BULLETIN DE L'INSTITUT ROYAL DES SCIENCES NATURELLES DE BELGIQUE, SCIENCES DE LA TERRE, **60**: 43-74, 1990
BULLETIN VAN HET KONINKLIJK BELGISCH INSTITUUT VOOR NATUURWETENSCHAPPEN, AARDWETENSCHAPPEN, **60**: 43-74, 1990

Frasnian Gypidulid Brachiopods froms the Holy Cross Mountains (Poland). Comparative Stratigraphic Analysis with the Dinant Synclinorium (Belgium)

by Jacques GODEFROID and Grzegorz RACKI

Abstract

The authors describe the Frasnian gypidulid brachiopods from the Holy Cross Mountains (Poland) with special emphasis on their stratigraphic distribution. Among the five taxa distinguished, *Physemella christinae* is new, two are identified as *Metabolipa* cf. *greindli* (MAILLIEUX, 1909) and *Neometabolipa duponti* GODEFROID, 1974 and two others are provisionally named *Novozemelia* ? sp. W and *Neometabolipa* ? sp. G.

The Polish gypidulids reveal close affinities to those of the Dinant Synclinorium (Belgium) and the recognized successional replacement of characteristic genera and species in the latter area appears to be a supraregional pattern. A preliminary three-step sequence of gypidulid faunas (in ascending order: *Novozemelia* ?, *Metabolipa* and *Neometabolipa*) is outlined for the Frasnian of both regions. Its importance for correlations and age-inferences in conodont-poor, reef-related facies is clearly demonstrated by the examples from the Holy Cross Mountains.

Key-words: Brachiopods. Gypidulidae. Devonian. Poland. Belgium.

Résumé

Les auteurs décrivent les Brachiopodes Gypidulidae du Frasnien des Monts Sainte-Croix (Pologne) et précisent leur distribution stratigraphique. Des cinq taxa distingués, un, *Physemella christinae*, est nouveau, deux sont déterminés *Metabolipa* cf. *greindli* (MAILLIEUX, 1909) et *Neometabolipa duponti* GODEFROID, 1974 et deux autres sont provisoirement nommés *Novozemelia* ? sp. W et *Neometabolipa* ? sp. G.

Les Gypidulidae de Pologne montrent d'étroites affinités avec ceux du Synclinorium de Dinant (Belgique) et la succession des genres et espèces caractéristiques observée dans cette dernière région se reconnaît également dans la première. Un schéma préliminaire de subdivision en trois parties sur base des faunes de Gypidulidae (de la base au sommet: les faunes à *Novozemelia* ?, *Metabolipa* et *Neometabolipa*) est proposé pour les deux régions. Son importance pour les corrélations et attributions d'âge dans des régions où sont développés des facies récifaux, pauvres en Conodontes, est mise en évidence par les exemples pris dans les Monts Sainte-Croix.

Mots-clefs: Brachiopodes. Gypidulidae. Dévonien. Pologne. Belgique.

Streszczenie

Autorzy opisują gypidulidy (Brachiopoda) z franu Gór Świętokrzyskich, ze szczególnym zwróceniem uwagi na ich rozprzestrzenienie stratygraficzne. Spośród pięciu wyróżnionych taksonów, *Physemella christinae* jest gatunkiem nowym, dwa kolejne oznaczono jako *Metabolipa* cf. *greindli* (MAILLIEUX, 1909) oraz *Neometabolipa duponti* GODEFROID, 1974, a dwa pozostałe określono jedynie jako *Novozemelia* ? sp. W i *Neometabolipa* ? sp. G.

Polskie gypidulidy wykazują ścisłe związki z fauną Synclinarium Dinantu (Belgia) i sekwencyjny rozwój charakterystycznych rodzajów i gatunków, ustalony na tym ostatnim obszarze, okazuje się mieć znaczenie ponad-regionalne. Trójczłonowe następstwo faun gypidulidowych (od dołu: *Novozemelia* ?, *Metabolipa* i *Neometabolipa*) zostało wstępnie zarysowane dla obu badanych obszarów. Na przykładach z Gór Świętokrzyskich przedstawiono znaczenie rozpoznanej sekwencji ramienionogowej dla korelacji i interpretacji wiekowej ubogich w konodonty facji przyrafowych.

Key-words: Ramienionogi. Gypidulidae. Dewon. Polska. Belgia.

Introduction

The first step in evaluating the biostratigraphic potential for particular fossil groups is a comparison of successions in two different regions. Such study is attempted here for some late Devonian (Frasnian) gypidulid brachiopods. GODEFROID (1974) established a sequential development in the gypidulid genera in the Couvin and Boussu-en-Fagne regions (Belgium, southern Dinant Synclinorium) and this pattern was examined in the Holy Cross Mountains (Central Poland).

Although previously reported by several workers [e.g. GÜRICH (1896, 1901), SIEMIRADZKI (1909) and SOBOLEV (1909)], these rather common brachiopods were relatively poorly known except for the Middle Devonian (latest Eifelian to early Givetian) fauna from the northern (Łysogóry) part of the Holy Cross Mountains (BIERNAT, 1966). The purpose of the present contribution is to supply the palaeontologic and stratigraphic elaboration of stratigraphically younger (mostly Frasnian) gypidulids from the southern (Kielce) region. Most available data on these fossils come from works of BIERNAT (1971, 1983) containing the descriptions of three taxa [*Gypidula (Ivdelinia) rectangularis* (TORLEY, 1934), *Gypidula (Devonogypa)* sp., *Gypidula* sp. A] from two sites. The present study, based on more than 240 specimens from 13 localities (Fig. 1), revealed the presence of 5 species belonging to 4 genera. Similarities in the stratigraphic distribution of the Polish and Belgian gypidulid associations are also

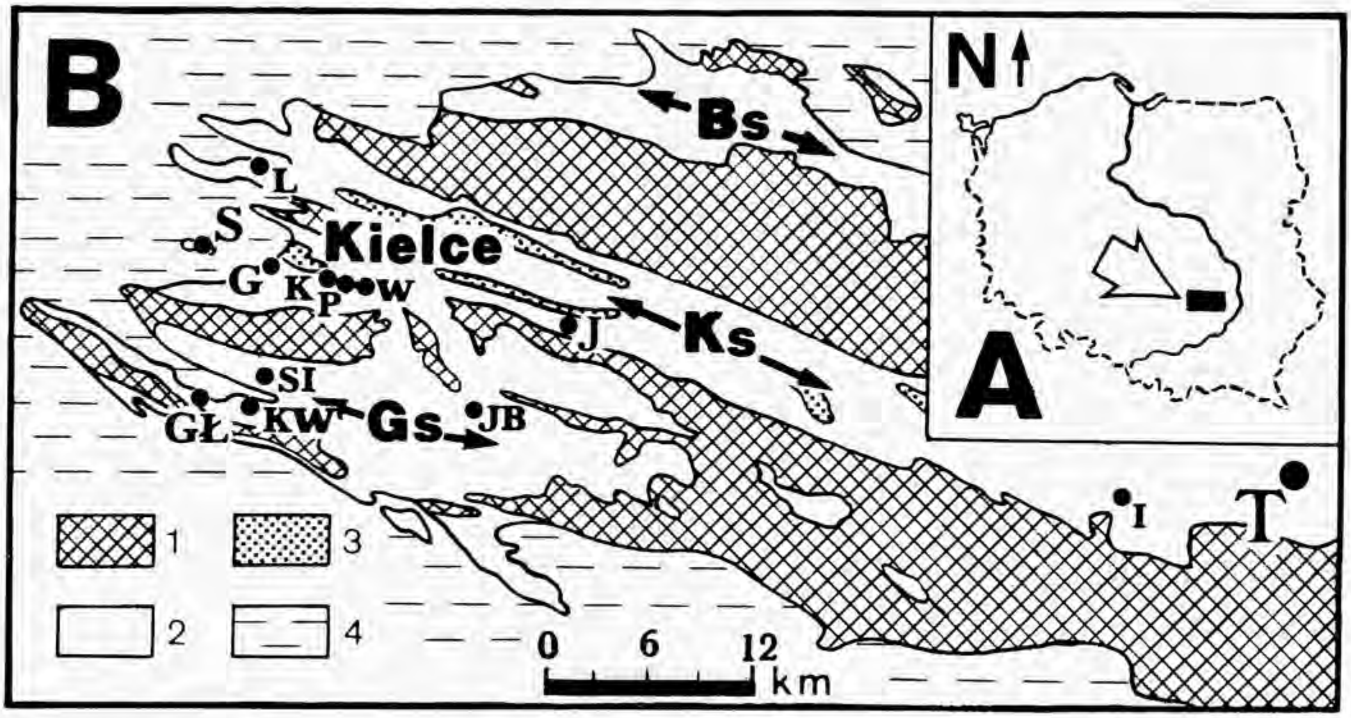


Fig. 1. – Map of the localities discussed in the text, in Poland (A) and in the Holy Cross Mountains (B).
1: Lower Paleozoic; 2: Devonian; 3: Carboniferous; 4: Post-Variscan cover.
T: Tudorów-Karwów area (see Fig. 2); S: Szczukowskie Hills quarry; L: Laskowa Hill quarry near Kostomłoty; G: Grabina quarry at Kielce; K: Kadzielnia quarry (and adjacent Cmentarna Hill) at Kielce; W: Wietrznia quarries at Kielce; P: Psie Hills at Kielce; J: Józefka Hill near Górno; SI: Sitkówka quarry; KW: Wola quarry near Kowala; GŁ: Ługawa Hill near Bolechowice; I: Wojnowice near Iwaniska; JB: Jabłonna Hill near Borków; Bs: Bodzentyn Syncline; Gs: Gałęzice Syncline; Ks: Kielce-Łagów Synclinorium.

clearly pointed out and some biostratigraphic consequences, both local and supraregional, are discussed.

The first author (J.G.) is responsible for the taxonomic identifications and descriptions; geological and ecological remarks are provided by the second author (G.R.); biostratigraphic considerations are joint. The main part of the studied material was collected by the second author, with help of other workers and students of the Silesian University at Sosnowiec, during the years 1976-1987; it is stored at Sosnowiec under the catalogue signature GIUS 4. Additionally, the old collection of SAMSONOWICZ, housed at the Museum of the State Geological Institute in Warsaw (catalogue number IG 8.II), was examined.

Stratigraphic setting and localities studied (G.R.)

The Frasnian limestones represent the upper part and/or cover of a thick stromatoporoid-coral sequence; it is a distinctive member of the Eifelian to Famennian transgressive succession typical for the vast epicontinental shelf of southern Poland (see NARKIEWICZ, 1988 for summary). Reef growth is responsible for the quasi-symmetric palaeogeographic differentiation of the Holy Cross area: the Frasnian shallow-water biogenic deposition is generally limited to the central part (Dyminy Reef Complex of NARKIEWICZ, 1988; see also SZULCZEWSKI, 1971).

The localities studied (Fig. 1) are distributed throughout the southern Kielce facies of the Holy Cross Mountains, and only supplementary data come from two sections (Laskowa Hill, Józefka) representing the northern Łysogóry intrashelf basin facies. Geographically, the majority of the outcrops are grouped in the better studied (and exposed) south-western Holy Cross Mountains, but the richest gypidulid site is localized in its eastern part. Some of the examined exposures were poorly known until the present study and are so more thoroughly described than the others. Lithostratigraphic terminology (Fig. 9) is taken from NARKIEWICZ, RACKI & WRZOŁEK (1990). The gypidulid-bearing units still have informal status (e.g. Detrital Beds, Laskowa Hill Beds) except for the Kadzielnia Massive Limestone Member, an early Frasnian biohermal unit of the Stromatoporoid-Coral Limestones and Dolomites of the Kowala Formation.

1. Eastern part

Outcrops of Frasnian deposits are situated at the vicinity of Opatów, in the eastern part of the Bratków-Tudorów Syncline (SAMSONOWICZ, 1934). Abundant Middle and Upper Devonian faunas are known here since the works of GÜRICH (1901) and, particularly, SAMSONOWICZ

(1917) but any more detailed studies have not been undertaken, also due to poor exposure conditions.

The most conspicuous and fossiliferous lithologic unit is composed of irregularly dolomitised, light-colored and poorly stratified limestones (Fig. 2A) best exposed in the active Karwów quarry. Unfortunately, only single and not very good preserved gypidulids were found in this outcrop. A very abundant collection (jointly with the original SAMSONOWICZ's material) is derived from brachiopod coquinas exposed in the overgrown, small rural quarry located near the entry of the southern ravine to the greater river valley, south of Tudorów village (Td-Ia, Fig. 2B-C). According to SAMSONOWICZ (1917, pp. 43-46; 1934, pp. 17-18), this reef-brachiopod, early Frasnian member caps the Givetian *Amphipora*-limestones and -dolomites and is overlain by higher Upper Devonian strata mostly developed as dark, platy and "lumpy" (nodular ?) limestones with shaly intercalations (see also NARKIEWICZ & OLKOWICZ-PAPROCKA, 1981). SAMSONOWICZ (1917, 1934) identified three gypidulid species in the material collected at Tudorów: *Pentamerus formosus* SCHNUR (very numerous), *P* cf. *galeatus* DALMAN and *P.* cf. *acutelobatus* SANDBERGER.

The observations at the present outcrops point to a great variability in the light-colored, massive unit: in addition to the stromatoporoid (and algal?) boundstones (framestones and bindstones including), there are more common detrital varieties, particularly calcarenites with rare corals and brachiopod accumulations. Furthermore, the age assignment by SAMSONOWICZ (1917, 1934), based on the general lithological and faunal analogies to the well-known early Frasnian (reef) limestone of Kadzielnia at Kielce is not supported by current data. Lithostratigraphically, this part of the sequence corresponds (excluding the lowermost, coelenterate-rich levels?) chiefly to the Detrital Limestones of NARKIEWICZ & OLKOWICZ-PAPROCKA (1983). The diverse (more than 20 species) atrypid-gypidulid assemblage from the Tudorów site is devoid of the characteristic species of the Kadzielnia-type bioherms (i.e. the *Fitzroyella alata-Parapugnax brecciae* assemblage *in* SZULCZEWSKI & RACKI, 1981, p. 152). A rather peculiar (in taxonomic composition) rugosan association, determinated by WRZOŁEK, comprises *Phillipsastrea* aff. *ananas* (GOLDFUSS, 1826), *Kuangxiastraea pengellyi* (MILNE-EDWARDS & HAIME, 1851), *Tabulophyllum normale* (WALTHER, 1929) and *Spinophyllum* sp. at the Karwów locality: it indicates a transitional interval between the 4th (*Macgeea-Thamnophyllum*) and the 5th (*Phillipsastrea smithi*) Zones defined by WRZOŁEK (1988) in the western Holy Cross Mountains, viz. the undivided Middle *asymmetricus* to *Ancyrognathus triangularis* Zones. A scarce conodont fauna, found in the topmost exposed part of the gypidulid-bearing complex (Fig. 2A), comprising *Ancyrodella nodosa* ULRICH & BASSLER, 1926 points to a level not lower than the *Ancyrognathus triangularis* Zone. The overlying unit contains numerous *Icriodus alternatus* BRANSON & MEHL, 1934 and probably belongs to the Upper *gigas* Zone.

2. *Western part*

a. *Kielce - Lagów Synclinorium*

Gypidulids are restricted to the higher Givetian and basal Frasnian strata in the Łysogóry (basin) facies. They are quite common in the lower part of the Laskowa Hill Beds (set A of RACKI, GŁUCHOWSKI & MALEC, 1985) at the Laskowa Hill quarry near Kostomłoty. These fossiliferous strata are composed of organodetrital (mainly crinoid) limestones and coral biostromes with several marly levels. The gypidulids, represented by large, almost exclusively isolated valves were cited by RACKI, GŁUCHOWSKI & MALEC (id. p. 166) as belonging to *Gypidula (Devonogypa)*. Most of them are here determinated as *Novozemelia*? sp. W. The others, represented by the specimens illustrated by RACKI, GŁUCHOWSKI & MALEC (id., pl. IX, figs. 4, 5) are not assigned to *Novozemelia*? through the presence of a pedicle sulcus. However, the scarcity of the material does not allow an accurate determination of these shells.

Similar, large specimens were collected from the poorly exposed early Frasnian organodetrital beds containing abundant crinoid debris, brachiopods, corals and bryozoans (lower part of set B *in* MAŁKOWSKI, 1981) at Józefka Hill, near Górno. Rare large gypidulids are also recorded in the topmost Givetian (?) fossiliferous and more marly beds equivalent to the Laskowa Hill Beds. The same brachiopods are typical for the lowest part (MAKOWSKI, 1988) of the fossiliferous limestone sequence exposed in the Wietrznia quarry at Kielce (Pl. 1) and representing the Givetian to Frasnian passage interval (BULTYNCK, 1982, fig. 4). The large pedicle valves are the main component of shell accumulations within light massive to thick bedded calcirudites with rock-forming reworked coelenterate skeletons and crinoid debris (set B of SZULCZEWSKI, 1971 in both Wietrznia profiles); these

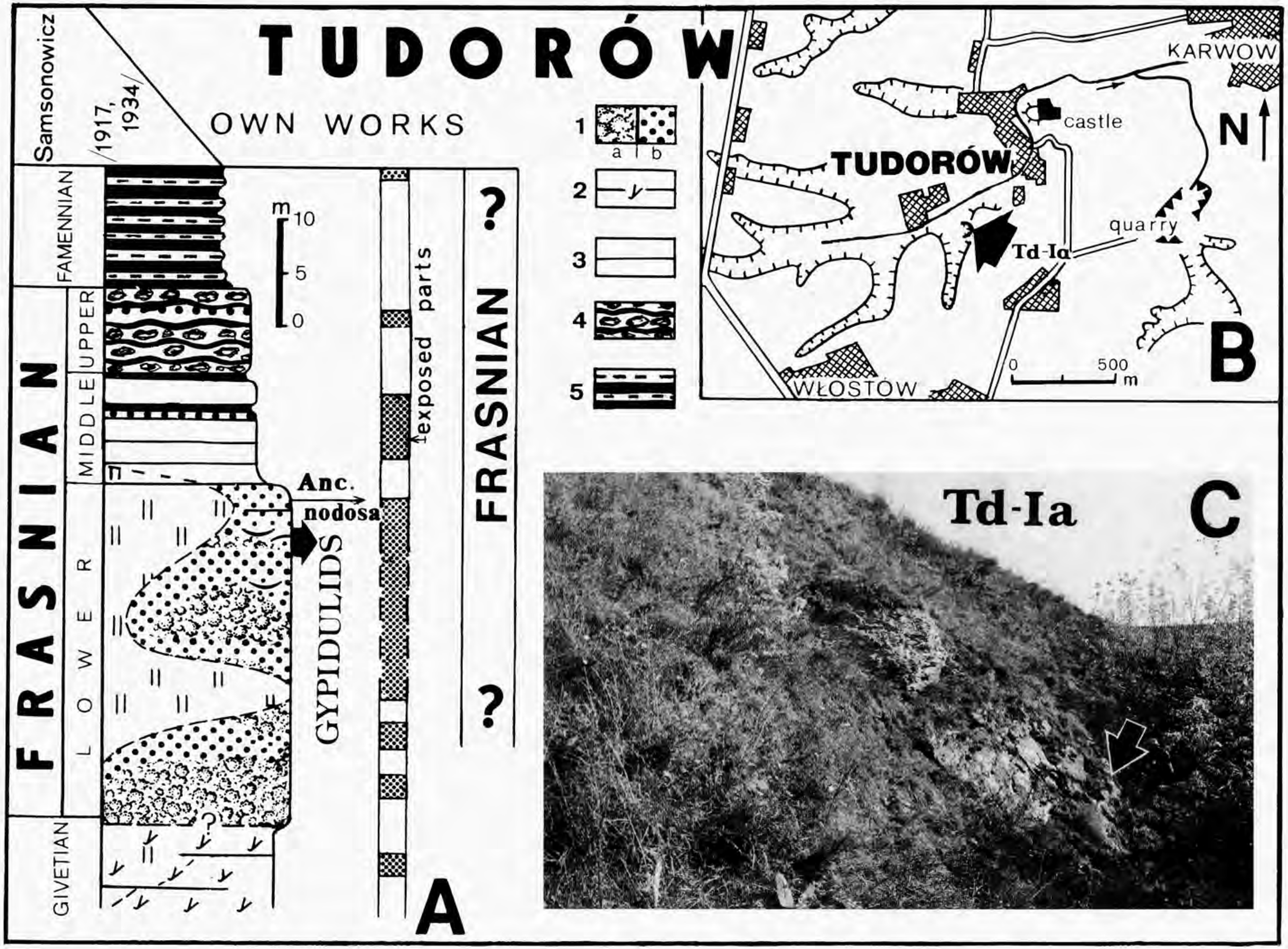
Fig. 2. – Frasnian deposits of the Tudorów-Karwów area, south of Opatów, in the eastern Holy Cross Mountains, showing the setting of the most abundant gypidulid locality (outcrop Td-Ia). ▷

A: Lithologic sequence based on SAMSONOWICZ (1917, 1934), NARKIEWICZ & OLKOWICZ-PAPROCKA (1981) and own works (G.R.).

1: light-colored poorly-stratified limestones (a: coelenterate-?algal boundstones; b: differentiated detrital varieties); 2: dark *Amphipora*-limestones; 3: dark, platy pelitic limestones; 4: dark "lumpy limestones" (*sensu* SAMSONOWICZ, 1917, 1934); 5: black marly limestones and shales; 6: secondary dolomites; 7: brachiopod coquina.

B: Location sketch map; Td-Ia is the gypidulid locality.

C: Overgrown exposure (Td-Ia) in the ravine south of Tudorów; arrow indicates the site of the brachiopod shell accumulation.


TUDORÓW
Samsonowicz
/1917, 1934/
OWN WORKS
FAMENNIAN
FRASNIAN
UPPER
MIDDLE
LOWER
GIVETIAN
m
10
5
0
Anc. nodosa
GYPIDULIDS
exposed parts
FRASNIAN
?
?
A
1
a
b
2
3
4
5
KARWOW
castle
TUDORÓW
N
quarry
Td-Ia
0
500
m
WŁOSTÓW
B
Td-Ia
C

deposits are regarded as fore-reef talus by NARKIEWICZ (1988, p. 624). Gypidulids are also found frequently in the underlying dark and bedded varieties of the Wietrznia Beds (viz. set A), partly of biostromal aspect and with rare marly partings. The Wietrznia sequences, representing transitional facies between the shallow-water Kielce region and the Łysogóry basin, is a well-known gypidulid site, but species determinations have varied from author to author: *Pentamerus formosus* SCHNUR (GÜRICH, 1901, p. 381), *P. galeatus* DALMAN (SIEMIRADZKI, 1909, p. 87), *P. acutelobatus* SANDBERGER (SIEMIRADZKI, 1909, p. 87), "*P.*" *brevirostris* (CZARNOCKI *in* RÓZKOWSKA, 1953, p. 1).

Other Frasnian localities studied are also distributed along the Kadzielnia Chain, south of Kielce. In palaeogeographic terms, these sites correspond to the northern periphery (foreslope) of the Dyminy reef. The most famous (elaborated for more than 150 years) locality is the former Kadzielnia quarry. The biohermal Kadzielnia Member, consisting of laminar stromatoporoid bindstone, is the source of small-sized gypidulids identified by BIERNAT (1971, pp. 140-141) as *Gypidula (Ivdelinia) rectangularis* (TORLEY, 1934). Large specimens were also present in the collection examined by BIERNAT (id., pp. 141-142) who determinated them as *Gypidula (Devonogypa)* sp. On the other hand, brachiopod lenses and "pockets" within *Alveolites*-rich part of the Kadzielnia-buildup at the adjacent Cmentarna Hill (set B-1 of GAWLIK, 1986; see also GÜRICH, 1896, p. 83 and WRZOŁEK, 1988, p. 418) contain very abundant juvenile gypidulids. The gypidulids, listed as *Pentamerus galeatus* DALMAN by SIEMIRADZKI (1909) and SOBOLEV (1909), play an important role in the atrypid-dominated faunas associated with the generally younger Frasnian detrital (fore-reef) facies (*sensu* SZULCZEWSKI, 1971). They are far more common in the western part of the Kadzielnia Chain. In the inactive Grabina quarry (Pl. 2, Fig. 1), there are frequent gypidulids in lumachelle "nests" within light-colored poorly-bedded calcarenites containing small *Renalcis*- and *Stachyodes*-mounds and stromatolite patches (set B of WRZOŁEK, 1988). More precise conodont and coral datings are available only for the overlying fossiliferous strata: the brachiopod-bearing deposits are tentatively assigned to the undivided *Ancyrognathus triangularis* to Upper *gigas* Zones.

More differentiated detrital limestones with scattered coelenterate- and/or *Renalcis*-buildups occur in the western-most, active Szczukowskie Hills quarry, west of Kielce. The rich fauna has not yet been elaborated palaeontologically with exception of the faunal list of SOBOLEV (1909, p. 178). Rugose corals (association close to that cited above from Karwów according to WRZOŁEK, unpublished data) and infrequent conodonts suggest that most of the exposed sequence should be place between the Middle *asymmetricus* and Lower *gigas* Zones. Thin shell-rich intercalations are commonly composed of juvenile gypidulid valves. Large shells are characteristic of the lower part of the section, visible in the north-eastern part of the quarry (Pl. 2, Fig. 2). An early Frasnian age is confirmed by conodonts (occurence of *Ancyrodella africana* GARCIA-LOPEZ, 1981). Extensive shell concentrations, up to 2 m thick and containing abundant atrypids, yielded most of the studied material; they are associated with more fine-grained lithologic varieties containing corals and branching stromatoporoids.

Gypidulids are relatively subordinate in the mostly stratified detrital deposits of the eastern part of the Kadzielnia Chain, exposed e.g. in the small abandoned quarries at Psie Hills (SZULCZEWSKI, 1971, pp. 67-68). The best preserved specimen came from coral-bearing, intraclastic calcirudites (set E of GAWLIK, 1986) belonging to the *gigas* Zone (see also WRZOŁEK, 1988).

b. Gałęzice Syncline

Gypidulid associations are not very abundant but were found at two levels in the southern limb of the Gałęzice Syncline. The richer, older fauna is limited to the Kadzielnia Member (SZULCZEWSKI & RACKI, 1981, pp. 150-151; set J of RACKI, 1981, p. 178) which is poorly exposed in the eastern part of Łgawa Hill, south of Bolechowice. Younger (*gigas* Zone) gypidulids, reported as *Pentamerus galeatus* DALMAN by SOBOLEV (1909, p. 221, p. 223) are present in the greyish-reddish, bedded to nodular marly deposits with detrital intercalations and brachiopod coquinas [e.g. complex R of RACKI, 1981 at the Łgawa Hill (or eastern Jaźwica) quarry; see also WRZOŁEK, 1988]; they are a minor element of the abundant, rhynchonellid (*Pammegetherhynchus*)-dominated fauna comprising also many corals and siliceous sponges. Slightly older brachiopods were collected from the coelenterate-rich, coarse-grained beds at the eastern wall of the Wola quarry, south of Kowala. These strata correspond to the late Frasnian set G in the nearby railway cut (see SZULCZEWSKI, 1971, pp. 74-75). A similar age can be inferred (see rugose coral zonation of WRZOŁEK, 1988) for the fauna derived from the light-colored and massive stromatoporoid-algal calcirudites of the northern limb of the syncline. Minute disarticulated shells are particularly typical of the lower part of the sequence exposed in the old Sitkówka quarry (set 2 of KAŹMIERCZAK, 1971, fig. 3D), recently used as a site for industrial waste.

Systematic palaeontology (J.G.)

Genus *Novozemelia* CHERKESOVA, 1973

1973 – Rod *Novozemelia* TCHERKESOVA, gen. nov. – CHERKESOVA, p. 28.

Type species: *Novozemelia olgae* CHERKESOVA, 1973.

Novozemelia ? sp. W

(Plate 3, Figures 1 – 3; Figure 3)

? 1971 – *Gypidula (Devonogypa)* sp. – BIERNAT, pp. 141-142, pl. 1, figs. 6,7; fig. 2;

e.p. 1985 – *Gypidula (Devonogypa)* – RACKI, GŁUCHOWSKI & MALEC, p. 166, non pl. IX, figs. 4,5.

DESCRIPTION

Exterior:

General characters:

The shell is longer than wide, strongly ventribiconvex with an highly arched pedicle valve and a moderately convex brachial valve. In ventral view, its outline is pyriform with evenly well-rounded anterior, lateral and postero-lateral margins. The commissure, observed partially on only three specimens, has its antero-median part deflected ventrally by the tongue (commissure sulcate). The shell being smooth, there is no indentation or undulation of the commissure except in one specimen (the thickest pedicle valve) bearing very low ribs (see ornamentation). The greatest width is located between the mid-length and a point located a little more anteriorly (the poorly preserved material does not allow precise measurements).

Dimensions:

Most of the specimens available for study are isolated and often incomplete (beak, umbonal region or anterior margin broken) pedicle valves. There are six articulated shells but too fragmentary and/or deformed to be measured. Consequently, the data given in the Table 1 (see p. 53 for explanation of the abbreviations) are approximate.

Pedicle valve:

The valve is 1,5 of 1,8 times wider than thick, in posterior view dome-shaped and, in some specimens, almost semicircular. In lateral profile, the curve of the valve is much more accentuated in the posterior half than in the anterior. The inflation of the umbo is very great and the umbonal region projects posteriorly far beyond the hinge line. The apsacline interarea is strongly curved with well rounded lateral margins. The blunt beak overhangs the dorsal umbo but is not in contact with it. The apical angle varies between 74°-85°. Two specimens have a poorly differentiated, low, flat topped fold in the anterior half of the valve. At the anterior commissure, the width of the fold is 64-68% of the width of the shell. The other specimens do not bear a fold.

Table 1.

Specimen	Dimensions (cm)				Apical angle
	l.	w.	tp.	wf.	
Gius 4-261a	±4,35	±3,70	2,05	2,40	76°
Gius 4-261b	3,90	±3,53	/	/	74°
Gius 4-261c	3,90	±3,60	±1,95	/	85°
Gius 4-261d	±3,70	±3,30	±1,90	2,25	/
Gius 4-261e	3,60	±3,10	±2,05	/	84°

Brachial valve:

There are only six fragmentary articulated specimens available for the description of the brachial valve. The outline of the valve is subelliptical, with the width being the largest dimension. The umbonal region is moderately inflated. In posterior view, the flanks whose upper surface is almost plane, are slightly inclined toward the commissures. A weakly developed sulcus is present on three specimens although their pedicle valves have no fold. The sulcus starts at about mid-length or more anteriorly and is only clearly delimited near the front. The tongue, only partly preserved, appears to have a low, semi-elliptical or subtrapezoidal outline.

Ornamentation:

The fold of the largest pedicle valve bears six to seven rounded, very low ribs and each flank has five ribs of the same type. These ribs originate at about mid-length. All the other specimens are unribbed. Very fine growth lines are present on some shells.

Interior (Fig. 3):

Pedicle valve:

There is no median septum. "Longitudinal grooves of muscle attachment" (JOHNSON, 1970, p. 99 = rainures spondyliales *in* GODEFROID, 1972, pp. 2-3) are developed on the bottom of the spondylium. These grooves are of irregular depth and have a rounded transverse section. The teeth are directed dorso-laterally. In their broadest portion, they are made up of a main internal lobe, subelliptical in transverse section and a less developed external extension.

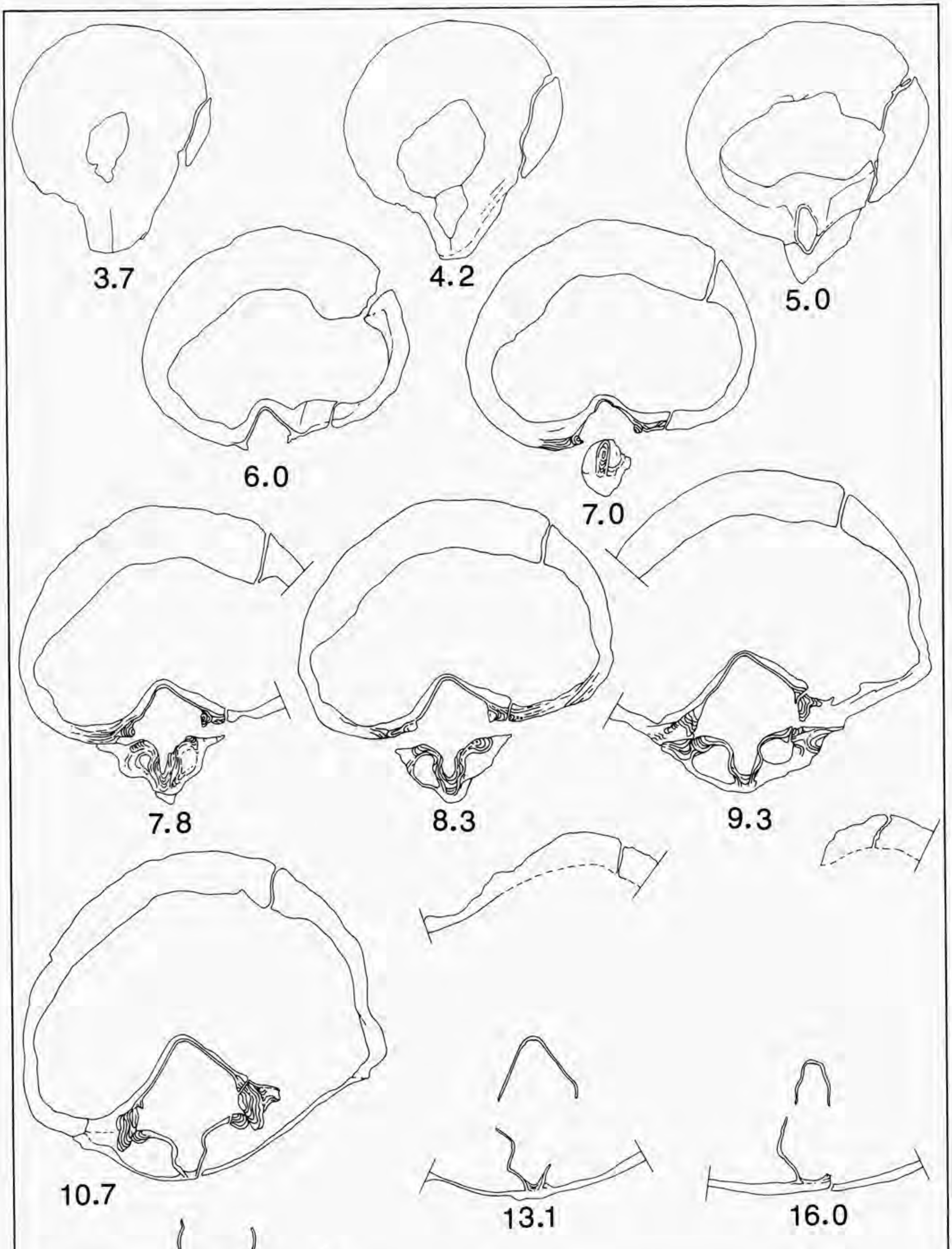
Brachial valve:

The bases of the brachial plates are close one to another on the bottom of the valve, but not joined. The orientation of the internal and external plates, and of the crural bases is illustrated on Figure 3. A thick connective arch is present between the posterior parts of the brachial plates.

DISCUSSION

The Polish shells are too poorly preserved for a confident identification. They cannot be assigned to *Gypidula (Devonogypa)* because of the lack of a median septum

Fig. 3. – *Novozemelia?* sp. W. ▷
Specimen GIUS 4-260a, Wietrznia quarry. Transverse serial sections. Distances are in mm from the top of the ventral umbo.


3.7
4.2
5.0
6.0
7.0
7.8
8.3
9.3
10.7
13.1
16.0
18.2
0
1cm

in their pedicle valve. The closest genus is *Novozemelia* Cherkesova, 1973 of which the Polish specimens have the size and general shape, but differ by the following characters:

- According to Cherkesova (1973, p. 28), *Novozemelia* has a short median septum and this structure is absent in the Polish species. However, it is difficult, especially with very inflated pedicle valves, to determinate whether the pedicle median septum is very short or absent.
- A fold is usually developed in *Novozemelia olgae*, type species of the genus from the Eifelian of USSR. Only two pedicle valves in our material have a very low fold.
- *N. olgae* is ribbed and *N.*? sp. W is smooth except for one specimen which bears very low ribs.
- The brachial plates of *N. olgae* meet on the bottom of the valve. In *N.* ? sp. W, the bases of the brachial plates are close one to another but not joined.

The genus *Physemella* Godefroid, 1974 and the subgenera *Carinagypa (Aseptagypa)* Brice, 1982 and *Ivdelinia (Ivdelinella)* Brice, 1982 also lack a median septum in the pedicle valve. The Polish species however cannot be assigned to any of these genera and subgenera. Its brachial plates do not unite on the floor of the valve to form a low septum as in *Physemella*. There is no carina developed at the junction of the internal plates and the brachial processes as in *Carinagypa (Aseptagypa)*. The shells of *Ivdelinia (Ivdelinella)* are wholly costate.

MATERIAL AND LOCALITIES

Kielce, Wietrznia-I quarry, sets A-B (Szulczewski, 1971): Gius 4-260 WI (5 incomplete pedicle valves and 4 fragmentary articulated specimens); set A and ?set B: Gius 4-261 WI (7 pedicle valves).

Górno, Józefka Hill, set B (Małkoswki, 1981): Gius 4-293 GN (1 incomplete articulated specimen, 4 damaged pedicle valves).

Kostomłoty, Laskowa Hill quarry, set A (Racki, Głuchowski & Malec, 1985): Gius 4-296 LA (1 fragmentary articulated specimen, 8 isolated and incomplete valves).

STRATIGRAPHIC RANGE

Late Givetian to early Frasnian (? Middle *varcus* to Lower *asymmetricus* Zones); Laskowa Hill Beds and Wietrznia Beds (lower part) (Fig.9).

Genus *Metabolipa* Godefroid, 1974

1974 – *Metabolipa* n. gen. – Godefroid, pp. 5-7.
Type species: *Pentamerus greindli* Maillieux, 1909

Metabolipa cf. *greindli* (Maillieux, 1909)
(Plate 3, Figures 4-10; Figure 4)

1896 – *Pentamerus galeatus* Dalm. var. c (*P. biplicatus* Schnur) – Gürich, p. 274;
cf. 1909 – *Pentamerus greindli* nov. sp. – Maillieux, pp. 230-231, fig. 3 a-c;
1971 – *Gypidula (Ivdelinia) rectangularis* (Torley, 1934) – Biernat, pp. 140-141, pl. 1, figs. 1-5; fig. 1;
cf. 1974 – *Metabolipa greindli* (Maillieux, E., 1909) – Godefroid, pp. 7-23, pl. I, figs. 1-7; pl. II, figs. 1-6; pl. III, figs. 1-6; pl. IV, figs. 1-5; pl. V, figs. 1,2; figs. 3-7.

DESCRIPTION

Exterior:

General characters:

The shell is ventribiconvex, wider than long. In ventral view, its subelliptical outline is modified by the inflation of the umbo. The anterior commissure is sulcate. On costate shells, the anterior and antero-lateral commissures are indented or undulated and the portions of the commissure close to the hinge line are straight.

Dimensions:

Most of the specimens at hand being poorly preserved, it is impossible to provide accurate measurements. The largest shell is 3,3 cm wide and 2,9 cm thick. The width/length ratio is about 1,1-1,2. The maximum width is located at the mid-length or somewhat anteriorly. The thickness of the pedicle valve is approximately twice of that of the brachial valve. The specimens from the Kadzielnia quarry are not in their full growth stage. The largest shell is represented by an incomplete pedicle valve (Pl. 3, Fig. 6a-b) about 1,45 cm long (anterior commissure partly broken) and 1,65 cm wide. These dimensions are close to those (length: 16 mm; width: 17,3 mm) of the specimen from the same locality, identified as *Gypidula (Ivdelinia) rectangularis* by Biernat (1971, pp. 140-141) and considered by this author, along with nine other specimens of the studied collection, as being not, "in all probability, in their full growth, ..." (Biernat, id., p. 141) (see also Gürich, 1896, p. 274 for size data). The specimens from the Szczukowskie Hills quarry are larger than those from the Kadzielnia quarry.

Pedicle valve:

The width/thickness ratio varies between 2 and 2,3. The inflated umbo extends far beyond the cardinal line and the posterior border of the brachial valve. In posterior view, the median part of the valve is regularly curved and the slightly convex upper surfaces of the flanks form with the commissural plane an angle of 50°-55°. In lateral profile, the maximum curvature is located in the posterior half. The curved, apsacline interarea has rounded lateral limits. The posterior part of the delthyrium is concealed by the blunt, incurved beak which does not overhang the dorsal umbo and is not in contact with it. The length of the fold is highly variable: the longest fold starts at the mid-length or a little posteriorly and the shortest at a point close to the front. Except at the point where it originates, the fold is generally well delimited and only a few specimens have a fold not easily separable from the flanks. At the front, the width of the fold varies between 55-64% of the width of the shell.

Brachial valve:
The valve is about 1,3 wider than long. Its elliptical outline is only slightly modified by the inflation of the umbo. In transverse section, the median part of the valve is gently and regularly convex and the flanks whose upper surface is plane, are inclined with a low slope towards the lateral commissures. The sulcus originates at the mid-length or slightly posteriorly. It is clearly delimited from the flanks except in the region where it starts. The tongue has a subtrapezoidal outline (width/height ratio: 2,8-3,2) and its upper part is rarely vertical (one subglobular shell with an high tongue displays this feature).

Ornamentation:
On the fold and in the sulcus and beginning with them, there are, in adult specimens, two to five and one to four ribs respectively. At their origin they are very low and rounded. Anteriorly their height increases and their cross section becomes generally subangular. Some specimens however, have only rounded ribs on the fold and in the sulcus. On most shells, each flank bears one to four ribs. The height, relief and length of these ribs vary from very low, rounded and short (on some shells, only present near the commissure) to better marked, longer and subangular. The pair closest to the plane of symmetry is always better developed than the others but never originates in the posterior half of the valve. Rare adult specimens have smooth flanks. The microsculpture is partially preserved on the pedicle valve of the small specimen GIUS 4-258. It consists of numerous and delicate, rod-like remnants of spines. The rods are 0,07 to 0,10 mm long and elongated radially. The distance between two adjoining rods varies between 0,05 and 0,10 mm.

Interior (Fig. 4):
Pedicle valve:
The spondylium is supported by a short septum.

Brachial valve:
The brachial plates are slightly divergent ventro-laterally to subparallel. Their bases (bases of the external plates) are clearly separated on the floor of the valve (brachial plates discrete) (see also BIERNAT, 1971, text-fig. 1D).

DISCUSSION
Brachial plates with bases clearly separated on the floor of the valve are also present in *Gypidula (Devonogypa)*, a subgenus erected by HAVLÍČEK (1952, pp. 3-4) whose "crural plates in the dorsal valve are always separated and diverge in the direction towards the anterior margin". The Polish specimens however, are not assigned to this subgenus because of the presence on many of them of rounded or subangular ribs and generally well marked fold and sulcus. Moreover, the microsculpture appears to be different: very fine and rod-like in the Polish species, granule-like in *Gypidula (Devonogypa) spinulosa* HAVLÍČEK (id., pl. II, fig. 2). Our Polish material is assigned to the genus *Metabolipa* (the microsculpture of the type species still remains unknown) on the basis of the following characters: general shape, presence of generally well developed fold and sulcus and even on small shells, ribs rounded or subangular and of variable length, internal structures.
The small sample of generally poorly preserved or not fully developed specimens available to us, does not permit a confident identification. They closely resemble *Metabolipa greindli* from the Belgian Frasnian.

MATERIAL AND LOCALITIES
Bolechowice, Łgawa Hill, set J (RACKI, 1981): GIUS 4-256 GŁ (1 pedicle valve and 1 brachial valve, incomplete).
Kielce, Kadzielnia quarry (see BIERNAT, 1971): GIUS 4-258 Kd (1 pedicle valve, 9 articulated shells of which 3 fragmentary).
Szczukowskie Górki, Szczukowskie Hills quarry: GIUS 4-264 SC (8 articulated shells of which only 2 complete, 4 incomplete pedicle valves, 1 fragment of brachial valve).

STRATIGRAPHIC RANGE
Early Frasnian (? only Middle *asymmetricus* Zone); Kowala Formation, Kadzielnia massive Limestone Member; lower part of the Detrital Beds (Fig. 9).

Genus *Neometabolipa* GODEFROID, 1974

1974 – *Neometabolipa* n. gen. – GODEFROID, pp.23-24.
Type species: *Neometabolia duponti* GODEFROID, 1974.

Neometabolipa duponti GODEFROID, 1974
(Plate 4, Figures 1-10; Plate 5, Figures 6-8; Figures 5,6)

e.p. 1917 – *Pentamerus formosus* SCHNUR – SAMSONOWICZ, p. 45, p. 46;
e.p. 1917 – *Pentamerus* cf. *acutelobatus* SANDBERGER -SAMSONOWICZ, p. 45, p. 46;
e.p. 1934 – *Pentamerus formosus* SCHNUR – SAMSONOWICZ, p. 18;
e.p. 1934 – *Pentamerus* cf. *acutelobatus* SANDBERGER -SAMSONOWICZ, p. 17, p. 18;
1974 – *Neometabolipa duponti* n.gen., n. sp. – GODEFROID, pp. 24-34, pl. VI, figs. 2-4; figs. 8-10.

We have not found specimens determinated as *P.* cf. *galeatus* DALMAN in the SAMSONOWICZ's collection although this taxon was listed in both SAMSONOWICZ's

Fig. 4. – *Metabolia* cf. *greindli* (MAILLIEUX, 1909) ▷
a: Specimen GIUS 4-264, Szczukowskie Hills quarry; b: Specimen GIUS 4-258, Kadzielnia quarry. Transverse serial sections. Distances are in mm from the top of the ventral umbo.

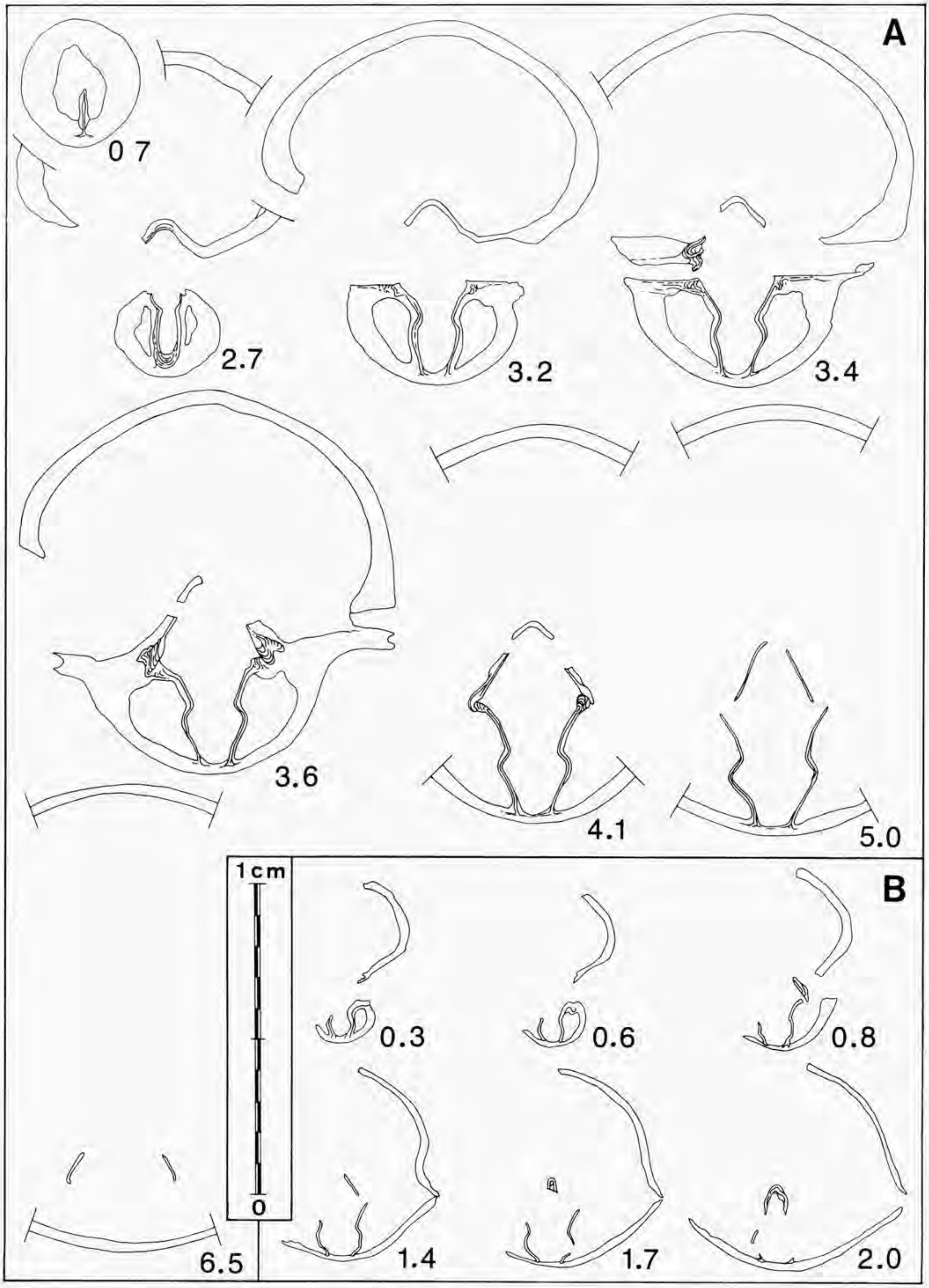

A
0 7
2.7
3.2
3.4
3.6
4.1
5.0
6.5
1 cm
0
B
0.3
0.6
0.8
1.4
1.7
2.0

Table 2.

Specimen	Median ribs	Dimensions (cm)												Apical angle
		l.	u.l.	lb.	u.lb.	w.	t.	tp.	tb.	u.lf.	wf.	u.ls.	ht.	
GIUS 4-263d1	5/4	±2,20	±3,00	/	/	±2,61	±1,44	±0,92	±0,52	1,40	±1,60	/	±0,50	/
GIUS 4-263d2	4/3	1,90	2,90	1,65	2,15	2,21	1,38	0,93	0,45	1,30	/	±1,10	±0,90	108°
GIUS 4-263d3	3/2	±1,82	±2,75	1,60	±1,90	±2,09	1,21	0,81	0,40	1,20	±1,30	±0,90	/	107°
IG 8-II-700a	4/3	1,76	2,45	1,64	2,00	2,09	1,11	0,71	0,40	1,20	1,23	1,00	0,35	110°
IG 8-II-700b	4/3	1,69	2,20	1,60	1,90	1,84	1,03	0,71	0,32	±0,50	1,04	±0,70	0,33	98°
IG 8-II-700c	4/3	1,55	2,05	1,50	1,85	1,95	1,00	0,60	0,40	1,00	1,05	±0,70	0,25	114°
GIUS 4-263d4	/	1,55	1,90	1,45	1,80	1,85	±0,88	/	/	/	±1,12	±0,50	±0,20	/
IG 8-II-700d	3/2	1,41	1,90	1,30	1,60	1,77	0,90	0,51	0,39	±0,40	1,00	0,60	0,23	107°
GIUS 4-263d5	2/1	0,93	1,35	0,90	1,15	±1,11	0,70	0,44	0,26	0,55	0,70	0,65	0,33	106°

papers. It is the reason why *P.* cf. *galeatus* is not included in the synonymy.

DESCRIPTION

Exterior:

General characters:

The ventribiconvex, wider then long shell has its greatest width located about mid-length. In ventral view, the outline of the shell, except the postero-median margin corresponding to the ventral umbo, is elliptical. In frontal view, the anterior commissure is variably but always clearly modified by the tongue (commissure sulcate). The anterior commissure is denticulated or, more rarely undulated, by the ribs of the fold and sulcus. The denticulations or undulations of the commissure resulting from the ribs of the flanks are progressively less prominent away from the plane of symmetry and only the most internal pair has, in some specimens, an amplitude as great as the ribs of the fold and sulcus. The postero-lateral commissures, near the hinge line, are straight.

Dimensions:

The dimensions of nine specimens are given in Table 2 (l. = length of the shell; lb. = length of the brachial valve; w. = width; t. = thickness; tp. = thickness of the pedicle valve; tb. = thickness of the brachial valve; ht. = height of the tongue; lf. = length of the fold; wf. = width of the fold and sulcus; ls. = length of the sulcus; u. = unrolled). The w./l. ration varies between 1,04 and 1,25. The pedicle valve is 1,3 to 2,1 times thicker than the brachial valve. The distance between the ventral beak and the point of the length corresponding to the maximum width ranges generally from 52% to 58% of the unrolled length of the shell. The length of the hinge line is 77-86% of the shell width.

Pedicle valve:

The valve is strongly arched with, in lateral profile, the curve of its posterior part more accentuated than the anterior. The w./tp. ratio varies between 2,3 and 3,0. The very inflated umbo extends posteriorly well beyond the brachial valve. The apsacline, curved interarea is not sharply delimited but has well rounded lateral margins. The blunt, incurved beak conceals the top of the delthyrium but does not overhang the dorsal umbonal region. Deltidial plates appear to be absent. The fold is of variable length and with a slightly convex top. It is generally restricted to the anterior half of the valve. Its unrolled length ranges in most of the specimens between 20-49% of the unrolled length of the valve. At the front, the width of the fold varies between 54-63% of the width of the shell.

Brachial valve:

The valve is very low and 1,2 to 1,4 times wider than thick. The weakly marked umbonal region extends only slightly beyond the hinge line and does not strongly modify the elliptical outline of the valve. In anterior view, the median part of the valve is broadly rounded and the slope of the plane to slightly convex flanks to the lateral commissures is low. The sulcus originates between the mid-length and a point close to the anterior commissure. It is not deep but clearly delimited, except in its very posterior part where it is not easily separable from the flanks. The tongue, except for indentations resulting from the ribs, has a trapezoidal or, rarely, half elliptical outline. Its upper part is never perpendicular to the commissural plane nor nearly so.

Ornamentation:

In the median part of the shell, the ribs originate with the fold and the sulcus. At their beginning, they are low, rounded and poorly defined but become progressively higher, subrounded to subangular and better marked anteriorly. In some specimens however, the ribs remain low to very low, rounded and weakly marked throughout their length. In others, the ribs are not of the same height, one or two of them being less prominent. There are three to five ribs on the fold and two to four in the sulcus; small specimens have two ribs on the fold and one in the sulcus. On the flanks, there are one to four ribs generally weak and rounded, rarely subangular and well marked. Only the internal pair may begin a little anteriorly to the mid-length. The others when present, are always shorter

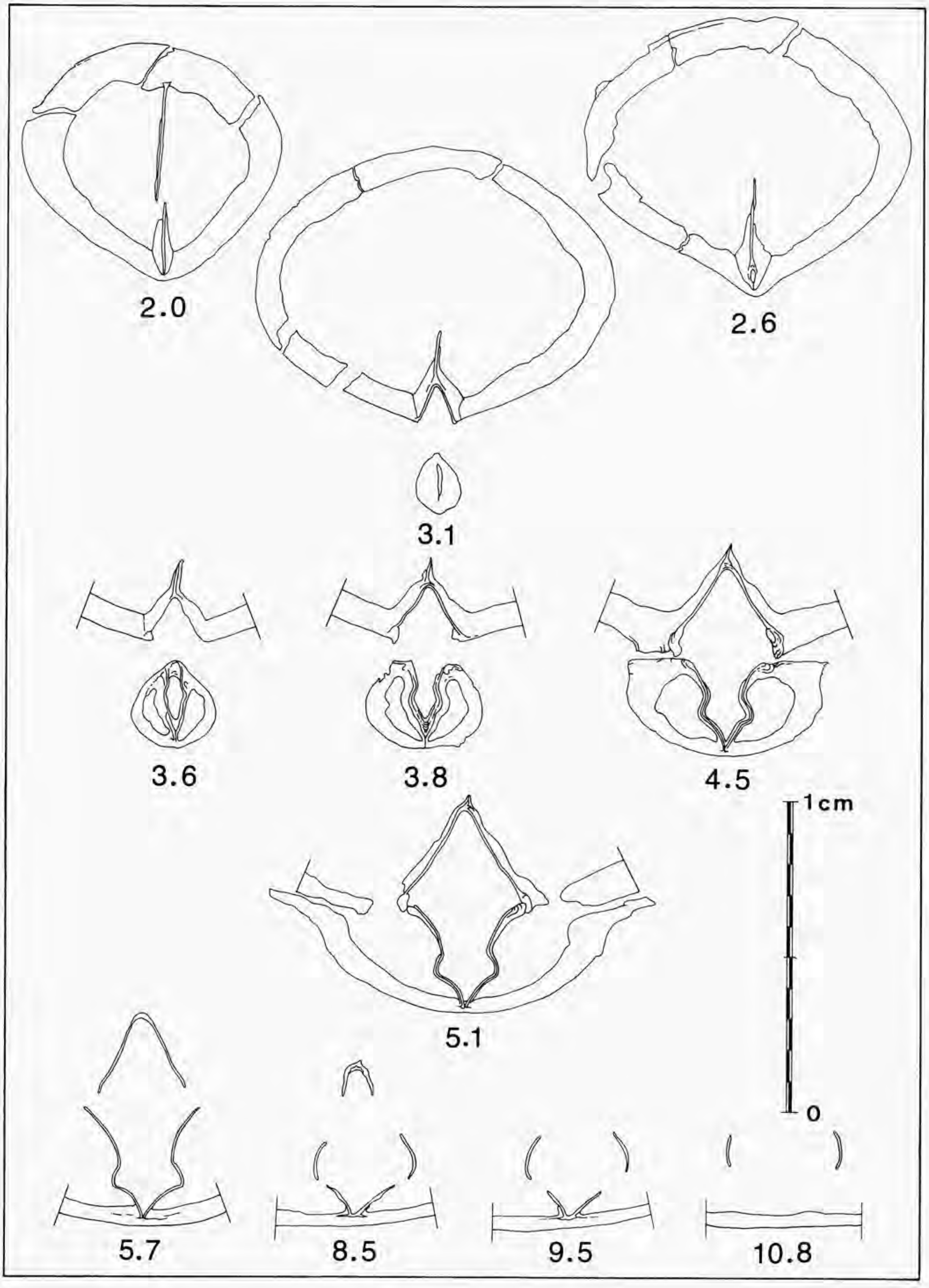

2.0
2.6
3.1
3.6
3.8
4.5
1 cm
5.1
0
5.7
8.5
9.5
10.8

Table 3.

Specimen	Median ribs	Dimensions (cm)												Apical angle
		l.	u.l.	lb.	u.lb.	w.	t.	tp.	tb.	u.lf.	wf.	u.ls.	ht.	
GIUS 4-277a	3/2	±1,60	/	1,45	2,05	1,95	1,23	0,78	0,45	0,80	0,90	0,80	0,41	112°
GIUS 4-277b	3/2	1,41	1,90	1,32	1,70	1,62	0,92	0,60	0,32	0,60	1,00	±0,60	0,42	116°

and less prominent and the outermost rib is no more than a weak undulation of the upper surface of the shell close to the commissure. One specimen has smooth flanks.

Interior (Figs. 5,6):
Pedicle valve:
A short median septum supports the spondylium in its posterior half.

Brachial valve:
The external plates strongly diverge ventro-laterally. Their bases are joined on the floor of the valve. The bases of the brachial processes and the brachial processes following them anteriorly are, in transverse section, convex outwards and slightly oriented ventro-medially. The internal plates, weakly convex inwards in transverse section, diverge ventro-laterally. A connective arch is developed.

DISCUSSION
Because they have brachial plates strongly diverging ventro-laterally and with their bases joined on the floor of the valve, the Polish specimens are assigned to the genus *Neometabolipa*. In the Polish specimens, the fold and sulcus are generally restricted to the anterior half of the valve whereas in the Belgian specimens their unrolled length may reach 63% of the unrolled length of the corresponding valve. In addition, the ribs of the Belgian species may be a little longer and more accentuated than those observed on the Polish shells. We regard however, these differences as insufficient for erecting a new species.

MATERIAL AND LOCALITIES
Tudorów: IG 8.II.697 (9 articulated shells but only 1 complete), IG 8.II.698 (2 articulated shells and 4 isolated valves), IG 8.II.700 (13 articulated shells), IG 8.II.703 (4 articulated shells), GIUS 4-263 TD (34 articulated shells of which 13 fragmentary, 17 pedicle and 8 brachial valves incomplete, 10 small articulated specimens).
Bolechowice, Łgawa Hill quarry, set R (RACKI, 1981): GIUS 4-284 GŁ (3 pedicle and 2 brachial valves damaged, 1 pedicle and 1 brachial valve, very small and fragmentary).
Kielce, Psie Hills, set E (WRZOŁEK, 1988): GIUS 4-356 PG (1 complete shell).

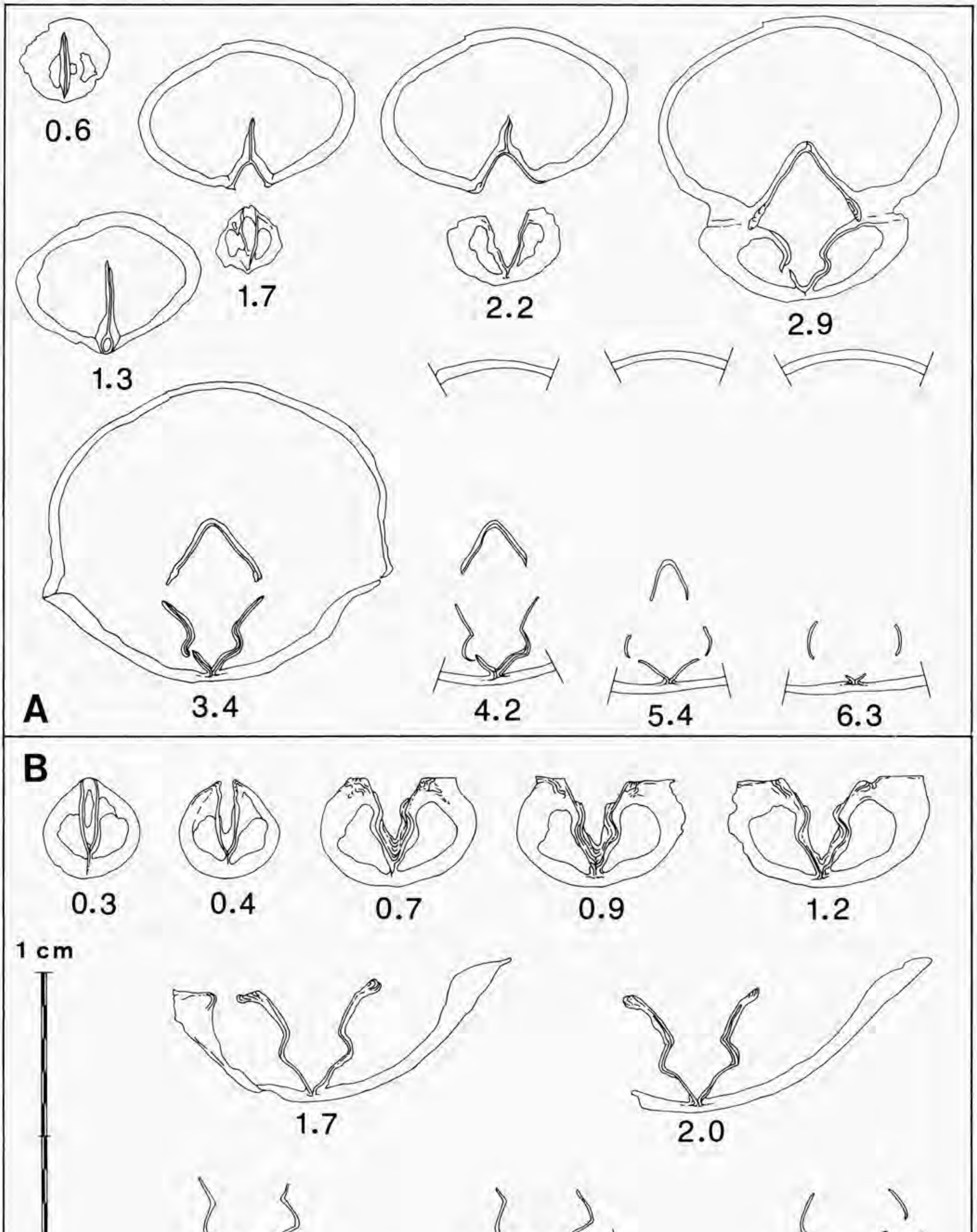
STRATIGRAPHIC RANGE
Late Frasnian (*gigas* Zone, possibly also *Ancyrognathus triangularis* Zone); upper part of the Detrital Beds and its marly, bedded-nodular equivalents (Fig. 9).

Neometabolipa? sp. G
(Plate 3, Figures 11-14; Figure 7)

DESCRIPTION
The gypidulids collected at the Grabina and Wola quarries display some pecularities differentiating them from the specimens determinated as *Neometabolipa duponti*. The shells are ventribiconvex (tp./tb. = 1,7-1,9), wider than long (w./l = ±1,1-1,2) and with a subelliptical outline in ventral view. The dimensions of two specimens are given in Table 3. The pedicle fold is typically low, restricted to the anterior half of the valve and more or less easily separable from the flanks only in the anterior third or quarter. The brachial sulcus, present in the anterior half of the valve, is generally deep, clearly delimited and better differentiated than the fold. On the fold, there are three to six subangular ribs and in the sulcus two to five. Each flank bears a maximum of three ribs, weakly marked and restricted to a portion of the shell close to the commissure. Rare shells have smooth flanks.
In the pedicle valve a short median septum supports the spondylium.
The internal structures of the brachial valve, observed in serial sections or after removing a part of the shell, are of two types: 1/the brachial plates are discrete (bases of the external plates separated on the floor of the valve) as in *Metabolipa* but they are a little more divergent and the

◁ Fig. 5. – *Neometabolipa duponti* GODEFROID, 1974.
Specimen IG 8.II.697c, SAMSONOWICZ's collection, Tudorów. Transverse serial sections. Distances are in mm from the top of the ventral umbo.

Fig. 6. – *Neometabolipa duponti* GODEFROID, 1974. ▷
a: Specimen IG 8.II.700e; b: Specimen IG 8.II.698b; SAMSONOWICZ's collection, Tudorów.
Transverse serial sections. Distances are in mm from the top of the ventral umbo.


0.6
1.3
1.7
2.2
2.9
3.4
4.2
5.4
6.3
A
B
0.3
0.4
0.7
0.9
1.2
1 cm
0
1.7
2.0
3.2
3.7
3.9

connective arch is more developed than in this genus (Fig. 7A) and 2/the brachial plates with their bases joined or very close one another in their posterior part are separated only anteriorly and a thick connective arch is present (Fig. 7B,C). This type has already been described in some specimens of *Neometabolipa duponti* and *N. delhayei* (GODEFROID, 1974, Figs. 10, 13) from the Belgian Frasnian.

DISCUSSION

Because of the presence, in some specimens, of discrete brachial plates, the specimens are questionably assigned to the genus *Neometabolipa*. They could represent the transition between *Metabolipa* and *Neometabolia*.

COMPARISON

Neometabolipa? sp. G is distinguished from *N. duponti* by its smaller size, its low, poorly delimited fold and by the sulcus being generally better differentiated than the fold.

Externally the specimens closely ressemble *N. delhayei* in the following characters: relief, length and delimitation of the fold, length and depth of the sulcus, length and relief of the ribs. However, in the sectioned specimens of *N. delhayei* from Belgium, discrete brachial plates have never been observed.

MATERIAL AND LOCALITIES

Kielce, Grabina quarry, set B (WRZOŁEK, 1988): GIUS 4-277 GR (8 articulated shells of which 4 fragmentary, 38 isolated pedicle and brachial valves, some of them being incomplete). Kowala, Wola quarry, set G (WRZOŁEK, 1988): GIUS 4-333 KW (1 incomplete articulated shell, 2 fragmentary pedicle valves, 1 brachial valve).

STRATIGRAPHIC RANGE

Late Frasnian (probably *Ancyrognathus triangularis* to Lower *gigas* Zones); Detrital Beds (Fig. 9).

Genus *Physemella* GODEFROID, 1974

1974 – *Physemella* n. gen. – GODEFROID, pp. 49-51.
Type species: *Physemella maillieuxi* GODEFROID, 1974.

EMENDED DIAGNOSIS

The diagnosis given by GODEFROID (1974, p. 50) is here emended in order to include in the genus species displaying a low, well delimited pedicle fold, a clearly marked brachial sulcus and bearing rounded to subangular ribs originating on the umbo or anteriorly and, in some specimens, increasing in number toward the anterior.

Physemella christinae n. sp.
(Plate 5, Figures 1-5; Figure 8)

e.p. 1917 – *Pentamerus formosus* SCHNUR – SAMSONOWICZ, p. 45, p. 46;
e.p. 1934 – *Pentamerus formosus* SCHNUR – SAMSONOWICZ, p. 18.

DERIVATIO NOMINIS

Species named after Mrs CHRISTINA, a well known and highly esteemed lady of the Holy Cross Mountains.

TYPES

Primary types are housed at the Museum of the State Geological Institute (IG) at Warsaw and at the Institute of Geology of the Silesian University at Sosnowiec (GIUS). Plaster casts of all the types are in the collections of the "Institut royal des Sciences naturelles de Belgique" at Brussels (Inventaire Général n° IG 27620).

Holotype: IG 8.II.702a (Pl. 5, Fig. 1a-e); Paratype A: IG 8.II.702b (Pl. 5, 2a-e); Paratype B: GIUS 4-263e TD (Pl. 5, Fig. 3a-e); Paratype C: GIUS 4-263f TD (Pl. 5, Fig. 4a-e); Paratype D: GIUS 4-263g TD (Pl. 5, Fig. 5a-e); Paratype E: IG 8.II.699; Paratype F: IG 8.II.697d (Fig. 8).

LOCUS TYPICUS

Small outcrop localised in a ravine, south of Tudorów village (exposure Td-Ia, Fig. 2B-C).

STRATUM TYPICUM

Light-colored calcarenites containing a brachiopod shell layer. Upper part of the Detrital Beds. Late Frasnian (probably *Ancyrognathus triangularis* or *gigas* Zone).

DIAGNOSIS

A species of the genus *Physemella* with well-delimited pedicle fold and brachial sulcus originating between the posterior quarter and third of the unrolled length of the valves or, in some specimens, even more posteriorly. On the pedicle fold, four to seven very low, rounded ribs originating on the umbo or slightly anteriorly, becoming higher and generally subangular and increasing by intercalations or division anteriorly; five to ten ribs at the anterior commissure. In the sulcus, three to six ribs starting on the umbo or a little anteriorly and four to nine at the front. Median septum absent in the pedicle valve. In the brachial valve, brachial plates uniting in their very anterior part slightly above the floor of the valve to form a very short septum.

DESCRIPTION

Exterior:

General characters:

The shell is strongly ventribiconvex and slightly wider than long. In pedicle view, the elliptical outline of the shell is modified by the very inflated umbo. The greatest width is located at the mid-length or a little more anteriorly. The commissure is sulcate and generally indented, rarely undulated, by the ribs of the fold and sulcus and indented or undulated by those of the flanks. The indentations or undulations of the antero-lateral and lateral commissures are weaker than those resulting from the ribs of the fold and sulcus and decrease in height away from the plane of symmetry. Only the parts of the commissure close to the hinge line are straight.

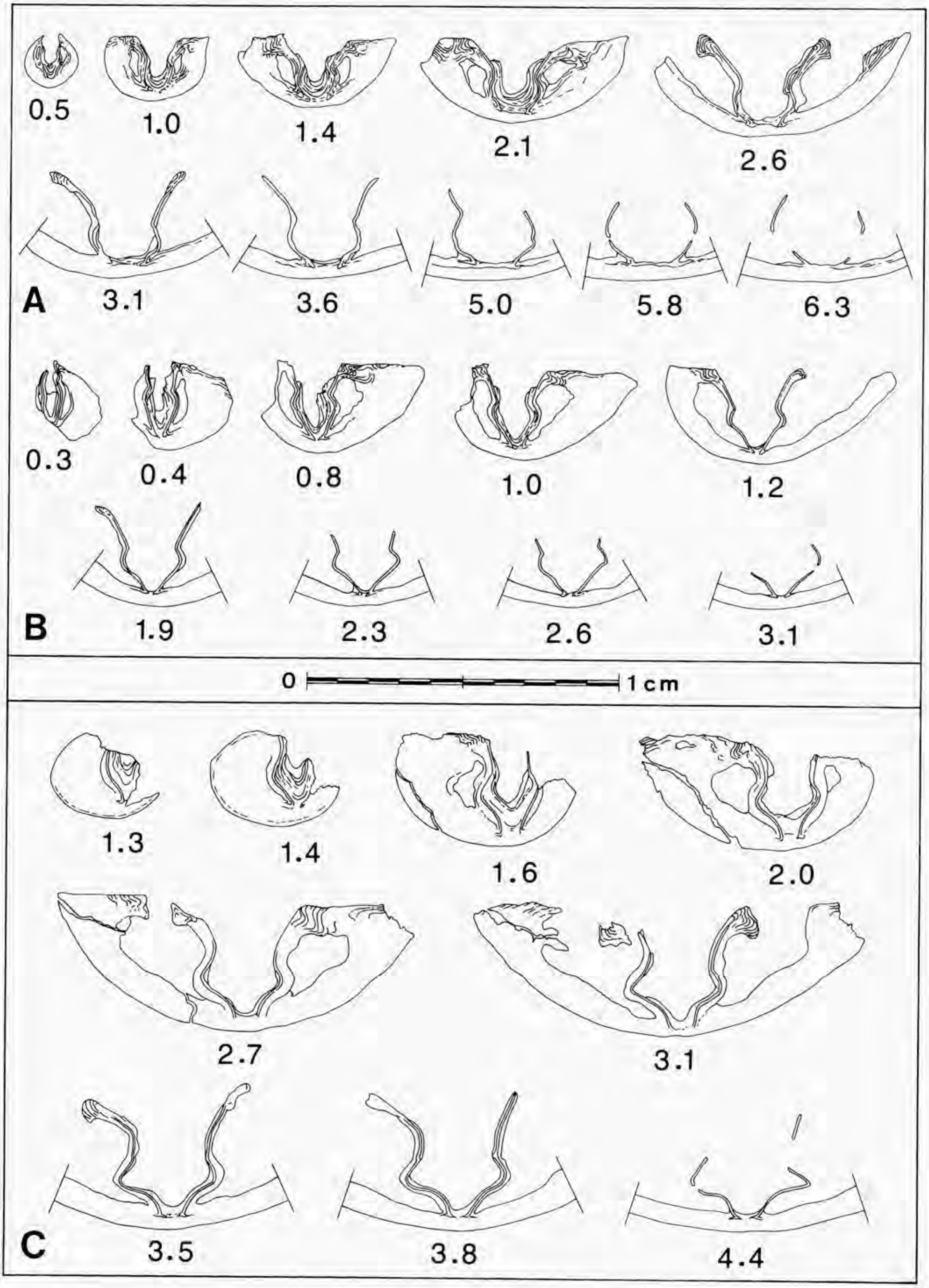

0.5
1.0
1.4
2.1
2.6
A
3.1
3.6
5.0
5.8
6.3
0.3
0.4
0.8
1.0
1.2
B
1.9
2.3
2.6
3.1
0
1 cm
1.3
1.4
1.6
2.0
2.7
3.1
C
3.5
3.8
4.4

Table 4.

Specimen	Median ribs	Dimensions (cm)												Apical angle
		l.	u.l.	lb.	u.lb.	w.	t.	tp.	tb.	u.lf.	wf.	u.ls.	ht.	
HOLOTYPE	10/9	2,95	4,60	2,45	4,20	3,40	2,57	1,82	0,75	3,20	2,40	2,80	1,00	110°
PARATYPE A	7/6	3,00	4,15	2,65	3,30	3,06	2,00	1,40	0,60	2,90	2,15	2,05	0,95	108°
PARATYPE B	6/5	2,90	4,00	2,65	3,60	3,20	2,10	1,40	0,70	2,80	2,00	2,40	0,95	/
PARATYPE C	6/5	2,35	3,20	2,08	2,90	2,50	1,75	1,10	0,65	2,30	1,50	2,10	0,83	/
PARATYPE D	5/4	/	/	2,05	3,50	2,60	1,97	1,35	0,62	/	1,80	2,20	1,00	/

Dimensions:
Some measurements given in Table 4 are approximate due to distortions and shell breakage.
The w./l. ratio varies between ±1,02 and ±1,15 and the tp./tb. ratio, from ±2,0 to ±2,4. The greatest width is situated at a distance from the ventral beak corresponding to 52-53% of the unrolled length of the shell. The length of the hinge line ranges between 76-80% of the shell width.

Pedicle valve:
The valve is subhemispherical, 1,9 to 2,2 times wider than thick. In posterior and anterior view, the median part of the valve is well rounded and the slope of the gently convex upper surface of the flanks is steep. The very inflated umbo extends posteriorly well beyond the hinge line and the posterior margin of the dorsal valve. The interarea is apsacline, strongly incurved and not clearly delimited laterally (rounded lateral margins). The blunt, incurved beak conceals the posterior part of the delthyrium but does not overhang the dorsal umbo. The fold starts imperceptibly around the posterior quarter or third of the unrolled length or, in some specimens, on the umbo. It rises and widens progressively toward the anterior but remains generally low and is clearly separable from the flanks only in the anterior half of the valve. The upper surface of the fold is slightly arched and at the posterior margin its width varies from 60% to 70% of the shell width.

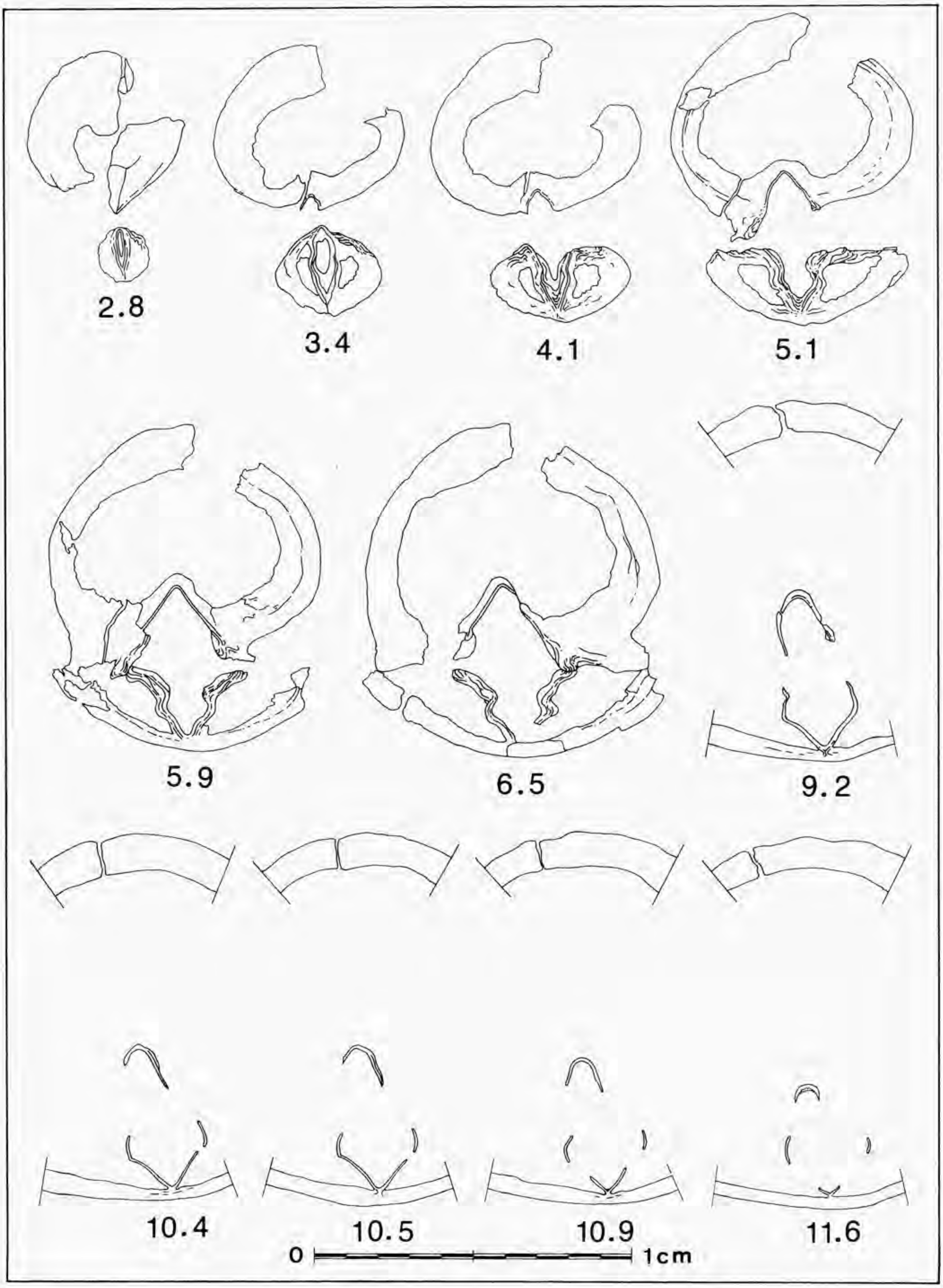
Brachial valve:
The valve is weakly convex, about 4 to 5 times wider than thick. Its outline is subelliptical, modified in its posteromedian portion by moderate inflation of the umbo extending a little beyond the hinge line. The upper surface of the flanks is weakly convex or plane and gently inclined toward the lateral and antero-lateral commissures. The sulcus begins between the posterior third and quarter of the unrolled length of the valve. As in the pedicle fold, the sulcus is only well-delimited from the flanks in the anterior half of the valve and its bottom is slightly arched. The tongue is well developed, 1,8 to 2,4 times wider than high and its outline is subtrapezoidal with the upper margin moderately arched ventrally, rounded upper angles and straight lateral borders. In some specimens, the upper portion of the tongue is almost vertical.

Ornamentation:
On the fold four to seven, more rarely eight, ribs originate on the umbonal region, posteriorly to the point where the fold starts. In their very posterior part, they are weakly marked and rounded. Anteriorly, they become progressively higher, wider and subangular. Divisions or intercalations may occur so that the number of ribs at the anterior margin may reach ten. In the sulcus the ribs are of the same type of those on the fold. Their number varies from three to six posteriorly and may reach nine at the anterior margin. On each flank, there are four to six ribs; they are rounded and always less well-marked than those of the fold and sulcus. The two ribs on the flanks nearest the plane of symmetry begin generally between the posterior quarter and third of the unrolled length of the valves. The others are progressively shorter and weaker away from the plane of symmetry. Intercalations or divisions on the flanks are rare.

Interior (Fig. 8):
Pedicle valve:
Thickening of the shell is important in the umbonal region. There is no median septum. The well developed spondylium bears longitudinal grooves of muscle attachment. The teeth are divided into a main internal lobe directed dorso-laterally and a less well-developed external lobe.

Brachial valve:
The bases of the brachial plates are joined on the floor of the valve or a little above it in their anterior portion

◁ Fig. 7. – *Neometabolipa?* sp. G.
a: Specimen GIUS 4-277d; b: Specimen GIUS 4-277e; Grabina quarry. c: Specimen GIUS 4-333b, Wola quarry, Kowala. Transverse serial sections. Distances are in mm from the top of the dorsal umbo.


2.8
3.4
4.1
5.1
5.9
6.5
9.2
10.4
10.5
10.9
11.6
0
1cm

so that a very low, short median septum is developed. A connective arch is present in the posterior part of the brachial plates. Anteriorly the brachial plates are thinner and better differentiated. The external plates are nearly straight or slightly convex inwards and strongly divergent ventro-laterally; the bases of the brachial processes and the brachial processes are convex inwards and more or less subparallel; the internal plates are nearly straight and divergent ventro-laterally. The inner brachial plates are shorter than the outer. The dental sockets are shallow and short.

COMPARISON

Physemella christinae clearly differs from *P. maillieuxi* by the following characters: the fold and sulcus of the Polish species are better differentiated than those of the type species; the ribs of *P. christinae* are well marked and not very low as in *P. maillieuxi*; the septum developed in the brachial valve of the latter is higher and longer than in *P. christinae*.

MATERIAL AND LOCALITIES

Tudorów: IG 8.II.699 (1 fragmentary shell, 1 pedicle valve), IG 8.II.702 (3 articulated shells, 1 incomplete pedicle valve), GIUS 4-263 TD (4 damaged articulated shells).

STRATIGRAPHIC RANGE

Late Frasnian (possibly *Ancyrognathus triangularis* or *gigas* Zone); upper part of the Detrital Beds (Fig. 9).

indet. gypidulids

The gypidulids collected at the localities listed below are fragmentary or only represented by juvenile specimens and do not allow a confident generic identification.

Kielce, Cmentarna Hill, set B (see WRZOŁEK, 1988): GIUS 4-259 GC (10 juvenile shells).

Sitkówka, Sitkówka quarry (see KAŹMIERCZAK, 1971, fig. 3D): GIUS 4-265 SJ (2 pedicle valves, 5 brachial valves).

Karwów, Karwów quarry and adjacent outcrop. GIUS 4-262 KR (3 fragmentary shells, 1 incomplete brachial valve).

Biostratigraphy (J.G. & G.R.)

1. Polish gypidulid faunas

The gypidulids from the Holy Cross Mountains studied in the present paper can be stratigraphically grouped into three main faunas. From oldest to youngest, these brachiopod units follow and partly overlap one another (Fig. 9) as indicated below.

a. The Novozemelia? fauna (GF 1)

This association is characterized by the large, ventribiconvex, generally smooth, non septate gypidulid *Novozemelia*? sp. W.

This gypidulid is limited to the localities situated in the western Łysogóry region (Laskowa Hill, Józefka) and its transition to the Kielce region (Wietrznia). The directly associated conodonts indicate a late Givetian to early Frasnian age. Furthermore, the specimens illustrated by BIERNAT (1971, pl. 1, figs. 6,7) and identified by her as *Gypidula (Devonogypa)* sp. probably belong to *Novozemelia*? sp. W (see p. 47). If this interpretation is correct, the range of this taxon would extend up to the lower part of the Kadzielnia Member.

A partial age equivalent seems to be a *Gypidula rectangularis* assemblage (RACKI, 1986, figs. 1, 2 & 3-2a,b) occurring only in the Givetian stromatoporoid-coral sequence of the eastern Holy Cross Mountains (site Iwaniska, Fig. 1). Apparently, the gypidulids are absent in the well-known late Givetian brachiopod faunas of the western part of the region.

b. The Metabolipa fauna (GF 2)

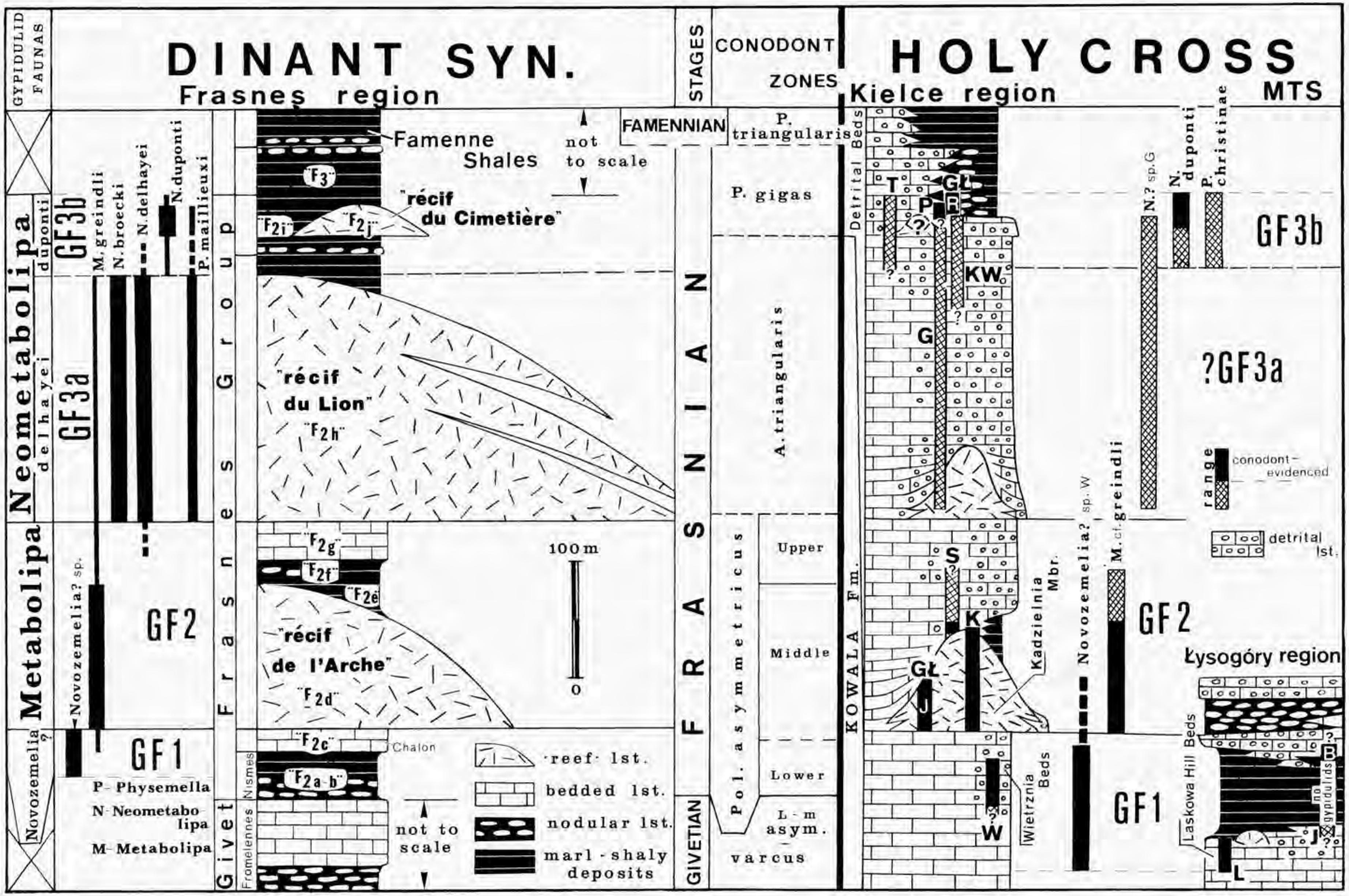
The index genus with its discrete brachial plates typifies the second gypidulid fauna which occurs at least in Kadzielnia, at Łgawa Hill and in the Szczukowskie Hills. The *Metabolipa* fauna spans the early Frasnian (only Middle *asymmetricus* Zone?) Kadzielnia Member at the two first localities (see SZULCZEWSKI & RACKI, 1982, pp. 155-157). A similar level, on the basis of this gypidulid record, is confirmed herein for the lowest part of the Szczukowskie Hills profile.

If the above mentioned occurence of *Novozemelia*? sp. W in the Kadzielnia Member could be verified, then the upper part of the *Novozemelia*? fauna covers part of the *Metabolipa* interval.

c. The Neometabolipa fauna (GF 3)

The gypidulids referable to the genus *Neometabolipa* occur alone or jointly with the genus *Physemella* at the following sites: Grabina, Wola, Łgawa Hill, Psie Hills and Tudorów. The phylogeny of *Neometabolipa* indicates that it is possible to subdivide this level. At Grabina and Wola, *Neometabolipa*? sp. G displays peculiar internal characters (brachial plates either discrete or partly joined on the floor of the valve) and may be a "transitional link" between true *Metabolipa* and *Neometabolipa*. If this interpretation is correct, the *Metabolipa* and *Neometabolipa* faunas would be phylogenetically joined and possibly overlap one another. The age range of the less-advanced (in evolutionary terms) *Neometabolipa* association is not known with precision due to the scarcity

◁ Fig. 8. – *Physemella christinae* n. sp.
Paratype F. Specimen IG 8.II.697d. SAMSONOWICZ's collection, Tudorów. Transverse serial sections. Distances are in mm from the top of the ventral umbo.


GYPIDULID FAUNAS
DINANT SYN.
Frasnes region
STAGES
CONODONT ZONES
HOLY CROSS MTS
Kielce region
Neometabolipa delhayei
Neometabolipa duponti
Metabolipa
Novozemelia ?
GF3b
GF3a
GF2
GF1
M.greindli
N.broecki
N.delhayei
N.duponti
P. maillieuxi
Novozemelia? sp.
P- Physemella
N- Neometabolipa
M- Metabolipa
Givet
Fromelennes
Nismes
Frasnes Group
Famenne Shales
not to scale
"F3"
"récif du Cimetière"
"F2i"
"F2j"
"récif du Lion"
"F2h"
"F2g"
"F2f"
"F2e"
"récif de l'Arche"
"F2d"
"F2c"
Chalon
"F2a-b"
100 m
0
reef lst.
bedded lst.
nodular lst.
marl - shaly deposits
FAMENNIAN
FRASNIAN
GIVETIAN
P. triangularis
P. gigas
A. triangularis
Pol. asymmetricus
Upper
Middle
Lower
L - m asym.
varcus
Detrital Beds
KOWALA Fm.
T
P
GŁ
R
KW
G
S
K
GŁ
J
W
?
Kadzielnia Mbr.
Wietrznia Beds
Novozemelia? sp. W
M.cf.greindli
N.? sp.G
N. duponti
P. christinae
?GF3a
range
conodont-evidenced
detrital lst.
Łysogóry region
Laskowa Hill Beds
no gypidulids
L

of conodonts; all data available (see also discussion on p. 47) point to late Frasnian, viz. *Ancyrognathus triangularis* and/or Lower *gigas* Zone.

N. duponti is accompanied by *Physemella christinae* at the Tudorów locality. The first species occurs certainly in the *gigas* Zone at Psie Hills and Łgawa Hill. The fauna from Tudorów is not directly dated by conodonts (Fig. 2), but can be tentatively referred to the same zone on the basis of the occurrence of *N. duponti*.

2. Comparison with the Belgian succession

The lithostratigraphic subdivisions of the Frasnian strata in the Frasnes and Boussu-en-Fagnes regions, together with the stratigraphic range of the gypidulid species (GODEFROID, 1974), are given in Figure 9 showing preliminary correlations between gypidulid-bearing beds of the Holy Cross Mountains and Dinant Synclinorium.

a. The Novozemelia? fauna (GF 1)

Large, globose, strongly ventribiconvex, pear-shaped gypidulids occur in the "F2b" and "F2c" shales and nodular limestones in the Nismes region and at Boussu-en-Fagnes (outcrop Chemin de l'Ermitage *in* LECOMPTE, 1959, pp. 71-75). The shales designated by the symbol "F2b" correspond to the upper part of the Sourd d'Ave Member and the La Pree Member of the Nismes Formation (BULTYNCK, CASIER, COEN, COEN-AUBERT, GODEFROID, SARTENAER, 1983, pp. 5-7) TSIEN (1974 a, p. 27) has introduced the term "Chalon Member" for the shales and stratified nodular limestones ("F2c") underlying the first reef level ("F2d"). Although more comprehensive investigations are needed, on the basis of the internal structures in these gypidulids, partly visible on some decorticated specimens, they probably belong to the same genus as the Polish shells here determinated to be *Novozemelia*? sp. W. Until now, no gypidulids of the type present in the Nismes Formation have been recorded in the Givetian Fromelennes Formation.

Consequently, we can only provisionally conclude that the strata containing the *Novozemelia*? fauna in Poland correspond partly to the Sourd d'Ave (upper part) and La Pree Members of the Nismes Formation and to the overlying Chalon Member.

b. The Metabolipa fauna (GF 2)

In the Frasnian sequence, *Metabolipa greindli* is known from the shales and nodular limestones "F2c" (Chalon Member) up to the second reef level "F2h" (= "récif du Lion"). The species is particularly abundant in the upper part of the first reef level "F2d" (= "récif de l'Arche"). In the "F2g" and "F2h", *M. greindli* coexists with representatives of the genera *Neometabolipa* and *Physemella*. In Poland, *Metabolipa* cf. *greindli* has, up to now, never been collected with these two latter genera and for that reason, the strata containing the *Metabolipa* fauna in Poland are correlated with the "F2c" and "F2d" units in which *M. greindli* occurs alone.

c. The Neometabolipa fauna (GF 3)

Neometabolipa species are present from the "F2g" up to "F2j" (= "récif du Cimetière"); mass occurrences characterize the second ("F2h") and the third ("F2j") reef levels. Originally, *Physemella maillieuxi* was considered to be present in the second reef level which was typified by the *Neometabolipa-Physemella* association (GODEFROID, 1974, fig. 16). Further investigations however, have shown that *P. maillieuxi* occurs also in the third reef level.

The Polish gypidulid *Neometabolipa*? sp. G is externally very close to *Neometabolipa delhayei*. These species are distinguishable by their brachial plates (see p. 57). The strata containing *N*? sp. G which is here considered as a "transitional form" between typical *Metabolipa* and *Neometabolipa*, could be preliminarily correlated with the Belgian "F2h" in which these two genera occur together.

In the Wola and Grabina quarries where *N*? sp. G has been found, we have not collected representatives of *Physemella*, genus appearing in the Belgian "F2h". Nevertheless it is not inconsistent with the proposed correlation because in the Polish localities gypidulids are not numerous in comparison with the very abundant gypidulid fauna of the Belgian "F2h" in which however *Physemella maillieuxi* is rare. It must be noticed here that the tetracorals associated with *N*? sp. G in the Wola profile, particularly *Frechastraea carinata* SCRUTTON, 1968, suggest a slightly different correlation with the "F2j" of the Dinant Synclinorium (see *Phillipsastrea smithi* Zone *in* WRZOŁEK, 1988, p. 416).

Physemella christinae and *Neometabolipa duponti* occur together at the Tudorów locality. These gypidulid-rich strata are correlated with the "F2j", corresponding to the upper *Neometabolipa* fauna characterised by *N. duponti*.

The occurence of *N. duponti* in the higher part of the Łgawa Hill section and in the outcrop of Psie Hills

◁ Fig. 9. – Stratigraphic distribution of gypidulids in the Frasnian of the southern border of the Dinant Synclinorium as a standard of reference for the proposed Gypidulid Faunas (GF 1-3) and in the Holy Cross Mountains. Conodont zones according to BULTYNCK (1987); "F2a" to "F3" symbols after MAILLIEUX & DEMANET (1929).

The generalized Holy Cross profiles are not to scale and the thickness relationships are referred chiefly to correlations with the Dinant Synclinorium. The thicknesses of the lithostratigraphic units are as follows: Kowala Formation: 350-800m; Detrital Beds: 25-150m; Wietrznia Beds: 70m; Kadzielnia Member: up to 50m; Laskowa Hill Beds: 5-10m.

Lithostratigraphic units after NARKIEWICZ, RACKI & WRZOŁEK (1990). For abbreviations of locality names see Fig. 1. Lithological sets identified by a letter within the range column.

supports the comparison of the gypidulid-bearing beds with the "F2i" or "F2j". It is possible, however, that at Łgawa Hills these strata (set R), belonging to the *Frechastraea pentagona* Zone of WRZOŁEK (1988), are age-equivalent of the "F3" (see also data on the range of the associated rhynchonellid genus *Pammegetherhynchus in* SARTENAER, 1985).

Summarizing, the proposed gypidulid-based correlations of the Polish and Belgian sequences are quite accurate and in good accordance with the accessible conodont and other megafaunal records. Thus, there is an opportunity to do more reliable age determinations based on gypidulids in cases of conodont-impoverished Holy Cross localities (e.g. Tudorów, Grabina).

Ecological account (G.R.)

Data from the Holy Cross Mountains confirmed the close association of the Frasnian gypidulid faunas and reef-complex development, as previously well-known in the Dinant Synclinorium (GODEFROID, 1974).

These brachiopods occur typically in irregularly distributed "nests", lenses and bands (see Pl. 1, Fig. 2), usually in combination with more numerous atrypids and other rarer articulates, particularly spiriferids, rhynchonellids and the genus *Schizophoria* (also athyrids in the Belgian reefs: MAILLIEUX's collection in the I R Sc N B, Brussels). This characteristic atrypid-gypidulid biofacies persisted through the Frasnian until the worldwide collapse of the stromatoporoid-coral reef ecosystem (see also JUX, 1969, p. 89), i.e. to the Frasnian-Famennian extinction event.

The composition of the Upper Frasnian brachiopod assemblage in the Holy Cross Mountains suggests that the abundance of gypidulids was strongly reduced in the latest Frasnian shelly benthos of the progressively drowning reefs, although atrypids were still quite frequent (see RACKI, 1990). Conversely, BIERNAT (1983, p. 137, pl. 1, fig. 6) described *Gypidula* sp. A (externally close to *Neometabolipa*) from Lower Famennian limestones of Jabłonna locality (Fig. 1B); this finding and particularly its stratigraphic position obviously needs confirmation.

The oldest *Novozemelia*? association is common in both Poland and Belgium in lithologies varying from organodetrital (primarily crinoid) limestones to marly shales (typical of fore-bank setting). All of the youngest occurrences of the Holy Cross gypidulids are associated with "pure", light-colored and chiefly algae-rich limestones of the fore-reef facies; the only exception is the redeposited gypidulid association from the late Frasnian of Łgawa Hill included in the deeper-water, rhynchonellid-dominated fauna. These data suggest some narrowing of gypidulid niches during the Frasnian to shallower-water environments and a generally similar pattern is recognizable in the Frasnian of Belgium.

It should be noted that the large-sized shells of pentamerids and their thickened umbonal parts are usually considered as adaptative characters for live in rough-water habitat on bioclastic, coarse-grained substrates (see Pentameridae and Gypidulidae groups of BOUCOT, 1975, pp. 233, 235, 251). In the case of the Holy Cross gypidulids, this supposition seems to be valid for some populations, particularly these from the Wietrznia Beds. Generally, it is thought that these brachiopods thrived in semi-protected, intermittently agitated habitats within morphologically differentiated slope and/or margin of the stromatoporoid-coral platforms and reefs. A similar conclusion was presented for the gypidulids of the Bergisches Land by JUX (1969, p. 85) who emphasized (see also BIERNAT, 1971, pp. 160-161) that brachiopods are sensitive indicators of local changes in turbidity, energy level and salinity.

The associations studied belong obviously to open-marine biofacies contrasting with lagoonal, restricted-shelf setting presumed for some gypidulids of the vast Givetian carbonate bank (RACKI, 1986). High turbulence episodes in these biotopes are indicated by extensive disarticulation of shells, selective removing of more delicate brachial valves and rapid deposition of shells in local bottom depressions usually after short transport. Gypidulid shell sizes demonstrate clear relationships with the distribution of the main reef-builders. In numerous occurrences associated with coelenterate- (Cmentarna Hill, Sitkówka, Kadzielnia) and/or algal-boundstones (Grabina, partly Szczukowskie Hills), the specimens are small and sometimes limited to juvenile individuals. On the other hand, more extensive shell beds within deposits containing rare coelenterates and algal debris (e.g. Tudorów, partly Szczukowskie Hills), yielded the largest-sized shells. Consequently, these brachiopods perhaps were able to cope only in limited manner with strictly "reefal" regimes: their explosive development is limited to some peculiar, generally inter- and peri-biohermal habitats on the seaward slope.

Final remarks (J.G. & G.R.)

Study of the Frasnian gypidulids from the Holy Cross Mountains showed their importance for phylogenetic and stratigraphic interpretations. Further investigations are necessary for refinement of some taxonomic questions, e.g. of eventual establishment of new genera or species.

The most important conclusion is the value of these widespread brachiopods for supraregional biostratigraphic application.

The Belgian succession, supplemented herein, is well documented (also in regard to conodont zonation) and can serve as a standard reference for the preliminary proposed Gypidulid Faunas (GF 1 -3, Fig. 9) based on the distribution of the genera (in ascending order) *Novozemelia?* (a provisional designation), *Metabolipa* and *Neometabolipa* (with minor contribution of *Physemella*).

Furthermore, the youngest fauna can be subdivided into two units according to the range of the most common species of the index genus, viz. *N. delhayei* (GF 3a) and *N. duponti* (GF 3b). As shown above and in Figure 9, these "standard" gypidulid levels are easily recognizable in the Holy Cross sequence, despite the fact that the unit GF 3a can be assumed only indirectly; unit GF 3 displays the impoverishment of the Polish association and probably reflects the poor reef record in comparison with the spectacular "Lion-type" buildups in Belgium.

Review of the gypidulid faunas outside Belgium and Poland would be significant for the verification of this biozonal scheme. Unfortunately, data available in the literature are still too scarce and insufficient to reach taxonomic conclusion. Detailed examination of the internal structures is fundamental for recognition of index genera and comparison with other successions. Therefore, the extensive revision of type material is a prerequisite for further progress in estimation of gypidulid brachiopods as biostratigraphic tools.

Acknowledgements

The authors express their gratitude to collaborators and students of the Silesian University at Sosnowiec, particularly M. RACKA, T. WRZOŁEK and I. MAKOWSKI, for their help in collecting much of the studied material. The gypidulids of SAMSONOWICZ's collection were kindly loaned for study through the courtesy of the Directorate of the State Geological Institut at Warsaw. The authors are indebted to P. BULTYNCK, head of the section of Micropalaeontology (I.R.Sc.N.B.) for his help in some conodont identifications. The manuscript was reviewed by J.A. FAGERSTROM of the Department of Geological Sciences at Boulder; the authors are deeply grateful to him for his comments, suggestions and emendations. Thanks also are due to C.H.C. BRUNTON of the Department of Palaeontology of the British Museum (Natural History) for reading the first part of the manuscript.

References

BIERNAT, G., 1966. Middle Devonian brachiopods of the Bodzentyn Syncline (Holy Cross Mountains, Poland). *Palaeontologia Polonica*, 17: 1-162.

BIERNAT, G., 1971. The brachiopods from the Kadzielnia limestone (Frasnian) of the Holy Cross Mts. *Acta Geologica Polonica*, 21 (1): 137-163.

BIERNAT, G., 1983. On the Famennian brachiopods from Jabłonna, Góry Świętokrzyskie Mts, Poland. *Biuletyn Instytutu Geologicznego*, 345: 135-153.

BOUCOT, A.J., 1975. Evolution and extinction rate controls. Elsevier, Amsterdam, 427 pp.

BRICE, D., 1982. Brachiopodes du Dévonien Inférieur et Moyen des Formations de Blue Fiord et Bird Fiord des îles arctiques canadiennes. *Geological Survey of Canada, Bulletin* 326: 175 pp.

BULTYNCK, P., 1982. The *Ancyrodella binodosa – A. rotundiloba rotundiloba* transition, a datum-level for correlation of the Givetian-Frasnian boundary. *In*: Papers on the Frasnian-Givetian boundary, Geological Survey of Belgium, Brussels, pp. 17-33.

BULTYNCK, P., CASIER, J.-G., COEN-AUBERT, M., GODEFROID, J. & SARTENAER, P., 1983. Proposal for an international Para-Stratotype for the Middle Devonian(Givetian) – Upper Devonian (Frasnian) boundary (Lower *Polygnathus asymmetricus* Zone) in the neritic facies of the southern flank of the Dinant basin. *Comité national belge des Sciences géologiques. Comité français de Stratigraphie. Subcommission on Devonian Stratigraphy*: 80 pp.

BULTYNCK, P., 1987. Le Dévonien Moyen et Supérieur. *In*: Itinéraires dans le Paléozoïque de la Belgique. *Groupe Français pour l'étude du Paléozoïque*, pp. 26-45.

BULTYNCK, P., DREESEN, R., GROESSENS, E., STRUVE, W., WEDDIGE, K., WERNER, R., ZIEGLER, W., 1988. Field Trip A (22. 24 July 1988) Ardennes (Belgium) and Eifel Hills (Federal Republic of Germany). *In*: ZIEGLER, W. (Editor), 1st International Senckenberg Conference and 5th European Conodont Symposium (ECOS V). Contributions I. Part 1: Guide to Field Trips. *Courier Forschungsinstitut Senckenberg*, 102.

CHERKESOVA, S.V., 1973. Vaskupyarnaya systema Pentameryd. *Paleontologicheskiy Zhurnal*, 1973, 4: 25-34.

GAWLIK, S., 1986. Fran wschodniej części Pasma Kadzielniańskiego (Góra Cmentarna, Psie Górkil) w Górach Świętokrzyskich. Unpublished Master Thesis, Silesian University, Sosnowiec.

GODEFROID, J., 1972. *Pseudosieberella* (Pentameridae), nouveau genre couvinien, et genres apparentés. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 48, *Sciences de la Terre*, 5, 41 pp.

GODEFROID, J., 1974. Les Gypidulinae des niveaux récifaux du Frasnien de Frasnes et de Boussu-en-Fagne. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 50, *Sciences de la Terre*, 9, 65 pp.

GÜRICH, G., 1896. Das Palaeozoicum im Polnischen Mittelgebirge. *Verhandlungen der Russisch-Kaiserlichen Mineralogischen Gesellschaft zu St. Petersburg*, 2 (32): 539 pp.

GÜRICH, G., 1901. Nachträge zum Palaeozoicum des Polnischen Mittelgebirges. *Neues Jahrbuch für Mineralogie, Geologie und Palaeontologie, Beilage-Band*, 13: 331-388.

HAVLÍČEK, V., 1952. A paleontological study of the Devonian of Celechovice – Brachiopods (Pentameracea, Rhynchonellacea, Spiriferacea). *Sbornik of the Geological Survey of Czechoslovakia*, 18, *Paleontology*: 1-20.

JOHNSON, J.G., 1970. Great Basin Lower Devonian Brachiopoda. *Geological Society of America, Memoir* 121: 421 pp.

JUX, U., 1969. Pentameriden aus dem Bergischen Devon. *Palaeontographica*, A, 138: 55-93.

KAŹMIERCZAK, J., 1971. Morphogenesis and systematics of the Devonian Stromatoporoidea from the Holy Cross Mountains, Poland. *Palaeontologia Polonica*, 26: 1-150.

LECOMPTE, M., 1960. Compte rendu de la session extraordinaire de la Société géologique de Belgique et de la Société belge de Géologie, de Paléontologie et d'Hydrologie, consacrée à l'étude du phénomène récifal dévonien dans la partie occidentale du bassin de Dinant et du bassin de Namur. *Annales de la Société géologique de Belgique*, 83: 1-134.

MAILLIEUX, E., 1909. Note sur les Pentamères frasniens de la bordure méridionale du bassin dinantais. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie*, 23, P.V.: 226-234.

MAILLIEUX, E. & DEMANET, F., 1929. L'échelle stratigraphique des terrains primaires de la Belgique. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie*, 38: 124-131.

MAKOWSKI, I., 1988. Ramienionogi dewońskie z Wietrzni w Górach Świętokrzyskich. Unpublished Master Thesis, Silesian University, Sosnowiec.

MAŁKOWSKI, K., 1981. Upper Frasnian deposits at Górno in the Holy Cross Mountains. *Acta Geologica Polonica*, 31 (3-4): 223-232.

NARKIEWICZ, M., 1988. Turning points in sedimentary development in the Late Devonian in southern Poland. *In:* MCMILLAN, N.J., EMBRY, A.F. & GLASS, D.J. (Editors), Devonian of the World (Proceedings of the International Symposium on the Devonian System, Calgary, Canada). *Canadian Society of Petroleum Geologists, Memoir* 14, vol. III: 413-423.

NARKIEWICZ, M. & OLKOWICZ-PAPROCKA, I., 1981. Tudorów-odsłonięcie gornodewońskich utworów marglistych. *In*: Przewodnik LIII Zjazdu Polskiego Towarzystwa Geologicznego, Kielce. *Wydawnictwa Geologiczne*: 292-294.

NARKIEWICZ, M. & OLKOWICZ-PAPROCKA, I., 1983. Stratigraphy of the Devonian carbonates in the eastern part of the Góry Świętokrzyskie Mts. *Kwartalnik Geologiczny*, 27 (2): 225-256.

NARKIEWICZ, M., RACKI, G. & WRZOŁEK, T., (1990). Lithostratigraphy of the Devonian stromatoporoid-coral series in the southern Holy Cross Mountains. *Kwartalnik Geologiczny*, 34 (4).

RACKI, G., 1981. Stratygrafia i tektonika utwòrow dewonu środkowego i górnego w kamieniołomach Jaźwica. *In*: Przewodnik LIII Zjazdu Polskiego Towarzystwa Geologicznego, Kielce. *Wydawnictwa Geologiczne*: 171-179.

RACKI, G., 1986. Brachiopod ecology of the Devonian carbonate complex, and problem of brachiopod hyposalinity. *In*: P.R. RACHEBOEUF & C. EMIG (Editeurs), Les Brachiopodes fossiles et actuels. Actes du 1er Congrès international sur les Brachiopodes, Brest 1985. *Biostratigraphie du Paléozoïque*, 4: 363-373.

RACKI, G., 1990. Frasnian-Famennian event in the Holy Cross Mts, Central Poland: stratigraphic and ecologic aspects. *In*: KAUFFMAN, E.G. & WALLISER, O.H. (Editors), Extinction Events in Earth History: 169-181. Springer. Berlín.

RACKI, G., GŁUCHOWSKI, E. & MALEC, J., 1985. The Givetian to Frasnian succession at Kostomłoty, and its regional significance. *Bulletin of the Polish Academy of Sciences, Earth Sciences*, 33: 159-171.

RÓŻKOWSKA, M., 1953. Pachyphyllinae et Phillipsastrea du Frasnien de Pologne. *Palaeontologia Polonica*, 5: 1-89.

SAMSONOWICZ, J., 1917. Les dépôts dévoniens dans la partie orientale des montagnes de Święty Krzyż, Pologne. *Prace Towarzystwa Naukowego Warszawskiego*, III (20): 1-69.

SAMSONOWICZ, J., 1934. Objaśnienia do arkusza Opatów Ogólnej Mapy Geologicznej Polski wskali 1:100000. *Państwowy Instytut Geologiczny*, Warszawa.

SARTENAER, P., 1985. The stratigraphic significance of rhynchonellid genera at the Frasnian-Famennian boundary. *Courier Forschungsinstitut Senckenberg*, 75: 319-330.

SIEMIRADZKI, J., 1909. Zbiory L. Zejsznera z kieleckiego dewonu. *Sprawozdanie Komisyi Fizyograficznej Akademia Umiejetności*, 43: 62-94.

SOBOLOEV, D., 1909. Srednij devon Kielecko-Sandomirskogo Krjazha. *Materialy dlya Geologii Rossii*, 24: 41-536.

SZULCZEWSKI, M., 1971. Upper Devonian conodonts, stratigraphy and facies development in the Holy Cross Mountains. *Acta Geologica Polonica*, 21 (1): 1-129.

SZULCZEWSKI, M. & RACKI, G., 1981. Early Frasnian bioherms in the Holy Cross Mts. *Acta Geologica Polonica*, 31 (3-4): 147-162.

TSIEN, H.H., 1974a. Excursion J. *In*: BOUCKAERT, J. & STREEL, M. (Editors), International Symposium on Belgian Micropaleontological limits from Emsian to Visean – September 1st to 10th, Namur 1974, 34 pp.

TSIEN, H.H., 1974b. Paleoecology of the Middle Devonian and Frasnian in Belgium. *In*: BOUCKAERT, J. & STREEL, M. (Editors), International Symposium on Belgian Micropaleontological limits from Emsian to Visean – September 1st to 10th, Namur 1974, 53 pp.

WRZOŁEK, T., 1988. Tetracoral zonation of the Devonian stromatoporoid-coral limestones in the SW Holy Cross Mts, Poland. *In*: MCMILLAN, N.J., EMBRY, A.F. & GLASS, D.J. (Editors), Devonian of the World (Proceedings of the Second International Symposium on the Devonian System, Calgary, Canada). *Canadian Society of Petroleum Geologists, Memoir* 14, vol. III: 413-423.

GODEFROID, J.
Département de Paléontologie
Section des Invertébrés Fossiles
Institut royal des Sciences naturelles de Belgique
rue Vautier 29
B – 1040 BRUXELLES
BELGIQUE

RACKI, G.
Zakład Paleontologii i Stratygrafii
Uniwersytet Śląski
ul. Mielczarskiego 60
PL – 41-200 SOSNOWIEC
POLAND

Typescript received 15 March 1990
Revised typescript received 1 June 1990

◁

PLATE 5

Physemella christinae n.sp.

Fig. 1a-e. – Holotype. Specimen IG 8.II.702a. Tudorów.

Fig. 2a-e. – Paratype A. Specimen IG 8.II.702b. Tudorów.

Fig. 3a-e. – Paratype B. Specimen GIUS 4-263e TD. Tudorów.

Fig. 4a-e. – Paratype C. Specimen GIUS 4-263f TD. Tudorów.

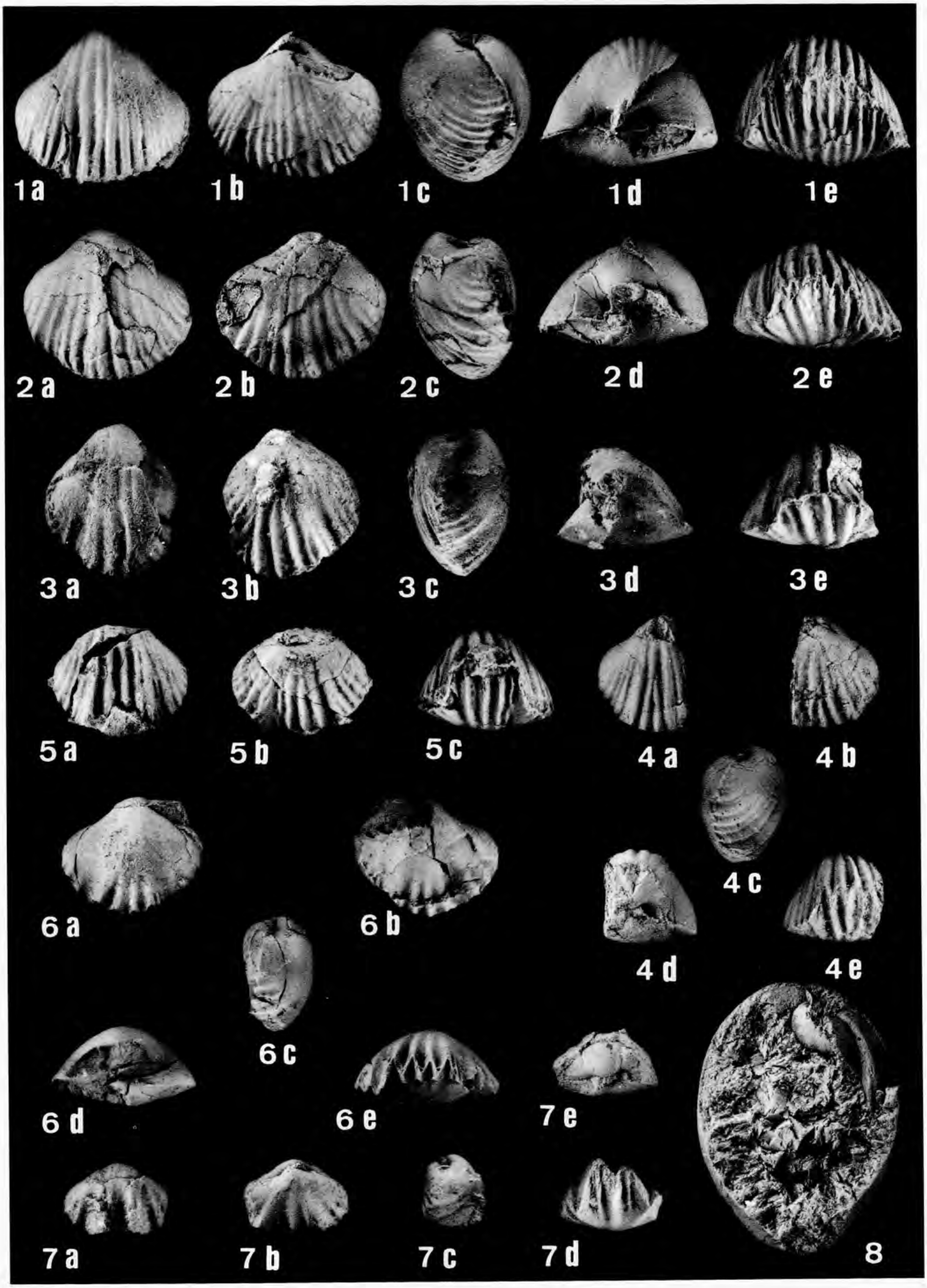
Fig. 5a-c. – Paratype D. Specimen GIUS 4-263g TD. Tudorów. a = ventral view; b = dorsal view; c = anterior view.

Neometabolipa duponti GODEFROID, 1974

Fig. 6a-e. – Specimen GIUS 4-263d1 TD. Tudorów.

Fig. 7a-e. – Specimen GIUS 4-263d6 TD. Tudorów.

Fig. 8. – Specimen IG 8.II.697b. Tudorów. Broken shell showing the septalium supported by a short median septum, the outer and inner brachial plates, the brachial process.


1a
1b
1c
1d
1e
2a
2b
2c
2d
2e
3a
3b
3c
3d
3e
5a
5b
5c
4a
4b
4c
6a
6b
4d
4e
6c
6d
6e
7e
7a
7b
7c
7d
8

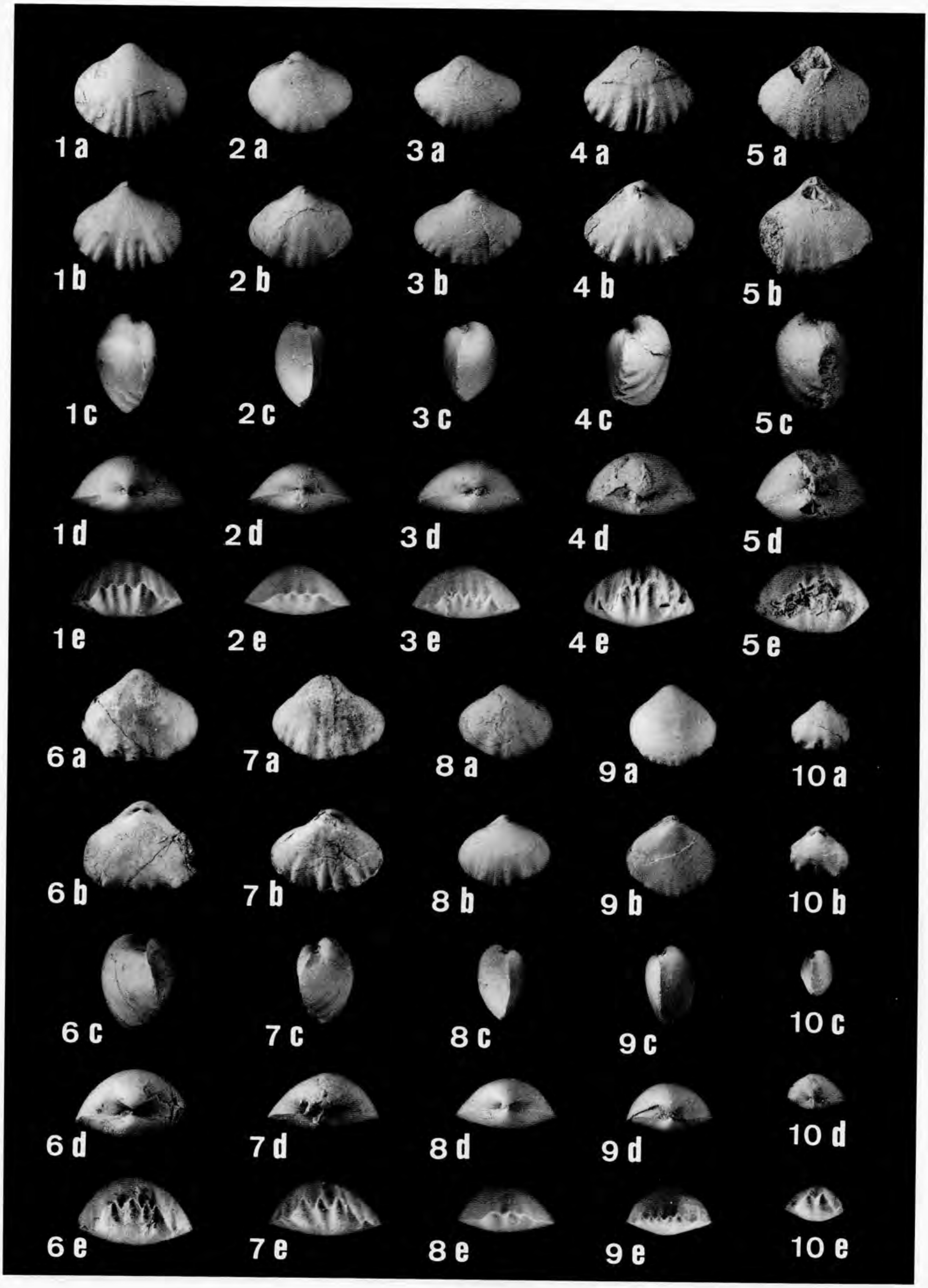

1 a
2 a
3 a
4 a
5 a
1 b
2 b
3 b
4 b
5 b
1 c
2 c
3 c
4 c
5 c
1 d
2 d
3 d
4 d
5 d
1 e
2 e
3 e
4 e
5 e
6 a
7 a
8 a
9 a
10 a
6 b
7 b
8 b
9 b
10 b
6 c
7 c
8 c
9 c
10 c
6 d
7 d
8 d
9 d
10 d
6 e
7 e
8 e
9 e
10 e

PLATE 3

Except when otherwise indicated, all illustrations are natural size and a = ventral view; b = dorsal view; c = lateral view; d = posterior view; e = anterior view.

Novozemelia? sp. W

Fig. 1. – Specimen GIUS 4-261a WI. Kielce, Wietrznia-I quarry, ?set B. Isolated pedicle valve.
Fig. 2. – Specimen GIUS 4-260b WI. Kielce, Wietrznia-I quarry, sets A-B. Isolated pedicle valve.
Fig. 3a, b. – Specimen GIUS 4-260c WI. Kielce, Wietrznia-I quarry, sets A-B. Incomplete articulated shell. a = dorsal view; b = lateral view.

Metabolipa cf. *greindli* (MAILLIEUX, 1909)

Fig. 4a-e. – Specimen GIUS 4-258c KD. Kielce, Kadzielnia quarry.
Fig. 5a-c. – Specimen GIUS 4-258b KD. Same locality.
Fig. 6a,b. – Specimen GIUS 4-258a KD. Same locality. a = ventral view; b = posterior view.
Fig. 7a-c. – Specimen GIUS 4-264a SC. Szczukowskie Hills quarry. a = ventral view; b = dorsal view; c = anterior view.
Fig. 8a-e. – Specimen GIUS 4-264b SC. Same locality.
Fig. 9. – Specimen GIUS 4-256a GŁ. Bolechowice, Łgawa Hill. Isolated pedicle valve.
Fig. 10. – Specimen GIUS 4-256b GŁ. Same locality. Isolated brachial valve.

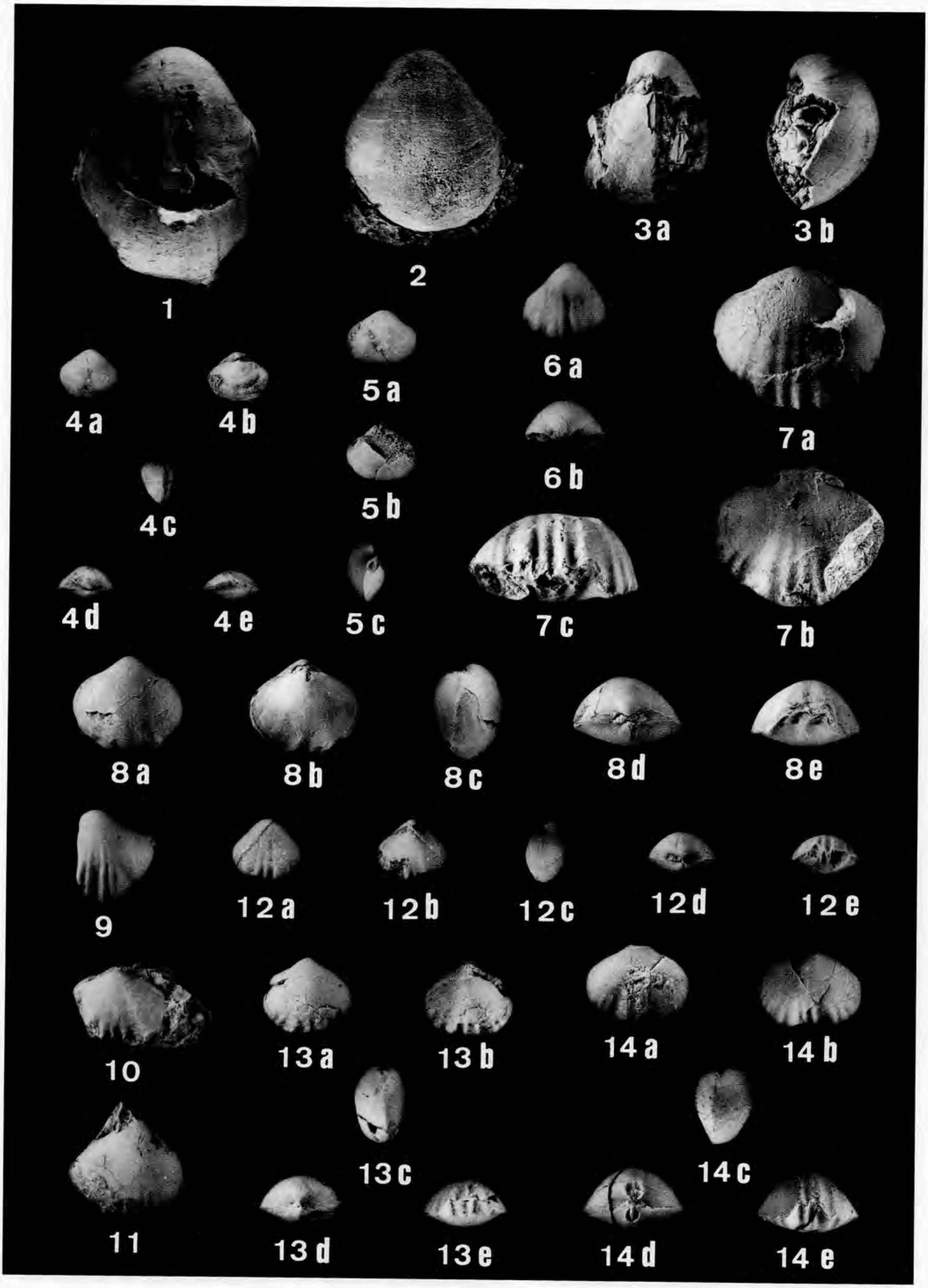
Neometabolipa? sp. G

Fig. 11. – Specimen GIUS 4-333a KW. Kowala, Wola quarry. Isolated pedicle valve.
Fig. 12a-e. – Specimen GIUS 4-277c GR. Kielce, Grabina quarry.
Fig. 13a-e. – Specimen GIUS 4-277b GR. Same locality.
Fig. 14a-e. – Specimen GIUS 4-277a GR. Same locality.

PLATE 4

Neometabolipa duponti GODEFROID, 1974

Fig. 1a-e. – Specimen IG 8.II.700a. Tudorów.
Fig. 2a-e. – Specimen IG 8.II.700c. Tudorów.
Fig. 3a-e. – Specimen IG 8.II.697a. Tudorów.
Fig. 4a-e. – Specimen IG 8.II.703a. Tudorów.
Fig. 5a-e. – Specimen IG 8.II.698a. Tudorów.
Fig. 6a-e. – Specimen GIUS 4-263d7 TD. Tudorów.
Fig. 7a-e. – Specimen GIUS 4-263d8 TD. Tudorów.
Fig. 8a-e. – Specimen IG 8.II.700d. Tudorów.
Fig. 9a-e. – Specimen GIUS 4-356 PG. Kielce, Psie Hills.
Fig. 10a-e. – Specimen GIUS 4-263d5 TD. Tudorów.


1
2
3a
3b
4a
4b
4c
4d
4e
5a
5b
5c
6a
6b
7a
7b
7c
8a
8b
8c
8d
8e
9
10
11
12a
12b
12c
12d
12e
13a
13b
13c
13d
13e
14a
14b
14c
14d
14e

1

2

◁

PLATE 1

Wietrznia quarries at Kielce (see SZULCZEWSKI, 1971). Locality of *Novozemelia?* sp. W in the Givetian to Frasnian boundary beds.

Fig. 1. – Eastern part of the Wietrznia-I quarry; arrow indicates a gypidulid-atrypid brachiopod coquina within the organodetrital set B.

Fig. 2. – Crinoid-brachiopod calcirudites in the Wietrznia-II section (set B); arrow indicates a gypidulid pedicle valve.

PLATE 2

▷

Gypidulid sites in the western part of the Kadzielnia Chain, south of Kielce.

Fig. 1. – Part of the eastern wall of the Grabina quarry; arrows indicate "nest-like" accumulations containing diversified brachiopods, including *Neometabolipa?* sp. G. Late Frasnian set B (see WRZOŁEK, 1988).

Fig. 2. – Eastern part of the Szczukowskie Hills quarry. The atrypid-dominated shelly bed (main source of *Metabolipa* cf. *greindli*) within early Frasnian strata is indicated by arrow.

1

2