rounded umbilical margin. Whorls high, ovate, with flattened flanks widening towards the base and with moderately narrow ventral side. Umbilicus with high wall and rounded margin, its width equals 1/5 of shell diameter. The last whorl covers slightly more than half of the preceding whorl. Body chamber occupies half of the whorl. Ventral lobe divided by median saddle in two secondary lobes with sharp terminations. Apices of median saddle and the subordinate lobe between them are sharp. Lateral saddle wide and asymmetric, subumbilical lobe with sharp bottom. Growth lines with deep ventral and lateral sinuses, separated by distinct linguoid bends on the lateral-ventral margin.

**Remarks:** It differs from *Manticoceras adorfense* Wedekind by its better rounded ventral side.

**Occurrence:** Poland: Holy Cross Mountains, Płucki section (upper Frasnian, conodont zone *linguiformis*); Germany, Sessacker; Australia, Canning Basin (conodont zones: *rhenana* – *linguiformis*).

*Manticoceras intumescens* (Beyrich 1837)

Figs 23D, 26A

1837. *Ammonites intumescens* Beyrich: p. 36, pl. 13, fig. 3.

1909. *Manticoceras intumescens* Beyrich: Gürich, p. 334, pl. 39, fig. 2.

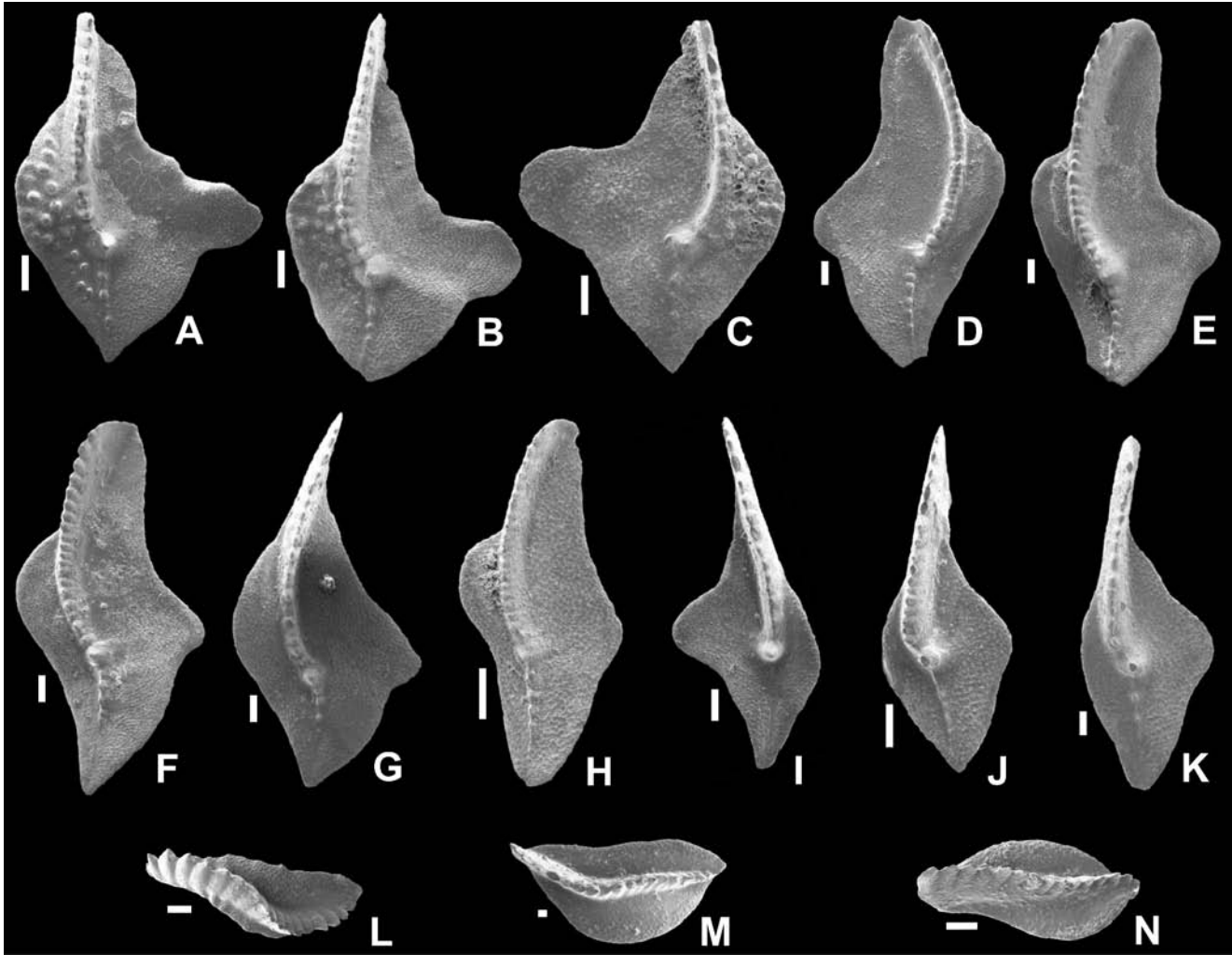
1962. *Manticoceras intumescens* (Beyrich): Makowski, pp. 42, 80, text-fig. 9 [non *Manticoceras ammon* (Keyserling)].

1968. *Manticoceras intumescens* (Beyrich): Gunia, p. 189, pl. 11, fig. 11.

1969. *Manticoceras intumescens* (Beyrich): Bogoslovsky, p. 238, pl. 15, figs 2, 3; pl. 16, fig. 1; pl. 17, fig. 2.

1969. *Manticoceras intumescens* (Beyrich): Claussen, pp. 126–128, pl. 22, fig. 3; pl. 26, figs 3–19.

1993. *Manticoceras intumescens* (Beyrich): Becker, p. 52.



**Fig. 10.** Lower Famennian conodonts from the Janczyce section, Upper *crepida* Zone, upper views. **A–C.** *Palmatolepis quadrantinodosalobata* Sannemann, A – sample 175.II.80, B – 175.II.91, C – 175.II.100; **D–F.** *Palmatolepis tenuipunctata* Sannemann, D – sample 175.II.80, E, F – 175.II.91; **G.** *Palmatolepis subperlobata* → *P. regularis* Cooper, sample 175.II.91; **H.** *Palmatolepis tenuipunctata* → *P. glabra prima* Ziegler et Huddle, sample 175.II.91; **I.** *Palmatolepis minuta wolskae* Szulczewski, sample 175.II.80; **J, K.** *Palmatolepis minuta minuta* Branson et Mehl, sample 175.II.80; **L–N.** P<sub>2</sub> (oz) elements; L – sample 175.II.80, M – 175.II.91, N – 175.II.100. Length of scale bars – 100  $\mu$ m

**Material:** MUZ PIG 175.II.51.

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
175.II.51	?100	39.0	-	38.8	-	?0.39	-	0.38	-

**Description:** Large, incomplete shell, up to 10 cm in diameter, moderately involute, subtrapezoid in cross section. Umbilical wall high with rounded margin. The last whorl covers 2/3 of the preceding one. Suture line with characteristic, moderately wide and high saddles and with narrow and sharp lobes. The height of the secondary median saddle equals less than a half of the lateral saddle height.

**Remarks:** Corresponds to *M. intumescens* (Beyrich) in shell form and suture line. The lack of material prevents a study of the growth line and possible attribution of the specimen to *Crickites*. It is distinguished from the closely affine species *M. guppyi* Glenister by the structure of subumbilical lobe.

**Distribution:** Poland: Holy Cross Mountains, Płucki section (upper Frasnian, conodont zone *linguiformis*), Sudetes, Cracovian-Silesian area (conodont zones: *rhenana* – *linguiformis*); Germany (upper Frasnian, zones I $\gamma$ –I $\delta$ ); Russia: Ural (Lyajolskaya svita, conodont zone: Upper *gigas*).

Genus *Crickites* Wedekind 1913

Type species: *Crickites holzapfeli* Wedekind 1913

*Crickites neverovi* (Bogoslovsky 1958)

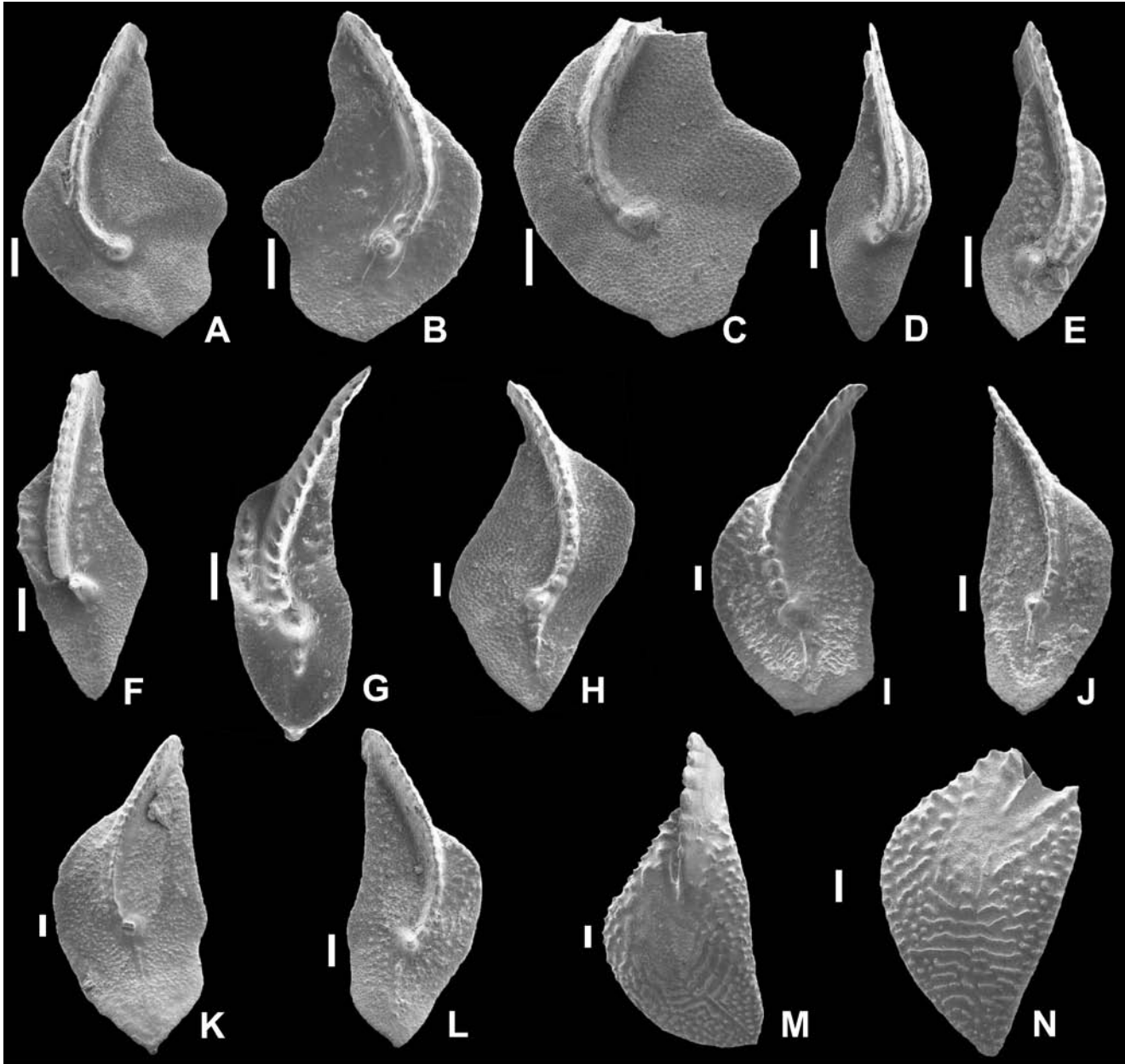
Fig. 26 (B, C)

1958. *Manticoceras neverovi* Bogoslovsky: p. 101, pl. 3, fig. 1.  
1994. *Crickites neverovi* (Bogoslovsky): Becker & House, p. 61.

**Material:** MUZ PIG 175.II.52.

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
175.II.52	45.5	25.3	-	30.0	13.2	0.55	-	0.65	0.28



**Fig. 11.** Lower Famennian conodonts from the Janczyce section, Upper *crepida* Zone, upper views. **A–C.** *Palmatolepis circularis* Szulczewski, sample 175.II.100; **D–G.** *Palmatolepis termini* Sannemann, D, G – sample 175.II.80, E – 175.II.100, F – 175.II.91; **H.** *Palmatolepis regularis* Cooper, sample 175.II.80; **I–L.** *Palmatolepis crepida* Sannemann, I – sample 175.II.80, J – 175.II.91, K – 175.II.100, L – 175.II.105; **M, N.** *Polylophodonta linguiformis* Branson et Mehl, sample 175.II.100. Length of scale bars – 100  $\mu\text{m}$

**Description:** Thick discoid shell, moderately involute, with maximum width close to umbilicus. Ventral side rounded, flanks convex. Whorl cross section low ovate, of similar height and width. Umbilicus wide and deep, with steep wall. Thin growth lines form broad and distinct sinuses on the ventral side and are bent forward on the flanks. The last whorl covers 2/3 of the preceding one.

**Remarks:** The lack of the description of the growth lines, coupled with the inflated shell form, in the Bogosłowski's (1958, 1969) specimens was the reason for their conditional attribution to genus *Crickites* (see synonymy). The presence of the distinct forward bend of the growth line on flanks and of the sinuses on the ventral side suggests that the species under discussion belongs to genus *Crickites*.

**Distribution:** Poland: Holy Cross Mountains, Płucki section (upper Frasnian, conodont zone: *linguiformis*); Russia: Rudny Altay (upper Frasnian).

*Crickites holzapfeli* Wedekind 1913  
Figs 25 (A–D), 26 (D–I), 28 (A, B)

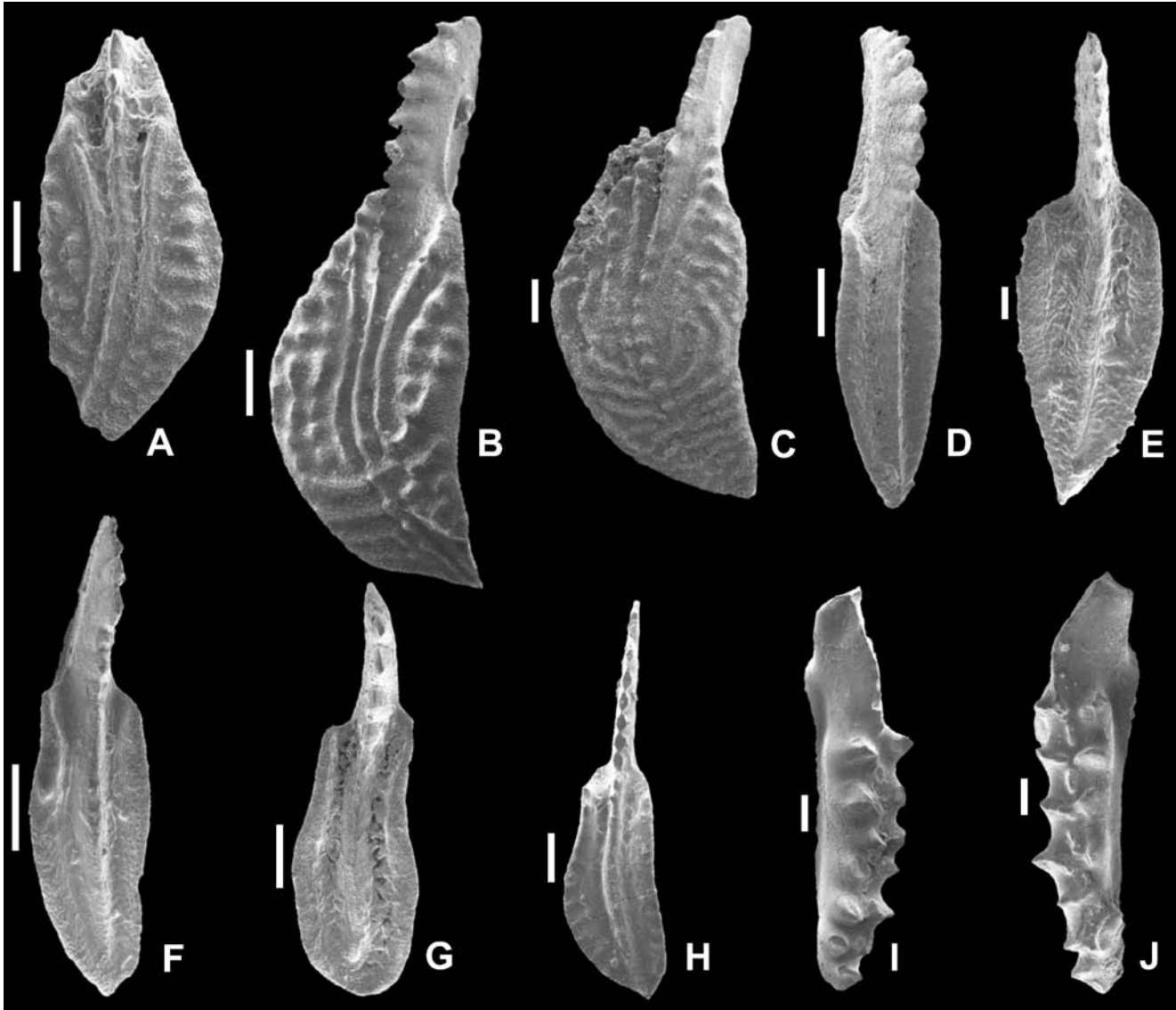
1913. *Crickites Holzapfeli* Wedekind: p. 72, pl. 7, figs 5, 6.

1918. *Crickites Holzapfeli* Wedekind: p. 131, fig. 39.

1963. *Crickites holzapfeli* Wedekind: House, pl. 3, fig. a.

1969. *Crickites holzapfeli* Wedekind: Clausen, pp. 158–159.

1994. *Crickites holzapfeli* Wedekind: Becker & House, pl. 3, figs 12–20.



**Fig. 12.** Lower Famennian conodonts from the Janczyce section, Upper *crepida* Zone, upper views. **A.** *Polygnathus nodocostatus* Branson et Mehl, sample 175.II.100; **B, C.** *Polylophodonta linguiformis* Branson et Mehl (junior forms), B – sample 175.II.80, C – 175.II.105; **D–F.** *Polygnathus pomeranicus* Matyja, sample 175.II.91; **G.** ?*Polygnathus pomeranicus* Matyja, sample 175.II.91; **H.** *Polygnathus subnormalis* Vorontzova et Kuzmin, sample 175.II.91; **I, J.** *Ieriodus cornutus* Sannemann, I – sample 175.II.80, J – 175.II.100. Length of scale bars – 100  $\mu\text{m}$

**Material:** IGP UW no. 003393, coll. H. Makowski, MUZ PIG 175.II.33, 45; in collections as *Manticoceras ammon* Keyserling.

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
175.II.33	45.5	27.0	18.2	27.0	11.7	0.55	0.43	0.63	0.27
175.II.45	55.0	29.0	-	29.0	10.5		-	0.52	0.19
UW 003393	77.0	40.5	-	38.0	12.4		-	0.49	0.16

**Description:** Thick discoid shell with wide, rounded ventral side and slightly flattened flanks widening downwards, subtrapezoid in section. Umbilical wall high with rounded margin. Body chamber occupies half of the whorl. Suture line, preserved at the margin of

the body chamber, is distinguished by its broad rounded, nearly symmetrical saddle, which occupies, together with the sharp umbilical lobe, the whole lateral side. Ventral lobe poorly preserved because of calcite recrystallisation. Median lobe on the secondary saddle moderately deep and rounded. Growth lines clearly preserved near the aperture of the body chamber, with broad rounded sinuses on the ventral side and straight, slightly bent forward lirae on the lateral side.

**Distribution:** Poland: Holy Cross Mountains, Plucki section (Frasnian, goniatite zone *Crickites holzapfeli*; conodont zone: *linguiformis*); Germany (Frasnian, zone I $\delta$ ).

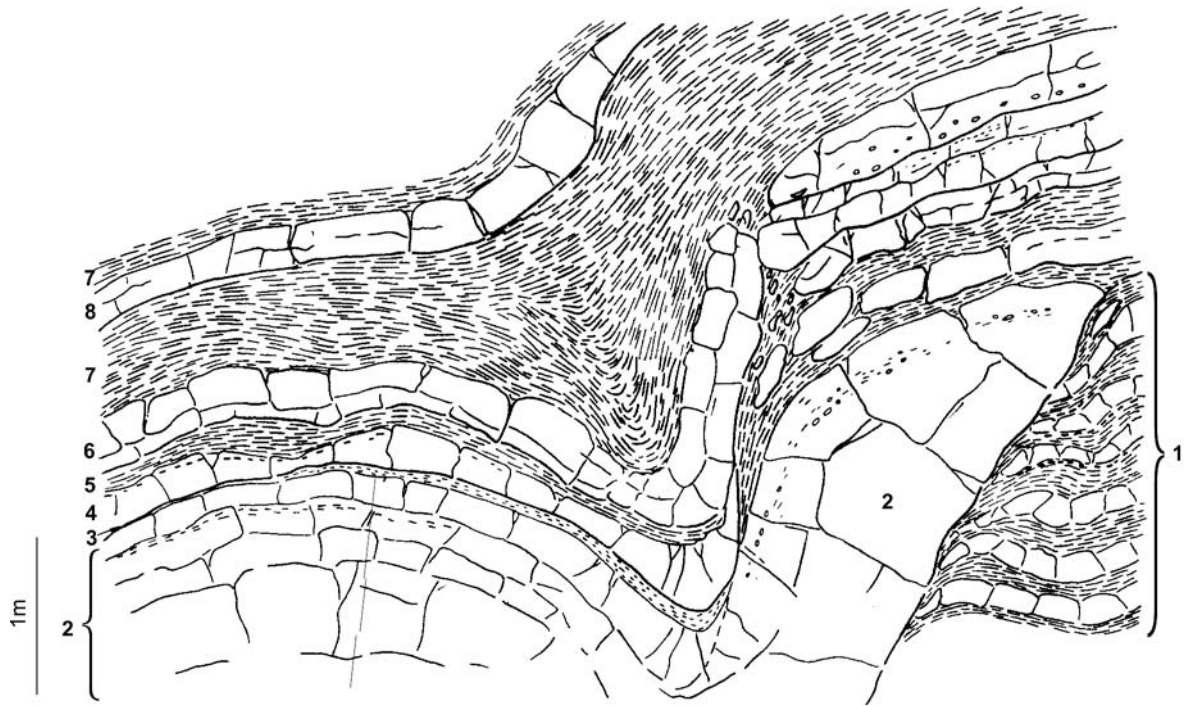


Fig. 13. Section of Famennian rocks at Łagów (Niwa ravine). Explanations of beds 1–8 in Table 4 (after Czarnocki, 1989)

Order GONIATITIDA Hyatt 1884  
 Suborder TORNOCERATINA Wedekind 1918  
 Superfamily TORNOCERATACEAE V. Arthaber 1911  
 Family TORNOCERATIDAE V. Arthaber 1911  
 Tribus TORNOCERATINI Becker 1993

Genus *Tornoceras* Hyatt 1884  
 Type species: *Goniatites uniaularis* Conrad 1842

*Tornoceras sublentiforme* (Sobolew 1914)  
 Figs 27 (A–E), 28 (C–J)

1914. *Gomi-monomeroceras (Tornoceras) sublentiforme* Sobolew: p. 56, pl. 8, fig. 14.  
 not 1991. *Tornoceras sublentiforme* (Sobolew): Makowski, p. 252, fig. 7.

**Material:** MUZ PIG 175.II.90, 93, 107, 111, 113, 116, 117; 176.II.61a, b; in collection as *T. simplex* (Buch).

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
175.II.90	29.5	16.0	-	9.6	-	0.54	-	0.33	-
175.II.111	71.0	40.0	-	?22.0	-	0.56	-	0.30	-
176.II.61a	53.0	32.0	18	18.0	-	0.60	0.33	0.33	-
176.II.61b	43.5	29.5	15	16.0	-	0.67	0.34	0.36	-

**Description:** Shell involute; at diameter of 3–8 mm the ventral side becomes gradually sharpened, while the shell cross section remains rounded and the shell form becomes more lenticular. Umbilicus closed in adult specimens. Body chamber occupies nearly the whole whorl. Suture line features small, sharp outer saddles and broad lateral saddles in the form of a rounded rectangle.

**Remarks:** The shape of suture line is very close to that of *Oxytornoceras*, while section of the shell outer side is rounded. It is possible that *T. sublentiforme* may be a transitional form between the representatives of *Tornoceras* and *Oxytornoceras*.

**Distribution:** Poland: Holy Cross Mountains, Janczyce section, Łagów section (Famennian, zone: II $\alpha$ ; conodont zones: upper *crepida/rhomboidea*).

Genus *Linguatornoceras* House 1965  
 Type species: *Goniatites retrorsus* var. *lingua* G. et F. Sandberger 1850/51

*Linguatornoceras* aff. *clausum* (Glenister 1958)  
 Figs 29A, 32 (A, B)

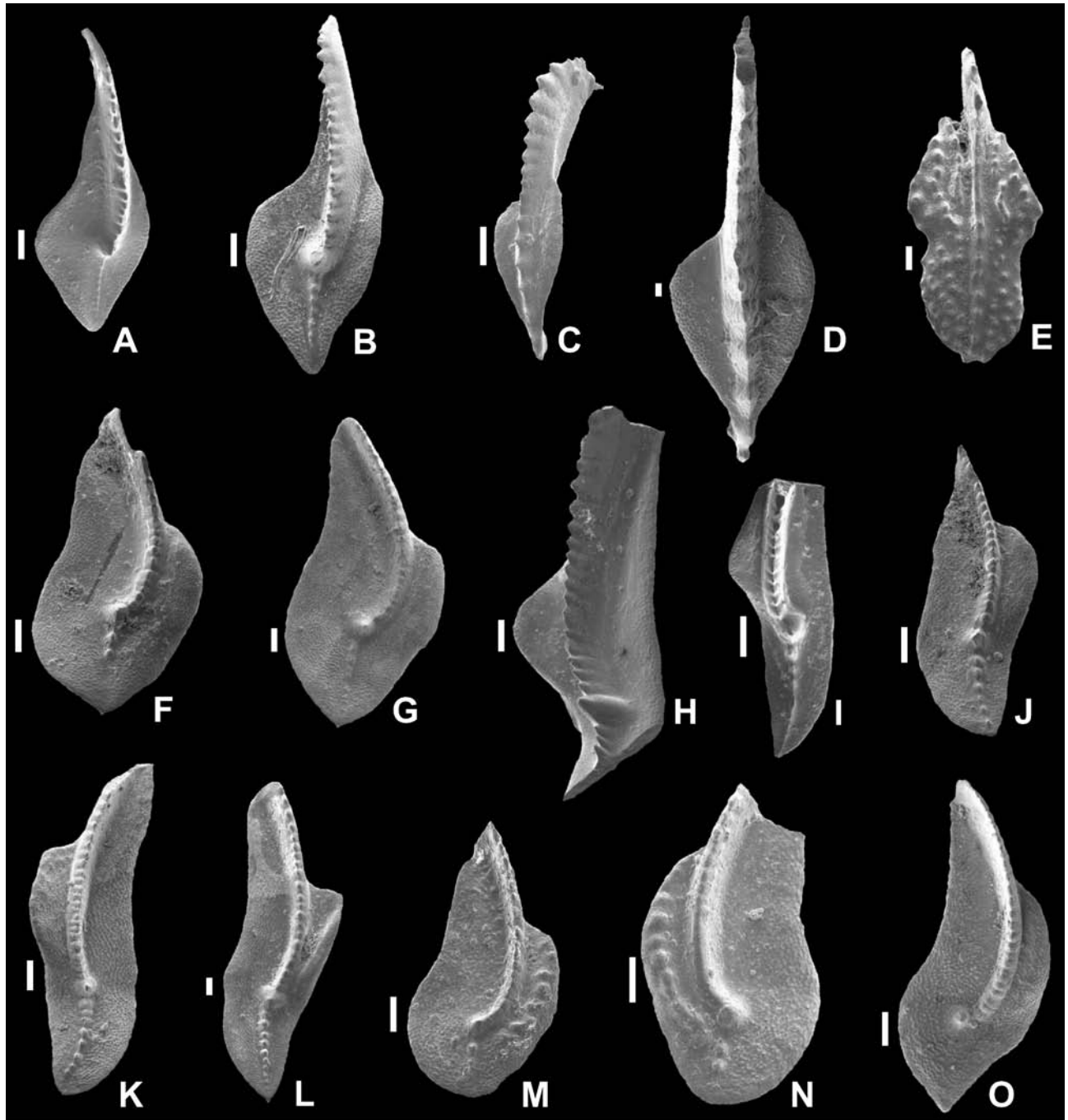
1958. *Tornoceras (Tornoceras) clausum* Glenister: pp. 92, 93, text-figs 16a, c, pl. 15, figs 7–9.

**Material:** MUZ PIG 175.II.42a; in collection not determined.

**Dimensions** (dm, wh, ah, ww, uw – in mm):

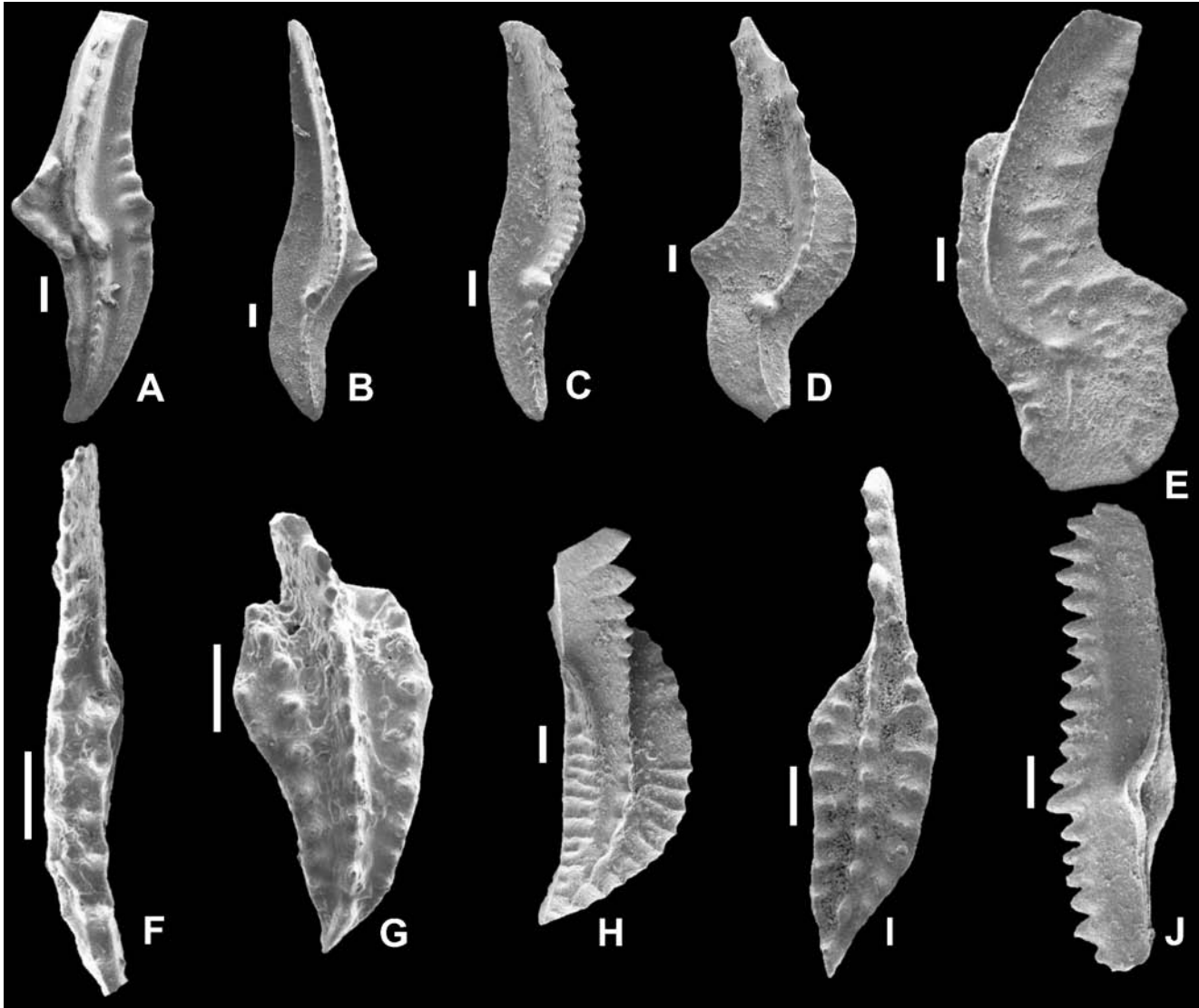
specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
175.II.42a	19.5	10.3	-	7.3	-	0.53	-	0.37	-

**Description:** Shell discoid up to 20 mm in diameter, with flattened flanks and rounded ventral side. Shell is widest near umbilicus. Umbilicus completely closed, lateral sides around it are slightly concave. Wrinkle-layer is well visible on the preserved shell fragment; the wrinkles arranged concentrically around umbilicus evenly cover the whole surface. Thin lirae visible on flanks and ventral side, in form of broad sinuses, separated by a distinct forward salient on the ventrolateral margin. The deep, sharp ventral lobe is limited by high and broad asymmetric saddles with slightly flattened apices. Adventitious lobe broad and asymmetrical, with external side steep, hook-like. Lateral saddle broad and rounded.



**Fig. 14.** Famennian conodonts from the Łagów section, Lower *marginifera* Zone, upper views. **A, B.** *Palmatolepis minuta minuta* Branson et Mehl, A – sample 176.II.27, B – 176.II.24; **C.** *Polygnathus glaber glaber* Ulrich et Bassler, sample 176.II.24; **D.** *Polygnathus glaber medius* Helms et Wolska, sample 176.II.24; **E.** *Polygnathus triphyllatus* (Ziegler), sample 176.II.24; **F, G.** *Palmatolepis stoppeli* Sandberg et Ziegler, F – sample 176.II.20, G – 176.II.24; **H, I.** *Palmatolepis glabra lepta* Ziegler et Huddle, H – sample 176.II.27, I – 176.II.20; **J.** *Palmatolepis glabra prima* Ziegler et Huddle, sample 176.II.20; **K.** *Palmatolepis glabra glabra* Ulrich et Bassler, sample 176.II.24; **L.** *Palmatolepis glabra acuta* Helms, sample 176.II.24; **M, N.** *Palmatolepis marginifera marginifera* Helms, sample 176.II.27; **O.** *Palmatolepis inflexoidea* Ziegler, sample 176.II.24. Length of scale bars – 100  $\mu$ m





**Fig. 15.** Famennian conodonts from the Łagów section, *trachytera* Zone, sample 176.II.56. **A–C.** *Palmatolepis glabra lepta* Ziegler et Huddle; **D.** *Palmatolepis perlobata helmsi* Ziegler; **E.** *Palmatolepis rugosa trachytera* Ziegler; **F.** *Scaphignathus velifer leptus* Ziegler et Sandberg; **G.** *Polygnathus granulatus* (Branson et Mehl); **H.** *Polygnathus planirostratus* Dreesen et Duser; **I.** *Polygnathus lauriformis* Dreesen et Duser; **J.** *Branmehla bohlenana* (Helms). **A–I** – upper views, **J** – lateral view. Length of scale bars – 100  $\mu\text{m}$

**Remarks:** The shell form and suture line shape correspond best to *L. clausum* (Glenister). The described species, having a similar asymmetric adventive lobes, differs in its hook-like form. The shape of the suture line in *L. aff. clausum* is closest to that of *L. haugi* (Frech), but its shell has a completely different form.

**Distribution:** Poland: Holy Cross Mountains, Płucki section (upper Frasnian, conodont zone: *linguiformis*).

Genus *Oxytornoceras* Becker 1993

Type species: *Tornoceras acutum* Frech 1902

*Oxytornoceras acutum* (Frech 1902)

Figs 29 (B, C), 32 (C–F)

1902. *Tornoceras acutum* Frech: 47, 102, pl. 2, fig. 17.

1918. *Tornoceras acutum* Frech: Wedekind, p. 136.

1993. *Oxytornoceras acutum* (Frech): Becker, pp. 195, 196, text-fig. 72 a, d, f, pl. 4, figs 15, 16; pl. 5, figs 5–7.

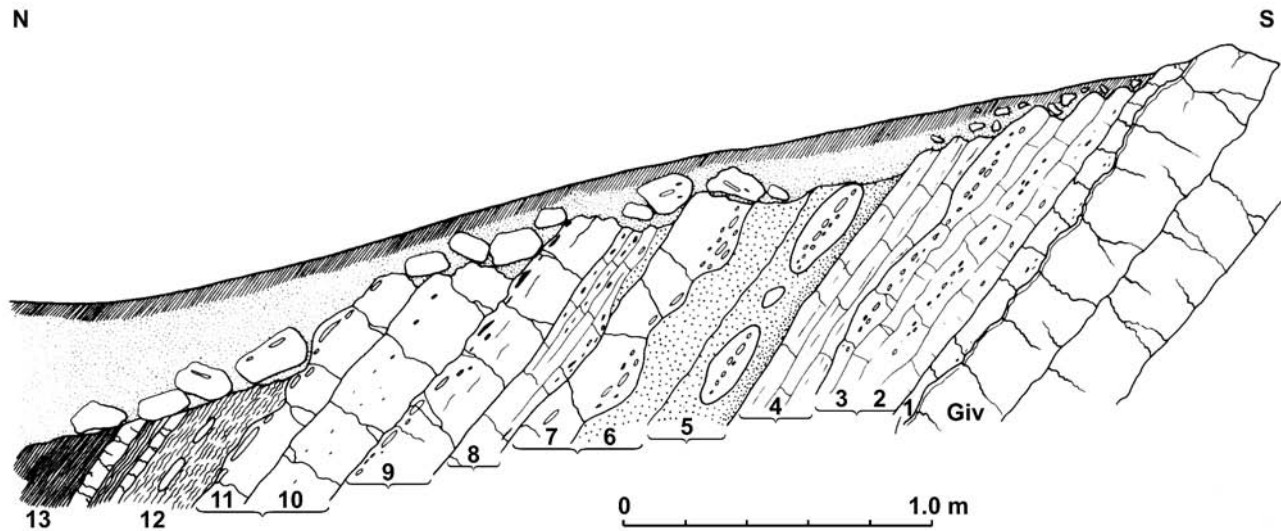
**Material:** MUZ PIG 175.II.77, 80, 88, 89 (in collection as *Tornoceras acutum* Frech).

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
175.II.77	32.4	19.8	-	12.4	-	0.61	-	0.38	-
175.II.78	59.0	35.0	-	15.3	-	0.59	-	0.26	-
175.II.88	63.0	39.0	-	18.0	-	0.61	-	0.28	-
175.II.89	58.0	36.7	-	15.0	-	0.63	-	0.26	-

**Description:** Shell involute, flat and slender, with sharp ventral side, up to 60 mm in diameter. Umbilicus closed. Body chamber occupies 3/4 of whorl. Suture line with narrow, funnel-shaped ventral lobe and broad, asymmetrical adventitious lobe. Ventral saddle high and narrow, lateral saddle broad and rounded.

**Distribution:** Poland: Holy Cross Mountains, Kielce (Kadzielnia section), Janczyce section (Famennian, conodont zone: Upper *crepida*); Germany (Famennian, goniatite zone: *globosum*; cono-



**Fig. 16.** Section of Famennian rocks on the Ostrówka hill, Gałęzice. Explanations of beds 1–11 in Table 6. Giv – Givetian limestone (after Czarnocki, 1989)

dont zones: Uppermost *crepida* – Lower *rhomboidea*); Russia: Ural (Famennian, zone II $\alpha$ ).

Tribus FALCITORNOCERATINI Becker 1993

Genus *Falcitornoceras* House et Price 1985

Type species: *Goniatites (Tornoceras) subundulatus* var. *falcata* Frech 1887

*Falcitornoceras bilobatum* (Wedekind 1908)

Figs 29 (D, E), 33 (A, B)

1908. *Tornoceras bilobatum* Wedekind: p. 579, pl. 39, fig. 35; pl. 40, fig. 8.  
 1914.  $\gamma$  - *Gomi-dimeroceras (Tornoceras) bilobatum*: Sobolew, p. 57, text-figs 88, 89, pl. 8, fig. 15.  
 1918. *Tornoceras bilobatum* Wedekind: Wedekind, p. 136, text-fig. 40c.  
 1963. *Lobotornoceras* aff. *bilobatum* (Wedekind): House & Peder, p. 529, 530, text-fig. 12a, pl. 77, figs 1, 2.  
 1971. *Lobotornoceras bilobatum* (Wedekind): Bogoslovsky, pp. 77–79, text-fig. 18, pl. 3, fig. 14; pl. 4, figs 1, 2.  
 1989. *Lobotornoceras bilobatum* (Wedekind): Babin, pp. 37–38, pl. 3, figs 11, 12.  
 1993. *Falcitornoceras bilobatum* (Wedekind): Becker, pp. 208, 209, text-fig. 74e, f, pl. 7, fig. 12; pl. 8, figs 1–8.

**Material:** MUZ PIG 284.II.288; in collection as *Tornoceras bilobatum* Wedekind.

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
284.II.288	47.5	28.0	?17	17.7	-	0.59	0.36	0.37	-

**Description:** Shell discoid, involute, with slightly flattened flanks. Whorl cross section high ovate, with maximum width near the rounded umbilical margin. Umbilicus closed, lateral sides around it depressed in funnel-like form (to 2–3 mm). The outer part of suture line consists of ventral, adventitious and lateral (its outer part) lobes, separated by broad and high rounded asymmetrical saddles. The first lateral lobe broad, deep, asymmetrical: with inclined outer, and steep inner side. The outer side of the umbilical lobe

wide and rounded. The saddle that divides the lateral lobe is marked outside the umbilical suture.

**Distribution:** Poland, Holy Cross Mountains, Gałęzice and Ostrówka sections (Famennian, “Levigites Beds”, conodont zone: lower *expansa*); Germany, France, North Africa (Famennian, zones: II–IV).

Genus *Phoenixites* Becker 1993

Type species *Tornoceras frechi* Wedekind 1918

*Phoenixites frechi* (Wedekind 1918)

Figs 30 (A–G), 31 (A–C), 32 (G–N)

1918. *Tornoceras Frechi* Wedekind: p. 136, pl. 16, fig. 9.  
 1962. *Tornoceras simplex* (Buch): Makowski, pp. 38, 78, text-fig. 11.  
 1991. *Tornoceras frechi* Wedekind: Makowski, p. 246, fig. 2.  
 1993. *Phoenixites frechi* (Wedekind): Becker, pp. 198–201, text-fig. 73 a–c, g–i, pl. 5, figs 12–17; pl. 6, figs 1–5.

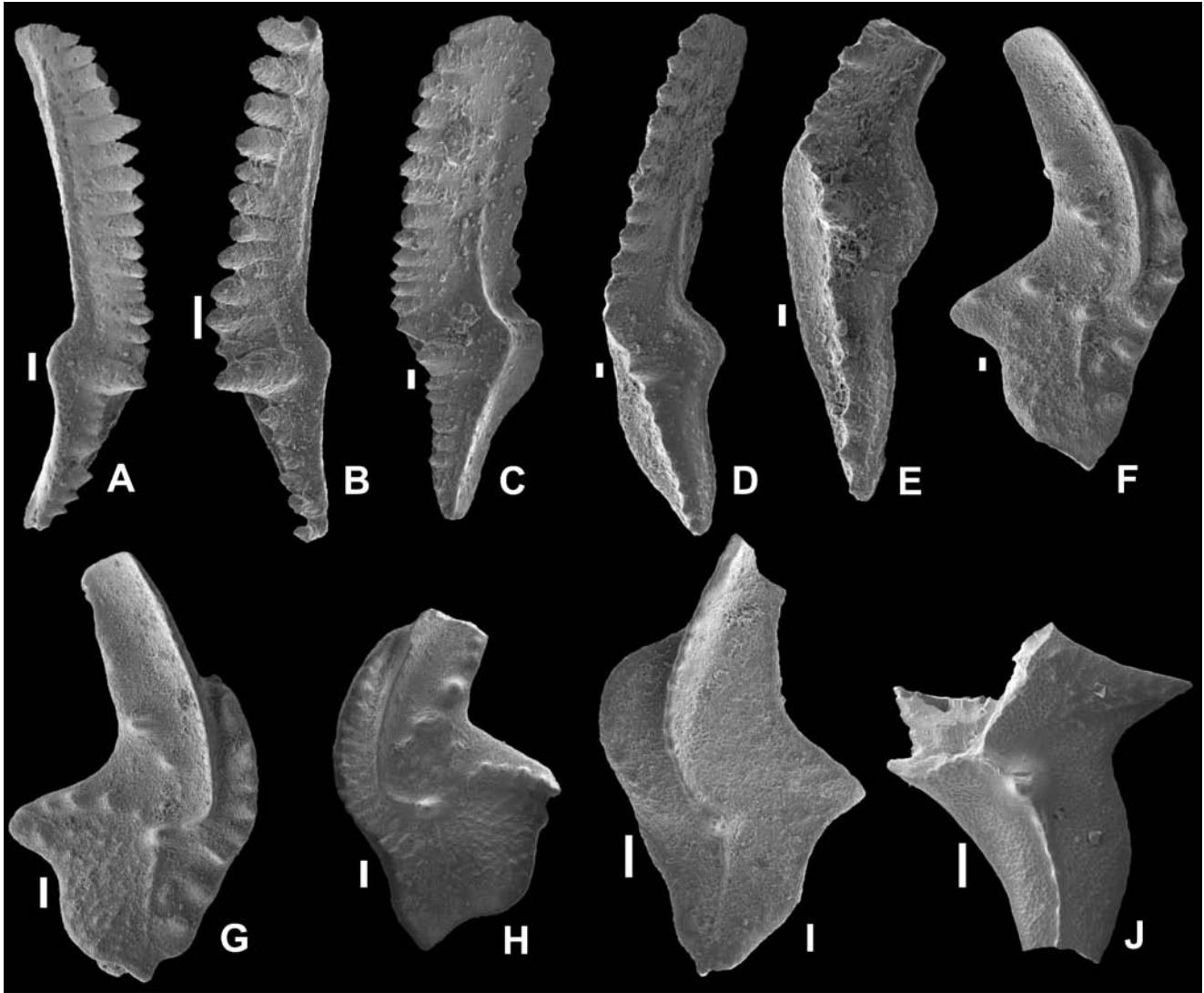
**Material:** MUZ PIG 175.II.93a, 97, 100, 103, 105, 106, 125; 176.II.60, 62; in collection as *Tornoceras simplex* (Buch).

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
175.II.93a	57.0	37.5	-	18.0	-	0.66	-	0.32	-
175.II.100	25.0	14.5	-	10.0	-	0.58	-	0.40	-
175.II.106	66.2	37.9	-	19.0	-	0.57	-	0.29	-
175.II.125	19.0	11.3	-	7.4	-	0.59	-	0.39	-

**Description:** Shell involute, discoid, widest near umbilicus, up to 130 mm in diameter. Umbilicus closed. Ventral side wide and rounded, passing smoothly to both sides. Longitudinal furrows are present on margins of the ventral side in young specimens, and the growth lines are distinctly biconvex.

**Distribution:** Poland: Holy Cross Mountains, Plucki section (Frasnian, conodont zone: *linguiformis*, Famennian, zone: *triangularis*), Janczyce section (Famennian, conodont zone: Upper *crepida*); Germany; France; Spain; Morocco (uppermost Givetian–Famennian, zone: *globosum*).



**Fig. 17.** Upper Famennian conodonts from the Ostrówka section (Gałęzice), Middle *expansa* Zone, upper views, sample 284.II.323; **A, B.** *Palmatolepis gracilis gracilis* Branson et Mehl. **C.** *Palmatolepis gracilis sigmoidalis* Ziegler; **D, E.** *Palmatolepis expansa* Sandberg et Ziegler; **F, G.** *Palmatolepis rugosa ampla* Müller; **H.** *Palmatolepis rugosa rugosa* Branson et Mehl; **I.** *Palmatolepis perlobata schindewolfi* Müller; **J.** *Palmatolepis perlobata helmsi* Ziegler. Length of scale bars – 100  $\mu$ m

Tribus AULATORNOCERATINI Becker 1993

Genus *Tornia* House 1970

Type species: *Protornoceras mirabile* Dybczyński 1913

*Tornia mirabile* (Dybczyński 1913)

Figs 29F, 33 (C, D)

1913. *Protornoceras mirabile* Dybczyński: p. 514, pl. 1, fig. 4; pl. 2, fig. 4.

1970. *Tornia mirabile* (Dybczyński): House, pp. 672, 673, text-fig. 2a, pl. 126, figs 3–5.

**Material:** MUZ PIG 284.II.734; in collection as *Tornoceras* (*Per-noceras*) *mirabile* (Dybczyński).

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
284.II.734	10.0	5.6	2.8	4.6	1.5	0.56	0.28	0.46	0.15

**Description:** Shell moderately evolute, with flat flanks. The outer whorl covers 2/3 of the preceding whorl. Ventral side rounded,

slightly flattened. Umbilicus broad, with step wall and rounded margin. Incomplete body chamber occupies less than a half of whorl. Suture line, with a small V-shaped ventral lobe, passes through indistinct outer saddle to broad and shallow adventitious lobe, and then into a feebly marked saddle disappearing in umbilicus.

**Distribution:** Poland: Holy Cross Mountains, Kielce (“Siek-lucki’s brickyard”) (Famennian, conodont zones: Upper *marginifera* – *trachytera*).

Family POSTTORNOCERATIDAE Bogoslovsky 1962

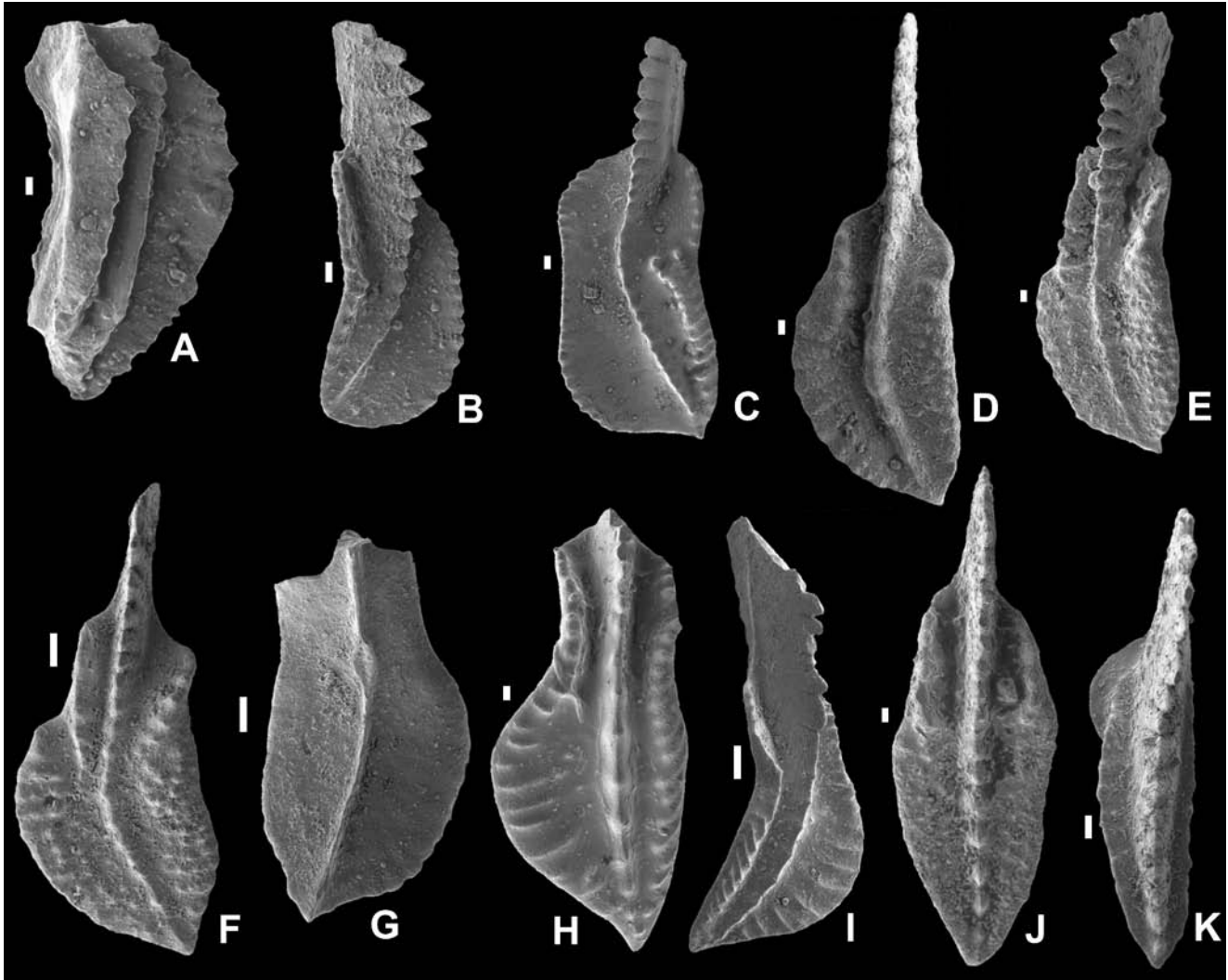
Genus *Posttornoceras* Wedekind 1910

Type species: *Posttornoceras balvei* Wedekind 1910

*Posttornoceras contiguum* Sobolew 1912

Figs 33 (F–H), 39A

1912. *Posttornoceras contiguum* (Münster): Sobolew, p. 8, pl. 6, figs 5–7.



**Fig. 18.** Upper Famennian conodonts from the Ostrówka section (Gałęzice), Middle *expansa* Zone, sample 284.II.323. **A.** *Polygnathus parapetus* Druce; **B, C.** *Polygnathus znepolensis* Spasov; **D–G.** *Polygnathus experplexus* Sandberg et Ziegler; **H, I.** *Polygnathus extralobatus* Schäfer; **J.** *Polygnathus hassi* Helms; **K.** *Pseudopolygnathus* aff. *micropunctatus* Bischoff et Ziegler. A – lateral view, B–K – upper views. Length of scale bars – 100  $\mu$ m

1914.  $\gamma$ -*Gomi-dimeroceras* (*Posttornoceras*) *contiguum* (Münster): Sobolew, p. 58, text-fig. 95, pl. 8, fig. 20.

1971. *Posttornoceras contiguum* Sobolew: Bogoslovsky, p. 87, text-fig. 23, pl. 4, fig. 8.

**Material:** MUZ PIG 284.II.735; in collection as *Posttornoceras S-ta Cruzensis* sp. n.

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
284.II.735	26.5	16.5	10.0	11.7	-	0.62	0.38	0.44	-

**Description:** Shell discoid and fully involute, with whorl widest near the umbilical margin. Ventral side moderately wide, flat-rounded; whorl cross section close to trapezoid. Umbilicus closed, with funnel-shaped depressions on flanks around it. Ventral lobe deep, narrow, funnel-shaped; First lateral lobe deep, asymmetrical, with pointed termination; second lobe shorter than first, similarly pointed. First lateral saddle wide and flat-rounded, with steep sides; second saddle high, narrow, linguoid, with steep and slightly depressed sides and rounded apex. The third saddle is broadly rounded and slightly asymmetric.

**Distribution:** Poland: Holy Cross Mountains, Łągów, Kowala sections (Famennian, conodont zones: Upper *marginifera* – *trachytera*); Germany; Russia, Ural (Famennian, goniatite zones *Posttornoceras contiguum* – *P. (Platyclymenia) annulata*; conodont zones: Upper *marginifera* – *trachytera*).

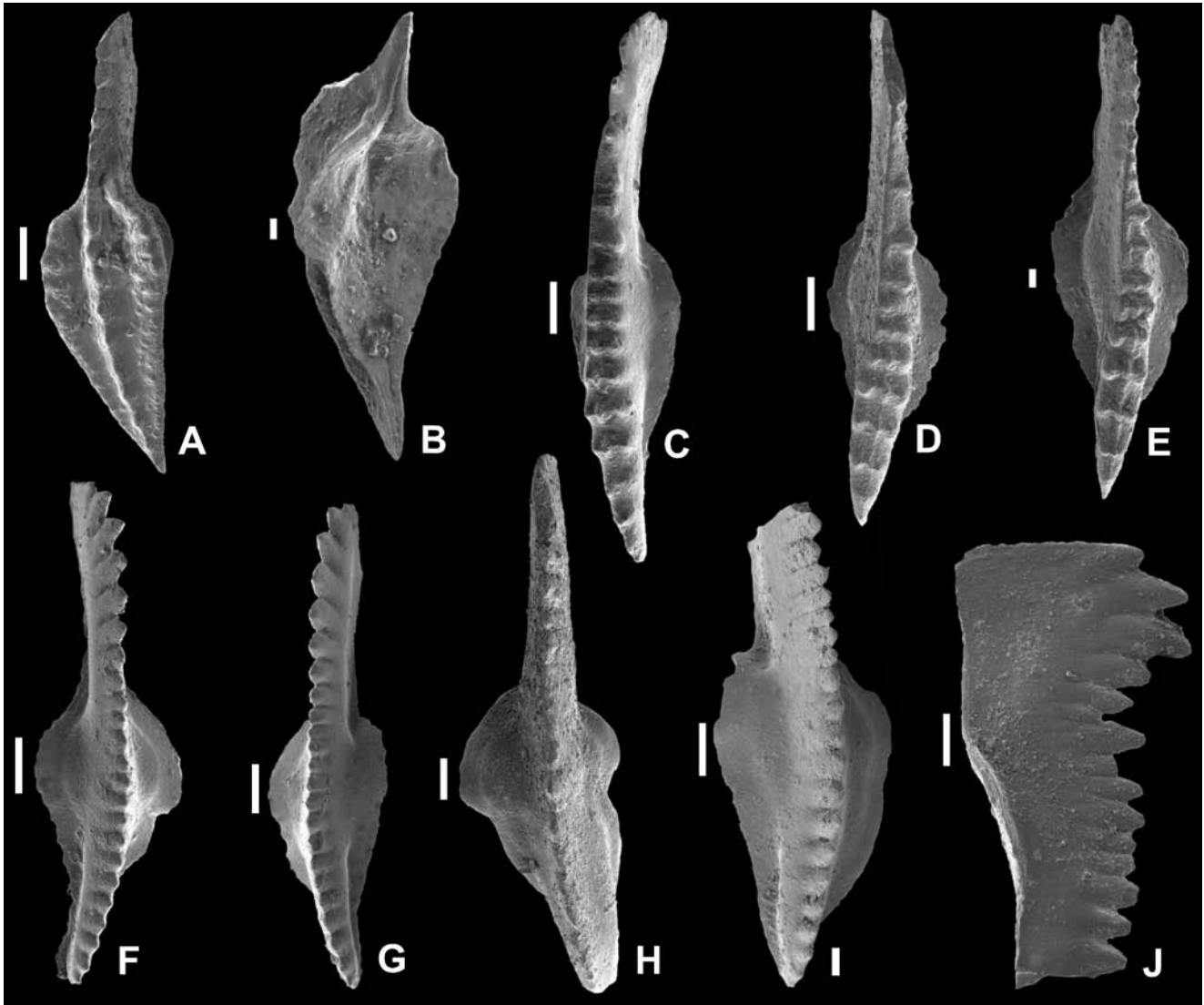
Subfamily DIMEROCERATACEAE Hyatt 1884  
Family CHEILO CERATIDAE Frech 1897

Genus *Cheiloceras* Frech 1897  
Type species *Goniatites subpartitus* Münster 1839

*Cheiloceras (Cheiloceras) subpartitum subpartitum*  
(Münster 1839)  
Figs 33 (I–M), 35 (A, B)

1839. *Goniatites subpartitus* Münster: p. 18, pl. 3, fig. 1.

1914. *Oma-monomero-ceras subpartitum lativaricatum* Sobolew: p. 36, pl. 3, fig. 5.



**Fig. 19.** Upper Famennian conodonts from the Ostrówka section (Gałęzice), Middle *expansa* Zone, sample 284.II.323. **A, B.** *Pseudopolygnathus brevipennatus* Ziegler, upper and lower views; **C–E.** *Bispathodus costatus sulciferus* (Branson et Mehl), upper views; **F, G.** *Bispathodus stabilis* (Branson et Mehl), upper views; **H, I.** *Brannehla suprema* (Ziegler), upper views; **J.** *Mehlina crassidentata* (Branson et Mehl), lateral view. Length of scale bars – 100  $\mu$ m

1914. *Oma-monomero-ceras subpartitum angustivaricatum* Sobolew: p. 37, pl. 3, fig. 6.

1971. *Cheiloceras (Cheiloceras) subpartitum* (Münster): Bogoslovsky, p. 105, 106, pl. 5, fig. 9.

1989. *Cheiloceras subpartitum* (Münster): Czarnocki, p. 18.

1993. *Cheiloceras (Cheiloceras) subpartitum subpartitum* (Münster): Becker, pp. 237–239, text-fig. 82a, 83a, pl. 13, figs 1–4, 9.

**Material:** MUZ PIG 175.II.14, 176.II.27.

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
175.II.27	18.8	11.5	3.7	7.2	-	0.61	0.19	0.38	-
175.II.27a	14.2	8.5	-	6.5	-	0.60	-	0.45	-
175.II.14	24.0	14.8	6.3	10.0	-	0.61	0.26	0.42	-

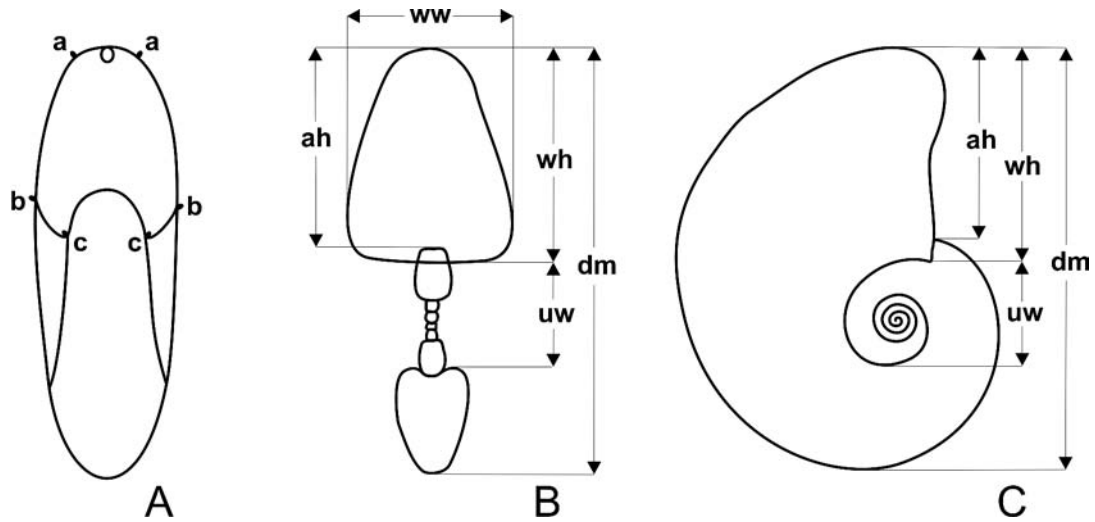
**Description:** Shell discoid, involute, with flat flanks. Ventral side narrow and rounded. Umbilicus closed, point-like. Distinct deep, straight or slightly bent, radial constrictions, 2 to 4 per whorl, are visible on the moulds.

**Distribution:** Poland: Holy Cross Mountains, Kielce, Łągów-Dule, Jancyce (Famennian, conodont zones: Upper *crepida* – Lower *marginifera*); Germany (goniatite zones: *subpartitum* – *biferum*; conodont zones: Upper *crepida* – Lower *marginifera*); Russia, Ural (lower part of the *Cheiloceras* genus zone).

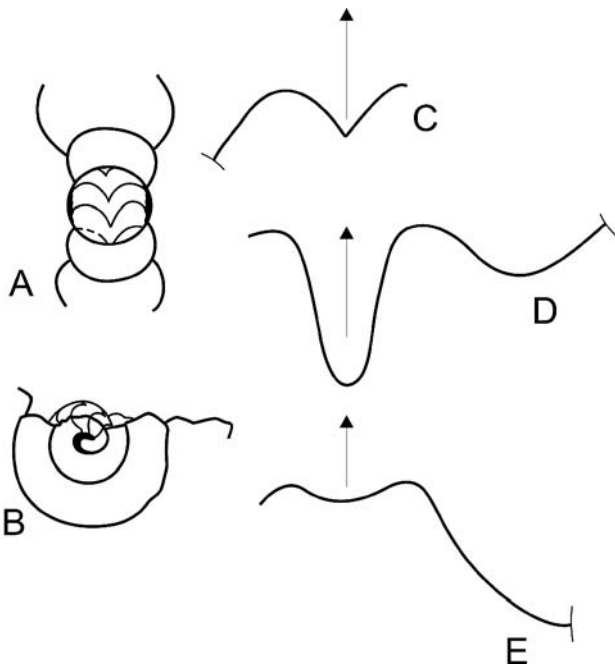
*Cheiloceras (Cheiloceras) longilobum* (Sobolew 1914)  
Figs 33E, 34 C

1914. *Oma-monomero-ceras (Cheiloceras) longilobum* Sobolew: p. 30, text-fig. 2, pl. 1, fig. 2a–b.

**Material:** MUZ PIG 175.II.7; in collection as *Cheiloceras curvispina* (Sandberger).



**Fig. 20.** Explanation of the morphological parameters of goniatite shells. **A** – view of the last whorl with aperture: a-a – outer or ventral side, a-b – whorl flank, b-c – umbilical part, c-c – inner or dorsal side; **B** – cross-section of shell; **C** – side view; dm – diameter of specimen; ww – whorl width; wh – whorl height; ah – aperture height; uw – umbilicus width



**Fig. 21.** Cross-section of shell with suture lines shown on the first whorl (**A**), side view of protoconch and whorls (**B**), suture lines (**C, D**) and growth lines (**E**) in *Archoceras varicosum* Drevermann; A–C – 175.II.50a, Plucki, wh = 1.0 mm; D, E – 175.II.50, Plucki, D – wh = 2.3 mm, E – wh = 2 mm

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
175.II.7	51.4	34.8	20.1	?20.0	-	0.67	0.39	0.39	-

**Description:** Shell discoid, with body chamber preserved, occupying 3/4 of whorl length. Umbilicus closed, with a broad funnel-like depression (3.5 mm) around it. Suture line with shallow

rounded ventral lobe, deep and narrow lateral lobe, and broad flat-rounded outer and lateral saddles.

**Distribution:** Poland: Holy Cross Mountains, Kadzielnia section (Famennian, zone: II $\alpha$ ).

*Cheiloceras (Staffites) curvispina curvispina*  
(G. et F. Sandberger 1850/51)  
Figs 34 (A, B), 35 (C–H)

- 1850/51. *Goniatites retrorsus curvispina* G. et F. Sandberger: p. 108, pl. 10, fig. 2, pl. 10b, figs 9, 10, 24, 28.
- 1914. *Oma-monomeroceras (Cheiloceras) acutilobum* Sobolew: p. 35, text-fig. 24, pl. 2, fig. 13.
- 1918. *Cheiloceras (Staffites) curvispina* (G. et F. Sandberger): Wedekind, p. 146, text-fig. 46m.
- 1971. *Cheiloceras (Staffites) curvispina* (Sandberger et Sandberger): Bogoslovsky, pp. 116, 117.
- 1993. *Cheiloceras (Staffites) curvispina curvispina* (G. et F. Sandberger): Becker, pp. 250, 251, text-figs 83l, 84c, 85a, b, 86a, b, pl. 15, figs 7–10.

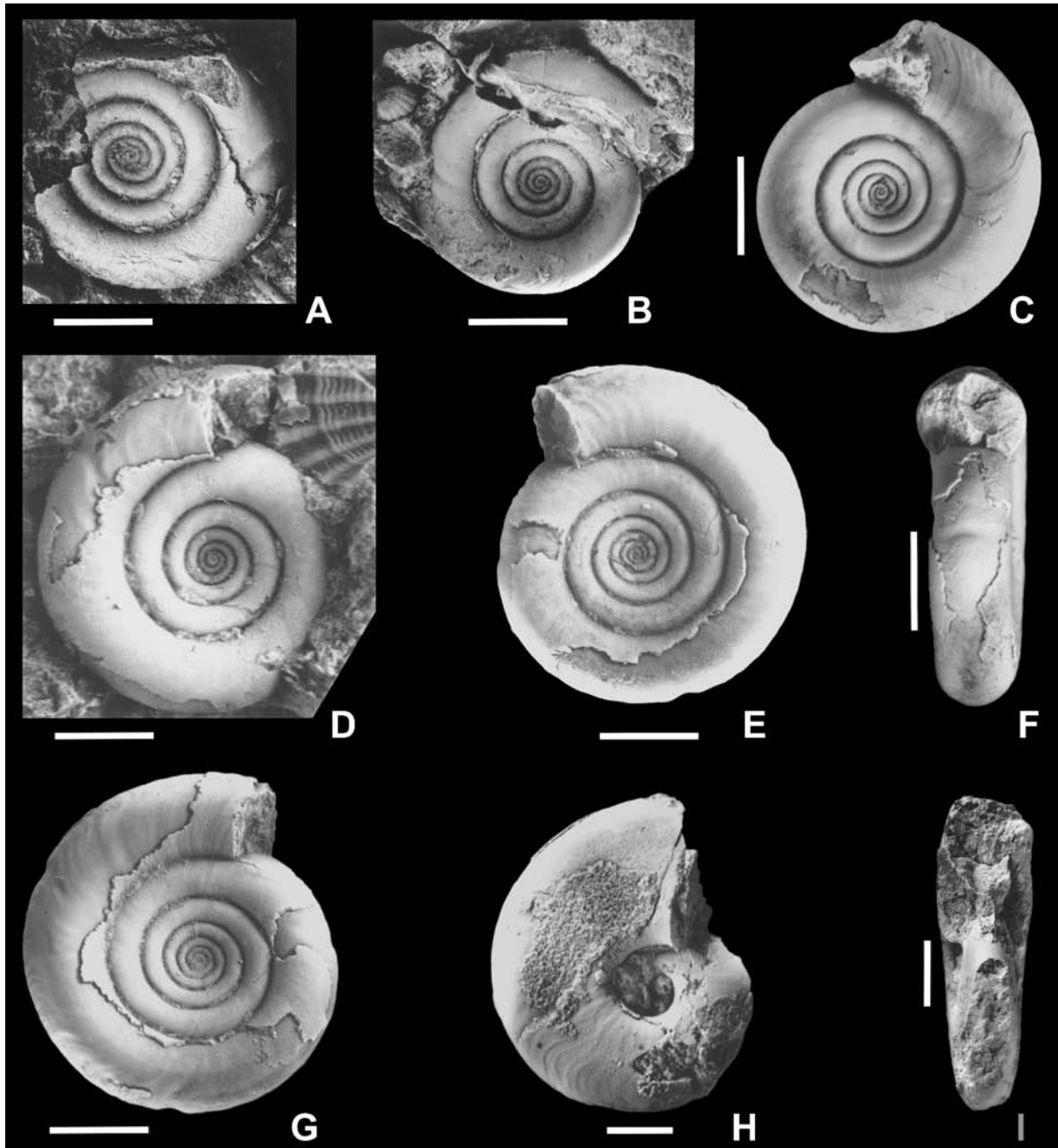
**Material:** MUZ PIG 175.II.5; in collection as *Cheiloceras acutilobum* Sobolew; 175.II.6, 7; 176.II.1–4.

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
175.II.5	35.3	21.3	-	16.6	-	0.60	-	0.47	-

**Description:** Shell thick-discoid, nearly subspherical, involute. Ventral side wide and rounded, flanks convex. Umbilicus closed. Growth lines convex on flanks, shaped in broad and rounded sinuses on ventral side. Distinct constrictions visible on moulds, 3–4 per whorl. Ventral lobe funnel-like, narrow, sharply pointed; the first lateral lobe pointed, in form of a hook bent toward the outer side. The outer saddle is flattened and broad, the lateral saddle is higher and broader than outer one.

**Remarks:** The present author, similarly as Becker (1993), included *Cheiloceras acutilobum* to synonymy of *Ch. (Staffites) curvispina curvispina*, as both species have similar suture line. R.T. Becker noted the unusually great dimensions of the Polish specimens (diameters from 50 to 70 mm), distinguishing them from the forms from the type area in Germany, which attain only 30 mm in diameter.



**Fig. 22.** A–G. *Archoceras varicosum* (Drevermann), A – sample 175.II.48; B – 175.II.50; C – Pl.12; D – 175.II.49; E–G. – Pl.1; **H, I.** *Manticoceras drevermanni* Wedekind, 175.II.40; A–E, G, H – lateral view, showing growth lines; F, I – adoral view; Plucki, Upper Frasnian, *Archoceras varicosum* Zone, *linguiformis* Zone. Length of scale bars – 10 mm

**Distribution:** Poland: Holy Cross Mountains, Łagów section, Kadzielnia section (Famennian, zone II $\alpha$ , conodont zones: Upper *crepida* – *rhomboidea*); Germany; North Africa; Russia, Ural (Famennian, upper part of zone II $\alpha$ , zones *globosum* – *acutum*).

*Cheiloceras* (*Raymondiceras*) *verneuili* (Münster 1839)  
Figs 34D, 35 (I, J)

1839. *Goniatites verneuili* Münster: p. 17, pl. 3, fig. 9.

1908. *Cheiloceras verneuili* (Münster): Wedekind, pp. 583, 584, pl. 39, fig. 1.

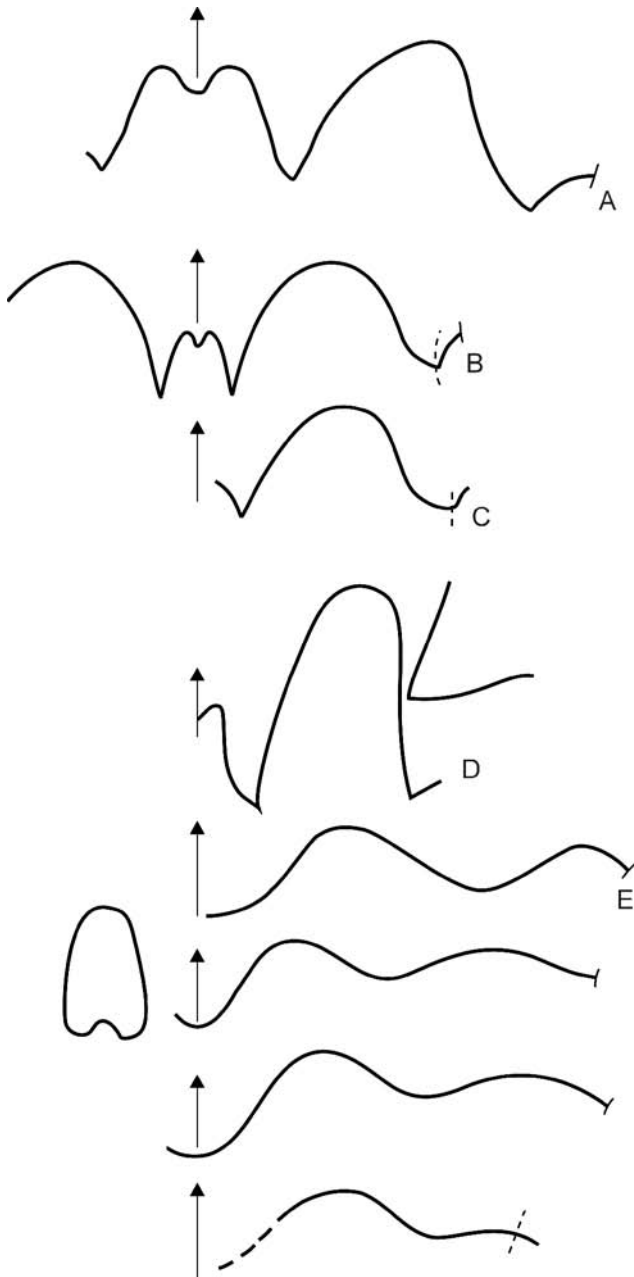
1914. *Oma-monomeroceras verneuili* (Münster): Sobolew, p. 32, text-fig. 11, pl. 2, fig. 1.

1966. *Cheiloceras verneuili* (Münster): Babin, pp. 374, 375, text-figs 36(1), 36(2), pl. 18, figs 11, 12.

1971. *Cheiloceras* (*Cheiloceras*) *verneuili* (Münster): Bogoslovsky, pp. 106, 107, text-fig. 31b, pl. 6, figs 1–3.

1993. *Cheiloceras* (*Raymondiceras*) *verneuili* (Münster): Becker, pp. 258–260, text-figs 84d, f, 87a, b, pl. 16, figs 3, 4, 6, 7, 10, 11.

**Material:** 176.II.31a, b, d; 43, 47; in collection as *Cheiloceras verneuili* (Münster).



**Fig. 23.** Suture lines (A–D) and growth lines (E–I) in *Manticoceras* Hyatt: **A.** *Manticoceras drevermanni* Wedekind, 175.II.39, Plucki, wh = 26.7 mm; **B.** *Manticoceras lamed* (G. et F. Sandberger), 175.II.42, Plucki, wh = 20 mm; **C.** *Manticoceras lamed* (G. et F. Sandberger), 175.II.43, Plucki, WH = 22 mm; **D.** *Manticoceras intumescens* (Beyrich), 175.II.51, Plucki, wh = 40 mm; **E.** *Manticoceras drevermanni* Wedekind, 175.II.40, Plucki, wh = 18.5 mm; **F.** *Manticoceras drevermanni* Wedekind, 175.II.35, Plucki, wh = 26.2 mm; **G.** *Manticoceras drevermanni* Wedekind, 175.II.33, Plucki, wh = 26.7 mm; **H.** *Manticoceras lamed* (G. et F. Sandberger), 175.II.46, Plucki, wh = 10.5 mm; **I.** *Manticoceras drevermanni* Wedekind, 175.II.35, transverse section, wh = 24.0 mm

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
176.II.31b	36.0	22.5	11.0	15.0	-	0.63	0.30	0.42	-
176.II.31d	36.5	19.6	8.0	16.5	-	0.54	0.22	0.45	-
176.II.43	72.5	42.0	16.7	29.0	-	0.58	0.23	0.40	-
176.II.47	39.5	24.3	11.4	17.3	-	0.61	0.29	0.44	-

**Description:** Shell discoid, from thick to thin, with variable aperture heights – from low to moderately high. Ventral side round, flanks are slightly flattened. Umbilicus in adult forms completely closed, a funnel-shaped depression visible around it. Growth lines on flanks are convex, and on the ventral side show angular sinuses with rounded bottoms. Constrictions on the ventral side, 4–6 per whorl, mimic the sinusoidal shape of the growth lines. Ventral lobe V-shaped, shallow; lateral lobe broad, open at an obtuse angle, asymmetric. Its outer side gently inclined, the inner – steep. Ventral saddle flattened, passes to lateral lobe; lateral saddle broad, rounded and flattened, passes gradually to umbilical margin.

**Remarks:** The variability of whorl and aperture height in this species is well reflected by the variation of the wh/dm (from 0.53 to 0.63) and ah/dm (from 0.22 to 0.30) indices.

**Distribution:** Poland: Holy Cross Mountains, Łagów section, Kadzielnia section (Famennian, zone: II $\alpha$ , conodont zones: Upper *crepida/romboidea*); Germany; France; Russia (Famennian, zones: II $\alpha$  – lower part of II $\beta$ , *verneuli* – *biferum*).

Family DIMEROCERATIDAE Hyatt 1884

Genus *Dimeroceras* Hyatt 1884  
Type species *Goniatites mamillifer*  
G. et F. Sandberger 1850

*Dimeroceras globosum* (Sobolew 1914)  
Figs 36B, 37 (A–C)

1914.  $\gamma$ -*Oma-dimeroceras* (*Dimeroceras*) *globosum* Sobolew: p. 42, text-fig. 58, pl. 4, fig. 9a, b.

**Material:** Muz. PIG 176.II.8a, b; 11a; in collection as *Cheiloceras globosum* (Münster).

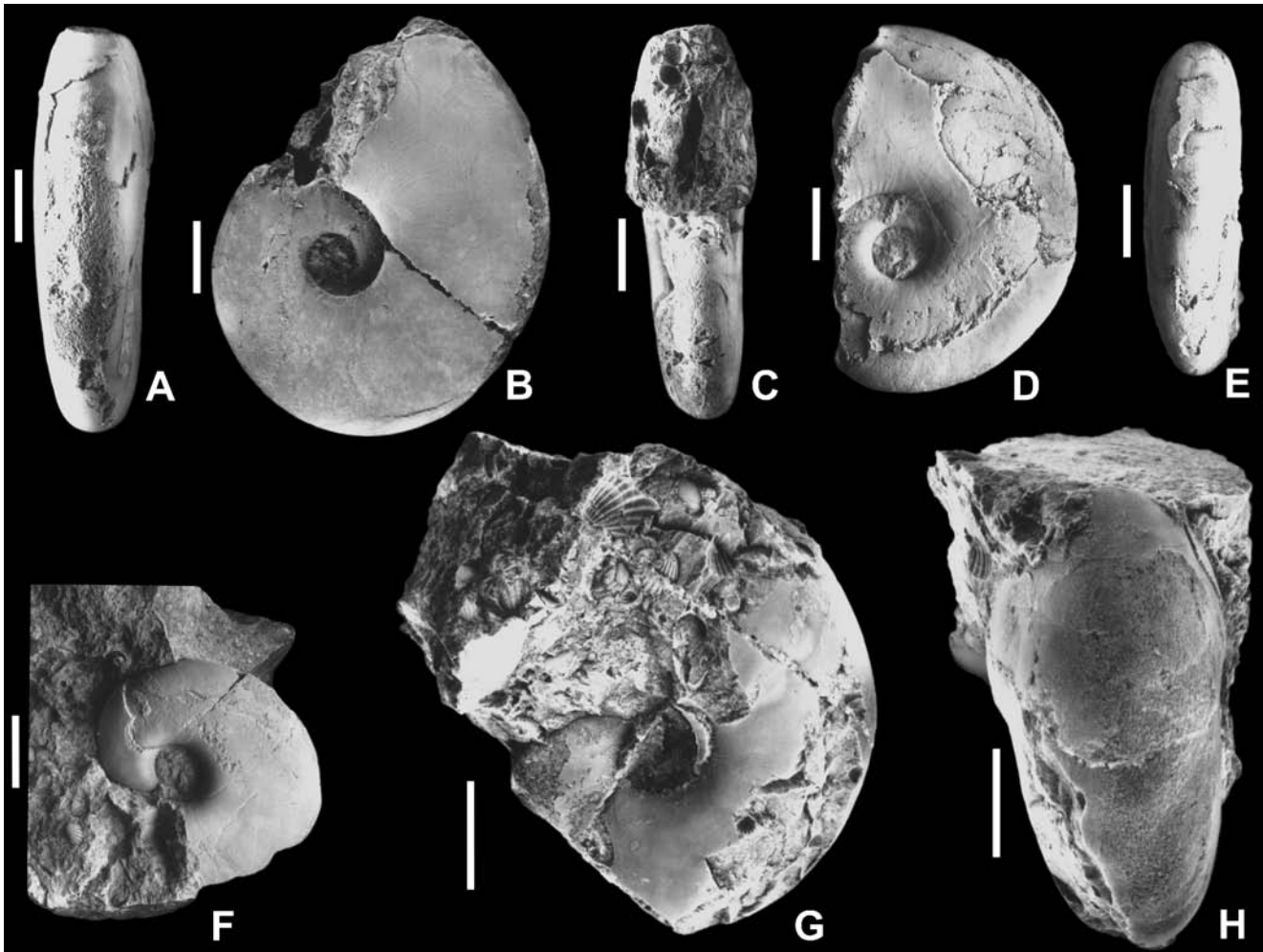
**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
Sobolev, tab. IV, fig. 9	28.0	15.0	7.4	18.0	-	0.54	0.26	0.64	-
176.II.8b	21.0	11.0	-	14.5	-	0.52	-	0.69	-
176.II.11a	26.2	16.2	7.0	15.0?	-	0.61	0.26	0.57	-
176.II.8a	37.0	23.0	13.5	23.0	-	0.62	0.36	0.62	-

**Description:** Shell nearly subspherical, involute, maximum diameter 37 mm. Ventral side wide and rounded, flanks slightly convex. Whorl cross section crescentic. Umbilicus closed at mature stage. Ventral lobe moderately broad, V-shaped, with rounded bottom, half the length of adventitious lobe. Adventitious lobe deep, with rounded bottom directed towards the outer side. Lateral lobe small, open at an obtuse angle. First saddle high, moderately broad, with steep sides. Lateral saddle asymmetric, broad and flattened, with steep outer side and gently inclined apex, passing abruptly to angular lateral lobe open at an obtuse angle. Subumbilical saddle low and wide-round.

**Distribution:** Poland: Holy Cross Mountains, Łagów section (Famennian, zone: II $\beta$ ; zones: Lower – Upper *marginifera*); Germany; North Africa; Russia (Famennian, zones: II $\beta$  – ?III $\beta$ ).





**Fig. 24.** A–E. *Manticoceras drevermanni* Wedekind; A–C – sample 175.II.37, D, E – 175.II.39. F–H. *Manticoceras lamed* (G. et F. Sandberger); F – 175.II.42, G, H – 175.II.44, A, E, H – ventral view, B, D, F, G – lateral view, D, E – with sutures, C – adoral view; Plucki, Upper Frasnian, *Archoceras varicosum* Zone, *linguiformis* Zone. Length of scale bars – 10 mm

Genus *Paratornoceras* Hyatt 1900  
Type species *Goniatites lentiformis* Sandberger 1857

*Paratornoceras polonicum* (Gürich 1896)  
Figs 36A, 37 (D–H)

1896. *Paradoceras? lentiforme* var. *polonica* Gürich: p. 343, pl. 13, fig. 1.

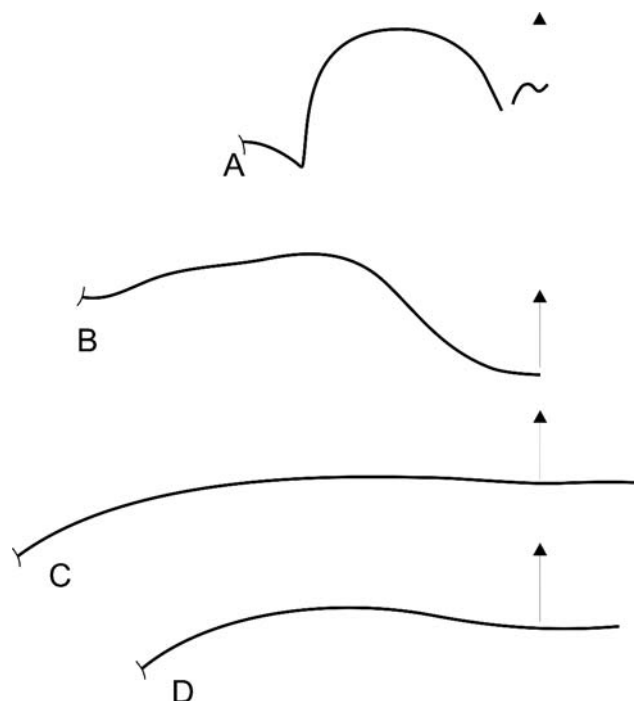
1914. *Oma-monomeroceras (Aganites?) lentiforme* Sandberg, em. Gürich: Sobolew, p. 34, text-figs 18–20, pl. 2, figs 9, 10.

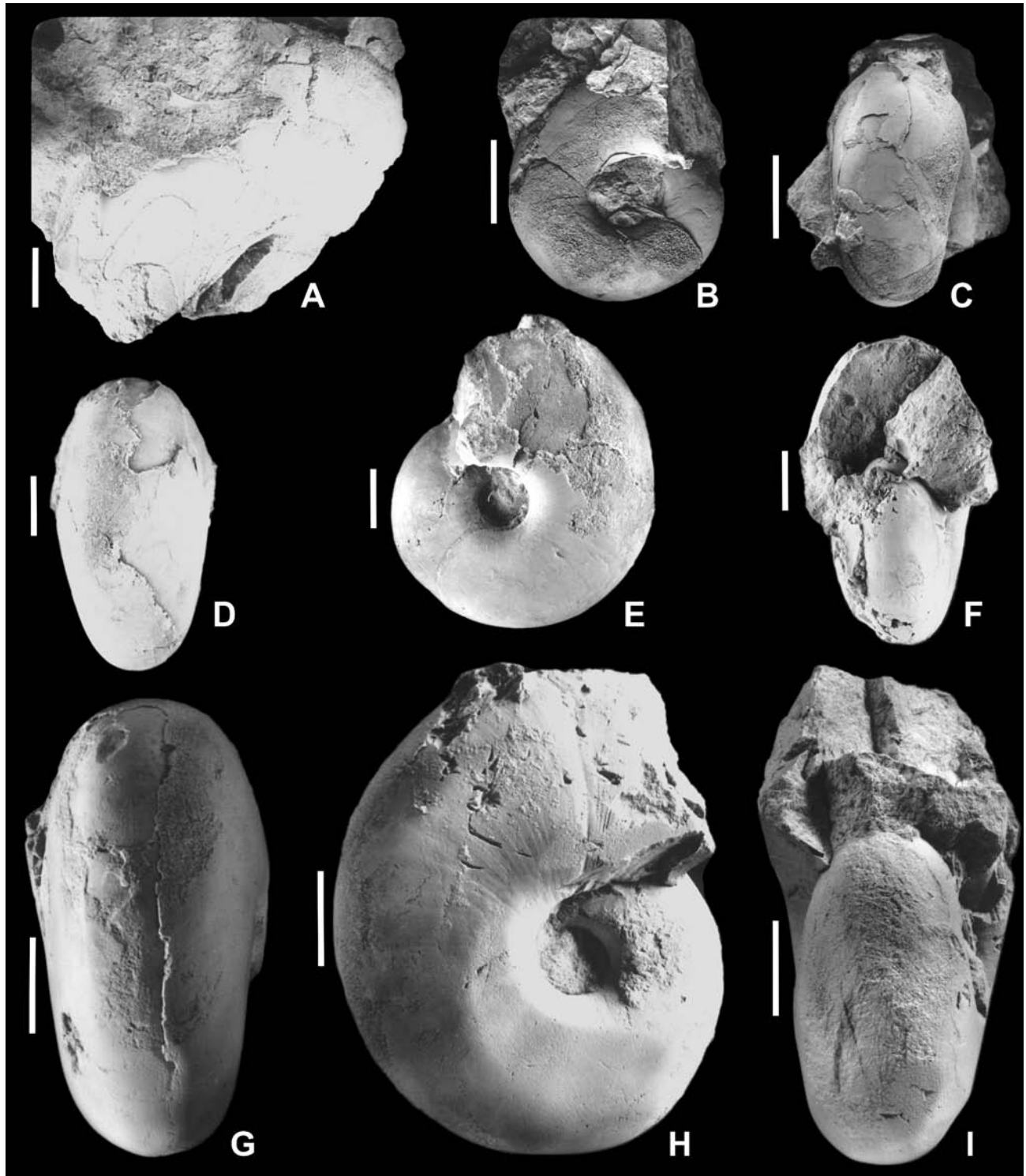
1971. *Paratornoceras (P.) lentiforme* (Sandberger): Bogoslawsky, pp. 176–179, text-fig. 57a, pl. 15, figs 1–6.

1975. *Paratornoceras lentiforme* (Sandberger): Petersen, p. 33, text-figs 12i, 18c, 19, 20a–d, pl. 3, figs 1–6; pl. 4, figs 6–8.

**Material:** MUZ PIG 176.II.20, 21, 22, 24, 25; in collection – 176.II. 20 as *Cheiloceras lagowiensis* Gürich; 176.II. 21, 22, 24, 25 – as *Cheiloceras lentiforme* Gürich.

**Fig. 25.** Suture lines (A) and growth lines (B–D) in *Crickites holzapfeli* Wedekind. A, B – UW 03393 coll. H. Makowski, Plucki; A – wh = 28.4 mm, B – wh = 38.8 mm; C, D – 175.II.35, Plucki, C – wh = 27.0 mm; D – wh = 18.0 mm





**Fig. 26.** A. *Manticoceras intumescens* (Beyrich), 175.II.51; B, C. *Crickites neverovi* Bogoslovsky, sample 175.II.52; D–I. *Crickites holzapfeli* (Wedekind), D–F – sample 175.II.33, G–I – sample UW 003393; A, B, E, H – lateral view, A – with sutures, H – with growth lines, C, D, G – ventral view, F, I – adoral view; Płucki, Upper Frasnian, *Archoceras varicosum* Zone, *linguiformis* Zone. Length of scale bars – 10 mm

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
176.II.21	32.0	20.0	-	18.6	-	0.63	-	0.58	-
176.II.22	47.0	28.0	14.0	18.5	-	0.60	0.30	0.40	-
176.II.24	37.0	25.0	?12.0	?18.0	-	0.67	0.32	0.50	-
176.II.25	?45.0	?29.0	14.5	18.0	-	0.64	0.32	0.40	-

**Description:** Shell at mature stage lenticular, strongly involute, 30–50 mm in diameter. Ventral side sharp, whorl flanks moderately and regularly convex. Umbilicus point-like, nearly closed. Body chamber occupies nearly the whole whorl. Shell smooth, though on moulds occur radial constrictions, 3–5 per whorl, well marked near the ventral side, where they slightly bend sinusoidally backwards. Suture line consists of: shallow V-shaped ventral lobe, deep and asymmetrical, pointed adventitious lobe, and wide and shallow lateral lobe. First lateral saddle is rounded and narrow, the second – broad and rounded.

**Distribution:** Poland: Holy Cross Mountains, Łagów section (Lower Famennian, upper part of *Cheiloceras* Zone; conodont zones: Lower–Upper *marginifera*); Germany (*Paratornoceras acutum* – to the top of Nehdenium Beds); Spain; North Africa; Russia, Ural (upper part of *Cheiloceras* genus zone).

Genus *Praemeroceras* Becker, 1993

Type species *Dimeroceras petterae* Petersen 1975

*Praemeroceras globosoides* (Sobolew 1914)

Figs 36 (C–F), 37 (I, J), 38 (A–D)

1914. *Oma* – *monomeroceras* (*Cheiloceras*) *globosoides* Sobolew: p. 42, text-fig. 57, pl. 4, figs 6a, b, 7, 8.

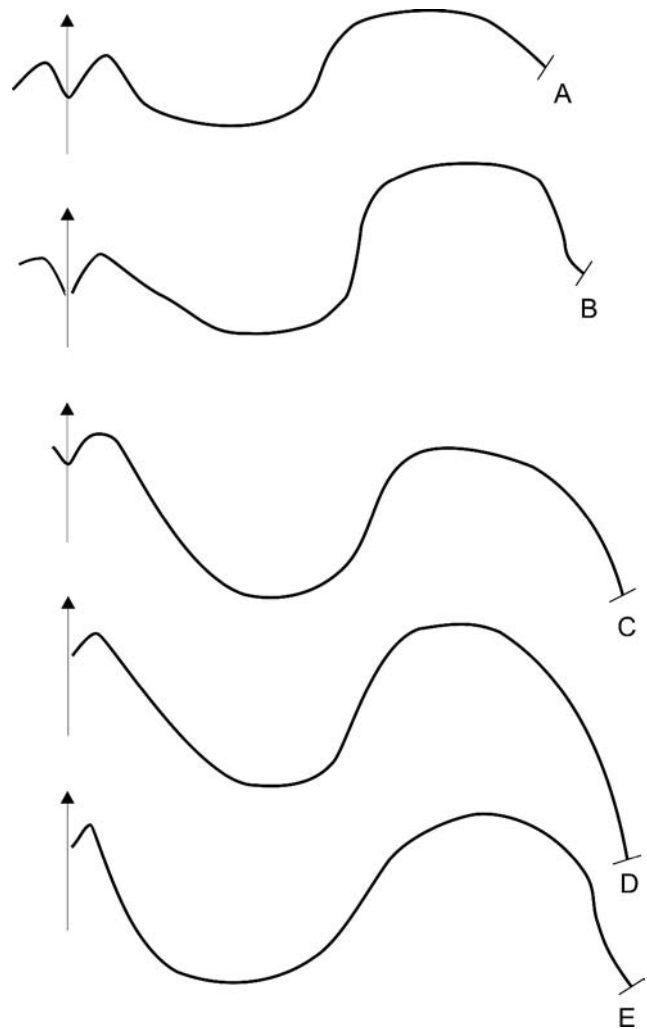
**Material:** 176.II.9, 10, 11b, 12–16, 63; in collection as *Cheiloceras globosum* (Münster); 176.II.40; in collection as *Cheiloceras verneuli* (Münster).

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
176.II.9	40.3	25.0	11.0	24.4	-	0.62	0.27	0.61	-
176.II.10	61.4	37.3	21.0	?29.0	-	0.60	0.34	0.50	-
176.II.16	54.0	33.3	15.0	?28.6	-	0.61	0.27	0.52	-
176.II.40	43.8	28.0	?10.0	?24.5	-	0.63	0.22	0.56	-

**Description:** Shell thick discoid, with wide and rounded ventral side, and slightly convex flanks. Whorl section crescentic. Aperture height usually equal to 1/2 of whorl height. Umbilicus closed in mature forms. Ventral lobe moderately broad, V-shaped, with rounded bottom, 1/2 the length of adventitious lobe. Adventitious lobe deep, narrow with rounded bottom. Lateral lobe widely rounded, divided by low saddle on the margin of circumumbilical depression. Ventral saddle moderately broad, with rounded apex and steep sides, lateral saddle of the same height as the ventral saddle, broad, rounded and asymmetric, with steep outer side and inclined inner side.

**Occurrence:** Poland: Holy Cross Mountains, Łagów section (Famennian, zone II $\beta$ ; conodont zones: Lower–Upper *marginifera*); Germany; North Africa; Russia (zone II $\alpha$ –II $\beta$ , zones *patterae* – *biferum*).



**Fig. 27.** A–E. Suture lines in *Tornoceras sublentiforme* (Sobolew). **A** – 175.II.90, Janczyce, wh = 17.2 mm; **B** – 175.II.93a, Janczyce, wh = 31.2 mm; **C** – 175.II.111, Janczyce, wh = 44.3 mm; **D** – 175.II.116, Janczyce, wh = 50.5 mm; **E** – 175.II.113, Janczyce, wh = 61 mm

## Family PROLOBITIDAE Wedekind 1913

Genus *Prolobites* Karpinsky 1885

Type species *Goniatites bifer* var. *delphinus* Sandberger et Sandberger 1851

*Prolobites* sp.

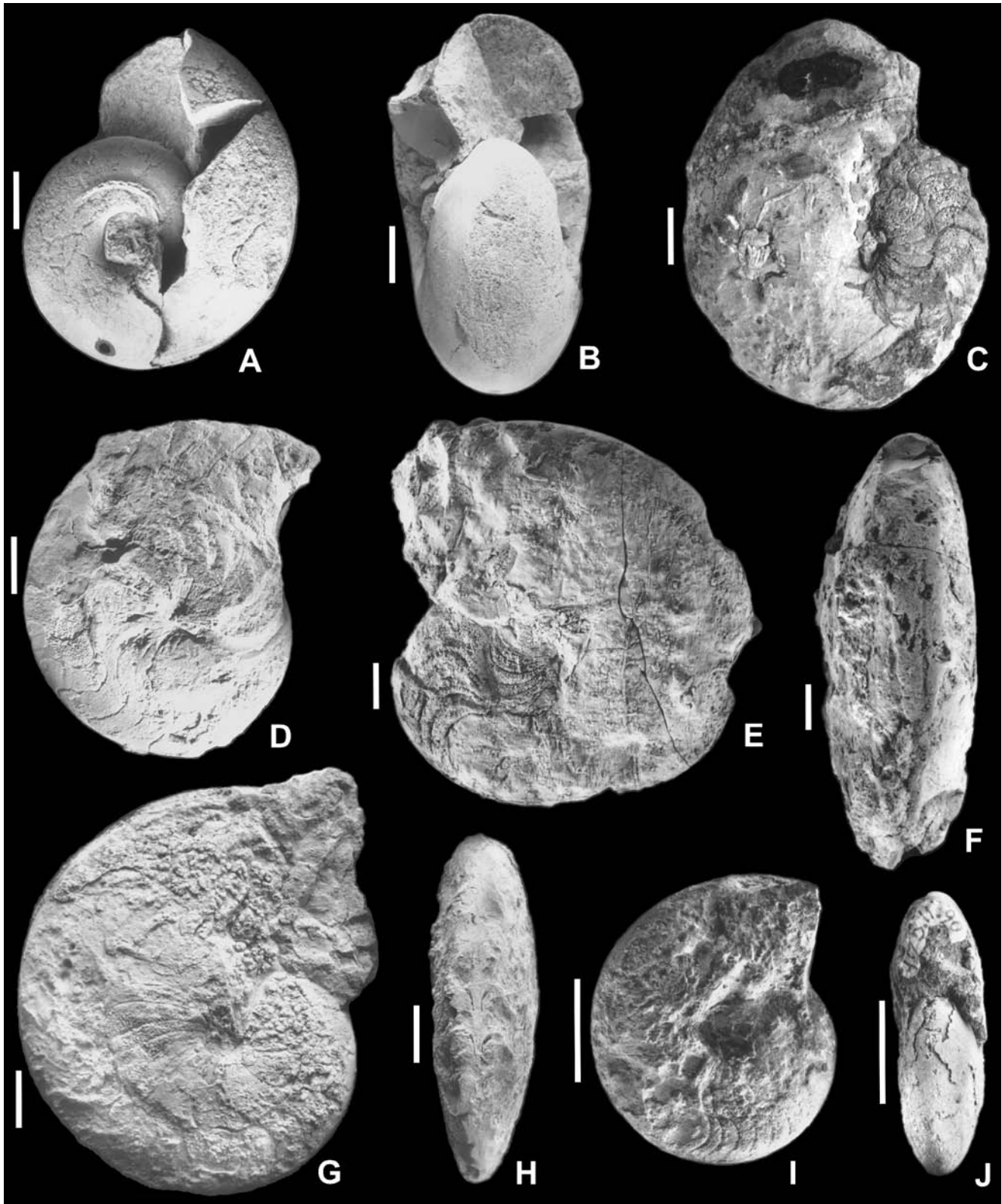
Fig. 38 (E–H)

**Material:** MUZ. FIG 284.II.85, 87.

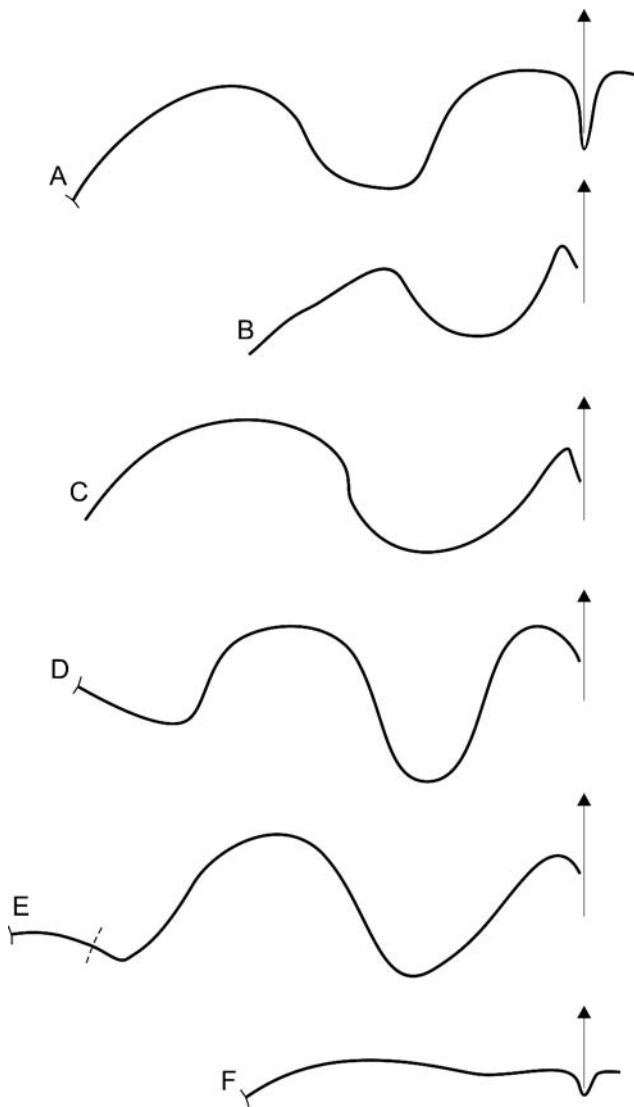
**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
284.II.85	21.9	13.1	5.0	11.9	-	0.59	0.22	0.54	-
284.II.87	22.3	13.0	6.3	13.7	-	0.58	0.28	0.61	-

**Description:** Shell discoid and involute, with flat flanks and distinct constriction near aperture, up to 23 mm in diameter. Ventral side narrow. Cross section of the last whorl high ovate. Umbilicus closed. A distinct circular depression visible before the apertural



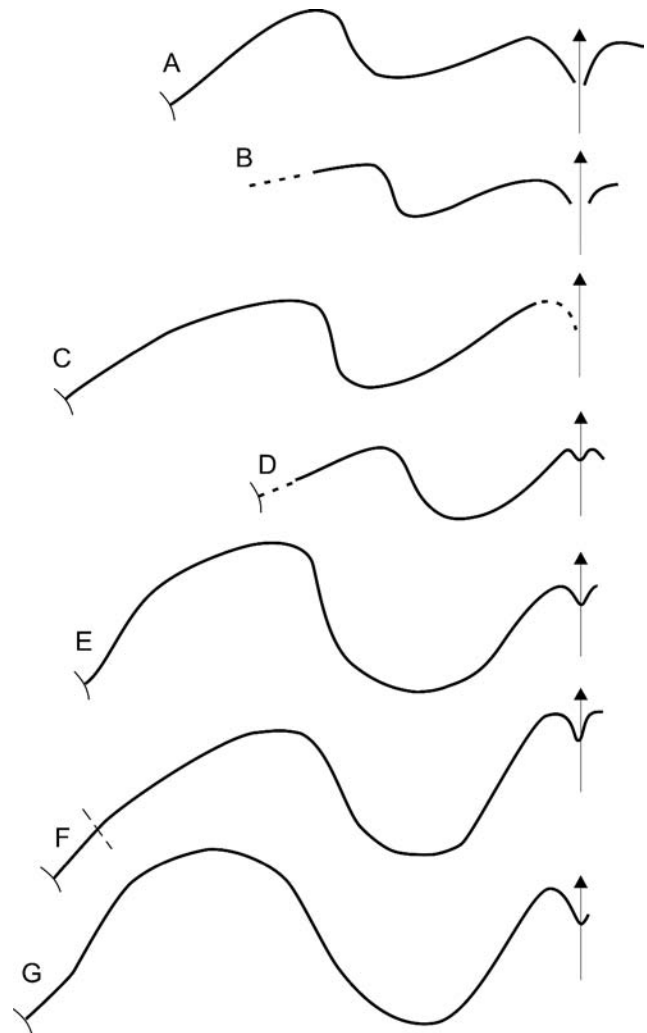
**Fig. 28.** A, B. *Crickites holzapfeli* (Wedekind), A – lateral view, B – adoral view, 175.II.45, Płucki, Upper Frasnian, *Archoceras varicosum* Zone, *linguiformis* Zone. C–J. *Tornoceras sublentiforme* (Sobolew), C – 175.II.117; D – 175.II.111; E, F – 175.II.113; G, H – 175.II.94; I, J – 175.II.90; C–E, G, I – lateral view with sutures, F, H – ventral view, J – adoral view; Janczyce, Famennian, *Cheiloceras* (*Ch.*) *subpartitum* Zone, Upper *crepida* Zone. Length of scale bars – 10 mm



**Fig. 29.** Suture lines in *Linguatormoceras* House, *Oxytormoceras* Becker, *Falcitormoceras* House et Price and *Tornia* House: **A** – *Linguatormoceras* aff. *clausum* (Glenister), 175.II.42a, Płucki, wh = 10.3 mm; **B** – *Oxytormoceras acutum* (Freck), 176.II.77, Janczyce, wh = 19.3 mm; **C** – *Oxytormoceras acutum* (Freck), 175.II.88, Kadzielnia, wh = 26.2 mm; **D, E** – *Falcitormoceras bilobatum* (Wedekind), 284.II.288, Ostrówka, D – wh = 24.4; E – wh = 27.5; **F** – *Tornia mirabile* (Dybczyński), 284.II.734, Kielce, “Sieklucki’s brickyard”, wh = 4.3 mm

constriction, connected with both, constriction and umbilicus. Growth lines straight, suture line not preserved. The described specimens are most similar to *P. delphinus* (G. et F. Sandberger), from which they differ by their higher whorls and the more distinct depression near the umbilicus.

**Distribution:** Poland: Holy Cross Mountains, Gałęzice: Ostrówka section (Upper Famennian, goniatite genus zone: *Prolobites*; conodont zone: Upper *trachytera*).



**Fig. 30.** A–G. Suture lines in *Phoenixites frechi* (Wedekind). **A** – 175.II.100, Janczyce, wh = 16 mm; **B** – 175.II.91a, Janczyce, wh = 11 mm; **C** – 175.II.105, Janczyce, wh = 12.5 mm; **D, E** – 175.II.97, Janczyce, D – wh = 8 mm, E – wh = 43 mm; **F** – 175.II.103, Janczyce, wh = 47.5 mm; **G** – 175.II.106, Janczyce, wh = 31.7 mm

#### Superfamily PRAEGLYPHIOCERATACEAE

Ruzhencev 1957

#### Family SPORADOCERATIDAE Miller et Furnish 1957

#### Genus *Sporadoceras* Hyatt 1884

Type species *Ammonites Münsteri* v. Buch 1832

#### *Sporadoceras muensteri* (v. Buch 1832)

Figs 38 (I–K), 39C

1832. *Ammonites Münsteri* v. Buch: p. 41, pl. 2, fig. 5.

1870. *Goniatites Münsteri* (v. Buch): Tietze, p. 28, pl. 1, fig. 7.

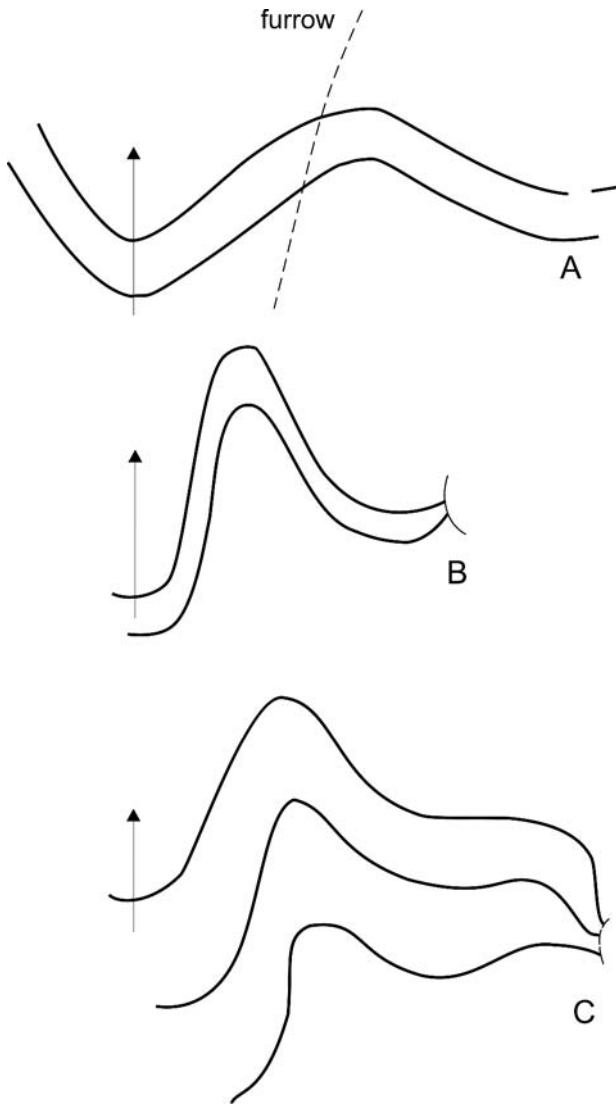
1971. *Sporadoceras (Sporadoceras) muensteri* (Buch): Bogoslovsky, pp. 141–144, text-fig. 41, pl. 9, figs 5, 6.

1975. *Sporadoceras (Sporadoceras) muensteri* (von Buch): Petersen, p. 42, text-figs 21d, 22b, pl. 6, figs 4–6.

1989. *Sporadoceras münsteri* (Buch): Czarnocki, p. 24.

1993. *Sporadoceras muensteri* (v. Buch): Becker, pp. 319, 320, text-fig. 95k, pl. 24, fig. 8.

**Material:** MUZ PIG 284.II.275.



**Fig. 31.** A–C. Growth lines in *Phoenixites frechi* (Wedekind). A – 175.II.105, Janczyce, wh = 12.5 mm; B, C – 175.II.125, Plucki, B – wh = 4 mm, C – wh = 11.7 mm

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
284.II.275	51.2	32.5	18.5	34.5	-	0.63	0.37	0.67	-

**Description:** Shell thick discoid, strongly involute, widest near umbilicus. Ventral side moderately wide, rounded, passes gradually to flat-convex flanks, forming funnel-like depression near umbilicus. Umbilicus closed. Whorl cross section elliptical. Suture line in mature forms with narrow and deep ventral lobe, whose depth equals 3/4 of the depth of lateral lobes. First and second saddle high and regular, bounded by almost parallel sides and rounded apices. Lateral lobes also have parallel sides, but their bottoms are elongated and pointed. Subumbilical saddle broad and rounded, slightly asymmetric.

**Distribution:** Poland: Holy Cross Mountains, Gałęzice: Ostrówka section (Upper Famennian, goniatite genera zones: *Platyclymenia* – *Clymenia*; conodont zones: Upper *trachytera* – Lower *expansa*); Sudetes: Dzikowiec, “*Clymenia* Limestone”; Germany; Morocco; Russia: Ural; Kazakhstan; Australia (Upper Famennian, cephalopod zones III–V).

*Sporadoceras posthumum* Wedekind, 1918  
Figs 39B, 40 (A, D)

1918. *Sporadoceras contiguum* var. *posthuma* Wedekind: p. 149, text-fig. 47k, pl. 18, fig. 13.

1971. *Sporadoceras (Sporadoceras) posthumum* Wedekind: Bogosłowsky, p. 155, 156, pl. 13, figs 1-3.

1975. *Sporadoceras (Sporadoceras) posthumum* Wedekind: Petersen, pp. 42, 45, text-figs 21e, 22a, 23, pl. 6, figs 1-3.

**Material:** MUZ PIG 284.II.323; in collection as *Sporadoceras contiguum* var. *posthuma* Wedekind.

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
284.II.323	?60.0	33.5	-	25.0	-	0.55	-	0.42	-

**Description:** Shell incomplete, strongly involute, ca 70 mm in diameter. Ventral side wide and rounded; flanks flat, forming a funnel-like depression near umbilicus. Umbilicus point-like, closed. Suture line with narrow, funnel-shaped and deep ventral lobe, whose depth equals half the depth of the first lateral lobe. The first lateral lobe deep and narrow, with pointed termination directed outwards. The second lobe shorter than first and mimics its shape. First and second saddles high, limited by nearly parallel sides and rounded apices; the first saddle much broader. Subumbilical saddle high, slightly broader than the other saddles.

**Distribution:** Poland: Holy Cross Mountains, Gałęzice: Ostrówka section (Upper Famennian, “*Gonioclymenia* Beds”, *Clymenia* Zone, conodont zone: Middle *expansa*); Germany; North Africa; Russia: Ural; Australia, Canning Basin (Upper Famennian, cephalopod zones: III–VI).

Family PRAEGLYPHIOCERATIDAE Ruzhencev 1957

Genus *Praeglyphioceras* Wedekind 1908

Type species *Sporadoceras pseudosphaericum* Frech 1902

*Praeglyphioceras kielcense* (Sobolew 1914)

Fig. 40 (B, C, E, F)

1914.  $\gamma$  - *Oma-dimeroceras (Praeglyphioceras) kielcense* Sobolew: p. 39, text-fig. 44, pl. 3, figs 14–16.

**Material:** MUZ PIG 284.II.34; 284.II.732; in collection as *P. pseudosphaericum* Frech.

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
284.II.732	21.0	12.0	-	10.8	3.0	0.57	-	0.51	0.14
284.II.34	8.3	5.0	1.6	5.3	1.3	0.60	0.13	0.64	0.16

**Description:** Shell thick discoid, nearly spherical, 9 to 20 mm in diameter. Umbilicus small, rounded and concave. Shell covered with thin and dense growth striae, convex on flanks and forming a shallow sinus on the ventral side. Indistinct radial constrictions, 4 per whorl, are present on moulds. Suture line with high lateral saddles, the first moderately broad and the second broader, and a V-shaped broad lateral lobe. Height of secondary median saddle equals 2/3 of the lateral saddle height. Indistinct straight constrictions, 4 per whorl, and the high median saddle distinguish this species from *P. pseudosphaericum* Frech.

**Distribution:** Poland: Holy Cross Mountains, Kielce: Sieklucki’s brickyard (“*Clymenia* Shales”), Gałęzice: Ostrówka section (Upper Famennian, goniatite genus zone: *Prolobites*; conodont zones: Upper *marginifera* – *trachytera*).

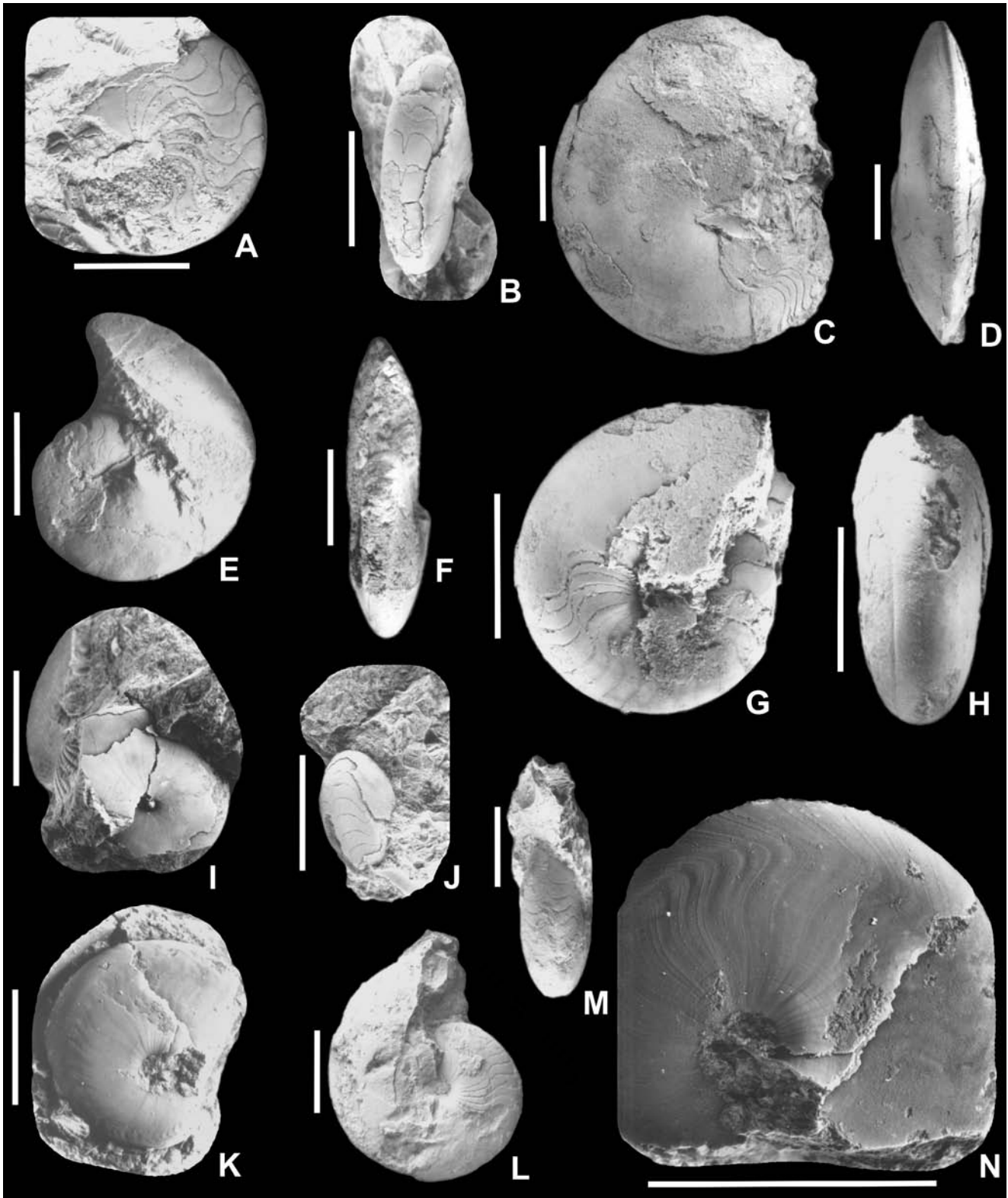
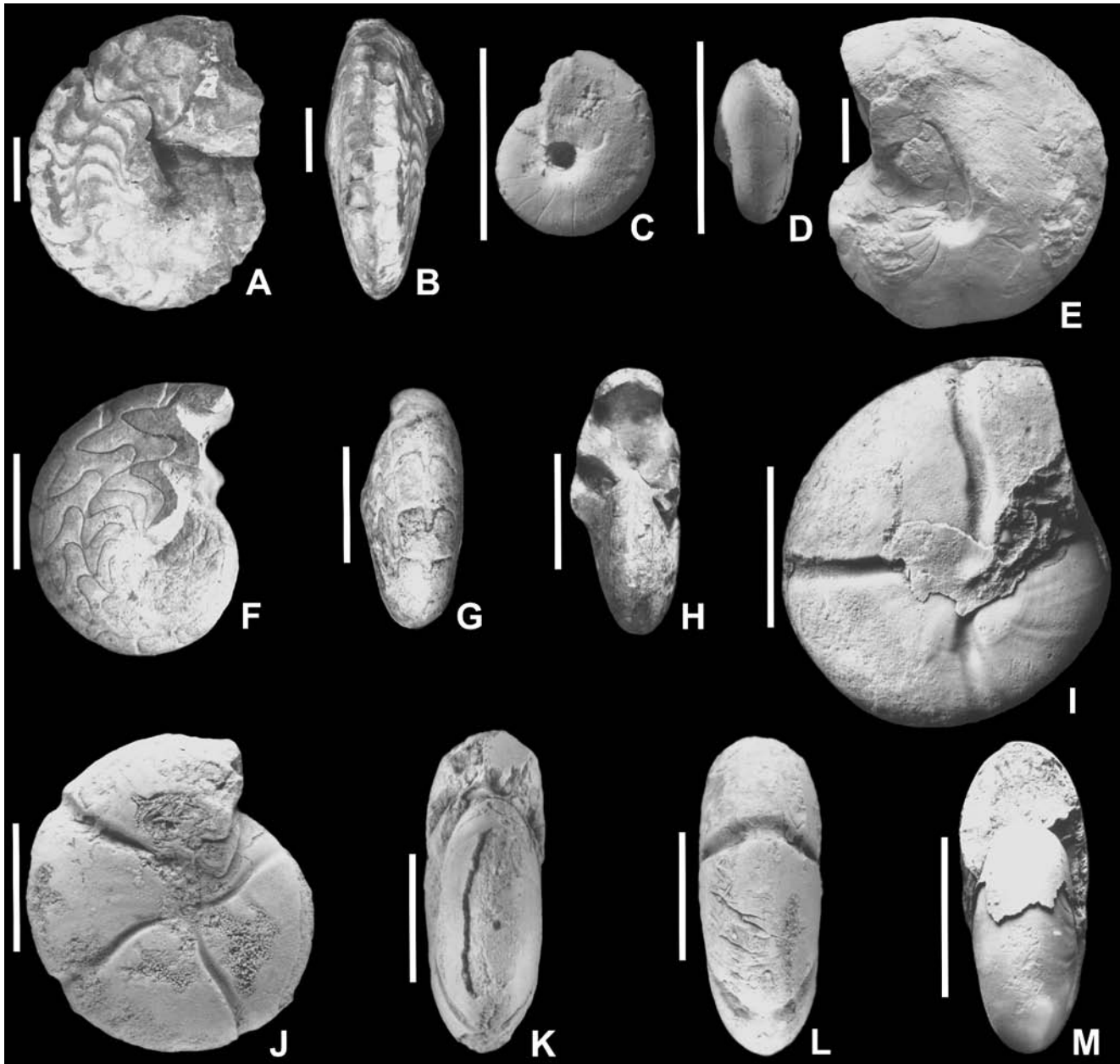


Fig. 32. A, B. *Linguatornoceras* aff. *clausum* (Glenister), sample 175.II.42a, A – lateral view with sutures, B – ventral view; Plucki, Upper Frasnian, *Archoceras varicosum* Zone, *linguiformis* Zone; C–F. *Oxytornoceras acutum* (Frech); C, D – sample 175.II.88, Janczyce E, F – 175.II.77, Kielce, Kadzielnia; C, E – lateral view, showing the last suture, D, F – ventral view; C–F – *Cheiloceras* (*Ch.*) *subpartitum* Zone, Upper *crepida* Zone; G–N. *Phoenixites frechi* (Wedekind), G, H – sample 175.II.100, L, M – 175.II.107; G, L – lateral view with the last sutures, H, M. – ventral view, H – showing the narrow ventrolateral furrows; G, H, L, M – Janczyce, *Cheiloceras* (*Ch.*) *subpartitum* Zone, Upper *crepida* Zone; I, J – sample P1-12, K, N – 175.II.125; I, K, N – lateral view showing biconvex growth ornament, J – ventral view with sutures; I–K, N – Plucki, *Archoceras varicosum* Zone, *linguiformis* Zone. Length of scale bars – 10 mm



**Fig. 33.** **A, B.** *Falcitornoceras bilobatum* (Wedekind), sample 284.II.288, A – lateral, B – ventral views with sutures, Gałęzice, Ostrówka, Famennian, “Lower *Lewigites* Beds”, Lower *expansa*; **C, D.** *Tornia mirabile* (Dybczyński), sample 284.II.734, C – lateral, D – ventral views with sutures; Kielce, “Siekłucki’s brickyard”, Famennian, Lower–Upper *marginifera* zones; **E.** *Cheiloceras* (*Cheiloceras*) *longilobum* (Sobolew), sample 175.II.7, lateral view with the last suture, Kadzielnia, Famennian, *Cheiloceras* (*Ch.*) *subpartitum* Zone, Upper *crepida* Zone; **F–H.** *Posttornoceras contiguum* Sobolew, 284.II.735, F – lateral, G – ventral views with sutures, H – adoral view; Kowala, Famennian, *Posttornoceras contiguum* Zone (IIβ), Upper *marginifera* Zone; **I–M.** *Cheiloceras* (*Cheiloceras*) *subpartitum subpartitum* (Münster), I, M – 175.II.14; J–L – sample 175.II.14a; I, J – lateral, K – ventral views with constrictions, L, M – adoral view; Janczyce, *Cheiloceras* (*Cheiloceras*) *subpartitum* Zone, Upper *crepida* Zone. Length of scale bars – 10 mm

Superfamily PRIONOCERATAEAE Hyatt 1884  
Family PRIONOCERATIDAE Hyatt 1884

Genus *Prionoceras* Hyatt 1884  
Type species *Goniatites divisus* Münster 1832

*Prionoceras sulcatum* (Münster 1832)  
Fig. 40 (G, J)

1832. *Goniatites sulcatus* Münster: p. 23, pl. 3, figs 7 a–c.

1959. ?*Prionoceras sulcatum* (Münster): Lewowicki, p. 95.  
1971. *Prionoceras sulcatum* (Münster): Bogoslowsky, p. 186, pl. 16, figs 4, 5.  
1989. *Prionoceras sulcatus* (Münster): Czarnocki, p. 18.

**Material:** MUZ PIG 284.II.296.

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
284.II.296	15.5	9.5	4.6	11.0	-	0.61	0.30	0.71	-



**Description:** Shell thick discoid and involute, 16 mm in diameter, with very wall increment in whorl height. Whorl cross section high ovale. Ventral side moderately narrow, gradually passes to flat-convex whorl flanks. Umbilicus point-like, closed and concave. Shell covered with thin and dense growth striae, forming a shallow sinus on ventral side. Three constrictions are present on the whorls, most distinct on flanks, and disappearing on ventral side. Ventral lobe narrow and deep, funnel-like. First lateral saddle narrow and high. Lateral lobe in form of wedge, with extended termination, of same depth as the ventral lobe. Second lateral saddle broad, the same height as the first.

**Distribution:** Poland: Holy Cross Mountains, Łagów (Upper Famennian, *Platyclymenia* Zone), Gałęzice - Ostrówka (*Clymenia* Zone, conodont zone - *expansa*); Sudetes (*Wocklumeria* genus zone); Germany; Russia: Ural, Kazakhstan (Upper Famennian, *Prolobites* genus zone); North Africa (*Clymenia laevigata* Zone).

*Prionoceras divisum* (Münster, 1832)

Fig. 40 (H, I)

1832. *Goniatites divisus* Münster: p.24, pl. 4, figs 6a–c.

1959. *Prionoceras divisum* (Münster): Lewowicki, p. 93, 94, pl. 2, fig. 6.

1971. *Prionoceras divisum* (Münster): Bogoslovsky, p. 187, 188, text-fig. 60, pl.16, figs 6–13.

**Material:** MUZ PIG 284.II.295.

**Dimensions** (dm, wh, ah, ww, uw – in mm):

specimen number	dm	wh	ah	ww	uw	wh/dm	ah/dm	ww/dm	uw/dm
284.II.295	9.5	5.5	1.6	7.0	-	0.57	0.16	0.73	-

**Description:** Shell inflates, 9 mm in diameter, strongly involute with low semicircular whorls, whose increment in height is low. Umbilicus slightly depressed, point-like and closed. Growth striae and constrictions and the suture line similar as in *P. sulcatum* (Münster), from which they differ by the inflates shell form.

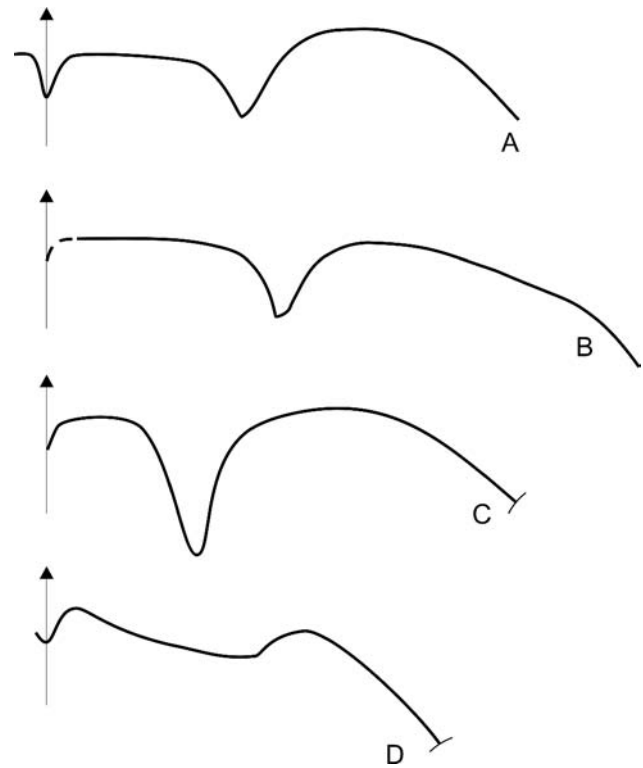
**Distribution:** Poland: Holy Cross Mountains, Gałęzice: Ostrówka section (Upper Famennian, *Clymenia* Zone, conodont zone: *expansa*); Sudetes (*Wocklumeria* genus zone); Germany, North Africa; Russia: Ural; Kazakhstan (Upper Famennian, *Prolobites* genus zone).

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I am particularly indebted to Prof. J. Dzik (Polish Academy of Sciences) for his discussion on goniatites. I am deeply grateful to Professor G. Racki and an Anonymous Referee for constructive reviews and to Dr. K. Bąk for fruitful editorial remarks. Special thanks go to M. Krzyżanowski, B. Ruskiewicz, A. Kościelniak, E. Starnawska M.Sc. and L. Giro for photographs of specimens, as well as to M. Krzyczyńska M.Sc. and B. Giblewska M.Sc. for computer graphics.

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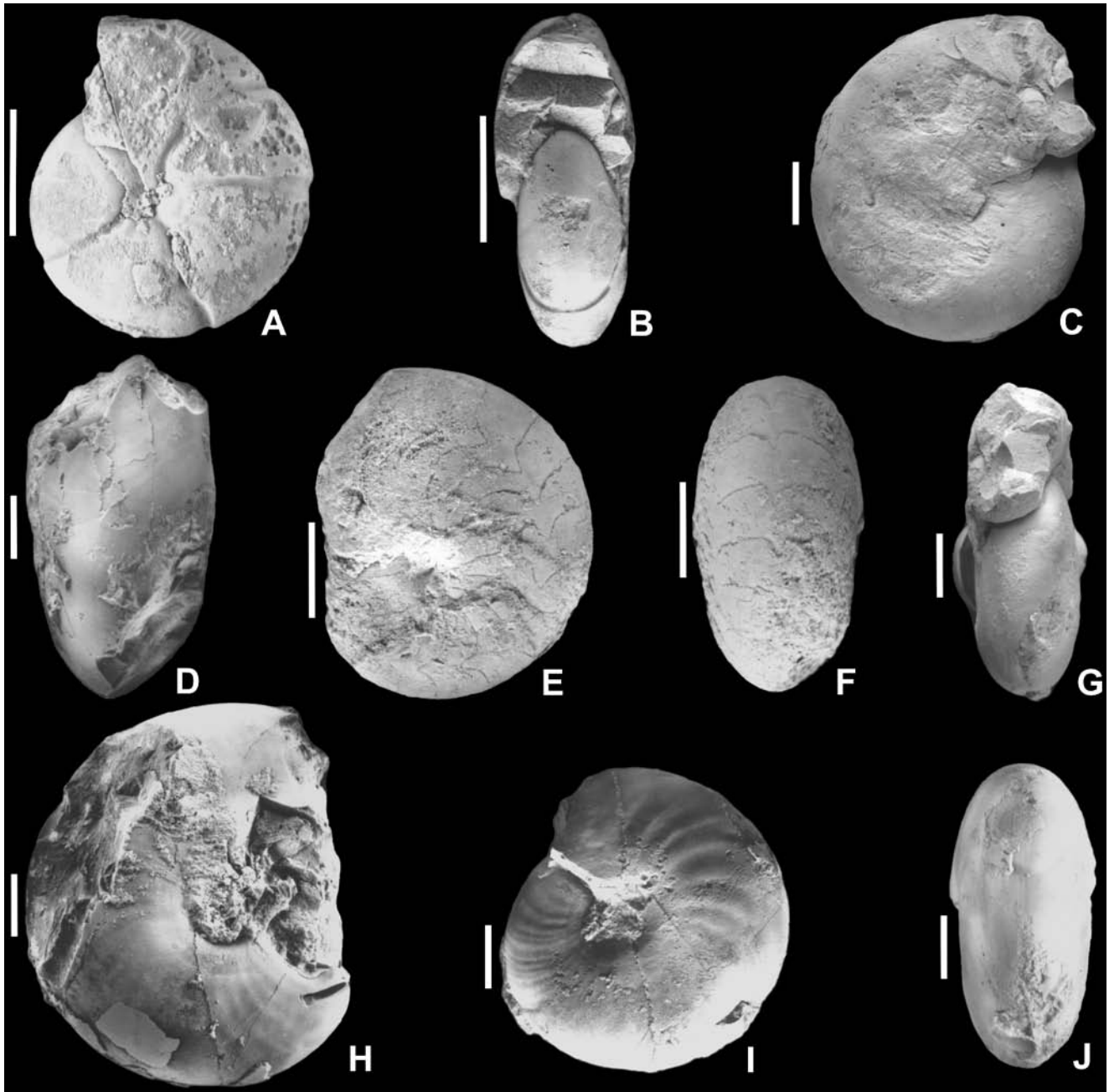
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**Fig. 34.** Suture lines in *Cheiloceras* (*Staffites*) Wedekind, *Cheiloceras* (*Cheiloceras*) Frech i *Cheiloceras* (*Raymondiceras*) Schindewolf. **A, B.** *Cheiloceras* (*Staffites*) *curvispina curvispina* (G. et F. Sandberger), A – 175.II.5, Kadzielnia, wh = 20.7 mm, B – 176.II.4, Łagów, wh = 28 mm; **C.** *Cheiloceras* (*Cheiloceras*) *longilobum* (Sobolew), 175.II.7, Kadzielnia, wh = 23 mm; **D.** *Cheiloceras* (*Raymondiceras*) *verneuili* (Münster), 176.II.47, Łagów, wh = 19.3 mm

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**Fig. 35.** A, B. *Cheiloceras (Cheiloceras) subpartitum subpartitum* (Münster), sample 175.II.14b, A – lateral, B – adoral views with constrictions; Janczyce, Famennian, *Cheiloceras (Cheiloceras) subpartitum* Zone, Upper *crepida* Zone; C–H. *Cheiloceras (Staffites) curvispina curvispina* (G. et F. Sandberger), C, G – sample 176.II.1, D, H – 176.II.4, Łagów, Famennian (II $\alpha$ ), Upper *crepida* / *rhomboidea* Zone; E, F – 175.II.5, Kadzielnia, Famennian (II $\alpha$ ), Upper *crepida* Zone; C, E, H – lateral view with growth ornament (H) and sutures, D, F – ventral view with sutures (F), G – adoral view; I, J. *Cheiloceras (Raymondiceras) verneuili* (Münster), sample 176.II.28, Łagów, Upper *crepida* / *rhomboidea*, I – lateral view with growth ornament, J – ventral view with constrictions. Length of scale bars – 10 mm

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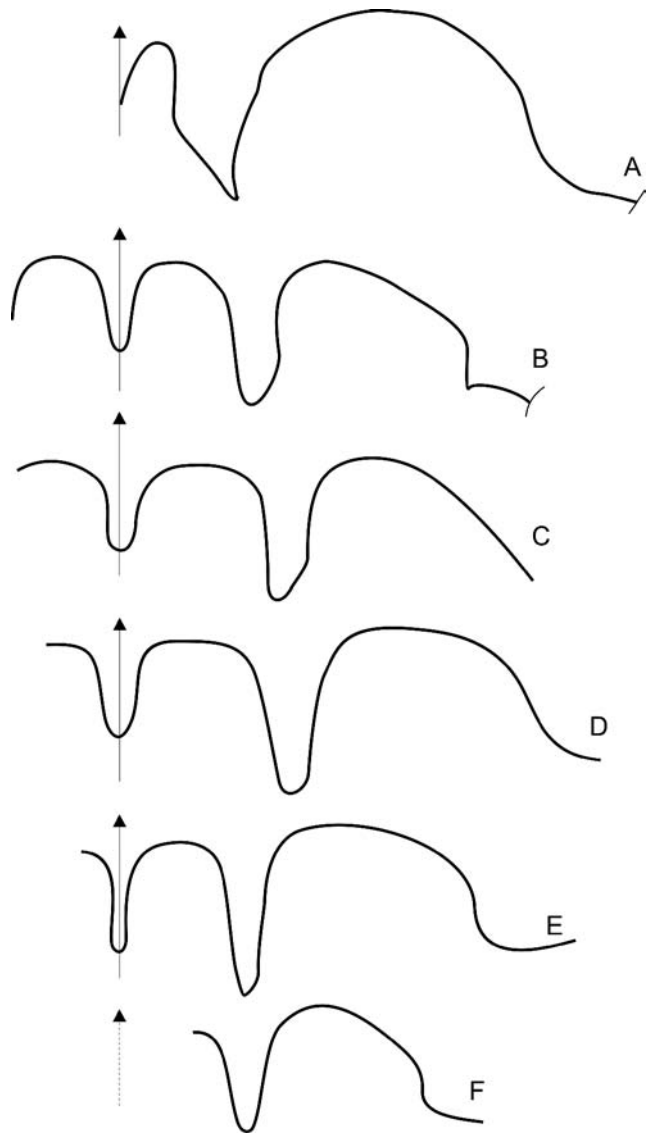
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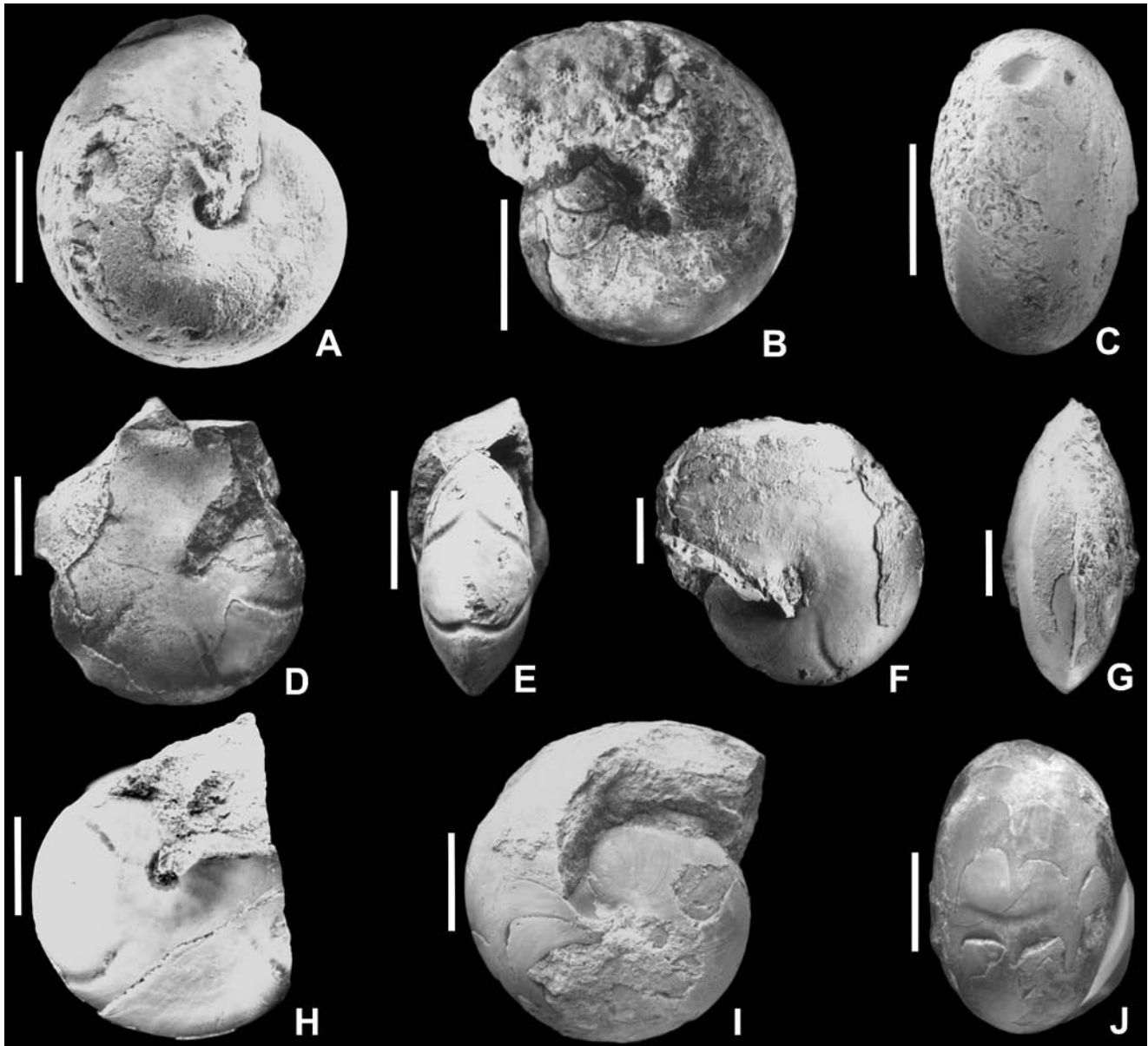
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**Fig. 36.** Suture lines in *Paratornoceras* Hyatt, *Dimeroceras* Hyatt and *Praemeroceras* Becker. **A.** *Paratornoceras polonicum* (Gurich), 176.II.24b, Łagów, wh = 25 mm; **B.** *Dimeroceras globosum* Sobolew, 175.II.11a, Łagów, wh = 16.2 mm; **C, D.** *Praemeroceras globosoides* (Sobolew), C – 176.II.63, Łagów, wh = 14.8 mm, D – 176.II.11b, Łagów, wh = 16.5 mm; **E, F.** *Praemeroceras globosoides* (Sobolew), 176.II.40, Łagów, E – wh = 24.3 mm, F – wh = 19.3 mm

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**Fig. 37.** A–C. *Dimeroceras globosum* Sobolew, sample 176.II.11a, A, B – lateral view, B – with sutures without chlorammonia, C – ventral view; D–H. *Paratornoceras polonicum* (Gürich), D, E – sample 176.II.20; F, G – 176.II.71; H – 176.II.25; D, F, H – lateral view showing constrictions, E – adoral view, G – ventral view; I, J. *Praemeroceras globosoides* (Sobolew), sample 176.II.11b, I – lateral view showing growth lines and sutures, J – ventral view with sutures. A–J – Łagów, Famennian (II $\alpha$ /II $\beta$ ), Upper *rhomboidea*–Upper *marginifera*. Length of scale bars – 10 mm

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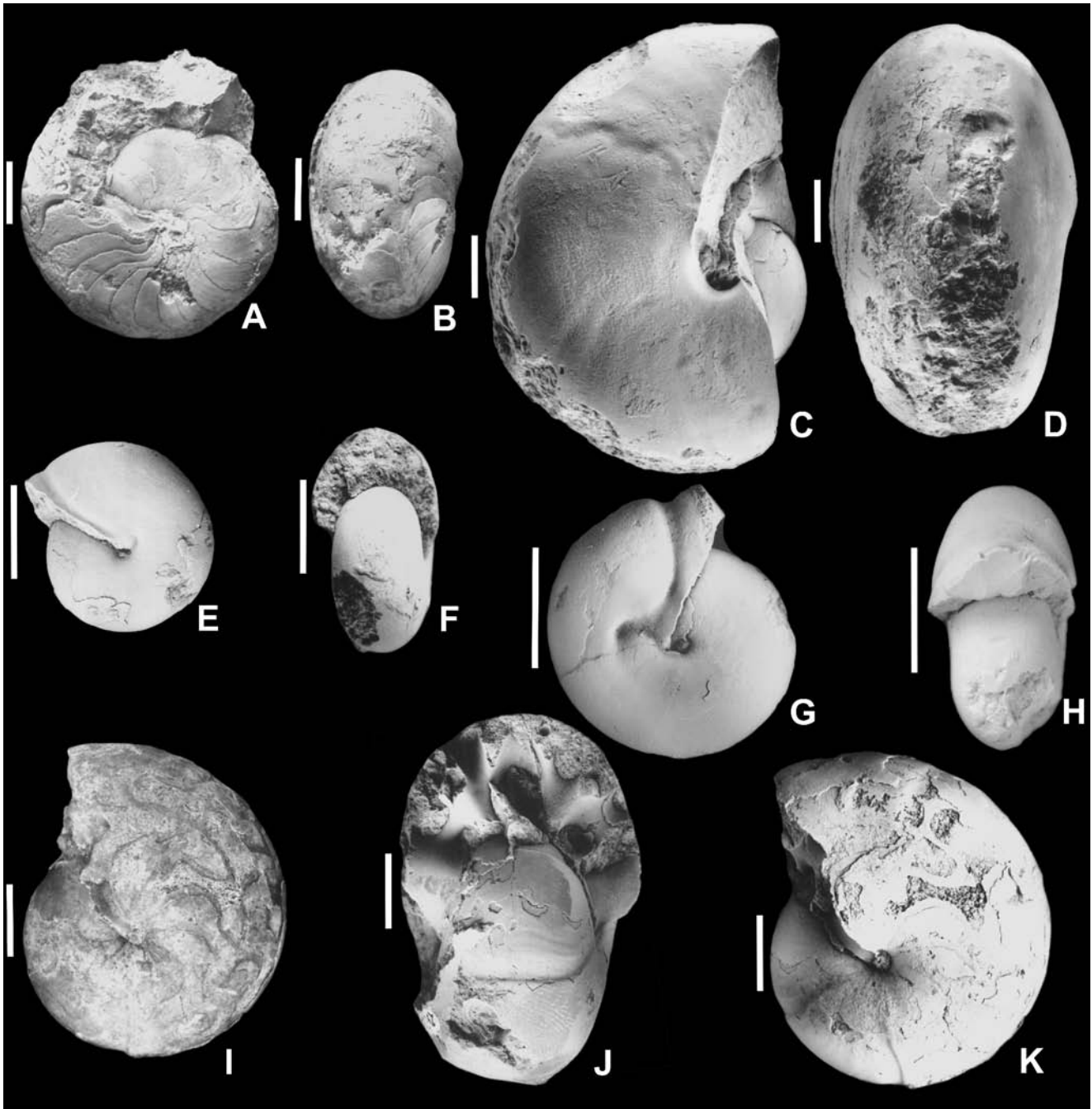
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**Fig. 38.** A–D. *Praemeroceras globosoides* (Sobolew), A, B – sample 176.II.40, A – lateral, B – ventral views with sutures; C, D – 176.II.63, C – lateral view with body chamber; A–D – Łągów, Famennian (II $\alpha$ /II $\beta$ ), Upper *rhomboidea*–Upper *marginifera*; E–H. *Prolobites* sp., E, F – sample 284.II.87, G, H – 284.II.85, E, G – lateral view, F, H – adoral view; Gałęzice, Ostrówka, Famennian, *Prolobites delphinus* Zone, Upper *trachytera*; I–K. *Sporadoceras muensteri* (V. Buch), sample 284.II.275, I, K – lateral view, I – without chloramonionia, J – adoral view, Gałęzice, Ostrówka, “Lower *Laewigites* Beds”, *Clymenia* Zone, Lower *expansa* Zone. Length of scale bars – 10 mm

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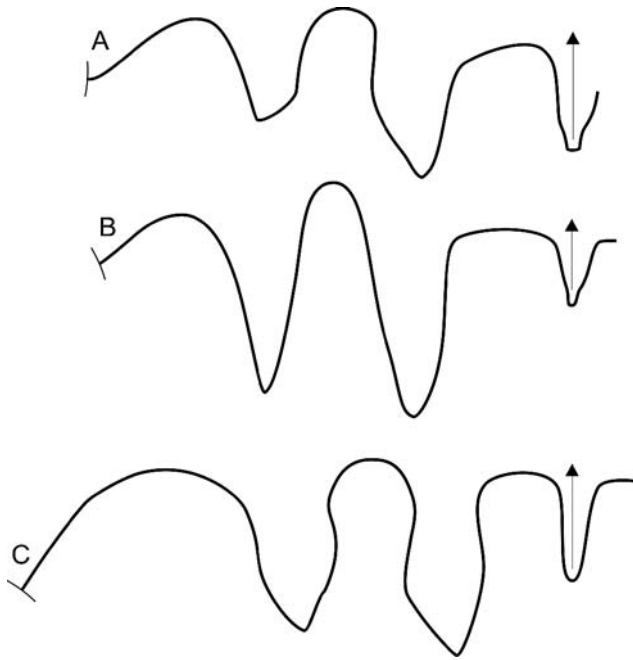
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**Fig. 39.** Suture lines in *Posttornoceras* Wedekind and *Sporadoceras* Hyatt. **A.** *Posttornoceras contiguum* Sobolew, 284.II.735, Kowala, wh = 16 mm. **B.** *Sporadoceras posthumum* Wedekind, 284.II.323, Ostrówka, wh = 33.5 mm. **C.** *Sporadoceras muensteri* (v. Buch), 284.II.275, Ostrówka, wh = 28.5 mm

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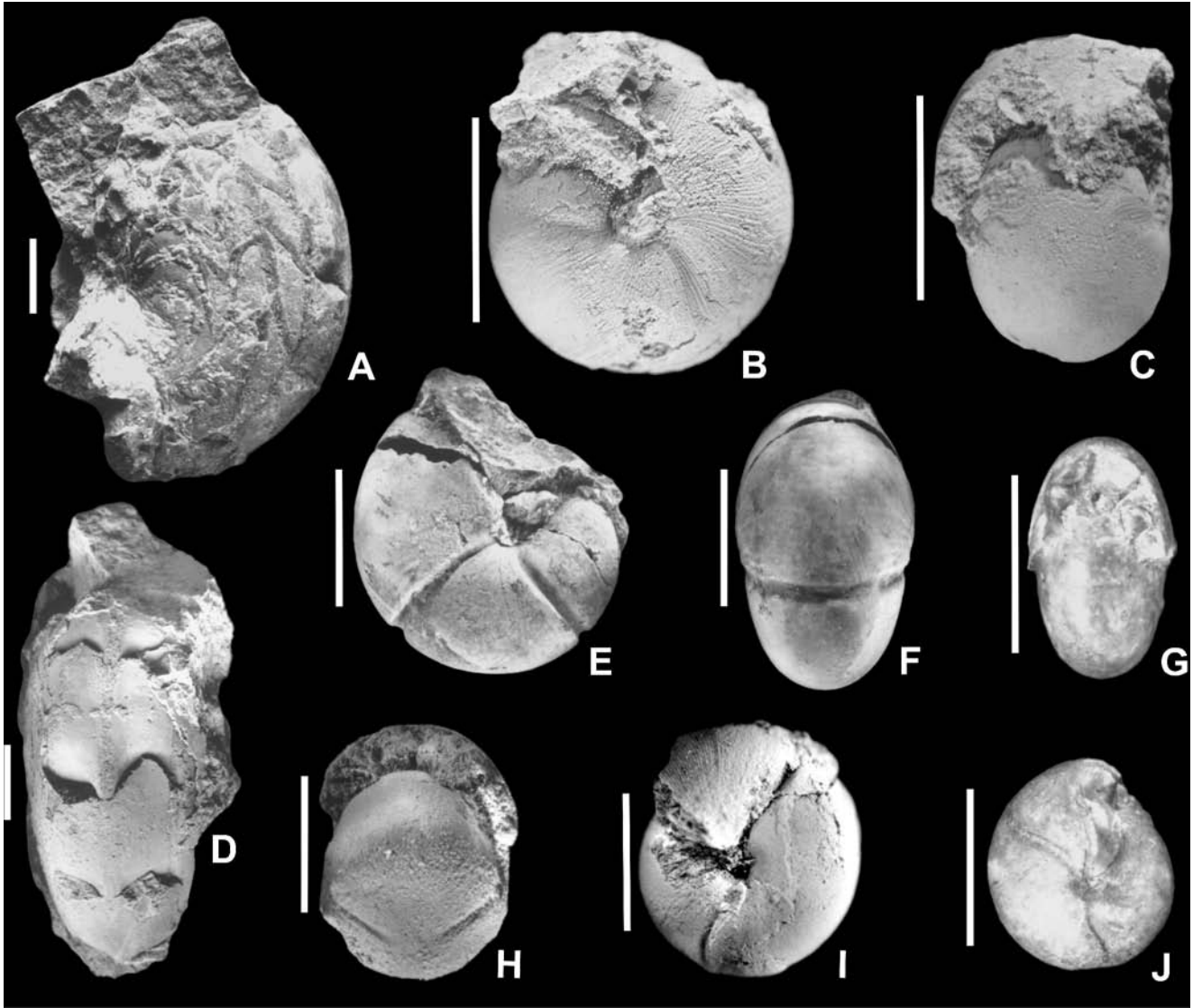
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## Streszczenie

### GÓRNODEWOŃSKIE GONIATYTY I WSPÓŁWYSTĘPUJĄCE KONODONTY Z GÓR ŚWIĘTOKRZYSKICH: BADANIA KOLEKCJI PAŃSTWOWEGO INSTYTUTU GEOLOGICZNEGO

Tatiana Woroncowa-Marcinowska

Kolekcje goniatytyw zgromadzone przed ponad półwieczem w Muzeum Geologicznym PIG zawierają okazy zebrane przez J.



**Fig. 40.** **A, D.** *Sporadoceras posthumum* Wedekind, sample 284.II.323, **A** – lateral view, **B** – ventral view, Gałęzice, Ostrówka, “*Goniclymenia* Beds”, *Clymenia* Zone, Middle *expansa*; **B, C, E, F.** *Praeglyphioceras kielcense* (Sobolew), **B, C** – sample 284.II.34, Gałęzice, Ostrówka, Famennian, *Prolobites* Zone; **E, F** – sample 284.II.732, Gałęzice, Besówka, Famennian, *Prolobites* Zone; **B, E** – lateral view with growth ornament and constrictions, **C** – adoral view, **F** – ventral view showing constrictions; **H, I.** *Prionoceras divisum* (Münster), sample 284.II.295, **H** – adoral and **I** – lateral views with growth ornament and constrictions, Gałęzice, Ostrówka, “*Laewigites* Beds”, *Clymenia* Zone; **G, J.** *Prionoceras sulcatum* (Münster), sample 284.II.296, **G** – adoral, **J** – lateral views with constrictions, Gałęzice, Ostrówka, “Lower *Laewigites* Beds,” *Clymenia* Zone, Lower *expansa* Zone. Length of scale bars **A, D, E, F, G, J** – 10 mm, **B, C, H, I** – 20 mm

Czarnockiego, H. Makowskiego i M. Rózkowską. Kolekcje pochodzą ze znanych profili (Fig. 1): Płucek koło Łagowa (Makowski, 1962, 1971; Dzik, 2002, Racki i in., 2002), Janczyc (Makowski, 1991), Łagów–Dule i okolic Gałęzic (Sobolew, 1914; Czarnocki, 1989; Wolska, 1967; Szulczewski, 1971; Szulczewski i in., 1996). Niniejsza praca zawiera taksonomiczną rewizję goniatytytów oraz biostratygraficzną analizę towarzyszących im konodontów, które wydobyto z otaczającej skały. Umożliwiło to przypisanie goniatytytów określonym poziomom konodontowym.

Frański zespół goniatytytów z dolnej części muszlowca głowonogowo-tentakulitoidowego z Płucek koło Łagowa zawiera (Fig. 2): *Archoceras varicosum* (Drevermann), *Manticoceras drevermanni* Wedekind, *M. lamed* (G. et F. Sandberger), *Crickites neverovi* (Bogoslovsky), *C. holzapfeli* (Wedekind), *Linguatornoceras* aff. *clausum* (Glenister), *Phoenixites frechi* (Wedekind) i reprezentuje poziom *Crickites holzapfeli*. Towarzyszący im zespół

konodontów zawiera: *Palmatolepis subrecta* Müller et Youngquist, *P. linguiformis* Müller, *Polygnathus imparilis* Klapper et Lane i in. (Tab. 1, 2; Fig. 2, 3-5, 6A-M) i odpowiada poziomowi *linguiformis*, znanemu w literaturze jako górny poziom Kellwasser. Z tym poziomem związany jest epizod wysokiej produktywności *Leiosphaeridia* (Fig. 8).

Najstarszy i najmniej zróżnicowany fameński zespół goniatytytów w poziomie *Phoenixites frechi* z Płucek jest reprezentowany jedynie przez gatunek indeksowy i odpowiada on poziomowi konodontowemu *triangularis* (Tab. 2; Fig. 2, 6N-R, 7, 8A-H, J).

Goniatyty z Janczyc, pochodzące z soczewki ciemnoszarých wapieni (Fig. 9) są reprezentowane przez gatunki *Tornoceras sublentiforme* (Sobolew), *Oxytornoceras acutum* (Frech), *Phoenixites frechi* (Wedekind) i *Cheiloceras* (*Cheiloceras*) *subpartitum* (Münster), wskazując na poziom goniatytytowy *Ch.* (*Cheiloceras*) *subpartitum* i poziom konodontowy – górny *crepida* (Tab. 3, Fig.

10-12). Podobny zespół goniatyków, w którym nominatywny podrodzaj *Cheiloceras* zastępują *Staffites* i *Raymondiceras* stwierdzony został w profilu Kadzielnia w Kielcach (Makowski *W*: Szulczewski, 1971). Ten zespół odpowiada dolnej części poziomu goniatykowego *Paratorleyoceras globosum* i pograniczu poziomów konodontowych *crepida* i *rhomboidea* (Tab. 3).

W profilu Łągów-Dule (Fig. 13; Tab. 4) Czarnocki (1989) wyróżnił trzy poziomy głowonogowe: cheilocerasowy, prolobite-sowy i platyklymeniowy. Wolska (1967) opisany przez siebie w tym profilu zespół konodontów zaliczyła do poziomów *rhomboidea-quadrantinodosa*, stwierdzając wymieszanie fauny. Konodonty wyseparowane z okazów reprezentujących różne poziomy głowonogowe wskazują jednak na obecność 4 kolejnych poziomów konodontowych w tym profilu. Na pograniczu poziomów konodontowych *crepida/rhomboidea* (Tab. 5) występują *Cheiloceras* (*Staffites*) *curvispina* (G. et F. Sandberger) i *Cheiloceras* (*Raymondiceras*) *verneuili* (Münster), odpowiadające poziomowi *Paratorleyoceras globosum*. Natomiast na pograniczu poziomów *rhomboidea*/dolny *marginifera* występuje *Paratornoceras polonicum* (Gürich), który razem z *Dimeroceras globosum* Sobolew i *Praemeroceras globosoides* (Sobolew) spotykany jest również w wyższej części profilu w poziomie konodontowym dolny *marginifera* (Fig. 14). Na poziomie dolny *marginifera* wskazuje obecność *Palmatolepis stoppeli* Sandberg et Ziegler i *P. inflexoidea* Ziegler. Współwystępowanie wymienionych rodzajów goniatyków sugeruje obecność standardowych poziomów goniatykowych od *Praemeroceras petterae* po *Postornoceras contiguum*. Konodonty wydobyte z okazji *Sporadoceras* sp. określają jedynie poziom *marginifera*, tym niemniej obecność tego goniatyka wskazuje na górną część poziomu *marginifera* (Becker, 1993). *Sporadoceras varicatum* Wedekind pochodzi z poziomu konodontowego *trachytera* (*Palmatolepis rugosa trachytera* Ziegler, *P. perlobata*

*helmsi* Ziegler, *P. p. sigmoidea* Ziegler, *Polygnathus granulosus* Branson et Mehl i in., Tab. 5; Fig. 15), wyróżnionego w badanym profilu po raz pierwszy. W Niemczech *Sporadoceras varicatum* znany jest z poziomu *Prolobites delphinus*, odpowiadając w skali konodontowej poziomowi górny *trachytera* (Becker, 1993).

W Gałęzicach w famenie wyróżnione zostały poziomy głowonogowe od *Prolobites* do *Wocklumeria* (Czarnocki, 1989) (Fig. 16; Tab. 6). Przedstawiciele rodzajów *Prolobites* i *Praeglyphioceras* oraz *Sporadoceras varicatum* reprezentują poziom *Prolobites delphinus*, któremu w skali konodontowej odpowiada poziom górny *trachytera*. *Falcitornoceras bilobatum* (Wedekind), *Sporadoceras muensteri* (v. Buch) oraz przedstawiciele taksonów *Prionoceras* – *Pr. sulcatum* (Münster) i *Pr. divisum* (Münster) pochodzą z warstw “lewigitosowych dolnych”, które w skali konodontowej reprezentują poziom dolny *expansa*. Okazowi gatunku *Sporadoceras posthumum* Wedekind z “warstw gonioklymeniowych” towarzyszy bogaty zespół konodontów z gatunku *Palmatolepis gracilis expansa* Sandberg et Ziegler, *P. gracilis sigmoidealis* Ziegler, *P. perlobata helmsi* Ziegler, *Polygnathus znepolensis* Spasov, *P. exstrolobatus* Schäfer i in. (Tab. 7), odpowiadający poziomowi środkowy *expansa* (Fig. 17-19), a w skali głowonogowej – górnej części poziomu *Clymenia*.

Pozycja stratygraficzna znacznej części badanych gatunków goniatyków w podziale konodontowym i głowonogowym została przedstawiona w Tabeli 8 i 9.

W części systematycznej opisano 26 gatunków goniatyków, należących do 20 rodzajów i 9 rodzin z rzędów Agoniatitida i Goniatitida. Po raz pierwszy u badanych goniatyków (Fig. 20, 22, 24, 26, 28, 32, 33, 35, 37, 38, 40) opisano i zilustrowano linie przegrodowe (Fig. 21A-D, 23A-D, 25A, 27A-E, 29A-E, 30A-G, 34A-D, 36A-F, 39A-C) oraz przyrostowe (Fig. 21E, 23E-I, 25B-D, 31A-C).