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MIDDLE DEVONIAN BRACHIOPODS OF THE BODZENTYN SYNCLINE (HOLY CROSS MOUNTAINS, POLAND)

(BRACHIOPODY ZE ŚRODKOWEGO DEWONU SYNKLINY BODZENTYŃSKIEJ GÓR ŚWIĘTOKRZYSKICH)

BY
GERTRUDA BIERNAT

(WITH 51 TEXT-FIGURES AND 32 PLATES)

WARSZAWA 1966

PAŃSTWOWE WYDAWNICTWO NAUKOWE

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CONTENTS

INTRODUCTION

The present paper is the last in a series of publications on the Middle Devonian brachiopods of the Skały and Pokrzywianka beds in the Holy Cross Mountains (Góry Świętokrzyskie), Łysogóry region. Two groups of brachiopods: Orthacea (BIERNAT, 1959) and Atrypacea (BIERNAT, 1964) have already been described in previous papers. This work deals with representatives of: Pentamerida, Strophomenida, Rhynchonellida, Spiriferida and Terebratulida.

As the brachiopods described in this paper come from the same region and almost the same exposures, as those in the preceding papers in which a review of the history and stratigraphy of the Middle Devonian of the Bodzentyn Syncline has already been given, this work will be confined to some new additional data based on general observations of brachiopods.

In the present studies special attention has been given to the facial distribution of brachiopods in the section of the Skały and Pokrzywianka beds, to the relationship between the state of preservation and the external morphology of brachiopod shells, as well as to some problems of palaeoecology of brachiopods, to individual variability and growth changes of the studied species.

The short descriptions of some species given earlier by GÜRICH (1896) and SOBOLEV (1904, 1909) have been supplemented by new observations on the external and internal morphology.

Sixty-one species belonging to 38 genera and 26 families are described here. Two new subgenera are proposed: *Eodevonaria (Devonaria)* within the family Eodevonariidae SOKOLSKAJA and *Mucrospirifer (Spinospirifer)* within Mucrospiriferidae PITRAT, 1965.

The studied material has been collected between 1948—1954 by the late Prof. R. KONGIEL and his collaborators from the Museum of Earth (Muzeum Ziemi) in Warszawa, and by the present author during field works in 1955 and 1956.

The present studies have been supplemented by comparative material from the Devonian of New York (North America), Moravia (Czechoslovakia) and the Devonian of Rhine region (West Germany) examined during the author's stay at the U. S. National Museum in Washington (1958—1959), National Museum in Prague (1961) and at the Senckenberg Museum in Frankfurt am Main (1963). The most valuable comparative material has been found at the Museum in Frankfurt am Main, for which the abbreviation SMF is used. It was possible to compare the external morphology of almost all species in our collection with corresponding ones from the Devonian of Germany [1].

The collection described in this paper is deposited at the Institute of Palaeozoology of the Polish Academy of Sciences in Warszawa, for which the abbreviation Z. Pal. is used.

[1] When the present paper was in press, the Treatise on Invertebrate Paleontology, Part H, Brachiopoda, 1965, appeared. The author was able to accept only some changes in the general systematics of brachiopods proposed in the Treatise.

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Thanks is also due to Mrs. K. BUDZYŃSKA for inking the text-figures which illustrate this paper, and Miss M. CZARNOCKA for photographs of described brachiopods.

Palaeozoological Institute
of the Polish Academy of Sciences
Warszawa, March 1965

GENERAL PART

CHARACTERISTIC AND STATE OF PRESERVATION OF THE STUDIED MATERIAL

An abundant and rich collection of brachiopods has been recovered from the Skały beds. In addition to numerous shells belonging to adult individuals, there are also shells of different dimensions, representing young and gerontic individuals, the latter, however, are not numerous (see p. 20).

In general, the number of specimens for various species differs considerably, some species being represented by a few or even single individuals, others by tens, hundreds and sometimes thousands.

The state of preservation varies widely and seems to depend to a considerable degree on the external morphology, shape and convexity of the shell, thickness of valves, and also position of the shell on the sea floor just after death, before burial.

Observations, during field work, show rather different position of brachiopod shells in the layers of Skały beds, this in all probability being, in the majority of cases, accidental. Thick-walled species, biconvex and ventri-biconvex, and characterized by a small size (to about 15 mm. in length), such as *Aulacella eifeliensis* (DE VERNEUIL), *Isorthis canalicula* (SCHNUR), *Uncinulus primipilaris* (BUCH), are in general well preserved. The same applies to the plano-convex and geniculated species, which are larger, to about 25 mm. in length or more; to these belong: thick-walled *Douvillina (Douvillina) interstrialis* (PHILLIPS), *Leptaena analogaeformis* n. sp., *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM), *Atrypa subtrigonalis* BIERNAT, *Desquamatia subzonata* BIERNAT, etc. On the other hand, the biconvex, dorsi-biconvex or ventri-biconvex shells of larger species, such as *Schizophoria striatula* (SCHLOTHEIM), *Gypidula (Devonogypa) spinulosa* HAVLIČEK, *Rensselandia* cf. *circularis* (HOLZAPFEL), *Athyris concentrica* (BUCH), *Mucrospirifer (Spinospirifer) diluvianoides* n.sp. although comparatively thick-walled, are often crushed and seriously deformed, broken into pieces and then usually preserved as only smaller or larger fragments of a shell or valve. These damages are purely mechanical due to the process of diagenesis.

Disarticulation of shells is small in comparison to the number of closed shells of each species. There are some exceptions however: e.g. *Aulacella eifeliensis* (VERNEUIL), a species thought to be the most numerous (thousands of specimens) in the Skały beds, recorded in the shales of almost the whole vertical profile. Separate brachial and pedicle valves are comparatively very numerous for this species, out of about a thousand closed shells, there are approximately 200 pedicle valves and almost the same number of brachial valves. In addition, there are nu-

merous partly open shells. In all probability, after the death of the animal the shells were inclined, sometimes highly to the bedding plane (instead of flat lying) as a result of which the pressure of sediments was not enough to close the shells tightly. The comparatively numerous separate brachial and pedicle valves of the mentioned species could probably be the result of a somewhat weaker hinge-apparatus. In some species (*Aulacella eifeliensis* [DE VERNEUIL], *Isorthis canalicula* [SCHNUR], *Phragmophora schnuri* COOPER) during mechanical preparation, it was possible to separate the valves of those, not tightly closed shells without damaging the hinge, which is impossible in species with a denticulate hinge, e.g. *Douvillina (Douvillina) interstrialis* (PHILLIPS) and *Douvillina (Douvillina) subcorrugata* n. sp.

For most species preserved as separate valves, the brachials are relatively abundant, often predominate, being in general well preserved. This is the case in plano-convex or concavo-convex species (which is probably not accidental), such as: *Productella varians* n. sp., *Douvillina (Douvillina) interstrialis* (PHILLIPS), *Parastrophonella anaglypha* (KAYSER) and *Leptodontella caudata* (SCHNUR). In the case of separate valves it has been found that flattened and thicker ones have a better chance of preservation as fossils than convex and thinner valves which are more easily crushed before or during deposition of sediments. This disparity between the numbers of opposite valves was observed in e.g. *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM), where 3 brachial valves (convex) and 40 pedicle valves (flattened), out of a total of 600 shells with conjoined valves, were found. In *Parastrophonella anaglypha* (KAYSER), out of a total number of about 100 closed shells, 40 well preserved pedicle valves and no brachial valves were found. In both mentioned species, the pedicle valves are flattened. In addition, in *Parastrophonella anaglypha* (KAYSER) they are thick, 3-4 times thicker than the brachial valves which are flat in *Parastrophonella anaglypha* (KAYSER), while strongly convex in *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM). Similarly, in *Productella varians* n. sp. the convex pedicle valves are slightly thinner than the opposite ones and so more easily broken. Out of a total number of 1000 shells with conjoined valves of *P. varians,* there were 30 separate brachial valves and no pedicles. These latter, 6 in number, were detached during mechanical preparation from a number of gaping shells.

In the light of what has been just mentioned about the chances of preservation of separate flat and convex valves, it is difficult to explain why such an abundance of closed shells have been found. One may suppose that the closed shells which were preserved, were ones which were quickly filled with sediment before the shell closed after the decomposition of the body of the animal due to bacterial activity. As a result, such shells, being heavy, settled flatly on the sea bottom (shell surface parallel to the bedding plane) which facilitated tighter closing of the shell, the latter then becoming resistent to the action of mechanical factors.

This good preservation of the shell was conditioned, in the first place, by its very quickly becoming filled with sediment before it finally closed. Those shells not completely filled with sediment did not withstand the pressure of the upperlying layers and became deformed and to a greater or lesser degree crushed.

In other positions of the shell after the death of the animal, not flat on the bottom, the shells could be subjected to even weak movements of bottom currents or wave action producing their disarticulation and probably deplacement which perhaps could account for the absence of separate valves in some species. Some authors, e. g. FERGUSON (1963), also suggested that under certain conditions, some valves could be transported by the currents and deposited rather far from the place occupied during life. MENARD & BOUCOT (1951), in connection with the transport of shells by currents, are of the opinion that shells filled with water, being lighter, are more easy moved by currents than the surrounding grains of sediment, and the speed ne-

cessary for such movement need not be greater than e. g. the speed of normal currents at a depth of 1500 m. in Pacific Ocean.

With regard to the Skały beds, the current action was probably uneven, e. g. the brachiopod shales (of great thickness) suggest a weak current action, while the more sandy and limy parts of the Skały beds are evidence of stronger currents.

Only in a few cases were the conditions for preservation unfavourable, i. e. the green-blue shales, a few metres in thickness (exposure 112), where there are only imprints of shells or sometimes thin and very crushed valves, especially of *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM). As shown by present observations, special conditions existed here favouring the dissolution of valves.

In limestone, the brachiopods are less numerous, but more differentiated. Their state of preservation is in general good, specimens being, as a rule, not damaged, with valves conjoined, disarticulation is very rare. Very often, the shells from limestone, especially in Miłoszów and exposure 89 in Skały, are recrystallized, due to the precipitation of $CaCO_3$ from the water, the resulting calcite filling up almost the whole shell. Loosely closed shells (as in shales) often became almost completely filled with limy sediment.

REMARKS ON THE STRATIGRAPHY OF THE SKAŁY BEDS

The exact stratigraphic position of the Skały beds of the Bodzentyn Syncline in the Łysogóry region is, up to now, questionable. In the opinion of some authors, e. g. SAMSONOWICZ (1934, 1936), CZARNOCKI (1950) and PAJCHLOWA (1957), the Skały beds are of Givetian age.

The present author, on the basis of brachiopods, inclines to the view that the Skały beds are of the Lower Givetian age. Skały beds overlie immediately but discordantly dolomites (see BIERNAT, 1964, and present paper — Text-fig. 2), the latter in turn overlying limestone with *Bornhardtina skalensis* BIERNAT interbedded with limestone containing *Amphipora ramosa*. Limestone with *Bornhardtina skalensis* is, up to now, regarded as Givetian (Poland, Czechoslovakia-Moravia). The unidentifiable fauna in the dolomites, as well as a discordance between the latter and the Skały beds, make their stratigraphic relationship unclear. This latter can be subjected to somewhat different interpretation.

The brachiopod fauna of the Skały beds is undoubtedly of Middle Devonian age, however, there is some difficulty in ascertaining, if it is Eifelian or Givetian. The majority of species from the Skały beds are of Eifelian and Givetian age. They are among others: *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM), *Uncinulus parallelepipedus* (BRONN), *Uncinulus pentagonus pentagonus* (KAYSER), *Desquamatia subzonata* (BIERNAT), *Atrypa subtrigonalis* BIERNAT and *Bifida lepida* (GOLDFUSS). A few species, such as e. g. *Hypothyridina* cf. *procuboides* (KAYSER) and *Pyramidalia* cf. *simplex* (PHILLIPS), continue up to the Frasnian. It is evident that the stratigraphic value of the former species, e. g. *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM) as zonal markers (for particular stages) of the Devonian, is not great. Some, not numerous species, e. g. *Enantiosphen* sp. cf. *vicaryi* (DAVIDSON), *Rensselandia* cf. *caiqua* (D'ARCHIAC & DE VERNEUIL), *Rensselandia* cf. *circularis* (HOLZAPFEL), *Spinocyrtia* sp., *Meristella* sp. and also *Hypothyridina* cf. *procuboides* (KAYSER) — although this latter extends to Frasnian — seem to be limited mainly to the Givetian and can be treated as «index» fossils. Such a stratigraphic range is ascribed to them in Germany, Rhine region (CLOUD, 1942), England (DAVIDSON, 1864—1865), USSR — Ural, Mugodzhar (NALIVKIN, 1947; ROZMAN, 1959), Poland and, in all probability, in Czechoslovakia (Moravia).

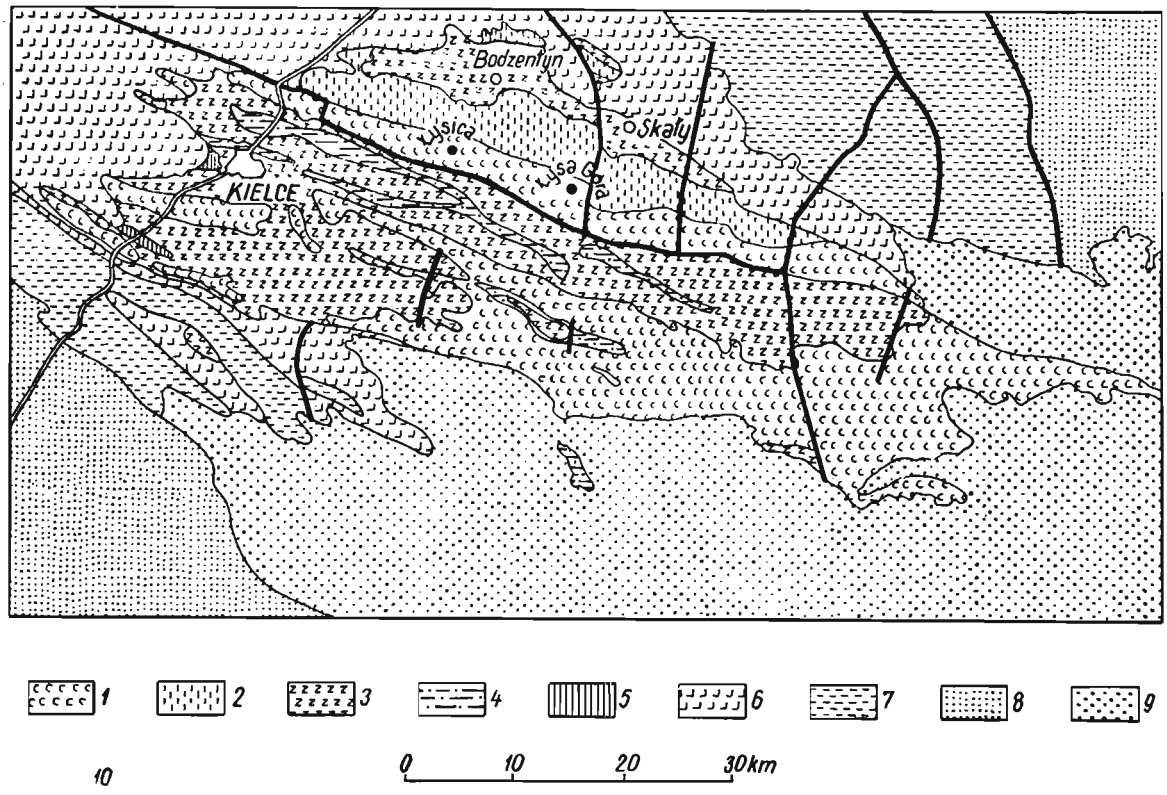


Fig. 1
Geological sketch map of the Łysogóry region in the Holy Cross Mountains (after CZARNOCKI, 1950)
1 Cambrian, *2* Ordovician and Silurian, *3* Devonian, *4* Carboniferous, *5* Permian, *6* Triassic, *7* Jurassic, *8* Cretaceous, *9* Tertiary, *10* faults

The brachiopod fauna of the Skały beds is extremely similar, but in majority of cases not identical to that of the Rhine region. In general, it can correspond to the Fleringer layers of the Rhine region, the age of which has lately been interpreted as Upper Eifelian (STRUVE, 1961; METJE, 1963; GLINSKI, 1961). In Moravia (Čelechovice) and in the Ural a similar assemblage of brachiopod species is characteristic for Givetian.

Although the brachiopod fauna of Łysogóry and Rhine regions is exactly alike as regards generic composition and has great similarity in specific composition, there are, however, significant differences in the general assemblage of species. The brachiopods in the Skały beds are, as a rule, poorer in species, e.g. within orthids and to a great degree spiriferids and often with fewer specimens. Many species, e.g. *Undispirifer* cf. *undiferus* (ROEMER), *Uncinulus parallelepipedus* (BRONN), *Hypothyridina* cf. *procuboides* (KAYSER) and *Plectospira ferita* (BUCH), rather abounding with specimens in Germany, have only been found in a few or single shells in the Skały beds. And reversely, species rich in specimens in the Skały beds, are rather rare in the Rhine region. There are also some taxonomic differences, shown by the presence of some new subspecies or species, so far not cited from the Rhine region. All this could point to some endemity of the brachiopods in the Łysogóry region. These «endemic» elements suggest a certain isolation of the Łysogóry region basin, hence some impediments to the migratory possibilities of the fauna between both basins (Łysogóry and Rhine). As a rule, it is difficult to make an exact correlation between the brachiopod fauna of both regions and some differences in their age cannot be ruled out.

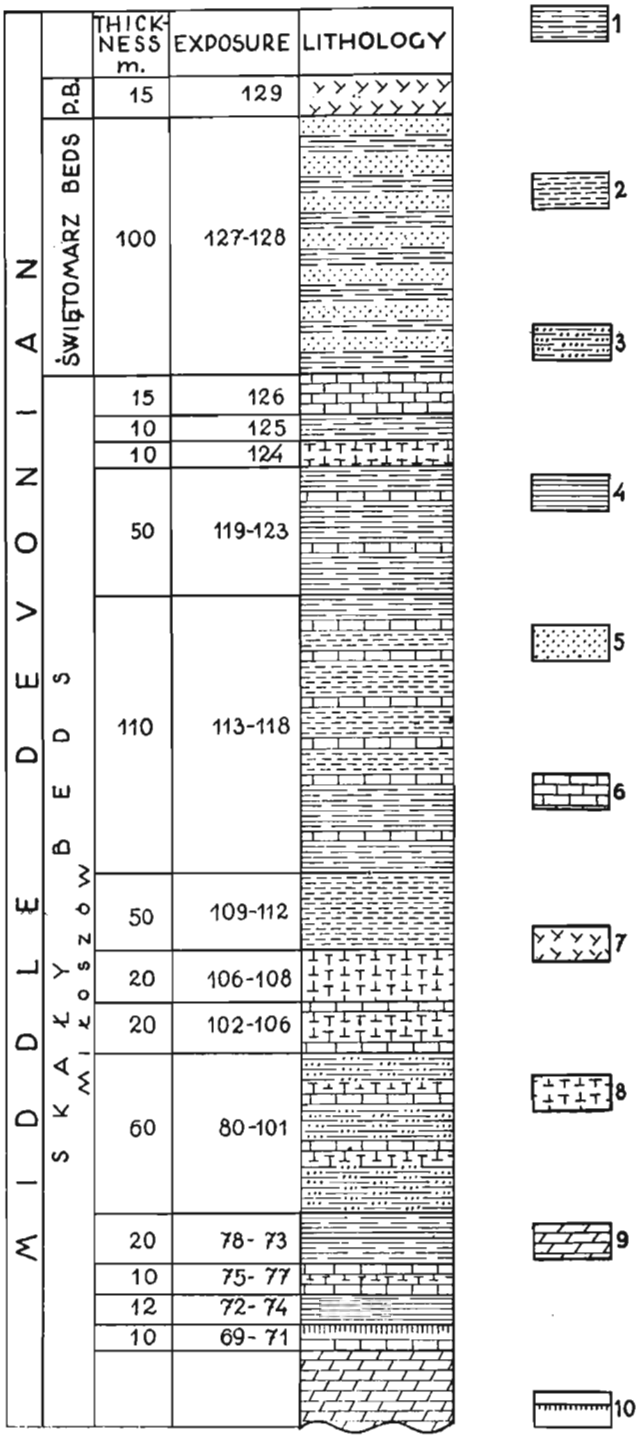


Fig. 2

Section of the Skały and Pokrzywianka beds (after PAJCHLOWA, 1957)

1 marly shales, *2* shales with tentaculites, *3* siltstones, *4* argillaceous shales, *5* sandstones, *6*, *7* limestones, *8* marls, *9* dolomites, *10* faults, *P. B.* Pokrzywianka beds.

The above observations on the specifity of faunal assemblage of the Skały beds and Rhine Basin, are in keeping with observations on trilobites, corals, bryozoans, ostracods, where several new subspecies and species, characteristic for the Skały beds, have been erected (KIELAN, 1954; ADAMCZAK, 1956; RÓŻKOWSKA, 1956; STASIŃSKA, 1958; PŘIBYL, 1953). Recently described Bryozoa of the Ctenostomata group (KIEPURA, 1965), although from only a small part of the Skały beds (shale facies, exposures 73, 76, 119) show out of a total of 10 species, 5 new species and 1 new subspecies.

The brachiopod fauna from Czechoslovakia (Moravia-Čelechovice) bears unusual similarity to that of the Łysogóry region. On the basis of studies made up to now, unfortunately fragmentary (SMYČKA, 1897, more recently HAVLIČEK, 1951, 1956, 1959, 1960, 1962), as well as on the present author's observations of Moravian collections, it can be stated that some species are in common with ours and the German ones (Rhine region), and the differences which do exist are insignificant. This applies to, among others: *Gypidula (Devonogypa) spinulosa* HAVLIČEK, *Radiomena irregularis* (ROEMER), *Uncinulus pentagonus pentagonus* (KAYSER), *Uncinulus minor minor* (SCHNUR), *Isopoma brachyptyctum* (SCHNUR) and *Hypothyridina procuboides* (KAYSER).

The brachiopod fauna from Moravia is also considered as Givetian. As investigations of the Moravian Devonian are not yet complete, it is not possible to draw far reaching conclusions as to the degree of faunal similarity between this region and the Łysogóry region.

Considerable similarity also exists between our brachiopod fauna and that of USSR (Kuznetsk region, Ural). This mainly concerns the species of some genera, e.g. of atrypids (BIERNAT, 1964) and the presence of some species in common, such as *Enantiosphen* sp. cf. *E. vicaryi* (DAVIDSON) (comp. NALIVKIN, 1947; ROZMAN, 1959), *Cyrtina heteroclita intermedia* OEHLERT, *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM), *Athyris concentrica* (BUCH) and *Squamulariina parva* (GÜRICH) (comp. IVANOVA, 1962, and our Text-fig. 3). The layers of the Kuznetsk Basin, in which the above species occur, are recognized as Givetian.

In the light of the above, the present author is of the opinion that the endemity of the fauna of the Bodzentyn Syncline basin in the Łysogóry region is not so great, as is generally considered. There is a very considerable number of species common to the whole area between the Rhine and Ural, evidence of comparatively free migration of fauna over a wide area from Western Europe to Asia.

LITHOFACIAL DEPENDENCE OF BRACHIOPODS IN THE SKAŁY AND POKRZYWIANKA BEDS

Distribution of brachiopods in the vertical section of the Skały beds shows some regularities caused, among others, by the facial conditions of the basin.

To characterize the relation between the brachiopod fauna and facies, a short review of the lithology and petrography of the Skały beds is given (according to PAJCHLOWA, 1957), as well as a sketch of the profile of Skały, Świętomarz and Śniadka beds, all of the Middle Devonian age. The lithological sequence is as follows:

1) The lowermost layers (10 m. thick) are of limestone with *Calceola sandalina* (LIN.), overlying dolomites (150 m. thick) interbedded with laminate dolomites and *Amphipora* banks;

2) Marly-argillaceous shales («brachiopod shales» — 12 m. thick), the most richly fossiliferous, exposures 72, 73, 74, underlying marls and limestone (10 m. thick) with corals and brachiopods, exposures 75, 76, 77;

Species \ Exposures	72	73	81	82	83	84	89	91	92	93	98	101	103	106	Mil.	110	112	121	125	129
Enantiosphen sp. cf. E. vicaryi (Davidson)																				r
Gypidula (Devonogypa) spinulosa Havliček					r		n						n	r						
G. (Gypidula) cf. biplicata (Schnur)			r																	
G. (Gypidula) parva n.sp.							r													
G. (Ivdelinia) cf. acutolobata (Sandberger)			r																	
G. (Ivdelinia) sp. cf. G. (I.) multiplicata (Roemer)			r																	
?Levigatella sp.						r														
Antirhynchonella linguiformis n.sp.															n					
Leptaena analogaeformis n.sp	n	n										r			r	r	r	r	r	
?Leptaena sp.		r																		
Douvillina (Douvillina) interstrialis (Phillips)	r	n		r						r									r	
D. (Douvillina) subcorrugata n.sp.		r																		
Leptodontella caudata (Schnur)		r																		
Parastrophonella anaglypha (Kayser)	r	vn													r				r	
Radiomena irregularis (Roemer)			r						r											r
Schellwienella (Sch.) umbraculum (Schlotheim)	n	vn			r							r						n	vn	
Schellwienella (Schellwienella) sp.			r																	r
Productella varians n.sp.	vn	vn																		
P. cf. subaculeata (Murchison)															r					
Chonetes supragibbosa Sobolev	r	r																		
Eodevonaria (Devonaria) zeuschneri (Sobolev)	n	vn																		
Leiorhynchus subplicatus n.sp.															r					
Uncinulus primipilaris (v. Buch)	r	n	r			r														
U. coronatus (Kayser)					r															
U. subcordiformis (Schnur)															n					
U. parallelepipedus (Bronn)		r	r				r													
U. pentagonus pentagonus (Kayser)							r								n					
U. minor minor (Schnur)															r					
U. implexus (Sowerby)								r	r						r					
Septalaria sp.		r																		
S. cf. gracilis (Gürich)						r														
S. cf. subtetragona (Schnur)															r					
Nemesa cf. nemesana H. Schmidt							r								r					
?Nemesa skalensis n.sp.							r													
Pseudocamarophoria undulataeformis n.sp.			r																	
Pseudocamarophoria sp.															r					
Hypothyridina cf. procuboides (Kayser)															r					
Isopoma brachyptyctum (Schnur)			r				r								r					r
Pugnax sp. cf. Pugnax pugnus (Martin)															r					
P. cf. anisodonta (Phillips)		r																		
Cryptatrypa philomela minor n. subsp.	n	vn	r																	
Bifida lepida (d'Archiac & de Verneuil)	n	n	r																	
Kayseria lens (Phillips)	r	r				r														
Undispirifer sp. cf. U. undiferus (Roemer)						r									r					
Mucrospirifer (Spinospirifer) diluvianoides n.sp.	n	vn	r	r																
Spinocyrtia sp.				r																
Crurithyris inflata (Schnur)	n	n			r															
Foreticularia eifeliensis (Frech)	r					n														
E. aviceps (Kayser)	r	r				n														
Minatothyris maureri (Holzapfel)							r		r	r		r			r					
M. sp. cf. M. concentrica (Schnur)															r					
Cyrtina heteroclita intermedia Oehlert	r	n				r													r	
Pyramidalia cf. simplex (Phillips)															r					
Squamulariina parva (Gürich)						r														
Dicamara plebeia (Sowerby)					r		r								r					
Nucleospira lens (Schnur)	n	vn		r	n															
Athyris concentrica (v. Buch)		r				r														
A. cf. ventrosa (Schnur)						r														
Plectospira ferita (v. Buch)						r														
Rensselandia cf. caiqua (d'Archiac & de Verneuil)																	r			
R. cf. circularis (Holzapfel)																	r			

Fig. 3. — Distribution of brachiopod species in the Middle Devonian of Skały and Pokrzywianka beds *vn* **very numerous specimens (50),** *n* **numerous specimens (20-50),** *r* **rare specimens (1-20),** *Mil.* **Miłoszów**

3) Green siltstones interbedded with marls containing *Microcyclus eifeliensis* (KAYSER), filled with crinoids (20 m. thick, exposures 78, 79);

4) Green mudstones interbedded with marls and limestone (60 m. thick), fauna rather abundant, exposures 80—101;

5) Marls (30 m. thick) with *Buchiola* sp., *Rensselandia* cf. *circularis* (HOLZ.) and *R.* cf. *caiqua* (A. & V.), exposures 106—108;

6) Argillaceous shales (30 m. thick) with tentaculites, exposures 109-112;

7) Siltstones and sandy shales with bryozoans (30 m. thick), exposures 119-123;

8) Limestone and crinoid marls (10 m. thick), exposure 124;

9) Green siltstones and shales with brachiopods (10 m. thick), exposure 125;

10) Limestone with corals (15 m. thick), exposure 126.

As given by PAJCHLOWA (1957), above those layers there are sandy and argillaceous shales (100 m. thick) of Święmarz beds, interbedded with sandstones. On the top are Pokrzywianka beds, about 15 m. thick, exposure 129, consisting mainly of limestone with stromatoporoids and large atrypids of the genus *Desquamatia* ANDREEVA (BIERNAT, 1964).

In general, brachiopods are numerous in all of the given lithofacial complexes of rock, throughout the whole profile, from the base (exposures 72, 73) to the top (exposure 129), being greatly differentiated from the systematical point of view. Particular species and genera are mostly restricted to one or two layers of the same or similar facies. No one species has been recorded in all complexes of rock and in all facies. This could be due to some general relation between the species and the facial conditions. That facial conditions can play an important role in the life of many brachiopods is supported by the fact that many species are repeated in the vertical profile, where more or less the same facial conditions are also repeated, i.e. in marly shales or limestone. Examples of this relation are: *Aulacella eifeliensis* (DE VERNEUIL), *Schizophoria striatula* (SCHLOTHEIM) and *Atrypa depressa* SOBOLEV, which occur several times in marly shales. It is significant that they occur in the same or similar lithofacies, although in a decreasing number towards the top of the profile. Probably, optimum conditions for life did not exist during the whole period of sedimentation of a given facies. In e.g. marly shales the greatest accumulation of fauna can be observed where the shales are less sandy, and with an increase in the amount of sand the fauna becomes poorer and poorer in number of species and specimens.

The assemblage of brachiopods occurring in limestone is quite different from that in shales in its systematic composition. While in the marly or argillaceous shales the genera were, as a rule, represented by only one species, this occurring in hundreds or thousands of specimens (e.g. *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM), *Productella varians* n. sp., *Aulacella eifeliensis* (VERNEUIL), *Cryptatrypa philomela minor* n. subsp. and *Crurithyris inflata* (SCHNUR), in the limestone facies, there are often a few species of one genus (e.g. *Uncinulus pentagonus pentagonus* (KAYSER), *U. minor minor* (SCHNUR), *U. implexus* (SOWERBY), but they are represented by much fewer specimens.

Specific conditions in some facies could have been responsible for the powerty of the fauna both in the number of species, as well as in the number of specimens, a good example of this being the green-blue shales, exposure 112.

In the profile of the Skały beds the facial distribution of brachiopods is as follows:

Orthida occur almost always in marly shales, the majority being recorded in very fossiliferous «brachiopod shales» — exposures 72, 73. Not numerous shells were found also in marls of exposure 83. This group is, in general, rather poorly differentiated, both in genera and species (BIERNAT, 1959). Single genera are represented by single species, the latter usually oc-

curring in great numbers of individuals, e.g. *Aulacella eifeliensis* (DE VERNEUIL), *Skenidium polonicum* GÜRICH, *Phragmophora schnuri* COOPER and *Schizophoria striatula* (SCHLOTHEIM). Some species, however, such as *Kayserella lepida* (SCHNUR) or *Isorthis canalicula* (SCHNUR) are only found in tens of exemplars.

Similarly as Orthida, Strophomenida seem to be restricted in the majority of cases to shale facies. It is, in general, a well differentiated group, consisting of several species, but with less individuals, an exception being *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM), very abundant in shale facies (layers of exposures 72, 73, 112, 121, 125). In one case (exp. 112) *Sch. (Schellwienella) umbraculum* (SCHLOTHEIM) is almost the only faunal component, except for a few shells of youthfull individuals of *Leptaena analogaeformis* n. sp. One could conclude that there were adverse environmental conditions, perhaps the rock being very alkaline, to which, however, the former species — *Sch. (Schellwienella) umbraculum* (SCHLOTHEIM) — had become accustomed. BELSKAJA (1960) mentions similar accumulation of e.g. camarotoechiids, with other fauna lacking, in the sea of Kuznetsk Basin, which she attempted to explain by the presence of abnormal chemical conditions. *Radiomena irregularis* (ROEMER) and *Sch. (Schellwienella)* sp. of large dimensions were found in the marly limestone of exposure 81 of the Skały beds and also in Pokrzywianka limestone. *Leptodontella caudata* (SCHNUR) and *Douvillina (Douvillina) subcorrugata* n. sp. occur only in the marly shales of exposure 73, and only a few specimens being found.

Pentamerida are above all connected with limestone and marly limestone, in the described collection being represented by 6 species: *Enantiosphen* sp. cf. *E. vicaryi* (DAVIDSON), *Gypidula (Devonogypa) spinulosa* HAVLIČEK, *G. (Ivdelinia)* sp. cf. *G. (Ivd.) multiplicata* (ROEMER), *G. (Ivd.)* cf. *acutolobata* (SANDBERGER), *Levigatella* sp. and *Antirhynchonella linguiformis* n. sp. They are most numerous in crinoid and marly limestones in the localities of Skały, Miłoszów and Kamieniec, but completely lacking in marly shales. Some species, such as *G. (Ivd.)* cf. *acutolobata* (SANDBERGER), *G. (Ivd.)* sp. cf. *G. (Ivd.) multiplicata* (ROEMER) and *Enantiosphen* sp. cf. *E. vicaryi* (DAVIDSON), are relatively uncommon, being recorded in single specimens only.

In contrast to the above facially localized forms, other groups of brachiopods are represented in marls as well as in limestone, but some species of the same genera are confined to shale facies, while others — to limestone or marly limestone; e.g. *Productella varians* n. sp. occurs in enormous numbers in marly or argillaceous shales (exposures 72, 73, 81, 84), while *Productella* cf. *subaculeata* (MURCHISON) is found only in limestone (locality of Skały, exposure 89, and Miłoszów).

Rhynchonellida are confined to marly shale facies and limestone. Genus *Uncinulus*, as the best represented group, comprises 7 species; *Uncinulus primipilaris* (BUCH), the most abundant in specimens, is restricted to shales only (exposures 72, 73, 81, 84), *Uncinulus parallelepipedus* (BRONN), *Uncinulus coronatus* (KAYSER); *Pseudocamarophoria undulataeformis* n. sp. being found in marls of exposure 84 in a few specimens; the remaining species, i.e. *Uncinulus pentagonus pentagonus* (KAYSER), *Uncinulus minor minor* (SCHNUR), *Uncinulus implexus* (SOWERBY) and *Leiorhynchus subplicatus* n. sp. being confined to limestone.

Atrypids are a very numerous and well differentiated group. Such genera as: *Gruenewaldtia* TSCHERNYSCHEV and *Desquamatia* ANDREEVA, are connected mainly with limestone facies (Miłoszów, Pokrzywianka, Kamieniec). Several species of the genera *Atrypa* and *Desquamatia*: *Atrypa subtrigonalis* BIERNAT *Atrypa depressa* SOBOLEV and *Desquamatia subzonata* (BIERNAT) are restricted to shales, being represented by an abundance of specimens, just as *Aulacella eifeliensis* (DE VERNEUIL), *Productella varians* n. sp. and *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM) (vide BIERNAT, 1959, 1964).

Spiriferida comprise 9 genera, the most numerous being *Mucrospirifer (Spinospirifer) diluvianoides* n. sp., occurring in the marly shales (exposures 72, 73, 81, 82).

This short review of the faunal composition, as well as the distribution of brachiopods in relation to facies in the Skały beds, concerns, it is true, only a small area, but a very differentiated section from the point of view of lithology and facies. The whole faunal assemblage belongs to one stratigraphic stage. Brachiopods, however, are rather susceptible to all changes that occur in the sea basin. In the Devonian sea of the Łysogóry region, changes in outline and depth occurred several times (PAJCHLOWA, 1957), as is seen by the considerable and continual ilthological changes observed in the profile. This latter is evidence of the alternate approaching and receding of the shore, carrying with it various amounts of terrigenous material, as well as of changes in the configuration of the basin.

GROWTH STAGES AND THEIR OCCURRENCE IN POPULATIONS

Specimens of fossil brachiopods representing the growth stages are, in general,rare, which is one of the main reasons why knowledge of the ontogenetic development of most of brachiopod species is inadequate.

The collections of brachiopods from marly-argillaceous shales (exposures 72, 73) contain specimens of the following species in different growth stages: *Aulacella eifeliensis* (DE VERNEUIL), *Schizophoria striatula* (SCHLOTHEIM), *Skenidium polonicum* GÜRICH, *Kayseria lens* (PHILLIPS), *Cryptatrypa philomela minor* n. subsp., *Bifida lepida* (D' A. & DE V.), *Atrypa depressa* SOBOLEV, *Mucrospirifer (Spinospirifer) diluvianoides* n. sp., *Productella varians* n. sp. and *Cyrtina heteroclita intermedia* OEHLERT. Although, they do not represent complete growth cycles, they give some picture of the ontogeny (postlarval growth) for particular species.

There are usually only a few specimens for each species which could correspond to the neanic, nepionic and gerontic stages, but their presence indicates that the studied faunal assemblage is natural, being rather a life, not a death assemblage. This is additionally supported also by the abundance of shells with both valves closed, which dominate the present collection.

Although the fauna of marly shales is slightly mixed and the shells often occupied different positions in the layers, these are rather local phenomena, observed in a small area only. There is no doubt that different species occupied different ecological niches on the sea bottom and whatever intermingling there was it took place after the death of the animal.

YOUNG INDIVIDUALS

The shells of the youngest individuals found are slightly over 1 mm. long. It seems improbable that the very limited number of young individuals preserved as fossils corresponds to the actual number that died in youth. On the basis of observations of some recent brachiopods, as: *Terebratula inconspicua* (SOWERBY), *Terebratula septentrionalis* (COUTHOUY) and some species of the genus *Lingula*, it can be supposed that fertility of brachiopods in past geological periods was also considerable, but only a small percentage of those individuals reached maturity and adult age. Those which died early, had very delicate shells and liable to damage easily. This may to some extent explain why so few were preserved in fossil state. Without doubt, illness, predation or unfavourable environmental conditions, such as fluctuations of temperature, pH, salinity etc., contributed to their death.

The causes of death of young individuals have received considerable attention. Among others, this problem was considered by FERGUSON (1963) in connection with his studies on the palaeoecology of *Lingula squamiformis* PHILLIPS. According to him, the shells of young individuals of recent *Lingula*, when changing from a planctonic to a bentonic life, are always decimated during the first month of their bentonic life, without leaving any traces of their existence. The causes of this decimation are, so far, not known. It is possible that young individuals had difficulty in becoming accustomed to the new conditions, in obtaining food, and most certainly they were prey for other animals. This latter is supported by the finding of almost whole *Lingula* in the stomach of some fishes (FERGUSON, 1963). A similar situation could apply to other groups of brachiopods. They all, after a free, swimming larval stage, pass to bentonic life. The first period, while they are becoming accustomed to the new conditions, is probably very difficult for all brachiopods, even though the adults seem to have acquired tolerance to various environmental conditions. Another case of death could be the poisoning of the water by some protozoans. It has been stated by GUNTER, 1948 (see TASCH, 1953) that when some representatives of Dinoflagellata, e.g. *Gymnodium brevis*, occur in a great number, they poison such marine animals as e.g. crabs, oysters etc.

All this could have been responsible for the small percentage of brachiopods which survived as adults, only the strongest and most healthy individuals surviving. PERCIVAL (1944), regarding a population of *Terebratula septentrionalis*, composed of 711 individuals, dradged at the end of March, before the breeding season, has suggested that about two-thirds of the population were 1 year old, one-fourth 2 years, one-seventh 3 years, and only one-thirty-fourth belonged to the oldest group, i.e. 4 years old individuals.

ADULT INDIVIDUALS

Very often, to simplify the problem of growth in brachiopods, two terms are used: immature and mature forms. The former applying to young individuals (nepionic and neanic, according to BEECHER, 1891), and probably corresponding to the period of morphogenesis of SEVERTZOV (1939), the latter term applying to adults (ephebic, according to BEECHER), and according to SEVERTZOV just after the period of morphogenesis, but while still growing. Of course, such terms as immature and mature are relative definitions, not defining when particular individuals reach sexual maturity.

According to the data on lingulids, *Lingula unguis* among others, given by CHUANG (1961*b*, p. 309), individuals could already be sexually mature by the time they had reached 33-40 per cent the maximum length of a given species in a given locality. Hence, taking the maximum length of an adult *Lingula unguis* (CHUANG, 1961*b*) as over 50 mm., then individuals 12·5—15·0 mm. long should already be sexually mature. Accepting the proportional development of individual, *Lingula unguis*, for example, would be about 12 years old when it reached a length of 50 mm., in which case maturity would probably have lasted about 8 years. PERCIVAL (1944), on the basis of observations on *Terebratula inconspicua* (SOWERBY), suggests 4 years of life for one population, but the possibilities for breeding in this short period is great. CLOUD (1948, p. 246) supposes that sexually mature individuals of *Terebratula septentrionalis* (COUTHOUY) breed a few times each year (April—August). A comparatively long period of sexual maturity would unquestionably be an important factor in the great rate at which these animals increase.

With regards to the Skały beds, shells of many individuals have been found, in all probability mature and adult, evidence of favourable environmental conditions and, in the light of the above, of great fertility.

GERONTIC INDIVIDUALS

While specimens of gerontic individuals are more numerous than young, their number in comparison with adults is very small. In some cases they only constitute 0·5—1·0 per cent of the total number of adult individuals, e.g. out of about 500 specimens of *Aulacella eifeliensis* (DE VERNEUIL), there are only about 10 specimens of gerontic individuals. Gerontic shells preserved in fossil state are judged to be those that have stopped growing in length, but still continue to grow intensively in thickness. Externally, old age is above all characterized by crowded concentric lines along antero-lateral commissures of shells.

Within every species represented by old individuals, the gerontic stage is, in general, reached by individuals of various shell length, but nevertheless by specimens of average length for the given species. The time, as also rate of growth, are not always equal. Very often, shells of gerontic individuals are slightly smaller than those of adults which though of larger dimensions do not yet show signs of the beginning of the old stage. These adults could represent individuals, which had attained the maximum dimensions possible for a given species in a given environment. The shells of these above average individuals are rather rare, compared with those whose shells attain mean size in adult stage for a given species, and they seem to show some tendency to gigantism. This applies especially to those forms, which increased in length during the whole life, and which were probably numerous. They include, among others, representatives of *Chonetes*, *Leptaena*, *Productella* and *Productus*. CHUANG (1961 *b*), on the basis of observations on *Lingula*, stated that the shells increase in length during their whole life, and he expresses the opinion that in every population of the above brachiopod only a small percentage could attain the maximum length for a given species. Probably, these rare long shells, so different in length from the average shell, can also represent the gerontic stage.

Some shells from the Skały beds are in a very advanced gerontic age, which is marked, both in the external and internal morphology. Externally, it is observed in: 1) a greatly thickened shell, to about 20 mm. along the antero-lateral commissure in e.g. *Schizophoria striatula* (SCHLOTHEIM), and *Atrypa depressa* (SOBOLEV); 2) thickened antero-lateral margins of each valve of the shell, e.g. *Leptodontella caudata* (SCHNUR) and *Leptaena analogaeformis* n. sp.; 3) a very thickened and so extremely strong incurvature of the ventral beak on the brachial valve, which often causes the pedicle, usually functional all during life, to disappear, e.g. in atrypids: *Atrypa*, *Desquamatia*, *Spinatrypa* (BIERNAT, 1964); 4) obliterated surface radial ornamentation mainly on the umbonal parts.

In the internal structure, the gerontic age is usually marked by very thickened, often deformed structural elements, as a results of continual secretion of $CaCO_3$. This especially applies to the cardinal process, dorsal septum in, among others, *Productella varians* n. sp. and *Leptodontella caudata* (SCHNUR). This deformation, in all probability, leads to the death of the animal. The thickened valves, as well as the excessive thickened internal elements rendered opening of shell more difficult, which in turn hindered the obtaining of food and so resulted in the death of animal.

It seems surprising why only a small percentage of shells of old individuals has been found in the Skały and Pokrzywianka beds, while at the same time there is abundance of adults, the more so as the thicker shells are more resistant to destruction and their possibilities for preservation in fossil state greater. This can be explained only by the fact that probably few individuals reached old age, despite favourable environmental conditions. Why this is so, is difficult to explain and understand, and probably the reason is complex.

DWARF FORMS

Among almost all species from the marly shale facies of the Skały beds, there is a number of individuals possessing the features of maturity, but whose size is nevertheless considerably less than the average shell dimensions for the species. This atypical specimens could be named dwarf. They differ from the normal ones not only in shell dimensions, but also in having less developed structural elements, mainly the cardinal process, cardinals and muscle area of both valves. The specimens under discussion are by their morphological features much nearer mature individuals than immature, differing from the latter mainly in a much thicker shell, in the degree of development of the surface ornament (if characteristic of species) and in a small but incurved and thickened ventral beak.

For those specimens, different terms usually signifying their small size, have often been used, such as: «dwarf», «diminutive», «micromorphic» and «stunted». To each of these terms the authors gave probably a slightly different meaning. TASCH (1953), considering the problem of the «abnormal» forms, proposes the term «dwarf», a term at present rather widely used for invertebrates, for defining the matural faunal elements having shell dimensions, like the juvenile specimens of a given species. AGER (1963), instead of the term «dwarfing», suggests the term «stunting» for species, whose growth had been arrested by adverse environmental influences, which may have affected whole populations. The term «dwarfing» should be limited to some extreme cases, i. e. where the size of some specimens, in an otherwise normal population, is well below normal and seems to imply genetic control (HALLAM, 1965).

In general, the authors trying to explain the cause of dwarfed or stunted growth within species, usually connect it with the abnormal environmental conditions in which the animal lived, such as e.g. the degree of salinity, oxygen content, pH, turbinity and water temperature, which could have adverse influences on the whole faunal assemblage. Additionally, water temperature, however, is judged not to be very significant factor in the stunting or dwarfing of smaller taxonomic units, e.g. species. GUNTER (1947) and KRISTENSEN (1957) express the opinion, that regional variations of size in relation to temperature are usually scarce, often difficult to recognize.

In some layers, often of considerable thickness, invertebrate shells, e.g. molluscs and brachiopods of much smaller dimensions than the same species in other layers, can be found. Among others, this atypical fauna occurs in layers containing e.g. rather much pyrit, the presence of which often signifies some reduction conditions in the whole or part of the basin. It is known that salinity has some influence on mobile animals, as well as on those whose mobility is very limited, due to their settled life (GUNTER, 1947). A similar observation was made by MILNE (1940) on alga *Laminaria* and a pelecypod *Mytilus*. It is generally accepted that an increase in the mean size of animals is evidence of a higher degree of salinity, the number of species also depending on the latter, of course, in the case of stenohaline species.

The term «growth» does not always apply to an increase in the length of a particular shell. Often, growth refers to some changes in the length/width ratio of the shell and to internal structural elements. That salinity has an influence on growth variations, was proved experimentally by some investigators, among others GAJEWSKI (1922).

It is difficult to consider the «dwarf» forms in the Skały beds in the same context as TASCH (1953), GUNTER (1947), FISHER (1951) and many others, who were dealing with «dwarfed» or «stunted» faunal assemblages from large areas. It is very probable that the just mentioned causes of «dwarfing» of «stunting» existed also in some parts of the Łysogóry Basin, however, they did not play a deciding role there.

The per cent of «dwarf» specimens in the Skały beds is small. Their size corresponds to more or less one-third to two-thirds average size of particular species. No layers with a great number of dwarf forms were found by the present author. They were always collected together with shells of average size of a given species. One should look for the causes of their abnormality rather in a too great density of individuals of a given population in a given area. In such conditions, some of the weaker individuals became dwarfed probably also because of deficiency in food supply.

The growth process is very complex, depending on many interacting different factors and a general explanation of these differences in growth (retardation) is not simple. Without doubt, environmental conditions, which control the growth process, play a big role.

ASYMMETRY

The phenomenon of asymmetry is fairly well known within brachiopods of different geological age. In the present studied collection this is most marked in the external structure, sometimes in the internal or in both the exterior and interior of many species. Asymmetry has been observed not only within cyrtinids, where it is an almost normal feature, probably depending on the life position of the shell, but also in many other species, such as: *Schellwienella (Schelwienella) umbraculum* (SCHLOTHEIM), *Eodevonaria (Devonaria) zeuschneri* (SOBOLEV), *Parastrophonella anaglypha* (KAYSER), *Chonetes supragibbosa* SOBOLEV, *Productella varians*, n. sp., *Mucrospirifer (Spinospirifer) diluvianoides* n. sp. and also in *Leptaena analogaeformis* n. sp. The state of preservation of the mentioned species is in general good, if we exclude, in majority of observed cases, some *post mortem* mechanical distortion. Specimens showing asymmetry come from shale facies, as a rule, from marly shales of great thickness (exposures 72, 73) characterized by an abundance of brachiopods (BIERNAT, 1959, 1964), many of the species being represented by great numbers of specimens. This could point to optimal life conditions for the animals. Their development, that means, quantity, probably reached the maximum. As a result, a very restricted environment, due to the great abundance of fossils, could, to some degree, be responsible for the shell asymmetry of some individuals. Evidence of good life conditions can also be seen by the epifauna, often abundant on brachiopod shells; the most commonly found are representatives of *Aulopora*, some bryozoans of the group Ctenostomata: *Ascodictyon* NICH., *Eliasopora* BASSLER, *Ropalonaria* ULRICH and *Allonema* ULRICH (KIEPURA, 1965). Some traces of annelids have also been found internally and externally on brachiopod shells (BIERNAT, 1961). In addition, the presence of epifauna has, as a rule, no effect on the general development of the host. Evidence of this is that brachiopod shells, carrying large epifauna, were in adult stage often longer than many without it (see *Schizophoria striatula* [SCHLOTHEIM] and *Desquamatia subzonata* BIERNAT).

In the majority of cases, the asymmetry affects the external shell structure, i.e. its shape and outline. It is marked in: 1) a pronounced skew of the ventral area or of the whole shell towards the right or left, e.g. in *Cyrtina heteroclita intermedia* OEHLERT; 2) unequal development of both lateral parts of the shell, e.g. *Mucrospirifer (Spinospirifer) diluvianoides* n. sp. and *Chonetes supragibbosa* SOBOLEV; 3) unequal development of mucronate extensions, e.g. in *Schellwienella (Schellwienella) umbraculum* (SCHLOTH.) and *Parastrophonella anaglypha* (KAYSER); 4) deformation of the ventral umbo, e.g. *Productella varians* n. sp.

In *Cyrtina heteroclita intermedia* OEHLERT assymmetry of the ventral area or of the whole shell is observed even in the few specimens available. This is probably connected with the

character of the sea bottom, to which the animal was attached by a short pedicle. IVANOVA (1962) observed a similar anomaly in *Cyrtina heteroclita intermedia* OEHLERT and *Cyrtina multiplicata* DAVIDSON from the Devonian of the Kuznetsk Basin, USSR. According to the above author, the shells were attached by a short pedicle or, in the case of the pedicle becoming atrophied, by the ventral beak and area only. IVANOVA also correlated the distortion of the ventral area and shell with the degree of activity of the bottom currents, the greater the movement of water — the greater the asymmetry. The fact that brachiopods lived in close clusters also probably had some influence on their appearance, growing in a restricted area, the shells were in contact with each other.

In *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM), and *Parastrophonella anaglypha* (KAYSER), deformation is most often shown in the various development of the mucronate extremities, on one side being weakly marked, while on the other — more long and often more wide (Text-fig. 38). This is not accidental and probably is connected with environment.

In some specimens of *Mucrospirifer (Spinospirifer) diluvianoides* n. sp. and *Eoreticularia eifeliensis* (FRECH), some anomaly is observed both in the external and internal structure. Internally, this deformation applies mainly to the brachidial cones, that means, their length and, in consequence, the number of coils and sometimes also to the direction of cones. AGER and RIGS (1964) made similar observations in *Spinocyrtia iovensis* (OWEN) from the Devonian of Cedar Valley, limestone of Vinton, Iowa, U. S. A. These authors suggested that, in all probability, the asymmetry was caused by the great accumulation of shells in places especially suitable for growth. In the case of spiriferids from the Skaly beds, it seems that favourable conditions for life existed there, as a consequence of which large assemblages of specimens were forced to live in a restricted area.

Some asymmetry also concerns, among others, the dorsal septum, cardinal process, usually in cases where it is simple, but with incisions or distinctly bilobed or trilobed, e.g. *Aulacella eifeliensis* (DE VERNEUIL), *Schizophoria striatula* (SCHLOTHEIM), *Phragmophora schnuri* COOPER (BIERNAT, 1959); *Schellwienella (Schellwienella) umbraculum* (SCHLOTH.), *Leptaena analogaeformis* n. sp. and *Productella varians* n. sp. (present paper). Very often the asymmetry of this internal structure can already be observed in young individuals, that is when the shell has not yet reached its maximum growth. Usually, one of the lobes of the cardinal process is considerably smaller than the other, its shape also differing from normal. It is possible that some influence is exercised by the function of the cardinal process which served as a place for diductor attachment. The cardinal process is one of the internal structural details most often deformed during life, but without influencing the external shell morphology. It often happens that in young individuals the cardinal process is symmetrical, deformation usually starting only when the shell reaches the adult age. Deformation in the latter being the same as in young shells, in adults, it could also be connected with the size of diductors and their placement on the cardinal process. Myophores are not always of the same size or similarly well marked, which could be attributed to the state of preservation. Almost certainly, this asymmetry is most probably not accidental, but, on the base of the facts available it is difficult to explain it. There are also examples of some deformation when the individual is probably sexually mature, but the shell not yet fully grown.

It seems to the present author that one should not confuse asymmetry with the phenomenon of individual variability, although the former could to some degree be treated as an extreme form of individual variability. Asymmetry in our case being (excluding some teratology or pathology) phenotypic, and not genetic, is very rarely observed, as a rule, in single specimens

only, most probably being a reflection of unfavourable life conditions for a given individual. Individual variability, on the other hand, concerns whole populations and seems to be mostly of genetic nature, connected with the evolution of particular groups, in consequence often leading to new taxonomic units. IVANOVA (1962), on the base of her studies on palaeoecology, inclines to the opinion that asymmetry is completely apart from individual variability.

REMARKS ON INDIVIDUAL VARIABILITY OF BRACHIOPODS

The problem of individual variability, although very important, has up to now received only little attention. One of the reasons for this is that usually only a very limited number of specimens of the same individual age are found for each species. As a result, many species were often incorrectly interpreted and misunderstood. Sometimes, specimens of one species, considerably differing in their external morphology, have been referred to different species.

Fortunately, in the case of brachiopods from the Skały beds, it was possible to study individual variability of a number of species which were represented by many specimens sometimes in different growth stages, 20 specimens for each growth being a minimum. As a result, some rules of individual variability of the studied brachiopods can be established.

1) Individual variability is not equally intensive in all species. For example, shells of particular individuals of *Productella varians* n. sp. sometimes differ considerably from each other, that they could be identified as belonging to separate subspecies or species on the base of such features of external morphology, as: shell outline, width and degree of elongation of the ventral beak, density and appearance of spine-bases on the pedicle valve surface. On the other hand, there are some species, e.g. *Schizophoria striatula* (SCHLOTHEIM), *Leptaena analogaeformis* n. sp., *Atrypa subtrigonalis* BIERNAT and *Desquamatia subzonata* (BIERNAT), which preserve a rather stable external appearance, hence with rather limited individual variability. In consequence, the differences between separate individuals or groups of individuals are small, often even difficult to recognize.

2) In general, the more differentiated the external shell morphology of a given species, the greater the number of varying features and individual variability. This was observed in species having, for instance, a smooth shell surface, e.g. *Cryptatrypa philomela minor* n. subsp., *Crurithyris inflata* (SCHNUR) and *Nucleospira lens* (SCHNUR), as well as in species with an ornamented shell surface, such as: *Douvillina (Douvillina) interstrialis* (PHILLIPS), *Chonetes supragibbosa* SOBOLEV, *Phragmophora schnuri* COOPER, *Atrypa depressa* SOBOLEV, *Parastrophonella anaglypha* (KAYSER) and *Kayseria lens* (PHILLIPS). Species with a smooth surface show variability almost exclusively in: a) the proportions of length, width and shell thickness and b) the size and degree of incurvature of the ventral beak. This variability is often visually indistinct,being of a quantitative type, but can be confirmed by biometry (see present paper, p. 142). Species with an ornamented surface show, in addition, some variability in ornamentation, as a rule, easy to visual observation. This variability concerns: the number of ribs, costae, costulae, striae, their thickness, height and some regularity in increasing.

3) No case was observed, either in external or internal morphology, where variability was confined to only a single feature. In general, variability of one feature evoked variability

in a series of others, e.g. a narrowing shell gave rise to a more elongated ventral beak, reduced in its width and often shortened the hinge line (*Pseudocamarophoria undulataeformis* n. sp., Pl. XIX, figs. 8, 12; *Cryptatrypa philomela minor* n. subsp., Pl. XXIII, figs. 7, 8). In turn, shortening of the hinge line give rise to a higher ventral area, causing greater concavity of this latter (e.g. *Douvillina (Douvillina) interstrialis* (PHILLIPS), Text-fig. 8; *Douvillina (Douvillina) subcorrugata* n. sp., Text-fig. 10; *Eodevonaria (Devonaria) zeuschneri* (SOBOLEV), Pl. XV, figs. 11-15); *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM). Also connected with changes in the above features is the appearance of the pseudodeltidium, deltidium and chilidium.

4) Individual variability mostly applies to shells of adult or nearly adult individuals. Shells of youthfull individuals (before morphogenesis has finished), as a rule, vary only in narrow limits, often preserving great stability in their morphological characters. This small variability in juvenile individuals is connected with the very limited number of features, characteristic for this growth stage. In all probability, environment affects shells in each growth stage and, as a result, some small changes in their morphology appear. With growth, the shell becomes more and more differentiated and changes can be observed in an increasing number of features.

5) Individual variability is also observed in the internal shell structure. Possibilities for study depend on the number of separate pedicle and brachial valves, which are usually rather rarely found.

In the case of brachiopods from the Skały beds, separate brachial and pedicle valves, with preserved internal structural details, have been found for some species, e.g. *Leptaena analogaeformis* n. sp., *Schizophoria striatula* (SCHLOTHEIM), *Phragmophora schnuri* COOPER, *Aulacella eifeliensis* (VERNEUIL), *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM), *Chonetes supragibbosa* SOBOLEV, *Parastrophonella anaglypha* (KAYSER) and *Productella varians* n. sp. On the base of observations one can state that just as for the external morphology, variation of the internal structural elements occurs in all species. This can be observed in: a) the appearance of the cardinal process (e.g. *Leptaena analogaeformis* n. sp., Text-fig. 6; *Eodevonaria (Devonaria) zeuschneri* (SOBOLEV), Text-fig. 24; *Productella varians* n. sp., Text-fig. 19); b) the length and thickness of the dorsal septum; c) the outline of the dorsal or ventral muscle area; d) length, thickness, degree of divergence of dental plates and crura; e) thickness of teeth. The degree of development and limits of variability of many of the above features are, above all, connected with the development and effectiveness of muscles.

Having at our disposal a great number of shells of the same individual age for one species, e.g. *Aulacella eifeliensis* (DE VERNEUIL), *Schizophoria striatula* (SCHLOTHEIM), *Atrypa depressa* SOBOLEV, *Phragmophora schnuri* COOPER, *Skenidium polonicum* GÜRICH and *Bifida lepida* (D'A. & DE V.), it was possible to observe gradual changes in the appearance of shells (transitional forms) between the very extreme «types». This corresponds to «continuous» variability (MAYR, 1963). In species with a sufficient numbers of specimens of one growth stage, «discontinuous» variability was not observed, extreme «morphological types» were not present, i.e. shells wide and short — shells long and narrow; beak short and wide — beak long and narrow. Even in the group of *Productella varians* n. sp., in which two morphological types have been recognized (1. elongated shell with longer ventral umbonal part, and 2. shell wide with smaller umbonal part), there are intermediate specimens.

It is difficult, on the base of fossil material, to state, if the observed individual variability is of genetic or nongenetic type. It is possible that in some cases, within the brachiopods of the Skały beds, there was «nongenetic», quantitative variability; this applies to individuals with an adaptive tendency controlled by natural selection. Sometimes however, specimens of

particular species (*Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM), *Leptaena analogaeformis* n. sp.) are of a rather stable phenotype and so have a limited range of variability. Some species, on the other hand, undergo greater modification (*Productella varians* n. sp.).

It should be mentioned that the above variations concern, in the first place, fauna from marly shales (exposure 73), where the environment was rather stable, and so one could suppose there was also a certain stability in the process of development. This stability is shown by some phenotypic uniformity within a given species. That is why the presence in the same environment of very variable species, such as e.g. the just mentioned *Productella varians* n. sp., suggests genetic variations (of qualitative type) which lead to new taxonomic units. Genetic factors can underlie both, the number and direction of phenotypic variations (MAYR, 1963).

SYSTEMATIC PART

Order **PENTAMERIDA** SCHUCHERT & COOPER, 1931

Suborder **PENTAMERIDINA** SCHUCHERT & COOPER, 1931

Family ENANTIOSPHENIDAE TORLEY, 1934

Genus **ENANTIOSPHEN** WHIDBORNE, 1893

Type species: *Meganteris (?) vicaryi* DAVIDSON, 1882, p. 20; Middle Devonian, England.

Enantiosphen sp. cf. **Enantiosphen vicaryi** (DAVIDSON, 1882)

(Pl. I, figs. 9 a—d)

Type horizon: Limestone of Kamieniec, Pokrzywianka beds, Middle Devonian.
Type locality: Kamieniec, Łysogóry region, Holy Cross Mountains.

Material. — One incomplete specimen with umbo greatly damaged. Approximate dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
1123	?38·3	45·0	20·0

Description. — Shell outline somewhat asymmetrical, transversely ellipsoidal in outline; lateral margins short, anterior commissure broadly rounded; antero-lateral margins geniculated towards the commissural line; surface smooth. Damaged posterior part shows internally a high median septum and spondylium duplex. No other internal details can be observed.

Remarks. — Our specimen is very close to the specimen of *Enantiosphen* aff. *Enantiosphen vicaryi* (DAVIDSON), figured by CLOUD (1942, Pl. 26, fig. 7), from limestone of Bilveringsen, *Stringocephalus* horizon, Germany; the only difference is that ours is slightly less transverse. There is also a great resemblance to *Enantiosphen beyrichi* (HOLZAPFEL) from the Devonian of Rhine region, limestone of Fretterthales (HOLZAPFEL, 1895, p. 292, Pl. 12, fig. 23; Pl. 17, fig. 3), but the latter is much more globular, with both valves deeper. *Enantiosphen torleyi* HOLZAPFEL from the Givetian limestone of Bilveringsen (TORLEY, 1934, Pl. 5, fig. 12) differs in being larger and having a weakly marked «sulcus» on the brachial valve. In *Enantiosphen librovitschi* NALIVKIN from the Middle Devonian (Givetian), horizon with *Stringocephalus burtini*, Ural, Mugodzhar (ROZMAN, 1959, Pl. 4, fig. 4) some differences appear in the bicon-

vexity of the shell. Both valves of our specimen are more flattened, being only weakly convex umbonally.

Occurrence. — Genus *Enantiosphen* characterizes Givetian, *Stringocephalus* horizon; England, Germany, USSR, Poland.

Family PENTAMERIDAE McCoy, 1844

Subfamily GYPIDULINAE Schuchert & Le Vene, 1929

Genus **GYPIDULA** Hall, 1867

Subgenus GYPIDULA (DEVONOGYPA) Havlíček, 1951

Subgenotype: *Gypidula (Devonogypa) spinulosa* Havlíček, 1951; Middle Devonian, Czechoslovakia (Moravia)

Gypidula (Devonogypa) spinulosa Havlíček, 1951

(Pl. I, figs. 1-5, 8; Pl. II, fig. 10)

1896. *Pentamerus globus* Bronn var. *a*; G. Gürich, Das Palaeozoicum... S. 275, Taf. 7, Fig. 6*a*, *b*, *c*.
1951. *Gypidula (Devonogypa) spinulosa*; V. Havlíček, Paleontologicka..., s. 5, Tab. 2, obr. 2, 3, 5.

Horizon: Marls, exposures 103-106; crinoids limestone, exposures 83, 89; Skały beds, Middle Devonian.
Locality: Skały.

Material. — About 30 fragments of separate valves, in majority pedicle valves, 2 nearly complete specimens.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
1625	30·5	30·2	18·3
1624	36·2	35·3	26·6

Description. — Shell of large size, thick-walled, suboval-pentagonal in outline; longer than wide; greatest shell width anterior to midlength. Pedicle valve: greatly convex with surface arching nearly uniformly from the beak to the anterior margin and more sharply to the lateral margins; umbo very prominent, with blunt and strongly incurved beak; area very small and poorly defined, striated horizontally and vertically; delthyrium trigonal, open, often not observed, covered by strongly incurved ventral beak. Brachial valve smaller and much less convex than the pedicle one with the greatest convexity, as a rule, at the umbonal part; beak small but distinctly incurved.

Ornamentation. — Shell surface seems smooth, with not very distinct concentric lines. These growth lines being, in general, exceedingly delicate bear spines. Bases of spines because of the bad state of preservation are rarely observed. They are of two sizes: smaller and more rounded posteriorly, and thicker, slightly ovate towards the anterior margin. Spine bases are

almost quincuncially distributed over all the shell surface (see Pl. I, fig. 8; Pl. II, fig. 10).

Interior. Pedicle valve: teeth short and blunt; spondylium distinct, supported apically by a stout, but short septum. Brachial valve interior not studied because of unavailable material.

Remarks. — Spinose shell surface is a feature considered by HAVLIČEK (1951, p. 5) as the most diagnostic for the subgenus. The presence of this feature in fossils, however, depends much upon the state of preservation of shells. Perhaps the poor state of preservation in many specimens explains the frequent absence of this microornamentation. Evidence of this is e.g. collection of *Gypidula (Devonogypa) spinulosa* HAVLIČEK from the Skały beds. It is rather rich in fragments of shells and nearly complete separate pedicle valves, but surface spinosity was only preserved on very few specimens. This feature has been mentioned and figured by GÜRICH in his «*Pentamerus*» *globus* BRONN var. *a* from the Middle Devonian of Skały beds (1896, p. 275, Pl. 7, fig. 6). Our specimens agree in their external appearance with specimens of *G. (Devonogypa) spinulosa* HAVLIČEK from the Middle Devonian of Czechoslovakia (Moravia). Specimens of the German collection of *Pentamerus globus* (SMF coll. XVII 253b, K. TORLEY coll. 1909; XVII 253*c* from Bilveringsen) are, in general, very close to ours, showing surface spinosity, some of them being only a little larger or having more thickened beak, than specimens from the Skały beds.

Occurrence. — Middle Devonian (Upper Eifelian-Givetian); Czechoslovakia (Moravia); Poland (Holy Cross Mountains); Germany (Rhine region, Bilveringsen); England.

Subgenus GYPIDULA (GYPIDULA) HALL, 1867

Type species: *Gypidula typicalis* AMSDEN, 1953 (*Pentamerus occidentalis* HALL, 1858). Upper Devonian, North America.

Gypidula (Gypidula) cf. **biplicata** (SCHNUR, 1854)

(Pl. I, fig. 11)

cf. 1854. *Pentamerus biplicatus*; J. SCHNUR, Zusammenstellung..., S. 196, Taf. 31, Fig. 3.

Horizon: Marls, exposure 81, Skały beds, Middle Devonian.
Locality: Skały.

Material. — One free specimen, slightly deformed.
Approximate dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	No. of plicae	
				ventral fold	brachial sulcus
65*a*	21·2	19·0	14·4	3	4

Description. — Shell of medium size, elongated, moderately pentagonal in outline; anterior commissure with broad sulcation. Pedicle valve larger and deeper than the opposite valve, nearly uniformly arched, umbo narrowed posteriorly, beak incurved; fold moderate, bearing 3 plicae marked on the anterior half; slopes with indistinct traces of folds. Brachial

valve convex umbonally; sulcus marked in the anterior half, with 4 not very distinct narrow plicae.

Remarks. — Our specimen is very close externally to SCHNUR's specimen of *G. biplicata* from the Middle Devonian of Eifel (SCHNUR, 1854, Pl. 31, fig. 3). There are some small differences, our shell being more elongated and more narrowed anteriorly. Our specimen is especially close to the specimen *G. biplicata* (SCHNUR) figured by KHODALEVITCH from Ural (1951, Pl. 7, fig. 4). In general, the species seems to be very variable, especially in the number of radial plicae.

Occurrence. — Middle Devonian; Poland (Holy Cross Mountains); Germany (Rhine region); USSR (Ural).

Gypidula (Gypidula) parva n. sp.

(Pl. I, figs. 6, 7; Text-fig. 4)

?1904. *Pentamerus brilonensis* KAYSER; D. SOBOLEV, Devonskija..., s. 88, Tabl. 9, ris. 13.

Holotype: Z. Pal. Cat. No. Bp. VII/3641, figured on Pl. I, fig. 7.
Type horizon: Limestone of Skały beds, exposure 89, Middle Devonian.
Type locality: Skały, Łysogóry region, Holy Cross Mountains.
Derivation of the name: Lat. *parva* — being of small size.

Diagnosis. — Small gypidulids with smooth shell surface, unequally biconvex, without sulcus and fold, anterior commissure straight.

Material. — Ten specimens, sufficiently well preserved.
Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
3641 (holotype)	12·4	14·4	8·3
3640	15·5	17·6	10·5

Description. — Shell of small to medium size, unequally biconvex, pentagonal in outline, with rounded antero-lateral margins. Pedicle valve regularly arched; umbo swollen, beak slightly incurved. Brachial valve a little only smaller than the opposite valve, convex umbonally, umbo well marked, beak small, slightly incurved.

Ornamentation. Shell surface smooth, the concentric growth lines not very distinctly marked.

Interior (Pl. I, figs. 6*a*, *b*; Text-fig. 4). Spondylium with narrowly rounded bottom, supported by a distinct medium septum. Brachial valve: brachial apparatus well developed (see Text-fig. 4).

Remarks. — Externally, the species can be compared with *Gypidula brevirostris* (PHILLIPS) from the Middle Devonian of England (NEWTON) (see PHILLIPS, 1841, p. 80, Pl. 32, fig. 143), assigned by RZONSNICKAJA (1961, p. 44, Text-fig. 2) to the genus *Sieberella* OEHLERT (OEHLERT, 1887) on the base of united «septal plates». The shell surface of the above species is smooth, without sulcus and fold, with the shell outline and shape similar as in our species. The differences lie in the comparatively very short ventral umbo, more transverse shell outline and much smaller shell size of our form.

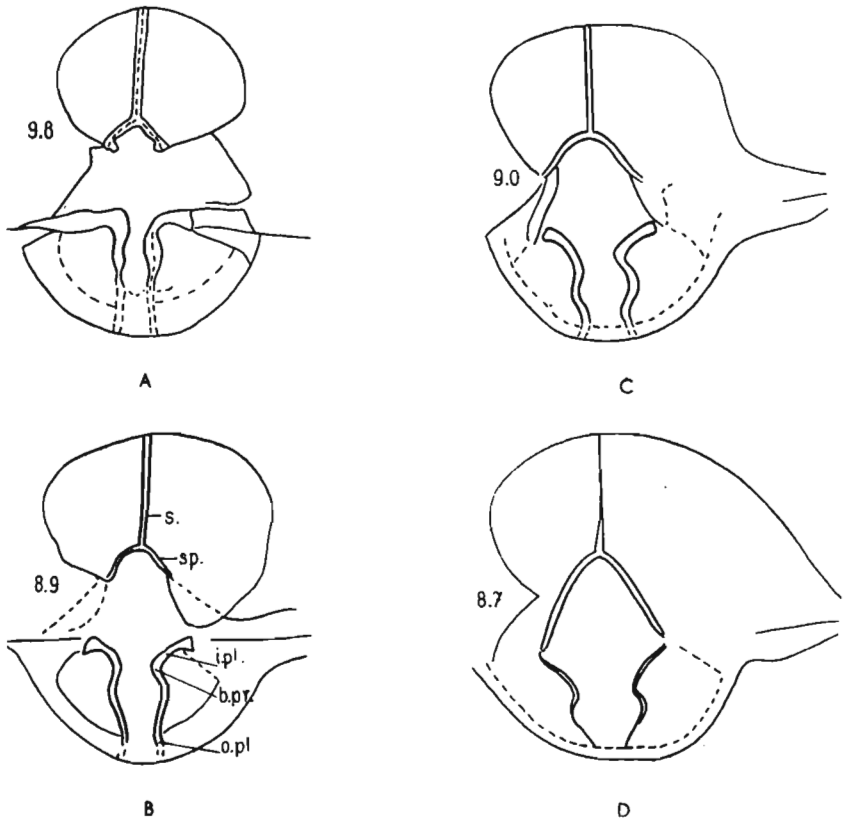


Fig. 4

Gypidula (Gypidula) parva n. sp. Skały, exposure 89. *A-D* serial sections of adult specimen, 18·8 mm. long (Bp. VII/3643): *i. pl.* inner plate, *b. pr.* brachial process, *o. pl.* outer plate, *s.* septum, *sp.* spondylium; × 6·6.

Subgenus GYPIDULA (IVDELINIA) ANDRONOV, 1961

Type species: *Gypidula ivdelensis* KHODALEVITCH, 1951; Eifelian of east part of Ural; p. 22, Pl. VI, figs. 3, 4.

Remarks. — ANDRONOV erected the genus in 1961 for a large group of Lower and Middle Devonian pentamerids, the majority of them were earlier assigned to the genus *Gypidula* HALL. One of the important diagnostic features of the new genus is, according to ANDRONOV (1961, p. 45), a constantly present division of radial costae anteriorly on the pedicle valve as in *Hypothyridina* BUCKMAN and *Uncinulus* BAYLE. The costae, in general, start at the umbo and in only two species — *Ivd. miloradovitschi* ANDRONOV and *Ivd. totaensis* (KHOD.) — are present in the anterior half of the shell (ANDRONOV, *l. c.*, p. 46). Internal structure of this taxonomic unit is the same as in *Gypidula*.

Although the above feature — the radial costae divided anteriorly on the pedicle valve — can be considered as diagnostic, it is only one characteristic and not therefore sufficient for generic definition (in this paper is not accorded more than subgeneric importance). Additional and well defined features especially of the internal structure are needed.

Only 4 European species are referred by ANDRONOV to his new taxon, the majority, 32 species, come from the Devonian of USSR. There is some doubt, however, if all these latter species can be considered as sufficiently valid species.

Occurrence. — Lower and Middle Devonian, Germany, France, Poland and USSR.

Gypidula (Ivdelinia) cf. **acutolobata** (SANDBERGER, 1850-1856)

(Pl. II fig. 1)

cf. 1850-1856. *Pentamerus acutolobatus*; G. & F. SANDBERGER, Versteinerungen..., S. 345, Taf. 15.

Horizon: Marly shales, exposure 81, Skały beds, Middle Devonian.
Locality: Skały.

Material. — Two free specimens of adult individual, greatly damaged. Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
62	28·0	29·3	21·3

Description. — Shell large ventri-biconvex, subtrigonal in outline; hinge line gently arched; lateral margins very short, rounded; ventral fold and dorsal sulcus present. Pedicle valve: umbo broad, greatly prominent with incurved beak; area poorly delimited; fold marked. Brachial valve much smaller than the opposite valve, transversally elliptical in outline, convex posteriorly, markedly lowered anteriorly; the sulcus beginning at about the midlength of the valve.

Ornamentation. Surface plicae are few, but distinctly marked being of the type of «*Pentamerus*» *acutolobatus* SANDBERGER (1850—1856, Pl. 33, fig. 15*a*). On the rather inconspicuous fold of the pedicle valve there are two median plicae and two very faint ones on each lateral slope. On the brachial valve there are 3 median plicae, one of them lying medially in the sulcus and two bordering it. Umbonal parts of both valves are smooth. Concentric lines not preserved.

Interior not studied.

Remarks. — »*Pentamerus*« *acutolobatus* SANDBERGER (1850—1856, Pl. 33, fig. 15*a-c*), described from the Middle Devonian of Nassau, Germany, *Stringocephalus burtini* horizon, may be a synonym of *Pentamerus formosus* described by SCHNUR in 1851 and figured in 1853 (SCHNUR, 1853, Pl. 31, fig. 2) from the limestone of Gerolstein and Prüm. The external morphology of both species appears to be basically the same, i.e. the shell outline and shape and thickness of radial plicae. SANDBERGER'S species differs, however, in having a more prominent ventral beak and less plicae on the ventral fold and dorsal sulcus, the plicae being distinctly incised anteriorly on the pedicle valve. Without a topotype material it is difficult to ascertain, if these differing features are stable within the species. Specimens labelled in the German collection XVII 2813 as *Gypidula acutolobata* (SANDBERGER), or *Pentamerus galeatus* var. *acutolobatus* SANDB., from Rommersheimer layers, are very close to ours, but have a less prominent ventral beak. Our specimen resembles SANDBERGER'S species in having the same number of surface plicae on fold and sulcus, but differs not being so acute and having only faintly marked plicae on slopes. Our *G. (Ivdelinia)* cf. *acutolobata* (SANDBERGER) is very close to SCHNUR'S species «*Pentamerus*» *formosus* (SCHNUR) (SCHNUR, 1853, Pl. 31, fig. 2), but the former has less plicae

on the fold and sulcus and differs from the two German species (*«Pentamerus» acutolobatus* and *«Pentamerus» formosus)* in having more prominent and slightly thinner ventral umbo. The Russian Middle Devonian species, assigned by ANDRONOV (1961) to his newly erected genus *Ivdelinia*, such as i.e. *Ivdelinia pseudoivdelensis* (KHODALEVITCH), *Ivd. miloradovitschi* ANDRONOV, *Ivd. uralensis* ANDRONOV, *Ivd. motowilichaensis* ANDRONOV, *Ivd. intima* (KHODALEVITCH) show, as far as can be judged from the illustrations of this author (ANDRONOV, 1961, Pl. 4, figs. 24-27; Pl. 6, figs. 1-9; Pl. 7, figs. 1-10; Pl. 8, figs. 4-11; Pl. 9, figs. 11-15), the ventral surface plicae incised anteriorly, similarly as observed in the species from the Skały beds. The differences concern the shell outline and number of radial plicae which are more numerous in the Russian forms.

Occurrence. — Middle Devonian; Poland (Holy Cross Mountains); Germany (Nassau); horizon with *Stringocephalus burtini* DEFR.

Gypidula (Ivdelinia) sp. cf. **G. (Ivdelinia) multiplicata** (ROEMER, 1854)

(Pl. II, figs. 2, 3, 4)

cf. 1904. *Pentamerus galeatus* DALM. var. *multiplicatus* F. ROEMER; D. SOBOLEV, Devonskija..., S. 87, Tabl. 9, ris. 14.

Type horizon: Marly shales, exposure 81, Middle Devonian.
Type locality: Skały.

Material. — Two free specimens, one almost complete.
Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
1	30·4	31·0	21·5
2	24·7	25·0	20·5

Description. — Large, subpentagonal in outline, only a little wider than long; greatest width at midlength; anterior commissure emarginate. Pedicle valve with broad and incurved beak and small interarea. Brachial valve weakly convex posteriorly, flattening anteriorly; median sulcus starting at midvalve, better defined anteriorly.

Ornamentation consists of distinct rounded costae, slightly wavy in appearance. Bifurcation is common, some costae may branch off three times, probably not more. Intercalation rare. Concentric lines distinct.

Interior only partly known in present material. Spondylium appears to be short with rounded anterior end, supported by a short medium septum; teeth strong; crural plates distinct, disappearing about midway of the valve. Brachial valve: crural plates gently convergent upwards, their bases separated.

Remarks. — The species occurs sporadically in quite fossiliferous layers within the Skały beds, being recorded in a few exemplars only by e.g. SOBOLEV (1904, p. 87) and recently in 2 specimens by the author. It was mentioned and figured by SOBOLEV as *Pentamerus galeatus* DALM. var. *multiplicatus* ROEMER (SOBOLEV, 1904) and *Pentamerus sieberi* V. B. (SOBOLEV, 1909), and probably by GÜRICH (1896) as *«Pentamerus» galeatus* DALM. var. *a*. It is very probable that specimens found by SOBOLEV, GÜRICH and the present author belong to the same species, although some small differences do exist (see SOBOLEV, 1904, Pl. 9, fig. 14). Our specimens seem

to be also distinct from *Pentamerus multiplicatus* (= *Ivdelinia europeica* ANDRONOV), figured by KAYSER (1871, Pl. 10, fig. 1), in having a slightly larger shell, a somewhat wavy appearance of radial costae which bifurcate and intercalate more often. The same difference is marked in comparison with German specimens (SMF coll. from *Calceola* layers — Gondelsheim, Eifel; *Ostiolatus* horizon of Prüm). This last feature also distinguishes our specimens from specimens of «*Pentamerus*» *multiplicatus* (= *Ivdelinia lemaitreae* ANDRONOV, 1962), listed and figured by LE MAÎTRE (1934, p. 54, Pl. 2, figs. 12-14) from the Devonian limestone of the Basin of Ancenis, France. A similar bifurcation of costulae can be observed in *Pentamerus davyi* OEHLERT (see LE MAÎTRE, 1934, Pl. 2, figs. 7-10) from the Devonian limestone of Chaudefonds, France. *Gypidula ivdelensis* var. *intima* KHODALEVITCH from Eifelian horizon of Sverdlovsk, Serovski region, USSR (KHODALEVITCH, 1951, p. 23, Pl. 6, fig. 1), while showing some external resemblance, is distinguished from ours mainly by larger but fewer radial costae. It is probable that our specimens represent a new subspecies or species.

Genus **LEVIGATELLA** ANDRONOV, 1961

Type species: *Gypidula olga* KHODALEVITCH, 1939; Lower Devonian, USSR.

Remarks. — ANDRONOV has erected the new genus for a group of smooth gypidulids with internal structure like *Gypidula* (see ANDRONOV, 1961, p. 38), but having a dorsal sulcus and a ventral fold. Unfortunately, the genus is based only on a few external features. The interior is not restudied and hence needs reexamination.

Occurrence. — Upper Silurian-Upper Devonian (Frasnian); USSR; Poland (Holy Cross Mountains).

?**Levigatella** sp.

(Pl. I, fig. 10)

Horizon: Marly shales, exposure 84. Skały beds, Middle Devonian.
Locality: Skały.

Material. — One specimen, sufficiently well preserved.
Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus
3642	18·4	19·2	11·3	10·3

Description. — Medium sized, pentagonal in outline, with sulcate anterior margin, lateral margins short and rounded. Pedicle valve arched along midline, umbo well marked with narrowed and slightly incurved beak; fold comparatively well elevated. Brachial valve: convex umbonally, lowered anteriorly; sulcus starting at about midlength of the valve. Shell surface smooth. Concentric lines in general well marked, thickened, regularly distributed on the shell surface.

Remarks. — Externally the specimen appears to be the closest to *Levigatella mirtschinki* ANDRONOV (1961, Pl. 1, figs. 11-15), described and figured from the rifs limestone of Frasnian (Severouralsk). A great external similarity exists also to *Levigatella shegultanica* ANDRONOV *l. c.*, Pl. 1, figs. 6-10) from the Frasnian limestone of USSR (Severouralsk).

Subfamily CLORINDINAE RZONSNICKAJA, 1956

Genus ANTIRHYNCHONELLA OEHLERT, 1887

non *Antirhynchonella* QUENSTEDT, 1871 (= *Barrandella* HALL & CLARKE, 1893)

Type species: *Atrypa linguifera* SOWERBY, 1839; Silurian, England.

Diagnosis. — Medium sized, smooth pentamerids with ventral sulcus and dorsal fold; spondylium with a short septum; brachial cruralium with carinae which extend inside of the inner plates; outer plates discrete; brachial processes relatively broad.

Remarks. — The genus on the basis of the above features (see Diagnosis) was included to the subfamily Clorindidae (AMSDEN, 1964) together with *Clorinda* BARRANDE, 1879, *Clorindina* KHODALEVITCH, 1939, and *Clorindella* AMSDEN, 1964. All these genera possess a carinate brachial cruralium, a feature highly characteristic for the subfamily Clorindinae RZONSNICKAJA, 1956 (see AMSDEN, 1964) and externally a ventral sulcus and dorsal fold. The differences are not great, concerning both the external shell surface and internal details of the brachial apparatus. *Clorinda* BARRANDE is smooth externally and has discrete brachial plates; *Clorindella* AMSDEN is externally costate and its cruralium is elevated on a septum; *Clorindina* KHODALEVITCH has a costate shell surface and discrete brachial plates.

Occurrence. — Silurian-Middle Devonian; Europe.

Antirhynchonella linguiformis n. sp.

(Pl. II, figs. 5-9; Text-fig. 5)

1896. *Pentamerus globus* var. *c*; G. GÜRICH, Das Palaeozoicum..., S. 276, Pl. 7, Fig. 9.
1909. *Pentamerus* cf. *linguifer* Sow.; D. SOBOLEV, Srednij devon..., s. 494, Tabl. 6, ris. 4, 5.

Holotype: Z. Pal. Cat. No. Bp. VII/3621, figured on Pl. II, fig. 6.
Type horizon: Limestone, exposure 2 (limestone of Miłoszów), Skały beds, Middle Devonian.
Type locality: Miłoszów near Skały, Łysogóry region, Holy Cross Mountains.
Derivation of the name: linguiformis — externally somewhat like *Antirhynchonella linguifer* (Sow.).

Diagnosis. — Medium sized pentamerids with slightly marked ventral sulcus and dorsal fold, but «linguiform extension» sufficiently distinct; ventral umbo thickened, beak incurved.

Material. — About 20 specimens, in general well preserved. Shells usually with valves closed.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus
3621 (holotype)	24·5	25·0	18·0	11·4
3622	21·7	22·4	16·2	12·8
3633	26·5	24·8	16·0	14·4
3634	18·6	20·3	12·2	?10·2

Description. — Shell suboval to pentagonal in outline, wider than long, of medium size, ventri-biconvex, anterior commissure uniplicate. Pedicle valve of moderate deepness; the greatest convexity posteriorly; umbo thickened with markedly incurved beak; wide and usually weakly defined sulcus starting about midlength of the valve, forming a «linguiform extension» slightly

directed to the opposite valve. Brachial valve nearly regularly convex, beak moderately incurved; fold not very distinct, observed in the anterior half of the valve.

Ornamentation. Shell surface smooth, covered by concentric growth lines. Microlines are delicate, closely set, posteriorly about 20 per 1 mm., anteriorly 9—10 per 1 mm.

Interior. Pedicle valve: teeth small; spondylium deepest in its median part, with narrowly rounded bottom; supporting septum probably small. Brachial valve: brachial apparatus consisting of short, converging outer plates, diverging laterally inner plates, carinae present (Text-fig. 5).

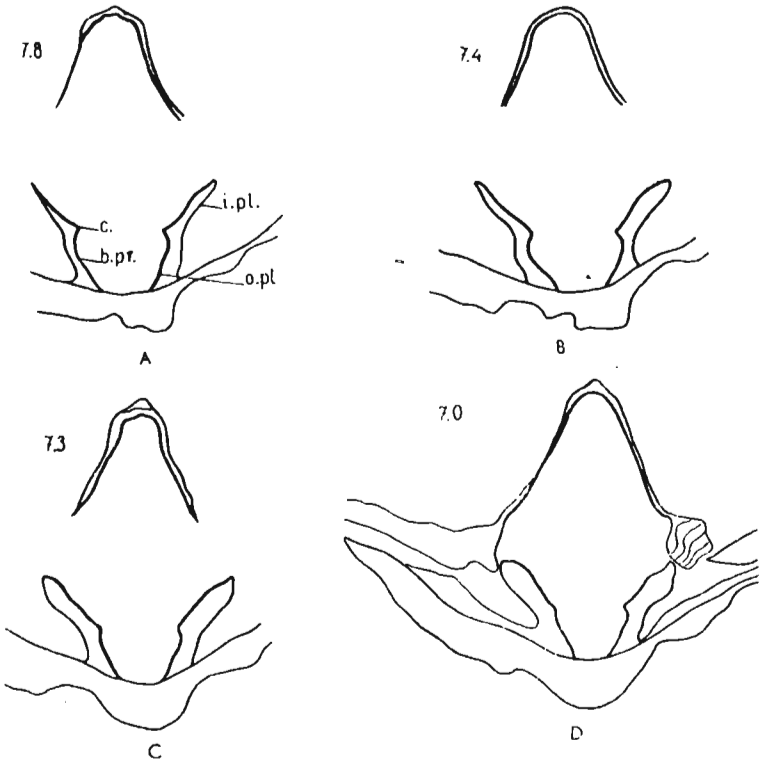


Fig. 5
Antirhynchonella linguiformis n. sp. Miłoszów. *A-D* serial sections of adult specimen: *i. pl.* inner plate, *o. pl.* outer plate, *b. pr.* brachial process, *c.* carina; × 6·6

Remarks. — The species shows a great resemblance to smooth gypidulids, but has a fold on the brachial valve and a sulcus on the pedicle one (one of the features characteristic for the subfamily Clorindinae RZONSNICKAJA, 1956). Externally, it is very similar to e.g. *Clorinda pseudolinguifera* KOZŁOWSKI, from Podole, Borszczów (KOZŁOWSKI, 1929, p. 137, Pl. 6, figs. 4-13), but it differs internally in having convergent outer plates. This last feature makes our species very close to *Antirhynchonella linguifer* (SOW.). There is also a great resemblance to *Pentamerella sublinguifer* (MAURER) (MAURER, 1885, Pl. 9, figs. 8, 10, and SMF coll. 2557, XVII 2895, Freilinger layers), but our specimens are of larger dimensions and their ventral umbo is more thickened. «*Pentamerella*» *sublinguifer* has probably more massive and convergent outer plates, as it is showed by LEIDHOLD (1928, Text-fig. 25). Our specimens, in general, look very much like specimens of TORLEY'S collection from Bilveringsen, labelled as «*Pentamerella*» *sublinguifer* (MAURER), SMF coll. XVII 355a, b, but are twice as large as the German specimens.

Order **STROPHOMENIDA** Öpik, 1934

Suborder **STROPHOMENIDINA** Öpik, 1934

Family LEPTAENIDAE Hall & Clarke, 1894

Genus **LEPTAENA** Dalman, 1828

Type species: *Leptaena rugosa* Dalman, 1828; Upper Ordovician — Ashgill, *Dalmanitina* layers, Sweden.

Remarks. — *Leptaena* is one of the few Devonian genera which in philogeny show great stability in their external and internal morphology. It has an extended vertical distribution, being known from Ordovician to ?Carboniferous. As the differences are very small, it is not easy to distinguish the early Palaeozoic representatives of the genus from the Carboniferous ones. In general, many species from different horizons and localities have been erroneously referred to the commonly known *Leptaena rhomboidalis* (Wilckens), this latter probably originating from the Silurian of Gotland, first found and described from erratics of the Baltic region. *Leptaena rugosa* Dalman, the type species of *Leptaena* and *L. depressa* (Sowerby) were often placed in synonymy with *L. rhomboidalis* (Wilck.). The great vertical range of the latter species was questioned by Poulsen (1943). This author on the base of *L. rhomboidalis* (Wilck.) and *L. depressa* (Sow.), both coming from the Silurian of Gotland, selected some important features which he considered as diagnostic for the species: 1) differences in the coarseness of concentric rugae; 2) degree of their reflection on the inner surfaces; 3) degree of divergence of the cardinal process lobes, i.e. subparallel or diverging; 4) appearance of deltidium, pedicle foramen and chilidium. However, up to now, it is not certain if these features are sufficiently stable within the species.

For the group of *Leptaena* a few genera have been proposed. Some, as *Leptagonia* M'Coy, 1844 (= *Leptaenella* Sokolskaja, 1952), are regarded as belonging to the genus *Leptaena* because of the great similarity in its external and internal morphology (Havlíček, 1963). *Pseudoleptaena* Miloradovitsch (Miloradovitsch, 1947) probably can also be assigned to *Leptaena*. *Notoleptaena* Gill (Gill, 1951), the Devonian genus of Australia (Victoria), is interesting because of the external differences, i.e. the presence of a tongue and ventrally geniculated pedicle valve. *Notoleptaena* is very close externally to *Leptodontella caudata* (Schnur). The differences being its probable lack of a denticulate hinge line, so characteristic of *Leptodontella* Khalfin, and ventral-dorsal muscles like *Leptaena* Dalman. The genus *Kiaeromena* with *Leptaena kjerulfi* Holtedhal, 1916, as type species, has been erected by Spjeldnaes (Spjeldnaes, 1957) for the Middle-?Upper Ordovician leptaenids, on the basis of some differences in the shape of the valves and cardinal process, compared with *Leptaena*. Recently, Havlíček in the Silurian and Devonian of Czechoslovakia has erected 5 new genera: *Rugoleptaena* (1956), *Lepidoleptaena*, *Leptaenopyxis*, *Bracteoleptaena* and *Elliptostrophia* (1963). He considers among others the degree of development of brachiophores (rudimentar in *Leptaena*), presence and distinctness of marginal ridge (Saum = ridge) in the dorsal interior, degree of development of dental plates as diagnostic on generic level.

It is considered here that the shape and height of the ventral muscle boundering ridges can also be of some diagnostic value, but probably not at generic level as mentioned by Sokolskaja (1954). Earlier, Davidson (1857) noted that the high muscle ridges in Carboniferous leptaenids are one of the internal pecularities. This feature is also present in the Middle Devonian leptaenids of the Skały beds.

Leptaena analogaeformis n. sp.

(Pl. III, figs. 1-16; Pl. IV, figs. 1-13; Text-figs. 6-7)

1869. *Strophomena rhomboidalis* var. *analoga*; L. ZEUSCHNER, Geognostische..., S. 268.
1896. *Leptaena depressa* SOW.; G. GÜRICH, Palaeozoicum..., S. 226.
1904. *Leptaena depressa* SOW.; D. SOBOLEV, Profil, s. 56.
1909. *Leptaena rhomboidalis* WILCKENS; D. SOBOLEV, Devonskija..., S. 450.

Holotype: Z. Pal. Cat. No. Bp. VII/1200, figured on Pl. III, fig. 4.
Type horizon: Marly shales, exposure 73, Skały beds, Middle Devonian.
Type locality: Skały, Łysogóry region, Holy Cross Mountains.
Derivation of the name: analogaeformis — internally like *Leptaena analoga* (PHILLIPS).

Diagnosis. — Medium sized *Leptaena*, strongly geniculated, with high muscle bounding ridges in the pedicle valve, coalesced anteriorly with a short medium septum as in *L. analoga* (PHILLIPS) (see SOKOLSKAJA, 1954, p. 66, Text-fig. 23); sockets ridges and «crural» plates = brachiophores: as in *L. rhomboidalis* (WILCKENS).

Material. — Thirty specimens nearly complete, 20 fragmentary shells, 18 separate pedicle valves, 12 brachial valves but many fragmentary. Majority of specimens belong to old individuals; 16 separate brachial and pedicle valves of immature specimens. The specimens come from exposures: 101, 110, 112, 121, 125; limestone of Miłoszów.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Shell length to geniculation	Length of geniculation	Width of shell	Width of hinge line	No. of concentric rugae	
					ped. v.	br. v.
1196	15·0	15·5	26·0	23·4	6	8
1195	15·6	10·0	25·4	?20·2	8	8
1194	15·6	9·0	23·4	19·8	9	10
1197	15·8	20·6	26·2	23·5	8	8
1202	17·4	19·0	27·5	28·0	11	9
1201	18·0	15·0	28·8	24·4	12	12
1198	18·5	17·4	32·0	32·4	12	12
1203	18·8	19·4	29·2	?26·8	13	11
1199	19·2	17·6	30·4	29·0	10	9
1200 (holotype)	20·0	18·2	32·0	34·5	9	8

Description. — Medium sized shell of subquadrate outline, with hinge extremities auriculate, to varying degree geniculate; rugate disc as long as trail, sometimes shorter, trail of variable length, straight anteriorly or slightly undulated. Pedicle valve: pedicle foramen small, circular lying a short distance from apex.

Ornamentation. Radial costellae fine, regularly spaced, 3—5 per 1 mm.; concentric rugae thick, usually contiguous, sometimes a little wavy, 8—13 in number, in general reflected on the internal surface of younger individuals. Shell pseudopunctate.

Interior. Pedicle valve: teeth strong; muscle area rhomboidal in outline, bordered partly by strongly divergent dental plates and very high, sharp lateral ridges, converging anteriorly; adductors small, divided by a septal ridge of varying length; diductors larger, often flabellate, sometimes radially striated; two parallel, very delicated ridges, probably intervascular in front of the muscles (see Pl. III, fig. 11). Brachial valve: cardinal process stout with divergent lobes, of varying appearance, often asymmetrical (see Text-fig. 6); chilidium large, medially grooved;

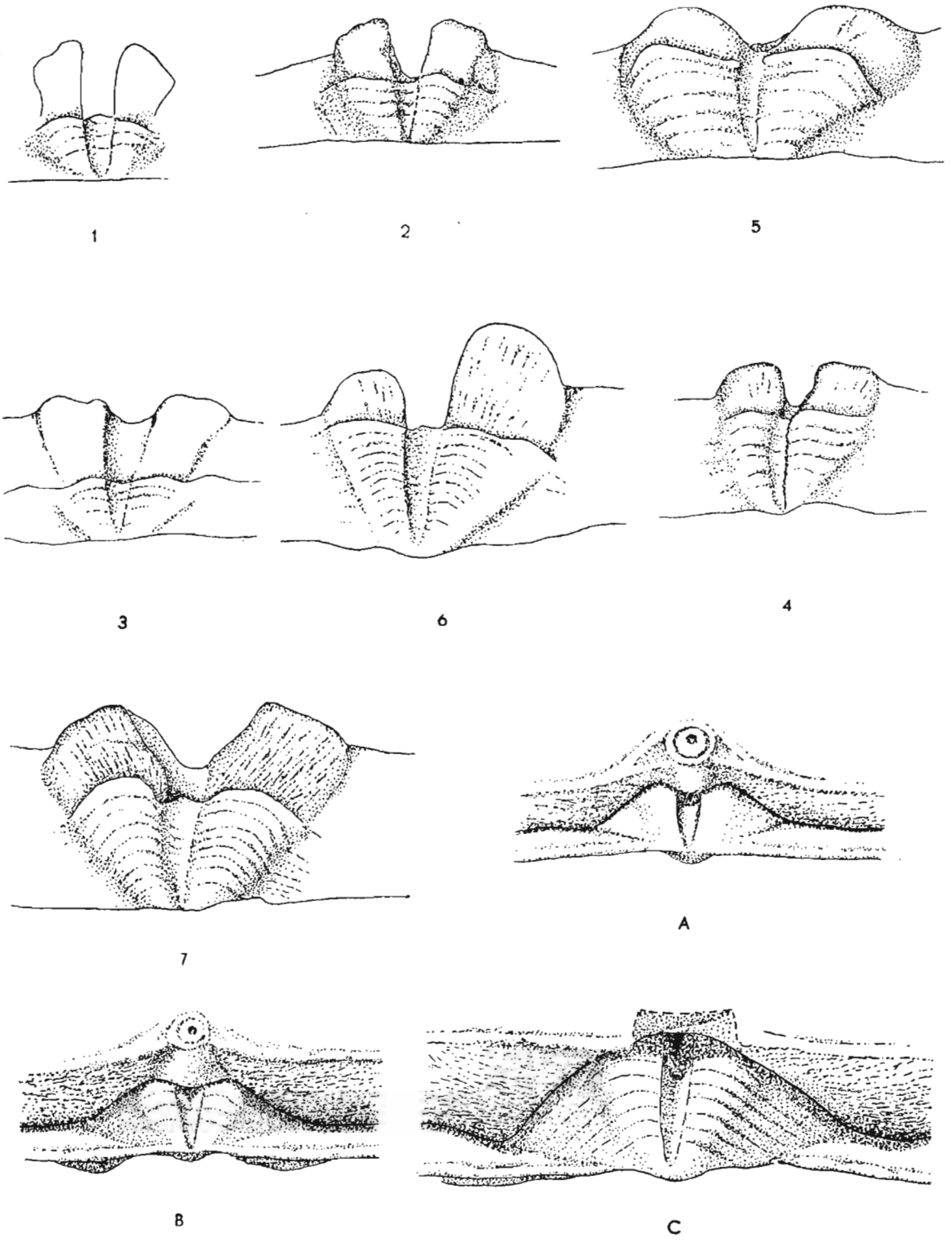


Fig. 6

Leptaena analogaeformis n. sp. Skały beds, exposure 73. *1-7* Different appearance of the cardinal process of adult specimens, *5-7* gerontic individuals (Bp. VII/1207, 1210, 1212, 1223, 1211, 1223*a*, 1211*a*). *A-C* Appearance of both areas of the shell, showing the differences in the size of chilidium; × 10·5

dental sockets deep, each bordered by two ridges, the internal could be interpreted as a weak brachiophore (according to HAVLIČEK, 1963, p. 223, one of the most diagnostic characters for *Leptaena*); median septal ridge of variable thickness, usually low, highest at the anterior end of the muscle area; muscles well impressed, but without distinct lateral ridges; on the trail pallial sinuses observed (Pl. III, fig. 14).

Growth changes. Not much can be said about growth changes in this species, as a range of specimens representing the full growth stages is lacking. The collection contains only a few immature separate pedicle and brachial valves about 3·5 mm. in length and completely adult specimens. Small shells of young individuals, found in two clusters in the shales of exposure 121, range from about 2 mm. to about 3·5 mm. in length. They are more wide than long, having a comparatively large, round pedicle foramen, hinge line smaller than the maximum shell width; concentric rugae occupy much more than half the whole valve length, all subcircularly outlined except the first, which is subquadrate and placed apically. The radial striae, 17 in number, start about 1·2 mm. from both apexes, hence, specimens slightly smaller than 1·2 mm. long are smooth, with only concentric rugae (Pl. IV, figs. 8, 9). With growth, the number of concentric rugae and radial striae progressively increases; specimens about 6·3 mm. long and 7·2 mm. wide possess about 5 concentric rugae and 40 radial striae, while those 7·2 mm. long and 8·8 mm. wide have 9—10 rugae and about 50 radial striae. The external sculpture is reflected in the interior. The trail (geniculation) is a feature of adult growth stage, lacking in young individuals.

In the brachial valve interior there is a median septal ridge, extending from the base of the cardinal process to the anterior margin of the valve. In some pedicle valves a corresponding median furrow is observed, projecting anteriorly from midlength of valve. Crural plates are slightly elevated; small but distinct dental sockets observed. In general, the studied growth stages of this species show a great regularity in the development of the internal structure and considerable stability in its appearance.

Variability within the species. The collection of Leptaenas, coming from a few exposures within the Skały beds, is mostly small, sometimes represented by single shells. They are in different state of preservation, some being very incomplete (e.g. shells from exposures 121, 125). This greatly limites the possibilities for detailed studies of growth changes and individual variability.

In the collection are: 1) usually complete thick-walled gerontic individuals and separate valves (exposures 72 and 73); 2) casts of separate valves of youthful individuals (exposure 121); 3) thin-walled and, as a rule, crushed and deformed shells of mature individuals from exposure 125; 4) thick-walled mature specimens embedded in the limestone coming from Miłoszów. All specimens are referred to one species — *Leptaena analogaeformis* n. sp. The small differences which occur do not merit diagnostic value, even of subspecific rank, being due to environment, as local conditions can slightly modify some features of external and internal morphology of the same species. Differences in our material are expressed in the shell size and outline and to some extent in the appearance and number of concentric rugae. The specimens from limestone, although adult, are the smallest in the collection, being nearly quadrate in outline with the greatest shell width at the hinge line, hinge extremities well auriculate (e.g. Pl. IV, figs. 1-4). Shells in argillaceous and marly shales are much larger and subquadrate in outline. The dimensions of visceral disc are nearly the same in all specimens, but its relation to the trail is different (see Text-fig. 7). Some variability may also be observed in the appearance of the chilidium (Text-fig. 6) and chilidial groove, and internally in the appearance of the cardinal process lobes with myophores, sometimes more marked, sometimes less (Text-fig. 6). The

ventral muscle area of different specimens is unstable especially in outline and slightly in dimensions (Text-fig. 7).

Remarks. — Our species is judged to be very close to *Leptagonia analoga* (PHILLIPS) figured by DAVIDSON (1857—1862, Pl. 28, especially figs. 3, 4, 9, 12). The ventral muscle platform, called «spondylium» by SOKOLSKAJA, considered by her as highly diagnostic for her new genus

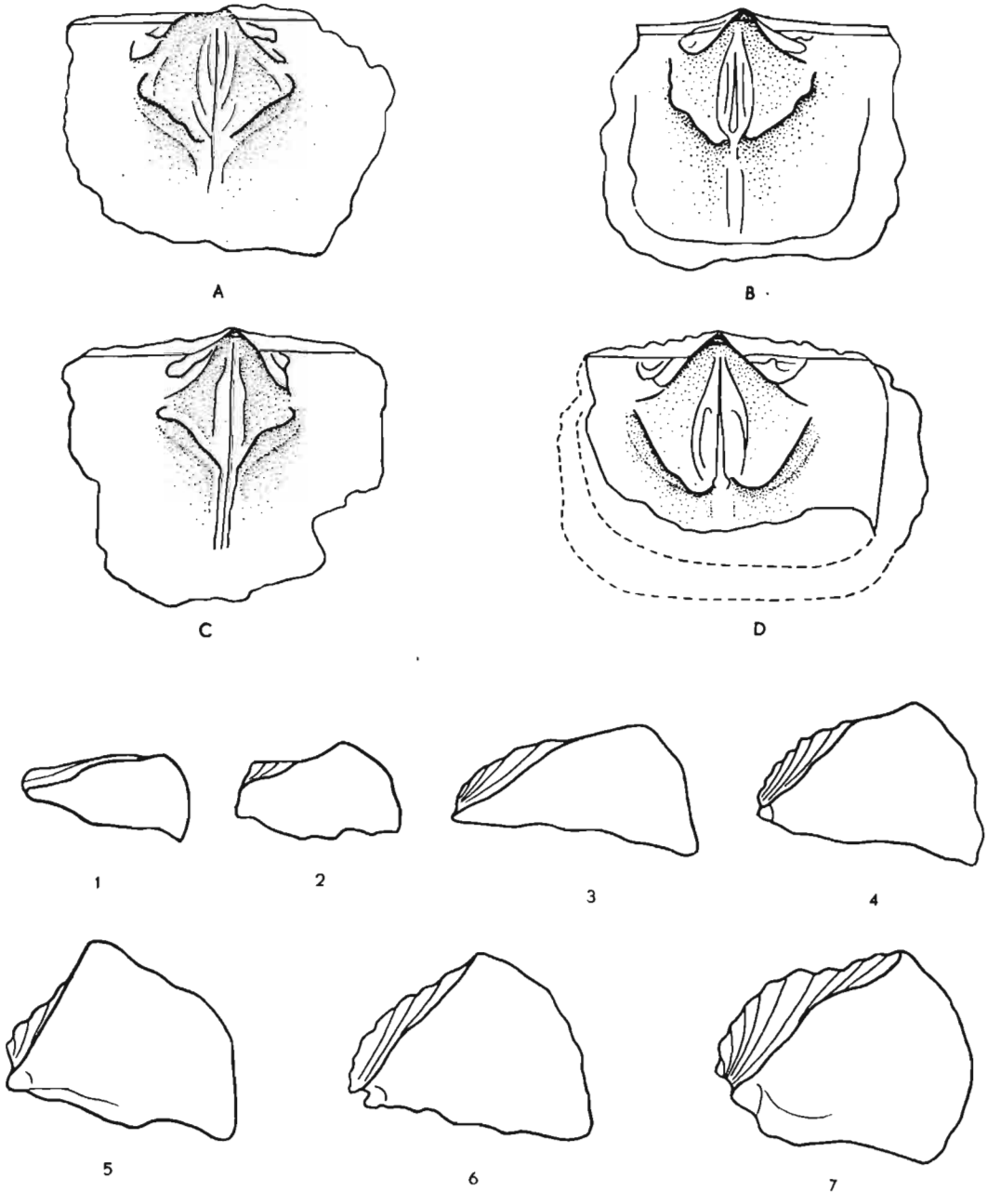


Fig. 7

Leptaena analogaeformis n. sp. Skały beds, exposure 73. *A-D* Ventral interior of 4 adult specimens (Bp. VII/3654, 3655, 3653, 3656). *1-7* Side view of adult specimens showing the relation of the visceral disc to the geniculated part of the shell; × 2·5

»*Leptaenella*« (1954, p. 65, Text-fig. 23), is almost the same as in PHILLIPS' species. Also, the diaphragmal ridge (the second important feature) seems to be very similar to that of *L. analoga* (PH.). Some differences can be observed in the dorsal interior (see SOKOLSKAJA, 1954, Text-fig. 22 and Pl. III, figs, 12, 13 in the present paper) and in the external morphology, the concentric rugae in our specimens being more distinct and thick, but slightly less in number. The dorsal interior of our species seems to resemble more that of *Leptaena depressa* DALMAN figured by HAVLIČEK (1963, Pl. 2, fig. 9) from Wenlock, England. In the shell outline and appearance of concentric rugae of *L. analogaeformis* n. sp. greatly resembles *L. rhomboidalis* (WILCKENS), figured by POULSEN from the Silurian of Gotland (1943, p. 20, Text-fig. 7), but our specimens are larger, muscle ridges bounding the ventral muscle area are much higher, united with a thick anteriorly raised medium ridge. *Leptaena rhomboidalis* (WILCKENS) from the Devonian of Czechoslovakia (HAVLIČEK, 1956, p. 23, Pl. 12, figs. 2, 3), vicinity of Prague, Hlubočepy, limestone of Zlichov, differs slightly externally, having less and thicker concentric rugae. The interior of the Czechoslovakian specimens is not described. *Leptagonia? rhomboidalis* (WILCKENS), recently figured by MCLAREN and NORRIS (1964, Pl. 14, figs. 1*a*-4*b*) from the Devonian (Horn Plateau Fm), District of Mackenzie, is very close in the shell size and outline to *Leptaena analogaeformis* n. sp. from the limestone of Miłoszów (see Pl. IV, figs. 1-4).

Comparing our species with available illustrations of e.g. *Leptaena rhomboidalis* (WILCKENS), *L. depressa* (SOW.), *L. rugosa* (DALMAN), *L. analoga* (PHILLIPS), our *L. analogaeformis* shows a great similarity to each of the mentioned species and to others of the «*Leptaena* group», but appears to be closest to *L. analoga* (PHILLIPS). This was also probably observed by ZEUSCHNER, who referred specimens from Śniadka and Skały to «*Strophomena*» *rhomboidalis* var. *analoga*. GÜRICH (1896) and SOBOLEV (1904) observed some differences in the dorsal interior of specimens from Skały beds referred to *L. depressa*, when compared with the specimens of this species from Dudley (GÜRICH, 1896, p. 226). Our species showing caracteristics of *Leptaena rhomboidalis* (WILCKENS) and *Leptagonia analoga* (PHILLIPS), being to some extent intermediate between them, is judged to be a distinct species.

?**Leptaena** sp.

(Pl. IV, figs. 14-16*a*; Pl. VI, figs. 8-10)

Horizon: Marly shales, exposure 73, Skały beds, Middle Devonian.
Locality: Skały.

Material. — Two pedicle valves with well preserved muscle platform. Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Visc. disc length	Ventral m. platform length	Ventral m. platform width
3683	16·6	24·4	14·3	7·8	11·7
3682	16·6	23·0	13·8	6·9	13·2

Remarks. — There are only 2 pedicle valves, representing extremely gerontic individuals with a well preserved interior. The latter resembles very closely the interior of *Leptaena analogaeformis* n. sp., that means the ventral muscle platform is very similar. Some differences are that in ?*Leptaena* sp. the geniculation of the pedicle valve begins just beneath the anterior end of muscles (Pl. IV, fig. 16*a*; Pl. VI, fig. 10), the medium ridge is shorter and the concentric rugae and radial striae are lacking. Although the above two valves show very advanced gerontic

individual age, no trace of any radial or concentric ornamentation was preserved, which seems improbable if it really was present. It is very suggestive that their shell was smooth. The described specimens are conditionally included to the genus *Leptaena*, because of some just mentioned similarity.

Family **STROPHEODONTIDAE** CASTER, 1939

Subfamily DOUVILLININAE CASTER, 1939

Genus **DOUVILLINA** OEHLERT, 1887

Type species: *Leptaena dutertrei* MURCHISON, 1839; Upper Devonian, France.

Subgenus DOUVILLINA (DOUVILLINA) OEHLERT, 1887

Douvillina (Douvillina) interstrialis (PHILLIPS, 1841)

(Pl. IV, figs. 17-20; Pl. V; Text-figs. 8, 9)

1841. *Orthis interstrialis*; J. PHILLIPS, Figures..., pp. 61-62, Pl. 25, figs. 103*a-d*.
1896. *Stropheodonta interstrialis* PHILL.; G. GÜRICH, Das Palaeozoicum..., S. 228.
1909. *Stropheodonta interstrialis* PHILL.; D. SOBOLEV, Srednij devon..., s. 451.

Horizon: Exposures 72,73 (marly shales); exposures 82, 93 (marly siltstones underlying the limestones); exposure 125 (argillaceous shales). Skały beds, Middle Devonian-Givetian.
Locality: Skały.

Material. — Over 25 specimens, majority gerontic; 2 incomplete brachial valves. Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Length of hinge line
1067	2·7	3·2	0·5	2·3
1068	6·6	7·8	0·8	6·0?
1076	20·8	23·5	5·5	19·4
1077	20·8	24·2	5·8	21·0
1078	21·0	24·5	5·8	21·2
1080	24·8	27·2	7·0	21·8
1071	24·8	26·5	4·2	24·8
1072	24·2	28·2	4·4	24·4
1073	25·0	27·2	3·8	20·0
1081	26·8	27·4	8·2	23·0
1083	27·2	29·0?	9·0	24·2?

Description. — Shell nearly subcircular in outline, of medium size; somewhat variable in concavo-convexity, wider than long, sometimes slightly mucronate. Pedicle valve deepest at midpoint (Text-fig. 9); beak small, slightly incurved, with some traces of pedicle foramen; interarea apsacline to orthocline; pseudodeltidium narrow, convex in younger growth stage, vestigial in maturity. Brachial valve with almost hypercline interarea, chilidium narrow, often vestigial (Text-fig. 8).

Ornamentation (Pl. V, figs. 9, 10) is slightly variable in different specimens, but still preserving the same characteristic pattern. It consists of: a) comparatively strong costellae, to about 50 in number, three or four generations, 6—7 being primaries, originating at the beak; b) 3—8 fine striae between each costellae, two or three generations. In general, the ornamentation of the brachial valve is much more regular than that of the pedicle valve. In many old

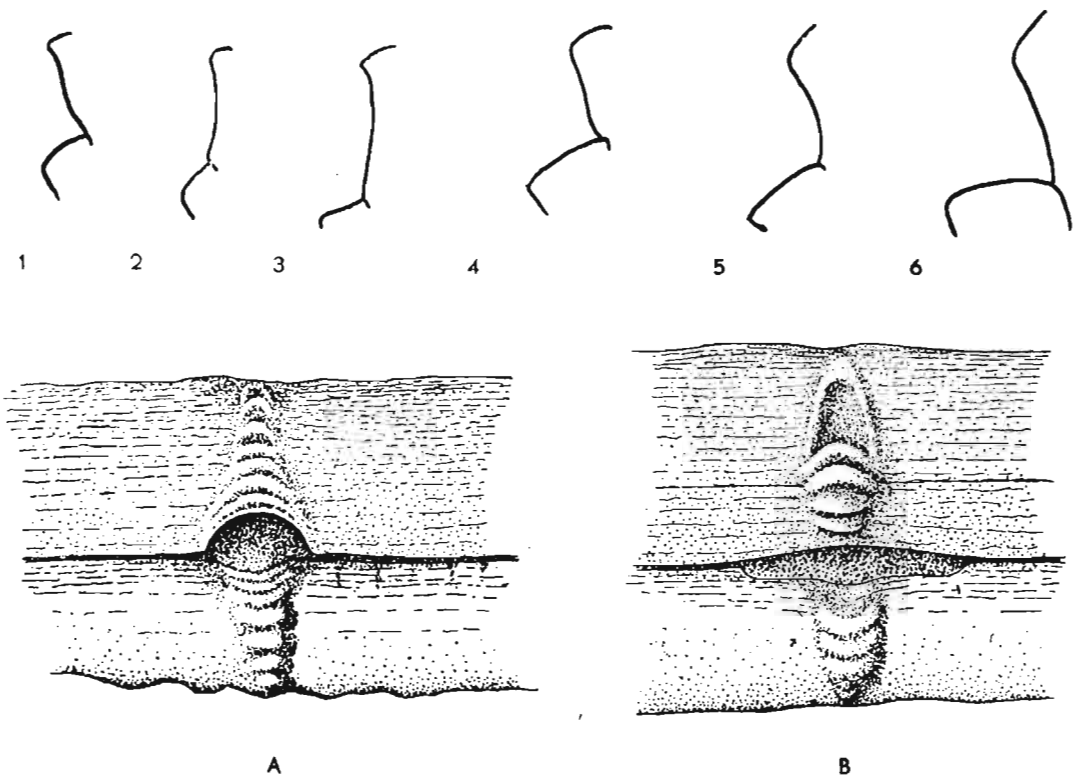


Fig. 8

Douvillina (*Douvillina*) *interstrialis* (PHILLIPS). Skały beds, exposure 73. *1-6* Relation of both areas of different adult shells; approx. × 10. *A-B* Deltidium and chilidium of two adult specimens; approx. × 12·5

specimens, the striae on both slopes of the pedile valve are absent or reduced in number to 1 or 2, the coarsity of costulae is variable, sometimes the ornamentation is partly or completely effaced. It is probably related to environment and to individual growth stage.

Interior. Pedicle valve: hinge line denticulate to about 3/4 of its width; ventral process distinct, occupying posterior part of the delthyrial cavity (Text-fig. 9 *D*, *E*); median septal ridge thick but low, extending to the anterior end of the muscle area; muscles limited to about one-third of valve length, suboval in outline (Pl. IV, fig. 20), bounded by strong lateral ridges which are in contact with the corresponding lateral ridges of the opposite valve (Text-fig. 9 *E*). Brachial valve (Pl. V, figs. 11, 12; Text-fig. 9 *A-G*) with cardinal process possessing two widely separated stout lobes, sometimes more divergent, sometimes less posteriorly;s socket plates divergent; muscle area deep, roundly outlined; median septum not very marked.

Remarks. — The species is widely known and shows some interpopulation variation. Variability is mostly expressed in the shell size and radial ornamentation, i.e. number of both costulae and striae. This is in agreement with some observations of REED (1908, p. 66). The

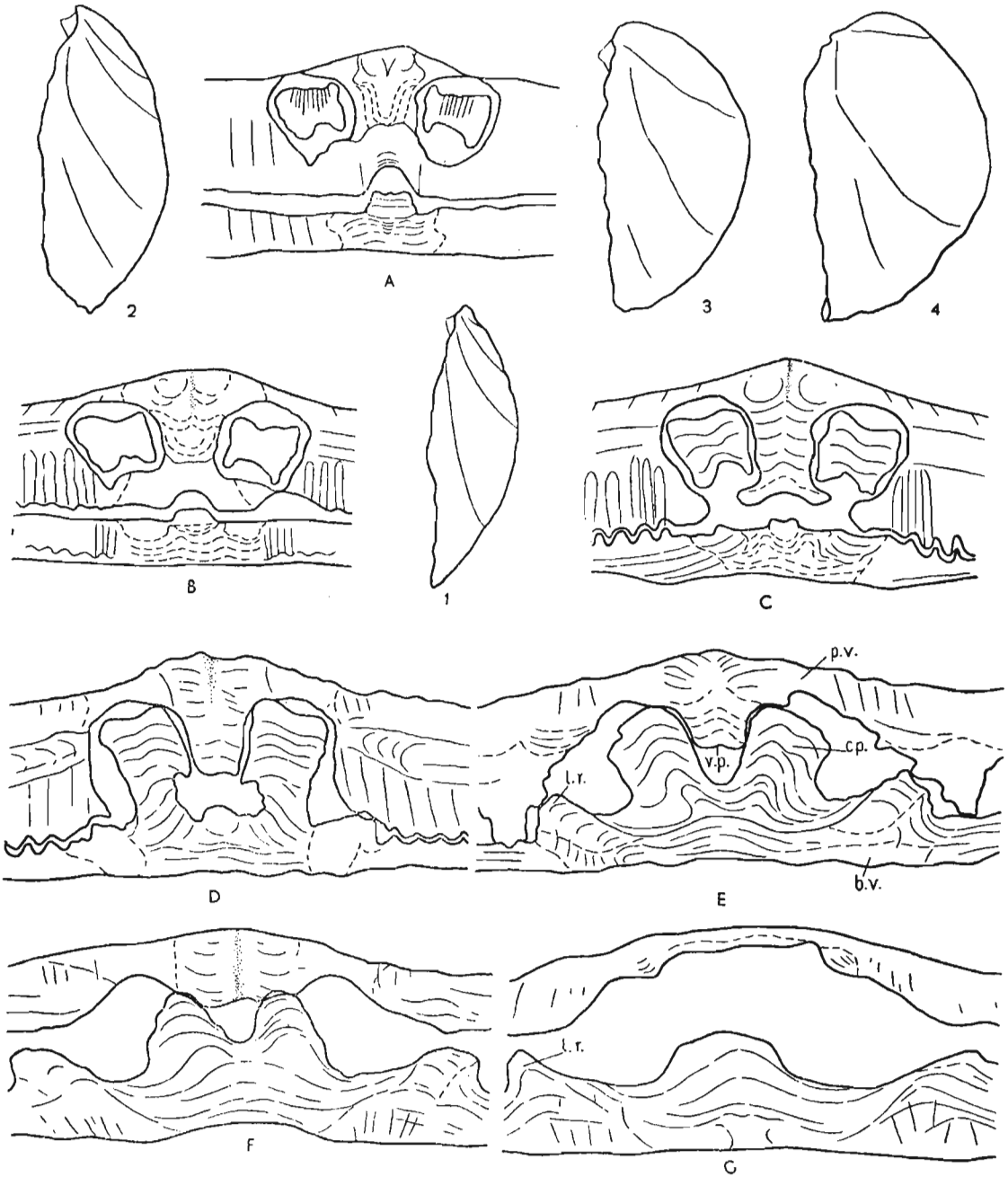


Fig. 9

Douvillina (*Douvillina*) *interstrialis* (PHILLIPS). Skały beds, marly shales, exposure 73. *1-4* Side view of adult and gerontic specimens; × 1·6. *A-G* Serial cross section of adult specimen: *v. p.* ventral process, *c. p.* cardinal process, *l. r.* lateral ridge, *b. v.* brachial valve, *p. v.* pedicle valve; × 10

degree of convexity of the pedicle valve and to some extent of concavity of the brachial valve are rather connected with the individual age of specimens.

Our specimens are of the type «*Orthis*» *interstrialis* PHILLIPS from the Devonian of Barton (PHILLIPS, 1841, p. 61, Pl. 25, fig. 103). Differences lie in the slightly larger size and probably more numerous radial costulae of our shells. This last feature is observed also in the German specimens (SMF collection from Prüm; TORLEY's coll. XVII 369 b), as well as in *Stropheodonta interstrialis* var. *birmanica* from the Middle Devonian of Padaukpin (REED, 1908, Pl. 11, figs. 1-3).

Occurrence. — Middle Devonian; Europe.

Douvillina (Douvillina) subcorrugata n. sp.

(Pl. VI, figs. 1-7; Text-figs 10, 11)

?1896. *Stropheodonta* sp. cf. *subtransversum* SCHNUR; G. GÜRICH, Das Palaeozoicum..., S. 228.

Holotype: Z. Pal. Cat. No. Bp. VII/1106, figured on Pl. VI, fig. 2.
Type horizon: Marly shales, exposure 73 (brachiopod shales), Skały beds, Middle Devonian.
Type locality: Skały, Łysogóry region, Holy Cross Mountains.
Derivation of the name: subcorrugata — external shell surface with discontinuous corrugations.

Diagnosis. — Medium sized mucronate douvillinids with slightly corrugate posterior half of the shell, shell surface costellate and striate, internally without diaphragmal ridge, but with elevated two lateral brachial ridges.

Material. — Six complete specimens in gerontic stage, 1 separate brachial valve. Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of hinge line
1101	9·4	13·2	—	12·5 (brachial valve)
1102	?11·0	14·2	4·0	13·2
1103	?12·0	15·5	3·5	14·2
1104	13·5	15·6	5·0	16·2
1105	12·8	17·0	2·8	17·4
1106 (holotype)	13·0	17·5	4·2	15·5
1107	12·8	17·0	3·0	18·0

Description. — Medium sized shell, subquadrate in outline, slightly mucronate, moderately concavo-convex, antero-lateral margins broadly rounded. Pedicle valve beak slightly marked, with a trace of apical pedicle foramen; interarea apsacline, pseudodeltidium narrow, convex, vestigial in old individuals. Brachial valve slightly concave with interarea hypercline, chilidium narrow to vestigial.

Ornamentation is characteristic for the species. In addition to radial costellae and striae (see Pl. VI, figs. 1-4), like *Douvillina interstrialis* (PHILLIPS) there are moderate undulations present, especially marked on the brachial valve, resembling to some extent those of e.g. *Nervostrophia rockfordensis* (FENTON & FENTON), figured by WILLIAMS (1953, Pl. 10, fig. 12), and also fine, discontinuous concentric corrugations, e.g. like *Cymostrophia* CASTER or *Herco-strophia* WILLIAMS. On gerontic shells they are limited to the postero-lateral parts of the shell,

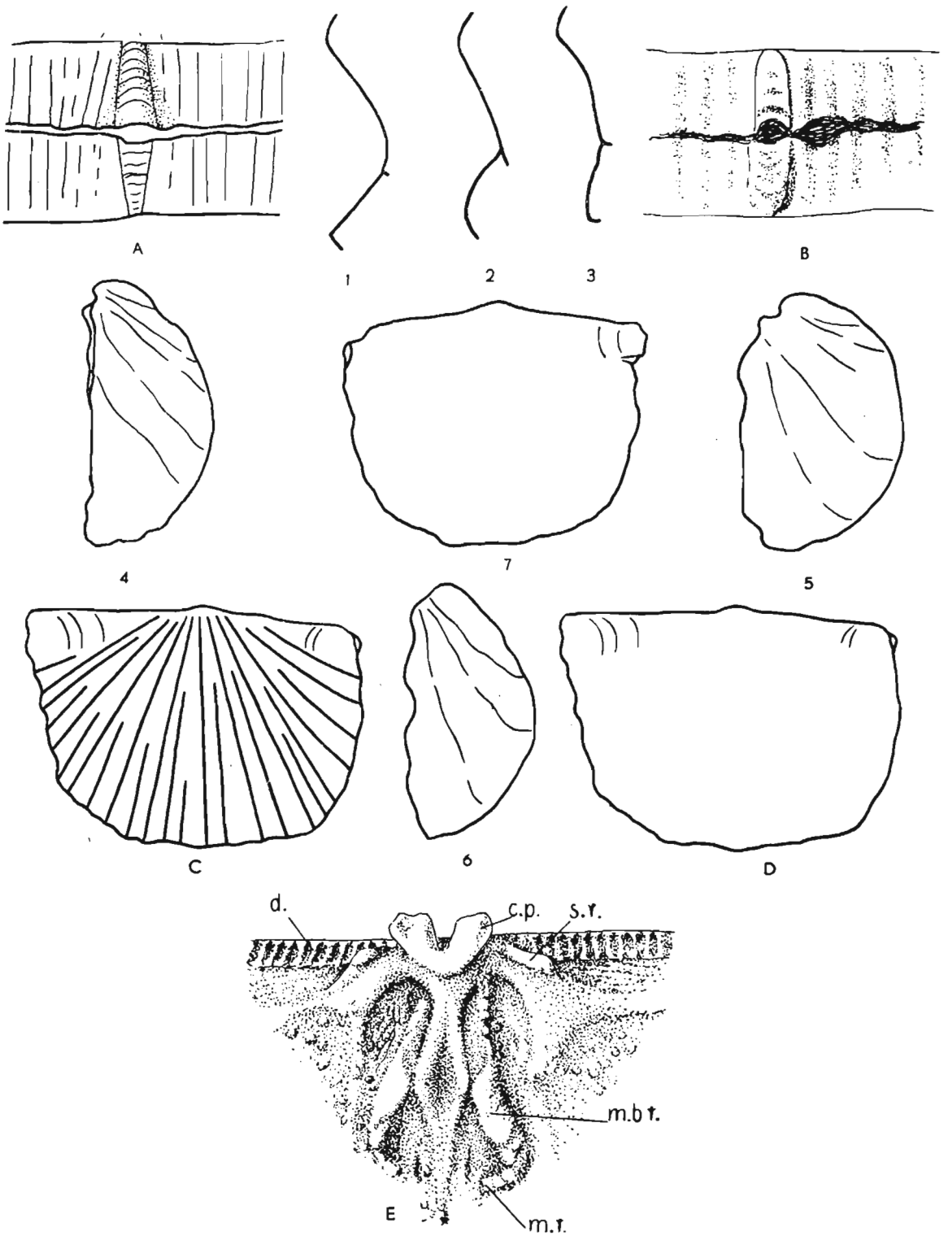


Fig. 10.— *Douvillina* (*Douv.*) *subcorrugata* n. sp. Skały beds, marly shales, exposure 73. *1-3* Relation of both areas of old shells. *A-B* Pseudodeltidium and chilidium of two different old specimens; approx. × 10. *4-6* Side view of 3 different specimens. *7* Ventral view of adult shell. *C-D* Pedicle valve exterior; × 3. *E* Dorsal interior of adult specimen (Bp. VII/1101): *c. p.* cardinal process, *d* denticulation, *b. r.* brachial ridge, *m. r.* median ridge, *s. r.* socket ridge; × 10

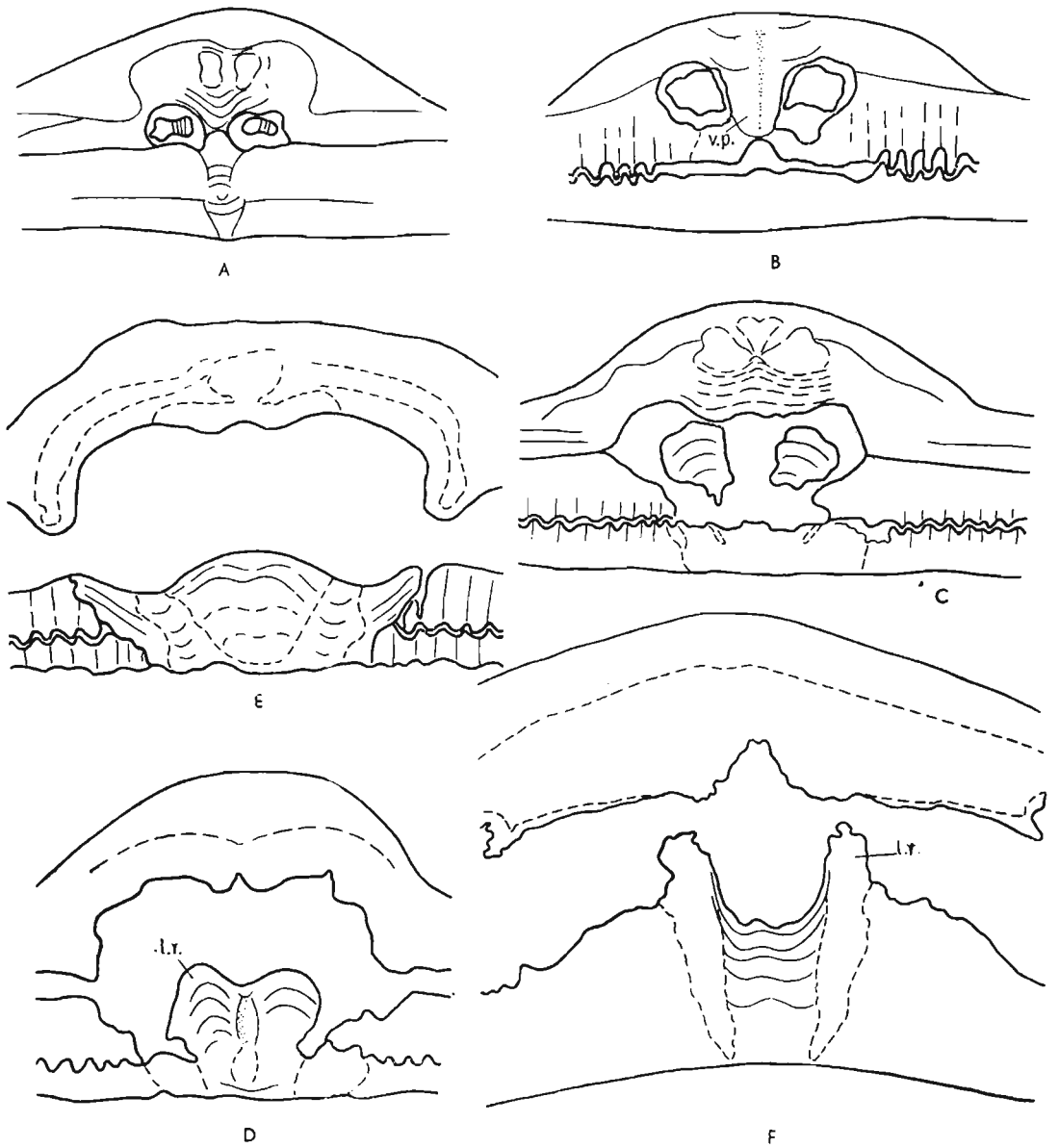


Fig. 11

Douvillina (*Douvillina*) *subcorrugata* n. sp. Skały beds, exposure 73. *A-F* Serial cross sections of adult specimen: *l. r.* lateral ridge, *v. p.* ventral process; × 10

covering almost the whole shell exterior in younger growth stage. These corrugations are quite common within stropheodontids, observed in many genera (WILLIAMS, 1953). Concentric lines present, but not always distinct. Pseudopunctae spaced in a moderately close radial pattern.

Interior. Pedicle valve (Text-fig. 11): hinge line denticulate for half to two-thirds distance between pseudodeltidium and hinge extremities; denticles small, separating grooves narrower, ventral process fits into two lobes of the cardinal process; adductors small, subcircular, diductor; larger and more longitudinal in outline. The rest of the interior unknown. Brachial valves cardinal process bilobed, lobes widely separated with distinct attachment faces for muscle:

directed posteriorly; shallow socket pits placed laterally to the process; short socket plates nearly parallel with the hinge line; median septum low but wide, bifurcating a short distance from the small posterior platform, joining again to form a low, single ridge anteriorly like *Leptodontella caudata* (see Pl. VII, fig. 7, Text-fig. 10*E*); muscle area with bordering ridges which are high and tuberculate; pallial sinuses comparatively well marked (vascula media, myaria and ?dentalia); distinct grooves for the mantle setae along the antero-lateral margins (see Pl. VI, fig. 7); rest of interior densely and distinctly papillate.

Remarks. — It is a rare species, found only in a few exemplars in the Skały beds. It shows the following distinct external and internal features: 1) thick-walled and moderately concavo-convex shell, 2) dorsal external surface slightly folded, 3) shell surface corrugated, in old individuals corrugations usually limited to the posterior half of the shell or to the cardinal slopes, in younger ones probably covering the whole shell surface, 4) comparatively high tuberculate ridges.

Externally, the species is very similar to *Douvillina? subtransversa* (SCHNUR) from Junkenberg layers (*subtransversa* — Mergel, at Gerolstein, Eifel, SMF coll. and a few specimens kindly obtained from Dr. W. STRUVE), but our specimens are about 3 times larger. Our species seems to be very close to *Moravostrophia moravica* (SMYČKA) from the Devonian of Moravia, Czechoslovakia (SMYČKA, 1897, Pl. 2, fig. 20; HAVLIČEK, 1962, p. 471, Text-fig. on p. 472, and photographs kindly sended by Dr. HAVLIČEK). External resemblance is very great. Internally there are some differences as can be judged from the schematic figure of the dorsal interior of *Moravostrophia moravica* (HAVLIČEK, 1962, p. 472) — the septal ridge in our species is slightly like that of *Leptodontella caudata*, being distinctly divided in its middle length (see Pl. VI, fig. 7; Text-fig. 10*E*) and there is no subperipheral rim, characteristic of the Moravian species. *Stropheodonta subtetragona* (ROEMER) var. *padaukpensis* described by REED (1908, Pl. 11, fig. 7) seems to belong to HAVLIČEK's genus *Moravostrophia*. The exterior is very similar (together with corrugations), the dorsal interior also shows the subperipheral rim, (mentioned by HAVLIČEK as a distinct feature of his genus *Moravostrophia*) and a septum, anterior to the muscle area.

Subfamiy LEPTODONTELLINAE WILLIAMS 1965,

Genus **LEPTODONTELLA** KHALFIN, 1948

1950. *Glossostrophia* WILLIAMS; A. WILLIAMS, 1954, North American..., p. 43, Pl. 11, figs 1-4.

Type species: Leptaena caudata SCHNUR, 1854, p. 224, Pl. 42, figs 3, 4; Middle Devonian, Gerolstein, Rhine region, Germany.

Remarks. — KHALFIN (1948, p. 253) has assigned to his genus a few species from the Devonian of Altai, USSR, as being closely related morphologically to the type species *Leptodontella caudata* (SCHNUR). They are: *Leptodontella acuta* KHALFIN, *L. rotundata* KHALFIN, *L. planuscula* KHALFIN. BUBLITCHENKO, however (1956, p. 95), on the base of a comparison between the inadequate illustrations of the brachial interior of the above species presented by KHALFIN (1948, Text-figs. 33, 34, 34*v*, 44) and *Leptodontella caudata* figured by SCHNUR (1853, Pl. 42, fig. 2) and REED (1908, Pl. 12, figs. 5, 6, 6*a*), noted some differences in the appearance of the cardinal process, length of the dorsal median septum and outline of dorsal muscle area. BUBLITCHENKO, in his short discussion of *Leptodontella*, considers these differences to be relevant for generic segregation and suggests another genus *Altaestrophia* for the Altai species, with *Leptodontella acuta* KHALFIN as a type species.

The present author provisionally includes the Altai species within the genus *Leptodontella*, at least until detailed revision ascertains the significance of the differences observed by BUBLITCHENKO, who unfortunately made no direct comparison with type species — *L. caudata*. The illustration given by KHALFIN are inadequate for detailed comparison and samples are not available for study.

Occurrence. — Middle Devonian; Germany, Poland, ?USSR.

Leptodontella caudata (SCHNUR, 1854)

(Pl. VII; Pl. VIII, fig. 17; Text-figs. 12, 13)

1854. *Leptaena caudata* SCHNUR; J. SCHNUR, Zusammenstellung..., S. 224-225; Tab. 42, Figs. 3*c*, 4*a-c*.
1908. *Strophonella caudata* (SCHNUR); R. F. C. REED, Devonian..., p. 71 Pl. 12, figs. 7-12*a*.
1948. *Leptodontella caudata* (SCHNUR); L. L. KHALFIN, Fauna i stratigrafija..., S. 253.
1953. *Glossostrophia caudata* (SCHNUR); A. WILLIAMS, North American..., p. 43, Pl. 11, figs. 1-4.
1956. *Leptodontella caudata* (SCHNUR); N. L. BUBLITCHENKO, Nekotorye novye..., s. 95-97, ris. 2.

Horizon: Marly, argillaceous shales of the Skały beds, exposure 73 (brachiopod shales).
Locality: Skały.

Material. — Five complete specimens, 1 pedicle and 5 separate brachial valves. All specimens represent gerontic individuals.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thick. poster.	Thick. anter.	Height of area	Length of hinge line	Tongue width
1055	23·7	35·2	6·2	5·0	2·4	?	12·0
1056	23·4	38·7	5·4	4·1	2·2	36·5	17·9
1057	21·7	?	4·5	4·4	2·0	?	14·1
1058	20·6	?27·7	4·5	3·6	2·7	?	14·8

Description (Pl. VII; Text-figs. 12, 13). — Large, geniculate, subquadrate in outline, hinge extremities slightly extended, sometimes auriculate; lateral margins weakly rounded and usually converging anteriorly; anterior margin with a tongue varying in dimensions (Text-fig. 13, draw. 1-4). Pedicle valve: area straight with horizontal and vertical striations, vertical striae being prolongations of numerous denticles; deltidium narrow. Brachial valve with area two or three times narrower than the ventral one, anacline; chilidium large.

Ornamentation (Pl. VII). All specimens are extremely old and the surface ornamentation is badly preserved. Some weak traces of radial striae and concentric lines are observed on the geniculated part of the shell, having a net-like appearance, which is also seen in specimens from the Devonian of Padaukpin (REED, 1908, Pl. 12, fig. 11*a*) and of Rhine region in Germany (SMF coll. RICHTER, Lower *Stringocephalus* limestone of Schönecken). The radial ornamentation is finely parvicostellate like that of *Leptodontella caudata* (= *Glossostrophia caudata* WILLIAMS, 1953, p. 43) from Gerolstein.

Interior. Pedicle valve (Pl. VII, figs. 9-10; Text-fig. 12*C*): hinge line almost entirely denticulate (Pl. VII, fig. 10); delthyrial cavity with callus (Text-fig. 12*C*; Pl. VII, fig. 10), followed anteriorly by a short grooved ridge; cardinal pits deep; median septal ridge fine, the highest at about midlength of valve merging posteriorly with a grooved ridge, continuing anteriorly

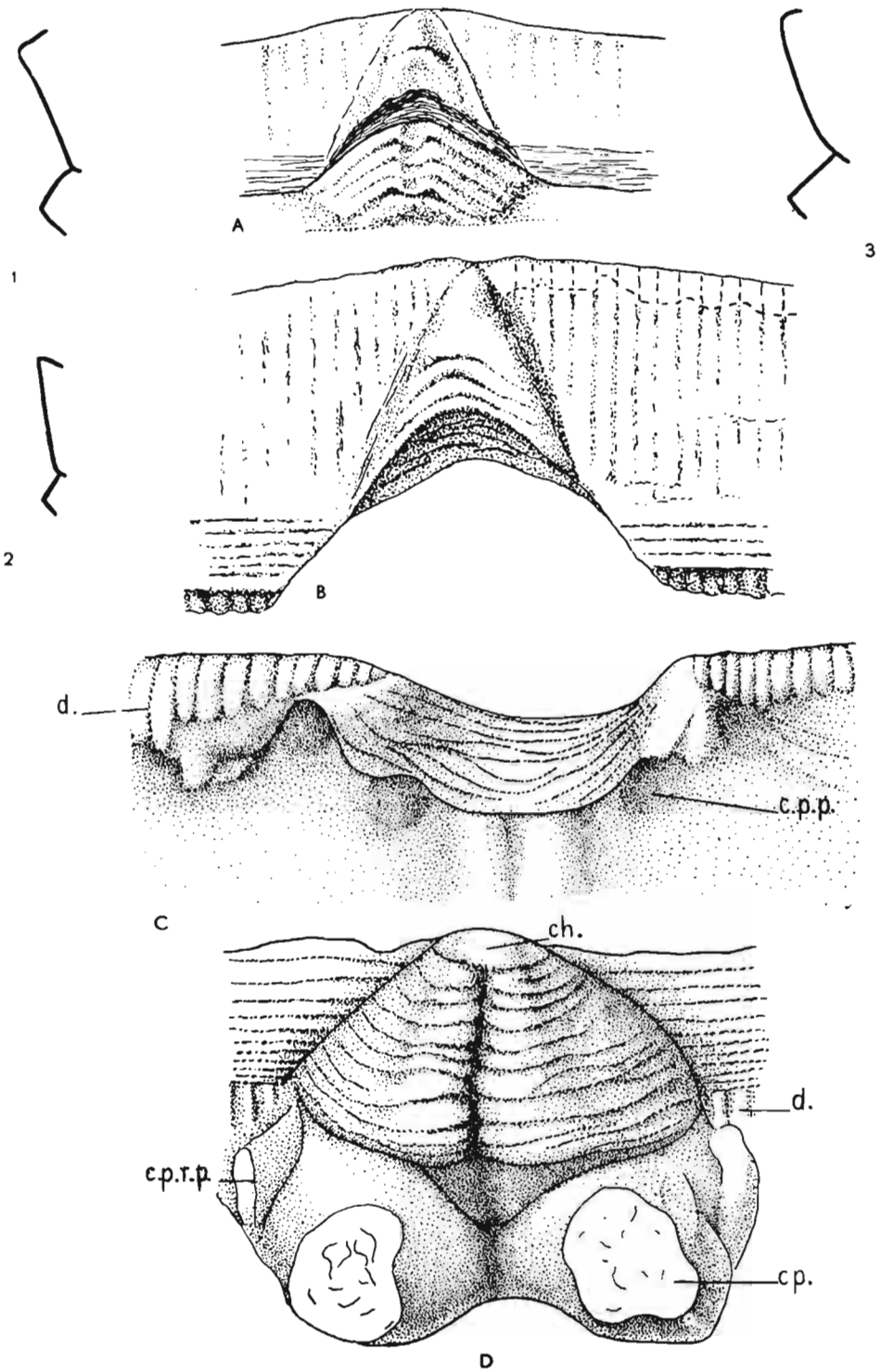


Fig. 12. —*Leptodontella caudata* (SCHNUR). Skały beds, marly shales, exposure 73. *1-3* Relation of both areas (side view) of old specimens. *A* Appearance of chilidium and pseudodeltidium of old specimen (Bp. VII/1055); approx. × 10. *B* Pseudodeltidium of old specimen (Bp. VII/1059); × 15. *C* Posterior part of the ventral interior (Bp. VII/1059). *D* External appearance of chilidium and cardinal process (Bp. VII/1063): *ch.* chilidium, *c. p.* cardinal process, *c. p. p.* cardinal process pit, *c. p. r. p.* cardinal process ridge pit, *d.* denticulation; × 21

as a thread; muscle area distinct, oval in outline, about three-fourths of valve length with lateral bordering ridges, anterior diductors oblong, lying externally to posterior adductors, the latter lying on both sides of the septal ridge, anterior diductors large, lanceolate; vascular sinuses well preserved (Pl. VII, fig. 9). Brachial valve: cardinal process strong, disjunct (Text-fig. 12*D*) two socket ridges lying laterally to both lobes of the cardinal process; median septum short but wide, with median bifurcation (see Pl. VII, figs. 5-7), continuing anteriorly

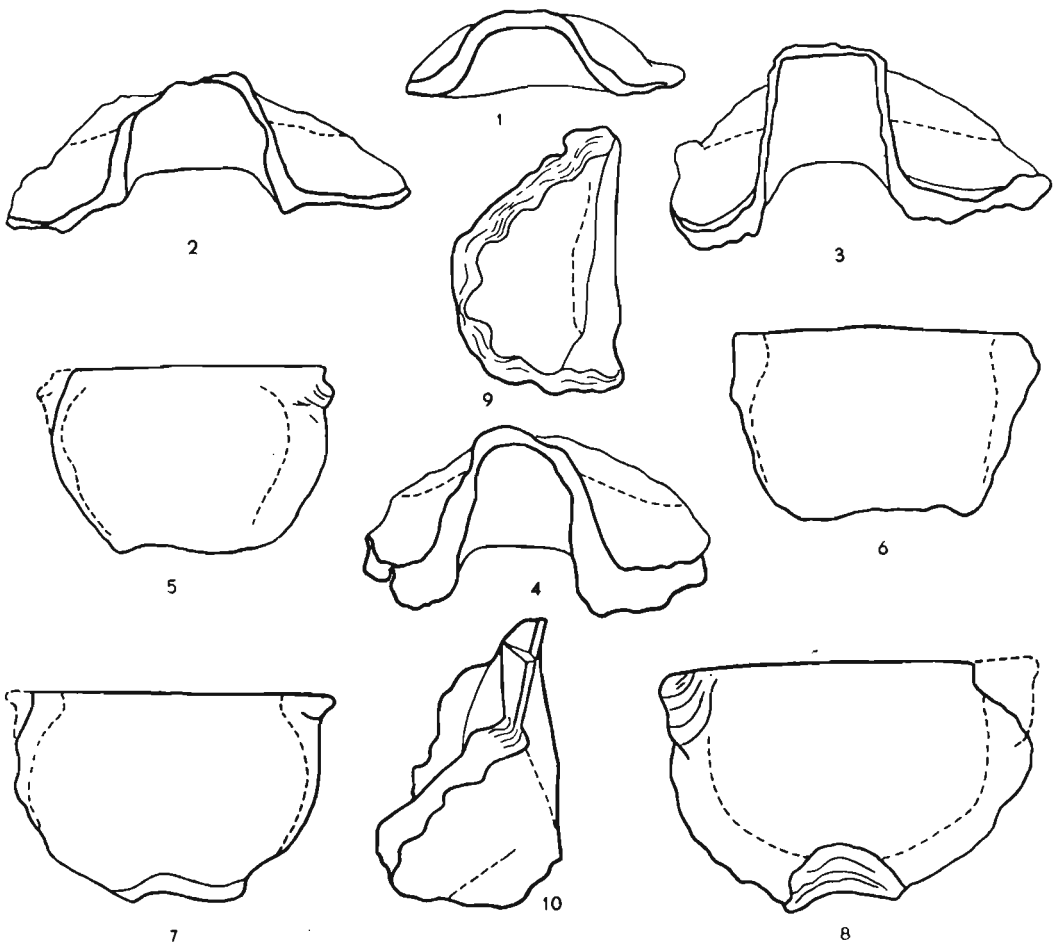


Fig. 13
Leptodontella caudata (SCHNUR). Skały beds, marly shales, exposure 73. *1-4* Anterior commissure view of 4 specimens (Bp. VII/1060, 1056, 1055, 1055*a*). *5-8* Pedicle valve view of 4 specimens (Bp. VII/1058, 1059, 1057, 1055). *9-10* Side view of 2 specimens (Bp. VII/1055, 1056*a*); approx. × 2

as a thin ridge often with highly elevated or very thickened end (Pl. VII, figs. 6, 8), muscle area deep, rounded in outline, bordered by ridges.

Remarks. — The species occurs sporadically in the Middle Devonian layers, being recorded, up to now, in Germany, Poland and in India — Padaukpin (REED, 1908, p. 71). It is a distinctive species, well distinguishable by its transverse outline, strong geniculation, comparatively large shell dimensions and transverse outline. Our specimens are considered to be conspecific with *Leptodontella caudata* (SCHNUR, 1854, Pl. 42). They are very closely comparable

to the German specimens (SMF collection 13430). Small differences are that the shells of our specimens are slightly larger, the tongue is more developed and the valves are much more thickened, probably due to the gerontic individual age. Also, there is some difference in the ventral interior of the Indian specimens figured by REED (1908, Pl. 12, figs. 7, 8). The muscle area is not so lanceolate as in specimens from the Skały beds (Pl. VII, fig. 9).

No information concerning the morphological variability of the species can be given because of the scarcity of material. Probably, it is a rather stable species, judging from the available illustrations (SCHNUR, 1854, Pl. 42, fig. 4; REED, 1908, Pl. 12, figs. 2—12*a*; WILLIAMS, 1953, Pl. 11, figs 3, 4) and small available samples.

Occurrence. — Middle Devonian-Eifelian-Givetian; Germany (Rhine region); Poland (Łysogóry region); India (Padaukpin).

Genus **PARASTROPHONELLA** part. sensu BUBLITCHENKO, 1956

Type species: *Strophomena anaglypha* KAYSER, 1871, p. 629, Pl. 14, fig. 3; Middle Devonian, crinoid layers of Prüm, Germany.

Diagnosis (emend.). — Tiny and geniculated stropheodontids with denticulated hinge, well developed ventral process, flabellate ventral muscles, cardinal process not extending above the hinge, bilobed, each lobe incised posteriorly; median ridge — a prolongation of the posterior platform, very flat and short, dividing only the posterior third of the muscle area, followed by a deep groove with broadly rounded bottom.

Remarks. — *Parastrophonella* comprises small to medium sized Devonian stropheodontids and is up to now known only by the type species — *Parastrophonella anaglypha* (KAYSER). The validity of this genus is, however, questionable (e.g. DROT, 1961; HERTA SCHMIDT, personal communication; the present author), the reason being that the diagnosis of *Parastrophonella* is only partly based on KAYSER'S *Strophomena anaglypha*. The original descriptions and illustrations given by KAYSER (1871, p. 629, Pl. 14, fig. 3) are quite insufficient and recently nobody has restudied it. BUBLITCHENKO, who discussed KAYSER'S species, considered it quite distinct externally and suggested that it could be accepted as a type species of a separate genus *Parastrophonella*. As knowledge concerning the internal structure of *Strophomena anaglypha* KAYSER was very limited, BUBLITCHENKO completed it tentatively on the basis of Russian specimens from Rudnyi Altai, earlier determined by him as *Strophonella anaglypha* KAYSER (BUBLITCHENKO, 1927, p. 1208).

The present author, on the basis of specimens from the Skały beds (carefully compared with the German SMF coll., unfortunately only a few specimens), considered as conspecific with KAYSER'S *Strophomena anaglypha*, suggests that this species sensu KAYSER differs considerably from *Parastrophonella anaglypha* sensu BUBLITCHENKO in important characters of the dorsal interior. The most notable differences concern: 1) cardinal process which is bilobed, but not extending above the hinge line, as is suggested by BUBLITCHENKO (1956, p. 96, Text-fig. 3); 2) lack of the septal ridge which is strong although short in Altai specimens; 3) short median ridge, a prolongation of the posterior platform, not bifurcating, as shown on Text-fig. 3 by BUBLITCHENKO (comp. Text-figs. 14 *D*, *E* in this paper). The Altai specimens appear to be different and represent another species, probably *Stropheodonta zmeinogorskiana* ?PETZ, as BUBLITCHENKO mentions (1956, p. 95), and also a different genus. The brachial valve interior of the Altai species suggests its close relation to *Leptodontella caudata* (SCHNUR) redescribed and figured in the present paper (see p. 50, Pl. VII, Text-figs. 12, 13). In consequence, the generic name *Para-*

strophonella, as is considered, is limited to *Strophomena anaglypha* sensu KAYSER. *Parastrophonella* shows some external and internal features characteristic of *Zophostrophia* VEEVERS (1959), the Devonian genus of Fitzroy Basin. They are both geniculated, biplanate, have a similarly outlined ventral muscle area (the latter can vary markedly, as is shown by our material), similar appearance of pallial sinuses, much the same cardinal process. The differences are small: the posterior of the ventral interior is somewhat different, medium dorsal septum is in *P. anaglypha* lacking, externally the differences are marked in the radial ornamentation and appearance of the pseudodeltidium.

Occurrence. — Middle Devonian; Germany, Poland.

Parastrophonella anaglypha (KAYSER, 1871)

(Pl. VIII, figs. 1-13; Text-figs. 14, 15)

1871. *Strophomena anaglypha:* E. KAYSER, Die Brachiopoden..., S. 628, Taf. 14, Fig. 3*a-e*.
1896. *Strophodonta anaglypha* KAYSER; G. GÜRICH, Das Palaeozoicum..., S. 228.
1904. *Strophodonta anaglypha* KAYSER; D. SOBOLEV, Devonskija..., s. 57, Tabl. 7, ris. 15.
1956. *Parastrophonella anaglypha* KAYSER; N. L. BUBLITCHENKO, Nekotorye..., s. 93, Tabl. 1, ris. 4*a, b*, non 5, 6, 7, non Text-fig. 3.
1961. *?Parastrophonella anaglypha* (KAYSER); J. DROT, Remarques..., p. 258. Pl. 3, figs 1, 2, ?4.

Horizon: Marly shales of exposures 72, 73, argillaceous shales of exposure 125, limestone of Miłoszów, Skały beds, Middle Devonian.

Locality: Skały, Miłoszów.

Material. — Hundred nearly complete specimens and fragments of shell, 40 separate pedicle valves, 1 partly exfoliated brachial valve.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Width of hinge line	Thickness
1144	6·8	11·0	12·2	1·0
1163	7·8	11·6	13·8	0·8
1146	8·0	13·4	14·0	1·4
1164	8·2	12·4	15·0	1·0
1152	8·4	12·0	14·0	1·2
1165	8·6	14·2	16·8	1·0
1151	9·0	12·2	13·0	1·4
1153	9·6	15·0	16·2	1·0
1154	10·0	14·8	15·8	1·4
1155	10·5	14·5	15·2	1·2

Description. — Shell below median size, flat, very tiny, with extremely small chamber body; subquadrate in outline, strongly geniculated; mucronate; interarea common to both valves, that of the brachial valve narrower or even linear. Pedicle valve: pseudodeltidium entire, arched, sometimes with a narrow median fold; beak small, weakly marked, with a trace of apical foramen. Brachial valve very thin, twice or three times thinner than the pedicle one and very fragile, usually lacking on the geniculated part, probably due to the state of preservation; arched chilidium entire, of different size, as large as the pseudodeltidium or smaller (Pl. VIII, fig. 4; Text-fig. 14*A, B, C*).

Ornamentation. Shell surface is finely parvicostellate, differentiated into thicker and thinner parvicostellae, similarly as in e.g. douvillinids. On the geniculated region all the parvicostellae

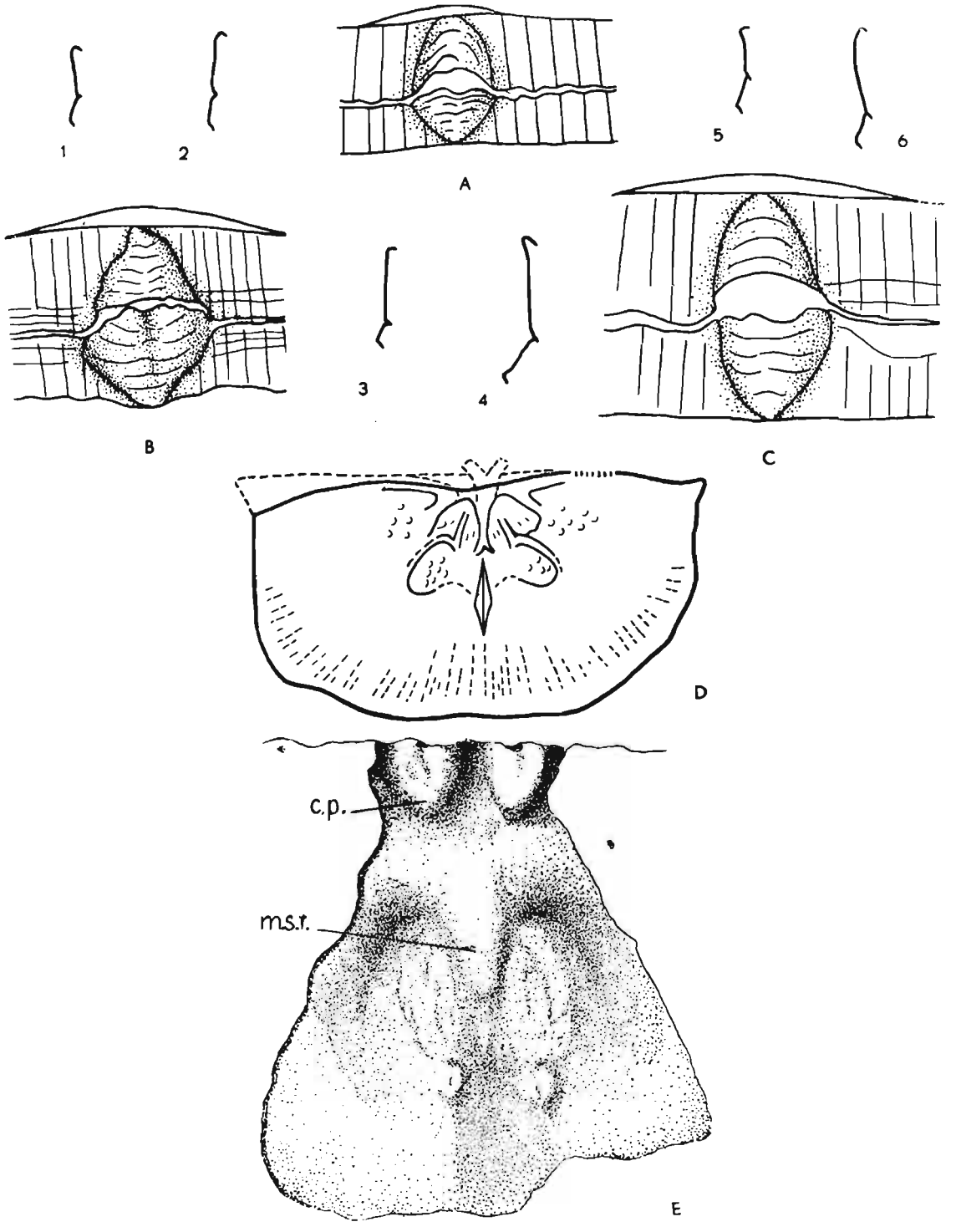


Fig. 14

Parastrophonella anaglypha (KAYSER). Skały beds, marly shales, exposure 73. *1-6* Relation of both areas of 6 shells × 9·5. *A-C* Appearance of pseudodeltidium and chilidium of 3 different specimens; × 12. *D* Dorsal interior of the; Altai specimen assigned by BUBLITCHENKO to *Parastrophonella anaglypha* (BUBLITCHENKO, 1956, fig. 3). *E* Partly exfoliated dorsal interior of specimen (Bp. VII/1312): *c. p.* cardinal process, *m. s. r.* median septal ridge; × 15

are almost of the same thickness. Growth lines not distinctly expressed, microlines closely set, sometimes of rugate appearance.

Interior. Pedicle valve: hinge line denticulate for nearly all its width, lacking only on the hinge-extensions; process pits deep, ventral process distinct, of moderate size, supporting the pseudodeltidium; deep diductors elongated or slightly flabellate (Pl. VIII, figs. 5, 10-13), bordered by ridges; adductors small; nearly entire internal surface papillose, pallial sinuses of polypalmate pattern, especially well preserved; they are distinct channels, which split at the antero-lateral margns; vascula media well marked, vascula myaria and ?dentalia present (Pl. VIII, fig. 13). Brachial valve: cardinal process strong and comparatively large, not extending above the hinge line, bilobed, deeply notched; each lobe with shallow, longitudinal groove posteriorly; posterior platform elongating anteriorly into a low flat, but very short median ridge, dividing the posterior third of the muscle area (Text-fig. 14*E*), which can correspond to the short and «stumpfe» ridge mentioned by KAYSER (1871, p. 629) in his *Strophomena anaglypha*; brachial ridges observed on cross sections, very low.

Individual variability. — The most variable is the length of the hinge line. All specimens show a hinge line approximately wider than the median shell width. Hinge extremities are more accentuated or less, in the majority of specimens being distinctly mucronate.

The shell outline varies from nearly subquadrate with the anterior commissure, nearly straight, sometimes weakly undulated (especially in specimens from argillaceous shales of exposure 125 and limestone of Miłoszów) to about subtriangular, with the anterior commissure rounded. The interarea is always small, extending across nearly all the width of the hinge line, but varies slightly in height.

In the interior of the pedicle valve some variations are observed in the outline of the muscle area, in the length and width of the median ridge separating the ventral muscles and in the distinctness of the muscle-bounding ridges (see Pl. VIII, figs. 5, 10-13).

Remarks. — The majority of specimens have been found in the «brachiopod» shales of exposure 73, a few only in the argillaceous shales of exposure 125 and in the limestone of Miłoszów. They all differ a little in the shell dimensions and shell outline, those from argillaceous shales being slightly larger, and more subquadrately outlined, with anterior commissure (geniculated portion) slightly undulating.

Our specimens are considered to be conspecific with KAYSER'S *Strophomena anaglypha*, agreeing very closely in external morphology and in internal structure, as can be seen from the illustrations (see KAYSER, 1871, Pl. 14, fig. 3,). They have a very similar pattern of ornamentation, consisting of numerous fine and regularly arranged parvicostellae of unequal size, but specimens from the Skały beds, especially those from marly shales (exposure 73), are smaller, slightly more transverse, with hinge extensions somewhat more accentuated and acute. German specimens labelled as *Douvillina? anaglypha* (KAYSER), (SMF collection from Crinoid layers — Prüm) are more subquadrate to nearly quadrate in outline, about twice as large as our specimens, with a delicate median undulation. The same small differences can be observed when comparing our specimens with those of *Parastrophonella anaglypha* (KAYSER) figured by BUBLITCHENKO (1956, Pl. 1, fig. 4) from the Middle Devonian of Rudnyi Altai, USSR, and by DROT (1961, Pl. 3, fig. 1) from the Devonian of Zemmour, Mauritanie.

Parastrophonella anaglypha (KAYSER) appears to be closely related to *Zophostrophia unganica* VEEVERS from the Devonian od Fitzroy Basin, Western Australia, so far as can be seen from the description and illustrations (VEEVERS, 1959, p. 63, Pl. 6, figs. 6-12; Text-figs. 33-35). Some external differences are found e.g. in the surface ornamentation — *Zophostrophia unganica* lacks the accentuated primary parvicostellae characteristic of *Parastrophonella anaglypha*, the

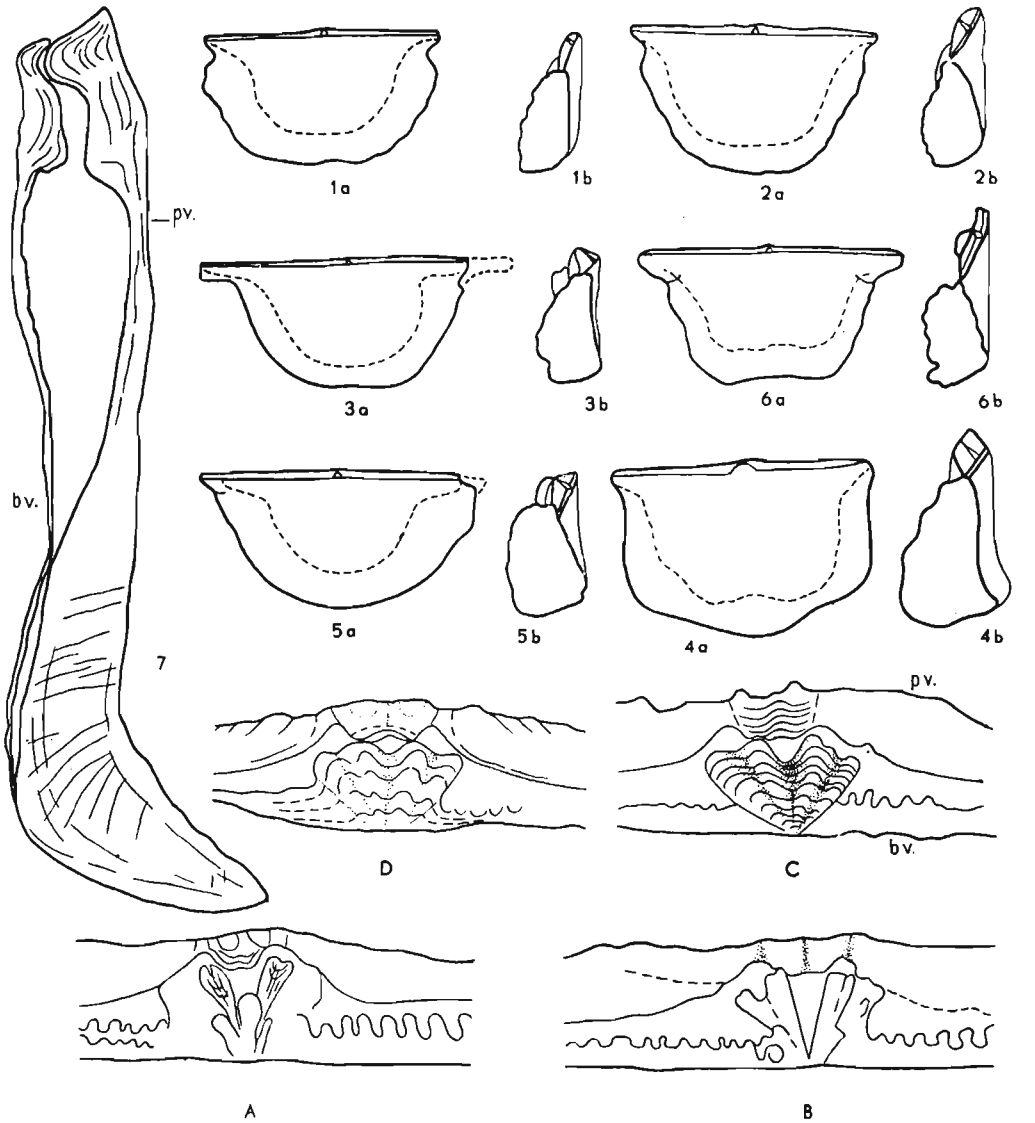


Fig. 15

Parastrophonella anaglypha (KAYSER). Skały beds, marly shales, exposure 73. *1-6* Pedicle valve and side views of 6 specimen to show some variability; × 2. *7* Longitudinal section of the shell, showing a great difference in the thickness of both valves of the shell. *A-D* Serial cross sections of adult specimen; × 11·4

pseudodeltidium is flat, flushing with the interarea, whereas in *P. anaglypha* it is distinctly arched. It is very probable that *Stropheodonta* sp. figured by DROT (1962, Pl. 11, fig. 4*a, b*) from the Devonian of d'Aînhoa, Basses Pyrénées, belongs to *Parastrophonella anaglypha* (KAYSER), the ventral interior being much the same. The shell outline of the former is less transverse than e.g. in our specimens of *Parastrophonella anaglypha* (KAYSER).

Occurrence. — Middle Devonian; Germany, ?France, Poland, ?USSR, Mauritanie.

Subfamily STROPHEODONTINAE CASTER, 1939

Genus **RADIOMENA** HAVLIČEK, 1962

Type species: *Orthis irregularis* ROEMER, 1844, S. 75, Taf. 4, Fig. 1; Middle Devonian, Givetian, limestone of Gerolstein, Rhine region, Germany.

Remarks. — The genus is characterized externally by its large size, geniculate and strongly transversely outlined shell with fine radial ornamentation. There are hair-like radial striae and their arrangement is very distinctive. The striae are of equal thickness on the anterior half of shell, but vary in thickness posteriorly (HAVLIČEK, 1962, p. 471).

The interior is not well known up to now. The specimens are, in general, in a bad state of preservation which is one of the reasons, why there is unsufficient information about the interior. HAVLIČEK (*l. c.*, p. 472) is of the opinion that *Radiomena* is close internally to *Megastrophia* CASTER (CASTER, 1939), differing more in the external morphology.

The only species assigned to *Radiomena* is *Orthis irregularis* ROEMER, type species, which is not easily confused with other forms. It appears that the genus is much restricted in time making it characteristic of the Givetian (?Upper Eifelian) stage.

Occurrence. — Middle Devonian, Givetian; Czechoslovakia (Moravia), Poland (Łysogóry region); ?Eifelian, Germany (Rhine region).

Radiomena irregularis (ROEMER, 1844)

(Pl. VIII, figs. 14-16; Pl. XIV, figs. 14, 15)

1844. *Orthis irregularis* ROEMER; C. F. ROEMER, Das Rheinische..., S. 75, Taf. 4, Fig. 1.
1962. *Radiomena irregularis* (ROEMER); V. HAVLIČEK, Oberfamilie Stropheodontacea..., S. 471.

Horizon: Skały beds, marly limestone of exposuxes 81, 92; Pokrzywianka beds, limestone; Givetian.
Locality: Skały and Pokrzywianka.

Material. — Five badly preserved specimens, pedicle valve partly decorticated. Approximate dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width
1047	32·0	44·0
1048	31·5	52·6

Remarks. — The species is uncommon in the Skały beds. There are no complete specimens available for observations and comparison. They are closest to *Orthis irregularis* ROEMER, possessing the typical geniculation and shell outline and considered as conspecific with ROEMER's species. When compared with representatives of the species from the limestone of Gerolstein, Schönecken (SMF coll.), our specimens are extremely close, only slightly smaller.

Occurrence. — The species is reported from the Middle Devonian of Germany (Rhine region); Givetian of Czechoslovakia (Moravia) and Poland (Łysogóry region).

Family MEEKELLIDAE STEHLI, 1954

Subfamily MEEKELLINAE STEHLI, 1954

Genus SCHELLWIENELLA THOMAS, 1910

Type species: *Spirifera crenistria* PHILLIPS 1836, Pl. 9, fig. 6; Lower Carboniferous of England.

Subgenus SCHELLWIENELLA (SCHELLWIENELLA) THOMAS, 1910

Schellwienella (Schellwienella) umbraculum (SCHLOTHEIM, 1820)

(Pls. IX, X; Text-figs 16-18)

1896. *Streptorhynchus umbraculum* SCHLOTH.; G. GÜRICH, Das Palaeozoicum..., S. 229.
1904. *Streptorhynchus umbraculum* SCHLOTH.; D. SOBOLEV, Profil..., s. 59, Tabl. 7, ris. 16-21.
1909. *Orthotetes umbraculum* SCHLOTH.; D. SOBOLEV, Srednij Devon..., s. 452.
1962. *Schellwienella (Sch.) umbraculum* (SCHLOTHEIM); E. IVANOVA, Ekologia..., s. 53, Tabl. 14, ris. 1-2.

Horizon: Marly shales of exposures 72, 73 (brachiopod shales), argillaceous shales, exposures 101, 121, 125.
Locality: Skały.

Material. — About 600 specimens of different size, more than a half of the total number incomplete; about 40 separate pedicle valves and 1 brachial valve.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of hinge line	Height of area
1300	3·1	3·9	0·7	4·0	?
1301	3·8	4·9	0·9	5·1	—
1302	6·3	8·0	0·8	7·8	0·8
1303	9·4	11·0	2·5	12·1	1·0
1304	14·0	18·2	3·7	18·2	1·5
1305	17·7	19·5	5·5	17·7	1·5
1306	20·0	22·3	7·1	19·0	3·8
1307	21·9	25·9	6·9	25·3	3·5
1308	24·0	27·0	8·5	22·3	3·9
1309	25·0	29·0	7·3	?	3·2
1310	26·7	31·4	9·1	?29·9	4·1
1311	34·5	38·0	8·5	?	4·1

Description. — Shell thick-walled, medium to large size, resupinate, usually subquadrate in outline; hinge extremities sometimes slightly mucronate, ventral interarea and perideltidium distinct (Text-fig. 17, draw. 1-4) pedicle foramen apical, distinct in younger individuals, dorsal area very small, deltidium and chilidium present.

Ornamentation consists of crenulate costellae, alternatively, lower and higher, appearing by intercalation; the separating furrows about twice as wide as the costellae. Concentric growth lines faintly expressed. Concentric microlines, apparently discontinuous (not visible on the backs of costellae) are closely and regularly spaced, about 20 per 1 mm. at the anterior margin.

Interior. Pedicle valve: teeth well developed, grooved; dental plates diverging anteriorly (degree of divergence slightly varying), laterally connected with ridges bordering the muscle

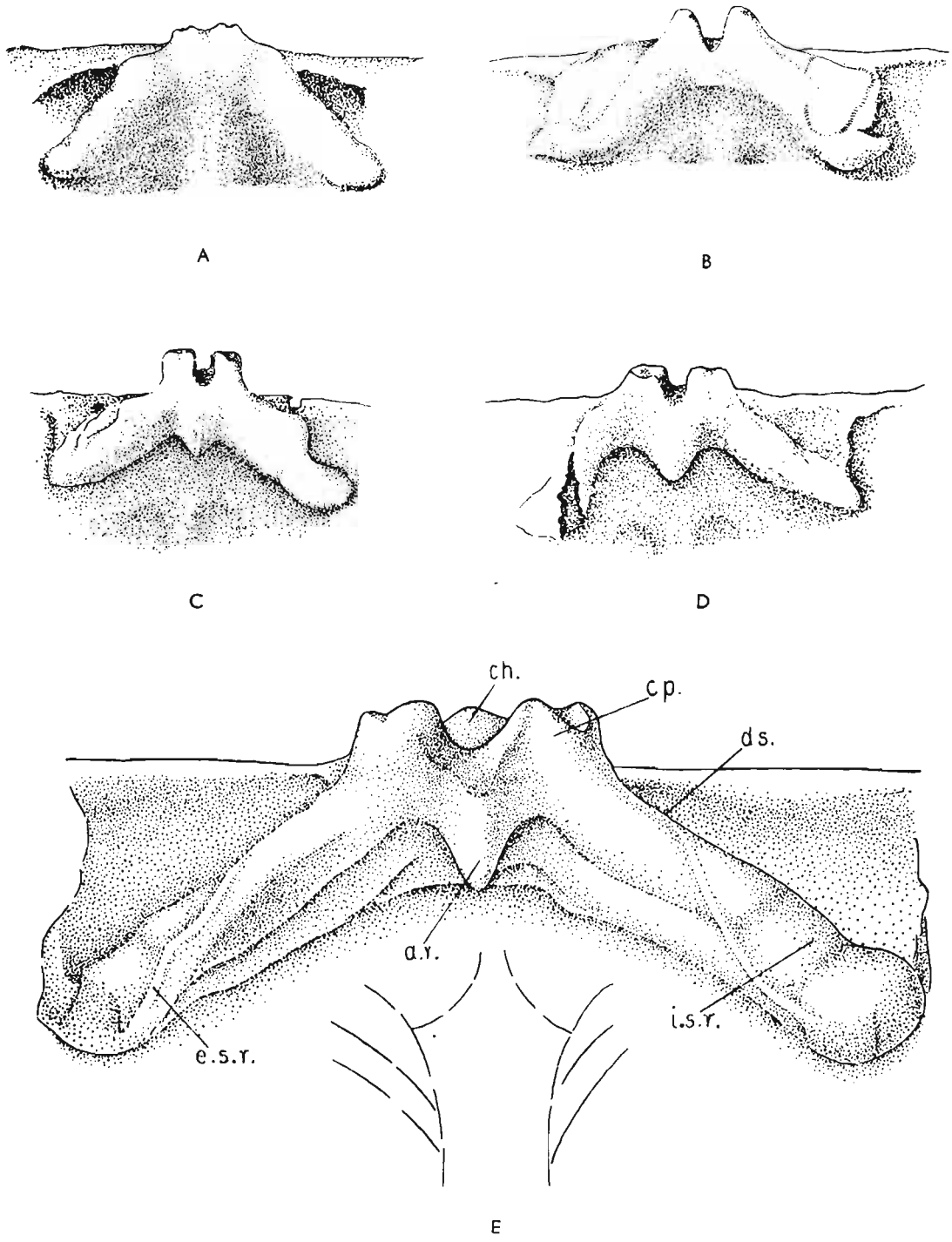


Fig. 16

Schellwienella (*Schellwienella*) *umbraculum* (SCHLOTHEIM). Skały beds, marly shales, exposure 73. *A-D* Appearance of the cardinal process and anterior ridge (Bp. VII/1602, 1603, 1601, 1600); approx. × 10. *E* Cardinal process of specimen (Bp. VII/3685): *a. r.* anterior ridge, *ch.* chilidium, *c. p.* cardinal process, *d. s.* dental socket, *e. s. r.* external socket ridge, *i. s. r.* internal socket ridge; × 20·5

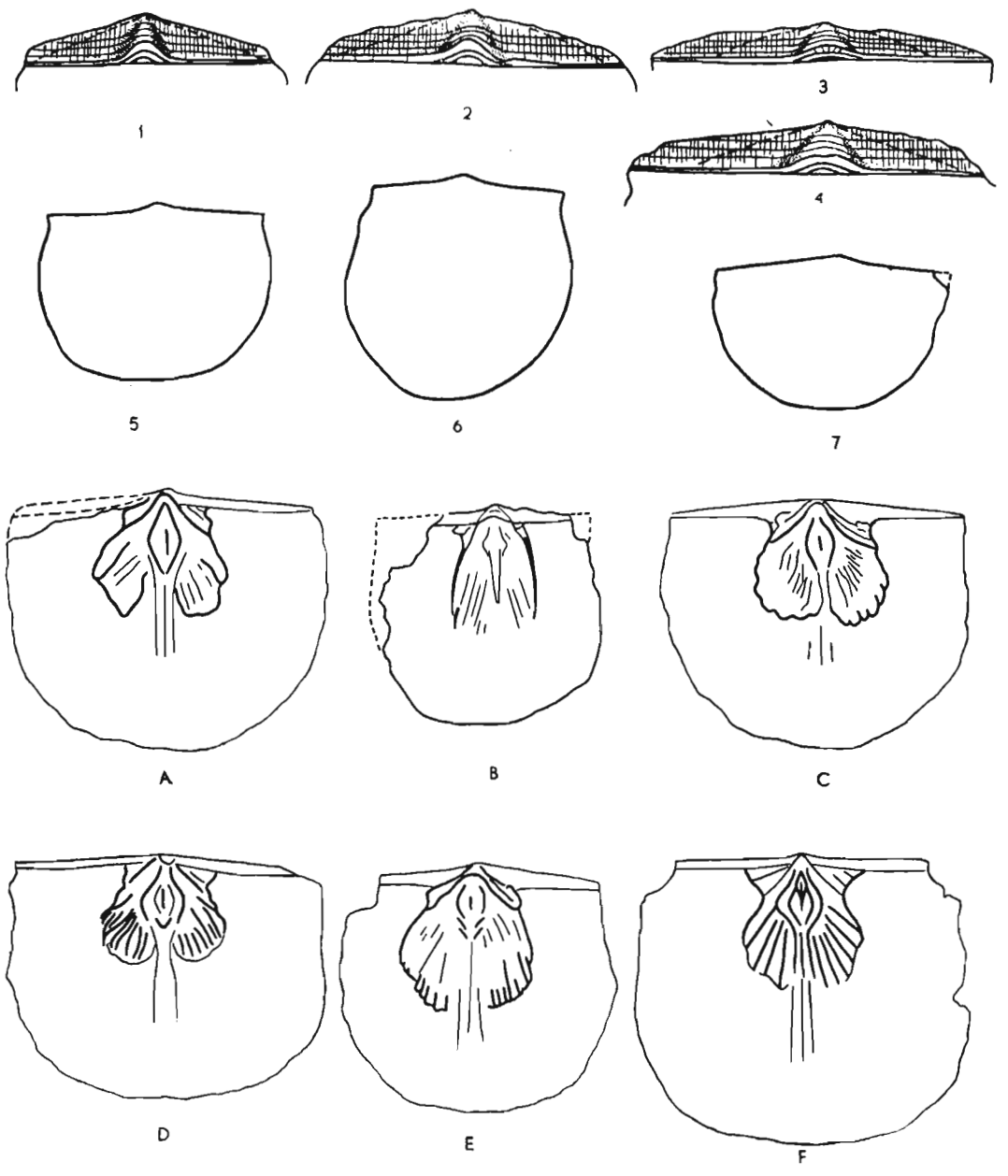


Fig. 17

Schellwienella (*Schellwienella*) *umbraculum* (SCHLOTHEIM). Skały beds, marly shales, exposure 73 (Bp. VII/3682, 3689—3693). *1-4* Appearance of the ventral area and pseudodeltidium in different specimens; × 2. 5-7 Some variation in the shell outline of adult specimens (Bp. VII/3689, 3690, 3691, 3692, 3693); × 1·6. *A-F* Ventral muscle area of different specimens; × 1·8.

area (Text-fig 17; Pl. X, fig. 9); muscle area distinct, varying in outline and to some extent in size, commonly subcircular to circular, striated, separated by a very low median septal ridge (Text-fig. 17*A-F*; Pl. X, fig. 9). Brachial valve: cardinal process bilobed; anterior ridge, a feature of adult age, usually developed (Text-fig. 16), but of varying distinctness, sometimes obsolete; dental sockets completely filled by teeth, which make articulation rather strong; muscle area large; medium septal ridge distinct but low; traces of pallial sinuses weakly marked.

Variability. — Some individual variability observed in external and internal morphology (within the specimens from marly shales of exposure 73). In general, specimens do not vary much in size and shape, but vary more in outline. All shells are usually wider than long, but the index of the length/width ratio somewhat differs. The shells can be: 1) considerably wider than long, with hinge line equal to maximum shell width or even longer with slightly mucronate hinge extensions (Text-figs. 17, draw. 5-7); 2) shells only a little wider than long, with hinge line, as a rule, shorter than the maximum shell width or occasionally equal to it, hinge extensions mucronate or not. The height of area is connected with the shell outline, but the differences are rather small (Text-figs. 17, draw. 1-4).

Internally, the ventral muscle area varies slightly in outline (Text-figs. 17*A-F*), dental plates show some changes in length and in the degree of divergence. The outline of the cardinal process as well as the appearance of the anterior ridge, as shown by Text-fig. 16, are rather variable.

Growth changes. The smallest specimens in the collection about 1·13 mm. long and 1·45 mm. wide, externally closely resemble the adults (Text-fig. 18). Their pedicle valve is gently convex, greatest convexity about midlength; pedicle foramen apical, round, apical part with distinct concentric lines (similarly as in brachial valve). Internally, teeth well developed, dental plates marked, not extending anteriorly, but reaching the floor of the valve. Brachial valve flat, lowering slightly anteriorly; cardinal process filling the notothyrium, weakly bilobed; socket plates diverging laterally. Radial costellae appear at about 0·5 mm. from both apexes, increasing rather regularly and always by intercalation. As shown by observations, during growth, the width of shell is greater than the length and the hinge extremities become more accentuated, in some cases auriculated. The width of the hinge line is somewhat variable during growth, being less than the maximum shell width, equal to or even exceeding it. The shell outline does not change much, but two rather distinct «types» of outline can be observed, however with transitions between them (see p. 63). Shell convexity is one of the features undergoing considerable change due to resupination of shell (Text-fig. 18).

Internally, the cardinals thicken, bilobation of the cardinal process is more marked and the anterior ridge slowly grows.

Remarks. — *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM) is well represented within the Skały beds, being collected in great abundance in the marly-argillaceous shales of a few exposures. The richest collection comes from the marly shales of exposures 72, 73 (brachiopod shales). Less numerous samples come from the shales of exposure 121 and are associated with a few small shells of *Leptaena analogaeformis* n. sp. The poorest collection, a few fragmentary specimens, comes from the argillaceous shales of exposure 125.

In general, all the specimens do not differ much in external morphology. Some small differences are found in:

1) the spacement of radial costellae, widely arranged in specimens from argillaceous shales (exposure 125), numbering 6-8 per 5 mm. at the anterior margin; more closely set (8-12

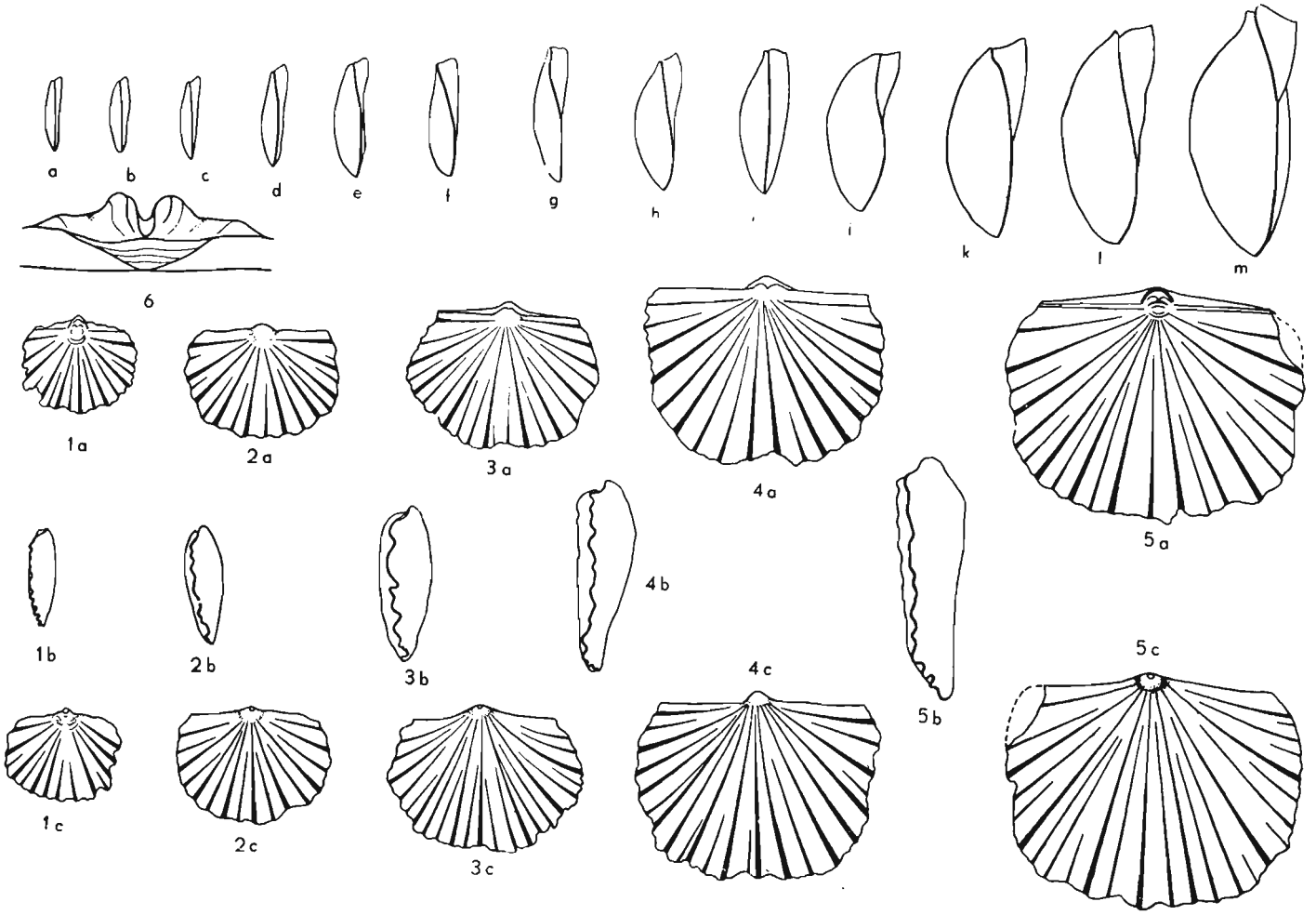


Fig. 18

Schellwienella (*Schellwienella*) *umbraculum* (SCHLOTHEIM). Skały beds, marly shales, exposure 73. *a-m* Changes in the shell convexity during growth; × 1·5. *1-5* Appearance of young individual in: *a* brachial valve, *b* side, *c* pedicle valve views. *6* Chilidium and cardinal process from exterior; × 5

per 5 mm.) in specimens from the marly shales (exposure 73), and about 8-10 per 5 mm. in shells from shales of exposure 121;

2) the coarsity of crenulation of costellae, the crenulae being in general less distinct in specimens from exposures 125, and relatively more widely spaced in specimens from exposure 121, having the appearance of transverse discontinuous ridges, somewhat like *Schellwienella (Schellwienella) wieniukowi* KOZŁOWSKI (1929) or *Sch. (Schelwienella) semenovi* SOKOLSKAJA (1954);

3) slightly in shell outline and size; specimens from exposure 121 are in general smaller and more transverse, those from exposure 73 usually more subquadrate, and from shales 125, judging from the scarce and incomplete material, about as long as wide.

In addition there are some differences in the shell thickness, convexity of the brachial valve, but those are probably closely dependent on the life conditions. All these mentioned differences are not employed here as distinguishable for new taxons, but they illustrate some variability within the species which is closely related to environmental fluctuations.

Our specimens are almost indistinguishable from the Middle Devonian of Padaukpin specimens of *Sch. umbraculum* figured by REED (1908, Pl. 13, figs. 2-14) and also from the German specimens of this species (SMF coll.) coming e.g. from Crinoid layers. The German specimens from Gerolstein (Gerolsteiner Mulde) show similar variability in shell outline (length/width ratio), in spacement of radial costulae and to some extent in the coarsity of crenulation. *Sch. (Schellwienella) umbraculum* (SCHLOTHEIM), figured by IVANOVA from the Middle Devonian of Kuznetsk (1962, Pl. 14, figs. 1-2), does not differ much from our specimens, but shows some small difference in the height of area.

Sch. (Schellwienella) umbraculum minor BIERNAT, described from the Lower Eifelian of Grzegorzowice beds (BIERNAT, 1954, p. 500, Pl. I, figs. 5-6), being in general close to *Sch. (Schellwienella) umbraculum* from the Skały beds, differs mainly in having much thicker radial costellae with less distinct crenulation on their backs, concentric microlines more distinct and continuous, whereas in specimens from the Skały beds they are discontinuous.

Occurrence. — The species is very common, known in the Middle Devonian throughout the world.

Schellwienella (Schellwienella) sp.

(Pl. X, fig. 10)

Horizon: Marly limestone of exposure 81, Skały beds; limestone of Pokrzywianka beds; Middle Devonian.
Locality: Skały and Pokrzywianka.

Material. — Two incomplete specimens and 1 fragment embedded in the rock, and poorly preserved.

Approximate dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	No. of costulae in 1 mm. at the anterior margin
3714	?45·6	?67·5	2

Description. — Large, transversely elongated shell, with rounded antero-lateral margins, along the midline of the brachial valve there is a faint and very shallow sulcus.

Ornamentation consists of distinct costellae; their height and thickness are differentiated similarly as in *Sch. (Schellwienella) umbraculum* (SCHLOTHEIM).

Remarks. — The above specimens can be compared to *Schellwienella? undifera* (SCHNUR) from the Middle Devonian of Rhine region (SMF coll. 1938, Crinoid layers, Rommerheim, 511). Our specimens are more flat and smaller, but the radial ornamentation is much the same as in the German specimen. *Schellwienella undifera* on SCHNUR's (1854) Plate 45, fig. 1 is more subquadrate than our specimens. There is also a great similarity to *Stropheodonta grandis* LEIDHOLD, described and figured from the limestone of Bilveringsen (LEIDHOLD, 1928, p. 18, Pl. 2, fig. 1; Pl. 3, fig. 1). Our specimens appear to be flatter, but probably this can be due to the state of preservation. Externally, our *Schellwienella (Schellwienella)* sp. closely resembles similarly large *Sch. (Schellwienella) umbraculum* (SCHLOTH.), described and figured by IVANOVA from the Middle Devonian of Kuznetsk Basin (IVANOVA, 1962, Pl. 14, fig. 2). The general appearance, shell outline and shape of both, Russian and ours, specimens are almost the same. IVANOVA suggests that the large shells as well as the small can belong to one species — *Schellwienella (Schellwienella) umbraculum* (SCHLOTHEIM).

Suborder **PRODUCTIDINA** WAAGEN, 1883

Family PRODUCTELLIDAE SCHUCHERT & LE VENE, 1929

Subfamily PRODUCTELLINAE SCHUCHERT & LE VENE, 1929

The group of Productellinae is rather large, including a number of genera, majority of them erected more recently (see MUIR-WOOD & COOPER, 1960), but is not well known especially in the aspect of the internal morphology. Although its representatives are numerous in the Devonian, their state of preservation is often insufficient to allow the detailed studies of their interiors. The most diagnostic features for the subfamily are up to now: appearance of the surface spinosity, bilobed cardinal process, teeth small to obsolescent, linear interareas.

In the Skały beds, the subfamily is represented by the genus *Productella* HALL, 1867. The collection is large, including a number of separate brachial valves.

Genus **PRODUCTELLA** HALL, 1867

Type species: *Productus subaculeatus* MURCHISON, 1840; Upper Devonian (Upper Frasnian), Ferque near Boulogne, France.

Remarks. — The definite type locality for the type species of the genus *Productella* is not given by MURCHISON. Although he cited a few localities, it is, however, commonly suggested that the type locality is Ferque, Boulogne (France), because MURCHISON's paper concerns the Devonian of the Bas-Boulonnais.

Up to now, the genus is not well known. In a short diagnosis of *Productella* given by MUIR-WOOD & COOPER (1960) the most diagnostic characters are: 1) differentiated surface spinosity, 2) bilobed cardinal process, 3) dental sockets bounded anteriorly by small ridges, 4) presence of teeth, 5) area linear, pseudodeltidium and chilidium obsolescent or absent. The above mentioned features appear to be common to a few Devonian genera such as: *Spinulicosta* NALIVKIN, *Helaspis* IMBRIE, to some extent *Orbinaria* MUIR-WOOD & COOPER, *Devonoproductus* STAINBROOK and others. For the most part, the criteria used to delimite the

above genera seem to be rather purely morphological, based mainly on the external features, the most diagnostic being considered the differences in the degree of surface ornamentation. This feature, up to now, has been rather little used as diagnostic on the generic level being considered insufficient. All of the above genera are characterized by the presence of teeth and a bilobed cardinal process, but their degree of development and appearance slightly differ. In *Devonoproductus*, e.g. the cardinal process is bilobed to nearly quadrilobed, in *Strophoproductus* NALIVKIN it is not incised posteriorly etc. It is not yet quite certain if these differences are sufficiently stable to have a diagnostic value for the Devonian genera. Judging from the studied material of *Productella varians* n. sp., these two features (teeth and cardinal process) appear to be rather strongly variable within a species and thus their diagnostic value on generic level seems to be doubtfull. Similar observations have been made by GOLDRING (1957) for the last toothed productellids and by FAGERSTROM and BOELLSTORFF (1964) for Juresania. It is interesting to note that all old separate brachial valves of our *Productella varians* n. sp. possess well developed brachial ridges, a characteristic feature of the brachial interior of productids (see our Pl. XII). Their presence in productellids has not been cited (as far as it can be judged from literature), probably because of the lack of available material. In some valves, the brachial ridges are preserved as simple ridges, somewhat like those of the Permian productids such as *Lialosia kimberleyensis* (PRENDERGAST) and *Wyndhamia jukesi* (ETHERIDGE) (see our Pl. XII, figs. 5, 6 and MUIR-WOOD & COOPER, 1960, e.g. Pl. 4, fig. 22; Pl. 5, fig. 8). In some cases, however, they look somewhat like the spiral coils of *Leptaenisca concava* (HALL) (compare our Pl. XII, figs. 7, 8, 9, and MUIR-WOOD & COOPER, 1960, Pl. 133, figs. 7-10). The brachial ridges are, in general, interpreted as the place of lophophore attachment, as suggested by NEUMAYR, as early as 1883 (p. 79), and more recently by WILLIAMS (1956, p. 262), MUIR-WOOD & COOPER (1960), in an analogy to recent brachiopods, suggest that the brachial ridges can possibly be a modified pallial cavity for the gonads. They had also been interpreted as remnants of pallial sinuses by DAVIDSON in 1860.

Occurrence. — Middle-Upper Devonian, throughout the world.

Productella varians n. sp.

(Pl. XI; Pl. XII, figs. 1-16; Pl. XIII, figs. 1-10; Text-figs. 19-21)

?1896. *Productella subaculeata* MURCH. var. *angustior*; G. GÜRICH, Das Palaeozoicum..., S. 217.
1896. *Productella subaculeata* MURCH. var. *latior*: G. GÜRICH, *Ibid.*, S. 218.
1904. *Productella subaculeata* MURCH.; D. SOBOLEV, Devonskija..., s. 50, Tabl. 7, ris. 6, Tabl. 8, ris. 14.
1909. *Productella subaculeata* MURCH.; D. SOBOLEV, Srednij devon..., s. 442.

Holotype: Z. Pal. Cat. No. Bp. VII/3750, figured on Pl. XI, fig. 10.
Type horizon: Marly shales, exposure **73**, Skały beds, Middle Devonian.
Type locality: Skały, Łysogóry region, Holy Cross Mountains.
Derivation of the name: varians — varying externally to a considerable degree and somewhat less internally.

Diagnosis. — *Productella* of small to medium size, varying in outline from broadly subquadrate to nearly ovate, spine bases, differently arranged, teeth present but in olds usually obsolete, dental sockets of moderate depth.

Material. — About 1000 specimens, free and almost complete, in different individual age; many shell fragments; about 30 separate brachial valves and 6 pedicle valves.

Approximate dimensions (in mm.):

Productella varians (Forma *A*)

Z. Pal. Cat. No. Bp. VII	Length *	Width	Thickness	Length of umbo	Width of umbo
4063	17·8	14·9	6·2	4·5	6·1
4069	17·9	16·6	5·9	5·8	6·0
4070	18·0	16·5	5·7	5·0	6·0
4068	18·0	18·2	6·7	4·5	6·6
4062	18·0	16·0	6·8	6·8	6·1
4067	19·1	18·0	6·9	6·5	8·0
4064	21·2	22·2	6·4	5·0	7·0
4066	21·7	19·6	6·2	6·9	9·0
4065	22·9	17·6	7·7	8·3	8·7
4061	23·5	?20·2	6·3	5·8	6·7

Productella varians (Forma *B*)

Z. Pal. Cat. No. Bp. VII	Length *	Width	Thickness	Length of umbo	Width of umbo
4077	13·7	16·0	4·4	3·0	5·5
4078	14·0	15·8	4·9	3·2	5·7
4080	14·9	16·0	4·0	3·2	5·3
4075	14·9	17·0	4·6	3·4	4·0
4079	15·2	?16·7	5·0	3·6	5·4
4071	15·9	16·7	4·9	3·6	5·9
4072	16·6	20·3	4·7	3·2	5·7
4076	16·7	18·7	4·9	3·4	6·6
4073	17·2	19·2	5·9	3·6	6·5
4074	17·4	18·0	6·5	4·6	5·5

* Length measured straight from beak to anterior margin (not along curvature of the pedicle valve).

Description. — Thick-walled, strongly concavo-convex shell, varying in outline from subquadrate to ovate; hinge extensions auriculate in varying degree. Pedicle valve usually convex posteriorly, umbo broad, very prominent beak slightly incurved, with sometimes slightly effaced apical part, traces of attachment being very distinct in youth, becoming rather obsolete with growth, interarea small and almost linear; pseudodeltidium indistinct. Brachial valve somewhat variable in its concavity, slightly convex umbonally; beak very small, pseudochilidium indistinct.

Ornamentation. The surface ornamentation consists of concentric wrinkles and growth lines on both valves, spine bases sometimes with fragments of spines on the pedicle valve and numerous dimples on the brachial valve, which correspond to some extent to the spines of the opposite valve. The arrangement and number of spines are variable and comparatively wide ornamental combinations can be observed in adult or gerontic specimens. Spine-bases can be:

1) rather irregularly arranged, somewhat like e.g. *Truncalosia gibbosa* IMBRIE (IMBRIE, 1959, Pl. 66, figs. 15-23);

2) comparatively widely scattered or subquincuncial to quincuncial as e.g. in *Helaspis luma* IMBRIE (IMBRIE, 1959, Pl. 65, figs. 26-29);

3) arranged slightly radially, showing indistinct spine-bearing ridges somewhat like *Spinulicosta* NALIVKIN or e.g. *Avonia youngiana* (DAVIDSON), in MUIR-WOOD & COOPER (1960, Pl. 47, figs. 17, 19, 21).

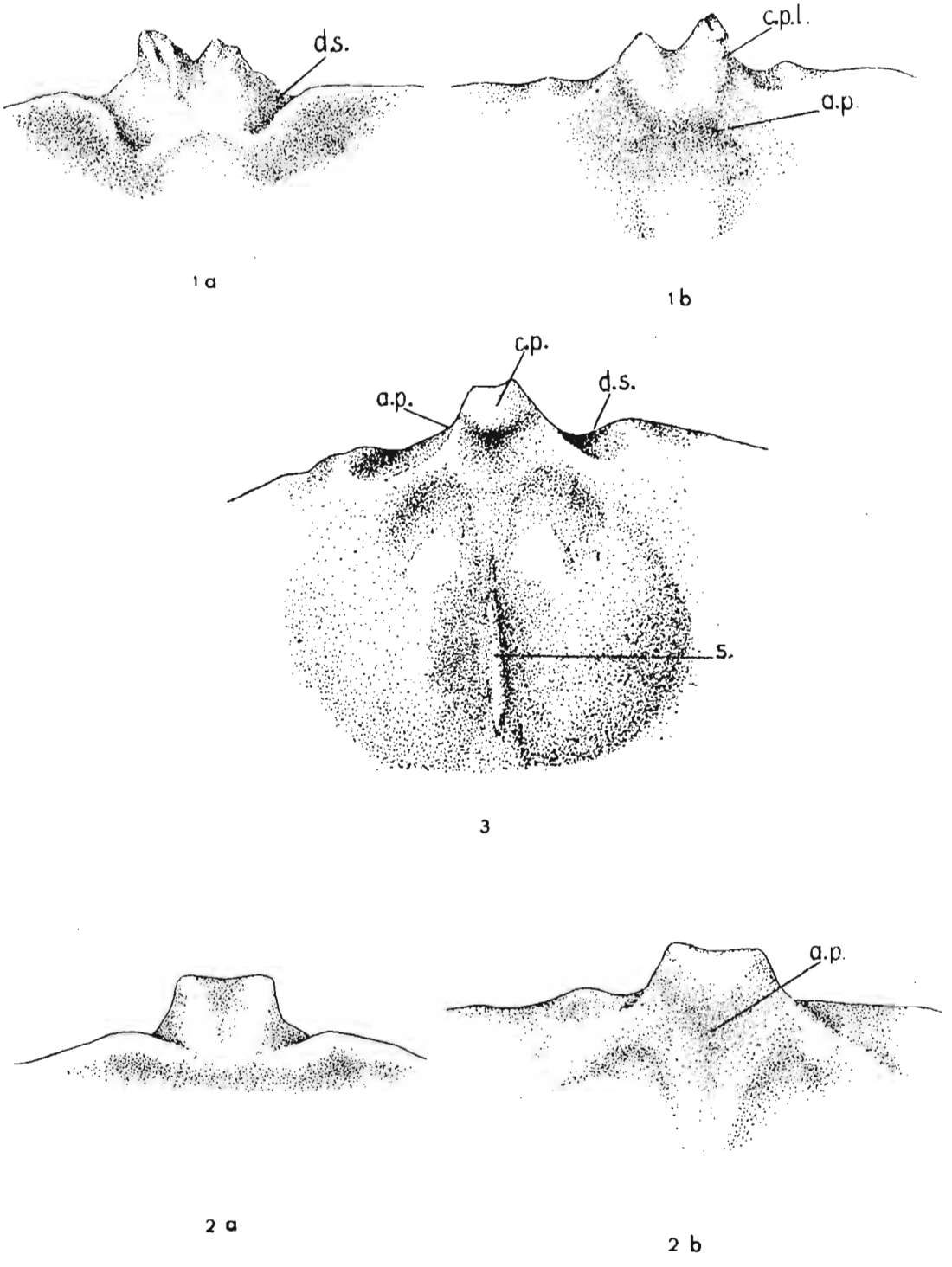


Fig. 19

Productella varians n. sp. Skały beds, exposure 73. *1-2* Cardinal process of younger individuals, *a* from exterior, *b* from interior (Bp. VII/1313, 1314). *3* Dorsal interior of not adult specimen (Bp. VII/1315): *a. p.* alveolar pit, *c. p. l.* lobe of the cardinal process, *d. s.* dental socket, *s* septum; approx. × 15

Each of the above ornamental «types» is represented by a number of specimens, but with many transitional specimens between them. This comparatively wide range of ornamentation within a species from 1 horizon (marly shales) in all probability points a way to new taxa, perhaps on generic level, known in the late Middle Devonian.

In addition, at the hinge line of all specimens there is a row of 6—8 small spine bases, and a few ones slightly larger on the hinge extensions, all probably serving as anchors.

Interior. Pedicle valve (Text-figs. 20*A*, *B*); umbonal cavity filled by a ridge, weak in younger individuals, but comparatively high and sharp of variable appearance in older ones, fitting between the two lobes of the cardinal process of the brachial valve, probably serving as an additional articulation; moderate teeth present, bounded anteriorly by ridges (= ?dental plates); marginal ridges (edges of visceral disc) very high posteriorly, gradually lowering, extending for half the valve length; muscle area distinct, especially in old specimens, occupying about one-third of the whole length of the valve; on both sides of the muscle area two round scars are sometimes observed, which can be interpreted as traces of lophophore cones, as mentioned in MUIR-WOOD & COOPER (1960). Brachial valve: cardinal process well developed, bilobed, sufficiently prominent, but somewhat varying in size and shape; each lobe with distinct grooves on its external (outer) surface; dental sockets correspondingly moderate, laterally elongated socket ridges well marked; medium septal ridge narrow, of moderate height, medially the highest, usually extending to midvalve or more; brachial ridges in old individuals thick and high; small adductors slightly or nondedritic, elevated on a small platform, usually subtrigonal in outline; all the interior of both valves covered with numerous, anteriorly directed pustules.

Growth changes. Studies of the growth series of our species reveal certain changes during growth. The area does not increase much in size from younger to older individuals or only to a very small degree. In specimens up to about 4 mm. in length the ventral area is trigonal, rather high compared with shell dimensions, almost twice as high as that of the brachial valve, showing moderate and slightly arched pseudodeltidium and pseudochilidium. With growth it becomes almost linear, preserving to some degree its trigonal appearance, being very small in comparison with shell dimensions; pseudodeltidium and chilidium obscure (Text-fig. 21).

The cardinal process varies in successive growth stages and also from one individual to another. In small specimens, up to about 5—6 mm. long it is small, slightly exceeding the hinge line, showing an incipient bilobation, two lobes slightly marked and a little divergent, start from a common base (Text-fig. 19), as also stated by GOLDRING (1955) in productellids. This base, however, is not bulbous, but a thin and delicately marked plate. At the base of the cardinal process an alveolar pit is observed, this being a feature of immature individuals, disappearing with growth, similarly as in *Eodevonaria (Devonaria) zeuschneri* (SOBOLEV) (Text-fig. 19; Pl. XV, figs. 3, 4, 7; Pl. XII, figs. 1-5). The growing cardinal process gradually exceeds the hinge line, becoming much thicker. The exterior and posterior surface of both lobes bears distinct grooves. In adults, the cardinal process varies in shape and size, in the degree of divergence of both lobes and in the deepness of separating sulcus. It is always bilobed, but not always distinctly separated by a sulcus and grooved on its posterior face (Text-fig. 20, draw. 1*a*, *b* — 3*a*, *b*). The variability of the cardinal process in the adult stage is considerable, therefore, the cardinal process not being a stable feature within a species, cannot be regarded as sufficiently diagnostic for the erection or recognition of genera.

The median septum, slightly marked in specimens up to about 5 mm. in length, starts usually at about 1 mm. from the base of the cardinal process, extending for about a half of two-thirds of the valve length. It is low, steeply increasing in height anteriorly. Brachial ridges

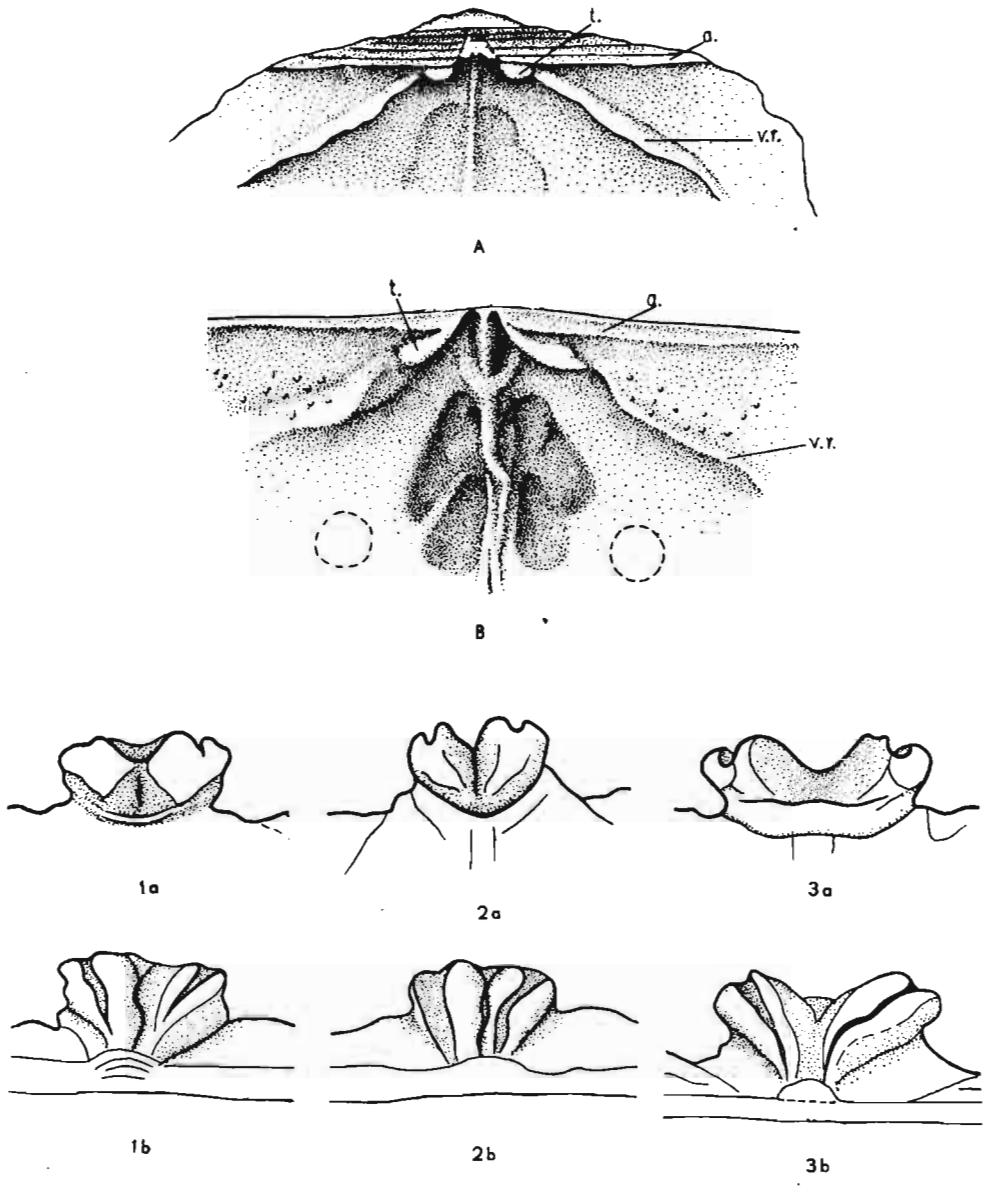


Fig. 20

Productella varians n. sp. Skały beds, marly shales, exposure 73. *A-B* Two ventral interiors showing teeth, slightly declined posteriorly (Bp. VII/3732, 3733); *A* × 7; *B* gerontic specimen, approx. × 8. *1-3* Internal and external views of the cardinal process (Bp. VII/3734, 3735, 3736): *a.* area, *t.* tooth, *v. r.* visceral ridge; × 11·4

scarcely recognizable in specimens of about 5—7 mm. long and not always very distinct in adults. In general, they look like these in *Productella pyxidata* (HALL) from the Mississippian of Missouri (SUTTON & SUMMERSON, 1943, Pl. 53, fig. 2). In some extremely old specimens they are very high and thick, extending anteriorly for about two-thirds of the valve length, being incurved towards the median septum. Externally, specimens up to about 4 mm. in length are nearly circular in outline, with growth tending towards greater transversal or longitudinal elongation. Umbo is very small, bearing a distinct, sometimes large cicatrix of attachment, somewhat varying in outline, bordered by a row of small spines. In general, this cicatrix disappears

with maturity, however traces of it can be observed in many adults or olds. Majority of old specimens have deformed beak region, or a greatly and regularly thickened apical part. It is considered here that the shells in youth were attached by spines to some foreign bodies, probably the steams of crinoids, touching them by beak. In maturity, the specimens were attached by a row of spines along the edges of the beak, by spines at the hinge extensions and by those covering the whole surface of the pedicle valve. The specimens were attached only slightly if at all by the beak itself.

The size and degree of the curvature of the umbo increases considerably with individual age.

Spine bases in youth are coarse nearly the same in appearance, rarely arranged on the pedicle valve. With age some differentiation is observed, although the umbonal part remains unchanged.

As appears from observations, immature individuals are very similar and rather stable in shell outline and surface ornamentation, whereas adults, in these respects, are highly variable. Most variation in this species is seen in surface ornamentation.

Individual variability. — The variability within the species is very great and it is possible to differentiate two forms *A* and *B*, on the basis of some external differences. Forma *A* (see Dimensions on p. 67 and Pl. XIII, figs. 1, 3, 5-7) is in general wide in outline, varying from broadly to less broadly subquadrate, having a blunt and relatively low umbo, i.e. moderately elevated above the hinge line. Ear-like extremities of the hinge line are laterally more expanded and more marked. Form *B* (see Dimensions on p. 67 and Pl. XIII, figs. 2, 4, 8-10) is usually oblong, varying from more ovate to less ovate in outline, having a beak narrower posteriorly and more elevated above the hinge-line. The spine bases look somewhat like spine-bearing ridges. These are the only differing features marked in the adult stage. Between these two groups there are intermediate specimens, which show features common to both forms and can be easily included to either of the two mentioned groups.

In addition, in youth, all specimens of *Productella varians* n. sp. appear to be very similar in their external morphology.

Remarks. — The species is included into the genus *Productella* HALL on the basis of similar shell outline and shape, linear interarea, obsolescent or absent pseudodeltidium and chilidium, presence of teeth, dental sockets bounded anteriorly by ridges and bilobed cardinal process. Alveolar pit very diagnostic for *Productella* (see MUIR-WOOD & COOPER, 1960, Pl. 147), although absent in maturity, is present in all immature specimens of our species (see p. 69, Pl. XII, figs. 1-4; Text-fig. 19). In the dorsal interior *Productella varians* n. sp. looks very like *Productella pyxidata* (HALL) from the Mississippian of Missouri (SUTTON & SUMMERSON, 1943, Pl. 53, fig. 2). The dorsal interior of *Productella hallana* WALCOTT, from the Devonian of Iowa, as shown by SUTTON and SUMMERSON (1943, Pl. 53, figs. 3, 4, 5), reminds one very much of our younger individuals (see our Pl. XII, figs. 1-4). *Productella varians* n. sp. differs externally from *Productella subaculeata* (MURCHISON) in having more densely spaced spine bases on the pedicle valve. *Productella subaculeata* (MURCH.) from the Devonian of USSR (NALIVKIN, 1947, Pl. 15, fig. 1) has a ventral beak more acute posteriorly, a more roundly outlined shell and less scattered spines, than specimens of our species. *Productella djaltulensis* NALIVKIN, from the Givetian of Siberia, USSR (NALIVKIN, 1961, p. 318, Pl. 78, figs. 1-3), appears in its external shell outline to be closeto our species (especially to Forma *A*, see Pl. XIII), being similarly widely outlined, also the surface ornament of the first species can be compared to some specimens of *Productella varians* n. sp. — Forma *B* (see Pl. XIII, fig. 10). Our species can be also compared to members of many

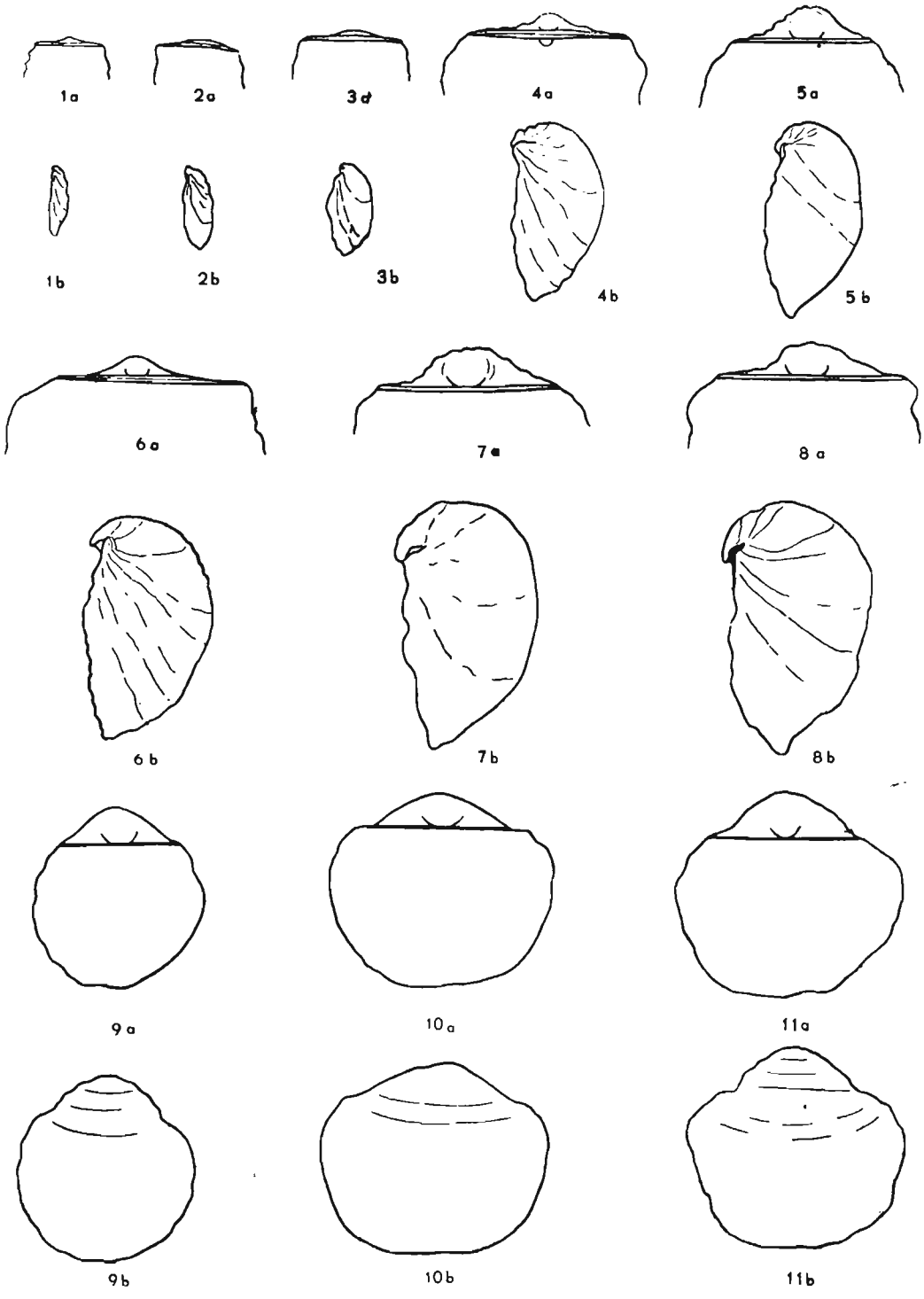


Fig. 21

Productella varians n. sp. Skały beds, marly shales, exposure 73. *1-8* A range of different individual age in: *a* hinge line, *b* side views (Bp. VII/3737-3744); × 1·6. *9a-b* Brachial valve and pedicle valve views of adult specimen (Forma *A*). *10-11a-b* Brachial valve and pedicle valve views of two different specimens (Forma *B*); × 1·4

genera. In external appearance it resembles very much e.g. *Helaspis luma luma* IMBRIE from the Middle Devonian — Traverse group of Michigan, and *Helaspis luma crispa* IMBRIE from Genshaw F. of Michigan (IMBRIE, 1959, Pl. 65). The differences seem to be small, mainly concerning the external morphology. *Spinulicosta* NALIVKIN, 1937, is close internally, but differs externally in having distinct spine bearing ridges. *Orbinaria* MUIR-WOOD & COOPER (1960, p. 149, Pl. 35, figs. 1-26) has not alveolus as our adult specimens, but its shell is nongeniculate (without trail?) and the surface spine bases are less numerous. Some of our completely adult specimens resemble in external appearance some representatives of the genus *Avonia* I. THOMAS, (MUIR-WOOD & COOPER, 1960, Pl. 47, figs. 16-25), but there are differences in the internal structure, mainly in the lack of teeth and sockets in the latter.

Productella cf. **subaculeata** (MURCHISON, 1840)

(Pl. XII, figs. 17-19; Pl. XIII, figs. 11, 12)

Horizon: Limestone of Miłoszów, Skały beds, Middle Devonian.
Locality: Miłoszów near Skały.

Material. — About 25 specimens embedded in the limestone, represented by pedicle valves.

Dimensions (in mm.):

Z. Pal. Cat. No Bp. VII	Length	Width
3796	11·7	16·4
3797	?14·6	?16·0
3798	14·3	17·6

Remarks. — All specimens are not well preserved. Judging from the pedicle valve exterior they look very much like *Productella subaculeata* (MURCHISON), from the Upper Devonian (Frasnian) of Boulonnais, France, figured by MUIR-WOOD & COOPER (1960, Pl. 32, figs 5-13). The majority of specimens look like the one on fig. 14, a hypotype of the genus according to SOKOLSKAJA (1948) from the Devonian — D_3^{el}, Jeletz, USSR. They are similarly wider than long and have widely arranged spine bases on the pedicle valve surface. Ventral umbo is well marked, being thickened and elevated above the hinge-line. Specimens of *Productella subaculeata* from the Devonian (Givetian) of Volhynia, figured by KELUS (1939, Pl. 3, figs. 7, 8), appear to be close to ours from Miłoszów in having a similarly outlined shell and less spines.

Occurrence. — Middle and Upper Devonian; almost throughout the world.

Suborder **CHONETIDINA** MUIR-WOOD, 1955

Family CHONETIDAE BRONN, 1862

Genus **CHONETES** FISCHER DE WALDHEIM, 1830

Type species: *Terebratulites sarcinulatus* SCHLOTHEIM, 1820; Devonian, Germany.

Chonetes supragibbosa SOBOLEV, 1909

(Pl. XIV, figs. 1-13; Text-figs. 22, 23)

1896. *Chonetes gibbosa*; G. GÜRICH, Das Palaeozoicum..., S. 223, Taf. 10, fig. 8.
1904. *Chonetes gibbosa* GÜRICH; D. SOBOLEV, Devonskija..., s. 55, Tabl. 7, ris. 11, 11a, 12.
1909. *Chonetes supragibbosa* SOBOLEV; D. SOBOLEV, Srednij Devon..., s. 446.

Horizon: Marly-argillaceous shales of exposures 72, 73 (brachiopod shales), Skały beds, Middle Devonian
Locality: Skały.

Material. — Twelve nearly complete specimens with both valves closed; 1 separate pedicle valve and 1 partly exfoliated brachial valve.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness		No. of costulae in 1 mm.	
			post.	ant.	post. p. v.	ant. p. v.
1132	9·9	16·0	1·9	0·7	4	2
1128	12·2	19·2	3·2	1·8	5	2
1130	12·6	17·8	2·7	1·6	5	2
1133	14·4	20·6	4·5	2·0	5	2
1122	15·4	24·2	?	2·4	5	2

Description. — (Pl. XIV, figs. 1-9, 12, 13; Text-fig. 22, draw. 1-5, *A*). — Shell of medium size, sometimes asymmetrical, transversely outlined, concavo-convex, with somewhat variable degree of curvature; ventral area anacline, dorsal orthocline, straight or slightly concave; antero-lateral margins rounded. Pedicle valve: surface sulcus narrow, more distinct or less but always present; hinge extensions sometimes auriculate; area trigonal, varying in height, average height = 1·7 mm.; anterior margin of the area slightly undulating (Text-fig. 22 *C*) for about two-thirds of its length; deltidium comparatively large, regularly arched; beak ridges with 8-10 irregularly distributed spine holes or short spine fragments, the holes penetrating to the interior of the shell (Text-fig. 22 *D*). Brachial valve in general regularly concave; chilidium as large as deltidium or slightly smaller.

Ornamentation. Radial costulae fine but distinct, closely and regularly distributed, somewhat corrugate in appearance due to distinct concentric rugae, increasing by division and to a lesser degree by intercalation, their number on one valve oscillating between 90-110; the separating furrows as large as costulae or a little more. Concentric lines especially marked at the anterior margin, having a somewhat lamellar appearance. Concentric microlines present, regularly distributed (Pl. XIV, figs. 5, 6*a*, 12).

Interior (Pl. XIV, figs. 10, 11; Text-figs. 22 *C*, *D*; 23). Pedicle valve: teeth small in proportion to the size of the valve; medium septum high posteriorly, narrowing and lowering anteriorly; muscle area well marked, with elliptical anterior diductors; a groove of the diaphragma preserved (Pl. XIV, fig. 10). Brachial valve: cardinal process strong with incisions (Text-fig. 22 *B*), at its base, two lateral dental sockets, not crenulated; muscle area deep, limited by lateral ridges; medium septum sufficiently distinct, highest at midpoint (Pl. XIV, fig. 11) of valve, in old individuals touching the opposite valve, leaving a trace like a narrow excavation.

Remarks. — The species was described by GÜRICH as *Chonetes gibbosa* (1896, p. 223, Pl. 10, fig. 8); the specific name «*gibbosa*», preoccupied by KAYSER (1878, p. 204, Pl. 30, fig. 10)

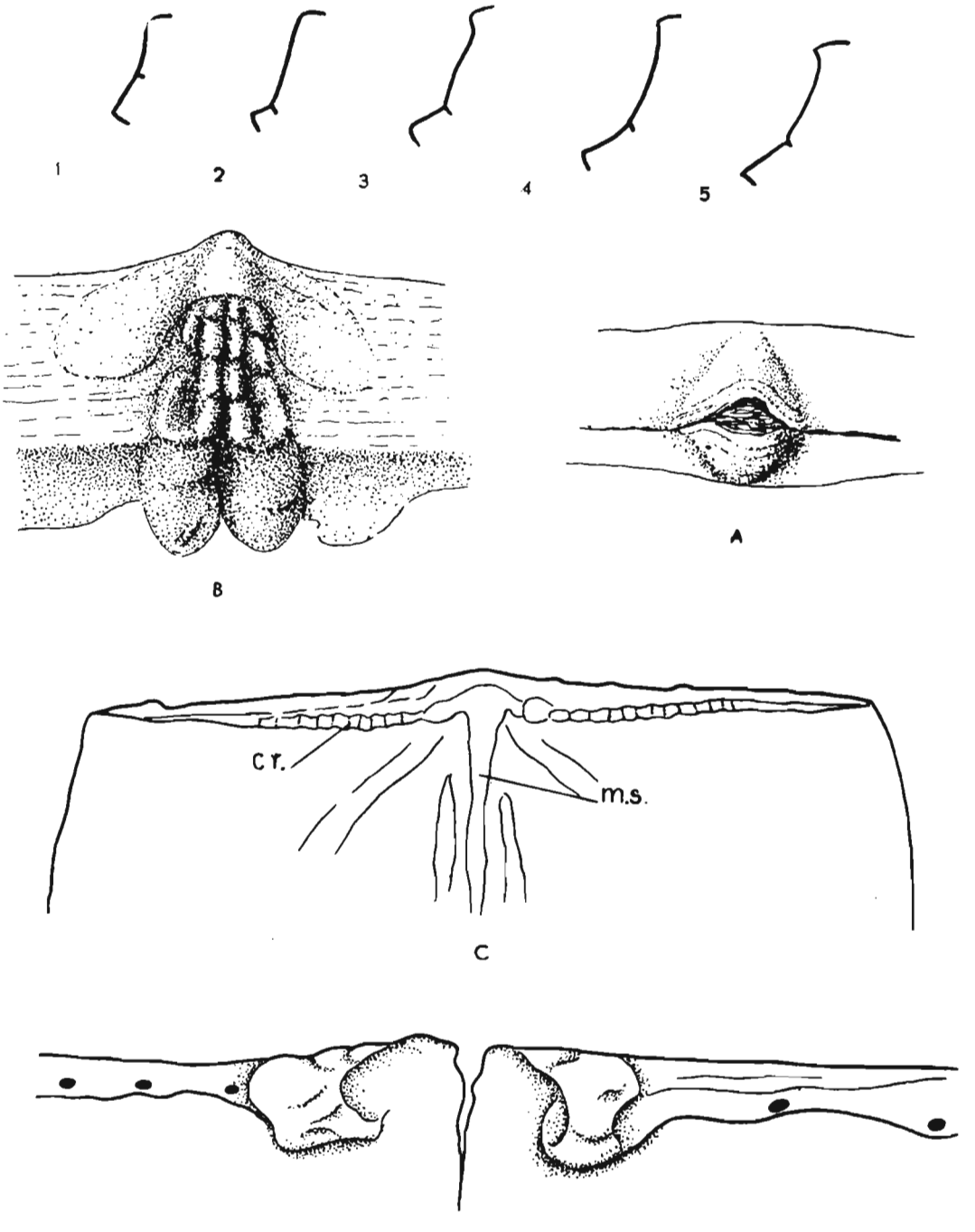


Fig. 22

Chonetes supragibbosa SOBOLEV. Skały beds, marly shales, exposure 73. *1-5* Relation of both areas of the shell. *A* Appearance of pseudodeltidium and chilidium of specimen (Bp. VII/1135); × 10. *B* Posterior view of the cardinal process of specimen (Bp. VII/1122); × 15. *C* Pedicle valve posteriorly showing slightly undulated anterior end of the ventral area (Bp. VII/1119); × 6·4. *D* Ventral area from inside, with holes for umbonal margin spines (Bp. VII/1119); *cr.* undulation (homologous to denticulation of strophoedontids), *m. s.* median septum; × 15

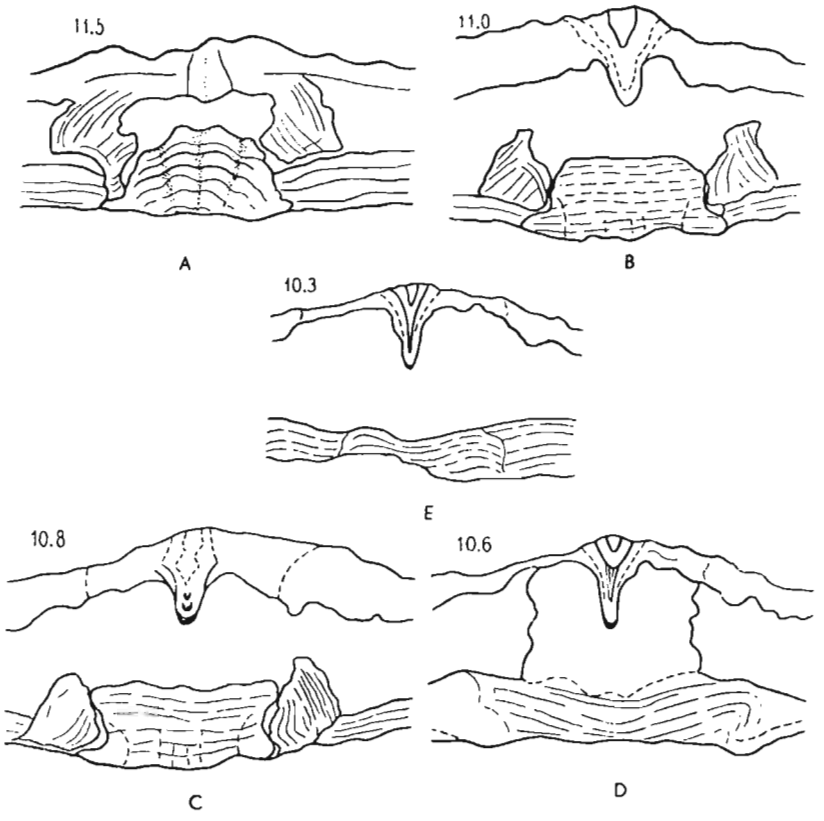


Fig. 23
Chonetes supragibbosa SOBOLEV. Skały beds, marly shales, exposure 73. *A-E* Serial cross sections of adult specimen about 11·7 mm. long; approx. × 15

for a species from the Devonian of Harz, has been changed by SOBOLEV (1909, p. 446) for «*supragibbosa*». It is a characteristic species, distinguished from the other known chonetids by a narrow sulcus, accentuated transverse shell outline and distinct although fine radial costulae arising by division. In general aspect it is similar to species of the genus *Rugosochonetes*.

Occurrence. — Marly and argillaceous shales of Skały beds. Middle Devonian, Łysogóry region, Holy Cross Mountains.

Family EODEVONARIIDAE SOKOLSKAJA, 1960

The family proposed by SOKOLSKAJA included up to now only one genus *Eodevonaria* BREGER, 1906. This genus with a number of Lower Devonian species, widely distributed, appears to be distinctive due to its chonetoid external appearance, i.e. shell shape and outline, surface ornamentation, and its denticulated hinge line of stropheodontid type. At present the above family comprises two subgenera: *Eodevonaria (Eodevonaria)* BREGER, 1906, with type species *Chonetes arcuatus* HALL, 1857, from the Lower Devonian of N. America, and *Eodevonaria (Devonaria)* n. subg. with type species *Chonetes zeuschneri* SOBOLEV, 1909, from the Middle Devonian of the Skały beds, Poland.

Occurrence. — Devonian (Lower, Middle and ?Upper), throughout the world.

Genus **EODEVONARIA** BREGER, 1906

Subgenus EODEVONARIA (DEVONARIA) n. subgen.

Type species: Chonetes zeuschneri SOBOLEV, 1909, s. 444 Middle Devonian of Skały beds, *Calceola* layers-marls.

Locality: Skały, Łysogóry region, Holy Cross Mountains.

Diagnosis. — Medium sized, thick-walled, concavo-convex, costulate and denticulate eodevonariids with spinose beak ridges; internally: very short medium septum in the brachial valve followed by a deep furrow, two median lamellae long and greatly elevated and two lateral additional ridges.

Remarks. — The new subgenus is proposed for the Middle Devonian (Upper Eifelian-Givetian) eodevonariids, probably deviating from *Eodevonaria (Eodevonaria)* BREGER. Externally, these two subgenera are much alike. Both are costulate, have spinose beak ridges and a denticulate hinge line. A comparison between the interiors of the brachial valve of *Eodevonaria (Eodevonaria)* and our subgenus shows some differences, regarded as being of taxonomic value for the new subgenus. The feature which differs most is undoubtedly the median septum, invariably very short in adult specimens of *Eodevonaria (Devonaria) zeuschneri* (SOBOLEV) and followed by a deep angular furrow, bordered by two long and thickened lateral lamellae. In the latter our subgenus is close to sowerbyellids.

Genus *Retichonetes* MUIR-WOOD (1962, p. 62), proposed for a group of small species from the Middle-Upper Devonian and Carboniferous, differs from *Eodevonaria (Devonaria)* n. subgen. in having prominent teeth in the pedicle valve; in the brachial valve, showing a long and well developed medium septum, two very short lateral septa and bilobed cardinal process. *Chonetes crenulata* ROEMER and *Chonetes minuta* BUCH, assigned by MUIR-WOOD to *Retichonetes* (1962, p. 62), are considered to be closer related to *Eodevonaria* and are here included to the new subgenus *Eodevonaria (Devonaria)*.

Occurrence. — Middle Devonian, Eifelian-Givetian.

Eodevonaria (Devonaria) zeuschneri (SOBOLEV, 1909)

(Pls. XV, XVI; Text-figs. 24-26)

1904. *Chonetes crenulata* F. ROEMER var.?; D. SOBOLEV, Devonskija..., s. 53, Tabl. 7, ris. 7-10.
1909. *Chonetes Zeuschneri* SOBOLEV; D. SOBOLEV, Srednij Devon..., s. 444.

Diagnosis. — Thick-walled, medium sized and densely costulate shells, with spinose beak ridges like chonetids, denticulate hinge line like eodevonariids; in brachial valve medium septum short tending to obsolescence, two lateral muscle lamellae much elevated (serving as attachment surfaces for muscles?).

Material. — About 400 free, entire shells of different individual age; 10 almost complete brachial valves and 2 pedicle ones; exposures 72, 73.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Width of hinge line	Thickness
1169	2·2	2·8	2·2	0·6
1171	2·8	3·5	2·8	0·8
1173	4·6	6·4	5·8	1·2
1176	6·0	7·4	6·2	1·2
1179	7·4	9·4	8·0	2·0
1181	8·4	10·0	8·2	2·2
1186	10·6	12·2	10·4	3·2
1187	11·5	14·2	12·8	3·0
1189	13·0	16·2	13·8	4·8
1193	16·2	17·5	17·0	6·2

Description. — Shell small to medium size, thick-walled, concavo-convex (Text-fig. 25*A-D*; Pl. XVI, figs. 1-4), somewhat variable in its semioval extensions; hinge line with a tendency to form auriculate extensions. Pedicle valve: umbo prominent with weakly marked beak, slightly incurved; beak ridges with 2-6 hollow spines (Pl. XV, figs. 11, 14; Text-fig. 26, draw. 8, 9); interarea of variable height, slightly concave beneath the beak; pseudodeltidium entire, arched (Pl. XV, figs. 11-15). Brachial valve varying in its concavity; interarea low; notothyrium partly covered by pseudochilidium, filled with cardinal process.

Ornamentation (Pl. XV, fig. 16; Pl. XVI, figs. 6, 7, 9, 11, 16; Text-fig. 25). Radial costulae numerous, subangular, slightly corrugated, varying in number from 28-50 at the antero-lateral commissure, single or divided, in varying degree increasing by addition on the lateral slopes by bifurcation and corresponding intercalation; separating furrows almost as deep as the costulae are high. Concentric growth lines often not observed. Concentric microlines continuous, closely set, generally 11-14 per 2 mm.

Interior. Pedicle valve (Pl. XV, figs. 1, 2; Pl. XVI, fig. 13; Text-fig. 24, draw. 4). On both anterior edges of the delthyrium two small hinge teeth present, the whole remaining hinge-line bears denticles arranged from nearly parallel to outwardly divergent; apical cavity with a callus merging with a short medium septum of slightly variable height and thickness, which greatly lowers anteriorly and disappears about halfway or more to the anterior margin; muscle area large, adductors elongated, diductors flabellate; marginal ridges moderately marked. Brachial valve (Pl. XV, figs. 3-9; Pl. XVI, figs. 13, 14; Text-figs. 24, 26*A-C*): hinge denticles shorter than those on the opposite valve; dental sockets and socket ridges slightly marked; cardinal process knob-like from interior, from outside with 4-6 incisions; it merges into a short medium septum and two short divergent ridges (= muscle bounding ridges); two lateral septa of varying arrangement (= ?attachment surfaces for muscles) greatly extending anteriorly, lacking in young growth stage; medium septum usually thickened anteriorly, occupying to about one-third of the valve length, joining a distinct fissure, extremely deep in old individuals; muscle area well marked especially in old individuals; entire shell surface distinctly papillate.

Individual variability. — The number of specimens available is quite sufficient to give some picture of the individual variability. However, specimens of this species vary only in a few features and rather within narrow limits. The shell outline ranges from quite transverse to slightly oval. The umbo rises always above the hinge line, having a nearly constant degree of beak incurvature, but varying somewhat in size and proportion. Interarea is one of the features which varies markedly in height and length with some corresponding changes in the shell outline

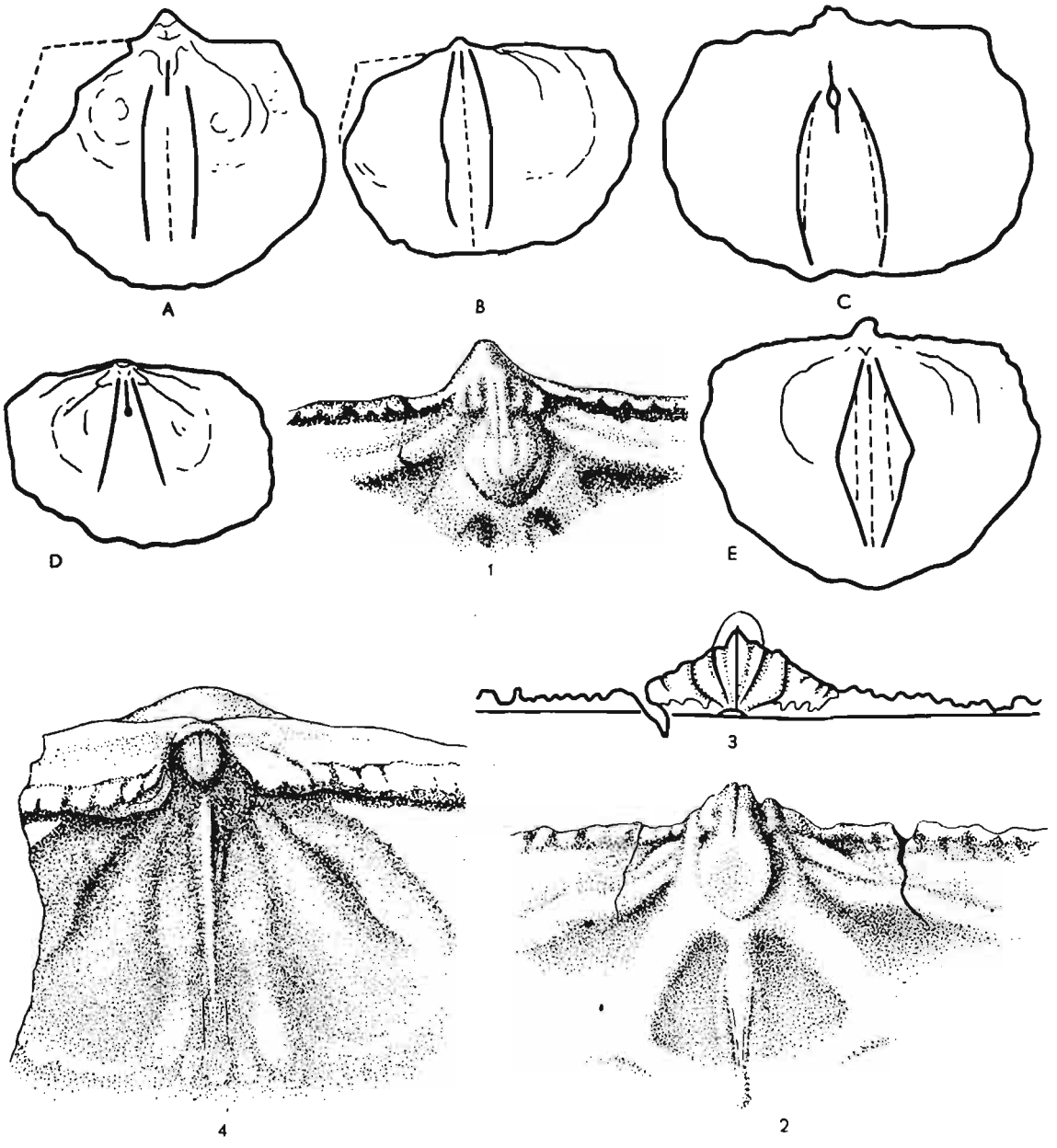


Fig. 24

Eodevonaria (*Devonaria*) *zeuschneri* (SOBOLEV). Skały beds, marly shales, exposure 73. *1-2* Cardinal process of old specimens (Bp. VII/3720, 3721); 12·5. *3* Posterior view of the cardinal process (Bp. VII/3721); × 9·5. *4* Ventral interior of adult specimen (Bp. VII/1620); × 12·5. *A-E* Dorsal interior of 5 specimens adult and old (Bp. VII/3722, 3723, 3724, 3725, 3726); × 4

(Text-figs. 25; 26, draw. 1-3). In more transverse shells the area extends for almost the full hinge width being rather small (low). Less transverse shells have shorter but about twice as high an interarea, which is softly incurved beneath the beak. Number of spines on the posterior margin of the pedicle valve varies from 2 to 6. Spines placed at the umbo are always more delicate, than those at the cardinal extremities, which are stouter as they appear earlier in the growth process.

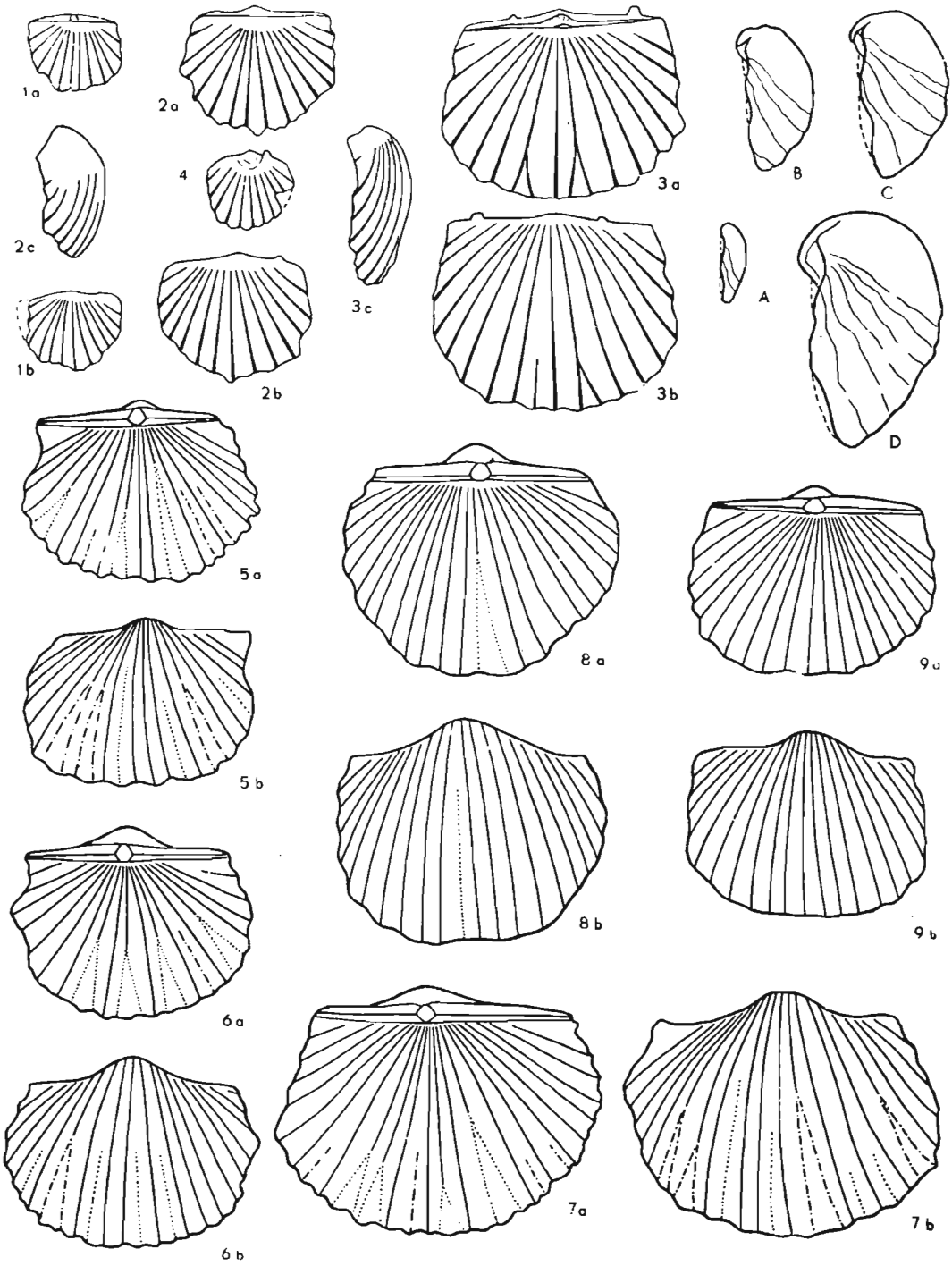


Fig. 25

Eodevonaria (*Devonaria*) *zeuschneri* (SOBOLEV). Skały beds, marly shales, exposure 73. *1-3* Younger individuals in: *a* brachial valve, *b* pedicle valve, *c* side views. *4* Pedicle valve view of young individual; × 6·6. *5-9* Surface radial ornamentation: *a* brachial valve, *b* pedicle valve. *A-D* Side view of specimens of different individuals; × 2

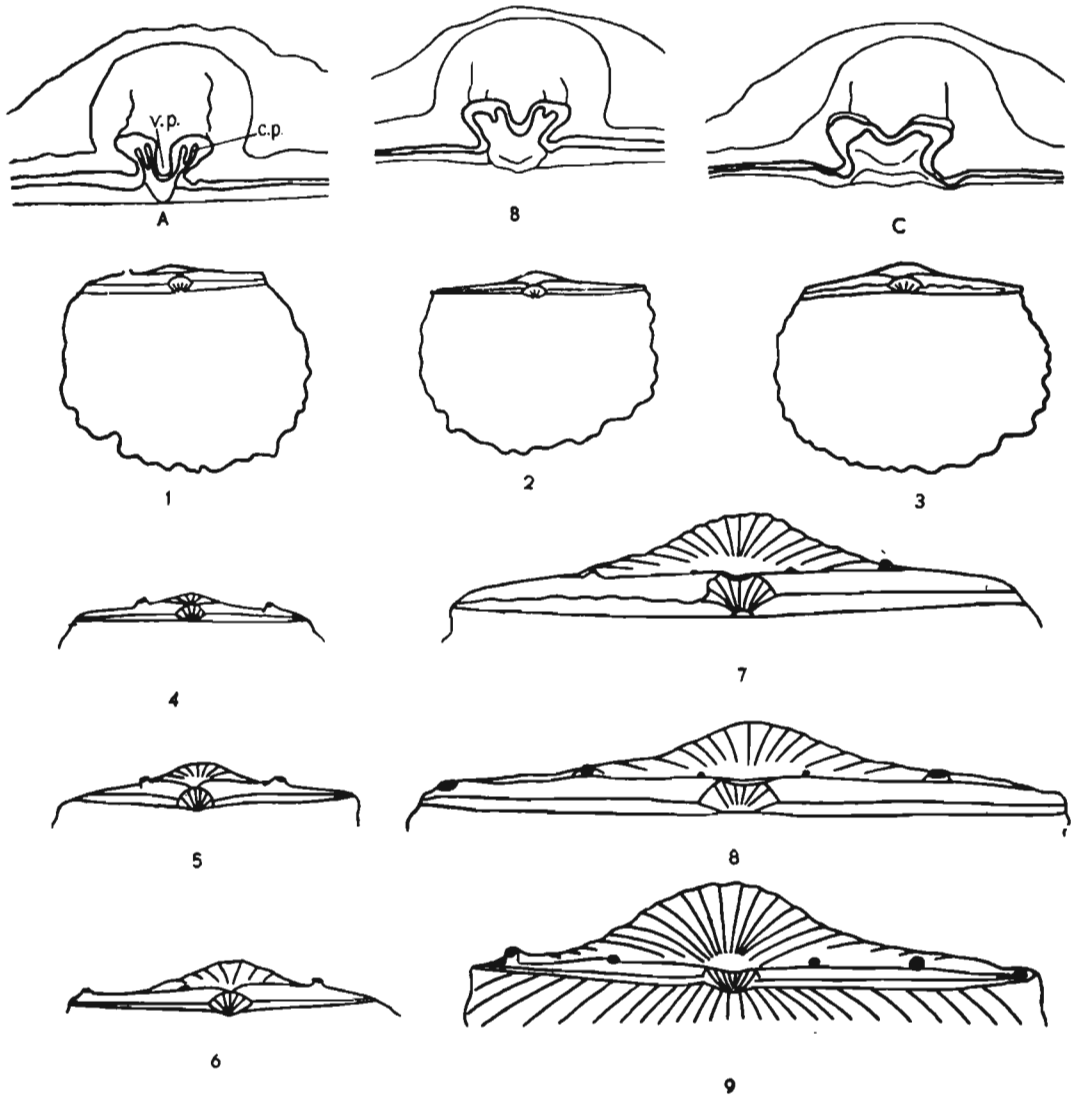


Fig. 26

Eodevonaria (*Devonaria*) *zeuschneri* (SOBOLEV). Skały beds, marly shales, exposure 73. *A-C* Serial cross sections of adult specimens; × 10. *1-3* Three immature specimens, brachial valve view, showing the same shell outline. *4-6* Number and distribution of spines on the ventral beak ridges in younger individuals. *7-10* Number and distribution of spines on the ventral beak ridges in adult specimens; × 6·6

Internally, only the lateral septa show a great variation in the degree of their divergence (Text-fig. 24*A-E*).

Growth changes. Shells of immature individuals, to about 1·5 mm. long and 2·0 mm. wide, are flat, subquadrate in outline, with accentuated cardinal extremities and moderately rounded antero-lateral commissure. The growing shell becomes concavo-convex, more transversely elongated, with cardinal extremities rounded or extended into small auricular extensions. Pseudodeltidium and chilidium is usually observed in specimens of about 3 mm. long.

Cardinal process in specimens of about 1·1 mm. long is, as a rule, composed of 2 small ridges, fused together posteriorly, forming a «roofIet» like structure with a small central «alve-

ola», placed anteriorly to it or just beneath it, like alveola in productellids. This alveola disappears with growth, being replaced in specimens of about 5 mm. long and 6 mm. wide by a platform, which merges with an incipient septum and later with two lateral ridges. Septum remains very short, having in maturity and in gerontic age a greatly thickened anterior end.

Two small teeth on both delthyrial corners and corresponding dental sockets are observed in specimens 1·5—2·0 mm. long. They grow very slowly, being not distinct in maturity. Denticulation of the hinge looks at first like incisions on both sides of the cardinal process, appearing almost contemporaneously with a brachial septum. With growth the denticles strengthen and increase in number towards the hinge extremities.

Remarks. — The species is fairly common in the marly shales of the Skały beds. Externally, the most distinctive feature is undoubtedly its shell size and outline with costulate surface and spinose beak ridges. It is most comparable with *Chonetes minuta* BUCH, 1836, from the Middle Devonian limestone of Eifel (SMF collection — Blankenheim, Vollendorf), but is slightly larger and more transversely outlined, the umbo less elevated and radial costulae, in general, two to three times more numerous. *Chonetes minuta* figured by SCHNUR (1853, Pl. 44, fig. 5) shows some similarity to our species in the brachial valve interior, with exception of the medium septum which is much longer in the former species. In the spinose beak ridges, and denticulate hinge-line our species resembles very much *Eodevonaria arcuata* (HALL). Differences may be seen in the brachial valve interior.

Order **RHYNCHONELLIDA** KUHN, 1949

Family CAMAROTOECHIIDAE SCHUCHERT & LE VENE, 1929

Subfamily CAMAROTOECHIINAE SCHUCHERT & LE VENE, 1929

Genus **LEIORHYNCHUS** HALL, 1860

Type species: *Orthis quadracostata* VANUXEM, 1842; Upper Devonian, N. America.

Leiorhynchus subplicatus n. sp.

(Pl. XVII, figs. 1-4; Pl. XIX, fig. 26)

Holotype: Z. Pal. Cat. No. Bp. VII/25, figured on Pl. XVII, fig. 1.
Type horizon: Limestone of Miłoszów, Skały beds, Middle Devonian.
Type locality: Miłoszów, near Skały, Łysogóry region, Holy Cross Mountains.
Derivation of the name: subplicatus — reminding one of *Leiorhynchus plicatus* ROZMAN (1962), but has less costae.

Diagnosis. — Medium sized *Leiorhynchus*, moderately biconvex, anterior margin sulcate. tongue short; nearly the whole shell surface covered by distinct but low and flattened costae,

Material. — Ten specimens, 7 sufficiently well preserved, 2 damaged and partly recrystallized, 1 specimen embedded in the limestone. Specimens come from limestone of exposure 89, and Miłoszów.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus	No. of costae
24	15·5	21·1	9·2	10·2	?-5-7
25 (holotype)	21·9	25·9	13·0	13·3	?-6-6?

Description. — Shell of medium size, pentagonal in outline, widely sulcate; width much greater than length, the greatest at midlength; almost equally moderately biconvex; apical angle moderate. Pedicle valve: sulcus wide and shallow, developed on the posterior half of the valve; beak small incurved. Brachial valve weakly convex; fold broad, low slightly more elevated at the anterior margin.

Ornamentation. The costae are low with rounded backs, probably covering the whole shell surface, except for the umbonal portion, 5-6 in the sulcus, 7-8 on the fold and 7-9 on both lateral slopes of each valve. The costae in the sulcus and fold are always distinct, those on the slopes are, in general, poorly preserved.

Interior not studied in details because of scarce material. On the fragment of the brachial valve, divided hinge-plates supported posteriorly by a median septum and a shallow septalium are observed. In the pedicle valve weak traces of the dental plates have been observed.

Remarks. — Although the collection is small, the specimens are quite distinct, so a new species is proposed. The species is characterized by its flattened shell convexity, pentagonal outline, broad but shallow ventral sulcus and correspondingly low dorsal fold, both starting at the umbonal region. It resembles, in general appearance, *Leiorhynchus* cf. *formosus* (KAYSER), described and figured by SOBOLEV from Świętomarz beds (1909, Pl. 6, figs. 17*a-c*), but the latter species is less transverse, slightly more globular and has wider and fewer radial costae. As far as it can be judged from illustrations, there is also some external similarity to *Leiorhynchus polonicus* (F. R. ROEMER) figured by SOBOLEV (1909, Pl. 6, figs. 7*a, b*) and cited by him from the limestone of Szydłówek, Kostomłoty, Chęciny (Holy Cross Mountains). Our specimens, however, are smaller, thinner and shallower, and the anterior commissure is more moderately sulcate, also the costae are smaller. Our species differs from *Leiorhynchus plicatus* ROZMAN, the Famennian species of Mugodzhar, USSR (ROZMAN, 1962, Pl. 10, figs. 1-6), which it much resembles in general shell dimensions and shape, in the more pentagonal shell outline and slightly in the appearance of radial costae, which appear to be more regular. It resembles also some Canadian species described by MCLAREN from the Early Upper Devonian — Alberta, such as *Leiorhynchus russelli* MCLAREN (1962, p. 95, Pl. 17, fig. 6), *Leiorhynchus avokanak* MCLAREN (1962, p. 91, Pl. 16, figs. 4, 5), but both mentioned species are more biconvex, especially their umbonal portions.

Family UNCINULIDAE RZONSNICKAJA, 1956

Genus **UNCINULUS** BAYLE, 1878

Type species: *Hemithiris subvilsoni* D'ORBIGNY, 1850; Lower Devonian, France.

Uncinulus primipilaris (v. BUCH, 1834)

(Pl. XVII, fig. 12; Pl. XVIII, figs. 1-15; Text-fig. 27)

1834. *Terebratula primipilaris* v. BUCH, L. v. BUCH Terebrateln..., S. 68, Taf. 2, Figs. 29*a, b, c*.
1904. *Rhynchonella primipilaris* v. BUCH; D. SOBOLEV, Devonskija.., s. 93, Tabl. 9, ris. 21.
1909. *Rhynchonella primipilaris* v. BUCH; D. SOBOLEV, Srednij Devon..., s. 505.
1941*b*. *Uncinulus primipilaris* (v. BUCH); H. SCHMIDT, Die Mitteldevonischen..., S. 23, Taf. 2, Fig. 21; Taf. 6, Fig. 17.

Horizon: Marly shales of exposures 72, 73, 84, marls of exposure 81, Skały beds, Middle Devonian.
Locality: Skały.

Material. — Over 500 specimens, free, with both valves closed; 20 separate pedicle valves, 1 brachial valve.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus	No. of ribs			
					ped. v.	br. v.	sulcus	fold
75	11·9	11·8	8·2	7·0	12	12	13	10
76	11·9	13·2	8·2	6·5	14	14	10	9
77	11·9	13·0	8·0	8·0	12	13	7	10
78	12·2	13·8	9·0	7·2	14	17	12	13
79	12·2	13·8	9·2	6·5	19	21	11	7
80	12·4	13·8	8·5	8·0	13	12	8	7
81	12·5	14·2	9·0	8·5	15	13	12	7
82	14·2	16·0	10·0	11·2	15	15	14	10
83	14·0	15·6	9·5	10·0	15	17	15	12
84	14·2	16·5	10·0	9·0	13	11	14	9

Description. — Shell of medium size, subquadrate to nearly pentagonal in outline, with anterior margin distinctly sulciplicate; tongue developed. Pedicle valve: beak prominent, slightly incurved; pedicle foramen apical, circular, surrounded by deltidial plates. Brachial valve with fold always distinct.

Ornamentation is distinctive, not easily comparable with that of other known uncinuloids and is considered to be highly diagnostic for the species. In general, the costae arise with great regularity from 4-6 primaries, originating at the umbo. With growth, however, they increase in a somewhat different way by branching, bifurcation and intercalation. In consequence, in maturity the ornamentation is considerably changeable, due to the differences in the number of costae and their arrangement, although its general pattern is preserved in all specimens.

The most common in the collection are specimens with numerous moderately acute costae, nearly of equal size (see Text-figs. 27, draw. 1*a*, *b*, 3*a*, *b*). As a rule, intercalation prevails, bifurcation is rarer giving rise to costae of secondary, sometimes tertiary order. This kind of ornamentation develops in harmony with the normal shell growth, the costae increasing gradually and slowly. Much less common are specimens with the ornamentation shown on Text-figs. 27, draw. 2*a*, *b*, which is rather striking. The costae are sharper, in the posterior half less numerous, single, thick, in the anterior half forming distinct bundles, probably as a result of faster, almost simultaneous branching from both sides of primary costae. The shells are on an average slightly smaller and these bundles of costae can be a reflection of a quicker tempo of shell growth. In all specimens, the two costae bordering the sulcus always branch in a similar way, forming similar bundles. It is one of the characteristics of radial ornament common for *Uncinulus primipilaris* (BUCH).

Interior. Pedicle valve (Pl. XVIII, figs. 10-14): delthyrial cavity deep, teeth small with small incisions on their inner sides; muscle area very deep; adductors small, with a weak median separating ridge, continuing anteriorly and dividing diductors which are larger, being of about circular outline. Vascular sinuses observed in parts only (Pl. XVIII, fig. 12). Brachial valve (Pl. XVIII, fig. 15): cardinal process raised with several longitudinal incisions; dental sockets of moderate depth; hinge plate undivided; medium septum thick, extending anteriorly to about two-thirds of the valve length. Vascular sinuses partly observed.

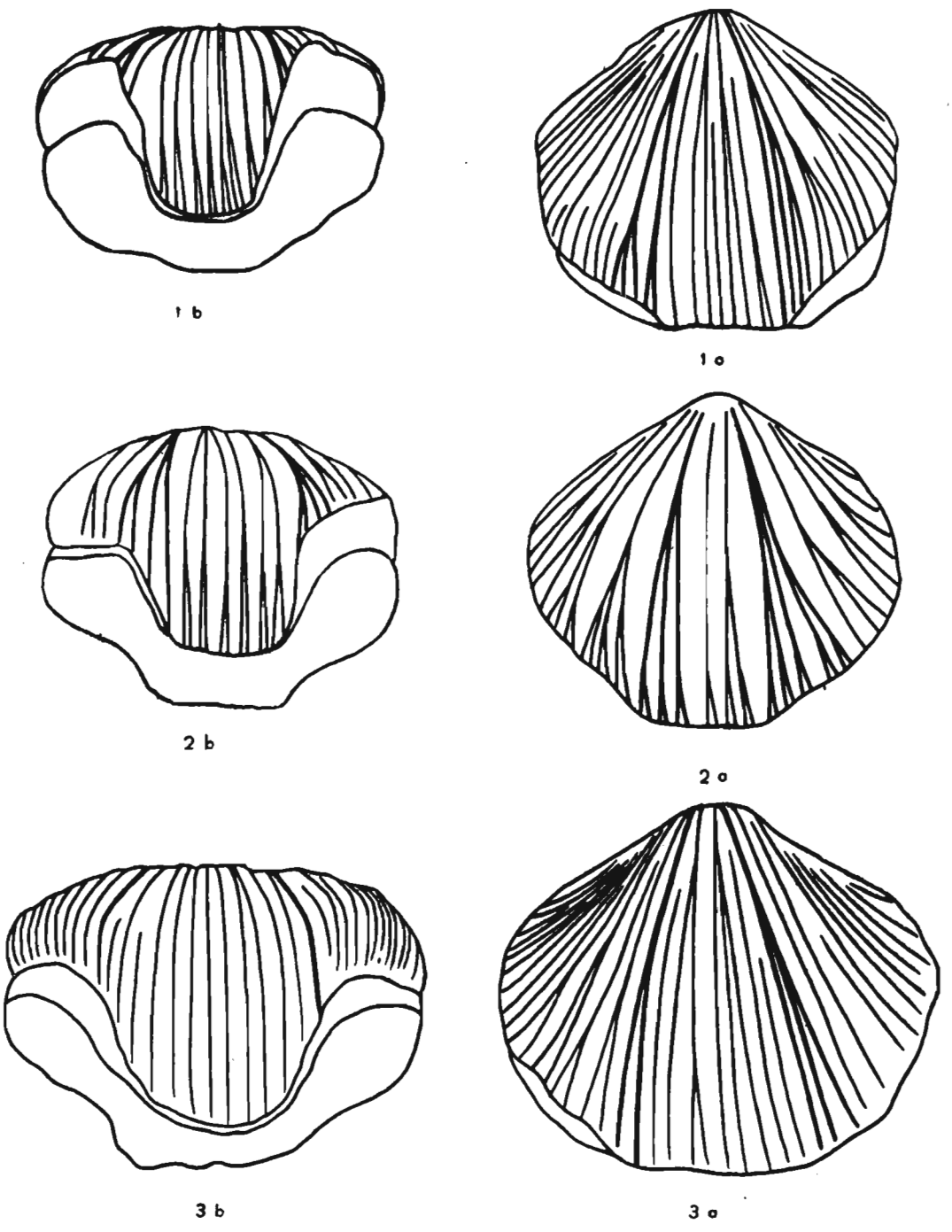


Fig. 27
Uncinulus primipilaris (v. BUCH). Skały beds, marly shales, exposure 84. *1-3* Three different specimens in: *a* pedicle valve, *b* anterior views, showing differences in the appearance of the radial ornamentation (Bp. VII/81, 76, 84); × 3·6

Individual variability. — The collection is rich, including samples from a few outcrops within the Skały beds. The most numerous are specimens from the base of the section (outcrops 72, 73), they become less numerous towards the top, being represented by only a few specimens (exp. 81, 84). The measurements of 100 specimens of one community (from marly shales of exposure 73) show great stability in their exterior, mainly in such features as length, width, thickness of the shell, with the exception of ornamentation (as mentioned on p. 84) and tongue outline, that means: its width, which is connected with the shell width rather, than with shell length and the degree of its elongation.

Remarks. — Our specimens are closest to specimens of *Uncinulus primipilaris* (BUCH) from Freilinger layers (SMF collection) mainly in the coarseness of costae. They can be compared with *Uncinulus parallelepipedus* (BRONN) which they resemble in the shell outline and appearance of the tongue, but differ considerably in the pattern of radial ornamentation.

Occurrence. — The species appears to be an important and useful index fossil. In Germany it is characteristic especially for Freilinger layers, passing throughout this horizon (METJE, 1963, p. 139). It is known from Middle Devonian of Germany (Rhine region) and Poland (Holy Cross Mountains).

Uncinulus coronatus (KAYSER, 1871)

(Pl. XIX, figs. 27-29; Text-fig. 28)

1871. *Rhynchonella coronata*; E. KAYSER, Die Brachiopoden..., S. 512, Taf. 9, Fig. 5.
1896. *Rhynchonella* aff. *coronatae* KAYSER; G. GÜRICH, Das Paläozoicum..., S. 285, Taf. 7, Fig. 5.
1904. *Rhynchonella coronata* KAYSER; D. SOBOLEV, Devonskija..., s. 94, Tabl. 9, ris. 23.
1909. *Rhynchonella coronata* KAYSER; D. SOBOLEV, Srednij Devon..., s. 507.
1941*b*. *Uncinulus coronatus* (KAYSER); H. SCHMIDT, Die Mitteldevonischen..., S. 24, Taf. 2, Fig. 24; Taf. 4, Fig. 73; Taf. 6, Fig. 18.

Horizon: Marls, exposure 83, Skały beds, Middle Devonian.
Locality: Skały.

Material. — Two free shells, strongly deformed; 1 fragment of shell. Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus
3	16·3	19·0	?11·2	10·1
4	16·4	18·0	?9·7	9·7

Description. — Shell of medium size, transversely subcircular in outline, moderately biconvex; shell widest at midlength; antero-lateral margins rounded; anterior margin angularly uniplicate. Pedicle valve slightly convex umbonally, lowering anteriorly, both flanks elevated; shallow sulcus beginning about midlength of valve; tongue marked; deltidial plates observed only on cross sections. Brachial valve: median fold distinct, starting about midlength.

Ornamentation. Costae, usually indistinct posteriorly, angular, widening anteriorly, about 22 to each valve — 9 on lateral flanks and 4 both, in sulcus and fold; as a rule costae are single, except for those limiting sulcus and fold, which can bifurcate even twice (this latter feature is believed by SCHMIDT (1941, p. 24) as characteristic for the species). The furrows are narrow.

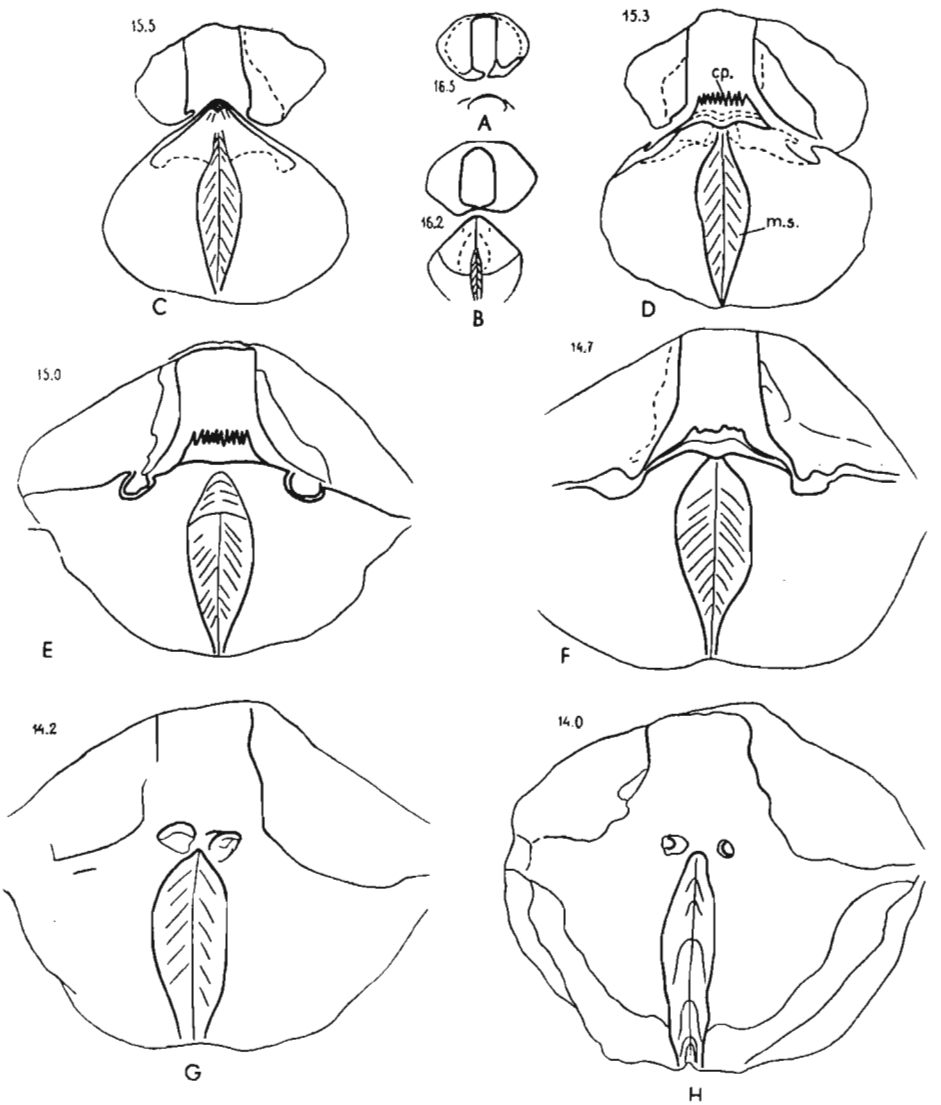


Fig. 28
Uncinulus coronatus (KAYSER). Skały beds, marls, exposure 83. *A-H* Serial cross sections of specimen (Bp. VII/4c): *c. p.* cardinal process, *m. s.* median septum; × 4.2

Interior (Text-fig. 28). Pedicle valve: dental plates thin, teeth small, simple, muscle scars deeply excavated. Brachial valve: cardinal process with distinct longitudinal incisions; medium septum very thick, thinning anteriorly, beginning just below the base of cardinal process; hinge line short united; crura thick, lying close together, dental sockets shallow; muscle scars deep; some traces of pallial sinuses observed on the exfoliated slope of valve (Pl. XIX, fig. 28*c*).

Remarks. — *Uncinulus coronatus* (KAYSER) appears to be a distinctive species, rather constant in its external morphology. The alate lateral slopes, distinct radial costae, quadrangular tongue, well limited by the high walls of the two lateral costae, are believed to be the most important and characteristic features for the species.

Our specimens in their external and internal characters correspond with those of KAYSER'S *Uncinulus coronatus* from the Middle Devonian of Eifel (KAYSER, 1871, Pl. 9, fig. 5; SCHMIDT,

1941*b*, Pl. 6, fig. 18). When compared with the small collection of specimens (SMF coll. XVII, 754c) from *Ostiolatus* horizon from Schönecken, a slight difference is observed in the thickness and distinctness of the radial costae, the lateral flanks being also less alate in our specimens. GÜRICH (1896, p. 285) noted slightly less coarse radial costae in specimens from Skały, assigned by him to *Rhynchonella* aff. *coronatae* KAYSER. *Uncinulus volmericus* VEEVERS from the Devonian of Australia has probably, judging from illustrations (VEEVERS, 1959, p. 96, Pl. 10, figs. 38, 40-42, 48) more flattened and somewhat less distinct radial costae and a more transverse shell.

Occurrence. — Middle Devonian; Germany (Rhine region), Poland (Łysogóry region).

Uncinulus subcordiformis (SCHNUR, 1854)

(Pl. XX, figs. 5-21, Text-fig. 29)

1854. *Terebratula subcordiformis*; J. SCHNUR, Brachiopoden..., S. 186, Taf. 25, Figs. 6*a*, *b*, *c*, *k*.
1904. *Rhynchonella subcordiformis* SCHNUR; D. SOBOLEV, Devonskija..., s. 91.
1909. *Rhynchonella subcordiformis* SCHNUR; D. SOBOLEV, Srednij Devon..., s. 506.
1941*b*. *Uncinulus subcordiformis* (SCHNUR); H. SCHMIDT, Die Mitteldevonischen..., S. 19, Taf. 2, Fig. 20; Taf. 4, Fig. 71.
1956. *Uncinulus (Uncinulus) subcordiformis* (SCHNUR, 1853); V. HAVLÍČEK, Ramenonožci..., p. 566, Tabl. 9, obr. 1-4.

Horizon: Limestone of Miłoszów, Skały beds, Middle Devonian.
Locality: Miłoszów.

Material. — Over 25, almost complete free specimens, with both valves closed, about 20 specimens enclosed in limestone.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus	No. of costae	
					sulcus	flanks
19	9·5	10·6	6·9	5·8	5	?12
16	13·5	13·4	8·8	—	—	—
11	14·8	15·0	9·5	9·8	8	16
7	14·9	?18·2	8·0	9·7	8	—
6	15·6	18·0	10·5	10·6	10	?19
10	16·0	19·5	10·7	10·0	9	—
8	16·4	21·2	11·2	11·7	12	?17
9	18·0	24·1	12·5	11·3	12	20

Description. — Medium sized shells, very transversely outlined, widest about midlength; anterior commissure broadly uniplicate. Pedicle valve: umbo low with slightly incurved beak; shallow sulcus curving dorsally into a small tongue. Brachial valve: fold correspondingly broad, marked at the anterior commissure.

Ornamentation. Radial costae numerous, low, with rounded backs, often bifurcating, fine posteriorly, tending to disappear at both beaks. There are 8-12 costae in both sulcus and fold and 32-40 on lateral flanks. The separating furrows are much narrower than the costae. Concentric lines indistinct.

Interior studied in serial section (Text-fig. 29). Pedicle valve: delthyrial cavity deep, walled by long and nearly vertical stout, but short dental plates; teeth small and short. Brachial valve: dental sockets shallow and small; hinge-plate thin, divided; medium septum stout, diminishing in height anteriorly, being posteriorly thickened, lenswise; crura small, extending anteriorly

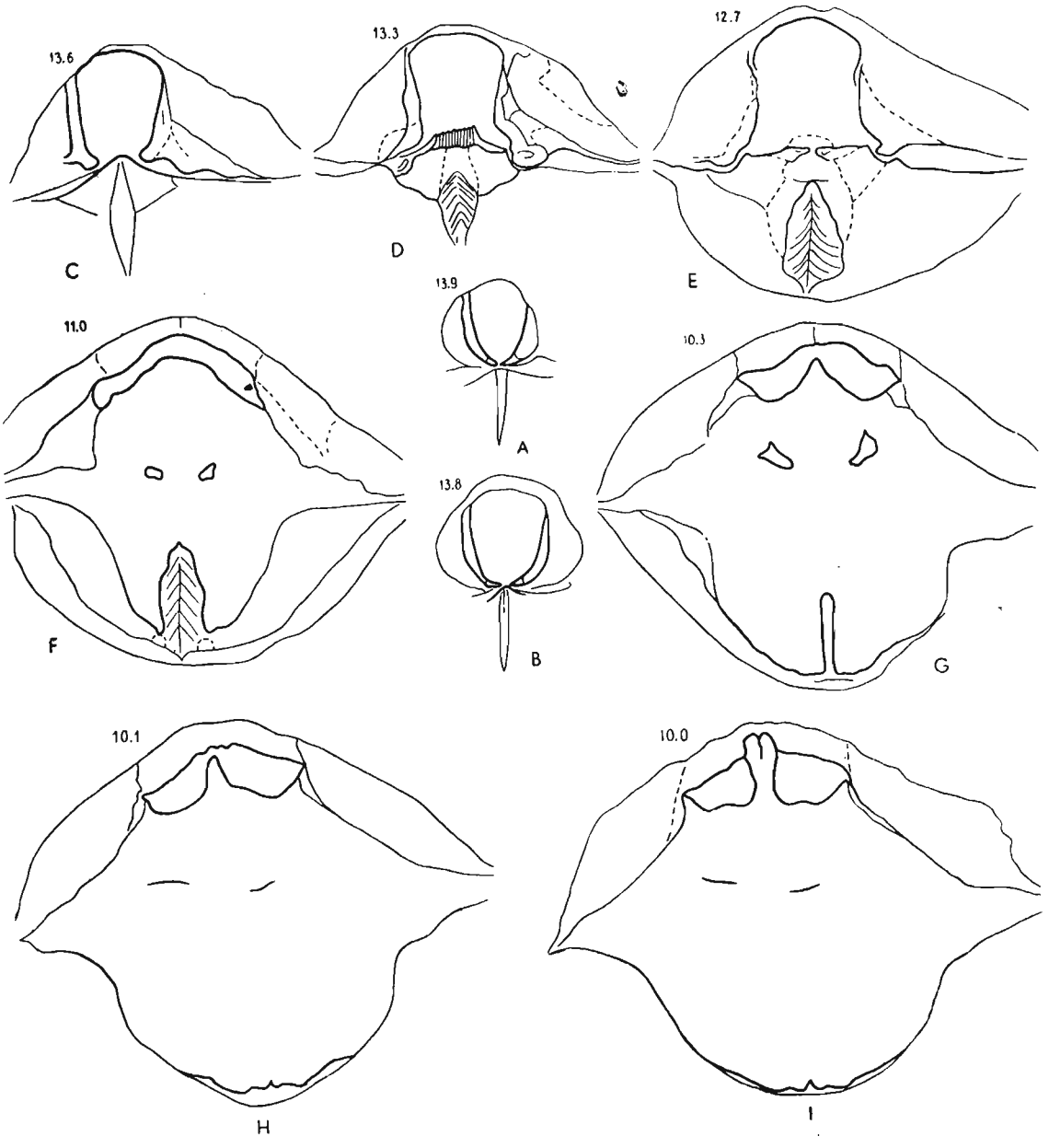


Fig. 29
Uncinulus subcordiformis (SCHNUR). Skały beds, limestone of Miłoszów, *A-I* Serial cross sections of adult specimen, (Bp. VII/12); × 5·3

from the hinge-plates; cardinal process broad with numerous, about 20, incisions on its posterior surface (Text-fig. 29 *D*).

Remarks. — In general, the species can be considered as somewhat variable, but distinctive. Above all, the variability is pronounced in the distinctness and number of radial costae, to some degree in breadth of sulcus and in shell outline, which is sometimes more transversely elongated (e.g. SMF coll. XVII 258 n), sometimes less (e. g. SMF coll. XVII 258 l). All specimens from the limestone of Miłoszów are represented chiefly by adult individuals, with variation

in the shell outline not very pronounced (shell is always much wider than long). The collection contains a few shells of younger individuals, which are less transverse and resemble LEIDHOLD's «schmale Form» of *Uncinulus subcordiformis* (SCHNUR) from Bilveringsen (LEIDHOLD, 1928, Pl. 2, figs. 3-5).

Our specimens assigned to *Uncinulus subcordiformis* (SCHNUR) have slightly more transversely outlined shell than the majority of German specimens of this species. They are most comparable to SCHNUR's specimens from the limestone of Prüm and Gerolstein (SCHNUR, 1853, Pl. 25, figs. 6*a*, *b*, *c*, *k*), to LEIDHOLD's «breite Form» from Bilveringsen (LEIDHOLD, 1928, Pl. 3, figs. 22*a*, *b*, 23*a*, *b*), and especially to specimens from Kerpen (SMF coll. S21), in their general shell outline and in the number of ribs in sulcus and fold. Specimens of *U. subcordiformis* (SCHNUR) from the Middle Devonian (Givetian) of Ural, USSR, figured by NALIVKIN (1947, Pl. 21, figs. 10, 11), are nearly indistinguishable from ours. Externally, the discussed species, especially LEIDHOLD's «schmale Form» (LEIDHOLD, 1928, Pl. 2, figs. 3-5), is similar to *Uncinulus parallelepipedus* (BRONN), but the latter species has, among others, a more distinctly limited and narrower sulcus and fold, bearing less ribs.

Occurrence. — The species is characterized by a rather great geographical distribution, judged by NALIVKIN (1947) as index fossil of the Middle Devonian (?Givetian). It is known from the Middle Devonian of Poland (Łysogóry region), Germany (Rhine region), Czechoslovakia (limestone of Zlichov, Hlubočepy) and USSR (Ural).

Uncinulus parallelepipedus (BRONN, 1837)

(Pl. XVII, figs. 8-11; Text-fig. 30)

1854. *Terebratula angulosa*; J. SCHNUR, Brachiopoden..., S. 185, Taf. 25, Fig. 5*a*, *b*.
1904. *Rhynchonella parallelepipeda* BRONN; D. SOBOLEV, Devonskija..., s. 91, Tabl. 9, ris. 20.
1941*b*. *Uncinulus parallelepipedus* (BRONN); H. SCHMIDT, Die Mitteldevonischen..., S. 18, Taf. 1, Figs. 17-18; Taf. 4, Figs. 63-67; Taf. 6, Figs. 14-16.

Horizon: Limestone, exposures 81, 89, and marly shales, exposure 73, Skały beds, Middle Devonian.
Locality: Skały.

Material. — Five specimens greatly damaged, partly recrystallized.
Approximate dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus	No. of costae (in 1 mm.)
1495	?9·5	12·0	8·7	5·5	—
1496	12·5	13·3	9·0	6·0	3
1493	13·6	15·2	10·7	7·9	3
1494	?14·2	17·0	9·7	7·6	3

Description. — Shell to about medium size, nearly subpentagonal in outline; moderately biconvex; anterior commissure greatly uniplicate. Pedicle valve: beak prominent, slightly incurved; sulcus well marked, distinctly bordered by two highly elevated walls of ribs (Pl. XVII, fig. 9); tongue comparatively short. Brachial valve with fold small and rather low.

Ornamentation. The costae although low and flattened, are distinct. In general, they are single, occasionally bifurcating in sulcus and lateral slopes. There are 8-10 costae in the sulcus and to about 20 on lateral slopes.

Interior as partly shown in serial sections on Text-fig. 30.

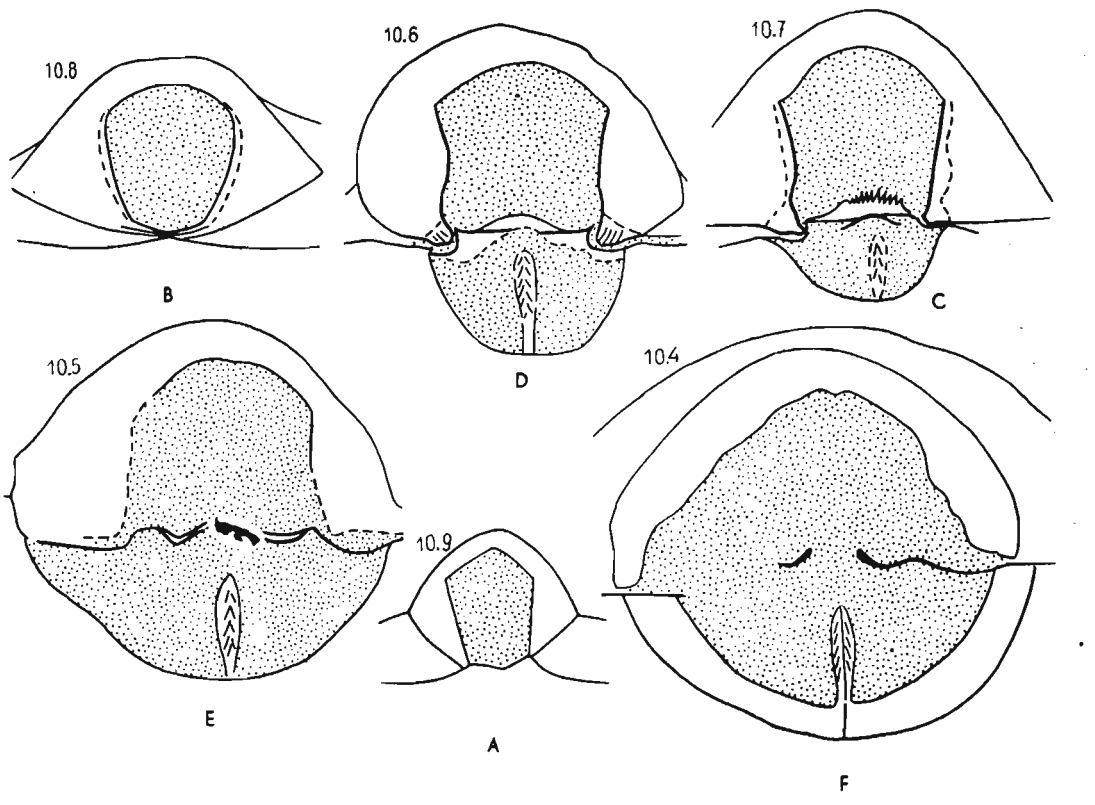


Fig. 30
Uncinulus parallelepipedus (BRONN). Skały beds, marls, exposure 81. *A-F* Serial cross sections of adult specimen; × 6·4

Remarks. — The above species is represented by a few specimens in the Skały beds, which show some external resemblance to specimens of *Uncinulus subcordiformis* (SCHNUR) from Miłoszów, but differ mainly in having more distinct radial costae and a better marked sulcus. They can be also compared with *Uncinulus pentagonus pentagonus* (KAYSER) partly in shell outline and size and to some extent in the pattern of radial ornamentation.

Occurrence. — Middle Devonian (Eifelian and rare in Givetian); Germany (Rhine region); Poland (Holy Cross Mountains); USSR.

Uncinulus pentagonus pentagonus (KAYSER, 1871)

(Pl. XXI, Figs. 3-15; Text-fig. 31)

1840. *Atrypa primipilaris* SCHLOTHEIM; J. C. SOWERBY, Organic remains..., Pl. 57, fig. 6.
1871. *Rhynchonella parallelepipeda* var. *pentagona* GOLDF.; E. KAYSER, Die Brachiopoden..., S. 308, Taf. 9, Fig. 4.
1904. *Rhynchonella pentagona* KAYSER; D. SOBOLEV, Devonskija..., S. 92, Tabl. 9, ris. 24.
1961. *Uncinulus pentagonus pentagonus* (KAYSER); V. HAVLÍČEK, Rhynchonelloidea..., S. 147, Taf. 27, Fig. 8.

Horizon: Limestone, exposure 89 („upper brachiopod limestone") and limestone in Miłoszów, Skały beds, Middle Devonian.

Locality: Skały and Miłoszów.

Material. — Twelve specimens embedded in limestone; fourteen free shells, all partly recrystallized.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus	No. of costae in sulcus
1501	6·8	7·0	4·6	4·6	—
1500	8·9	9·8	6·7	6·8	5

Description. — Shell small, pentagonal in outline, biconvex; width and length subequal; lateral margins slightly rounded, anterior commissure uniplicate. Pedicle valve moderately convex, beak suberect to greatly incurved; deltidial plates small, partly covering pedicle foramen; sulcus beginning almost at the umbo, widening anteriorly. Brachial valve of regular convexity, beak in some specimens covered by incurved ventral beak; fold flatly elevated, starting on the umbonal region.

Ornamentation. Shell surface covered by about 20 low costae (3-5 in both, sulcus and fold) with broadly rounded backs, widening anteriorly. Separating furrows narrow. Sulcus limited by two elevated costae, strongly diverging anteriorly, branching a few times, usually at about midlength of the valve, giving off two distinct bundles of costae. The costae are as a rule single, sometimes branching on lateral slopes.

Interior — studied in serial sections (Text-fig. 31). Pedicle valve: teeth small without incisions; muscle scars weakly marked. Brachial valve: cardinal process small, longitudinally incised; dental sockets shallow; hinge-plate divided, and thickened; crura long, laterally di-

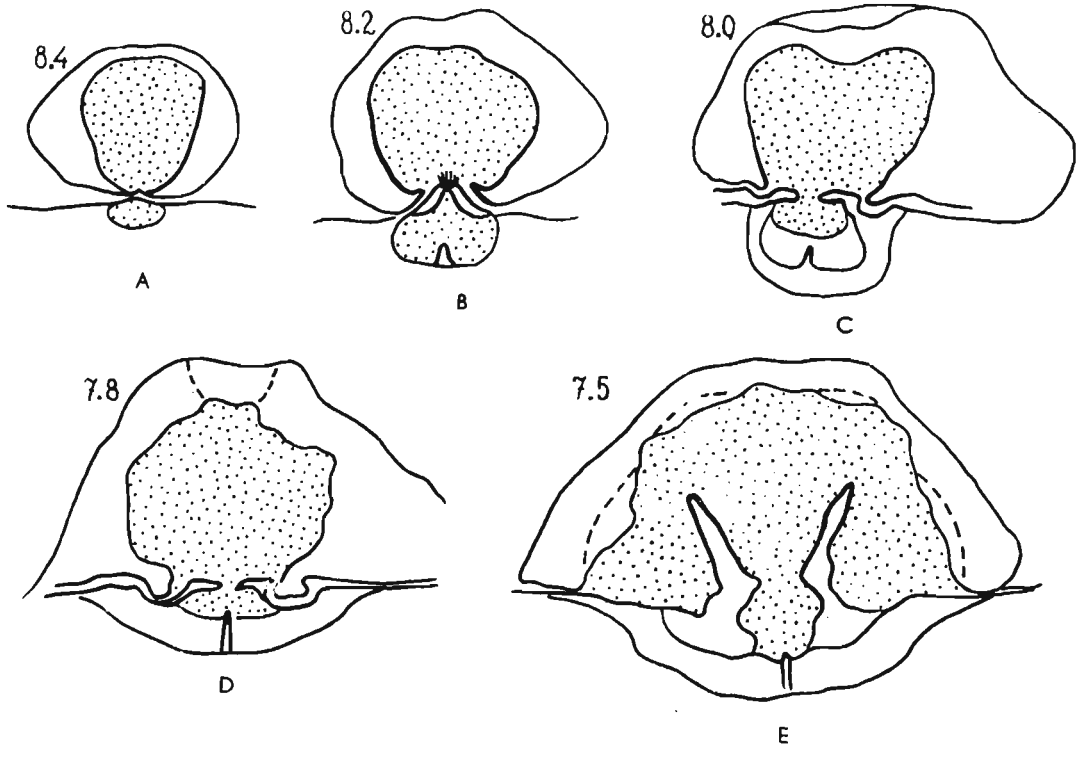


Fig. 31
Uncinulus pentagonus pentagonus (KAYSER). Skały beds, limestone, exposure 89. *A-E* Serial cross sections of adult specimen; approx. × 10

verging; medium septum of moderate thickness and height, extending to about three-fourths of shell length.

Remarks. — The described specimens are conspecific to *Uncinulus pentagonus pentagonus* (KAYSER) figured by KAYSER (1871, Pl. 9, fig. 4), showing all the features characterizing the latter subspecies. *Uncinulus pentagonus pentagonus* (KAYSER), judging from comparative studies of collections (SMF coll. XVII, 287g, XVII 287ee, ff, dd) and illustrations (SCHMIDT, 1941*b* Pl. 2, figs. 22, 23; HAVLIČEK, 1961, Pl. 27, fig. 8; KAYSER, 1871, Pl. 9, fig. 14; SMYČKA, 1897, Pl. 1, fig. 3; SOBOLEV, 1904, Pl. 9, fig. 24), is a characteristic species, distinguished by a small shell, pentagonal outline, marked sulcus bordered by two bundles of costae. In general, the costae have an uncinuloid character, being lowly flattened, as e.g. in *Uncinulus implexus* (see Pl. XX, fig. 2). The above mentioned features appear to be stable with a diagnostic value for species. The only features, which slightly vary, are the size and outline of shell and thickness of radial costae.

Our specimens are almost identical to the German ones from the Middle Devonian of Rhine region, showing some unimportant differences in the size and distinctness of the costae.

Occurrence. — Middle Devonian (Eifelian-Givetian); Poland (Łysogóry region); Germany (Rhine region); Czechoslovakia (Moravia, Čelechovice); USSR (West Fergana).

Uncinulus minor minor (SCHNUR, 1854)

(Pl. XXI, figs. 16-17)

1854. *Terebratula angulosa* var. *minor* m.; J. SCHNUR, Brachiopoden..., S. 185.
1941*b*. *Uncinulus minor* (SCHNUR, 1853); H. SCHMIDT, Die Mitteldevonischen..., S. 20, Abb. 1, Taf. 2, Figs. 25, 26.
1961. *Uncinulus minor minor* (SCHNUR, 1853); V. HAVLIČEK, Rhynchonelloidea..., S. 148, Taf. 26, Figs. 13-15.

Horizon: Limestone of Miłoszów, Skały beds, Middle Devonian.
Locality: Miłoszów.

Material. — Five specimens, partly recrystallized; in general sufficiently preserved. Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus
1505	7·2	6·4	4·9	4·0
1506	7·6	7·0	5·0	3·8
1504	?8·5	8·0	6·5	4·5

Description. — Shell small, ovate, biconvex; sulcus and fold marked in the anterior half of the shell; beak incurved, bearing a small, round pedicle foramen; tongue-like extension small.

Ornamentation. Radial costae observed on the anterior half of shell, being usually obscured on the posterior one. The costae are small, low with rounded backs, about 3-5 in the sulcus.

Remarks. — Our specimens are very similar to those of *Uncinulus minor minor* (SCHNUR) figured by SCHMIDT (1941*b*, Pl. 2, figs. 25, 26) from Gondelsheimer layers, *Ostiolatus* horizon, and Rommersheimer layers in Rhine region in their general outline and in a marked dorsal fold. They differ slightly from specimens figured by HAVLIČEK (1961, Pl. 26, figs. 13-15) from Givetian of Czechoslovakia (Moravia, Čelechovice) in being more ovate and in having a more marked dorsal sulcus.

Occurrence. — Middle Devonian; Germany (Rhine region; Gondelsheimer layers, *Ostiolatus* horizon; Rommersheimer layers); Czechoslovakia (Moravia, Čelechovice); Poland (Łysogóry region).

Uncinulus implexus (SOWERBY, 1840)

(Pl. XX, figs. 1-4; Text-fig. 32)

1840. *Atrypa implexa*; J. SOWERBY, Organic remains..., Pl. 57, fig. 4.
?1909. *Rhynchonella* cf. *implexa* SOW.; B. SOBOLEV, Srednij Devon..., s. 507.
1941*b*. *Uncinulus implexus* (SOWERBY, 1840); H. SCHMIDT, Die Mitteldevonischen..., S. 22; Taf. 1, Fig. 15.

Horizon: Limestone of exposures 91, 92, and Miłoszów, Skały beds, Middle Devonian.
Locality: Skały and Miłoszów.

Material. — Six free specimens, about 10 specimens embedded in the limestone; few fragment of shells. All the specimens not well preserved, partly recrystallized.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	No. of costae in 1 mm.	
				anterior	posterior
69	11·5	13·1	9·0	2	4
70	11·8	13·0	8·6	2	4

Description. — Shell small, round in outline, nearly uniformly biconvex; lateral margins rounded, anterior commissure straight to very weakly flexuous; sulcus and fold absent or only faintly marked at the anterior commissure. Pedicle valve of moderate convexity; beak small, slightly incurved. Brachial valve a little convex umbonally; beak very small, partly covered by ventral beak.

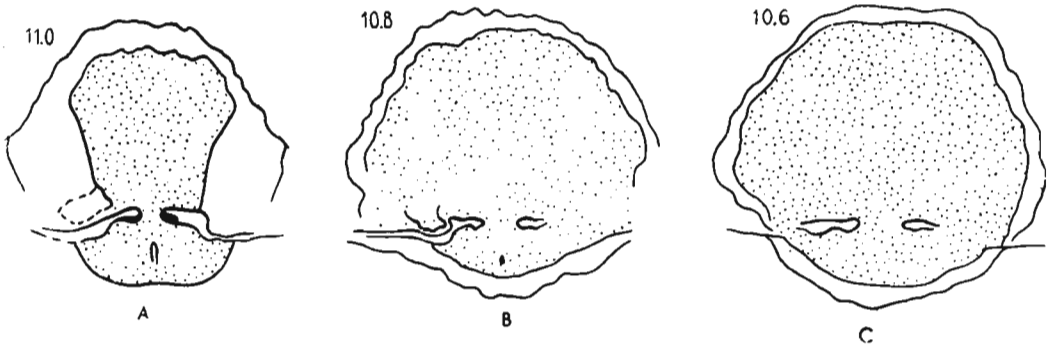


Fig. 32
Uncinulus implexus (SOWERBY). Skały beds, limestone of Miłoszów. *A-C* Serial cross sections of adult specimen, (Bp. VII/69); × 6·4

Ornamentation consists of about 32-34 costae on each valve, covering all shell surface, delicate posteriorly, thickening anteriorly, being lowly arched or flat. Usually, costae are single, some bifurcating, intercalation seems to be rare. Separating furrows are extremely linear. At the anterior commissure growth lines are weakly observed, arranged zigzag.

Interior studied in serial section (Text-fig. 32). Pedicle valve: teeth small, elongated; dental plates slender, coalesced with the shell. Brachial valve: cardinal process with some incisions; dental sockets shallow; hinge-plate separate; median septal ridge present.

Remarks. — Our specimens are conspecific to *Uncinulus implexus* (SOWERBY), having features characteristic for the latter species. They are, mainly a lack of sulcus and fold, in consequence, the anterior commissure is straight or slightly flexuous. This is a stable feature in this species, being repeated in all available collections (our specimens from the Skały beds; German collections — SMF Prüm XVII 261 c, d; Kerpen XVII 261 g; Gerolstein XVII 261 i) and is regarded as important diagnostically. It really can help to distinguish *Uncinulus implexus* (Sow.) from other uncinuloids, such as *Uncinulus parallelepipedus* (BRONN); *U. pentagonus pentagonus* (KAYSER), *U. subcordiformis* (KAYSER) as is stated by SCHMIDT (1941 *b*, p. 23). The character of costae in *U. implexus* does not differ significantly from the other species assigned to *Uncinulus*. The costae are low, flattened, somewhat subdued and widened anteriorly, as e.g. in *U. pentagonus pentagonus* (KAYSER) or *Uncinulus minor minor* (SCHNUR). In general, they do not change very much within the species in question. Sometimes, the costae, in specimens from one community, are more distinct as in the specimens from Kerpen (Amygdala horizon, SMF XVII 261 k) or less distinct, as in our specimens and the majority of the studied German collections. A changeable feature (but to very limited degree) is the shell outline which can vary from somewhat elongated in length to transversely outlined, e.g. specimens from Gerolstein — Fleringer layers (SMF XVII 261 d) are more longitudinal as is shown by SCHMIDT (1941 *b*, Pl. 1, fig. 15).

Our specimens are more roundly outlined in comparison with the specimens of *U. implexus* (Sow.) from Middle Devonian (Givetian) of Ural, USSR, figured by NALIVKIN (1947, Pl. 21, fig. 14), which are distinctly oval.

Occurrence. — The species appears to be an index fossil for the Middle Devonian (Eifelian-Givetian); known from England, Germany, USSR (Ural, Asia) and Poland. It is rare, rather sporadically recorded in the dark limestone with stromatoporoids in the Skały beds.

Family SEPTALARIIDAE HAVLÍČEK, 1960

Genus **SEPTALARIA** LEIDHOLD, 1928

Type species: *Terebratula ascendens* STEININGER 1883 (= *Terebratula subtetragona* SCHNUR, 1851); Middle Devonian, Germany, Rhine region.

Septalaria sp.

(Pl. XVII, fig. 7; Pl. XIX, figs. 23, 24; Text-fig. 33)

?1909. *Liorhynchus gracilis* GÜRICH, var. *plana* MAURER; D. SOBOLEV, Srednij Devon..., s. 503, Tabl. 6, ris. 13-15.

Horizon: Marly shales, exposure 73, Skały beds, limestone of Miłoszów Middle Devonian.
Locality: Skały.

Diagnosis. — Like *Septalaria subtetragona* (SCHNUR), but with more transverse shell outline, wider sulcus, more elevated fold and more ribs in both, sulcus and fold.

Material. — Four specimens with both valves closed, strongly deformed.

All specimens come from Skały, Skały beds, brachiopod shales and limestone of Miłoszów.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of tongue	No. of costae pedicle valve
62	14·9	17·7	9·5	10·4	12-8-14
63	?	?18·8	?	11·0	?-8-?

Description. — Exterior: Shell about subquadrate in outline, wider than long; slightly convex umbonally; lateral margins rounded, anterior commissure uniplicate; tongue subquadrate with straight lateral margins. Pedicle valve: sulcus marked at the anterior margin. Brachial valve: fold distinct, discernible about midlength of valve.

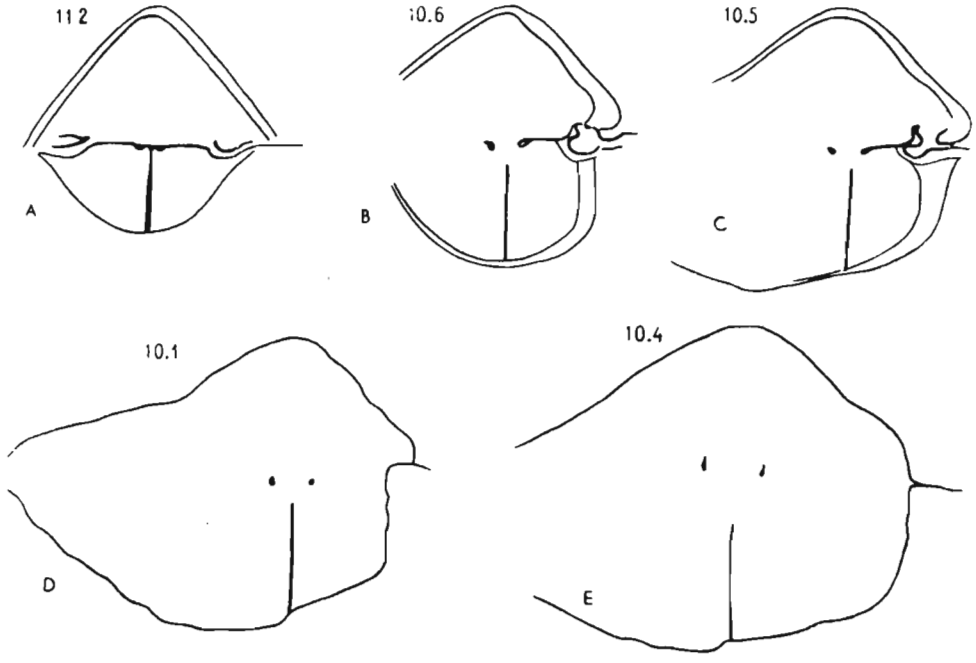


Fig. 33
Septalaria sp. Skały beds, marly shales, exposure 73. *A-E* Serial cross sections of adult specimen; × 6·8

Ornamentation. Radial ribs numerous, observed in anterior half of shell; the posterior half smooth, only with concentric lines. The ribs low, flat, being shallowly grooved, especially on the lateral flanks of the brachial valve and in the sulcus of the pedicle valve (see Pl. XIX, fig. 23*b*). The separating furrows are one to two times narrower than the ribs. There are 7-10 ribs in the sulcus and fold and 12-16 on lateral flanks.

Interior not well known because of scarcity of material, which in addition is poorly preserved. Pedicle valve shows developed dental plates. Brachial valve: median septum short, extending to one-third or a little over the valve length; cardinal process present, rather low and thickened, with distinctly marked myophore platform; hinge plate entire: crural bases observed (Text-fig. 33).

Remarks. — The described specimens are congeneric with *Septalaria* LEIDHOLD, 1928, having internal features diagnostic for the mentioned genus, the most characteristic being the cardinal process and entire hinge plate, which distinguish it from some other very close

genera such, as e.g. *Calvinaria* STAINBROOK (STAINBROOK, 1945), without cardinal process, concave hinge plate divided, or *Pseudocamarophoria* WEDEKIND (WEDEKIND, 1925), without cardinal process and with entire hinge plate.

Our specimens can be compared to *Septalaria subtetragona* Forma *B* (SCHNUR) (SCHMIDT, 1941*b*, p. 35, Pl. 13, fig. 43), but differ in having less acute beak ridges, a wider tongue, more numerous radial ribs. There is rather great external similarity to Bohemian septalarioids, especially to Eifelian *Septalaria palumbina* (BARRANDE, 1879) and somewhat less to *Septalaria matercula* (BARRANDE, 1847), both described and figured by HAVLIČEK (1961, p. 181, Pl. 27, figs. 1-5, 9-11). Our specimens are larger, have a more accentuated fold and sulcus than both Bohemian species, and show some differences in the thickness of radial ribs. There is also a great external similarity to «*Liorhynchus*» *gracilis* GÜRICH var. *plana* MAURER from the Middle Devonian of Śniadka, figured by SOBOLEV (1909, Pl. 6, figs. 13-15), especially in the appearance of the sulcus and surface radial costae. It is difficult, however, to make further comparison as the few specimens at our disposal are very damaged.

Septalaria cf. **gracilis** (GÜRICH, 1896)

(Pl. XVII, fig. 6)

?1896. *Camarophoria gracilis*, G. GÜRICH, Paläozoicum..., S. 278, Taf. 7, Fig. 3.
?1909. *Liorhynchus gracilis* GÜRICH; D. SOBOLEV, Srednij Devon..., s. 503, Tabl. 6, ris. 8-12, 16.

Horizon: Limestone of exposure 84, Skały beds, Middle Devonian.
Locality: Skały.

Diagnosis. — Small *Septalaria*, ventribiconvex, with a narrow and elongated tongue; shell surface ribbed, ribs small and rounded, 3 in the sulcus, 4 on the fold and 4-5 on each lateral slope.

Material. — One specimen, free, with valves closed, slightly damaged.
Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
120	9	8·7	5·9

Description. — Shell small, biconvex, subelliptical in outline, slightly longer than widei greatest width at midlength. Pedicle valve: beak small, greatly incurved; sulcus shallow, begn, ning near the midlength, extending into a flat tongue. Brachial valve: beak inconspicuous, covered by the pedicle valve beak; fold beginning in posterior part of valve, but from about midlength elevated anteriorly.

Ornamentation not observed posteriorly. On the anterior half of the shell the ribs are single, low, with broadly rounded backs; separating furrows shallow, two to three times narrower than the ribs. There are 3 ribs in sulcus, 4 on fold and 4-5 on lateral slopes of each valve. The ribs occupy two-thirds of all shell length.

Interior not studied in detail due to scarce material. On the brachial valve can be observed rather stout median septum and undivided hinge plate with well marked crural bases.

Remarks. — Developed median septum in the brachial valve and undivided hinge plate are the diagnostic properties of *Septalaria*. On the basis of the mentioned features the specimen

in question is assigned to this genus. Externally, our specimen shows a great similarity to *Septalaria subtetragona* (SCHNUR) Forma *A* (SCHMIDT, 1941*b*, Pl. 2, fig. 40, and SMF coll. XVII 729a-f, Hillesheimer Mulde), but differs in being of smaller size and ribs are longer, covering two-thirds of the shell length. It is also very like «*Camarophoria*» *gracilis* GÜRICH from the Middle Devonian of Śniadka (GÜRICH, 1896, p. 288, Pl. 7, fig. 3), but differs in having a thicker and much less prominent ventral umbo and wider lower radial costae. Our specimen can resemble some Maroccan septalarids, especially *Septalaria lehmani* DROT (1964, Pl. 20, fig. 9) from the Upper Givetian of the province of Tarfaya, but is not so much convex umbonally and has a thicker ventral umbo.

Septalaria cf. **subtetragona** (SCHNUR, 1851)

(Pl. XIX, fig. 25)

cf. 1851. *Terebratula subtetragona* n. sp.; J. SCHNUR, Programm..., S. 3.
cf. 1854. *Terebratula subtetragona*; J. SCHNUR, Brachiopoden..., S. 177, Taf. 23, fig. 4.

Horizon: Limestone of Miłoszów, Skały beds.
Locality: Miłoszów.

Material. — One free specimen, sufficiently preserved.
Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus
67	10·0	13·3	5·5	10·7

Description. — Shell of medium size, about subpentagonal in outline, the widest about midlength, biconvex; sulcus of moderate depth starting about midlength, distinctly limited by two high lateral walls; fold on the brachial valve, beginning on the posterior half of the shell, is elevated being well limited by two similarly high, as in pedicle valve, walls. Anterior commissure uniplicate. Shell surface is rather smooth. There are only 3 distinct ribs in the sulcus and 4 on the fold. The lateral slopes of the shell show some but very faint 5 radial ribs.

Interior. Dental plates as distinct as it is shown in *Septalaria subtetragona* (SCHNUR) from Middle Devonian of Germany-Nohner layers, Uexheim (see HAVLÍČEK, 1961, p. 181, Text-fig. 81).

Remarks. — The above specimen shows a great external similarity to SCHNUR's *Septalaria subtetragona* (1854, Pl. 23, fig. 4) from the Devonian limestone of Prüm. Our specimen is much wider than the German ones (partly due to some deformation). It is also very much like the specimen of *Septalaria subtetragona* (SCHNUR) figured by SCHMIDT (1941*b*, Pl. 2, fig. 80*a*, *b*) from the Devonian of Germany, Gondelsheimer layers (Geeser Horizon), but has a more flattened shell. *Septalaria* cf. *subtetragona* resembles in shell outline and shape the Maroccan *Septalaria subtetragona tarfayensis* n. subsp., described and figured by DROT from the Devonian of Tarfaya (1964, Pl. 20, fig. 6).

Occurrence. — Middle Devonian; Germany, Poland.

Genus NEMESA H. SCHMIDT, 1941

Type species: *Nemesa nemesana* H. SCHMIDT, 1941*b*, p. 41, Pl. 3, figs. 51, 52, 55; Middle Devonian, Germany, Rhine region.

Remarks. — The characteristic features of the genus are only a few: shell of medium size, broadly outlined; ventral sulcus marked, dorsal fold usually indistinct; shell poorly ornamented; small septalium and cardinal process present, the latter observed by HAVLIČEK (1961) in his new species *Nemesa hertae*. The genus *Nemesa* H. SCHMIDT shows a great internal and external similarity to *Septalaria* LEIDHOLD and *Amissopecten* (sensu HAVLIČEK), differing a little only from both genera mainly in having a more weak median dorsal septum and more thickened umbonal portion.

The genus *Nemesa* H. SCHMIDT is provisionally included to septalariids, its systematic position within Palaeozoic Rhynchonellacea being uncertain.

Occurrence. — Middle Devonian; Germany (Rhine region); Czechoslovakia (Bohemia); Poland (Łysogóry region).

Nemesa cf. nemesana H. SCHMIDT, 1941

(Pl. XXII, figs. 11-13)

cf. 1941*b*. *Nemesa nemesana*; H. SCHMIDT, Die Mitteldevonischen..., S. 41, Taf. 3, Figs 51, 52, 55.

Horizon: Limestone of exposure 89 (upper part); limestone of exposure 2 in Miłoszów; Skały beds.
Locality: Skały and Miłoszów.

Material. — Two free specimens with both valves closed; 8 specimens embedded in the limestone. All shells rather sufficiently preserved.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
20	6·5	7·8	3·6
19	8·3	10·0	3·5

Description. — Shell small to medium size, pentagonal in outline, widest at midlength, anterior margin widely and shallowly uniplicate. Pedicle valve weakly convex posteriorly, flattening toward the anterior margin; umbo small, beak slightly incurved; flat, wide sulcus, more distinct anteriorly, starting at about midlength of valve, bearing a weak median rib; brachial valve moderately but regularly convex along all valve length; median fold faintly marked.

Ornamentation. The whole shell surface smooth, covered by regularly spaced concentric lines and microlines, both being weakly expressed, an exception being the pedicle valve sulcus, which has a weak median costella, and corresponding median furrow on the dorsal fold.

Interior not studied because of scarcity of material.

Remarks. — Only few shells are known from the Skały beds, and they all show much reduced shell convexity, probably representing younger individuals. Externally they resemble very much specimens of *Nemesa nemesana* H. SCHMIDT from Rommersheimer layers (SMF coll. XVII 911g, i, l) differing only in a slightly less elevated ventral beak. The examined German specimens from different localities and layers (SMF XVII 911c-d, i, f — Prümer Mulde, Gondels-

heimer layers; SMF XVII 911 1, 0, r — Rommersheimer layers, Prüm; SMF XVII 911p, s, crinoid layers, Schönecken) do not change in their exteriors and show some constant features of external morphology: prevailingly pentagonal outline, rarely subpentagonal, small beak, pedicle valve lowered anteriorly, anterior commissure moderately uniplicate with a short and a delicate medial costella, which probably disappears with progressing individual age, never being observed in old individuals.

Nemesa hertae HAVLIČEK from Middle Devonian (Upper Eifelian) of Bohemia, Hlubočepy (HAVLIČEK, 1961, p. 190, Pl. 27, Figs. 13-15) differs from *Nemesa nemesana* H. SCHMIDT in having 4-5 costellae in the sulcus, 2-5 on each lateral slope and a more developed dorsal fold.

Occurrence. — Middle Devonian (?Upper Eifelian); Germany (Rhine region); Poland (Holy Cross Mountains).

?Nemesa skalensis n. sp.

(Pl. XXII, figs. 14-17)

?1904. *Camarophoria brychyptycta* SCHNUR; D. SOBOLEV, Devonskija..., s. 89, Tabl. 9, ris. 15.

Holotype: Z. Pal. Cat. No. Bp. VII/53, figured on Pl. XXII, fig. 14.
Type horizon: Limestone, exposure 89, Skały beds.
Type locality: Skały, Łysogóry region, Holy Cross Mountains.
Derivation of the name: skalensis — found in Skały beds, locality Skały.

Diagnosis. — *Nemesa* of medium size with short tongue bearing 2-4 short costellae, the median one the longest and most distinct 4 on the fold, with a distinct mesial furrow between them, 4-6 on each lateral slope.

Material. — Four free and nearly complete specimens, 3 partly embedded in the limestone, 1 imprint of the brachial valve.

Approximate dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus	No. of costae	
					sulcus	fold
54	12·5	15·4	?8·5	10·3	3	4
53 (holotype)	13·4	16·2	8·9	11·3	5 on lateral slopes	—
55	15·4	18·0	9·9	?11·3	—	—

Description. — Shell transversely elongated, moderately dorsi-biconvex; lateral margins short, rounded; anterior commissure uniplicate, broadly serrate. Pedicle valve slightly convex posteriorly; broad but flat sulcus beginning at midlength, umbo broad, beak suberect. Brachial valve weakly convex, with a corresponding broad fold observed anteriorly.

Ornamentation consists of short, single costellae, developed near the antero-lateral commissure. There are usually 5 costellae on each lateral slope, 3 in the sulcus, the central one being slightly longer (corresponding to the median costella of *Nemesa nemesana* H. SCHMIDT) and 4 on the fold, with a comparatively long median furrow (corresponding to a median costella in the sulcus). This feature might be probably taxonomically important on specific level, being repeated in all specimens at hand. The number of costellae, covering the antero-lateral parts of the shell, is suggested as constant (or changeable in very narrow limits). The remaining shell

surface is smooth, covered only by very delicate concentric lines, regularly spaced all over the shell surface, 8-10 per 1 mm.

Interior partly observed on slightly sectioned shell. Pedicle valve: dental plates slightly divergent anteriorly; teeth small. Brachial valve: medium septum short and faintly developed; small ?septalium observed; dental sockets broad, moderately shallow; outer hinge plate deeply grooved, thin; crura delicate.

Remarks. — Although the specimens are not numerous their exterior is quite distinct and characteristic, differing from the other known species of the genus *Nemesa*. It is considered here that the number of new costellae, developed along the antero-lateral commissure, is one of the important diagnostic features for our species. *?Nemesa skalensis* n. sp. has some diagnostic properties of *Nemesa nemesana* SCHMIDT, namely: transversely elliptical shell outline, uniplicate anterior commissure, sufficiently well marked ventral umbo. It differs in having more costellae in the sulcus and on the fold, but all of our specimens have a counterpart of the single costella and median furrow of *N. nemesana* SCHMIDT, which are distinctly marked in our specimens. This feature suggests that our species is akin to *N. nemesana*. *Nemesa hertae* HAVLIČEK ((HAVLIČEK, 1961, p. 190, Pl. 27, figs. 13-15) from Bohemian Upper Eifelian, Hlubočepy (Czechoslovakia) and is externally very similar to our species (in having more costellae along the antero-lateral commissure), but differs in not being so transversely elongated and in having a much lower apical angle. Judging from the Pl. 27, fig. 13 (HAVLIČEK, 1961), the distinct median furrow on the fold and probably the costella in the sulcus, so characteristic of our specimens, are also observed in the younger specimen of *Nemesa hertae* HAVLIČEK (HAVLIČEK, 1961, Fig. 13), disappearing probably in very adult individuals.

It is suggested here that *Camarophoria brachyptycta* SCHNUR from the Skały beds, figured by SOBOLEV (1904, Pl. 9, fig. 15), should be included to *?Nemesa skalensis*, on the basis of external similarity (3 ribs in the sulcus, the median one being longer, as in our specimens). Our specimens, can be compared externally with specimens of *Isopoma brachyptyctum* (SCHNUR), but the ribs in our species are more coarse and in place of the median costella in the sulcus there is a median furrow in *Isopoma brachyptyctum* (SCHNUR).

Genus **PSEUDOCAMAROPHORIA** WEDEKIND, 1925

?1960. *Amissopecten* HAVLIČEK, 1960; V. HAVLIČEK, Bericht über die Ergebnisse..., S. 243.
?1961. *Amissopecten* HAVLIČEK, 1960; V. HAVLIČEK, Rhynchonelloidea..., p. 184.

Type species: *Terebratula microrhyncha* ROEMER, 1844, S. 65, Taf. 5, Fig. 2; Middle Devonian, Germany.

Remarks. — HAVLIČEK (1961, p. 185) included *Terebratula microrhyncha* ROEMER, 1844 in his newly erected genus *Amissopecten* with *Terebratula velox* BARRANDE, 1847, from the Middle Devonian of Bohemia, as type species. The interiors of both types (i.e. *Terebratula microrhyncha* ROEMER and *Terebratula velox* (BARRANDE) are nearly identical, especially in such a diagnostically important details as the appearance of cardinals: hinge plate undivided, lack of the cardinal process, lack or extremely weakly developed dental plates. Probably the genus *Amissopecten* HAVLIČEK, 1961, can be treated as a junior synonym of the genus *Pseudocamarophoria* WEDEKIND, 1925.

Pseudocamarophoria WEDEKIND shows a great external similarity to e.g. *Septalaria* LEIDHOLD, *Nemesa* SCHMIDT, *Calvinaria* STAINBROOK, and it is often difficult to recognize the particular genera without cross section. The differences between these genera are above all based on the characters of the cardinals, such as 1) hinge plate divided in e.g. *Calvinaria* STAIN-

BROOK and *Nemesa*, undivided in *Pseudocamarophoria* WEDEKIND; 2) cardinal process (present in e.g. *Septalaria*, *Nemesa*, lacking in *Pseudocamarophoria*, *Calvinaria*); 3) distinctness or absence of the dental plates etc. (absent in *Pseudocamarophoria*).

GRANT (1965, p. 163) compares the genus *Pseudocamarophoria* to the genus *Stenoscisma* CONRAD, 1839, on the basis of the similarity in the shell shape and profile of the median septum. He is of the opinion that the former genus may be related to the Stenoscismatacea, but cannot be assigned to this family as proposed by LEIDHOLD (1928) and SCHMIDT (1941*b*).

As far as can be judged from the available literature, the members of *Pseudocamarophoria* WEDEKIND, 1925, seem to constitute distinctive taxonomic units on specific level, based on such external features as: number of ribs or plicae, depth of sulcus and appearance of fold; outline of antero-lateral commissure which depends on the number of ribs or plicae and, to some extent, the general shape and outline of shell and appearance of umbo.

Occurrence. — Lower Devonian-Middle Devonian; Germany, Poland, ?Czechoslovakia.

Pseudocamarophoria undulataeformis n. sp.

(Pl. XIX, figs. 1-22; Text-fig. 34)

?1904. *Camarophoria brachyptycta* SCHNUR; D. SOBOLEV, Devonskija..., s. 89, Tabl. 9, ris. 15.

Holotype: Z. Pal. Cat. No. Bp. VII/108, figured on Pl. XIX, fig. 6.
Type horizon: exposure 81, Skały beds, Marls, Middle Devonian.
Type locality: Skały, Łysogóry region, Holy Cross Moutains.
Derivation of the name: undulataeformis — externally like *Septalaria undulata* H. SCHMIDT (1941*b*, Pl. 3, fig. 46).

Diagnosis. — Wider than long, 1-2 small plicae in the sulcus, 2-3 on the fold and 2-3 on lateral slopes.

Material. — About 25 free specimens with valves closed, partly damaged.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus	No. of plicae		
					sulcus	fold	slopes
99	9·3	9·7	4·4	5·3	1	2	1
100	8·3	9·7	4·4	5·8	1	2	?3
101	7·1	8·0	3·7	5·2	1	2	2
102	8·5	9·9	4·7	5·9	1	2	2
103	8·9	10·5	4·9	6·0	1	2	2
104	8·2	9·0	4·7	5·2	1	?2	3
105	9·5	9·9	4·9	5·5	1	2	1
106	?	11·7	6·0	6·5	1	2	2
107	9·3	11·3	?4·5	6·6	1	2	1
108 (holotype)	?9·8	11·4	6·6	6·5	1	2	1
109	10·3	11·5	6·0	5·6	1	2	3
110	10·7	12·0	6·9	7·6	1	2	2
111	11·4	14·2	7·3	7·7	1	2	3

Description. — Shell small, somewhat subcircular to widely elliptical in outline, nearly equally biconvex, greatest biconvexity to the posterior half; width greater than length; lateral

margins rounded; anterior commissure uniplicate. Pedicle valve: umbo low with incurved beak; oval pedicle foramen small; median sulcus greatly broadened anteiorly, of variable depth and width. Brachial valve with a poorly developed median fold, which begins at about the midlength of valve; umbo small, partly covered by incurved pedicle valve beak.

Ornamentation. Shell surface smooth, except for the antero-lateral parts which are weakly plicated. The plicae (ribs) are rounded, weakly expressed especially on lateral slopes. There are 1 plication in the sulcus (occasionally 2), 2 on the fold and 1-3 on each lateral slope. Concentric growth lines are equally faintly expressed. Some shells with better preserved exterior show a delicately spinose surface with traces of hair-like spines, similarly as is seen in *Nucleospira lens.*

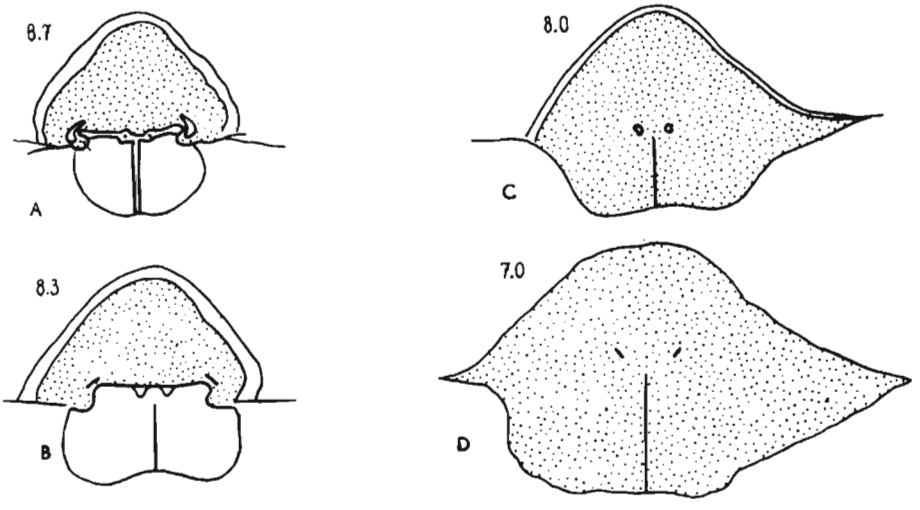


Fig. 34
Pseudocamarophoria undulataeformis n. sp. Skały beds, marls, exposure 81. *A-D* Serial cross sections of adult specimen; × 6·4

Interior studied in serial section (Text-fig. 34). Pedicle valve: teeth small without dental plates; umbonal callus faintly marked. Brachial valve: cardinal process not present; median septum extends for about a third of the valve length; dental sockets very shallow; hinge plate undivided; crural bases usually weakly marked.

Remarks. — The species is not common in the Skały beds, being limited to one layer of marls only. All specimens are of different size, ranging from about 9 mm. to 14 mm. in length. Judging from the collection, their exterior is, in general, more stable than for the other species of this genus. A little variation is shown in the number of plicae on the lateral slopes, minimum 1 plica on each slope, maximum 3. Specimens about 9 mm. in length (the smallest in the collection) are similar to the larger in the shape of the shell, in having accentuated sulcus on the anterior half of the valve and in slightly plicated lateral margins.

Our specimens externally resemble very much *Septalaria undulata* SCHMIDT (SCHMIDT, 1941 *b*, p. 39, Pl. 3, fig. 46; Pl. 4, fig. 81), from Rommersheimer layers, having a similar shell outline and ventral sulcus, differing only in a tendency to have more radial plicae, which in general are better marked, and a deeper median sulcus with a corresponding more uniplicate anterior commissure. There is also a great external similarity to *Amissopecten leidholdi* (HAVLÍČEK, 1961) from the Lower Devonian of Bohemia, limestone Zlichov, Hlubočepy), but our specimens

are slightly more transversely outlined, with more marked sulcus and fold. A great resemblance to *Calvinaria* STAINBROOK (STAINBROOK, 1945), e.g. *Calvinaria albertensis albertensis* (WARREN) from the Middle Devonian of Western Canada (MCLAREN, 1962, p. 26, Pl. 1, figs. 1-11) also exists, externally in the weakly developed ribs on the lateral shell slopes and internally in the lack of cardinal process. Our specimens differ, however, in having an undivided hinge plate.

Pseudocamarophoria sp.

(Pl. XVII, figs. 5)

Horizon: Limestone of Miłoszów, exposure 2, Skały beds, Middle Devonian (Givetian).
Locality: Miłoszów, in vicinity of Skały.

Material. — One nearly complete specimen and 1 slightly damaged pedicle valve. Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
3776	?15·9	20	9·2

Description. — Shell of medium size, transversely elongated, much wider than long, biconvex umbonally, flattened anteriorly; hinge line weakly convex (nearly straight), lateral margins rounded, anterior commissure weakly undulating, extending into a small and broad tongue. Pedicle valve with small and slightly incurved beak, sulcus shallow, trigonal in outline (narrow posteriorly, widening anteriorly), well marked in the anterior half of the shell. Brachial valve more regularly arched than the opposite valve, fold weakly marked.

Ornamentation. The surface is smooth, except for 1 costa in the sulcus and 2 weakly marked on the fold. Concentric growth lines indistinct, concentric microlines regularly distributed on the shell surface.

Interior. Slightly damaged umbonal part of the shell shows dental plates in the pedicle valve, comparatively wide and undivided hinge plates and a small cruralium; the medium septum is stout.

Remarks. — The external appearance such as: the general shell outline, shape and convexity, poor radial ornamentation (the posterior half of the shell and lateral slopes always smooth) and tongue-like extension, suggest that the described specimen belongs to the genus *Pseudocamarophoria* WEDEKIND. It differs rather considerably from the other described rhynchonellids coming from the Skały beds. Externally, it can be compared with *Septalaria* cf. *subtumida* H. SCHMIDT, figured by SCHMIDT from the Middle Devonian (*Ostiolatus* horizon at Schwirzheim) in Germany (SCHMIDT, 1941*b*, Pl. 3, fig. 41*b*), but in our specimen the pedicle valve is more flattened, the ventral sulcus is more trigonal and more distinctly marked. It resembles *Calvinaria albertensis opima* MCLAREN (1962, Pl. 2, figs. 4-6) in shell outline and shape, but differs in having a less convex shell and less distinct radial costae, sulcus and fold. The other Canadian species described and figured by MCLAREN (1962) such as: *Calvinaria variabilis variabilis* (WHITEAVES), *Calvinaria variabilis insculpta* (MCLAREN), *C. variabilis athabascensis* (KINDLE) and others, possess a similarly trigonal ventral sulcus, but have a more convex brachial valve and more costae in sulcus, on fold and on the lateral slopes.

Family HYPOTHYRIDINIDAE RZONSNICKAJA, 1956[2]

Subfamily HYPOTHYRIDININAE RZONSNICKAJA, 1956

Genus **HYPOTHYRIDINA** BUCKMAN, 1906

Type species: *Atrypa cuboides* SOWERBY, 1840; Upper Devonian, England.

Hypothyridina cf. **procuboides** (KAYSER, 1871)

(Pl. XXI, fig. 2)

cf. 1909. *Rhynchonella procuboides* KAYSER; D. SOBOLEV, Srednij Devon..., s. 504.

Horizon: Limestone of Miłoszów, Skały beds, Middle Devonian, (Givetian).
Locality: Miłoszów, in vicinity of Skały.

Material. — One specimen, with valves closed, slightly damaged.
Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus	No. of costae
23	16·8	18·8	14·4	12·7	12-9-?

Description. — Shell of medium size, transversely outlined, widest about midlength, dorsi-biconvex, subglobular in lateral view; anterior commissure uniplicate, quadrangular. Pedicle valve convex umbonally, tongue long, to about 9 mm. in length, its antero-lateral margins straight. Brachial valve greatly and moderately convex, median fold marked at the anterior margin, low but sufficiently prominent.

Ornamentation. Shell surface, except for the umbonal region covered with flat costae, separated by linear furrows, 8-9 on the tongue and 12 or more on each lateral slope. The costae are shallowly grooved at the antero-lateral commissure. Growth lines indistinct.

Interior not studied, because of scarce material.

Remarks. — Our specimen is extremely close to a specimen of *Hypothyridina procuboides* figured by KAYSER (1871, Pl. 9, fig. 3) from the Middle Devonian of Rhine region. One of the similarities is to be found in the almost square tongue which is, however, shorter in our specimen. Other differences are: a weaker marked fold on the brachial valve and smaller shell dimensions of specimens from the Skały beds. In comparison with specimens from Bilveringsen (TORLEY, 1934, Pl. 4, figs. 50-52, 54) our specimen is less transverse, with shorter tongue. Specimens of *Hypothyridina procuboides* (KAYSER) from Prümer Mulde, Rommersheimer layers (SMF coll. XVII 348ff, r) are in general larger and have more costae on the tongue. SOBOLEV (1909, p. 504, Pl. 6, fig. 20) has mentioned and figured *Rhynchonella procuboides* KAYSER from Świętomarz beds. Our specimen from Skały beds is more globular, with costae grooved anteriorly — a feature which SOBOLEV (*l. c.*, p. 504) also considers as characteristic for species. There is also a great external similarity to *Hypothyridina margarita* VEEVERS from Sadler For-

[2] In the Treatise on Invertebrate Paleontology, Part H. Brachiopoda, 1965, this family is reduced to subfamilial level and placed in the family Camarotoechiidae SCHUCHERT & LE VENE.

mation of Fitzroy Basin, West Australia (VEEVERS, 1959, p. 100, Pl. 10, figs. 22-35), but the Australian species has a more elevated fold on the brachial valve and slightly wider costae.

Occurrence. — Middle Devonian-Givetian; Poland (Holy Cross Mountains); Germany (Rhine region, Gondelsheimer, Rommersheimer, Fleringer layers); Czechoslovakia (Moravia).

Family PUGNACIDAE RZONSNICKAJA, 1956

Genus ISOPOMA TORLEY, 1934

Type species: *Terebratula brachyptycta* SCHNUR, 1854, p. 178, Pl. 23, fig. 6; Middle Devonian, Germany, limestone of Blankenheim.

Isopoma brachyptyctum (SCHNUR, 1854)

(Pl. XXII, figs. 1-9; Text-fig. 35)

1854. *Terebratula brachyptycta* SCHNUR; J. SCHNUR, Zusammenstellung..., S. 178, Taf. 23, Fig. 6.
1961. *Isopoma brachyptyctum* (SCHNUR); V. HAVLIČEK, Rhynchonelloidea..., S. 39, Taf. 4, Figs. 6, 7.

Horizon: Limestone, exposures 81 (upper part), 89; Miłoszów-Skały beds, Pokrzywianka beds.
Locality: Skały, Miłoszów, Pokrzywianka.

Material. — About 13 free specimens with valves closed; nearly 26 shells embedded in the limestone, partly to totally recrystallized. In general, all specimens are sufficiently well preserved.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus	No. of plicae: pedicle valve
34	9·2	11·0	5·4	7·0	— — —
33	8·3	9·8	4·2	7·5	1+3+2
32	10·5	12·0	7·2	8·0	2+2+2
30	11·0	12·3	8·8	7·0	2+2+3
36	11·2	13·2	7·1	9·0	2+2+2
31	11·9	13·0	8·6	8·7	2+2+2
35	12·8	14·1	7·7	8·6	2+2+2

Description. — Shell small, wider than long, subpentagonal in outline; nearly equally biconvex; hinge extensions rounded; anterior commissure zigzag, forming a broad tongue. Pedicle valve convex posteriorly, weakly depressed anteriorly; small, broad beak slightly elevated and incurved. Brachial valve regularly convex along all its length; low and not very distinct fold present at the anterior margin.

Ornamentation. Posterior and lateral parts of the shell smooth, covered only by concentric lines and microlines. On the anterior half distinct but short plications are present, 6-8 on the pedicle valve and 7-9 on the brachial one. The separating furrows distinct, especially deep at the antero-lateral commissure.

Interior studied in serial cross section. Pedicle valve: teeth small, no dental plates; median septal ridge low, but broad. Brachial valve: hinge plate thickened, divided; crura thin, short, almost parallel to each other.

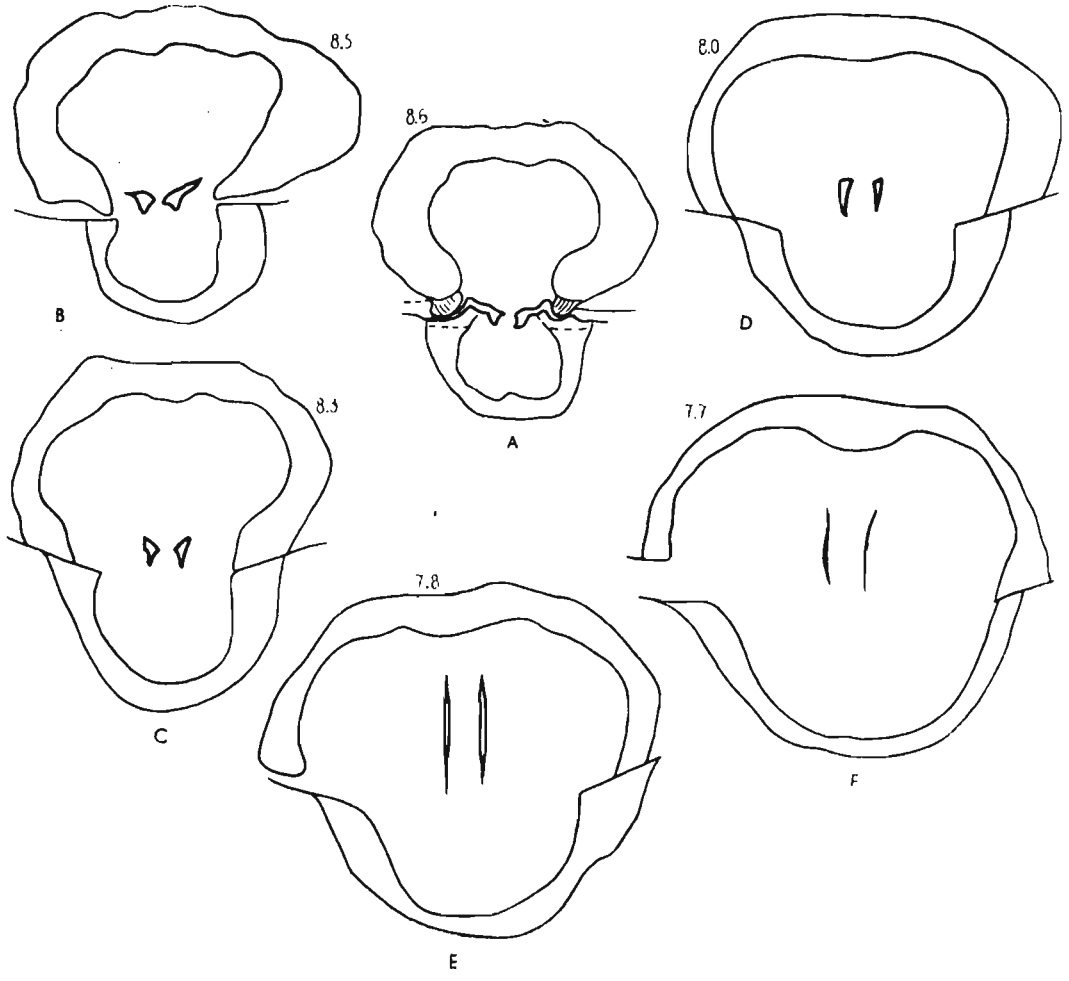


Fig. 35
Isopoma brachyptyctum (SCHNUR). Skały beds, limestone, exposure 89. *A-F* Serial cross sections of adult specimen about 10·5 mm. long (Bp. VII/32); × 6

Remarks. — The present collection is not very numerous, but composed of specimens from a few outcrops. All shells come from the limestone of the Skały beds (Skały and Miłoszów), except one from the limestone of Pokrzywianka beds (Pokrzywianka). In general, the exterior of all specimens is more or less the same. The only small difference is that the specimens from Skały (exposures 81, 89) are slightly wider and have a more distinctly marked mesial furrow between the two plicae in the tongue, than specimen from Pokrzywianka beds. *Isopoma brachyptyctum* (SCHNUR), as far as can be judged from the present material and investigated collections (SMF), is a characteristic and distinctive species, easy to recognize. The variability within it being very limited, concerns the shell outline and the antero-lateral commissure. The most characteristic features repeating in all specimens of the studied collection are: the presence of a marked deep mesial furrow between two plicae in the tongue, which in some specimens extends towards the umbo, and a constant number of plicae in tongue and fold. The former feature is not common in specimens from Germany, being observed only in shells from crinoid layers (SMF, coll. H. SCHMIDT, 1950) and somewhat less in specimens from

Bilveringsen (SMF XVII 342f). The latter feature is more common (judged as stable for species), being also observed in specimens from the Middle Devonian of Rhine region and Čelechovice.

Our specimens are indistinguishable externally from TORLEY's specimens from Bilveringsen at Iserlohn, figured by him on the Pl. 3, figs. 12*a*, *b*, 13*a*, *b* (1934). *Isopoma alecto* (BARRANDE) from Lower Devonian limestone of Bohemia at Menany (HAVLIČEK, 1961, Pl. 6, fig. 5) differs from *Isopoma brachyptyctum* (SCHNUR) in having 4-5 plications in its sulcus. Both, ?*Camarophoria lummatoniensis* DAV. (DAVIDSON, 1864-1865, Pl. 14, fig. 15) from Lummaton near Torquay, and *Camarophoria* (*globulina* var.?) *rhomboidea* (PHILLIPS) from Middle Devonian of Barton (DAVIDSON, 1864-65, Pl. 14, fig. 21) can be compared externally to *Isopoma brachyptyctum* (SCHNUR), all having two plicae in sulcus and three on fold. It is possible that they are conspecific with *Isopoma brachyptyctum* (SCHNUR).

Occurrence. — Middle Devonian; Germany (Rhine region); Czechoslovakia (Moravia); Poland (Holy Cross Mountains).

Genus **PUGNAX** HALL & CLARKE, 1893

Type species: *Terebratula acuminata* SOWERBY, 1822: Lower Carboniferous, England.

Pugnax sp. cf. **Pugnax pugnus** (MARTIN, 1809)

(Pl. XXII, figs 10*a-e*)

Horizon: Llimestone of Miłoszów, Skały beds, Middle Devonian (Givetian).
Locality: Miłoszów.

Diagnosis. — *Pugnax* of medium size with acuminate tongue and 9 plications in it.

Material. — One free, nearly complete specimen with both valves closed.
Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of tongue		No. of plications in tongue
				poster.	anter.	
51	20·1	19·7	13·5	15·7	5·5	9

Description. — Shell of medium size, subtriangular in outline, dorsi-biconvex, widest at midlength; length and width nearly equal; lateral margins almost straight; anterior commissure acuminate. Pedicle valve weakly convex umbonally, gibbous anteriorly, producing a distinct tongue; beak small and incurved. Brachial valve deepest posteriorly; fold marked at anterior margin.

Ornamentation. The whole shell surface smooth, with concentric lines, except for the anterior part of the tongue, where the plications are angular, short and single, 9 in number.

Interior unknown.

Remarks. — The above specimen is not easily confused with any other known species of the genus *Pugnax*, differing by its exterior, a more gibbous pedicle valve and more numerous narrow plications, which cover the anterior part of the tongue. It externally resembles *Pugnax* sp. cf. *Pugnax pugnus* (MARTIN) from Sadler formation of Australia, figured by VEEVERS (1959,

Pl. 11, figs. 22-25), but has more plications on the tongue, the latter being more acuminate than the Australian one, which is gently rounded. Our specimen shows also some external resemblance to *Parapugnax brecciae* (SCHMIDT, 1941) from the Devonian of Rhine region (Adorf layer-Iberger limestone), differing mainly in having more numerous plications on the tongue.

It may, to some extent, be compared to *Pugnax pugnoides pugnoides* (SCHNUR) from Middle Devonian of Gondelsheimer layers of Prümer Mulde (SMF XVII 719j), but differs in having a more acute and curved tongue with more numerous plications. The specimen in question may represent a new species, however, the scarcity of material (1 specimen) does not permit precise specific identification.

Pugnax cf. **anisodonta** (PHILLIPS, 1841)

(Pl. XVII, fig. 13; Pl. XIX, fig. 30)

Horizon: Marly shales, exposure 73, Skały beds, Middle Devonian.
Locality: Skały.

Material. — One specimen, well preserved.
Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Breadth of sulcus
20*a*	12·0	11·9	7·7	9·4

Description. — Shell of medium size, transversely outlined, weakly biconvex; umbonal angle acute, ventral beak prominent, lateral margins very short; anterior commissure widely uniplicate and zigzag; tongue short, rather shallow but wide. Pedicle valve slightly convex umbonally, lowered medially, with lateral slopes elevated. Brachial valve very faintly convex.

Ornamentation consists of thick costae which cover all the shell surface. The costae are narrow at the umbo and greatly thickened anteriorly, having at the anterior commissure a zigzag form (Pl. XIX, fig. 32). There are 4 costae in the sulcus, 5 on the fold and 4 on lateral slopes of each valve.

Remarks. — The specimen appears to be close to *Pugnax anisodonta denticulata* (MAURER, 1885) from Fleringer layers (Achbach, SMF XVII 2439) in its external appearance, mainly in the strongly denticulate antero-lateral commissure. But the German specimens have only 2 costae in the sulcus, 3 on the fold and 2-3 on each lateral slope. Specimens of *Pugnax denticulata* (MAURER) from Middle Devonian of Germany (Grübe Heina bei Waldgirmes, SMF coll. 1948, coll. of Dr. B. MÜLLER) are, in general, larger, with less costae on the shell, than our specimen. Externally, the specimen from the Skały beds closely resembles *Terebratula anisodonta* PHILLIPS (1841, p. 86, Pl. 34, fig. 154) from Middle Devonian of England (Barton), but differs mainly in having less costae on the fold and in the sulcus. There is also a great similarity to specimens of *Pugnax anisodonta* (PHILLIPS) figured by ROZMAN from the Middle Devonian (Givetian) of Mugodzhar, USSR (ROZMAN, 1962, Pl. 31, figs. 1-4) mainly in the shell size and outline.

Occurrence. — Middle-Upper Devonian (?Givetian-Frasnian); England; Germany; USSR (Mugodzhary; Kuzbas according to ROZMAN (1962, p. 156); Poland (Holy Cross Mountains).

Order **SPIRIFERIDA** Waagen, 1883
Family LISSATRYPIDAE Twenhofel, 1914
Subfamily SEPTATRYPINAE Kozłowski, 1929,
Genus **CRYPTATRYPA** Siehl, 1962

Type species: *Terebratula philomela* Barrande, 1847, p. 387, Pl. 15, fig. 5; Bohemia.

Remarks. — Externally the genus is relatively simple. It is characterized by small shell size, smooth surface, covered with concentric lines only, well marked and acute beak, and internally with dental plates slightly divergent anteriorly. This last feature is highly diagnostic for the genus. *Cryptatrypa* should be valuable as an index form because of its rather restricted stratigraphic range — ?Lower Devonian-Middle Devonian.

The assigned species:
Cryptatrypa philomela (Barrande, 1847), ?Lower Devonian, Czechoslovakia,
Cryptatrypa n. sp. *A* (see Siehl, 1962, p. 197, Pl. 37, fig. 9) Upper Eifelian, Germany,
Cryptatrypa n. sp. *B* (Siehl, 1962, p. 197, Pl. 37, fig. 10), Givetian, Germany,
Cryptatrypa philomela minor n. subsp.; Givetian (?Eifelian), Poland.

Occurrence. — ?Lower-Middle Devonian (Eifelian-Givetian); Czechoslovakia (Bohemia, Koneprus); Germany (Rhine region); Poland (Łysogóry region).

Cryptatrypa philomela minor n. subsp.

(Pl. XXIII, figs. 1-8; Text-fig. 36)

Holotype: Z. Pal. Cat. No. Bp. VII/1025, figured on Pl. XXIII, figs. 8*a*, *b*.
Type horizon: Marly shales, exposure 73, Skały beds, Middle Devonian.
Type locality: Skały, Łysogóry region, Holy Cross Mountains.
Derivation of the name: Lat. *minor* — much smaller in comparison with the known German species.

Diagnosis. — Small, smooth, ovate to subpentagonal, with prominent ventral beak which is acute, pedicle foramen subapical, no sulcus or fold; dental plates occupying about one-third to one-fourth of the valve length.

Material. — About 100 specimens of different dimensions, with valves closed; two separate pedicle valves. All shells sufficiently preserved. All specimens from exposures 72, 73, 81.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
1024	0·6	0·6	0·25
1023	0·7	0·6	0·3
1022	0·8	0·7	0·3
1021	1·0	0·7	0·5
1017	1·2	1·1	0·4
1008	1·5	1·2	0·7
1007	1·6	1·2	0·6
1003	2·5	2·0	1·0
1001	3·0	2·2	1·0
992	4·0	3·5	2·0
989	5·0	4·6	3·0
986	5·5	5·2	2·8
985	7·8	6·5	4·2

Description. — Small, biconvex, in adults longitudinally ovate to subpentagonal in outline, widest about midlength; antero-lateral commissure rounded, anterior commissure rectimarginate. Pedicle valve regularly but moderately convex; beak very prominent, acute, in adults slightly incurved; area small but concave; delthyrium usually partly closed (anteriorly) by two deltidial plates which are trigonal; pedicle foramen comparatively minute, round, subapical. Brachial valve of regular convexity as in the opposite valve; beak marked (Text-fig. 36, draw. 1*a-d*). Exterior smooth, shell surface covered by distinct concentric lines, evenly spaced; concentric microlines not observed.

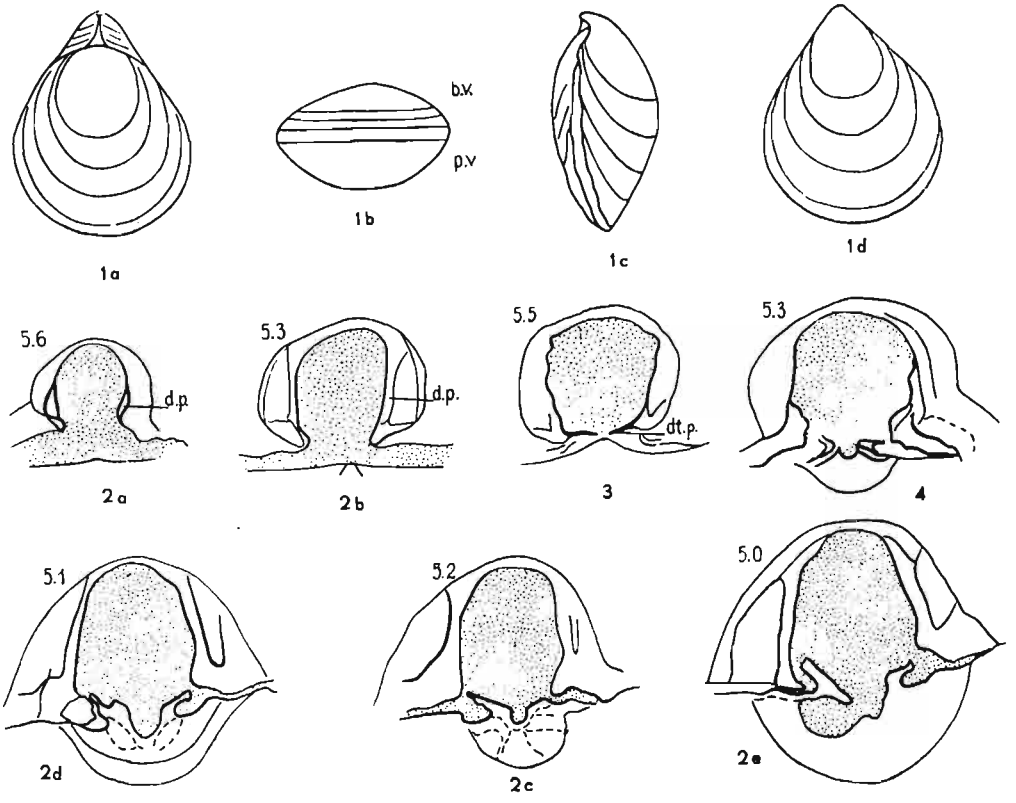


Fig. 36

Cryptatrypa philomela minor n. subsp. Skały beds, marly shales, exposure 73. *1* Adult specimen in: *a* brachial valve, *b* anterior commissure, *c* side, *d* pedicle valve views (Bp. VII/3815); × 7. *2a-e* Serial cross sections of adult specimen; × 14. *3, 4* Two cross sections of different specimens; × 14. *d. p.* dental plate, *dt. p.* deltidial plate

Interior (Text-fig. 36, draw. 2*a-e*, 3, 4). Pedicle valve: apical cavity deep, not thickened; teeth fairly well developed, dental plates distinct, slightly divergent anteriorly towards the bottom of valve, extending to about one-third to one-fourth of valve length (Text-fig. 36); muscle scars, observed in one separate pedicle valve, very weakly marked, being indiscernible in cross section. Brachial valve: hinge plates separated, narrow; median ridge low; dental sockets correspondingly deeply excavated; 4-5 coils to each cone.

Growth changes. There is great regularity with progressive growth. In the external morphology some small changes are observed in the shell outline and in the appearance of the ventral beak. The smallest specimens are distinctly ovate, showing a striking resemblance to *Cryptatrypa philomela* (BARRANDE) figured by SIEHL from the Greifensteiner limestone of the Eifel-

Middle Devonian (SIEHL, 1962, Pl. 37, figs. 7, 8). With progressive growth the shell width increases and specimens are subcircular in outline, with a widely rounded anterior margin and incurved beak, resembling *Cryptatrypa* n. sp. *A* and *Cryptatrypa* n. sp. *B*, figured by SIEHL in 1962 (Pl. 37, figs. 9, 10).

Remarks. — As the genus is relatively simple externally, variation within the species and, in all probability, interspecific variation are very limited. In general, in our subspecies the small size of the shell characteristic for *Cryptatrypa* is preserved. This feature together with some others, such as a thin, acute and more prominent ventral beak and smaller shell, are considered to be sufficient to separate a new taxon from *Cryptatrypa philomela* (BARRANDE). In addition, *Cryptatrypa philomela* has much weaker dental plates, closely adhering to the lateral walls of the pedicle valve (see SIEHL, 1962, Pl. 26, fig. 6; Pl. 27, fig. 1). Internally, our new form is close to *Cryptatrypa* n. sp. *A* (SIEHL, 1962, Pl. 27, fig. 3) from the Upper Eifelian, Greifensteiner limestone, Rhine region, having distinct dental plates, but it differs externally in being not so wide, having a longer beak and a rectimarginate anterior commissure (slightly sinuous in the German species). *Cryptatrypa* n. sp. *B* (SIEHL, 1962, p. 197, Pl. 37, fig. 10), from Givetian limestone of Waldgirmes in Rhine region, is about as wide as our subspecies, but in the former the width is equal to the length and it has a shorter and thicker ventral beak.

Family ANOPLOTHECIDAE SCHUCHERT, 1894

Genus **BIFIDA** DAVIDSON, 1882

Type species: *Terebratula lepida* D'ARCHIAC & DE VERNEUIL, 1840; Middle Devonian, Rhine region.

Bifida lepida (D'ARCHIAC & DE VERNEUIL, 1842)

(Pl. XXIV, figs. 17-33; Text-fig. 37)

1842. *Terebratula lepida* GOLDF.; V. D'ARCHIAC & E. DE VERNEUIL, Descriptions..., p. 388, Pl. 35, fig. 2.
1896. *Bifida lepida* GOLDFUSS; G. GÜRICH, Das Palaeozoicum..., S. 269.
1909. *Anoplotheca lepida* GOLDF.; D. SOBOLEV, Srednij Devon..., s. 483.
1954. *Anoplotheca lepida* A. & V.; G. BIERNAT, Ramienionogi..., p. 516, Pl. 6, figs. 4-8.
1956. *Anoplotheca (Bifida) lepida* D'ARCHIAC & DE VERNEUIL, 1840; VL. HAVLÍČEK, Ramenonožci..., p. 589 (55), Pls. 7, 8.

Horizon: Marly shales, exposures 72, 73, 81; Skały beds, Middle Devonian.
Locality: Skały.

Material. — About 150 complete specimens; 15 separate pedicle valves and 10 brachial valves, with interiors sufficiently well preserved.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
800	4·0	4·0	2·8
801	4·2	4·0	3·0
807	4·4	4·0	2·8
803	4·6	4·0	2·0
805	4·8	4·4	2·2
808	5·0	4·2	3·0
809	5·4	4·5	2·8
819	5·8	5·0	3·0
816	6·4	5·6	3·6
815	6·8	6·0	3·5

Description. — Shell small, thick-walled; ventri-biconvex to plano-convex, subcircular to oval in outline, small beak slightly incurved. Pedicle valve strongly arched, weakly grooved along the middle of the valve. Brachial valve flattened, medianly depressed.

Ornamentation. Fine plications indistinct anteriorly, 4-6 on the pedicle valve and 5-7 on the brachial valve. Concentric lines of lamellar appearance.

Interior (Pl. XXIV, figs. 25-33; Text-fig. 37). The same as described in *A. lepida* from Grzegorzowice (BIERNAT, 1954, pp. 517-518).

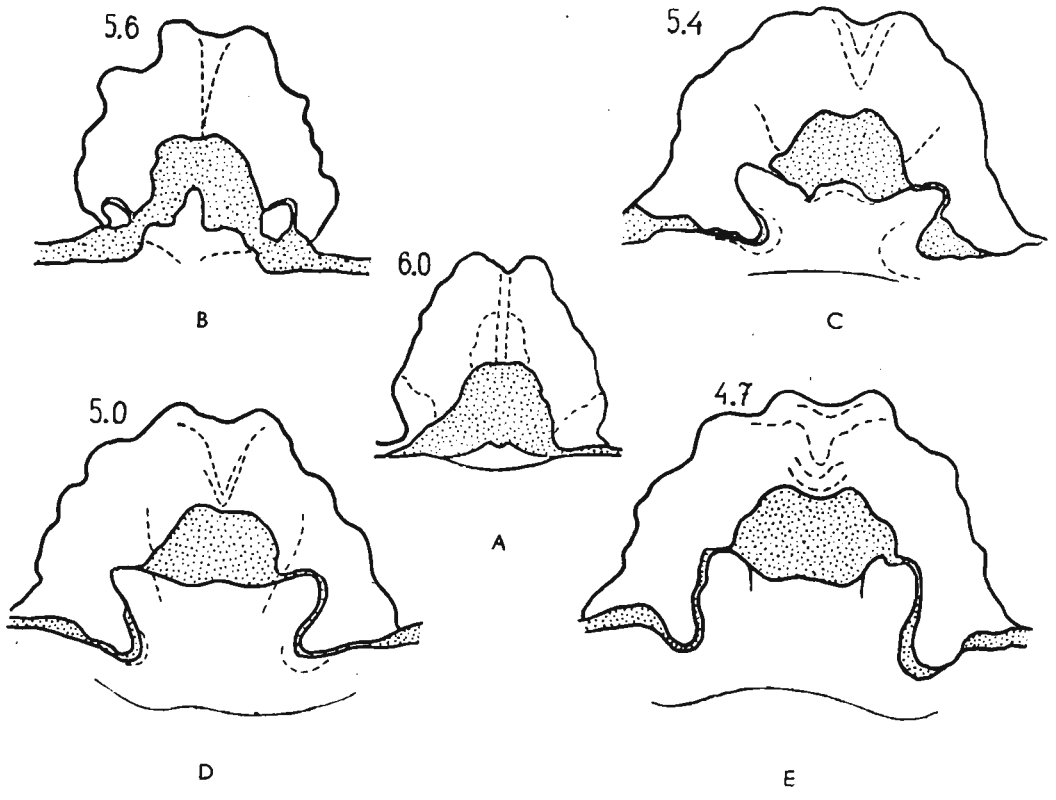


Fig. 37
Bifida lepida (D'ARCHIAC & DE VERNEUIL). Skały beds, marly shales, exposure 73. *A-E* Serial cross sections of adult specimen, about 6·4 mm. long; × 15

Individual variability. — Specimens of this species vary a little in outline, ranging from subcircular to nearly elongate-oval. The umbo rises above the hinge being always incurved, the degree of its incurvature varying slightly. The radial ornamentation has a fairly constant character in this species. Some variations can be observed in the number of concentric lines, which can be sometimes more closely set, sometimes less, ranging from about 17-29 on each valve.

Growth changes. Changes during growth are minimal. The smallest specimens in the collection: 1·4 mm. long, 1·4 mm. wide and 0·4 mm. thick, do not differ externally very much from adults. In general, they are nearly circular in outline, with length equal to width, have a much less convex pedicle valve and a straight, slightly prominent ventral beak. The median plications, developed earlier, are observed at a distance of about 0·4 mm. from the beaks and

bifurcate at about midlength of the shell in a similar way as in atrypids (see BIERNAT, 1964) and *Kayseria lens* (PHILLIPS) (see p. 115). The similarity is, in general, great but identification of younger individuals is facilitated by the somewhat different appearance of the umbo. Adult and gerontic individuals are almost globular in profile, with a strongly incurved small beak, radial plications being almost obsolete and the concentric lamellar lines closely crowded.

Remarks. — Our specimens appear to be almost identical with *Terebratula lepida* figured by D'ARCHIAC & DE VERNEUIL (1842, Pl. 35, fig. 2) from the Devonian of Rhine region. No important differences are shown by comparison with the German specimens (SMF coll. of RICHTER — 29 specimens). Our specimens seem to be slightly smaller in size and the ventral beak is a little more elevated.

The species can be compared with *Anoplotheca venusta* (SCHNUR) (SCHNUR, 1853, Pl. 24, figs. 3*a*, *b* = ?*Anoplotheca (Anoplotheca) lamellosa* (SANDBERGER) (SANDBERGER, 1855, Pl. 34, fig. 18), differing however in being of smaller dimensions and in having a more distinct radial ornamentation. *Anoplotheca nitida* H. SCHMIDT (SCHMIDT, 1951) is larger, having a more arched brachial valve and a slightly more rounded pedicle valve. *Anoplotheca (Bifida) dahlia* HAVLÍČEK from the Devonian of Czechoslovakia, Hlubočepy, has among others a less marked concentric lamellar lines, more distinct median plication on the dorsal sulcus and internally a low and thin dorsal septum (see HAVLÍČEK, 1956, p. 590(56), Pl. 4, figs. 9-13). *Anoplotheca (Bifida)* aff. *lepida* figured by SIEHL from Rhine region, Eifelian, Greifensteiner limestone (SIEHL, 1962, Pl. 29, figs. 1-3; Pl. 39, fig. 1) is more rounded, having probably a more distinct median dorsal fold.

Occurrence. — Middle Devonian of Europe (England, Czechoslovakia, Germany, Poland).

Family KAYSERIIDAE BOUCOT, JOHNSON, STATON, 1964

Genus **KAYSERIA** DAVIDSON, 1882

Type species: *Orthis lens* PHILLIPS, 1841, p. 65, Pl. 26, fig. 110*a*, *b*; Middle Devonian, South Devon, vicinity of Torquay, England.

Kayseria lens (PHILLIPS, 1841)

(Pl. XXIX, figs. 10-28)

1841. *Orthis lens*; J. PHILLIPS, Figures and Descriptions..., p. 65, Pl. 26, fig. 110.
1854. *Terebratula dividua* PHILLIPS; J. SCHNUR, Brachiopoden..., S. 179, Taf. 24, Fig. 2.
1904. *Kayseria lens* PHILLIPS; D. SOBOLEV, Devonskija..., s. 79, Pl. 8, fig. 25.

Horizon: Marly shales of exposures 72, 73; marls exposure 84, Skały beds; Middle Devonian.
Locality: Skały.

Material. — About 20 specimens, sufficiently well preserved.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
902	2·5	2·2	1·0
904	3·6	3·6	1·2
907	3·8	3·8	1·6
910	4·2	4·5	1·2
909	4·8	4·5	1·4
912	5·2	5·0	2·0
913	6·0	5·0	2·2
919	7·0	6·2	2·2
921	9·8	8·0	3·2
901	13·4	10·2	4·0

Description. — Shell small; subovately to ovately outlined in maturity and nearly circular in the younger growth stage; moderately ventri-biconvex, anterior margin slightly rounded, often slightly incised. Pedicle valve weakly arched along midline; umbo pointed, beak small, slightly incurved. Brachial valve medially depressed by a shallow sulcus, greatly widening anteriorly.

Ornamentation. It consists of about 18 to 22 radial costulae, two to three times larger than the intercostal furrows. The costulae are, in general, single with the exception of the median ones on each valve, which usually branch two or three times (Pl. XXIX, figs. 10-20). New costulae appear by intercalation, especially those in the median sulcus of the brachial valve, which are often thin and less distinct. Concentric lines rarely observed.

Interior not studied because of scarce material.

Remarks. — Our specimens are considered to be conspecific with PHILLIPS species *Kayseria lens*, described from the Middle Devonian of England (South Devon, vicinity of Torquay). As is shown by figures (see PHILLIPS, 1841, Pl. 26, fig. 110) the external resemblance is very great. Specimens of *Kayseria lens* (PHILLIPS) from the Middle Devonian of Gerolstein (Rhine region) (SMF coll.) are almost identical with ours.

Occurrence. — Middle Devonian; Europe (England, Germany, Poland, USSR).

Family DELTHYRIDIDAE WAAGEN, 1883

Genus **UNDISPIRIFER** HAVLÍČEK, 1957[3]

Type species: *Spirifer undiferus* C. F. ROEMER, 1844, p. 73, Pl. 4, figs. 6*a-c*; Middle Devonian, Germany.

Remarks. — The genus was proposed by HAVLÍČEK (1957) for a small group of European Devonian species, some of which were previously included into the genus *Plectospirifer* GRABAU. In all probability it is a valid genus, but at present some doubts must remain until the interior of *Plectospirifer* is known.

[3] This genus is included, in the Treatise on Invertebrate Paleontology, Part H, Brachiopoda, 1965, to the family Reticulariidae WAAGEN, 1883.

There are only a few distinguishing characteristics of the genus *Undispirifer*, all considered by HAVLIČEK (1959, p. 168) as significant. They concern mainly the external morphology: sulcus and fold always smooth, plicae tending to be obsolescent, the general shell outline usually more transverse, internally the delthyrial plate is developed. This last feature has been observed by VANDERCAMMEN (1957*b*) in *Undispirifer undiferus* (ROEMER).

Plectospirifer GRABAU, a closely related genus, is not a very clearly defined generic group. The species referred to it by GRABAU, the majority Chineese, are morphologically diversified and show a range of gradual changes in the general shell outline and radial ornamentation. In general, exteriors of *Plectospirifer* GRABAU and *Undispirifer* HAVLIČEK are rather well known, their interiors, however, inadequately for detailed comparison. The only features mentioned by GRABAU in *Plectospirifer* are the dental plates and a weak dorsal median septum.

Species which can be assigned to *Undispirifer*:
Undispirifer microspinosus (KHALFIN, 1950), Upper Devonian-Frasnian of Siberia,
Undispirifer transiens (BARRANDE, 1879), Middle Devonian of Czechoslovakia,
Undispirifer undiferus (ROEMER, 1844); Middle Devonian of Germany,
Undispirifer undulatus (ROEMER, 1844); Middle Devonian of Germany,
Undispirifer subundulatus (GRABAU, 1931), Middle Devonian of China,
Undispirifer gerolsteinensis (STEININGER, 1853), Middle Devonian of Germany.

Undispirifer sp. cf. **Undispirifer undiferus** (ROEMER, 1844)

(Pl. XXVIII, figs. 2-4)

cf. 1844. *Spirifer undiferus* ROEMER; C. F. ROEMER, Das rheinische Übergangsgebirge..., S. 73, Pl. 4, fig. 6.
cf. 1904. *Reticularia(?) undifera* F. ROEMER; D. SOBOLEV, Devonskija..., s. 74.

Horizon: Limestone, exposure 84, Skały and Miłoszów.
Locality: Skały, Miłoszów, Łysogóry region, Holy Cross Mountains.

Material. — Two free specimens, quite complete; one specimen embedded in the limestone.

Dimensions of 2 specimens (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus anteriorly	No. of ribs
598	23·9	30·0	17·0	10·3	22-26
599	22·5	30·3	15·4	9·5	—

Description. — Shell transversely outlined, biconvex; hinge line shorter than the greatest shell width; cardinal angles rounded; beak of moderate length, incurved; area concave, not very distinguished. Pedicle valve slightly deeper than the brachial valve; median sulcus broad but shallow, tending to be angular. Brachial valve of moderate convexity; median fold broad, of moderate elevation, angular to obtusely rounded.

Ornamentation. Radial costae are numerous, 22-26 on each valve, indistinct umbonally and laterally. They are single, increasing by intercalation. Bifurcation not observed. Concentric lines contiguous, fine, regularly spaced, bordered by spine bases. Spine bases differentiated, being in general of two sizes, the larger lenticular in outline and the smaller more rounded. They are alternately arranged, in some cases the smaller lying anteriorly to the larger ones,

somewhat resembling the arrangement of the spine bases in *Undispirifer undiferus* (C. F. ROEMER) figured by VANDERCAMMEN (1957*b*, Pl. 5, fig. 1).

Interior not studied. The ventral beak, slightly damaged, shows two dental plates slightly divergent laterally. On the umbonal part of the brachial valve there is a weak trace, suggesting a delicate median septal ridge, extending to about one-third of the valve length.

Remarks. — Whereas the specimens are identifiable as *Undispirifer*, the material is too scarce to allow specific identification. However, their characteristics (see description) are very close to those of *Spirifer undiferus* var. *undulatus* ROEMER from the Middle Devonian of the Eifel, figured by SCHNUR (1853, Pl. 34, figs. 3*g*, *h*) and DAVIDSON (1864, Pl. 7, fig. 11). Our specimens have a similar outline, but are smaller, with much lower and narrower plicae, smaller hinge line and area (the latter less marked). German specimens of *Spirifer undiferus* ROEMER (SMF coll. 17671-17673, 17675, 17677-17681) from Givetian of Gerolstein and Eifel, are characterized by 6-8 weakly marked radial plicae, obsolete laterally, with a globular shell, differing in all these features from our specimens. Specimens from the Skały beds correspond to *Plectospirifer subundulatus* GRABAU (1931, p. 390, Pl. 39, fig. 9), except for the convexity of the shell which is smaller and the radial plicae which are narrower and more numerous. In number of plicae they are very close to *Undispirifer gerolsteinensis* (STEININGER) (1853, p. 70), a local form in the Eifel (according to LEIDHOLD, 1928, p. 74), included into the synonymy of *Plectospirifer undiferus* (ROEMER) by VANDERCAMMEN (1957, p. 3). Judging from the plaster cast kindly received from Dr. W. STRUVE, *Undispirifer gerolsteinensis* corresponds externally especially to *Plectospirifer subundulatus* GRABAU from the Middle Devonian of China and to the third type of *Spirifer undiferus* ROEMER (see LEIDHOLD, 1928, Text-figs. 26*a*-41*b*, p. 70), having a similar high area, distinct and numerous radial plicae, but *Undispirifer gerolsteinensis* is larger and probably more transverse than the Chinese species.

Family MUCROSPIRIFERIDAE PITRAT, 1965

Genus **MUCROSPIRIFER** GRABAU, 1931

(= **LAMELLISPIRIFER** NALIVKIN, 1937)

Type species: *Delthyris mucronata* CONRAD, 1841; Middle Devonian, Hamilton group, New York, N. America,

Subgenus MUCROSPIRIFER (SPINOSPIRIFER) n. subgen.

Type species: *Mucrospirifer (Spinospirifer) diluvianoides* n. sp. (see p. 118, Pl. XXVI, fig. 12), Skały beds, marly shales, exposure 73, Łysogóry region, Holy Cross Mountains, Poland; Middle Devonian.

Diagnosis. — Internally like *Mucrospirifer* GRABAU, 1931, but with concentric lines rather irregularly distributed on the shell surface, obsolescent posteriorly, crowded anteriorly, and with spine-bases on the backs of radial folds and in the furrows with net-like micro-ornamentation.

Remarks. — There is a striking similarity in the shell outline and shape, mucronate hinge-extensions and in the internal structure between *M. (Mucrospirifer) mucronatus* (CONRAD) and *M. (Spinospirifer) diluvianoides* n. sp. The two subgenera, however, are clearly differentiated by surface markings: *Mucrospirifer (Mucrospirifer)* has concentric lamellae very regularly

arranged on the whole shell surface and a net-like micro-ornamentation, *Mucrospirifer (Spinospirifer)* is spinose, micro-ornamented (net-like) and possesses concentric growth lines sufficiently marked on the anterior half of the shell.

To the newly proposed subgenus can be included the German Middle Devonian species described by STEININGER, mainly *Spirifer diluvianus* (STEININGER, 1853, Pl. 7, fig. 1).

Mucrospirifer (Spinospirifer) diluvianoides n. sp.

(Pls. XXV, XXVI; Pl. XXVII, figs 3-9; Text-figs 38-40)

1896. *Spirifer elegans* STEININGER; G. GÜRICH, Palaeozoicum..., S. 247.
1904. *Spirifer elegans* STEININGER; D. SOBOLEV, Devonskija..., s. 71, Tabl. 8, ris. 17, 18, 19.
1909. *Spirifer elegans* STEININGER; D. SOBOLEV, Srednij Devon..., s. 469.

Holotype: Z. Pal. Cat. No. Bp. VII/4012, figured on Pl. XXVI, figs 12*a, b*.
Type horizon: Marly shales, exposure 73, Skały beds, Middle Devonian.
Type locality: Skały, Łysogóry region, Holy Cross Mountains.
Derivation of the name: diluvianoides — externally like *Spirifer diluvianus* STEININGER, 1853.

Diagnosis. — Shell of median size, mucronate to a varying degree, with small and almost linear ventral area; radial folds; surface spinose; delthyrial cavity with callus, dental plates short, teeth small, dental sockets of moderate deepness, fulcral plates present.

Material. — About 500 mature specimens, 50 specimens of young individuals, 1-6 mm. in length; 15 separate pedicle valves and 10 brachial valves, in general not complete. All specimens come from marly shales, exposures 72, 73, 81, 82 (marls), Skały beds.

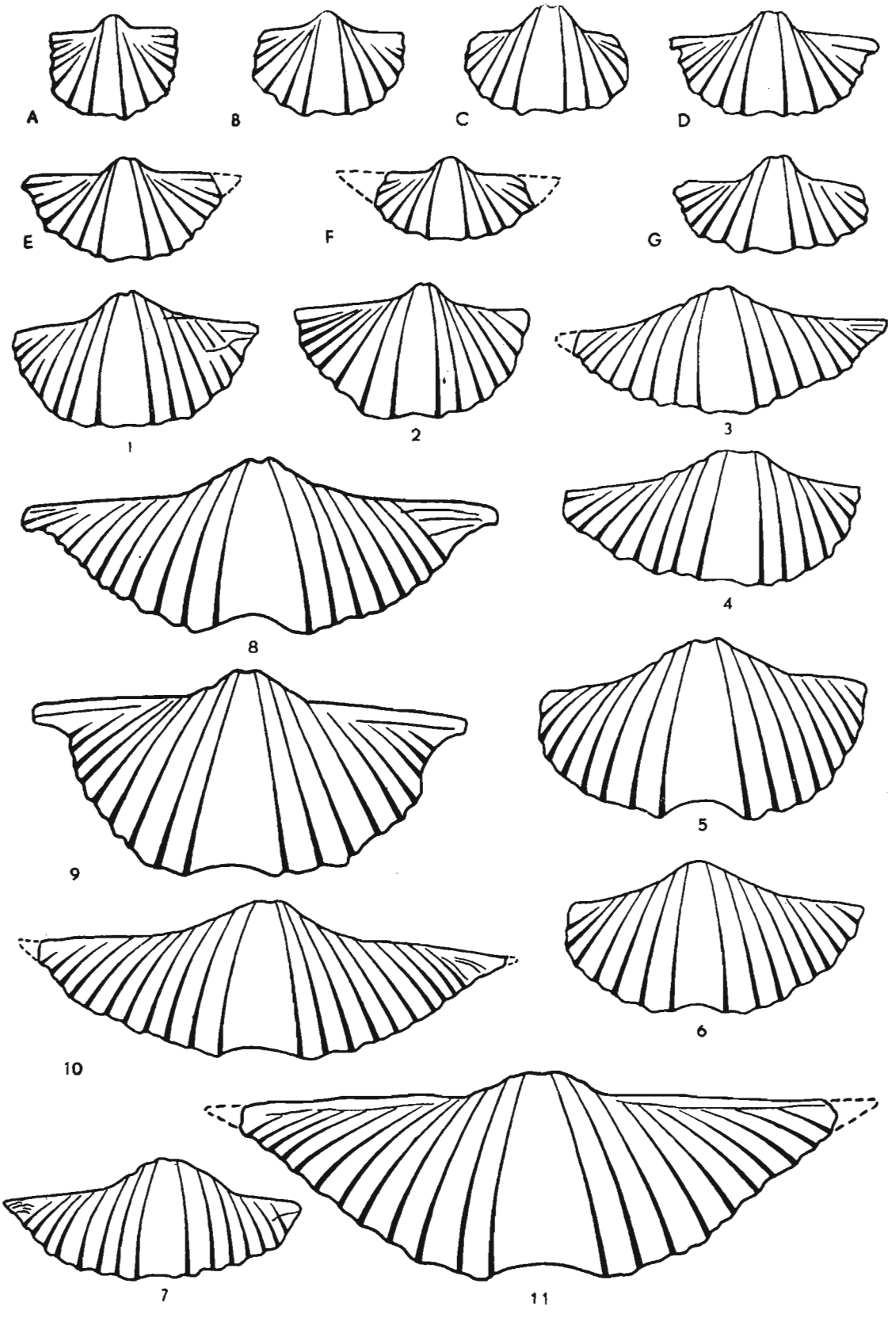
Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus	No. of costae	
					brachial v.	pedicle v.
688	4·4	6·2	3·2	1·7	4+1+4	5+5
685	5·2	9·0	3·2	2·4	5+1+5	5+5
684	9·9	?20·0	7·0	5·0	7+1+8	8+9
682	12·0	24·0	9·0	7·3	9+1+8	10+9
679	12·3	30·2	11·0	6·5	10+1+9	9+10
681	12·4	29·3	8·7	5·7	8+1+8	9+9
676	13·6	?29·6	11·3	6·7	8+1+9	9+9
672	14·5	?23·3	9·8	7·3	?	8+8
670	14·6	28·1	11·9	8·0	9+1+8	9+9
675	15·6	?34·2	11·4	6·2	8+1+9	10+10

Description. — Shell transverse, unequally biconvex in adult stage; hinge extremities moderately to distinctly mucronate; area comparatively low, horizontally striated, often slightly concave directly below the beak, almost linear, very weakly lowering towards the hinge extremities, it is about twice as high as the dorsal area; umbo large with incurved beak; delthyrium posteriorly covered by deltidium (a feature of maturity), medially elevated, with

Fig. 38

Mucrospirifer (Spinospirifer) diluvianoides n. sp. Skały beds, marly shales, exposure 73. *A-G* Variability in the shell outline of younger individuals; × 2·3. *I-II* Variability in the shell outline of adult specimens; nat. size


A
B
C
D
E
F
G
1
2
3
8
4
9
5
10
6
7
11

a median thickness, probably a trace of a pedicle foramen, present in *Mucrospirifer mucronatus* (CONRAD), as it is shown by TILLMAN (1964, Pl. 153, figs. 1-3).

Ornamentation. Sulcus and corresponding fold on the brachial valve, originating at the umbo, deep, widening anteriorly. The medium fold is often flattened, especially on its anterior half, showing a trace of median depression which could be interpreted as a probable precursor of a distinctly furrowed fold (a feature characterizing genus *Tylothyris* NORTH); the above median depression is a little only shallower than in *Mucrospirifer mucronatus* (CONRAD), (see TILLMAN, 1964, Text-fig. 1); slopes of both valves marked by 8-12 simple, subangular plications, the number differing for each slope (Text-fig. 38), the separating furrows much narrower. In one specimen bifurcation of 1 lateral plica has been observed. Almost whole shell surface is covered with distinct, closely set anteriorly, imbricating lamellae. Concentric microlines arranged very closely and regularly, about 20 to 1 mm. Crossing the lamellae is a number of fine radial striae, about 15 per 1 mm. They are more delicate at the beak and more thickened and rised anteriorly, giving the impression of imperceptible serration of the lamellar edges.

Interior. Delthyrial cavity filled with callus; dental plates thickened, slightly extended anteriorly, divergent laterally; teeth well developed, distinctly grooved on their internal faces (see Pl. XXV, figs. 7-13); muscles are in general not distinct, adductors can be distinguished, divided by very fine septal ridge, not always present, also a pair of posterior diductors, sometimes fairly deep, and a pedicular — median. Brachial valve: dental sockets comparatively deep; crural plates of moderate length with concave inner faces; cardinal process broad, distinctly incised on its postero-ventral face; median septal ridge low; two pairs of diductors marked; the cones of the brachidium directed laterally, each composed of 10-12 coils (Text-fig. 39; Pl. XXV, figs. 1-5).

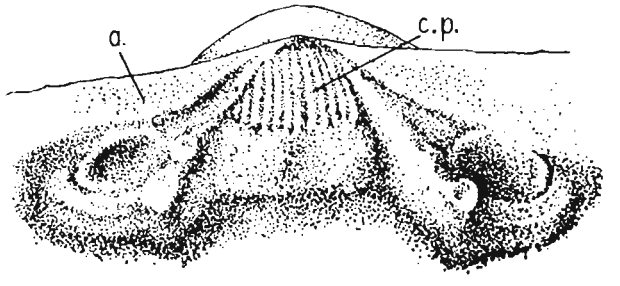


Fig. 39
Mucrospirifer (*Spinospirifer*) *diluvianoides* n. sp. Skały beds, marly shales, exposure 73. *A* Appearance of the cardinal process of adult specimen (Bp. VII/685*a*): *a* area, *c. p.* cardinal process; × 15

Growth stages. The collection includes specimens from about 1 mm. to 15 mm. in length. The outline and to some extent the shape is one of the most variable features of external morphology. The shell is nearly as wide as long in specimens up to about 2 mm. in length and strongly transverse, twice as wide as long or more, with mucronate hinge extensions in adults (see Text-fig. 38). The number of folds changes considerably with growth. Immature specimens to about 2 mm. in length have only the sulcus and fold sufficiently deep, the remaining shell surface is smooth. Specimens to about 4 mm. in length have an average of 8 simple folds on the pedicle valve and 9 on the brachial, gradually appearing on the lateral slopes by addition. The adult specimens have in general 20-24 folds on each valve. Length of the area appears

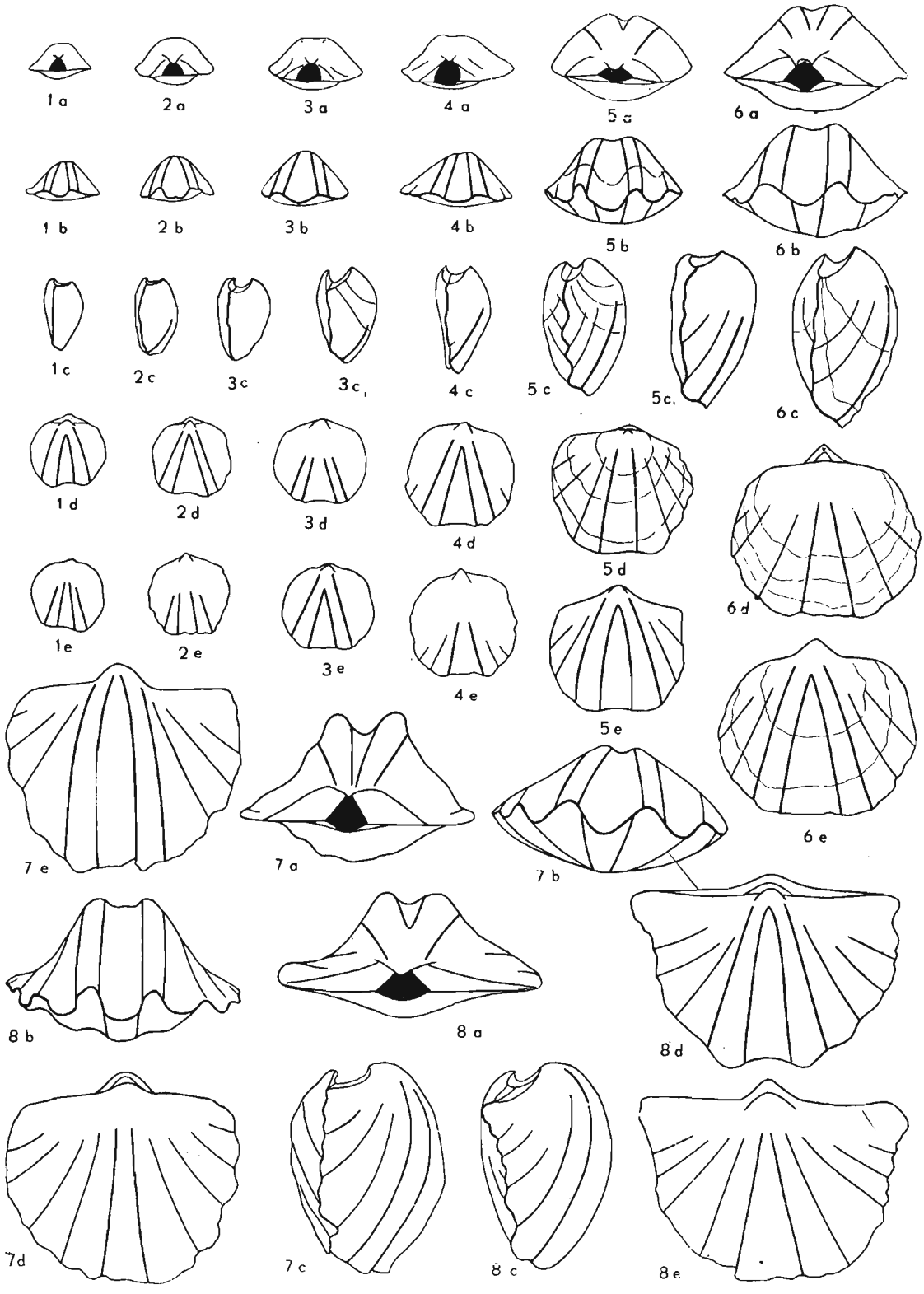


Fig. 40. — *Mucrospirifer* (*Spinospirifer*) *diluvianoides* n. sp. Skały beds, exposure 73. *1-8* A range of younger individuals in: *a* ventral area, *b* anterior margin, *c* side, *d* brachial valve, *e* pedicle valve views: × 5·3

to be connected with the shell outline. As is shown on Text-fig. 40, it is comparatively short, but high in the immature stage, conforming to a quadrate to subquadrate shell outline (width equal to length or slightly exceeding it). With age, the shell grows considerably more in breadth than in length, in consequence, the hinge line extensions appear and area becoming almost linear in maturity. Other features such as the appearance of both umbones, delthyrium, biconvexity of the shell, show gradual and progressive changes corresponding to the process of growth (Text-fig. 40).

Shell surface is distinctly micro-ornamented horizontally and radially. In immature specimens only the spine-bases are distinctly observed, arranged somewhat regularly in radial, but discontinuous threads. In maturity they form, together with crossing concentric microlines, a delicate net observed chiefly on the posterior half, anteriorly the granular spine-bases are slightly more thickened, especially along the edges on the concentric growth lines.

The growth range of specimens shows some progressive «tendency» towards a two-ways development. One leading to shells of varying degrees of subtransversity, with small but distinctly marked auriculate extensions, often not preserved in fossil state, and resemble much more the immature shells, which are subquadrate to nearly quadrate in outline. In the second case «alatiform» shells are developed (Text-figs. 38, 40). Although between these two «types» there are intermediate specimens, it is easy even visually to recognize in the collection the above mentioned variants of shell outline. An explanation of the presence of these two variants in the discussed species is not easy.

It could be possible that they are an expression of sexual dimorphism as postulated by VANDERCAMMEN (1959) in e.g. *Cyrtospirifer* NALIVKIN. The problem of sexual dimorphism in brachiopods is not as yet well known. At recent, some authors have given it some attention.

Remarks. — Our new species can be compared with any species of the genus *Mucrospirifer*, however it can be distinguished by its lack of distinct and regularly distributed growth lamellae, and by the presence of surface spinosity. It is also very close to *Spirifer diluvianus* STEININGER described from the Middle Devonian of Germany, but our species seems to be more mucronate and it is less lamellose than it can be seen in *Spirifer diluvianus* figured by STEININGER (1853, Pl. 7, fig. 1). *M. (Spinospirifer) diluvianoides* is also comparable to some species of the genus *Eleutherokomma* CRICKMAY, described and cited from the Devonian of Canada, e.g. *Eleutherokomma implana* MCLAREN (1964, Pl. 16, figs. 17*a*-19; Pl. 17, figs 1*a*-3*e*). The differences lie in the shell outline, and in the general appearance of the surface radial and concentric ornamentation. The Canadian species has more irregular folds, an incipient costa in the sulcus, has lower ventral area and is not spinose like *Mucrospirifer (Spinospirifer)*.

Family AMBOCOELIIDAE GEORGE, 1931

Genus **CRURITHYRIS** GEORGE, 1931

Type species: *Spirifer urei* FLEMING, 1828; Lower Carboniferous of England.

Crurithyris inflata (SCHNUR, 1854)

(Pl. XXIX, figs. 1-9; Text-figs. 41, 42)

1854. *Spirifer inflatus* SCHNUR; J. SCHNUR, Zusammenstellung..., S. 211, Taf. 37, Figs. 2*a-d*.
1896. *Martinia inflata* SCHNUR; G. GÜRICH, Das Palaeozoicum.... S. 262, Taf. 9, Fig. 5?

1904. *Martinia inflata* SCHNUR; D. SOBOLEV, Devonskija..., s. 75.
1956. *Crurithyris inflata* (SCHNUR); A. VANDERCAMMEN, Revision..., p. 11, Pl. 1, figs. 10-27.

Horizon: Marly shales, exposures 72, 73 (brachiopod shales); exposure 83, marly shales underlying the limestone.
Locality: Skały.

Material. — Over 300 free specimens of different dimensions, many of them very damaged.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
759	3·6	4·0	2·6
760	3·8	4·2	2·5
762	4·2	5·0	3·0
765	4·6	5·2	3·5
767	4·8	5·8	3·2
768	5·2	6·0	4·0
769	5·8	6·2	4·2
771	6·0	6·5	4·2
775	6·2	6·2	4·8
778	6·2	7·0	4·2

Description. — Shell small, subpentagonal in outline, wider than long, greatest width anterior to hinge line; sulcus on both valves very shallow, scarce, more common in the brachial valve; antero-lateral margins rounded. Pedicle valve larger and deeper than the opposite one, regularly arched all over the valve length; umbo moderately prominent with incurved beak; area apsacline, not very distinct.

Ornamentation. Shell surface smooth with rarely observed concentric lines. Micro-ornamentation composed of densely spaced microspines (Pl. XXIX, fig. 9), arranged almost regularly, quincuncially. The spines are simple. The spine bases or preserved spine fragments are ovate and exceedingly delicate, distributed over the shell surface, always in two sizes, the longer observed posteriorly and the shorter anteriorly, always being in conformity with the distribution of concentric lines.

Interior (Text-fig. 41). Pedicle valve: deltidial plates very narrow bordering delthyrial edges; delthyrial plates developed, filling the posterior part of delthyrium; dental plates absent, teeth small. Brachial valve: cardinal process low, longitudinally incised; chilidial plates observed; crural plates short, subparallel, each cone of the brachidium composed of 4-6 coils.

Individual variability. — The species is rather stable, with just a little variation, which concerns the outline and shape of the shell. Width/length ratio varies in the limits of 0·9-1·4. Majority of specimens, 54 out of 110 measured, have width/length index ratio 1·1. On the graph the curve is one-topped, having a strongly elevated tip. Some variation is shown in the thickness/length ratio, varying from 0·5-1·0; 64 per cent of all measured specimens with index ratio 0·7 have an average shell length 5·5 mm. and shell thickness 3·8 mm. The arrangement of spine bases on the shell surface is almost the same, more or less regularly quincuncial.

Growth changes (Text-fig. 42). The species shows very small morphological changes during growth. In general, young, small specimens show the same external features as adults, but are less developed. They differ a little in having a more rounded outline, a smaller and lower pedicle valve beak, which is not prominent, the delthyrium, shared by both valves, becomes with growth trigonal and finely ovate in outline. Delthyrial plates, as a rule, can be observed in

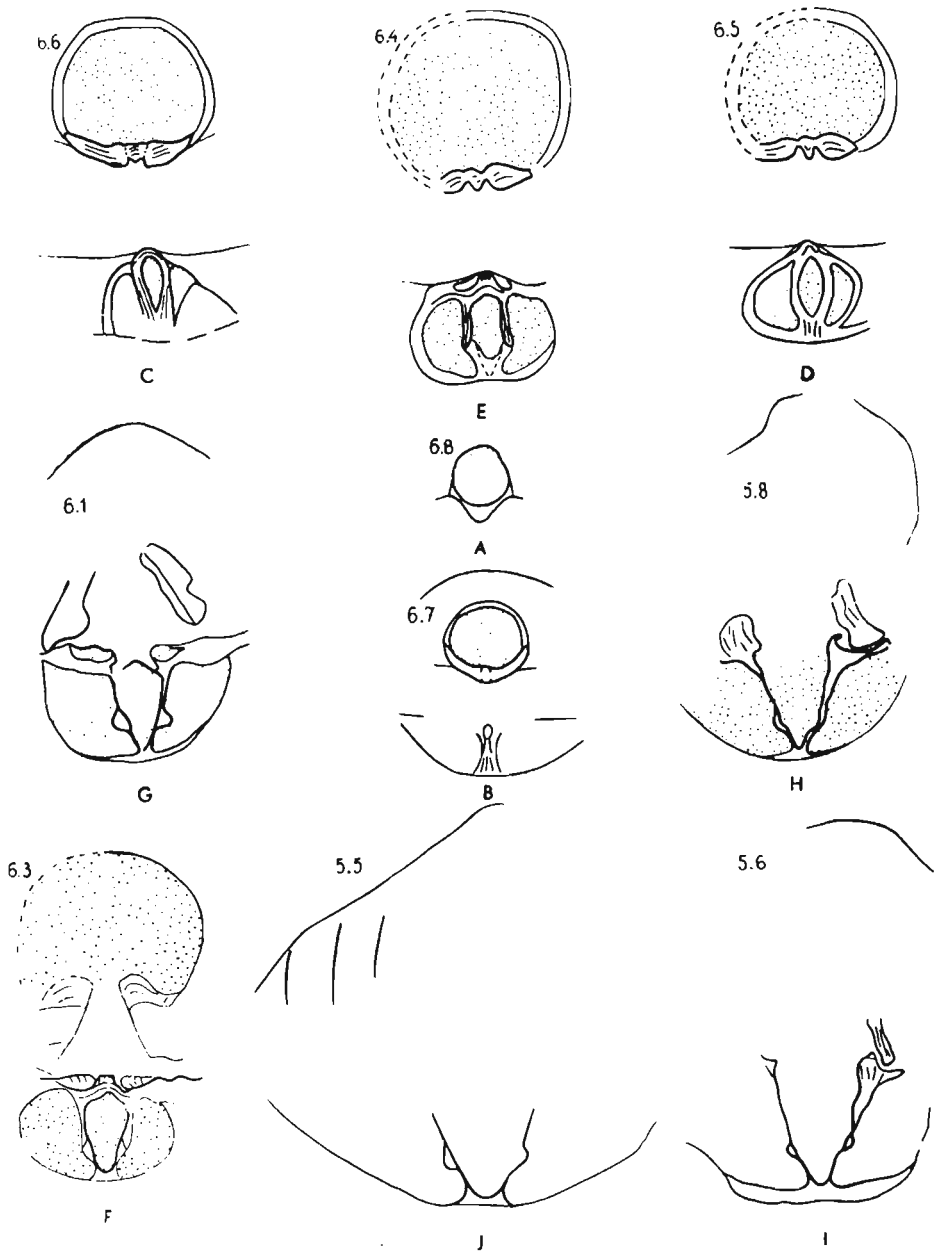


Fig. 41
Crurithyris inflata (SCHNUR). Skały beds, marly shales, exposure 73. *A-I* Serial cross sections of adult specimen; × 8·2

specimens of about 2·5 mm. long, being very narrow and slightly elevated above the ventral area. Immature specimens of about 1 mm. long are probably completely smooth, without spine bases, these latter being observed in specimens of about 2 mm. long.

It may be stated here that specimens of different size, it means of different individual age, are always wider than long, with pedicle valve more convex than the opposite one.

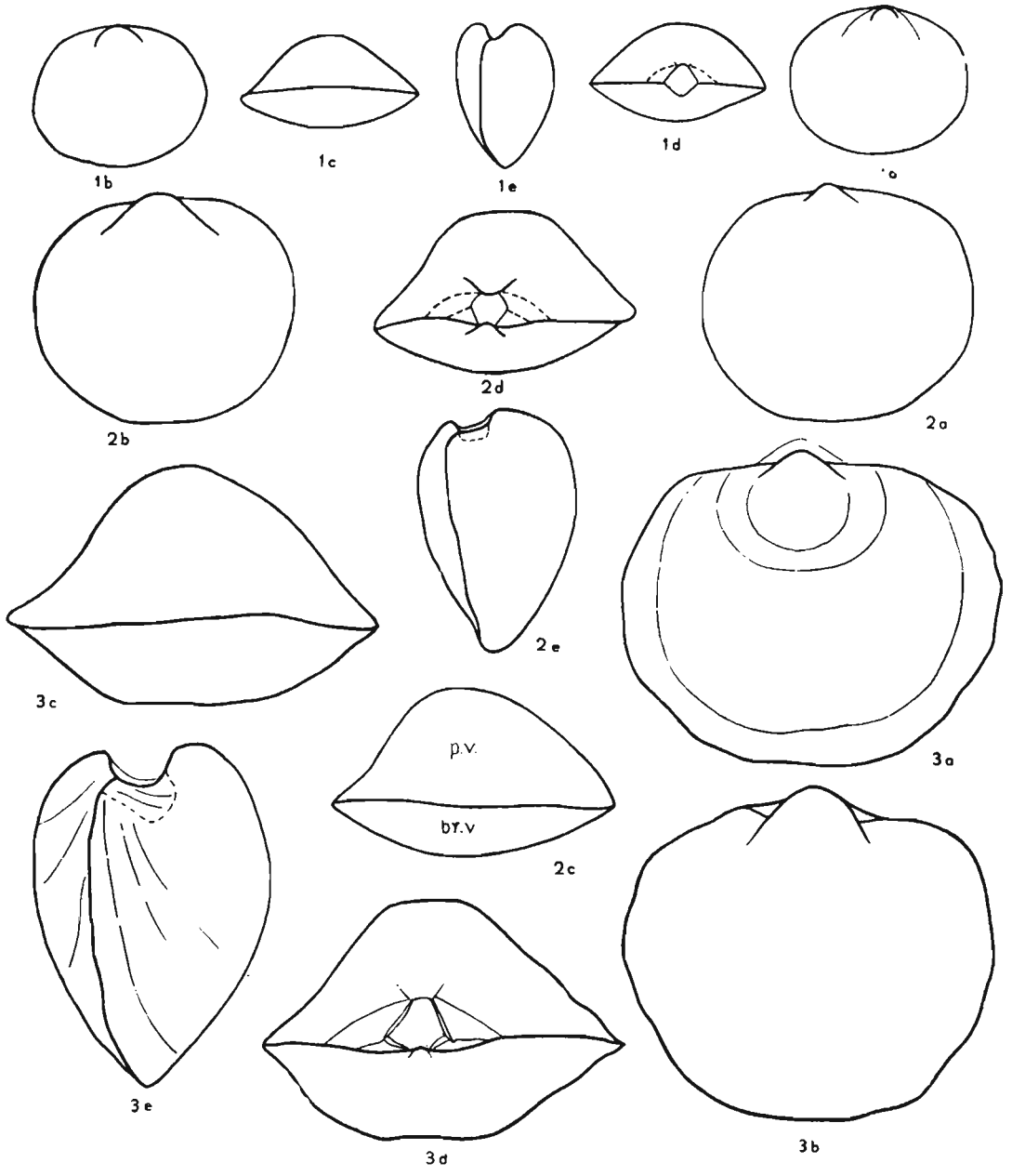


Fig. 42

Crurithyris inflata (SCHNUR). Skały beds, marly shales, exposure 73. *1-3* Three young specimens in: *a* brachial valve, *b* pedicle valve, *c* anterior commissure, *d* ventral area, *e* side views (Bp. VII/3762-3764): *b. v.* brachial valve, *p. v.* pedicle valve; × 20

Remarks. — Our specimens are small and their size corresponds to the specimen of *Crurithyris inflata* figured by SCHNUR (1854, Pl. 37, fig. 2*d*). The German collection (SMF coll. from the Eifel) contains specimens in general 2-3 times larger than ours, with a more prominent and a little larger ventral beak. This reduction in size of our specimens has been observed in some other species, coming from the marly shales of the Skały beds, such as i.e. *Schellwienella (Schellwienella) umbraculum* (SCHLOTH.), *Cyrtina heteroclita intermedia* OEHLERT, *Bifida lepida*

(D'ARCHIAC & DE VERNEUIL), and is in all probability connected with lithofacies. *Crurithyris inflata* (SCHNUR) resembles *Crurithyris apena* VEEVERS (1959, p. 133, Pl. 13, figs. 10-19; Text-fig. 86) from the Devonian of Western Australia, the Fitzroy Basin, being distinguished by a nearly pentagonal shell outline, a narrower and more distinct surface sulcus. *Emanuella(?)* cf. *inflata* (SCHNUR) from Givetian of USSR, Tchelevye beds, figured by RZONSNICKAJA (1952, p. 150, Pl. 5, fig. 4*a-e*), is also larger, with a more elevated ventral beak than in our specimens.

Occurrence. — Middle Devonian; Germany (?Upper Eifelian); Belgium (Upper Couvinian-Upper Frasnian, especially numerous in the Middle Frasnian); Poland (Middle Devonian of the Łysogóry region); USSR (Givetian).

Family RETICULARIIDAE WAAGEN, 1883

Genus ?EORETICULARIA NALIVKIN, 1924[4]

Type species: *Spirifer indifferens* BARRANDE, 1847; Devonian, Czechoslovakia.

Eoreticularia eifeliensis (FRECH) in SCUPIN, 1900

(Pl. XXX, figs. 13-19; Text-figs. 43, 44)

1900. *Spirifer robustus* var. *eifeliensis* FRECH; H. SCUPIN, Die Spiriferen..., S. 56 (260); Taf. 5 (28); Fig. 5.
1909. *Spirifer robustus* var. *eifeliensis* FRECH; D. SOBOLEV, Srednij Devon..., s. 478.
1962. *Spirifer robustus* var. *eifeliensis*; A. J. BOUCOT, Observations..., p. 416, Pl. 51, fig. 12.

Horizon: Marly shales of exposure 84; two specimens from shales of exposure 72; Skały beds, Middle Devonian.
Locality: Skały.

Material. — About 40 specimens of unequal dimensions, in general badly preserved. Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus	Microlines post. (in 2 mm.)
1365	11·0	?12·4	6·4	4·0	4
1366	12·9	16·5	7·2	—	3
1364	12·9	16·6	9·0	?5·0	4
1367	14·4	18·9	12·2	—	—
1363	17·9	23·6	11·7	6·7	4
1362	20·8	24·9	16·4	—	—

Description. — Shell of medium size, subequally biconvex, tranversely outlined; shell widest in the region of hinge line; hinge extremities rounded, sulcus and fold starting at the umbonal region, usually well marked. Pedicle valve more convex in the posterior half; area catacline to procline of moderate height, with longitudinal and horizontal striation; delthyrium open, bordered by two anchylosed elevated deltidial plates, coalesced just beneath the beak in adults and old individuals, similarly as in *Ambocoelia umbonata* CONRAD (see HALL, 1896,

[4] This genus is included, in the Treatise on Invertebrate Paleontology, Part H. Brachiopoda, 1965, into the synonymy of the genus *Reticulariopsis* FREDERIKS, 1916, with the type species *Spirifer (Reticularia) dereimsi* OEHLERT, 1901, described from the Lower Devonian of Spain.

p. 54, Pl. 39, fig. 14). Brachial valve with very small area, notothyrium low, bordered by 2 small linear chilidial plates, which extend from the beak to about a half of the notothyrium length.

Ornamentation. Much like *Eoreticularia curvata* (SCHLOTHEIM) from the Eifelian of Grzegorzowice beds (BIERNAT, 1954). Concentric lines distinct, spinose, usually 4-5 per 2 mm. on the umbonal part and 4-7 anteriorly, densely bordered by oval spine bases (12-16 in 1 mm.); the latter continuing as fine radial microstriation which stretches between two concentric lines. In some cases fine and comparatively long, to about 2·5 mm., spines are preserved on shells, bearing patches of shale. They are of hair-like appearance, but somewhat thicker than those in e.g. *Nucleospira lens* (see p. 140).

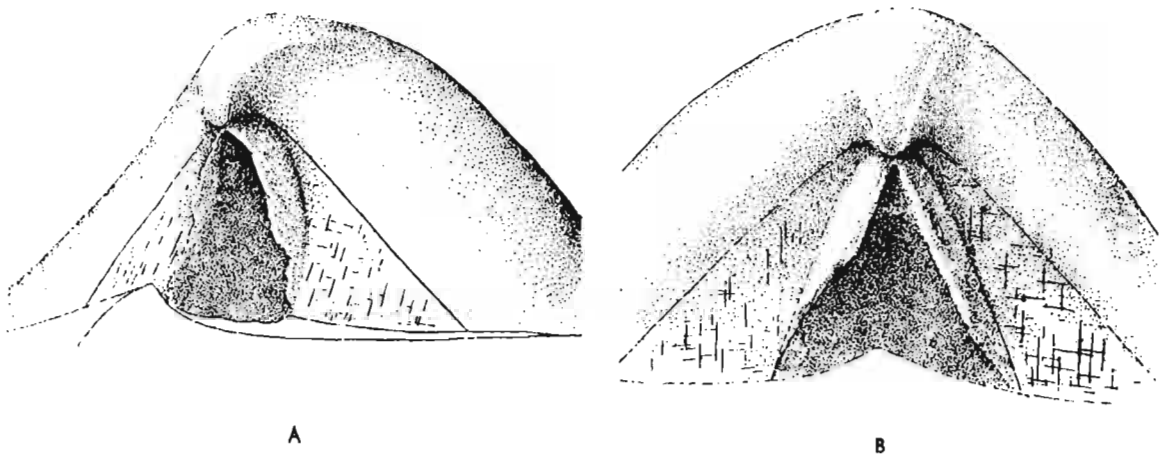


Fig. 43
Eoreticularia eifeliensis (FRECH). Skały beds, marls, exposure 84. *A-B* Delthyrium and deltidial plates of two different specimens; approx. × 10

Interior. Pedicle valve: dental plates thick, high, extending to about one-third of the valve length, slightly divergent anteriorly; delthyrial plates (= ?subdelthyrial plates, HAVLÍČEK, 1959, p. 163, Text-fig. 79) developed; no medium septum, but in some specimens a faint trace of a medium ridge can be observed. Brachial valve: cardinal process wide and low with longitudinally incised attachment surface for muscles; apical plates united with the valve floor; crura short, somewhat converging towards the valve bottom; each brachidial cone consisting of 6-8 coils.

Remarks. — The close similarity of our specimens to *Spirifer robustus* var. *eifeliensis* figured by SCUPIN (1900, Pl. 5, fig. 5) and to the German specimens (SMF 10111, 10113-10118) from the Middle Devonian of Prüm and Gerolstein, afirme that the former are conspecific with *Eoreticularia eifeliensis* (FRECH). *Spirifer (Reticularia) aviceps* KAYSER figured by REED (1908, Pl. 16, figs. 1-3) probably belongs to *Eoreticularia eifeliensis*, as it shows two elevated deltidial plates, characteristic for the discussed species. *Eoreticularia eifeliensis* can be also compared with *Spirifer curvatus* (BUCH) figured by SCHNUR (1853, Pl. 36, figs. 3*c*-3*i*) having a similar shell outline and spinose concentric lines, however it is smaller, with a more moderate sulcus and fold. *Tingella remesi* HAVLÍČEK from the Middle Devonian of Moravia, Čelechovice (HAVLÍČEK, 1959, Text-fig. 75; 1951, Pl. 3, figs. 1, 3) appears to be close to *Eoreticularia eifeliensis*, but differs somewhat in shell outline, in slightly more divergent dental plates and probably in a more marked sulcus and fold.

Occurrence. — Middle Devonian; Germany (Eifelian-Ahrdorf beds); Poland (Skały beds).

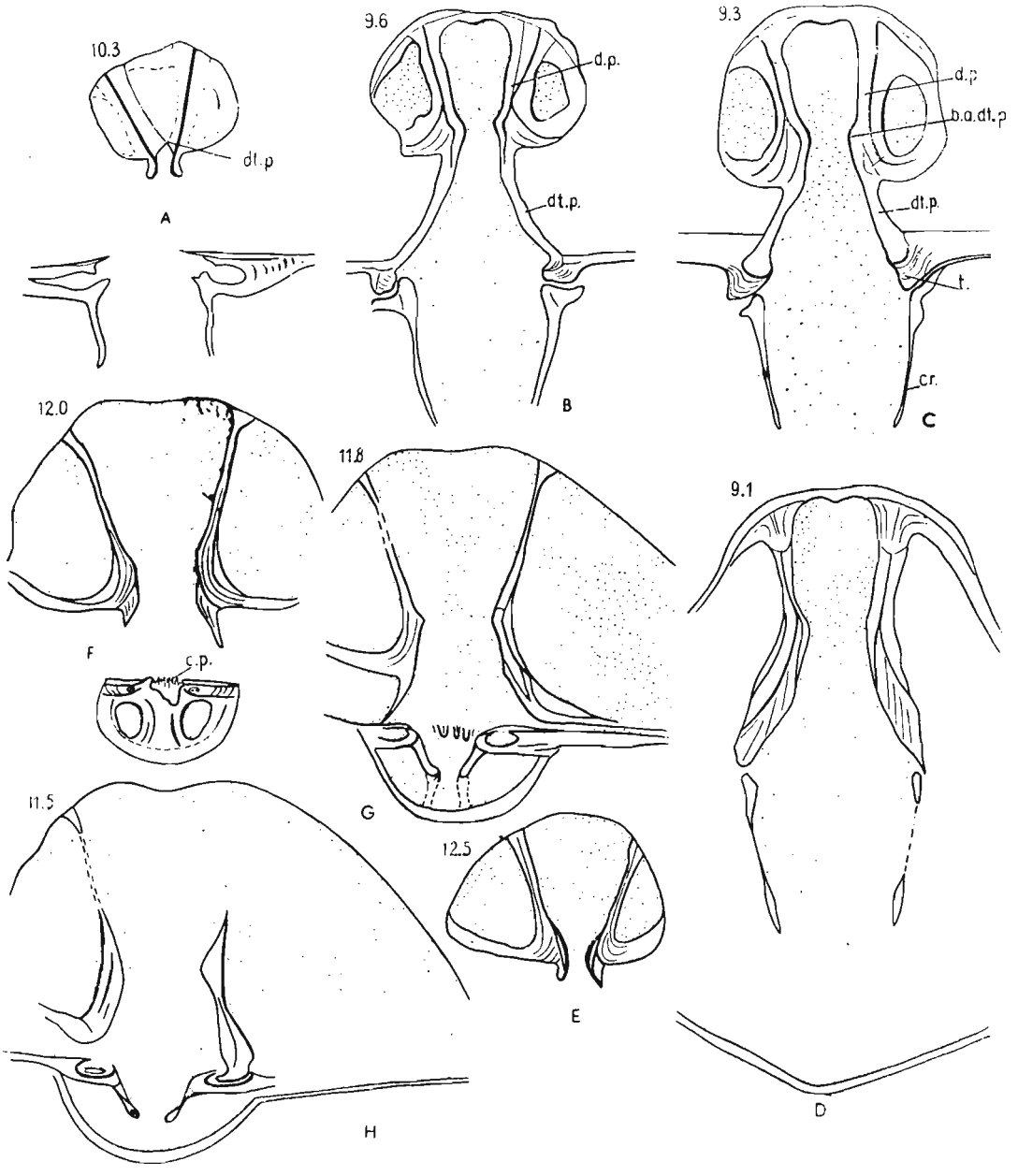


Fig. 44

Eoreticularia eifeliensis (FRECH). Skały beds, marls, exposure 84. *A-D* Longitudinal cross section of adult specimen. *E-H* Serial cross sections of adult specimen: *c. p.* cardinal process, *cr.* crura, *b. a. dt. p.* basal arc of delthyrial plate, *d. p.* dental plate, *dt. p.* delthyrial plate, *t.* tooth; × 6·4

Eoreticularia aviceps (KAYSER, 1871)

(Pl. XXX, figs. 1-12; Text-figs. 45, 46)

1871. *Spirifer aviceps*; E. KAYSER, Brachiopoden..., S. 578, Taf. 11, Fig. 4.
1871. *Spirifer lineatus* var.; E. KAYSER, *Ibid.*, S. 582, Taf. 12, Fig. 2.
1896. *Reticularia aviceps* KAYSER; G. GÜRICH, Palaeozoology..., S. 257, Taf. 9, Fig. 7.

1904. *Reticularia aviceps* KAYSER; SOBOLEV, Devonskija..., s. 72.
1909. *Spirifer aviceps* KAYSER; D. SOBOLEV, Srednij Devon..., s. 474.
1951. *Reticularia aviceps* (KAYSER); V. HAVLIČEK, Paleontologicka studie..., p. 15, Pl. 3, fig. 6.

Horizon: Marly shales, exposures 72, 73, 84, Skały beds, Middle Devonian.
Locality: Skały.

Material. — Thirty-two specimens of different size, in general sufficiently preserved; twelve fragments of pedicle valve with well preserved dental plates; fifteen fragments of shells.

Approximate dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus
978	9·0	11·2	5·5	3·0
981	9·0	13·8	7·0	4·2
979	9·3	11·2	5·6	4·4
980	9·5	13·0	6·2	3·4
986	12·0	20·8	8·6	—
982	14·0	?15·2	8·5	6·0
983	14·0	18·6	9·5	6·2
988	14·2	21·0	8·8	?6·0
984	15·0	18·6	7·8	6·8
985	15·6	20·0	8·5	?5·0
991	16·0	20·0	11·0	?6·5
989	?19·8	23·4	10·0	—

Description. — Shell medium sized, unequally biconvex, wider than long, greatest width just beneath the hinge line, which is less than the maximum shell width; anterior commissure uniplicate. Pedicle valve moderately and regularly arched from beak to front; umbo greately elevated, acutely pointed, with beak a little incurved; area of moderate height, slightly concave and horizontally striated; delthyrium very narrow, closed in upper part by «delthyrial» thickenings extending inwardly from the dental plates, coalesced medially: a trace of coalescence, expressed as a distinct median groove, usually disappears in old individual, giving the impression of a small concave or flat deltidium?, closing the upper part of the delthyrium (Text-fig. 45); both sides of delthyrium thickened; sulcus originating on the umbo, shallowly rounded at the bottom. Brachial valve of moderate convexity, highest in posterior region; fold present in the anterior half of the shell; notothyrium low and broad; beak small but pointed.

Ornamentation. Spinose concentric lines, closely but regularly aggregated. There are 8-10 per 2 mm. at the umbonal part and 11-13 per 2 mm. at the front margin of an average shell. Spine bases are round, densely arranged into concentric rows (commonly 14 in 1 mm.); slightly elongating upwards, giving (under microscope) the impression of fine radial ornamentation.

Interior. Pedicle valve: dental plates well developed, thick, moderately divergent, extending for about one-third of valve length; teeth short but pointed. Brachial valve: cardinal process broad, incised longitudinally several times, partly filling up the notothyrium; dental sockets moderately broad and shallow in cross section; hinge-plate divided, with outer parts shallowly excavated; crura slender, slightly convergent towards valve floor.

Individual variability. — In general the species is not highly variable, exceptions are the shell outline and the appearance of the pedicle valve area, i.e. degree of concavity and, as a result, some differences in the inclination of the area from the plane of commissure.

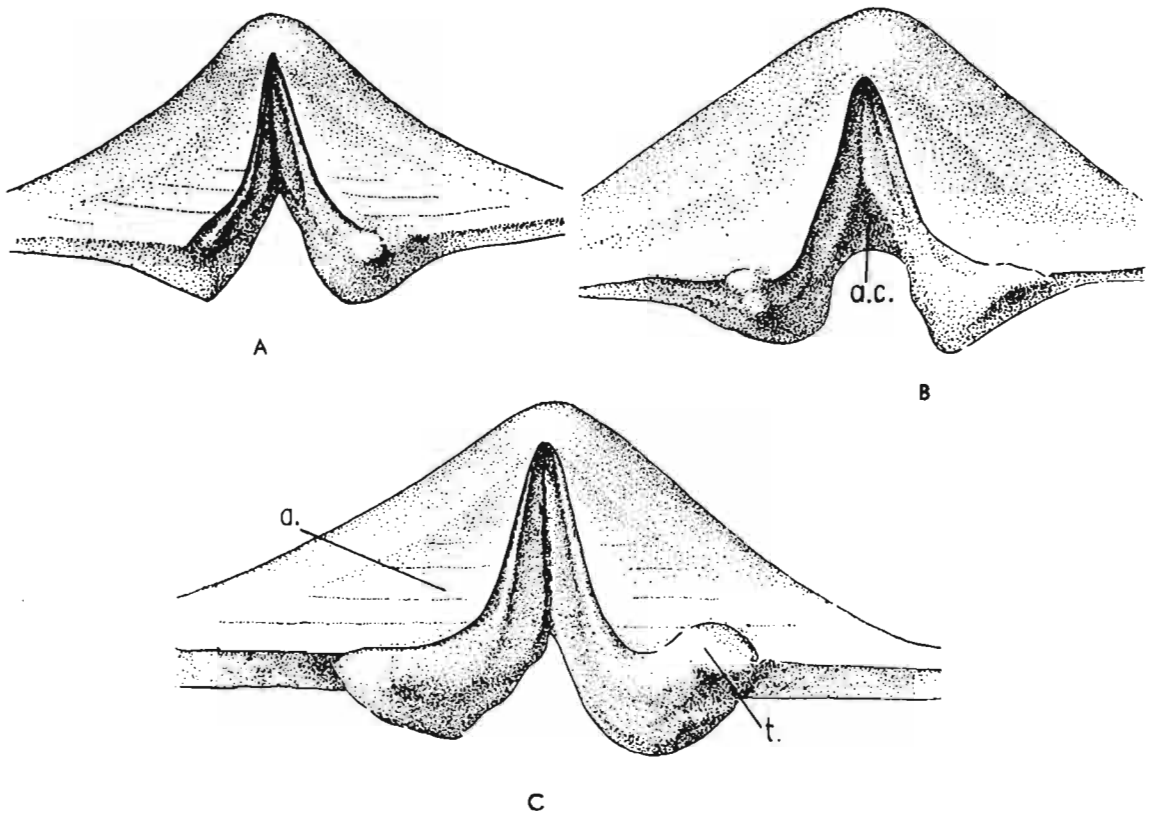


Fig. 45
Eoreticularia aviceps (KAYSER). Skały beds, marly shales, exposure 73. *A-C* Appearance of the ventral area of 3 different specimens (Bp. VII/4023, 4024, 4025): *a* area, *a. c.* apical callosity, *t* tooth; × 10

As is shown by our material, all specimens from exposure 72 of the Skały beds have an area of moderate height, regularly concave, ranging from slightly orthocline to more or less apsacline. Specimens from exposure 84 have a slightly higher area, but it is less concave and in general apsacline to slightly catacline. Shell outline in all probability varies from transversely to more longitudinally elongated.

Similar variations are shown in specimens of *Spirifer aviceps* figured by KAYSER (1871, Pl. 11, figs. 4*a-g*). Area is in general higher, varying from apsacline to nearly catacline. The height of the area of the German specimens may to some extent be connected with the length/width ratio. Shells with greater length have probably an area less inclined from the plane of commissure. Area is lower, being nearly catacline in more transversely elongated shells. The species does not appear to be variable in other respects.

Remarks. — Our specimens are of the type *Spirifer aviceps* figured by KAYSER (1871, p. 578, Pl. 9, fig. 4), having a similar acute beak, a narrow delthyrium and a transverse shell outline. Comparison with the German specimens from the Middle Devonian of the Eifel (SMF coll. of SCHNUR) shows, that our specimens are close, if not exactly identical, to the smaller German specimens, the larger German specimens being more transverse.

Occurrence. — Middle Devonian; Germany (Freilinger layers); Czechoslovakia (Čelechovice); Poland; USSR.

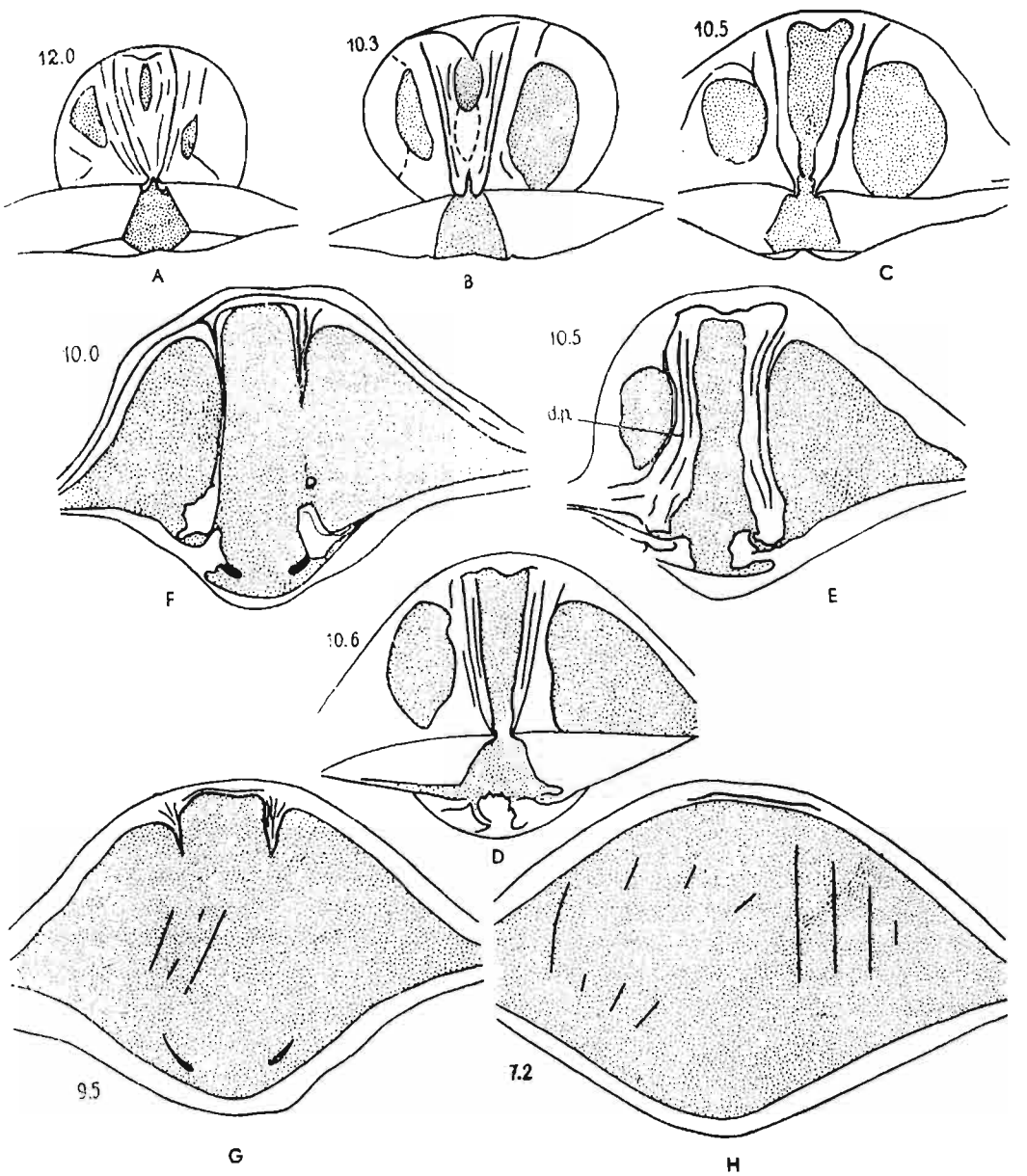


Fig. 46
Eoreticularia aviceps (KAYSER). Skały beds, marly shales, exposure 73. *A-H* Serial cross sections of adult specimen about 12·8 mm. long; *d. p.* dental plate; × 7

Genus **MINATOTHYRIS** VANDERCAMMEN, 1957

Type species: *Spirifer euryglossus* J. SCHNUR, 1851, p. 11; Devonian of Eifel, *Cuboides* layers, Germany.

The Canadian genus *Warrenella* CRICKMAY (CRICKMAY, 1953) with the type species *Warrenella eclectea* CRICKMAY, 1953, from the Upper Devonian, Alberta, seems to be very near to the European genus *Minatothyris* VANDERCAMMEN, 1957. Some characteristic of the genus *Warrenella*, such as: medium to large ventri-biconvex shell with sulcus and fold; delthyrium

usually covered; internally — apical callus, cardinal process, well developed teeth and dental lamellae — are also observed in the species of the genus *Minatothyris*. It is quite possible that these two genera are congeneric.

Minatothyris maureri (HOLZAPFEL, 1896)

(Pl. XXXI, figs. 4-5)

1895. *Spirifer maureri*; E. HOLZAPFEL, Das Obere Mitteldevon. S. 256, Taf. 17, Figs. 1, 2.
1957*a*. *Minatothyris maureri* (E. HOLZAPFEL, 1896); A. VANDERCAMMEN Revision des Reticulariinae..., p. 7, Pls. 2, 3.

Horizon: Shales and limestone of exposures 89, 92, 93, 101; limestone of Miłoszów, Skały beds, Middle Devonian.
Locality: Skały and Miłoszów.

Material. — Five, not well preserved specimens, with fragments of concentric ornamentation; a few fragments of shell and of isolated pedicle valve.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus
1040	?30·2	40·0	21·0	?15·5
1041	28·2	30·0	17·4	12·0
1043	33·2	38·2	20·8	16·0
1044	?34·0	34·8	23·6	14·5

Description. — Shell moderate to large in size, moderately ventri-biconvex, rounded to about subcircular in outline, wider than long, antero-lateral commissure rounded, anterior margin sulciplicate; both valves regularly arched along midline from umbo to front. Pedicle valve deeper than the opposite valve: umbo thickened and elevated, beak pointed and incurved; area small, concave; delthyrium with distinct symphytium, greatly thickened in old individuals; sulcus starting almost at the umbo, moderately deep, widening anteriorly and rounded at the bottom. Brachial valve of moderate convexity; fold more elevated at the anterior margin, beak very small. Shell surface smooth, covered by concentric lines, generally somewhat thickened, with rows of short spine bases, observed on some small fragments of shell.

Interior. Pedicle valve: apical cavity thickened, completely filled with callus; very weak septal ridge (= *coussinet septal* sensu VANDERCAMMEN, 1957*a*, p. 9, Text-fig. 2) present; dental plates much thickened, slightly divergent anteriorly, extending to about one-fourth of the valve length; teeth massive with thickened surfaces for articulation; muscle scars deeply excavated. Brachial valve: cardinal process low, large, stout, with numerous longitudinal incisions; crura comparatively large and thickened; each cone of brachidium with about 10-12 coils.

Remarks. — Our specimens are more closely related to the specimens of *Minatothyris maureri* (HOLZAPFEL) from the Givetian of Rhine region, than to any other species of this genus. They are almost identical to *M. maureri* figured by HOLZAPFEL (1895, Pl. 17, fig. 1). German specimens from Bilveringsen (SMF XVII, 256b), labelled as *Spirifer maureri* HOLZAPFEL, are in general a little more transverse than the specimens from the Skały beds. *Minatothyris maureri* shows a great morphological similarity to *M. concentrica* (SCHNUR), but it has a much more thickened umbo and a less circular outline, which constitute a definite difference between

the two species. *M. euryglossa* (SCHNUR), rather easily confused with *Minatothyris maureri*, is smaller, with a deeper and narrower but more elevated fold.

Occurrence. — Middle and Upper Devonian; Germany (Rhine region); England (Lummaton); Belgium; Poland (Łysogóry region); Canada.

Minatothyris sp. cf. **Minatothyris concentrica** (SCHNUR, 1854)

(Pl. XXXI, fig. 6)

Horizon: Limestone of Miłoszów, Skały beds, Middle Devonian.
Locality: Miłoszów, Łysogóry region, Holy Cross Mountains.

Diagnosis. — Large *Minatothyris*, almost circular in outline, very moderately biconvex, fold distinct but narrow and acute; sulcus narrowly acute at the bottom, umbo small with acutely pointed beak which is slightly incurved; area small: delthyrium partly closed posteriorly; hinge line very short; surface ornament consisting of concentric, thickened lines, 10-15 per 10 mm., bordered with ovate spine bases.

Material. — One specimen well preserved.
Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	Width of sulcus
1045a	40·2	50·5	21·6	20·2

Remarks. — The specimen appears to be characteristic because of its circular outline, with the greatest width midway, the presence of an acute fold and culcus and very low convexity. These features are judged to be sufficient to differentiate it from typical *M. concentrica* (SCHNUR) to which it is almost certainly closely related.

Family CYRTINIDAE FREDERIKS, 1912

Genus **CYRTINA** DAVIDSON, 1858

(CYRTINA DAVIDSON, 1858; SPINOCYRTINA FREDERIKS, 1916; CYRTINAELLINA FREDERIKS, 1926)

Type species: *Calceola heteroclita* DEFR., 1828; Lower Devonian, France.

Cyrtina heteroclita intermedia OEHLERT, 1886

(Pl. XXIII, figs. 9-27; Pl. XXXII, fig. 13; Text-fig. 47)

1962. *Cyrtina heteroclita intermedia* OEHLERT; E. IVANOVA, Ekologija..., s. 110, Tabl. 4, ris. 1-4; Tabl. 5, ris. 1.

Horizon: Marly shales of exposures 72, 73, 84; argillaceous shales of exsposure 125, Skały beds, Middle Devonian.
Locality: Skały.

Material. — Forty specimens, with valves closed, in general of small sizes. State of preservation sufficient.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Height of area	Width of brachial valve	Length of brachial valve	Length of pedicle valve	Folds	
					brachial valve	pedicle valve
1225	0·5	1·0	1·0	0·95	sulcus and fold marked	
1223	0·95	1·75	1·25	?1·25	,, ,, ,, ,,	
1226	1·2	2·25	1·5	1·3	,, ,, ,, ,,	
1227	2·0	3·5	2·35	2·9	,, ,, ,, ,,	
1228	2·5	4·0	2·5	2·9	3	4
1230	3·3	8·0	5·2	7·2	3+1+3	4+4?
1231	5·6	9·0	6·0	6·8	3+1+3	3+3
1232	4·7	9·3	5·3	7·0	3+1+2	4+4
1233	5·5	8·7	5·7	?7·9	3+1+3	3+4
1234	7·5	10·3	6·6	12·0	3+1+4	4+4

Description. — Shell small, often asymmetrical, subpyramidal in shape and subquadrate in outline; antero-lateral margins rounded; the greatest width just beneath the hinge line; antero-lateral commissure plicate. Pedicle valve moderately convex; umbo elevated with pointed beak, slightly incurved in maturity, in some specimens turned somewhat to the left or right; area high, slightly concave posteriorly; delthyrium narrow, slightly arched, covering a half to about two-thirds of delthyrium, posterior third of the delthyrium usually open. Brachial valve nearly flat, beak slightly marked.

Ornamentation. Ventral sulcus and corresponding fold starting some distance from beaks; the remaining shell surface plicated. In general there are 6-8 folds on the pedicle valve and 6-8 on the brachial valve. Surface granulation observed.

Interior much the same as in *Cyrtina heteroclita intermedia* OEHLERT from Kuznetsk Basin, USSR, figured by IVANOVA (1962, Text-fig. 46).

Growth changes. Immature specimens differ greatly from adults in their external morphology. Small shells (length of the pedicle valve 0·6-2·0 mm.; width 1·3 mm. to about 3·0 mm.) have the brachial valve larger than the pedicle valve or sometimes equal to it, the ventral beak is slightly elevated above the hingeline, but very much turned to one side (in lateral view) (Text-fig. 47); ventral area is comparatively high, straight or slightly concave; delthyrium oval, open, its base occupying about one-fourth to one-fifth of the length of the area, delthyrial edges thickened; sulcus and fold faintly marked.

In the next stage (specimens Bp. VII/122-132), length of the pedicle valve = 2·9 mm. to about 7·0 mm.; the pedicle valve exceeds the dimensions of the brachial valve, height of the area increases; delthyrium is closed by a delicate and faintly arched deltidium, pedicle foramen present; the base of the delthyrium is equal to about one-third of the area length; about 6 radial folds on each valve. With progressing growth the shell becomes thicker and proportionally larger, which continues into gerontic age. Two specimens in the collection (Bp. VII/1233-4) represent the gerontic stage, however not an advanced one. The delthyrium and the apical part of the pedicle valve are greatly thickened; pedicle foramen quite indistinct, evidence of atrophy of the pedicle. Probably as a result of uneven substratum the pedicle foramen migrated towards the apex and finally disappeared (see IVANOVA, 1962, p. 31).

Individual variability. — All specimens come from the shales of a few exposures in the Skały beds. They are all small, the majority representing a submature stage, a pedicle valve of 12 mm. is apparently the maximum length attained by our adult specimens. The exterior of all shells

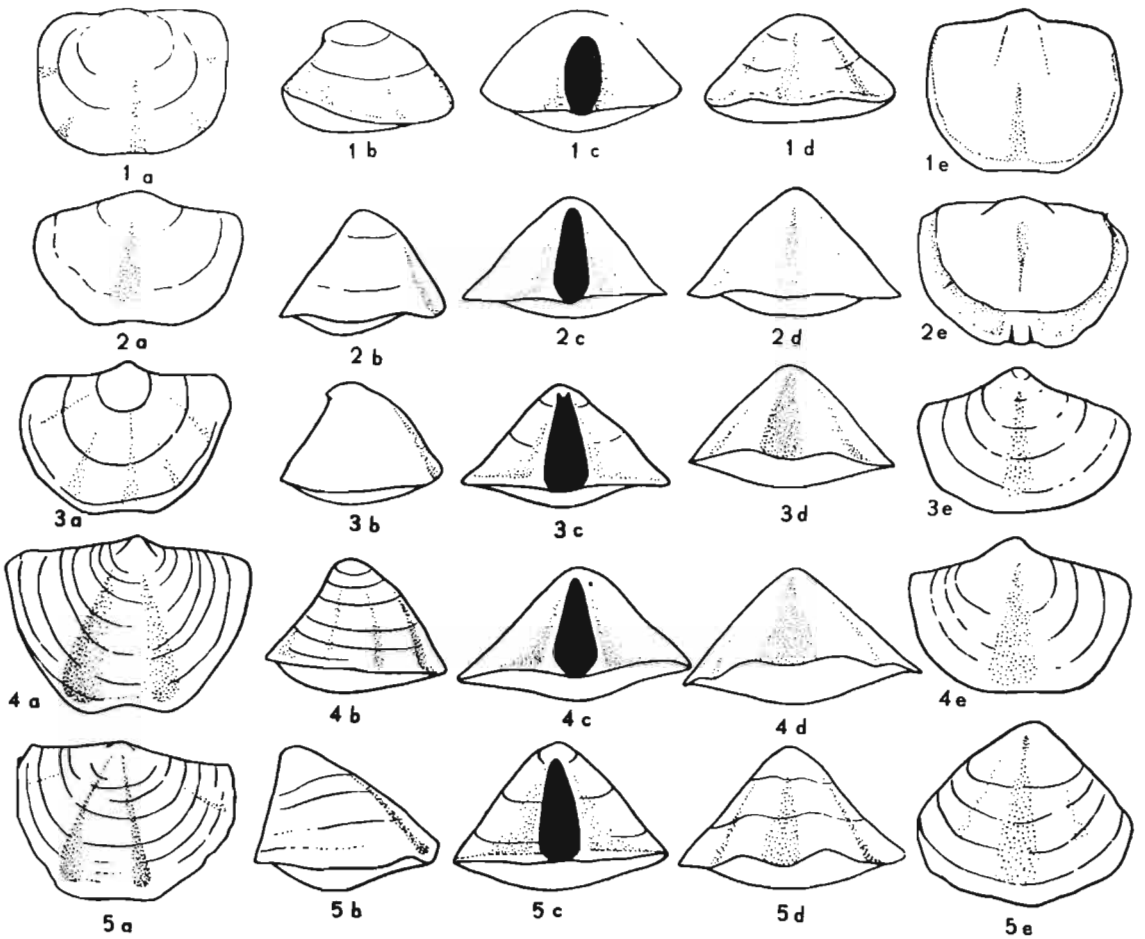


Fig. 47

Cyrtina heteroclita intermedia OEHLERT. Skały beds marly shales, exposure 73. *1-5* five immature specimens, in: *a* brachial valve, *b* side, *c* hinge-line, *d* anterior margin, *e* pedicle valve views; *1* × 25, *2* × 12·5, *3—5* × 17, *4* × 20

shows some variability in the length/width ratio, height of the area, its degree of concavity, number and distinctness of radial folds. Many specimens are asymmetrical because of the ventral beak being turned aside and because of differences in the width of both valves of the shells. This asymmetry, so extremely marked in cyrtinoids, is closely connected with the type of substratum. This problem has been discussed by some authors and lately by IVANOVA (1962). According to her, the appearance of the shell and of the ventral area are a direct reflection of the type of substratum, to which the shell was attached by a short pedicle.

Remarks. — Our specimens closely correspond to the specimens of *Cyrtina heteroclita intermedia* OEHLERT from the Middle Devonian of Kuznetsk Basin, Safonovski horizon, USSR, figured by IVANOVA (1962, Pl. 4, figs. 1-4), differing slightly in less distinct radial folds, and in somewhat smaller shell dimensions. Closer comparative studies could probably reveal further external differences, even making it possible to erect a new subspecies.

Occurrence. — Middle Devonian; Poland; USSR (to the end of the Middle Devonian); France; England.

Genus ?PYRAMIDALIA NALIVKIN, 1947[5]

Type species: *Spirifera simplex* PHILLIPS, 1841, p. 71, Pl. 29, fig. 124; Middle Devonian, England.

Pyramidalia cf. simplex (PHILLIPS, 1841)

(Pl. XXVII, fig. 1)

1841. *Spirifera simplex*; J. PHILLIPS, Figures and descriptions..., p. 71, Pl. 29, figs. 124*a, b, d.*
1957*b*. *Plectospirifer simplex* (J. PHILLIPS, 1841); A. VANDERCAMMEN. Des Reticulariinae..., p. 12, Pl. 2, figs. 3-17.

Horizon: Limestone of Miłoszów, Skały beds, Middle Devonian.
Locality: Miłoszów.

Material. — One incomplete specimen.
Approximate dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Height of area
892	?19·4	27·0	?14·2

Description. — Shell of medium size, unequally convex, with high area, anterior commissure uniplicate; sulcus on the pedicle valve distinct, starting at the beak; fold on the brachia valve medially furrowed, in general not distinctly marked. Damaged apical part of the pedicle valve shows short but high dental plates.

Remarks. — Although insufficiently preserved the above specimen shows diagnostic properties of *Spirifera simplex* figured by PHILLIPS (1841, Pl. 29, figs. 124*a, b, d*), coming from the Devonian of Plymouth (South Devon, England). Features slightly differing are: a more acute sulcus and a slightly furrowed median fold, which in our specimen is lesser marked.

Occurrence. — Middle Devonian; Germany, England, Poland, ?France, USSR.

Genus SQUAMULARIINA FREDERIKS, 1916

Type species: *Cyrtina parva* GÜRICH, 1896, p. 266, Pl. 9, fig. 9; Middle Devonian Śniadka, Łysogóry region, Holy Cross Mountains.

Squamulariina parva (GÜRICH, 1896)

(Pl. XXIII figs. 28, 29; Pl. XXXII, figs. 1-13)

1896. *Cyrtina parva* GÜRICH; G. GÜRICH, Das Palaeozoicum..., S. 266, Taf. 9, Fig. 9.
1962. *Squamulariina parva* (GÜRICH); E. IVANOVA, Ekologija..., s. 119, Tabl. 4, ris. 10, ris. 51, 45*g*.

Horizon: Marly shales of exposure 84, Skały beds; marly shales of exposure 101 of Śniadka beds.
Locality: Skały, Śniadka.

[5] In the Treatise on Invertebrate Paleontology, Part H Brachiopoda, 1965, the genus *?Pyramidalia* is included into the synonymy of FREDERIKS, genus *Cyrtinaella* FREDERIKS, 1916.

Material. — Twelve specimens, two nearly complete, the rest greatly deformed; two incomplete separate pedicle valves with partly preserved spondylium.

Approximate dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length of pedicle valve	Height of area	Width of shell
652	14·2	9·0	?
653	15·4	9·4	15·9
651	15·6	8·4	15·8

Description. — Small to about medium size, subpyramidal, about as long as wide; hinge-line straight, slightly shorter than width of shell (Pl. XXXI, fig. 9); shell substance as well as the area and deltidium punctate, punctae small (see Pl. XXIII, fig. 28, Pl. XXXII, fig. 13). Pedicle valve of marked depth; area high, triangular, somewhat varying in its concavity, beak weakly incurved; delthyrium narrow, completely covered by convex and thickened deltidium (Pl. XXXII, figs. 4, 8-10); sulcus distinct, beginning at beak, widening anteriorly. Brachial valve partly preserved, showing a small, probably weakly convex fold. Interior of the pedicle valve — spondylium well developed (Pl. XXXII, figs. 1, 5).

Ornamentation. Exterior smooth, with sulcus and fold, lateral plications obsolete. Microsculpture of the shell exterior usually not preserved, but occasionally on some fragments of the outer layer of the shell a microsculpture pattern similar to this figured by IVANOVA can be observed (IVANOVA, 1962, p. 111, Text-fig. 45*d*).

Remarks. — The species is uncommon in the Middle Devonian deposits, usually recorded in a few specimens only. Although closely resembling *Cyrtina laevis* KAYSER (1871, Pl. 12, fig. 3), in general appearance it can be distinguished from the latter by its wider shell, more robust umbo with a less acutely pointed ventral beak, slightly wider sulcus with more acute bottom. Russian specimens of *Squamulariina parva* (GÜRICH) from Kuznetsk Basin, D_2^2 (IVANOVA, 1962,p. 111, Pl. 4, fig. 10, Text-fig. 51) have a slightly higher ventral area, probably less convex. Judging from the material and available illustrations of the species in question, the height of the area and the degree of its concavity can be considered as a changeable feature. *Squamulariina parva* (GÜRICH) may also to some extent be compared to the American species *Cyrtina biblicata* HALL from Schoharie, N. Y., but its shell is not so wide, hinge extremities are not auriculate, sulcus and fold are rather narrow (HALL, 1894, Pl. 28, figs. 7-10).

Occurrence. — The species has been recorded only in Poland (Holy Cross Mountains, Skały beds, Śniadka) and in USSR (Kuznetsk Basin, Safonovski horizon).

Family MERISTELLIDAE WAAGEN, 1883

Subfamily MERISTINAE HALL & CLARKE, 1895

Genus **DICAMARA** HALL & CLARKE, 1893

Type species: *Atrypa plebeja* SOWERBY, 1840 (= *Terebratula scalprum* ROEMER, 1844); Middle Devonian, Germany.

Dicamara plebeia (SOWERBY, 1840)

(Pl. XXI, fig. 1; Text-fig. 48)

1840. *Atrypa plebeja* Sow.; J. C. SOWERBY, Explanation..., Pl. 56, figs. 12, 13.
1841. *Spirifera plebeia* SOWERBY; J. PHILLIPS, Palaeozoic fossils of Devon, Cornwall, p. 70, Pl. 28, fig. 121.
1864-65. *Merista plebeja* Sow.; TH. DAVIDSON, Monography of Devonian Brachiopoda..., p. 20, Pl. 3, figs. 2-6.
1896. *Merista plebeja* Sow.; G. GÜRICH, Paläozoicum..., S. 268.
1964. *Dicamara plebeia* (SOWERBY 1840, in SEDGWICK & MURCHISON 1840); W. STRUVE, Über einige..., S. 515.

Horizon: Limestone, exposures 83, 89, Skały beds, Miłoszów, Middle Devonian.
Locality: Skały.

Material. — Species not abundant in specimens; three free shells with valves closed; seven separate pedicle or brachial valves embedded in the limestone, in general recrystallized.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
3745	17·2	18·2	11·2
3745*a*	16·5	17·5	12·4

Description. — Shell of medium size, ventri-biconvex, subpentagonal in outline, wider than long; greatest width generally in anterior half; hinge-line less than the greatest shell width; antero-lateral margins rounded, anterior commissure uniplicate, with a small tongue-like extension; hinge extremities rounded. Pedicle valve deeper than the dorsal valve, with stronger convexity near the umbo, umbo small, narrowing posteriorly; sulcus very flat, beginning about midlength, widened anteriorly. Brachial valve: umbo small, fold indistinct, slightly marked at the anterior margin.

Ornamentation. Shell surface smooth, covered by closely arranged concentric lines, which are as a rule indistinct.

Interior. Pedicle valve: teeth well developed, dental plates thin, occupying a little less than half of the valve depth; «shoe-lifter» trigonal in the cross section, arched, extending for about one-third to two-thirds of valve thickness (see Text-fig. 48). Brachial valve: small septalium present: «shoe-lifter» conspicuosly developed, like that of *Seminula trinuclea* HALL (see HALL & CLARKE, 1894, Pl. 47, fig. 11), separated by a long median septum, extending to about two-thirds of valve length; brachidium not known because of recrystallized interior.

Remarks. — The species in external appearance can resemble *Merista plebeja* (SOWERBY) (in DAVIDSON, 1865, Pl. 3, fig. 2) illustrating SOWERBY's type from Mount Wise near Plymouth. It differs, however, in comparison with *Atrypa plebeja* figured by SOWERBY (1840, Pl. 56, figs. 12, 13) in having slightly thicker ventral umbo. In comparison with PHILLIPS *Spirifera plebeja* from Devonian of Barton (PHILLIPS, 1841, Pl. 28, fig. 121) specimens from the Skały beds somewhat differ in being much more longitudinally elongated. The latter specimens may also be compared with *Dicamara scalprum* (ROEMER) (1844, Pl. 5, fig. 1*d*) in having a very similar shell outline. ROEMER's specimens figured on Pl. 5, figs. 1*a-c* (ROEMER, 1844) are more transversely elongated than our specimens. German specimens labelled as *Dicamara scalprum* ROEMER (SMF coll. 17238,—17240, 17253—17256, from Refrath) greatly resemble ours in the external morphology. *Merista* aff. *plebeja* from the Middle Devonian of Bashkiria — Mendymski layer, USSR, is of much smaller size and has more distinct sulcus and fold (see MIKRIUKOV, 1955, Pl. 3,

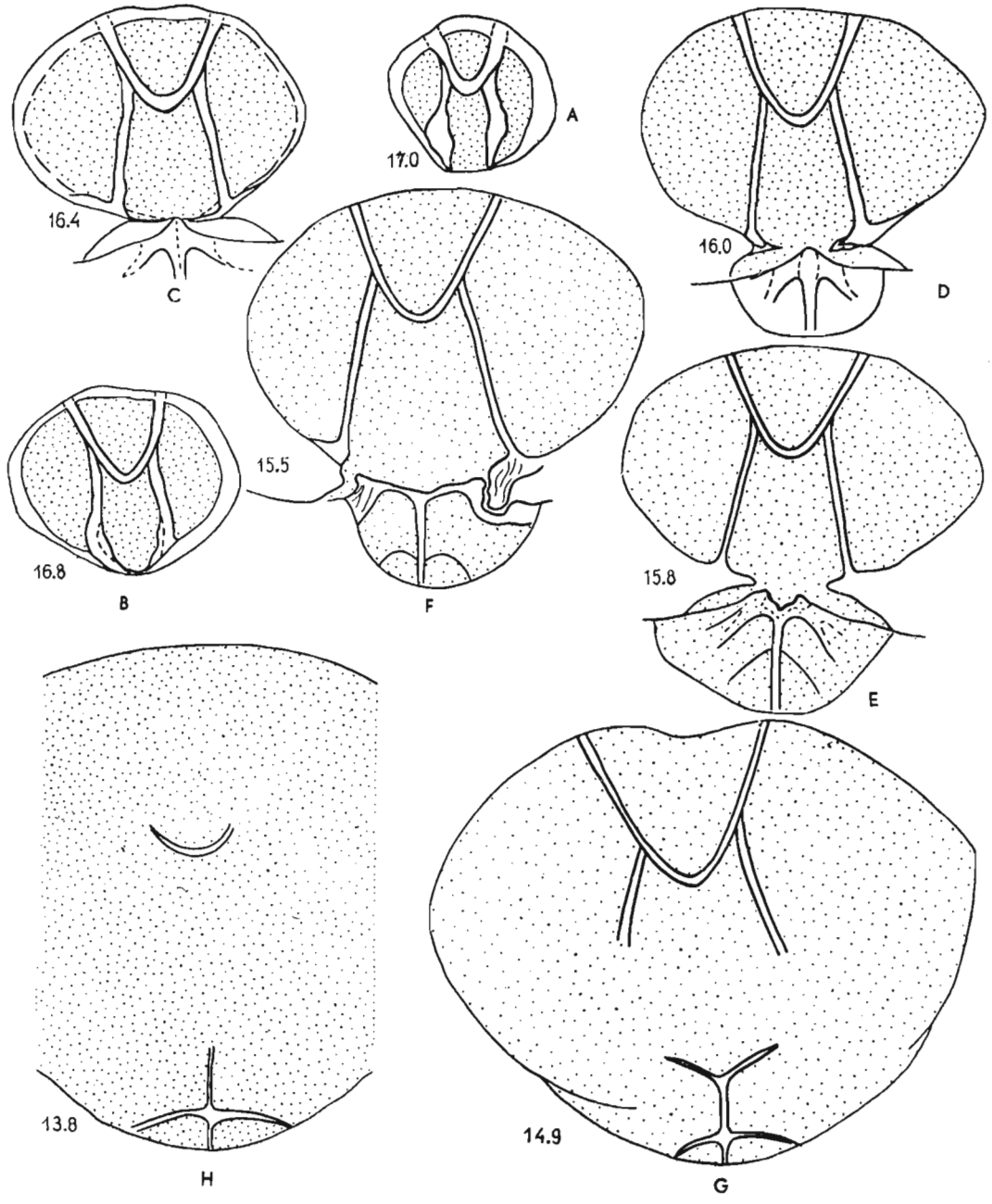


Fig. 48
Dicamara plebeia (SOWERBY). Skały beds, limestone, exposure 81. *A-H* Serial cross sections of adult specimen about 17·2 mm. long; × 6·8

fig. 10). In Poland, GÜRICH mentioned this species in Śniadka layers and in the limestone of Kadzielnia (1896, p. 268). SOBOLEV listed it from crinoids limestone of theSkały beds (1909).

Occurrence. — The species is known from the Middle Devonian of England (Plymouth, Torquay, Ogwell, Newton, Abbot, Ilfracombe in Devonshire); Germany (Gerolstein, Eifel); Poland (Holy Cross Mountains); USSR.

Family NUCLEOSPIRIDAE DAVIDSON, 1881

Genus **NUCLEOSPIRA** HALL, 1859

Type species: *Spirifer ventricosus* HALL, 1857; Lower Devonian, N. America.

Nucleospira lens (SCHNUR, 1851)

(Pl. XXIV, figs. 1-16; Text-fig. 49)

1851. *Spirifer lens* SCHNUR; J. SCHNUR, Programm..., S. 12.
1904. *Nucleospira lens* SCHNUR; D. SOBOLEV, Devonskija..., s. 77, Tabl. 8, ris. 24.
1909. *Nucleospira lens* SCHNUR; D. SOBOLEV, Srednij Devon..., s. 482.

Horizon: Argillaceous shales of exposure 72; marly shales (brachiopod shales) of exposure 73; marly shales underlying the limestone of exposures 82, 83; Skały beds, Middle Devonian.
Locality: Skały.

Material. — Over 350 specimens well preserved, of different dimensions, all shells with valves closed; 1 separate pedicle valve and 1 brachial valve.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
300	3·0	3·2	1·8
302	3·2	3·4	1·8
305	3·5	3·6	2·0
308	4·0	4·2	2·2
310	4·2	4·6	2·8
314	5·5	6·0	3·2
317	6·0	6·5	3·8
319	5·8	6·2	3·2
320	7·0	8·0	4·2
321	7·2	8·2	4·2

Description. — Shell small, circular to transversely ovate in outline, moderately biconvex, most convex near the middle; hinge-line narrow. Pedicle valve with umbo slightly raised and incurved; delthyrium closed by deltarium; area small, slightly concave, extending for about three-fourths to full width of hinge line; delicate trace of a median depression often present in adults. Brachial valve slightly smaller than the pedicle one, almost similarly convex; notothyrium broad, low; chilidial plates narrow, linear.

Ornamentation. Shell without any radial ornament. Surface (except median parts of umbones) covered with delicate, comparatively long hair-like spines, radially arranged. In

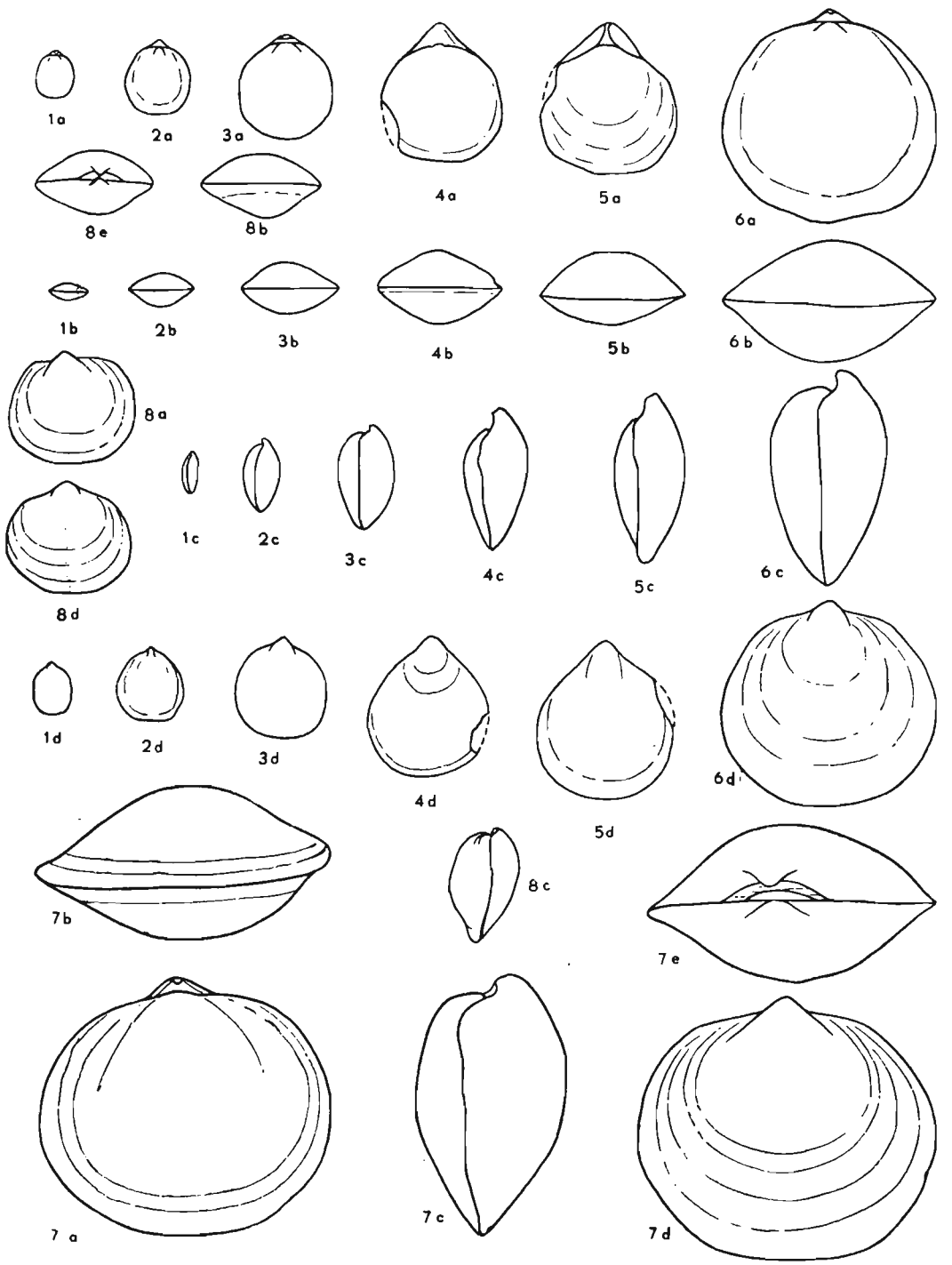


Fig. 49

Nucleospira lens (SCHNUR). Skały beds, marly shales, exposure 73. *1-6* A range of specimens of different dimensions in: *a* brachial valve, *b* anterior commissure, *c* side, *d* pedicle valve views. *7* Adult specimen in: *a* brachial valve, *b* anterior commissure, *c* side, *d* pedicle valve, *e* ventral beak views; × 7. *8* Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* side, *d* anterior commissure, *e* hinge-line views (Bp. VII/321); × 2·8

general, they are not preserved and, as a result, are not often observed. Concentric lines, if preserved, present rather in the anterior half of shell.

Interior. Pedicle valve: teeth distinct, directed upwards, muscle area ovate, a median delicate septal ridge, which can be continued towards the anterior margin. Brachial valve: cardinal process low, dental sockets deep, crural plates slightly divergent anteriorly; median septal ridge similarly low as in opposite valve, but a little thicker; both cones of the brachidium directed laterally, each composed of 4-6 coils (Pl. XXIV, fig. 16).

Growth changes. All specimens of the collection can be divided into three comparatively distinct groups on the basis of differences in shell outline (Text-fig. 49).

1. The smallest specimens of the studied population, to about 2 mm. long, are lenticular in outline with both lateral sides of shell nearly parallel, anterior margin rounded. Their length greatly exceeds the width, generally a third longer than wide (Text-figs. 49, draw. 1*a-d* — 3*a-d*).

2. The second group (Text-figs. 49, draw. 4*a-d* — 6*a-d*) comprises specimens ranging in length from about 2 mm., semicircular to circular in outline, with length greater, about equal or smaller than width. Measurements of 150 well preserved specimens show the index ratio of width/length changing within the limits of 0·9—1. 2, with approximate data showing gradual changes in the shell outline (see Table).

Total No. of measured spec. length 2·0-4·5 mm.	Index ratio width/length	No. of specimens	Per cent	An average difference (numeral value) in mm.
150	0·9	2	1·3	0·4 longer, wide
	1·0	86	56·7	0·1 wider, long
	1·1	59	40·0	0·39 ,, ,,
	1·2	3	2·0	0·66 ,, ,,

As can be seen from the above Table, the maximum of shells (56·7 per cent) shows an index ratio 1·0, being about as long as wide, or imperceptibly wider than long (on an average 0·1 mm. wider). The ventral beak of all specimens of this group is more incurved, the median sulciform depression on the pedicle valve absent, if present—faintly marked. On the shell surface are observed delicate hair-like spines or only spine bases.

3. The third group (Text-fig. 49, draw. 7*a-d*) consists of specimens up to 7·4 mm. long, with shell outline always transversely ovate. Measurements of 150 specimens show predominating index ratio of width/length 1·1 (105 specimens — 70 per cent) shell on an average 0·5 mm. wider than long, with approximate data showing gradual increase of the shell width (see Table below).

Total No. of measured spec. 4·5-7·4 mm. long	Index ratio width/length	No. of specimens	Per cent	An average difference (numeral value) in mm.
150	1·0	31	21·6	0·1 wider, long
	1·1	105	70·0	0·5 ,, ,,
	1·2	31	8·7	0·85 ,, ,,
	1·3	1	0·7	about 1·1 wider, than long

To sum up, in *Nucleospira lens* (SCHNUR) a definite trend was observed in the gradual progressive changes of the shell outline during growth, that means — longitudinally ovate in youngest (= smallest) specimens in the collection, circular in more adult, to distinctly transverse for the largest specimens. It is the only external feature which shows fairly wide variation during growth. The other features are not subject to much change.

In addition, the German specimens of *Nucleospira lens* (SCHNUR) (SMF collection from Gerolstein), as well as those from the Middle Devonian of Padaukpin figured by REED (1908, p. 111, Pl. 16, figs. 21, 21*a*, *b*), although being of much larger sizes, correspond in their circular outline to our specimens of the 2nd group (Text-figs. 49, draw. 4*a-d* — 6*a-d*).

Remarks. — Our specimens possess the characteristic external features of *Nucleospira lens* figured by SCHNUR (1854, p. 211, Pl. 26, fig. 6) described from the Middle Devonian limestone between Prüm and Wensheim. The only differences lie in the smaller dimensions and slightly more transversely outlined shells of the German specimen. *Nucleospira lens* described by REED (1908, p. 111, Pl. 16, fig. 21) from the Middle Devonian of Padaukpin is larger, with a more circular outline.

Occurrence. — Middle Devonian, rather rare; Germany (Rhine region, *Calceola* limestone, crinoid layers); Belgium (*Calceola* layers); Poland (Holy Cross Mountains, shales, the commonest in the brachiopod shales-outcrop 73); India (Padaukpin).

Family ATHYRIDIDAE M'COY, 1844

Genus **ATHYRIS** McCOY, 1844

Type species: *Terebratula concentrica* BUCH, 1834; Middle Devonian of Europe.

Athyris concentrica (v. BUCH, 1834)

(Pl. XXXI, figs. 1-2)

1834. *Terebratula concentrica*; L. v. BUCH, Ueber Terebrateln..., S. 103.
1904. *Athyris concentrica* v. BUCH; D. SOBOLEV, Devonskija..., s. 80.
1909. *Athyris concentrica* v. B.; D. SOBOLEV, Srednij Devon..., s. 483.
1962. *Athyris concentrica* (BUCH); E. IVANOVA, Ekologija..., Pl. 1, figs. 2, 3.

Horizon: Marly shales of exposures 73, 84, marls; Skały beds, Middle Devonian.
Locality: Skały.

Material. — Eight specimens, sufficiently preserved.
Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	No. of concentric lamellae in 1 mm.	
				post.	ant.
1400	9·7	10·5	5·8	2	1
1402	10·2	11·9	7·7	1	1
1403	12·2	14·0	8·0	—	—
1401	4·6	4·6	3·0	1	1

Description. — Shell small, almost equally biconvex; roundly outlined; hinge extremities and antero-lateral margins rounded; anterior margin sulcate. Pedicle valve: umbo low with slightly incurved beak; apical pedicle foramen circular, sulcus deepest anteriorly, present in the anterior half of the valve. Brachial valve with fold observed anteriorly, similarly as a sulcus in the opposite valve.

Ornamentation consists of distinct concentric lamellae, comparatively regularly spaced, in general 1-2 per 1 mm. In some cases, a few fragments of small lamellar fringes are observed (Pl. XXXI, fig. 2*d*). Concentric growth lines are closely set, 3-4 between every two lamellae.

Interior not studied.

Remarks. — Our specimens show the features characteristic of *Athyris concentrica* (BUCH) mainly: circular shell outline, almost equal biconvexity, circular pedicle foramen and widely spaced concentric lamellae (comp. e.g. QUENSTEDT, 1871?, Pl. 51, figs. 46, 47). In the above mentioned features they also agree with specimens of *Athyris concentrica* (BUCH) figured by IVANOVA (1962, Pl. 1, figs. 2, 3) from the Middle Devonian of Minusinsk Basin, USSR. Our specimens are distinguished from the specimens of *Athyris squamosa* KAYSER, from the Middle Devonian of Germany (SMF coll. — Giesdorf, Blankenheim) mainly in being much smaller and in having a more roundly outlined shell. They are also close to *Terebratula concentrica* form *beta* figured by SCHNUR (P853, Pl. 27, figs. 3*h*, *k*) having similarly spaced and marked concentric lines. The Australian Fitzroy species *Athyris oscarensis* VEEVERS (1959, Pl. 14, figs. 1-13) is distinguished by its characteristic almost pentagonal shell and its more closely set concentric lines. Our specimen does not differ from specimen of *Athyris concentrica* (BUCH) figured by NALIVKIN from the Middle Devonian of Ural (Jeletzcki layers; see 1947, Pl. 31, fig. 16).

Occurrence. — Middle Devonian; Europe.

Athyris cf. **ventrosa** (SCHNUR, 1854)

(Pl. XXX, fig. 20; Text-figs. 50, 51)

1854. *Terebratula ventrosa* SCHNUR; J. SCHNUR, Brachiopoden..., S. 193, Taf. 28, Fig. 2.
1871. *Athyris concentrica* var. *ventrosa* SCHNUR; E. KAYSER, Die Brachiopoden..., S. 548.
1904. *Athyris concentrica* L. v. B. var. *ventrosa* SCHNUR; D. SOBOLEV, Devonskija..., s. 80.

Horizon: Marls of exposure 84, Skały beds, Middle Devonian.
Locality: Skały.

Material. — Ten specimens, partly recrystallized, in different states of preservation. Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	No. of concentr. lines	
				posterior	anterior
1410	8·2	8·0	4·6	—	—
1411	9·6	8·8	6·2	4	3
1414	11·0	10·7	7·3	—	—
1412	10·6	10·4	6·4	4	3
1413	11·4	11·0	7·2	5	3
1415	12·6	12·4	8·4	4	3

Description. — Shell small, subpentagonal to subrounded in outline, biconvex, greatest convexity at the umbonal regions; width, measured at midlength, being less than length; hinge extremities obtuse, antero-lateral margins rounded, anterior margin with a small tongue-like

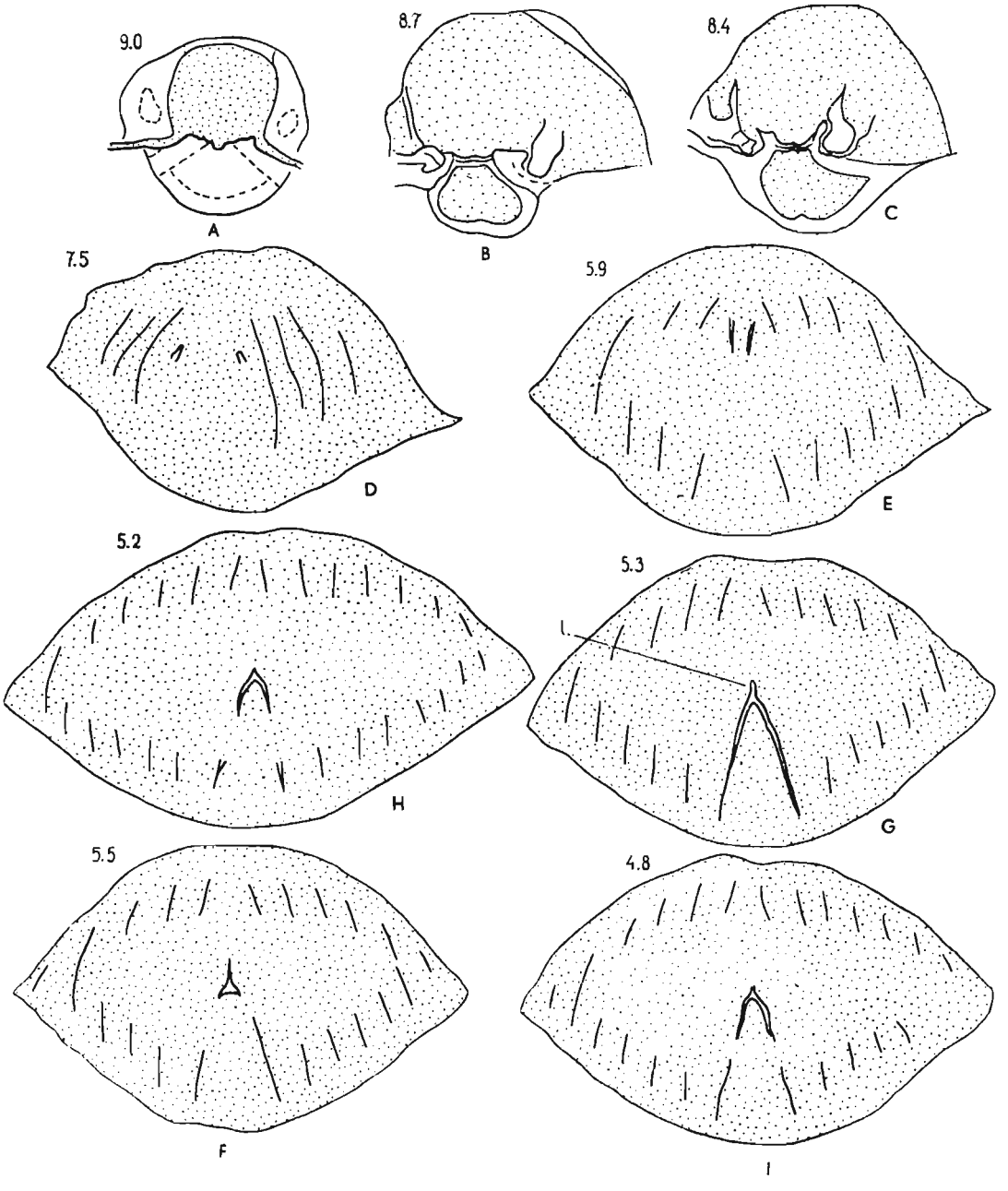


Fig. 50
Athyris cf. *ventrosa* (SCHNUR). Skały beds, marls, exposure 84. *A-I* Serial cross sections of adult specimen; × 7·5

extension. Pedicle valve: umbo low, beak slightly incurved, bearing an oval pedicle foramen; sulcus flat, sometimes distinctly marked at the umbo. Brachial valve with distinct fold.

Ornamentation. Shell surface entirely covered by concentric bands, closely arranged posteriorly, usually 4-5 per 1 mm. and anteriorly.

Interior. Pedicle valve: teeth small, supporting dental plates short and thin. Brachial valve: crural bases distinct but small, inner hinge-plate striated horizontally, outer hinge-plate marked; dental sockets deep; brachial cones consisting of 6-7 coils.

Remarks. — Although the species is very close to *Athyris concentrica* (BUCH) it can be distinguished by a few features. They are: a more pointed ventral umbo, subpentagonal shell outline, a ventral sulcus starting at the umbo and more closely set concentric bands, sometimes wavey in appearance. The German specimens (e.g. SMF coll. from Upper *Calceola* layers,

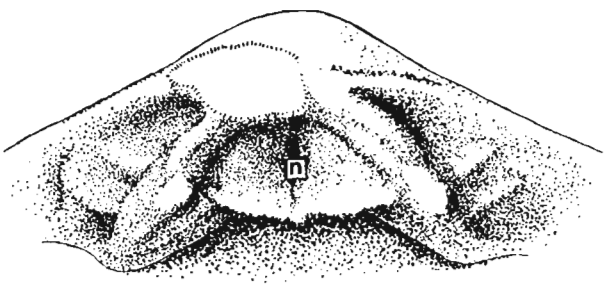


Fig. 51
Athyris cf. *ventrosa* (SCHNUR). Skały beds, marls, exposure 84.
n Notothyrial cavity; × 15

Slg. RICHTER, 1913) labelled as *Athyris concentrica* BUCH var. *ventrosa*, are twice as large as ours, having anteriorly a more narrowed and more elongated anterior margin. Our shells resemble *Athyris bayeti* RIGAUX, figured by NALIVKIN (1947, Pl. 31, figs. 17, 18) from the Devonian of Ural, Voronezh layers, in their shell outline and similarly marked ventral sulcus. They differ from *Athyris oscarensis* VEEVERS — the Fitzroy species from the Devonian of Australia (1959, Pl. 14, figs. 1-13), to which they resemble in general appearance, in having a more prominent ventral umbo and a more oval shell outline. As far as it can be judged from SCHNUR's illustrations (1853, Pl. 28, fig. 2), our form shows the greatest resemblance to *Athyris ventrosa* (SCHNUR).

Occurrence. — Middle Devonian of Germany and Poland.

Family RETZIIDAE WAAGEN, 1883

Genus **PLECTOSPIRA** COOPER, 1942

Type species: *Terebratula ferita* L. v. BUCH 1834, p. 96, Pl. 2, fig. 37; Middle Devonian, Germany.

Plectospira ferita (L. v. BUCH, 1834)

(Pl. XXVIII, fig. 1)

1834. *Terebratula ferita* BUCH; L. v. BUCH, Über Terebrateln..., S. 76, Taf. 2, Fig. 37.
1960. *Ptychospira ferita* (BUCH); N. P. KULKOV, O faune brachiopod..., s. 191, Tabl. 7, fig. 6, ?fig. 5.

Horizon: Marls of exposure 84, Skały beds, Middle Devonian.
Locality: Skały.

Material. — One well preserved adult specimen.

Dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness	No. of plications	
				pedicle valve	brachial valve
663	5·0	5·8	3·1	6	7

Description. — Shell small, slightly elongated transversely, weakly biconvex; beak small, a little incurved, with subapical small pedicle foramen, bordered anteriorly by a deltidium composed of two plates; hinge line short; antero-lateral margins strongly folded in zigzag form. Shell surface with 6 very strong folds on the pedicle valve and 7 on the brachial one. At the anterior margin of the pedicle valve between the two median folds there is a short, thin, but distinct rib and a corresponding weak furrow on the brachial valve. Shell surface with distinct granulae, observed on the walls of the folds. All shell surface is exopunctate, exopunctae are round, arranged somewhat concentrically.

Interior not studied because of scarcity of material.

Remarks. — The species is not common in the Devonian deposits. Externally, it is a quite characteristic form, easily distinguishable by its surface ornamentation. Its interior, however, judging from available literature, is imperfectly known, probably because it is rare, recorded usually in a few specimens only. Our specimen possesses all the external features of *Terebratula ferita* BUCH (BUCH, 1834, Pl. 2, fig. 37), differing a little only in a less furrowed median fold on the brachial valve. German collections (SMF coll. of DREVERMAN, 1908, from the Middle Devonian of Gerolstein; SMF coll. of RICHTER from Prüm) include a number of specimens, which are more transversely outlined, with more numerous radial folds, 10-11. *Ptychospira ferita* (BUCH) from the Middle Devonian of West Siberia (Peserevski limestone, USSR), figured by KULKOV (1960, Pl. 7, figs. 6 and 5?), is more rounded in outline, having more surface folds and a somewhat more prominent beak, like in *Plectospira longirostris* (KAYSER) (see KAYSER, 1871, p. 558, Pl. 10, fig. 5). Specimens of *Plectospira sexplicata*, described by HAVLIČEK from Zlichov limestone of Hlubočepy, Czechoslovakia (1956, p. 83, Pl. 4, figs. 18-22), differ from our specimen in having a narrow median fold, in a much more broadly outlined sulcus and in having a slightly furrowed median fold on the brachial valve. The same is observed in *Plectospira varioplicata* SIEHL from Upper Eifelian?, Greifensteiner limestone of Rhine region (SIEHL, 1962, p. 210, Pl. 40, figs. 4-6) which, in addition, is characterized by different height of the brachial folds (the median on the brachial valve being always very low), a diagnostic feature for this species.

Occurrence. — Middle Devonian (Eifelian-Givetian); Germany (Rhine region); England (limestone of Barton); USSR (West Siberia); Poland (Holy Cross Mountains).

Order **TEREBRATULIDA** WAAGEN, 1883

Family STRINGOCEPHALIDAE KING, 1850.

Subfamily RENSSELANDIINAE CLOUD, 1942

Genus **RENSSELANDIA** HALL, 1867

Type species: *Rensselandia? johanni* HALL, 1867, by subsequent designation of SCHUCHERT, 1879, p. 271; Middle Devonian, N. America.

Rensselandia cf. **caiqua** (D'ARCHIAC & DE VERNEUIL, 1842)

(Pl. XXVIII, fig. 6)

1842. *Terebratula caiqua*; D'ARCHIAC & DE VERNEUIL, On the fossils..., p. 367, Pl. 35, fig. 1.
?1909. *Newberia(?) caiqua* A. V.; D. SOBOLEV, Srednij Devon..., s. 510.
1942. *Rensselandia caiqua* (D'ARCHIAC & DE VERNEUIL); P.E. CLOUD, Terebratuloid genera..., p. 97.

Horizon: Marls of exposure 112, Skały beds. Middle Devonian.
Locality: Skały.

Material. — One incomplete specimen.
Approximate dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
1220	about 50·0	30·9	20·1

Description. — Shell large, subequally biconvex, convexity of both valves quite regular from beak to front; shell longitudinally elongated; hinge extremities rounded, lateral margins subparallel; hinge line subterebratulid; probably without sulcus and fold. Pedicle valve slightly keeled (Pl. XXVIII, fig. 6*c*); area small, moderately concave; beak short and incurved; pedicle foramen apical. Brachial valve convex umbonally, lowering slightly anteriorly. Shell surface covered with concentric lines only, not very distinctly marked. Shell substance punctate.

Remarks. — Our specimen in external appearance closely resembles *Terebratula caiqua*, described and figured by D'ARCHIAC and DE VERNEUIL from the Rhine region, Devonian (1842, Pl. 35, fig. 1), but is has a less elevated ventral umbo and a slightly narrower beak. Almost the same difference is seen in specimens of *Rensselandia caiqua* from the German collection (SMF coll., *hians* layers at Bergisch Gladbach and Paffrath). Externally, our specimen resembles also the specimens of *R. johanni* HALL (CLOUD, 1942, Pl. 13, figs. 9-16; Pl. 14, figs. 1-3) from the Upper Devonian of Iowa (Cedar Valley limestone), except that the former is less biconvex and probably not so narrow anteriorly.

Occurrence. — Middle Devonian (Givetian); Poland (Łysogóry region); Germany (Rhine region).

Rensselandia cf. **circularis** (HOLZAPFEL, 1912)

(Pl. XXVIII, fig. 5)

1942. *Rensselandia circularis* (HOLZAPFEL); P.E. CLOUD, Terebratuloid genera..., p. 97.

Horizon: Marls of exposure 112, Skały beds, Middle Devonian.
Locality: Skały.

Material. — Two specimens with valves closed, fairly well preserved.
Approximate dimensions (in mm.):

Z. Pal. Cat. No. Bp. VII	Length	Width	Thickness
1221	22·3	23·2	10·8
1222	41·9	42·2	18·7

Description. — Shell large, moderately biconvex, with regular curvature of both valves in side view; circular in outline; anterior commissure rectimarginate, lateral margins rounded; the greatest width about midlength. Pedicle valve moderately and regularly arched; hinge line subterebratulid; area small, concave; beak prominent, acute, slightly incurved; pedicle foramen apparently apical; deltidial plates not preserved. Concentric lines crowded anteriorly. Shell substance densely punctate. Interior not studied.

Remarks. — Our specimens in external appearance resemble very much *Rensselandia circularis* (HOLZAPFEL) from the Middle Devonian (Givetian) of Rhine region (HOLZAPFEL, 1912, Pl. 7, figs. 1, 3-4). Compared with specimens of *R. circularis* from Bilveringsen (SMF coll. XVII 388), ours have a more acute and more prominent ventral beak. They are distinguihed from *R. gibbosa* CLOUD (1942, Pl. 14, figs. 5-9), from the Middle Devonian of Paffrath, in being less convex and in having a less incurved beak.

Occurrence. — Middle Devonian (Givetian); Germany (Rhine region); Poland (Holy Cross Mountains).

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ALPHABETICAL INDICES

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II. PALAEONTOLOGICAL INDEX

Systematic names cited only are indicated by *italic*, and names accompanied by description are indicated by roman letters.

Numerals which indicate the page, on which the species is cited only, are standard; numerals, which indicate pages with description, are **bold.**

Numerals denoted with asterisks (*) indicate pages with figures.

PLATES

G. BIERNAT: MIDDLE DEVONIAN BRACHIOPODS

PLATE I

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Gypidula (Devonogypa) spinulosa HAVLIČEK 28
(Skały beds, exposure 89)

Figs. 1-4. Pedicle valve view of 4 different specimens, 2*b* side view (Bp. VII/3637, 3639, 3635, 3638); nat. size.
Fig. 5. Adult specimen in 5 views: *a* pedicle valve, *b* side, *c* brachial valve. *d* ventral umbo, *e* anterior commissure (Bp. VII/1624); nat. size.
Fig. 8. Surface spinosity of the posterior half of the shell; × 8.

Gypidula (Gypidula) parva n. sp. 30
(Skały beds, limestone, exposure 89)

Fig. 6. Adult specimen in: *a* dorsal interior, *b* ventral interior, *c* side, *d* anterior commissure views (Bp. VII/3640); × 2.
Fig. 7. Type specimen in: *a* brachial valve, *b* pedicle valve, *c* side views (Bp. VII/3641); approx. × 2·5.

Enantiosphen sp. cf. *Enantiosphen vicaryi* (DAVIDSON) 27
(limestone of Kamieniec)

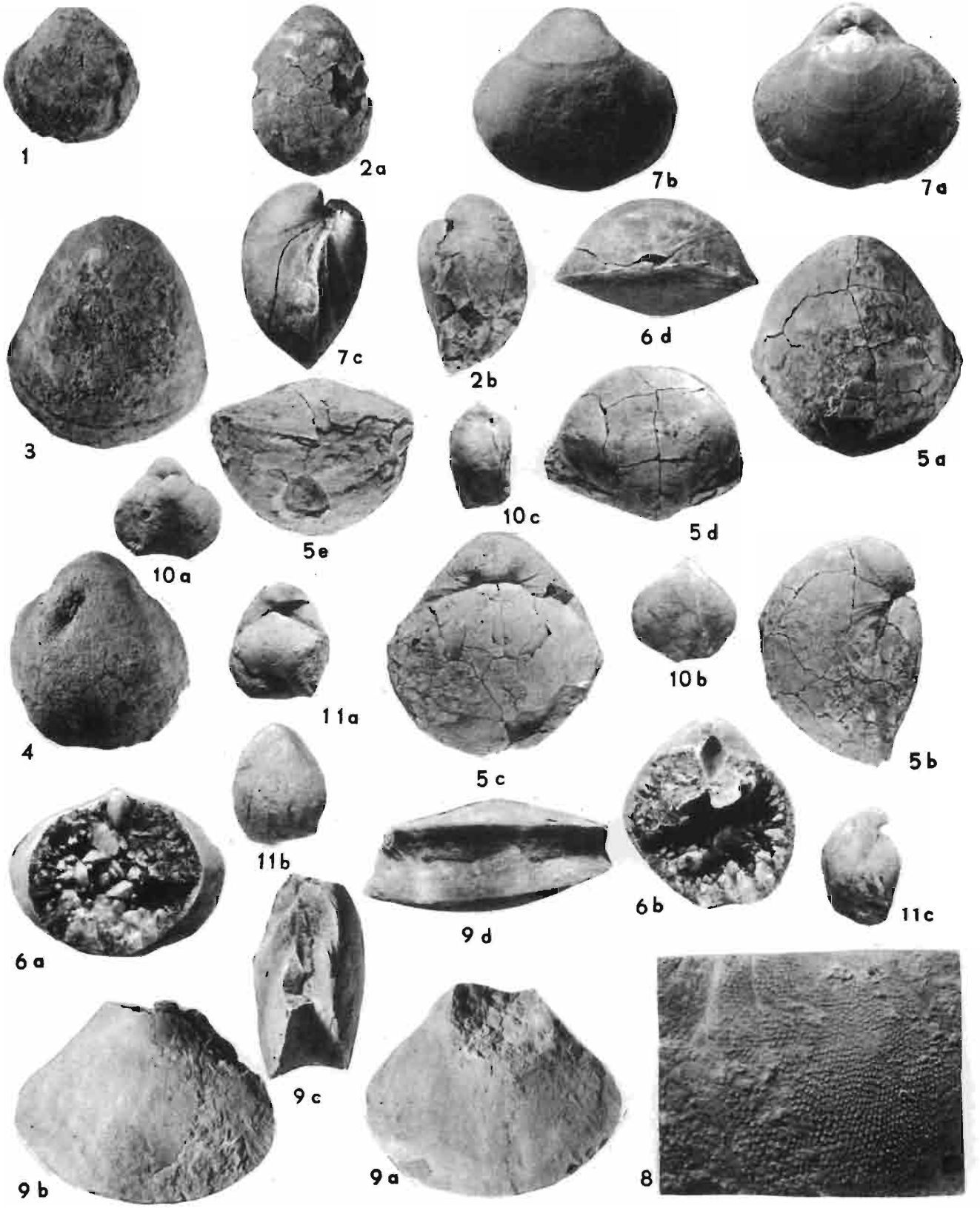
Fig. 9. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* side, *d* anterior margin views (Bp. VII/1123); nat. size.

? *Levigatella* sp. 34
(Skały beds, exposure 84)

Fig. 10. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* side views (Bp. VII/3642); nat. size.

Gypidula (Gypidula) cf. *biplicata* (SCHNUR). 29
(Skały beds, exposure 81)

Fig. 11. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* side views (Bp. VII/65*a*); nat. size.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G. BIERNAT: MIDDLE DEVONIAN BRACHIOPODS

PLATE II

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Gypidula (Ivdelinia) cf. *acutolobata* (SANDBERGER) 32
(Skały beds, marls, exposure 81)

Fig. 1. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c-d* anterior margin, *e* side views (Bp. VII/62); nat. size.

Gypidula (Ivdelinia) sp. cf. *G. (Ivdelinia) multiplicata* (ROEMER) . . . 33
(Skały beds, marls, exposure 81)

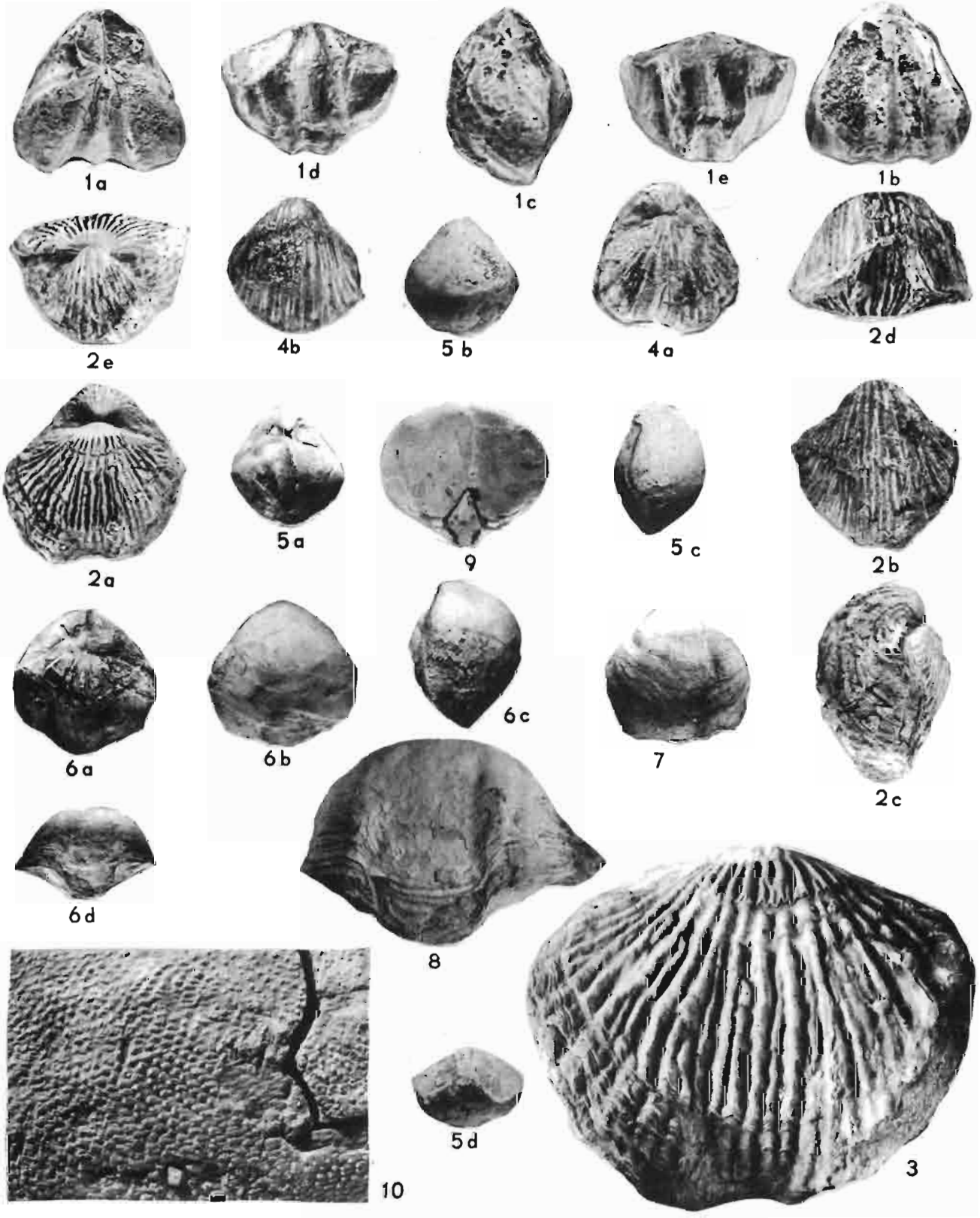
Fig. 2. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* side, *d* anterior commissure, *e* umbonal views (Bp. VII/1); nat. size.
Fig. 3. Surface ornamentation on the brachial valve (Fig. 2*a* enlarged); × 2·5.
Fig. 4. Adult specimen in: *a* brachial valve, *b* pedicle valve views (Bp. VII/2); nat. size.

Antirhynchonella linguiformis n. sp. 35
(Skały beds, limestone, Miłoszów)

Fig. 5. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* side, *d* anterior commissure views (Bp. VII/3650); nat. size.
Fig. 6. Type specimen in: *a* brachial valve, *b* pedicle valve, *c* side, *d* anterior margin views (Bp. VII/3621); nat. size.
Fig. 7. Pedicle valve view of adult specimen (Bp. VII/3651); nat. size.
Fig. 8. Anterior margin view of adult specimen (Fig. 7 enlarged); × 2.
Fig. 9. Section of the shell (Bp. VII/3600); × 2.

Gypidula (Devonogypa) spinulosa (HAVLÍČEK) 28
(Skały beds, marls, exposure 89)

Fig. 10. Surface spinosity of the antero-lateral slope of the pedicle valve; × 8.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G. BIERNAT: MIDDLE DEVONIAN BRACHIOPODS

PLATE III

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Leptaena analogaeformis n. sp. 38
(Skały beds, exposure 73)

Figs. 1-6. Pedicle valve view of 6 adult specimens (Bp. VII/1194, 1198, 1203, 1200 (type specimen), 1219, 1224); nat. size.
Fig. 7. Old specimen in: *a* pedicle valve, *b* side, *c* hinge line views (Bp. VII/1217); *a* nat. size, *b*, *c* × 2.
Fig. 8. Geniculated portion of adult specimen (Fig. 4); × 2.
Fig. 9. Brachial valve view of adult specimen (Bp. VII/1230); approx. × 1·3.
Figs. 10-11. Two ventral interiors (Bp. VII/3655, 3667); *10* nat. size, *11* × 2.
Figs. 12-13. Dorsal interiors (Bp. VII/1203, 1211); *12*, *13* nat. size, 12*a* × 2.
Fig. 14. Internal surface of the trail with preserved pallial sinuses (Bp. VII/1203); × 2·4.
Fig. 15. Cross section of adult specimen (Bp. VII/3668); approx. × 1·5.
Fig. 16. Posterior view of the dorsal interior (Bp. VII/1203); × 2.

(See also Plate IV)

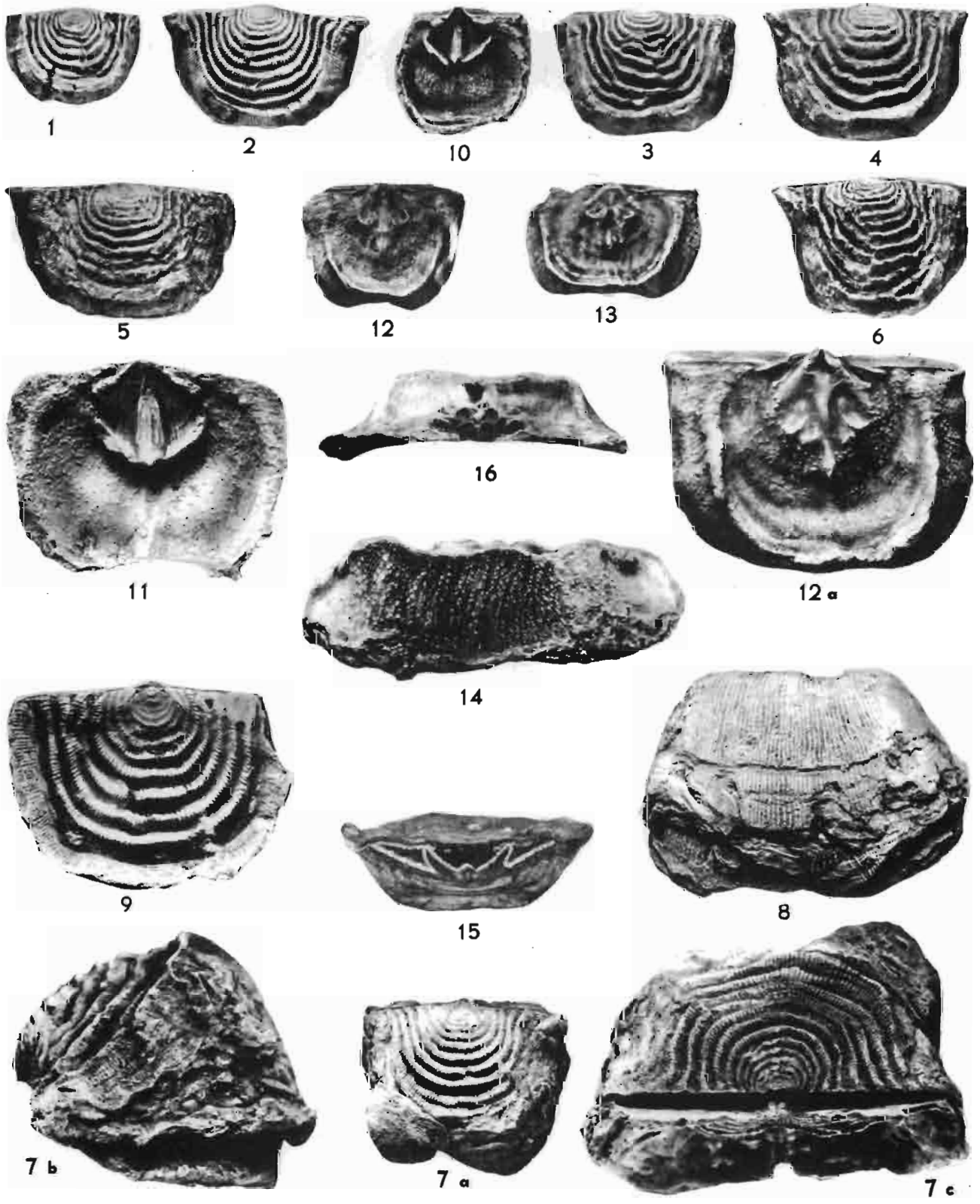
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PLATE IV

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Leptaena analogaeformis n. sp. 38
(Skały beds)

Figs. 1-4. Pedicle valve view of 4 different adult specimens (Bp. VII/3670-3673); Miłoszów, limestone; nat. size.
Figs 5-6. Two incomplete specimens: *a* ventral interior, *b* dorsal interior (Bp. VII/3674, 3675): shales. exposure 121; *5a-b* nat. size, *6a-b* × 2.
Fig. 7. Dorsal interior of young specimen (Bp. VII/3676): shales, exposure 121; × 6.
Figs. 8-9. Clusters of immature specimens (Bp. VII/3677, 3678): shales, exposure 121; × 5.
Figs. 10-11. Pedicle valve view of 2 specimens (Bp. VII/3679, 3679*a*) shales, exposure 125; nat. size.
Fig. 12. Dorsal interior of adult specimen (Bp. VII/3680); shales, exposure 125; nat. size.
Fig. 13. Dorsal interior of a specimen (Bp. VII/3681): shales, exposure 125; × 4·5.

(See also Plate III)

?*Leptaena* sp. 42
(Skały beds, exposure 73)

Figs 14-15. Two ventral interiors of gerontic specimens (Bp. VII/3682, 3683); nat. size.
Figs 16, 16*a*. Ventral interior of the same specimen (Bp. VII/3683); *16* nat. size, *16a* approx. × 3.

(See also Plate VI)

Douvillina (Douvillina) interstrialis (PHILLIPS) 43
(Skały beds)

Figs 17-19. Brachial valve view of 3 different specimens (Bp. VII/1080, 1078, 1094): marly shales, exposure 73; nat. size.
Fig. 20. Ventral interior of incomplete valve, muscle area well preserved (Bp. VII/3684); shales, exposure 125; × 4.

(See also Plate V)

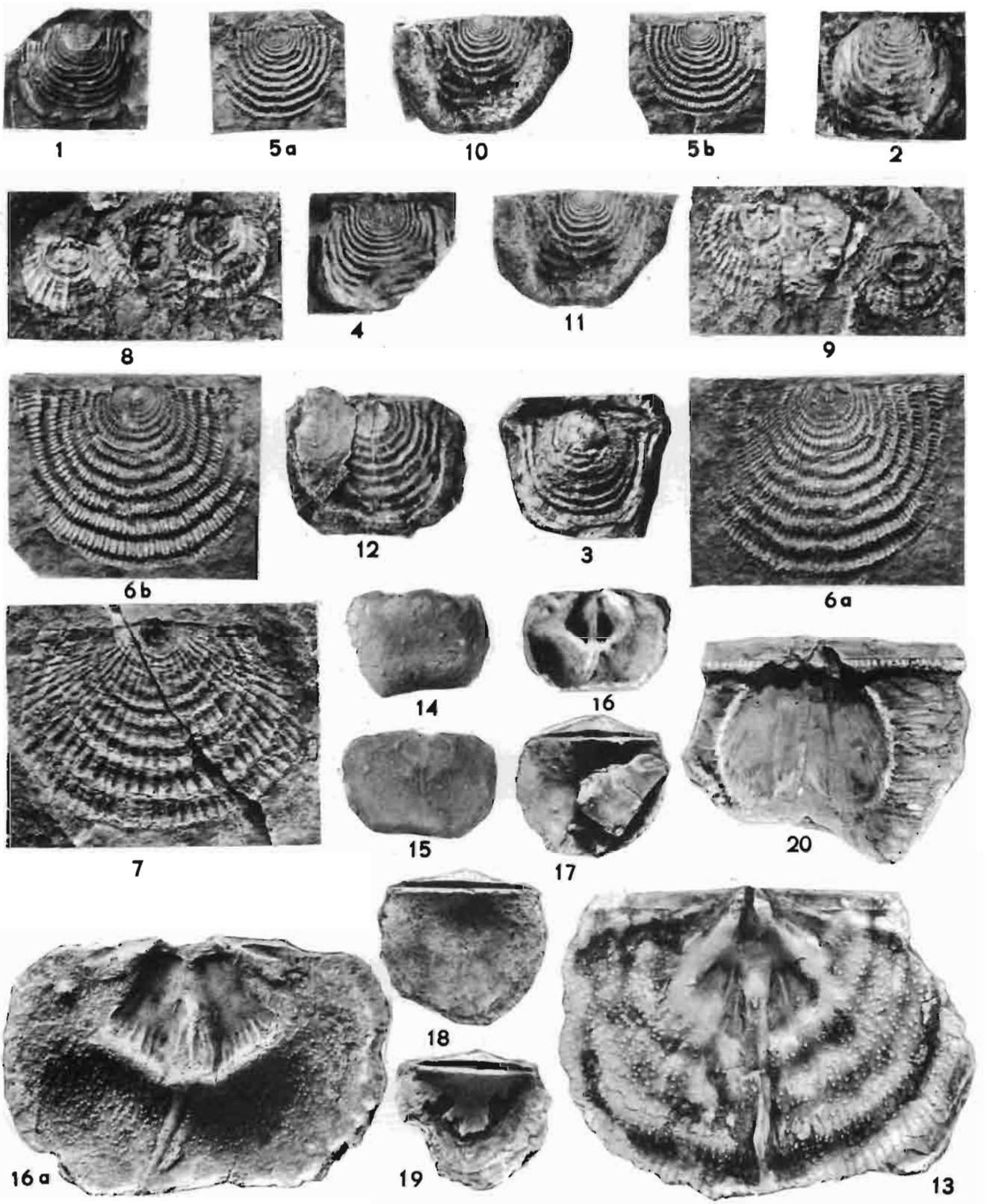
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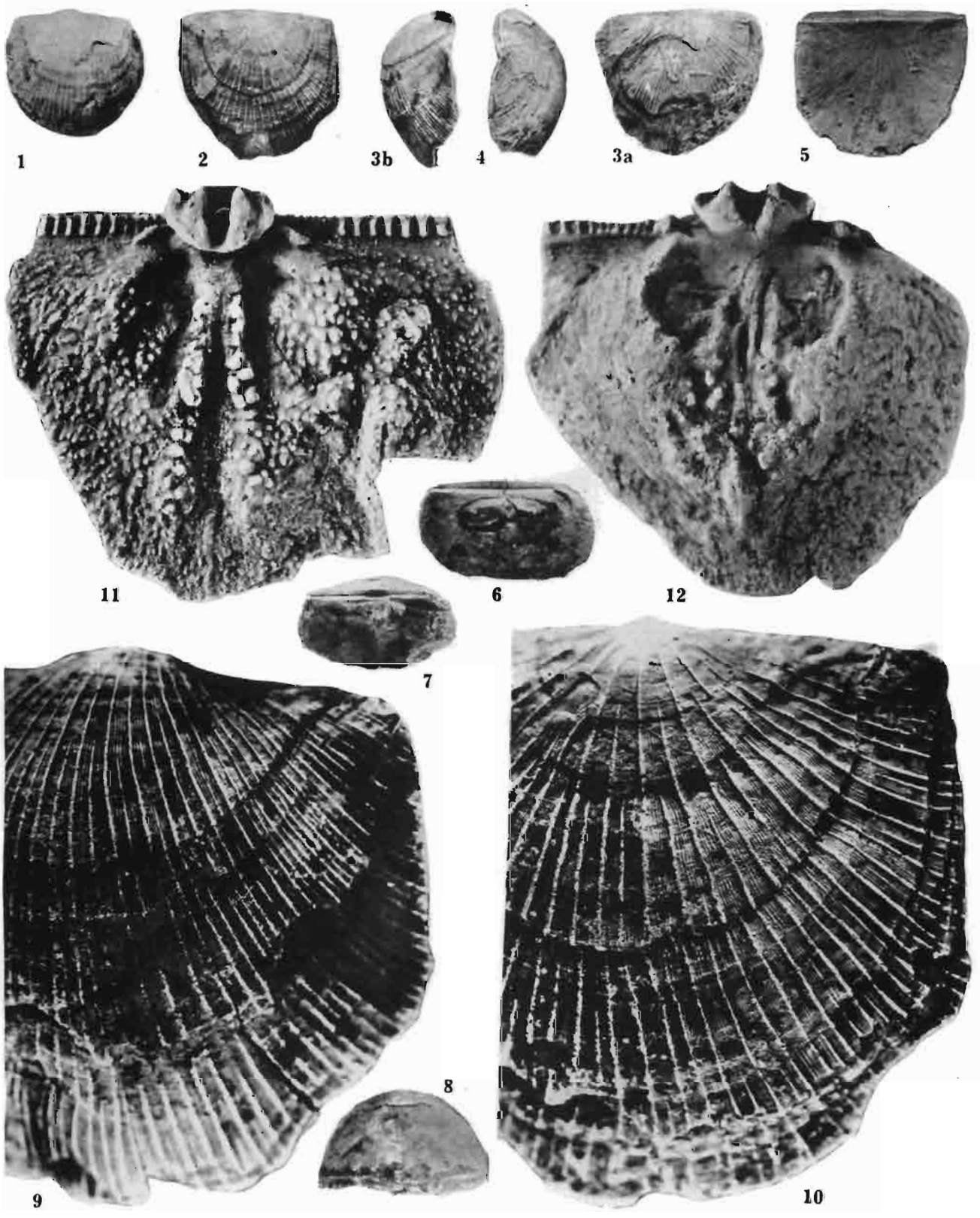
PLATE V

Page

Douvillina (Douvillina) interstrialis (PHILLIPS) 43
(Skały beds, marly shales, exposure 73)

Figs. 1-2. Pedicle valve view of 2 adult specimens (Bp. VII/1076, 1071); nat. size.
Fig. 3. Adult specimen in: *a* pedicle valve, *b* side views (Bp. VII/1072); nat. size.
Fig. 4. Side view of adult specimen (Bp. VII/1096); nat. size.
Fig. 5. Brachial valve view of adult specimen (Bp. VII/1074); nat. size.
Figs. 6-7. Hinge-line view of 2 old specimens (Bp. VII/1089, 1094); nat. size.
Fig. 8. Anterior view of old specimens (Bp. VII/1081); nat. size.
Figs. 9-10. Surface ornamentation of two different pedicle valves (Bp. VII/1071*a*, 1071); × 4·5.
Figs. 11-12. Two dorsal interiors. *11* younger individual, *12* old individual (Bp. VII/1084, 1085); approx. × 4·5.

(See also Plate IV)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G. BIERNAT: MIDDLE DEVONIAN BRACHIOPODS

PLATE VI

Page

Douvillina (Douvillina) subcorrugata n. sp. 46
(Skały beds, marly shales, exposure 73)

Figs. 1-3. Three different specimens in: *a* brachial valve, *b* pedicle valve views; Fig. 2-type specimen (Bp. VII/1104, 1106, 1105); × 3.
Fig. 4. Brachial valve view of old specimen (Bp. VII/1105*a*); × 4.
Fig. 6. Cross section of old specimen; approx. × 4·5.
Fig. 7. Dorsal interior of old specimen (Bp. VII/1101); × 7.

?Leptaena sp. 42
(Skały beds, marly shales, exposure 73)

Figs. 8-9. Pedicle valve exterior of two specimens (Bp. VII/3683, 3682); × 2.
Fig. 10. Ventral interior of a specimen (Bp. VII/3682); × 2·5.

(See also Plate IV)


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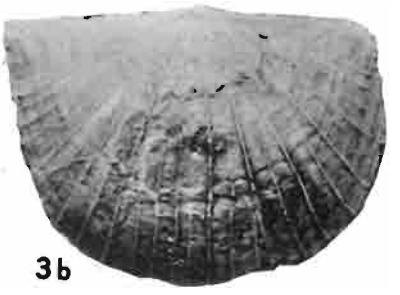
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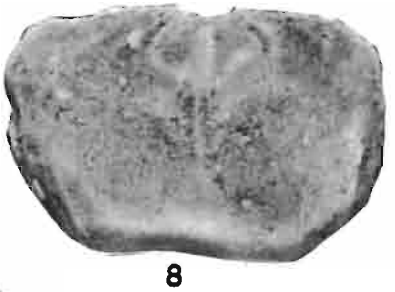
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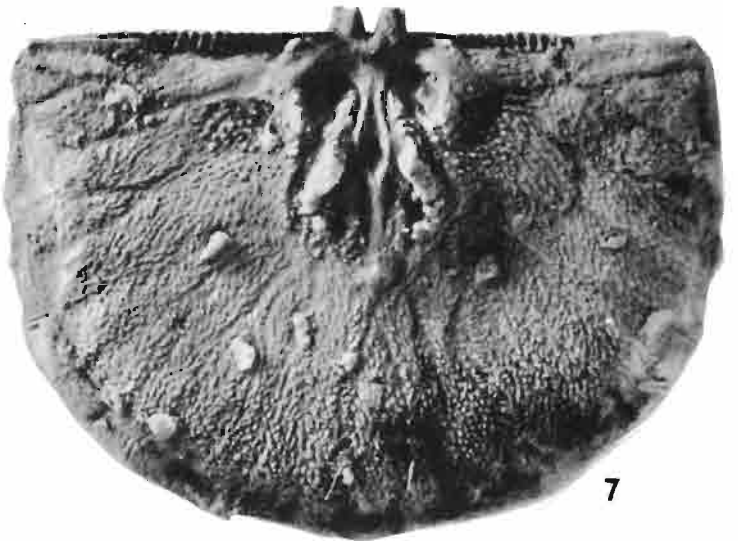
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PLATE VII

Fig. 1. Posterior view of old specimen (Bp. VII/1056); *a* nat. size, *b* × 2.
Fig. 2. Pedicle valve view of old specimen (Bp. VII/1056); nat. size.
Fig. 3. Old specimen in: *a* brachial valve view, *b* anterior margin view (Bp. VII/1055); nat. size.
Fig. 4. Side view of old specimen (Bp. VII/1057); *a* nat. size, *b* × 2.
Figs. 5-7. Dorsal interior of 3 different old specimens (Bp. VII/1063, 1060, 1061); × 3·1.
Fig. 8. Dorsal interior posteriorly (Bp. VII/1062); × 3.
Fig. 9. Ventral interior (Bp. VII/1059); × 3.
Fig. 10. Ventral interior posteriorly (Bp. VII/1059); *a* × 3·1, *b* approx. × 6.

(See also Plate VIII)

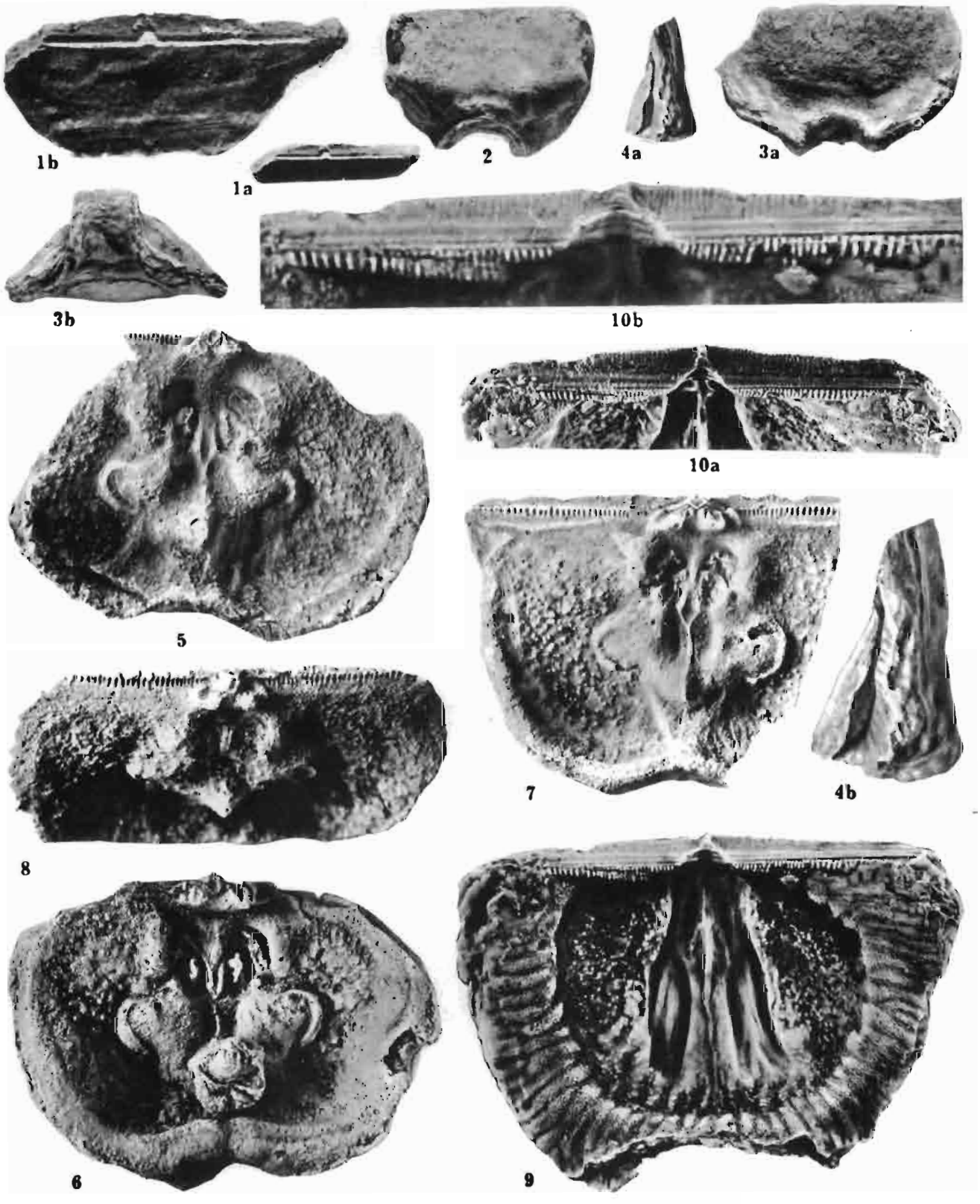
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PLATE VIII

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Parastrophonella anaglypha (KAYSER) 54
(Skały beds, marly shales, exposure 73)

Fig. 1. Pedicle valve view of adult specimen (Bp. VII/1150); slightly enlarged.
Fig. 2. Adult specimen in: *a* pedicle valve, *b* hinge-line, *c* side views (Bp. VII/1140); × 3.
Fig. 3. Pedicle valve view of adult specimen (Bp. VII/1146); × 3.
Fig. 4. Hinge line view of adult specimen; × 4.
Figs. 6-8. Brachial valve view of 3 different specimens (Bp. VII/1162, 1159, 1312); × 3.
Fig. 9. Trail with preserved radial ornamentation (Bp. VII/1159); × 3.
Figs. 5, 10-13. Ventral interior of 5 specimens (Bp. VII/1157, 1153, 1164, 1154); × 3.

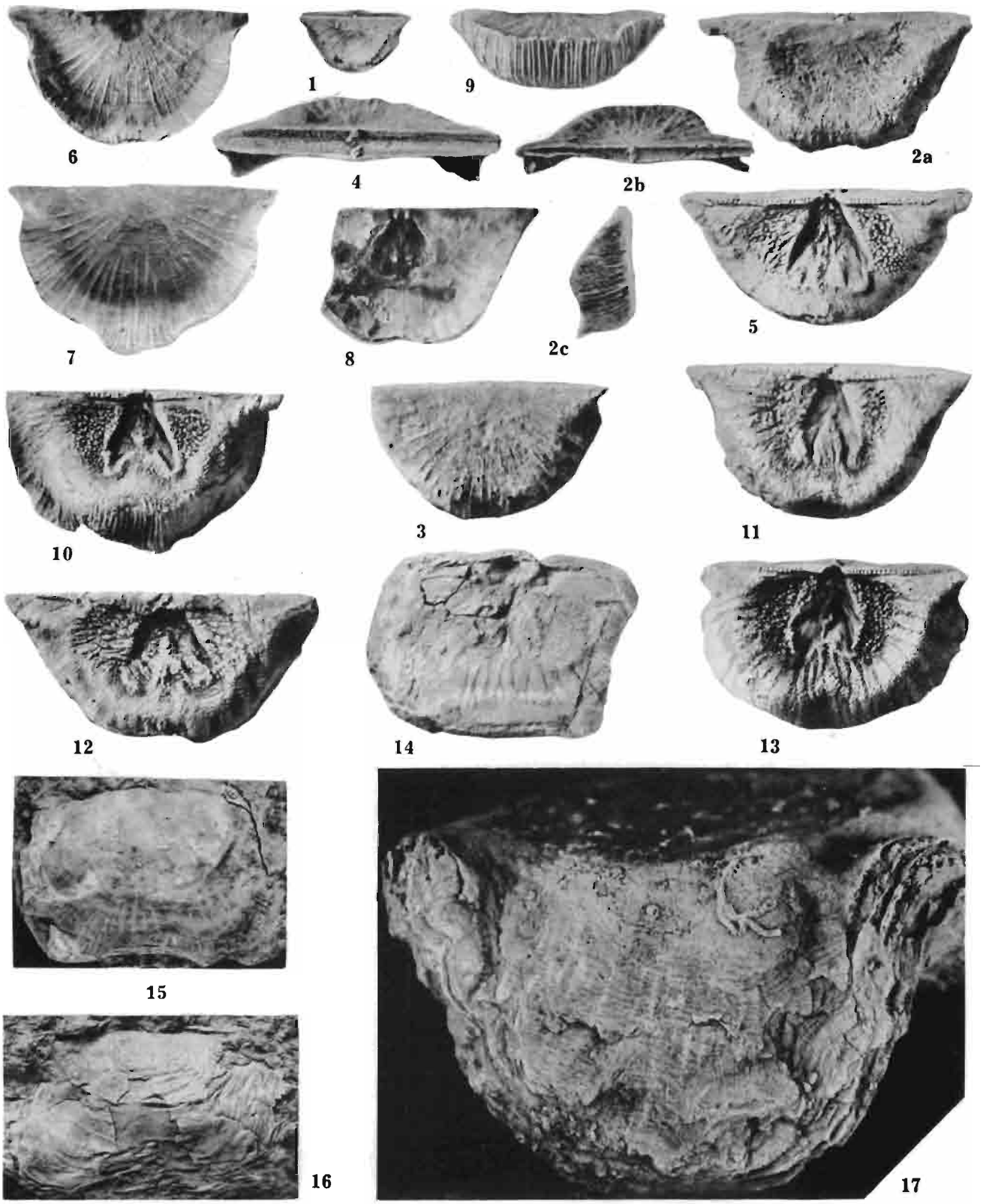
Radiomena irregularis (ROEMER) 58
(Skały beds, limestone, exposure 81)

Fig. 14. Ventral interior of badly preserved specimen (Bp. VII/1047); nat. size.
Figs. 15-16. Pedicle valve view of 2 old specimens embedded in the limestone (Bp. VII/1048, 1050); nat. size.

Leptodontella caudata (SCHNUR) 50
(Skały beds, marly shales, exposure 73)

Fig. 17. Appearance of the tongue with traces of radial and concentric ornamentation (Bp. VII/1055); × 8.

(See also Plate VII)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G. BIERNAT: MIDDLE DEVONIAN BRACHIOPODS

PLATE IX

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Schellwienella (Schellwienella) umbraculum (SCHLOTHEIM) 59
(Skały beds, marly shales, exposure 73)

Figs. 1-6, 8. Brachial valve view of specimens of different shell dimensions (Bp. VII/3697, 1304, 1308, 1307, 3698, 1311, 3699); nat. size.

Fig. 7. Brachial valve view of younger specimen (Bp. VII/3700); × 3.

Figs. 9-10. Pedicle valve view of 2 different specimens with well preserved surface ornamentation (Bp. VII/3701, 3702); × 2·4.

Figs. 11-13. Ventral area view of 3 adult specimens (Bp. VII/3702, 3703, 1308); *11* × 2, *12*, *13* × 2·5.

Fig. 14. Side view of adult specimen (Bp. VII/3698); nat. size.

Fig. 15. Brachial valve view of adult specimen with *Aulopora* sp. (Bp. VII/3704); nat. size.

Figs 16-18. Dorsal interior of 3 specimens of different individual age (Bp. VII/3705, 3706, 3707); nat. size.

(See also Plate X)

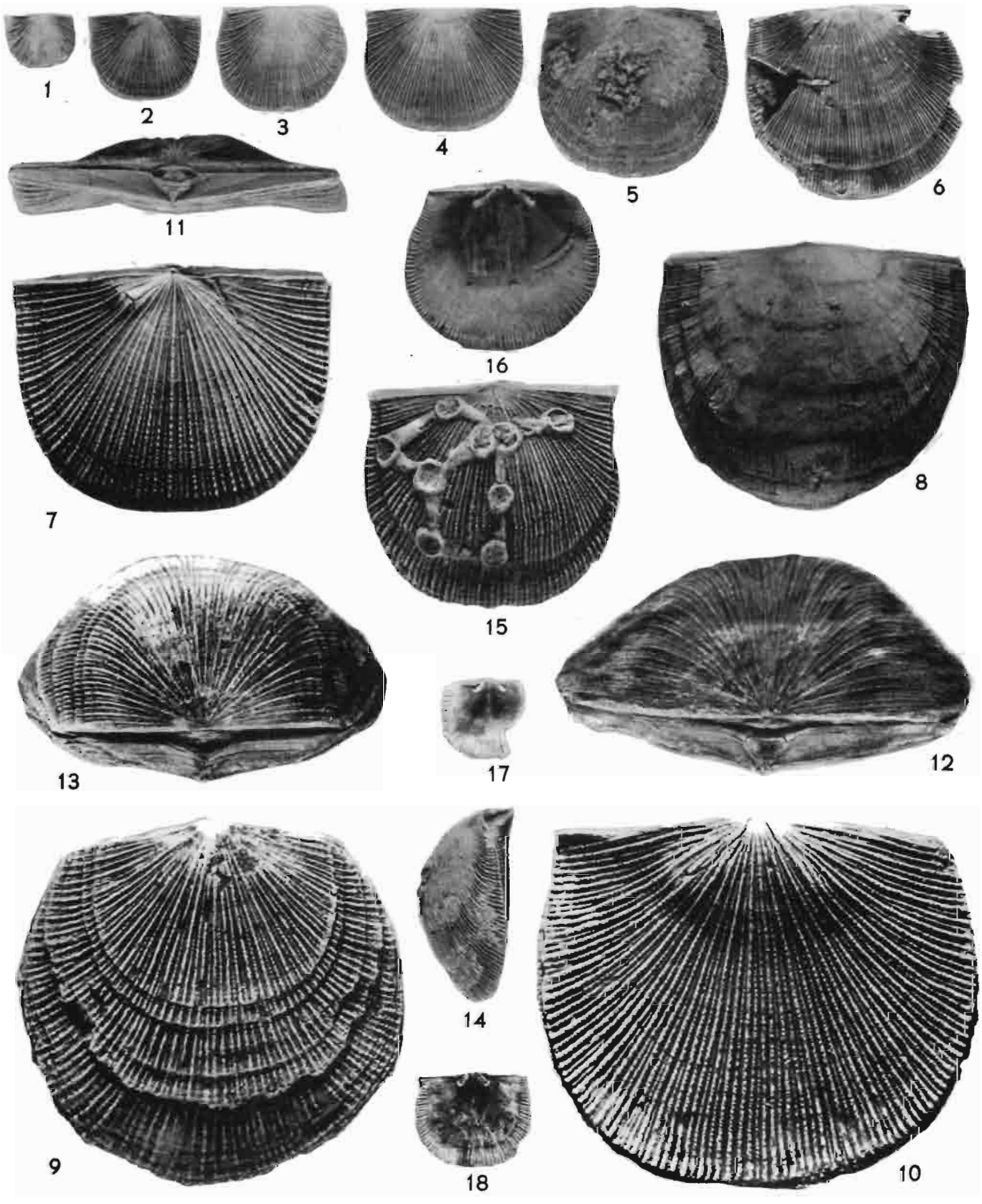
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PLATE X

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Schellwienella (Schellwienella) umbraculum (SCHLOTHEIM) 59
(Skały beds)

Fig. 1. Brachial valve view of adult specimen (Bp. VII/3708), shales of exposure 121; × 2.
Fig. 2. Pedicle valve view of young specimen (Bp. VII/3709), shales of exposure 121; × 6·3.
Fig. 3. Ventral area view of adult specimen (Bp. VII/3710), shales, exposure 121; × 3.
Fig. 4. Ventral interior of younger specimen, partly exfoliated (Bp. VII/3711), shales, exposure 121; × 4.
Fig. 5. Pedicle valve view of younger specimen (Bp. VII/3712): shales, exposure 121; × 5·4.
Figs. 6-7. Ventral area view of 2 adult specimens (Bp. VII/3698, 1310), marly shales, exposure 73; × 2·4.
Fig. 8. Anterior view of adult specimen (Bp. VII/1310); marly shales, exposure 73; × 2·4.
Fig. 9. Ventral interior of adult specimen (Bp. VII/3713), marly shales, exposure 73; × 3.

(See also Plate IX)

Schellwienella (Schellwienella) sp. 64
(Skały beds, exposure 81)

Fig. 10. Brachial valve view of specimen embedded in the marly limestone (Bp. VII/3714); nat. size.


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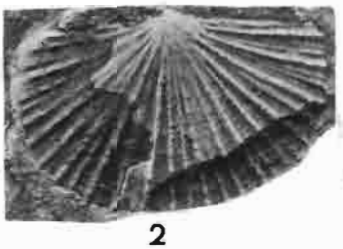
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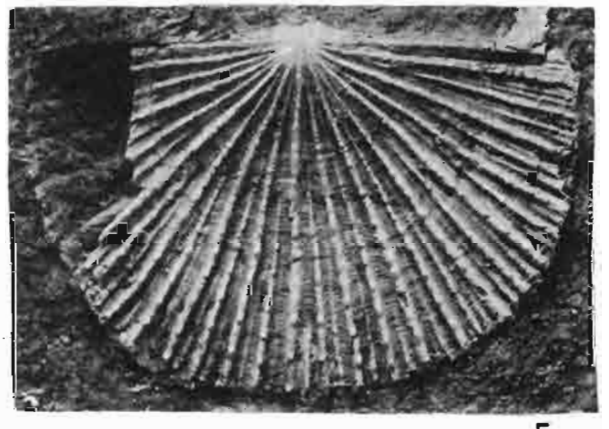
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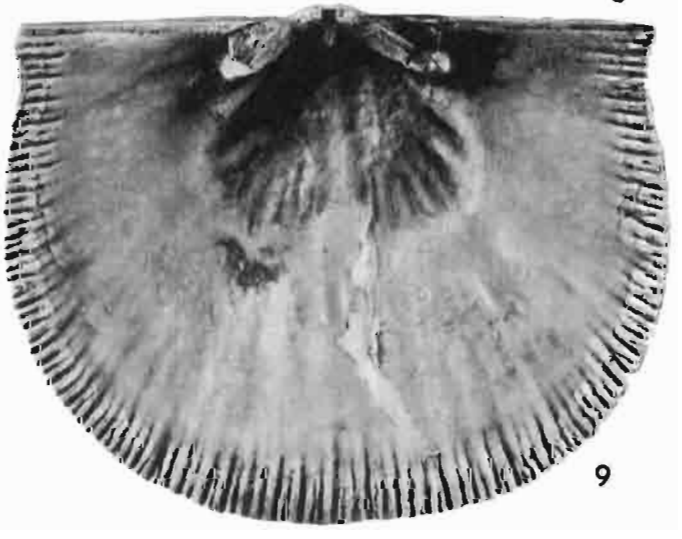
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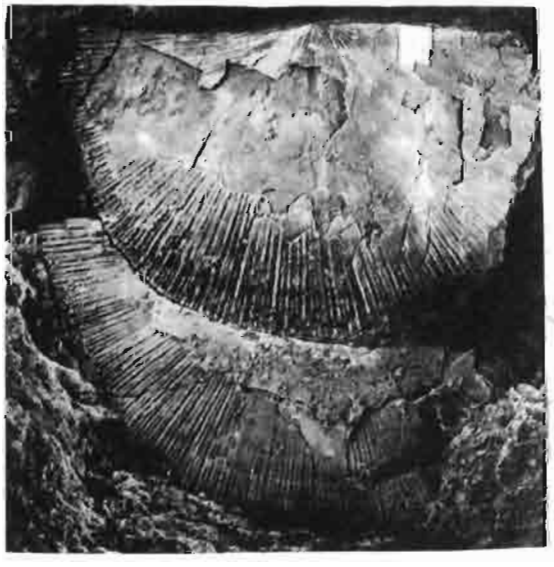
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PLATE XI

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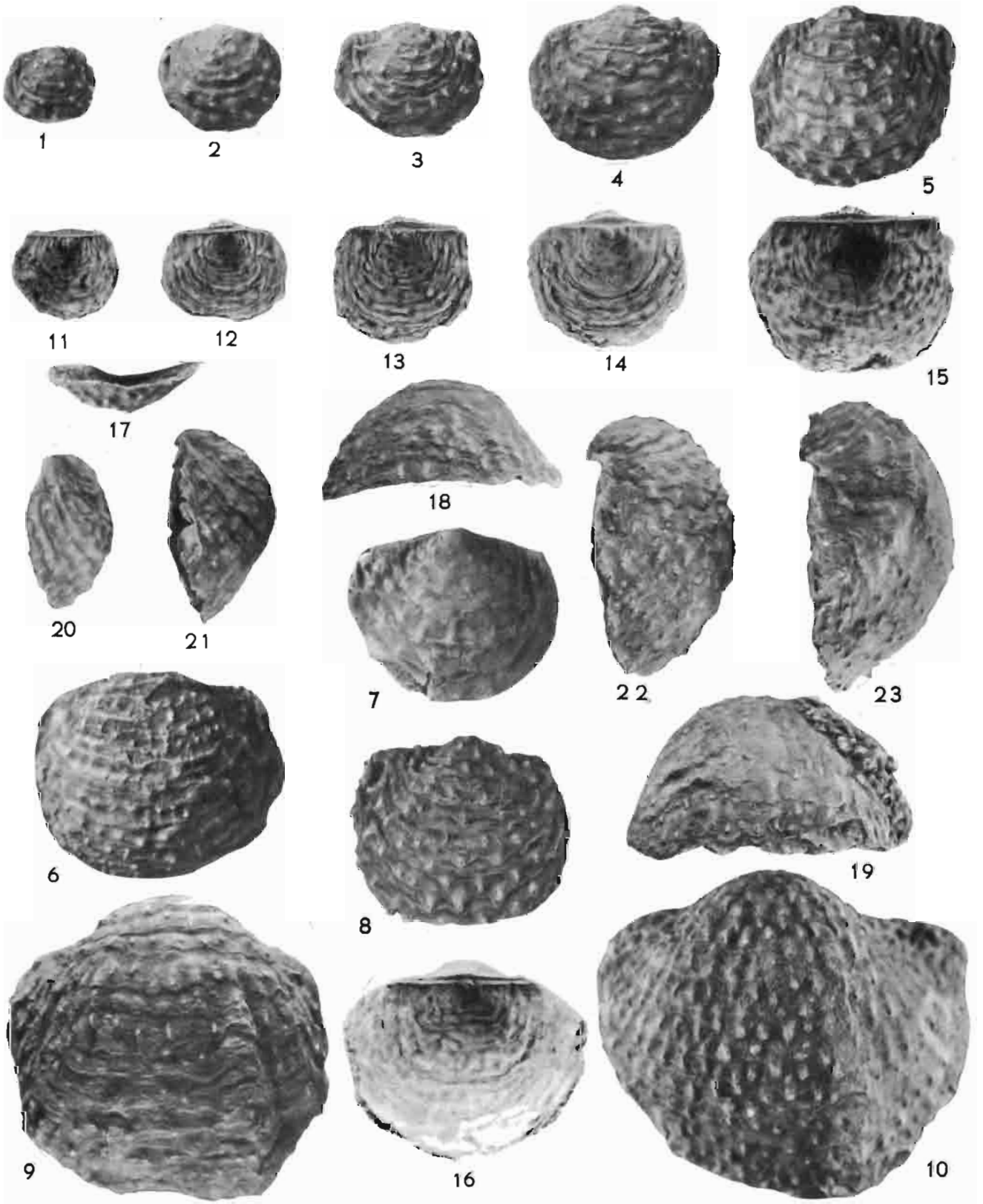
Productella varians sp. 66
(Skaly beds, marly shales, exposure 73)

Figs. 1-10. Pedicle valve view of different specimens (Bp. VII/3737, 3739, 3743a, 3745—3749, 3749a, 3750-type specimen); × 3·5.
Figs. 11-16. Brachial valve view of different specimens (Bp. VII/3738, 3751-3755); × 3·5.
Figs. 17-19. Anterior margin view of 3 specimens (Bp. VII/3759*a*, 3759, 3759*b*); × 3·5.
Figs. 20-23. Side view of different specimens (Bp. VII/3756-3759); × 4.

(See also Plates XII and XIII)



G. Biernat: Middle Devonian brachiopods of the Bodzentyn syncline

PLATE XII

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Productella varians n. sp. 66
(Skały beds, marly shales, exposure 73)

Figs. 1-8, 11. Dorsal interior of specimens in different growth stage (Bp. VII/3760*a*, 3760-3762, 3765, 3759); *1-4* approx. × 6·5, *5*, *8*, *11* × 2·4.
Figs. 9-10. Dorsal interior of 2 adult specimens (Bp. VII/3767, 3768); × 2·4.
Fig. 12. Dorsal interior posteriorly; × 2·5.
Figs. 13-14. Dorsal area and cardinal process of 2 different specimens (Bp. VII/3770, 3771); × 3.
Figs. 15-16. Ventral interior of 2 specimens (Bp. VII/3763, 3764); *15* × 2, *16* × 3.

(See also Plates XI and XIII)

Productella cf. *subaculeata* (MURCHISON) 73
(Skały beds, limestone, Miłoszów)

Figs 17-19. Pedicle valve view of 3 different specimens embedded in the limestone (Bp. VII/3773, 3774, 3775); nat. size.

(See also Plate XIII)


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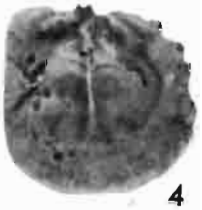
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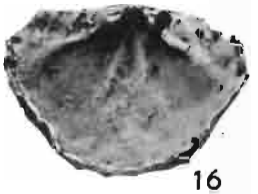
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PLATE XIII

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Productella varians n. sp. 66

(Skały beds, marly shales, exposure 73)

Figs. 1, 3, 5-7. Pedicle valve view of different specimens, Forma *A* (Bp. VII/3778, 3776, 3780, 3782, 3782*a*); × 3·2.

Figs. 2, 4, 8-10. Pedicle valve view of 5 different adult specimens, Forma *B* (Bp. VII/3777, 3779, 3781, 3783, 3784); × 3·2.

(See also Plates XI and XII)

Productella cf. *subaculeata* (MURCHISON) 73

(Skały beds, limestone, Miłoszów)

Figs. 11-12. Pedicle valve view of 2 specimens (Bp. VII/3783, 3784); × 4.

(See also Plate XII)


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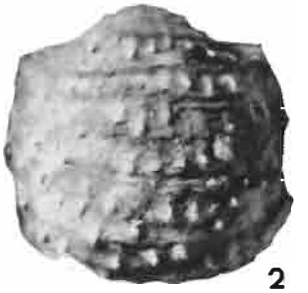
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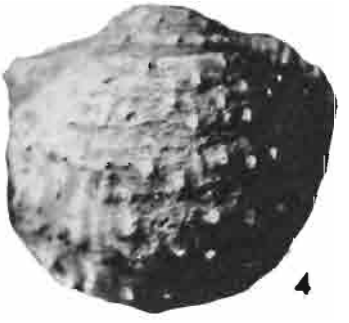
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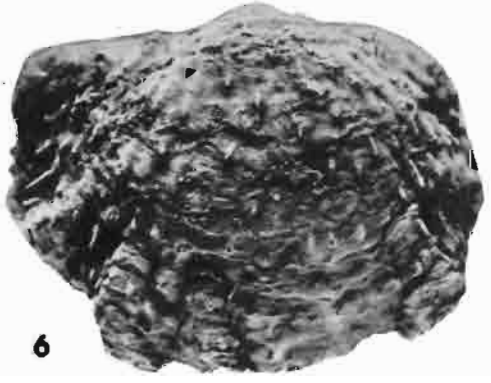
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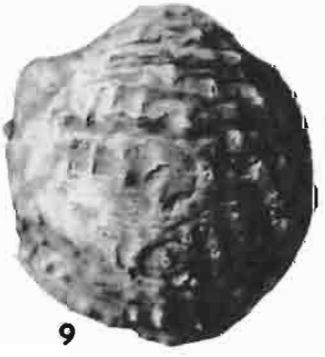
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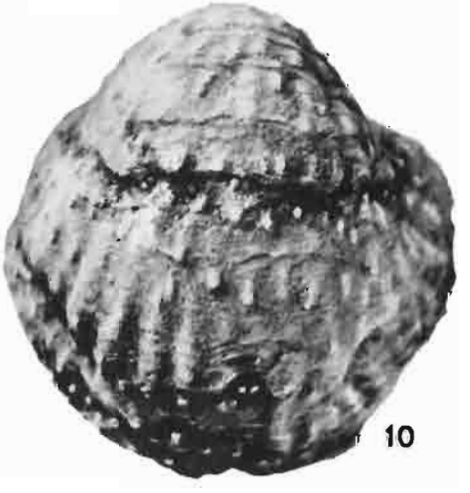
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G. BIERNAT: MIDDLE DEVONIAN BRACHIOPODS

PLATE XIV

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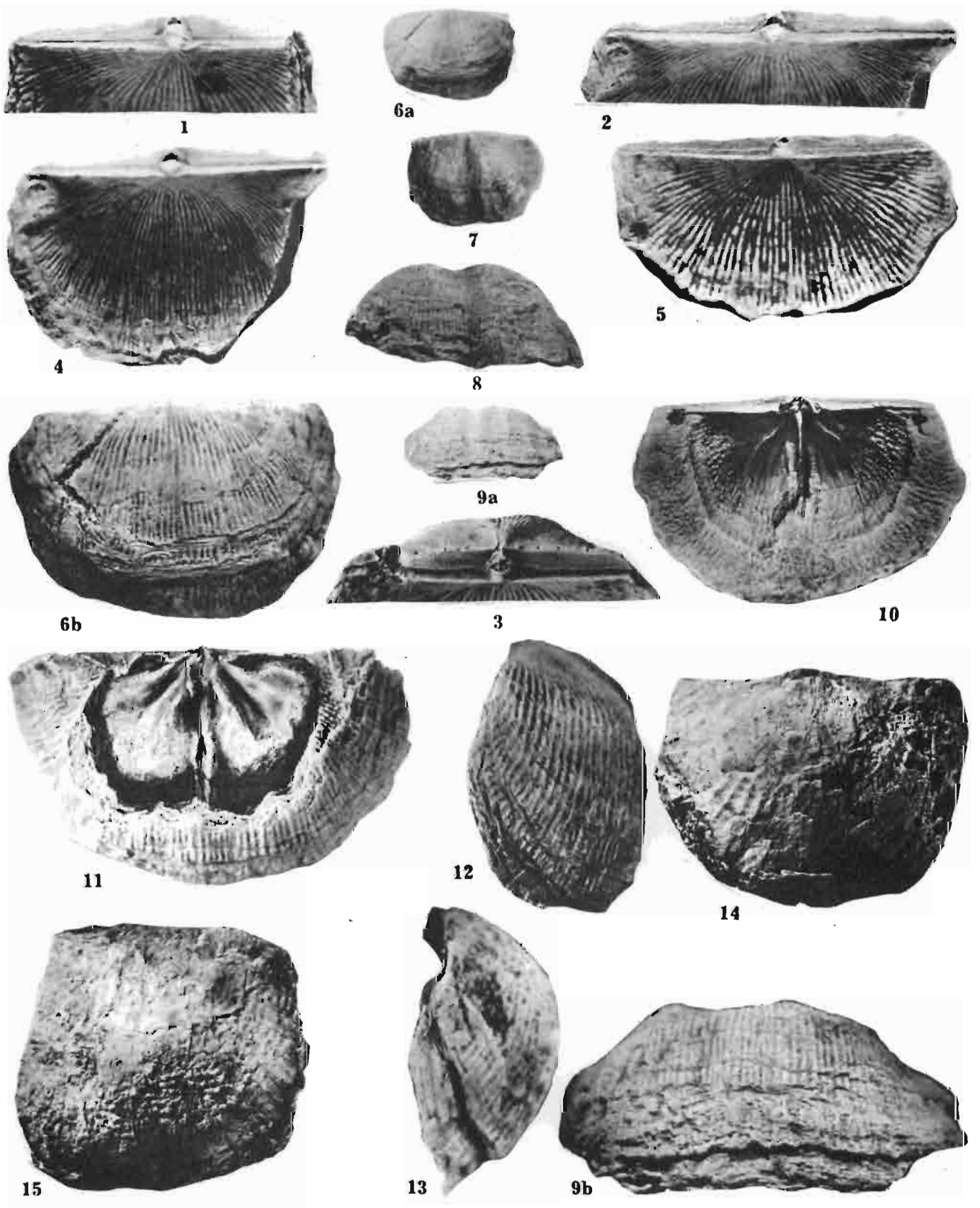
Chonetes supragibbosa SOBOLEV 74
(Skały beds, marly shales, exposure 73)

Figs. 1-3. Hinge-line view of 3 specimens (Bp. VII/1135, 1131, 1121); × 3.
Figs. 4-5. Brachial valve view of 2 specimens (Bp. VII/1131, 1139); × 3.
Figs. 6, 7. Pedicle valve view of 2 specimens (Bp. VII/1120, 1133); *6a*, *7* nat. size, *6b* × 3.
Figs. 8-9. Anterior view of 2 adult specimens (Bp. VII/1133, 1120); *8* × 2, *9a* nat. size, *9b* × 3.
Fig. 10. Ventral interior of adult specimen (Bp. VII/1119); × 2·7.
Fig. 11. Dorsal interior partly exfoliated (Bp. VII/1122); × 3.
Figs. 12-13. Side view of 2 different specimens (Bp. VII/1133, 1120); × 3.

Radiomena irregularis (ROEMER) 58
(Pokrzywianka beds, limestone)

Figs. 14, 15. Pedicle valve view of 2 specimens (Bp. VII/3696, 3696*a*); nat. size.



G. BIERNAT: MIDDLE DEVONIAN BRACHIOPODS OF THE BODZENTYN SYNCLINE

PLATE XV

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Eodevonaria (Devonaria) zeuschneri (SOBOLEV) 77
(Skały beds, marly shales, exposure 73)

Figs. 1-2. Ventral interior of 2 adult specimens (Bp. VII/3727, 3728); × 3.
Figs. 3, 4. Dorsal interior of 2 young specimens (Bp. VII/3729, 3729*a*); *3* approx. × 10, *4* × 15.
Figs. 5-7. Dorsal interiors of 3 different specimens (Bp. VII/3730, 3731, 3731*a*); × 3·4.
Fig. 8. Dorsal interior posteriorly (Bp. VII/3727); × 3·4.
Fig. 9. Posterior view of the dorsal interior (Bp. VII/3722); × 3·4.
Fig. 10. Hinge-line from exterior (Bp. VII/3727); approx. × 5.
Figs. 11-15. Appearance of both areas of 5 adult shells (Bp. VII/1191, 3728, 1187, 3729, 3730); × 5·3.
Fig. 16. Surface ornamentation of the pedicle valve (Bp. VII/3731); × 8.
Fig. 17. Side view of adult specimen (Bp. VII/1189); × 3.

(See also Plate XVI)

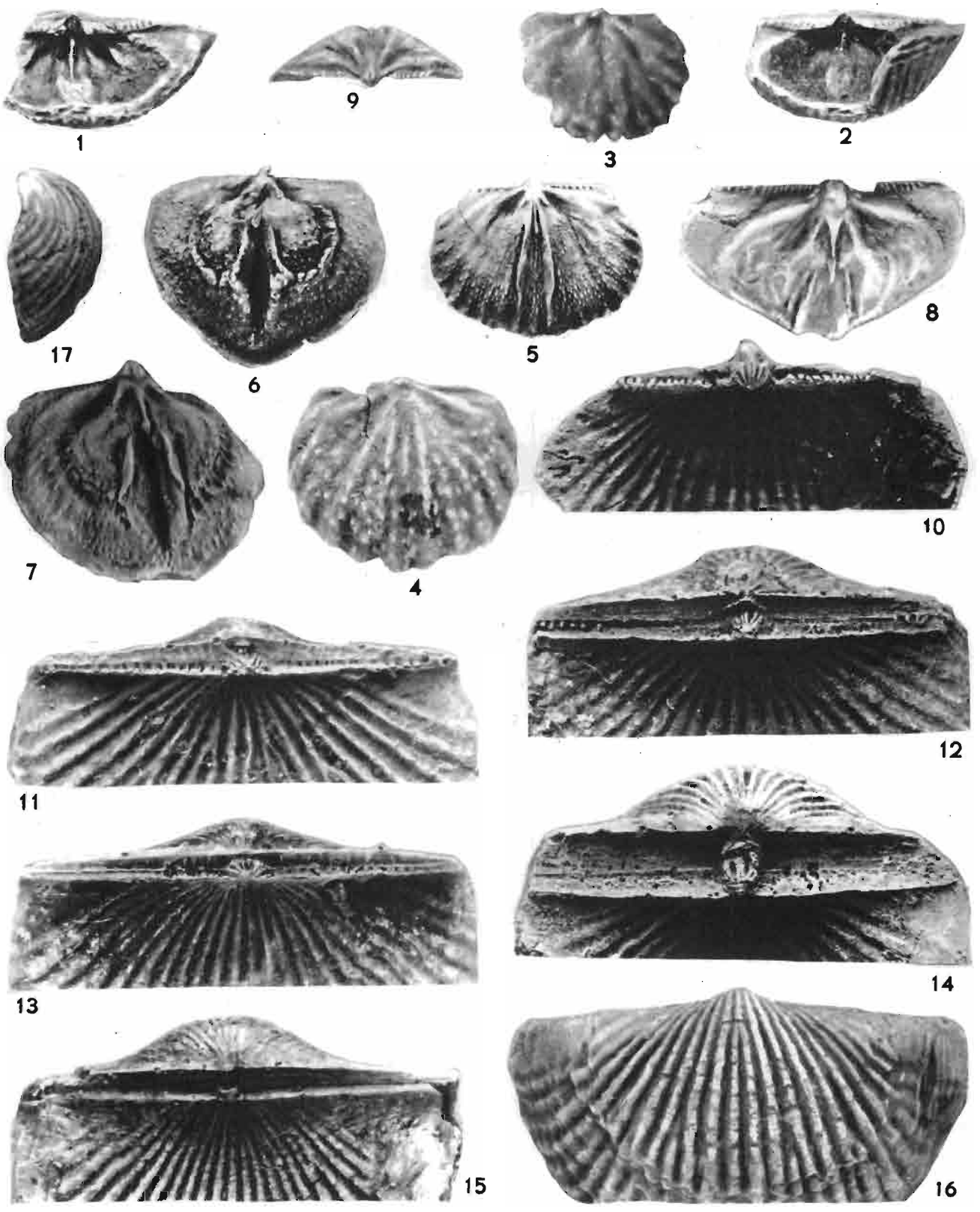
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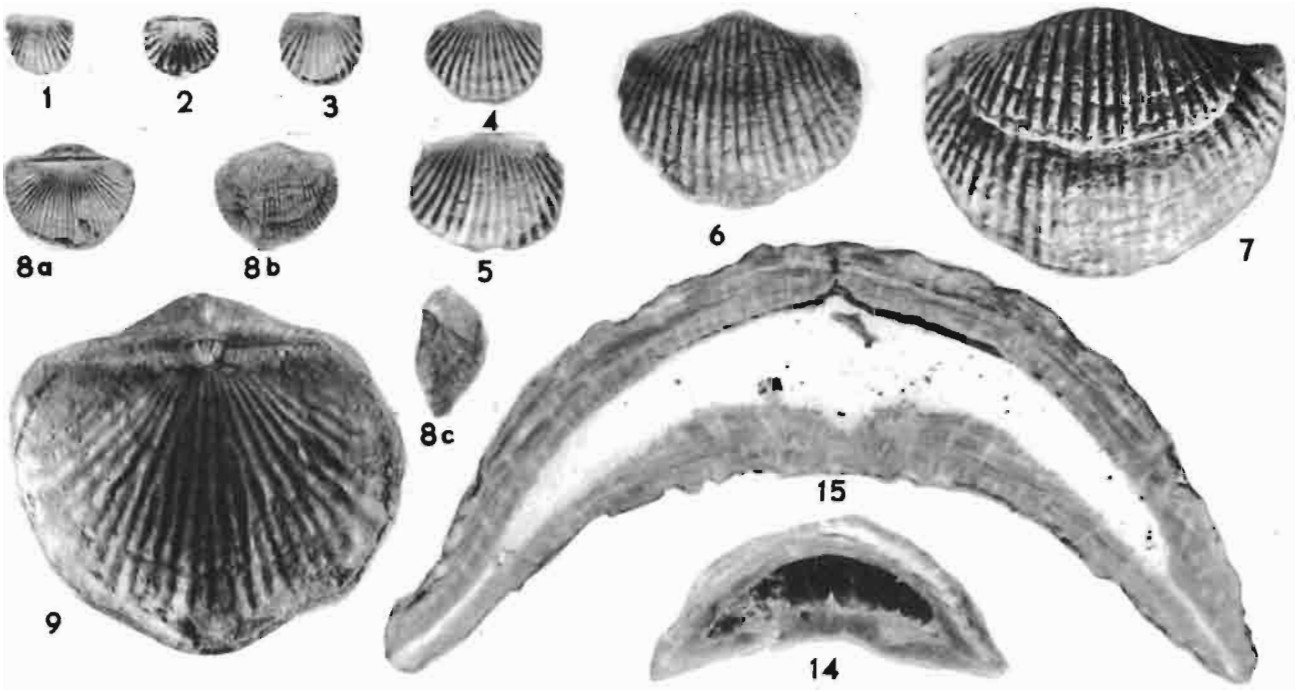
PLATE XVI

Figs. 1, 3-5. Pedicle valve view of 4 younger specimens; × 3.
Fig. 2. Brachial valve view of younger specimen; × 3.
Figs. 6-7. Pedicle valve view of 2 adult specimens (Bp. VII/3732, 3733); × 3.
Fig. 8. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* side views; nat. size.
Figs. 9-10. Brachial valve view of 2 old specimens (Bp. VII/3735, 3736); × 3.
Figs. 11-12. Pedicle valve view of 2 old specimens (Bp. VII/3737, 3738); × 3.
Fig. 13. Thin slide of adult specimen showing denticulated hinge-line (Bp. VII/3739); × 4·9.
Figs. 14-15. Cross sections of adult specimen (Bp. VII/3740); *14* × 3, *15* approx. × 6.
Fig. 16. Surface radial ornamentation with distinct concentric lines; approx. × 7·5.

(See also Plate XV)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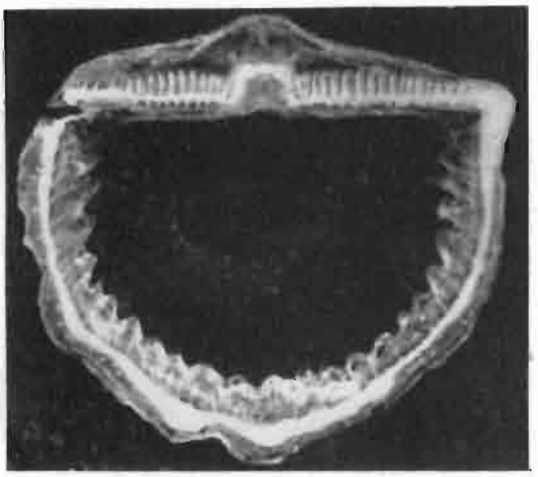
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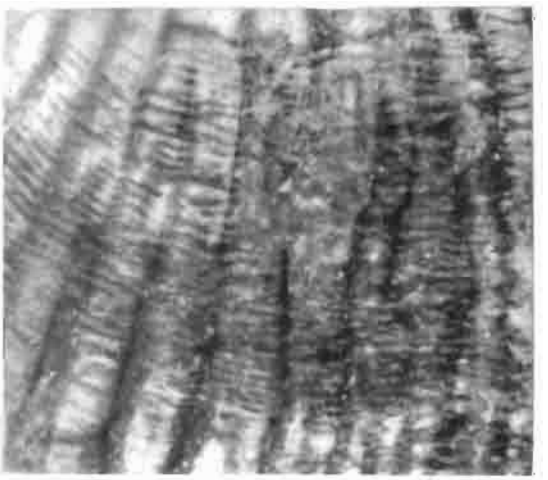
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G. BIERNAT: MIDDLE DEVONIAN BRACHIOPODS

PLATE XVII

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Leiorhynchus subplicatus n. sp. 82
(Skały beds, limestone, Miłoszów)

Fig. 1. Type specimen in: *a* brachial valve, *b* pedicle valve, *c* anterior commissure, *d* side views (Bp. VII/25); nat. size.
Fig. 2. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* anterior commissure views (Bp. VII/24); nat. size.
Fig. 3. Brachial valve view of adult specimen (Bp. VII/25*a*); nat. size.
Fig. 4. Pedicle valve view of adult specimen (Bp. VII/25*b*); nat. size.

(See also Plate XIX)

Pseudocamarophoria sp. 104
(Skały beds, limestone, Miłoszów)

Fig. 5. Adult specimen in: *a, b* brachial valve, *c* pedicle valve views (Bp. VII/3776); *a-c* nat. size, *b* × 2.

Septalaria cf. *gracilis* (GÜRICH) 97
(Skały beds, limestone, exposure 84)

Fig. 6. Adult specimen in: *a, b* brachial valve, *c, d* pedicle valve, *e* anterior commissure *f* side views (Bp. VII/120); *a, c, e, f* × 2, *b, d* × 3.

Septalaria sp. 95
(Skały beds, limestone, Miłoszów)

Fig. 7. Adult specimen in: *a* brachial valve, *b* pedicle valve views (Bp. VII/121); approx. × 2.

(See also Plate XIX)

Uncinulus parallelepipedus (BRONN) 90
(Skały beds, marly shales, exposure 73)

Fig. 8. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* side views (Bp. VII/1494); nat. size.
Fig. 9. Adult specimen in: *a, b* pedicle valve view, *c* side view (Bp. VII/1494); × 2.
Figs. 10, 11. Anterior commissure view of two different adult specimens (Bp. VII/3785); limestone, exposure 81; *10a, 11a* nat. size, *10b-11b* × 2.

Uncinulus primipilaris (v. BUCH) 83
(Skały beds, marly shales, exposure 73)

Fig. 12. Pedicle valve view of adult specimen (Bp. VII/82); × 2.

(See also Plate XVIII)

Pugnax cf. *anisodonta* (PHILLIPS) 109
(Skały beds, marly shales, exposure 73)

Fig. 13. Adult specimen in: *a* brachial valve, *b* pedicle valve views (Bp. VII/20*a*); × 2.

(See also Plate XIX)

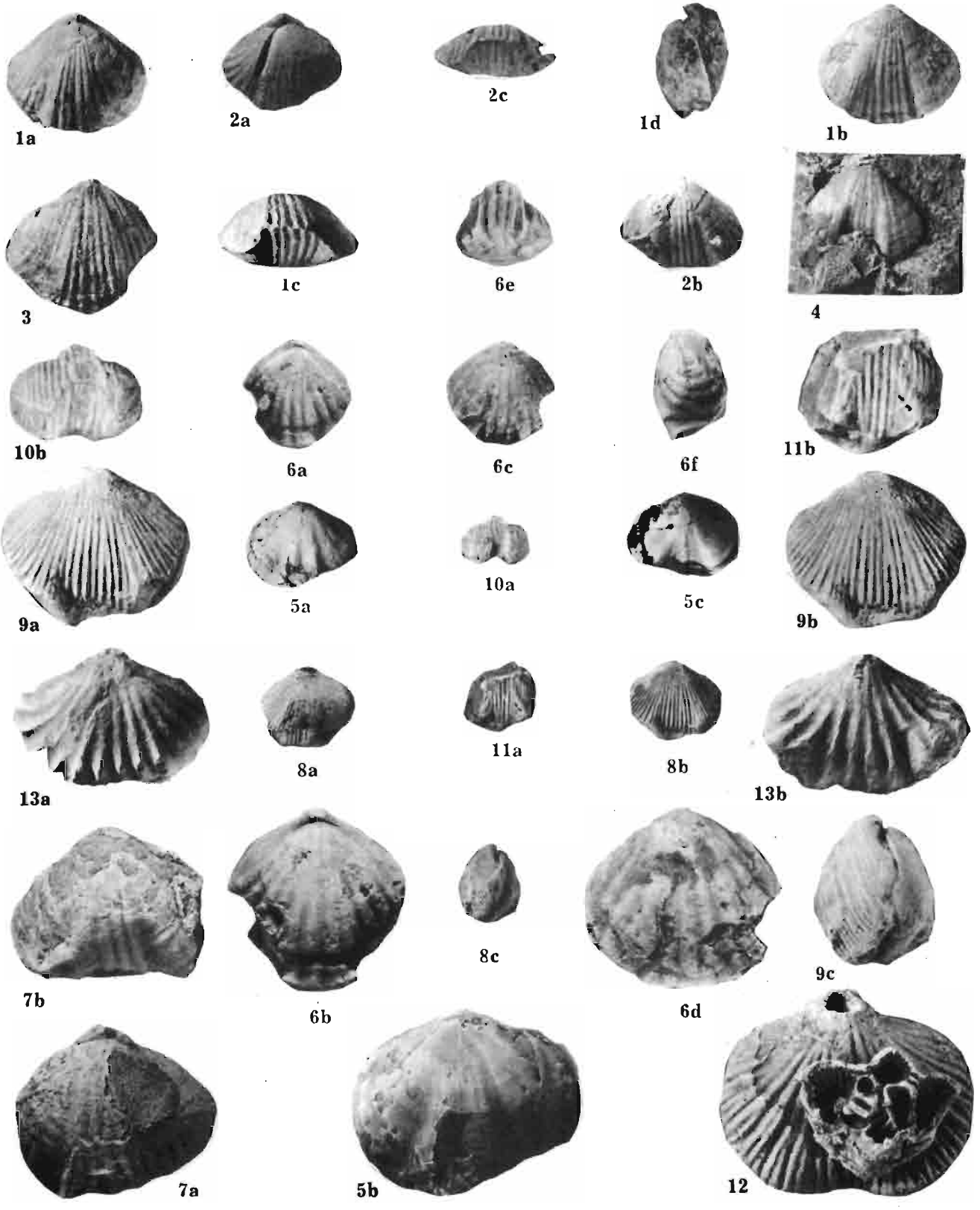
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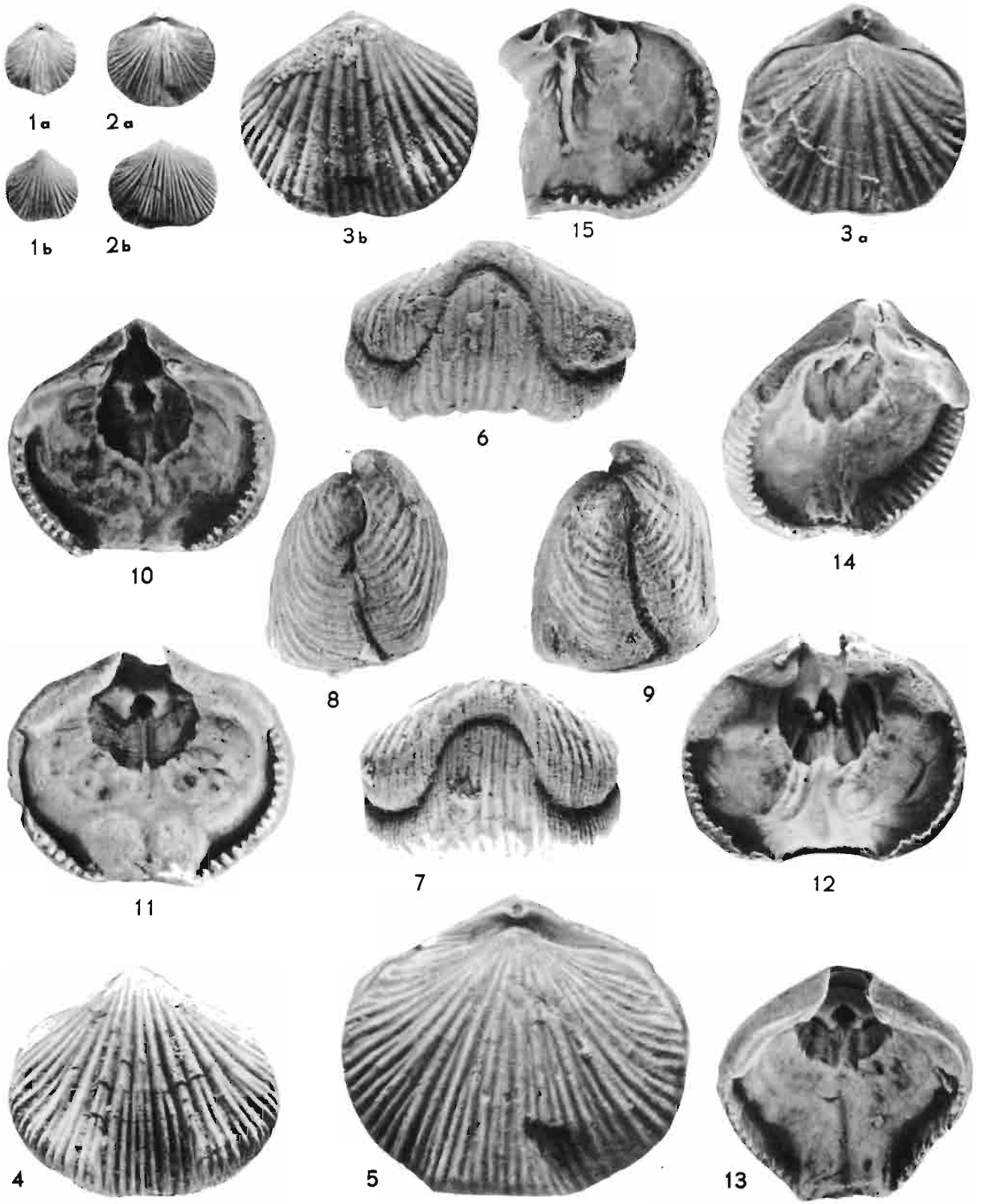
PLATE XVIII

Figs. 1-2. Two adult specimens in: *a* brachial valve, *b* pedicle valve views (Bp. VII/31, 32); nat. size.
Fig. 3. Adult specimen in: *a* brachial valve, *b* pedicle valve views (Bp. VII/33); × 3.
Fig. 4. Pedicle valve view of adult specimen (Bp. VII/43); × 3.
Fig. 5. Brachial valve view of adult specimen (Bp. VII/32); × 3.
Figs. 6-7. Anterior commissure view of 2 different specimens (Bp. VII/42, 41); × 3.
Figs. 8-9. Side view of 2 different adult specimens (Bp. VII/35, 32); × 3.
Figs. 10-14. Ventral interior of 5 specimens (Bp. VII/36-40); × 3.
Fig. 15. Incomplete dorsal interior (Bp. VII/34); × 3.

(See also Plate XVII)



G. Biernat: Middle Devonian brachiopods of the Bodzentyn syncline

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PLATE XIX

Page

Pseudocamarophoria undulataeformis n. sp. 102
(Skały beds, marls, exposure 81)

Figs. 1-6. Brachial valve view of different specimens (Bp. VII/105, 100, 116, 102, 109, 108 — type specimen); approx. × 2·4.
Figs. 7-12. Pedicle valve view of different specimens (Bp. VII/99*a*, 99, 101, 103, 110, 123); approx. × 2·4.
Fig. 13. Posterior view of adult specimen (Bp. VII/122); × 2·4.
Figs. 14-16. Side view of adult specimens (Bp. VII/111*a*, 111, 111*b*); approx. × 2·4.
Figs. 17-21. Anterior commissure view of different specimens (Bp. VII/104—106, 106*a*, 107); × 2.
Fig. 22. Cross section of adult specimen; approx. × 5.

Septalaria sp. 95
(Skały beds, marly shales, exposure 73)

Fig. 23. Adult specimen in: *a*, *b* brachial valve, *c* pedicle valve, *d*, *e* anterior margin views (Bp. VII/63); nat. size.
Fig. 24. Brachial valve and anterior margin views of adult specimen (Bp. VII/63*f*); nat. size.

Septalaria cf. *subtetragona* (SCHNUR) 98
(Skały beds, limestone, Miłoszów)

Fig. 25. Brachial valve view of specimen (Bp. VII/67); *a* nat. size, *b* × 2.

Leiorhynchus subplicatus n. sp. 82
(Skały beds, limestone, Miłoszów)

Fig. 26. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* anterior commissure views (Bp. VII/24); nat. size.

(See also Plate XVII)

Uncinulus coronatus (KAYSER) 86
(Skały beds, marls; exposure 83)

Fig. 27. Pedicle valve view of adult specimen (Bp. VII/4); nat. size.
Fig. 28. Adult specimen in: *a*, *b* pedicle valve, *c* brachial valve, *d*, *e* anterior margin views (Bp. VII/3); *a* nat. size, *b-e* × 2.
Fig. 29. Side view of adult specimen (Br. VII/3*m*); × 2.

Pugnax cf. *anisodonta* (PHILLIPS) 109
(Skały beds, marly shales, exposure 73)

Fig. 30. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* anterior commissure views (Bp. VII/20*a*); nat. size.

(See also Plate XVII)

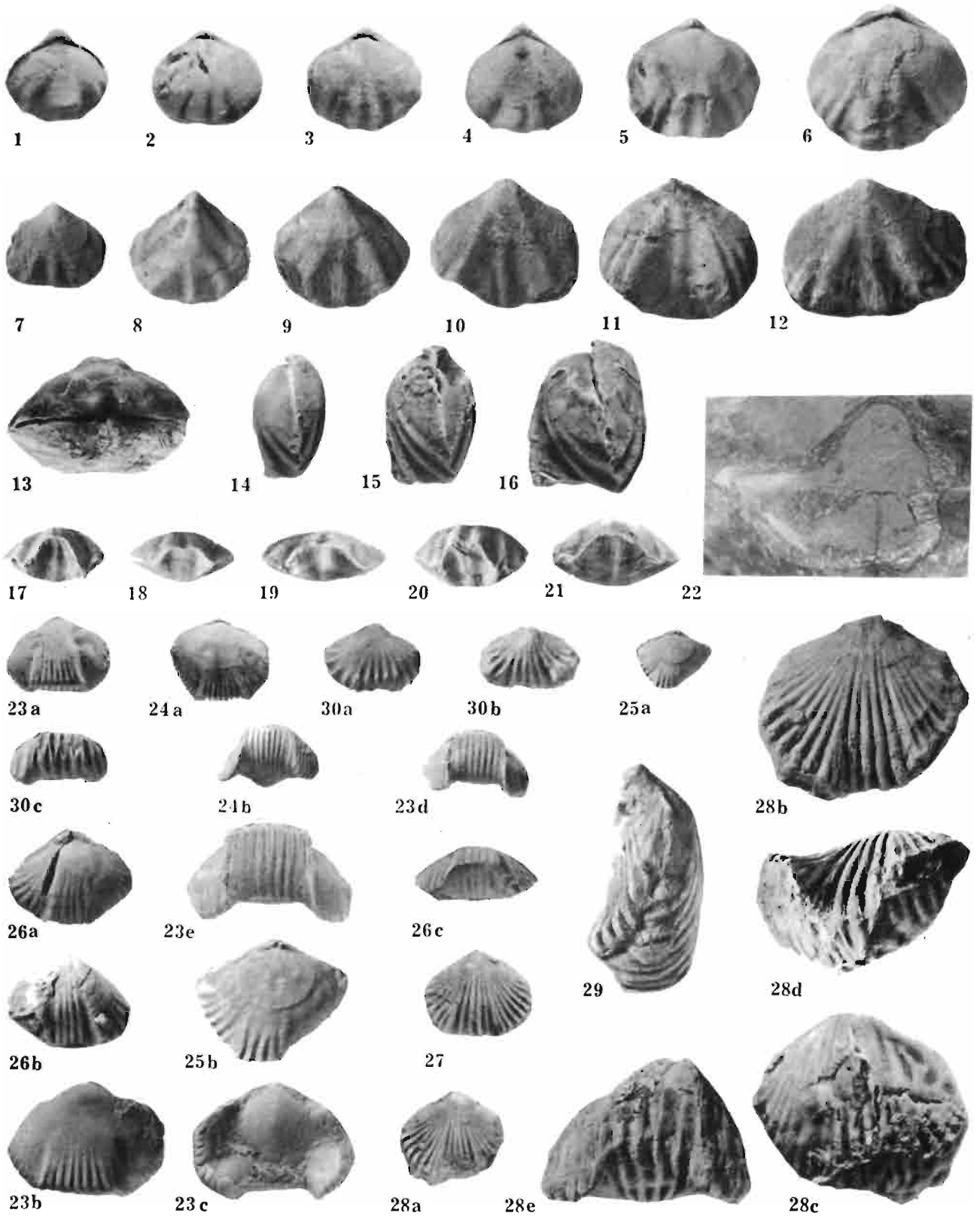
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PLATE XX

Page

Uncinulus implexus (SOWERBY) 94
(Skały beds, limestone, exposure 91)

Fig. 1. Pedicle valve view of adult specimen (Bp. VII/69); nat. size.
Figs. 2-3. Brachial valve and anterior commissure views of adult specimen (Bp. VII/70); × 2·1.
Fig. 4. Pedicle valve view of adult specimen (Bp. VII/70*a*); × 2.

Uncinulus subcordiformis (SCHNUR) 88
(Skały beds, limestone, Miłoszów)

Figs. 5-8. Side view of different specimens (Bp. VII/11, 10, 10*a*, 10*b*); × 2.
Figs. 9-11. Anterior commissure view of different specimens (Bp. VII/7, 13, 12); × 2.
Figs. 12-15. Pedicle valve view of adult specimens (Bp. VII/8, 9, 6, 15); × 2.
Figs. 16-17. Anterior commissure view of 2 adult specimens, marls, exposure 81; *16* × 3, *17* × 2.
Figs. 18-21. Pedicle valve view of adult specimens, marls, exposure 81; *18*, *19* nat. size, *20*, *21* × 2.

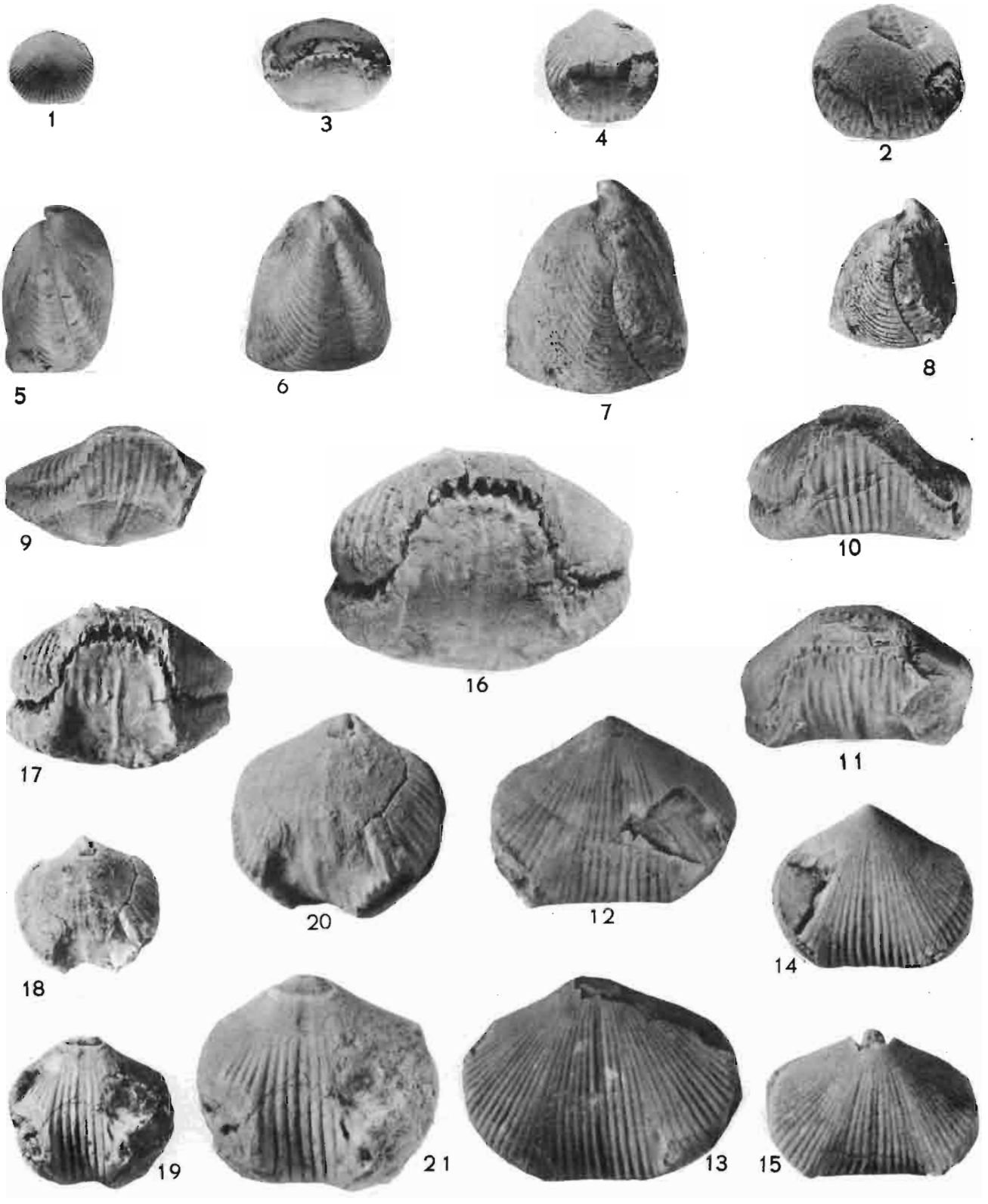
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PLATE XXI

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Dicamara plebeia (SOWERBY) 138
(Skały beds, limestone, exposure 83)

Fig. 1. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* anterior commissure views (Bp. VII/3475); nat. size.

Hypothyridina cf. *procuboides* (KAYSER) 105
(Skały beds, limestone, Miłoszów)

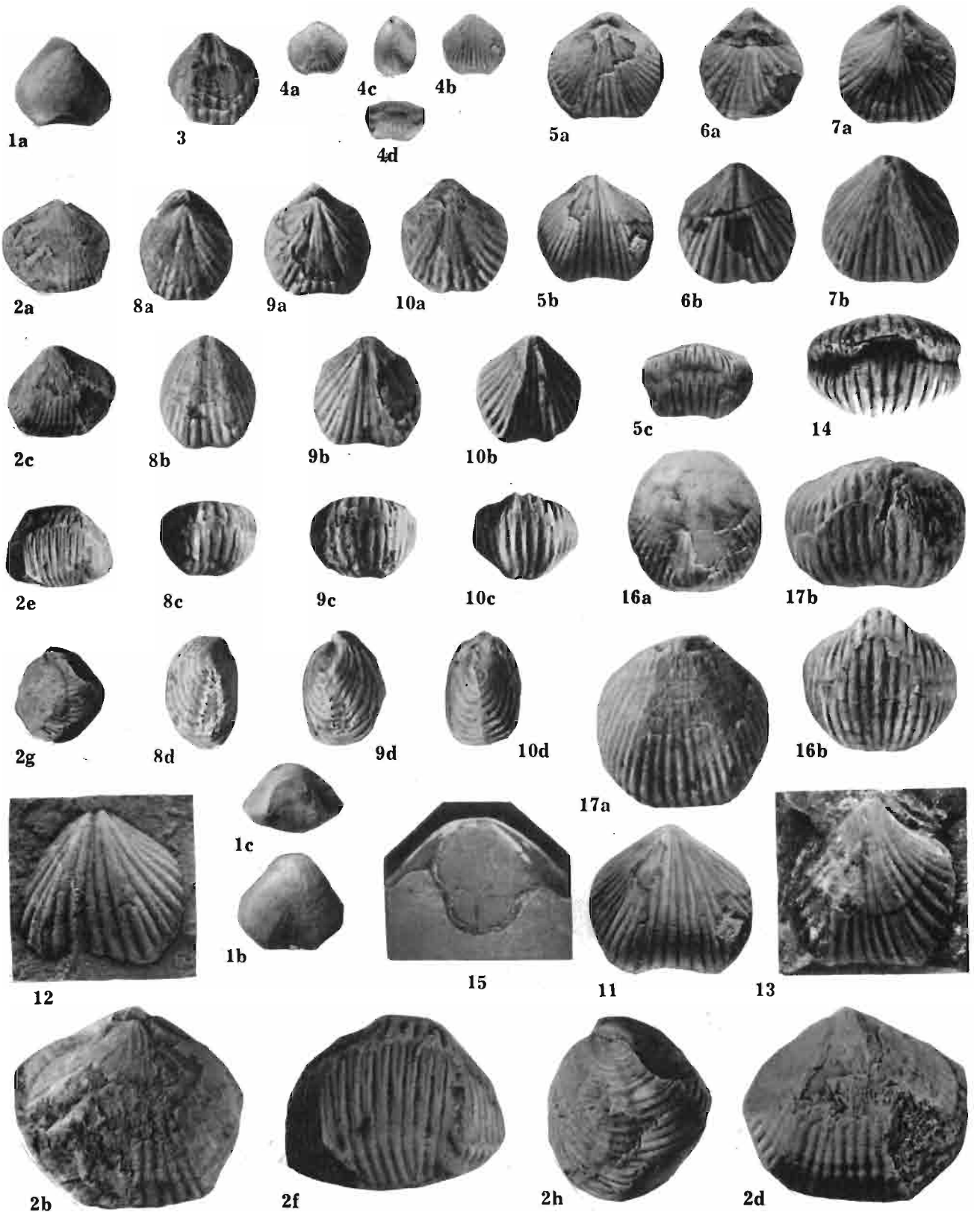
Fig. 2. Adult specimen in: *a, b* brachial valve, *c, d* pedicle valve, *e, f* anterior commissure, *g, h* side views (Bp. VII/23); *a, c, e, g* nat. size, *b, d, f, h* × 2.

Uncinulus pentagonus pentagonus (KAYSER) 91
(Skały beds, limestone, exposure 89)

Fig. 3. Pedicle valve view of adult specimen (Bp. VII/1500m); × 2.
Fig. 4. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* side, *d* anterior margin views (Bp. VII/1500); nat. size.
Figs. 5-7. Different specimen in: *a* brachial valve, *b* pedicle valve, *c* anterior commissure views (Bp. VII/1500, 3747, 3748); × 2.
Figs. 8-10. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* anterior commissure, *d* side views (Bp. VII/3762, 3763, 3764); × 2·2.
Figs. 11-13, 19. Pedicle valve view of different specimens (Bp. VII/1500, 3749, 3759); × 3.
Fig. 14. Anterior margin view of specimens (Bp. VII/3760, 4761); approx. × 2·5.
Fig. 15. Cross section of adult specimen (Bp. VII/500 r); approx. × 12.

Uncinulus minor minor (SCHNUR) 93
(Skały beds, limestone, Miłoszów)

Fig. 16. Brachial valve (*a*) and anterior commissure (*b*) views of adult specimen (Bp. VII/1504); approx. × 3.
Fig. 17. Pedicle valve (*a*) and anterior commissure (*b*) views of specimen (Bp. VII/1504); approx. × 4.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G. BIERNAT: MIDDLE DEVONIAN BRACHIOPODS

PLATE XXII

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Isopoma brachyptyctum (SCHNUR) 106
(Skały beds, limestone, exposure 89)

Fig. 1. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* side, *d* anterior margin views (Bp. VII/35); nat. size.
Fig. 2. Anterior commissure view of adult specimen (Bp. VII/37*a*); × 2·5.
Fig. 3. Pedicle valve view of specimen (Bp. VII/3789); × 1·5.
Figs. 4-8. Pedicle valve view of 5 specimens (Bp. VII/3787-3791); × 2.
Fig. 9. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* anterior margin, *d* side views (Bp. VII/35); × 3.

Pugnax sp. cf. *Pugnax pugnus* (MARTIN) 108
(Skały beds, limestone, Miłoszów)

Fig. 10. Adult specimen in: *a* pedicle valve, *b, c* anterior margin, *d* umbonal part, *e* side views (Bp. VII/51); nat. size

Nemesa cf. *nemesana* H. SCHMIDT 99
(Skały beds, limestone, exposure 89)

Fig. 11. Adult specimen in: *a* brachial valve, *b* pedicle valve views (Bp. VII/20); × 3.
Fig. 12. Pedicle valve view of specimen (Bp. VII/19); × 3.
Fig. 13. Pedicle valve view of specimen embedded in the limestone (Bp. VII/20*a*); nat. size.

?Nemesa skalensis n. sp. 100
(Skały beds, limestone, exposure 89)

Fig. 14. Type specimen in: *a* pedicle valve, *b* side views (Bp. VII/53); × 2.
Figs. 15, 16. Pedicle valve view of specimen (Bp. VII/3792*a*, 3792); × 2.
Fig. 17. Anterior commissure view of damaged specimen (Bp. VII/54); × 2.

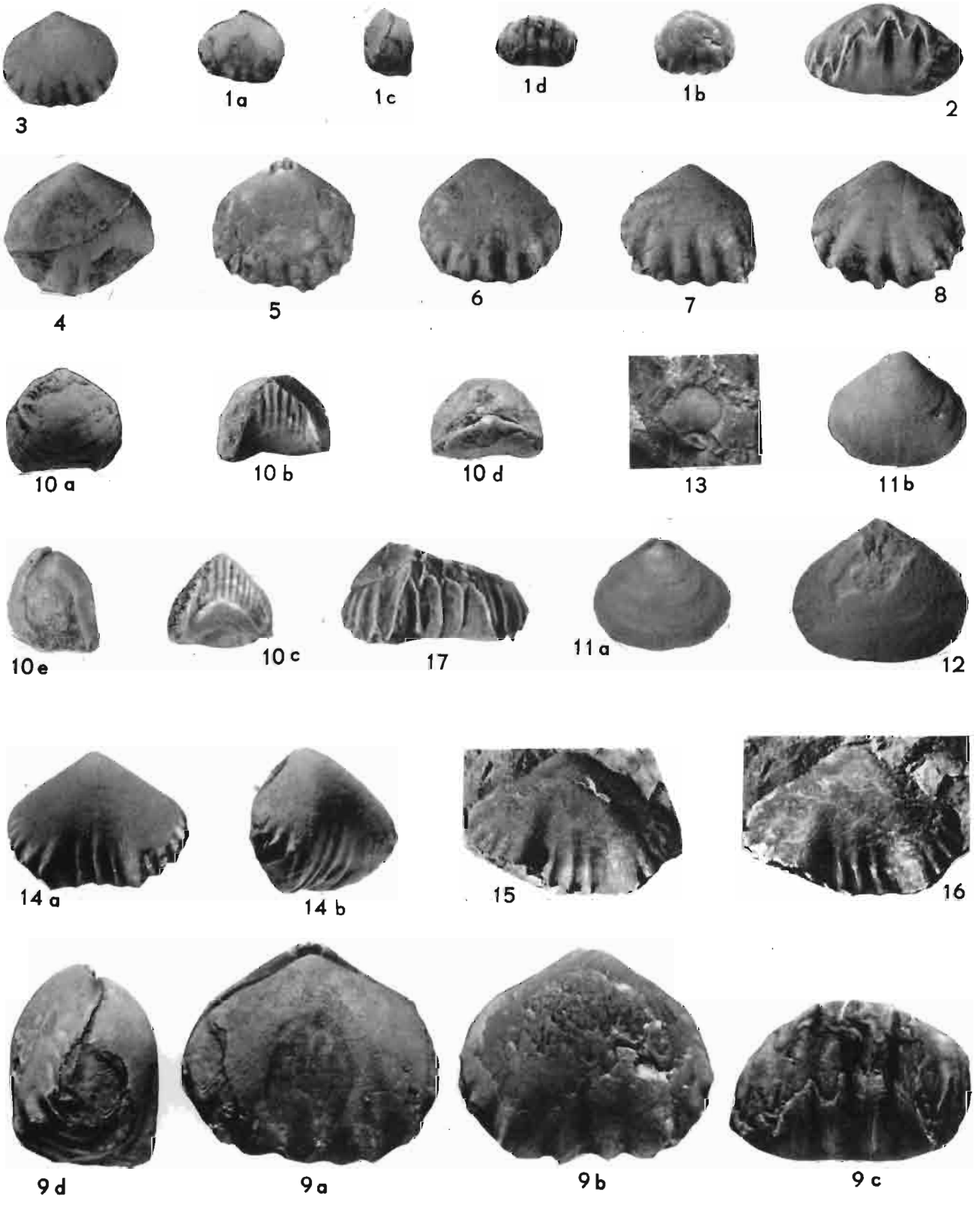
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PLATE XXIII

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Cryptatrypa philomela minor n. subsp. 110
(Skały beds, marly shales, exposure 73)

Figs. 1-7. Different specimens in: *a* brachial valve, *b* pedicle valve views (Bp. VII/3812-3818); × 3·2.
Fig. 8. Type specimen in: *a* brachial valve, *b* pedicle valve views (Bp. VII/1025); × 3·2.

Cyrtina heteroclita intermedia OEHLERT. 133
(Skały beds, marly shales, exposure 73)

Figs. 9-12, 22. Pedicle valve view of different specimens (Bp. VII/3819-3822, 3822*a*); × 3.
Figs. 13-15. Adult specimens in: *a* pedicle valve, *b* side views (Bp. VII/3823-3825); × 3.
Figs. 16-21. Side view of 5 specimens (Bp. VII/3826-3829); × 3.
Figs. 23-27. Brachial valve view of adult specimens (Bp. VII/3830-3834); × 3.

(See also Plate XXXII)

Squamulariina parva (GÜRICH) 136
(Skały beds, marls, exposure 84)

Figs. 28-29. Thin cross sections of adult specimen, approx. × 7.

(See also Plate XXXII)

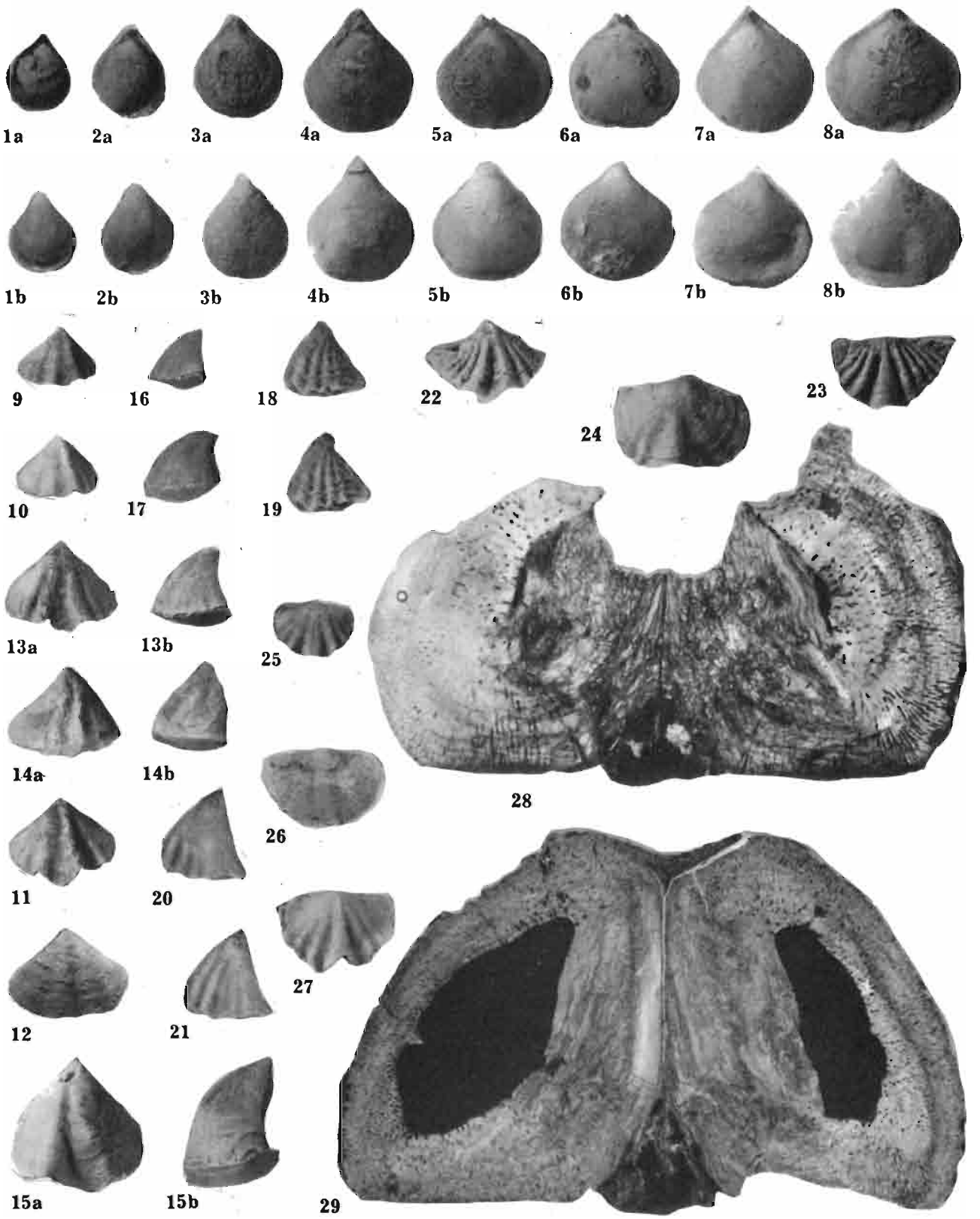
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PLATE XXIV

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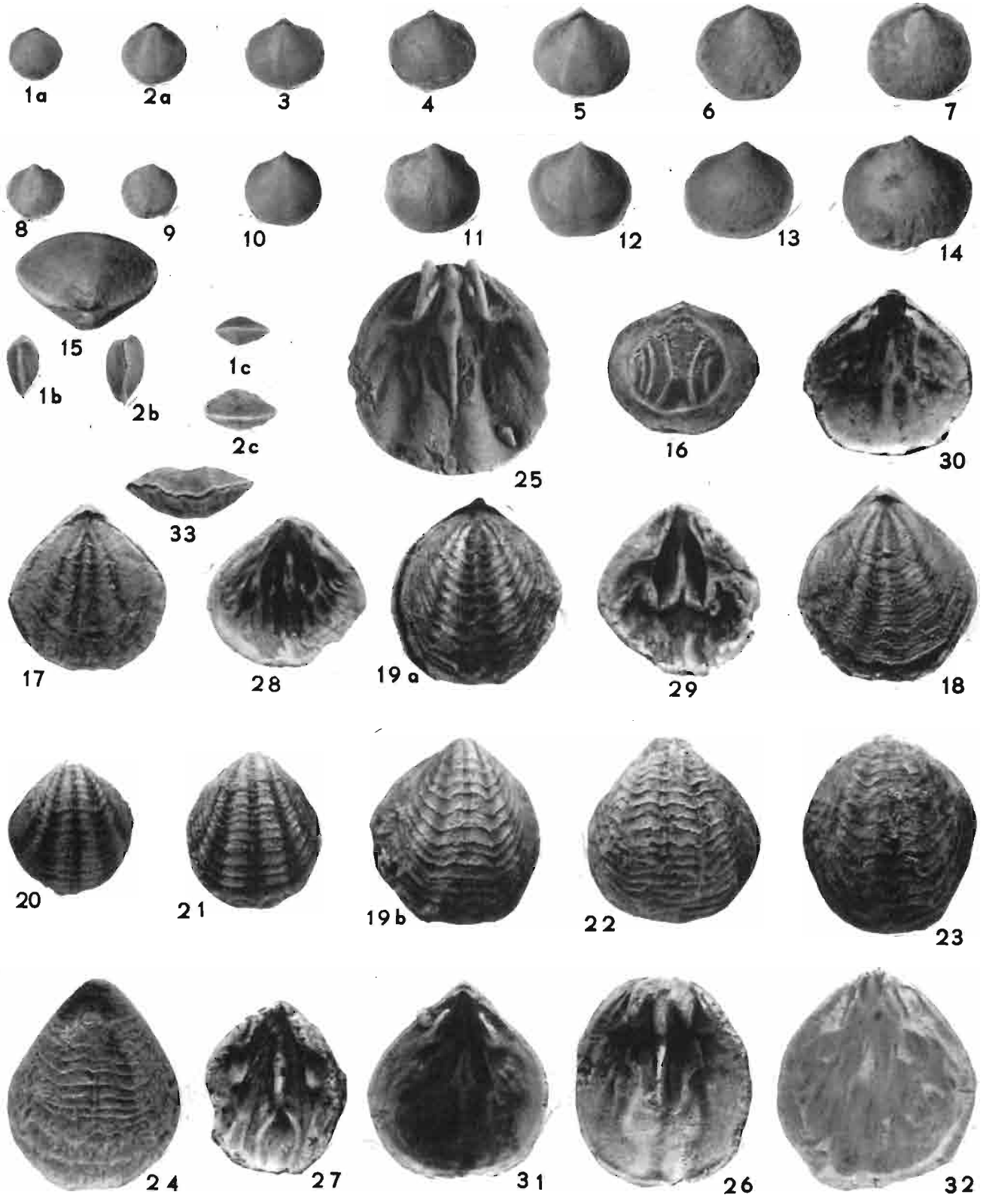
Nucleospira lens (SCHNUR) 140
(Skały beds, marly shales, exposure 73)

Figs. 1-2. Two different specimens in: *a* brachial valve, *b* side, *c* anterior commissure views (Bp. VII/300, 302); × 3·2.
Figs. 3-7. Brachial valve view of 5 adult specimens (Bp. VII/308, 310, 314, 319, 317); × 3·2.
Figs. 8-14. Pedicle valve view of specimens (Bp. VII/300*a*, 300*b*, 305, 310,*a*, 314*a*, 319*a*, 317*a*); × 3·2.
Fig. 15. Hinge-line view of adult specimen (Bp. VII/314); × 5.
Fig. 16. Dorsal interior partly exfoliated (Bp. VII/3795); × 5.

Bifida lepida (D'ARCHIAC & DE VERNEUIL) 112
(Skały beds, marly shales, exposure 73)

Figs. 17-18. Brachial valve view of 2 different specimens (Bp. VII/3796, 3797); × 7.
Fig. 19. Adult specimen in: *a* brachial valve, *b* pedicle valve views (Bp. VII/3798); approx. × 7.
Figs. 20-24. Pedicle valve view of 5 different specimens (Bp. VII/3799-3803); × 7.
Figs. 25-27. Three dorsal interiors (Bp. VII/3804-3806); *9* × 8, *10, 11* × 7.
Figs. 28-32. Five ventral interiors (Bp. VII/3807-3811); × 7.
Fig. 33. Anterior commissure view of adult specimen; × 6.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G. BIERNAT: MIDDLE DEVONIAN BRACHIOPODS

PLATE XXV

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Mucrospirifer (Spinospirifer) diluvianoides n. sp. 118
(Skały beds, marly shales, exposure 73)

Figs. 1-5. Dorsal interior of 5 different specimens (Bp. VII/4026-4030); *1-4* × 2, *5* × 4.
Fig. 6. Thin section of adult specimen showing a cardinal process and crura; × 5·5.
Figs. 7-11. Five ventral interiors (Bp. VII/4031-4035); *7-10* × 2·5, *11* × 3.
Fig. 12. Ventral interior posteriorly showing teeth, dental plates and delthyrial callosity; × 3·5.
Fig. 13. Slightly sectioned ventral umbo with well preserved dental plates; × 2·5.
Figs. 14-16. Ventral area view in slightly different positions (Bp. VII/4036-4038); × 2·3.
Fig. 17. Pedicle valve view of adult specimen (Bp. VII/4039); × 3·5.

(See also Plates XXVI and XXVII)

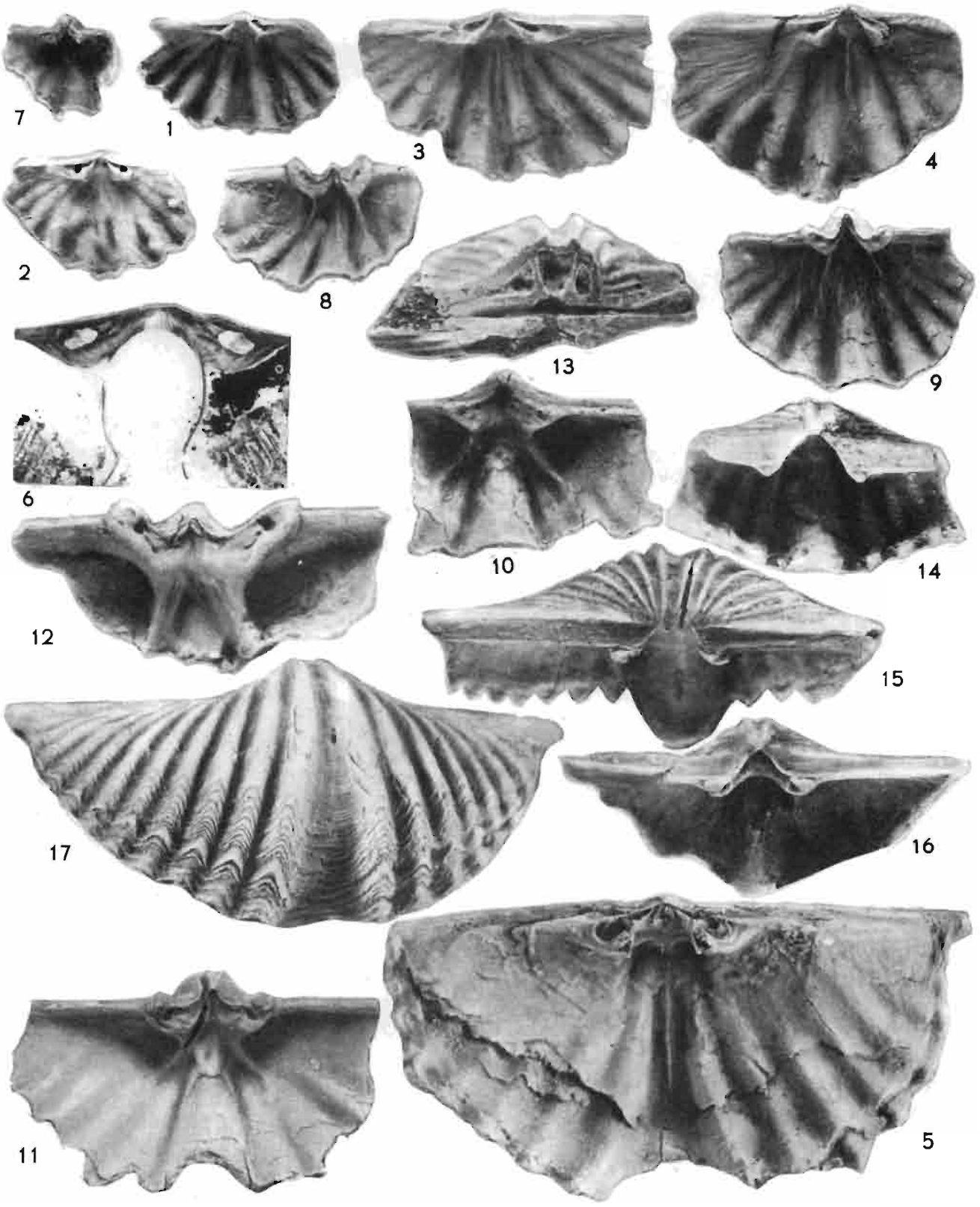
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PLATE XXVI

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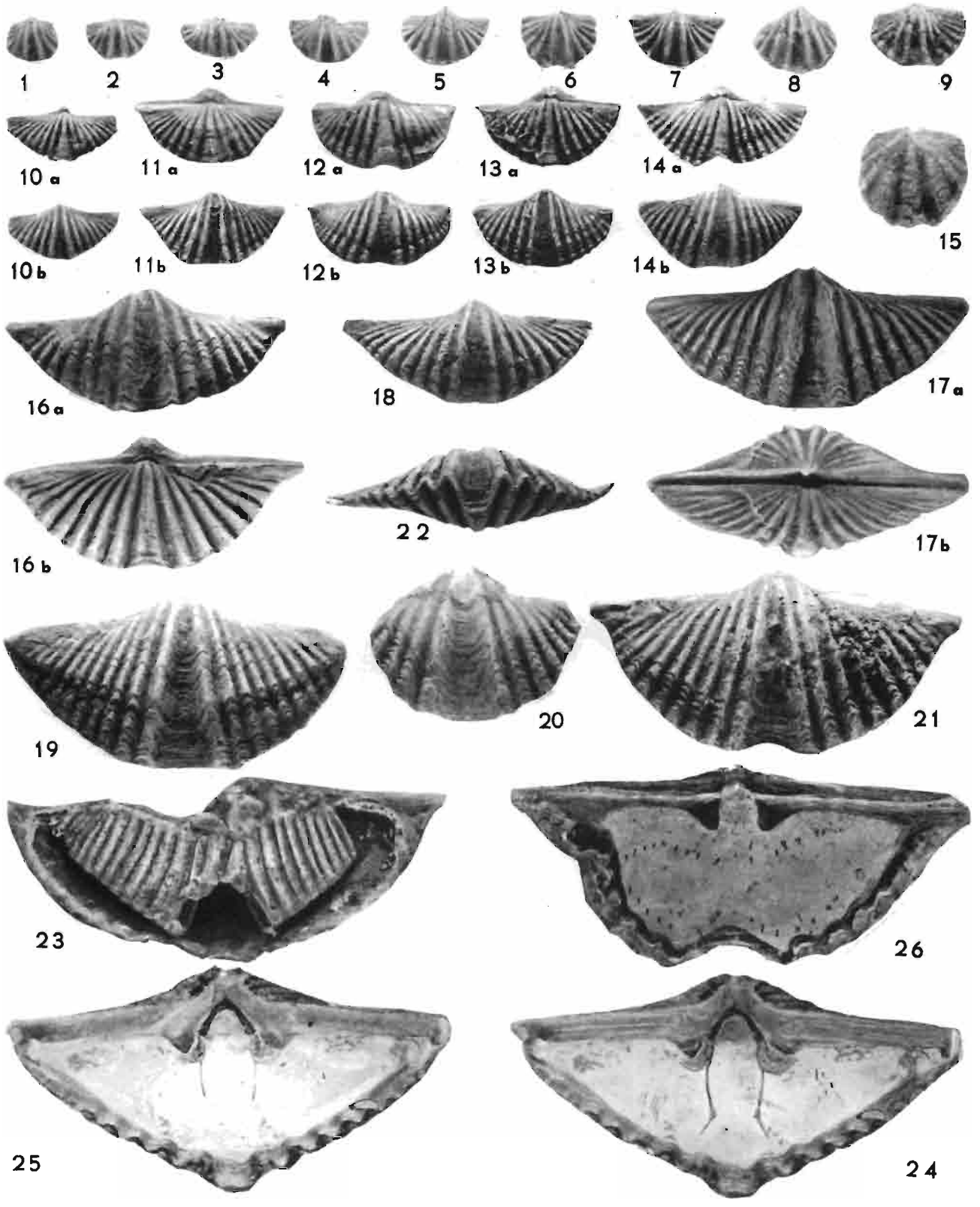
Mucrospirifer (Spinospirifer) diluvianoides n. sp. 118
(Skały beds, marly shales, exposure 73)

Figs. 1-9. A range of specimens of different size in pedicle valve view (Bp. VII/4000-4009); × 2.
Figs. 10-14. Different specimens in: *a* brachial valve, *b* pedicle valve views, *12a, b* type specimen (Bp. VII/4010-4014); nat. size.
Fig. 15. Brachial valve view of young specimen, about 3·6 mm. long with preserved spine bases (Bp. VII/4015); × 5.
Fig. 16. Adult specimen in: *a* pedicle valve, *b* brachial valve views (Bp. VII/4016); × 2.
Fig. 17. Adult specimen in: *a* pedicle valve, *b* posterior views; approx. × 2·2.
Figs. 18-21. Pedicle valve view of 4 different specimens (Bp. VII/4017-4020); × 2·2.
Fig. 22. Anterior commissure view of adult specimen (Bp. VII/4021); × 2.
Fig. 23. Brachidium partly exfoliated (Bp. VII/4022); × 2·5.
Figs. 24-26. Three partly sectioned specimens showing crura and traces of spires (Bp. VII/4023-4025); × 2·5

(See also Plates XXV and XXVII)



G. BIERNAT: MIDDLE DEVONIAN BRACHIOPODS OF THE BODZENTYN SYNCLINE

PLATE XXVII

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Pyramidalia cf. *simplex* (PHILLIPS) 136
(Skały beds, limestone, Miłoszów)

Fig. 1. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* anterior margin views (Bp. VII/892); nat. size.

Spinocyrtia sp. 11
(Skały beds, limestone, exposure 82)

Fig. 2. Sufficiently preserved specimen in: *a* pedicle valve, *b* anterior margin, *c* ventral area views (Bp. VII/4050); nat. size.

Mucrospirifer (Spinospirifer) diluvianoides n. sp.. 118
(Skały beds, marly shales, exposure 73)

Figs. 3-4. Pedicle valve view of two different specimens (Bp. VII/4051, 4052); × 2·5.
Fig. 5. Dorsal interior with partly preserved brachidium; × 3.
Fig. 6. Partly preserved ventral interior (Bp. VII/4053); × 3.
Figs. 7-8. Ventral area view of 2 different specimens (Bp. VII/4054, 4055); × 6.
Fig. 9. Brachial valve surface with microornamentation (Bp. VII/4056); × 6.

(See also Plates XXV and XXVI)

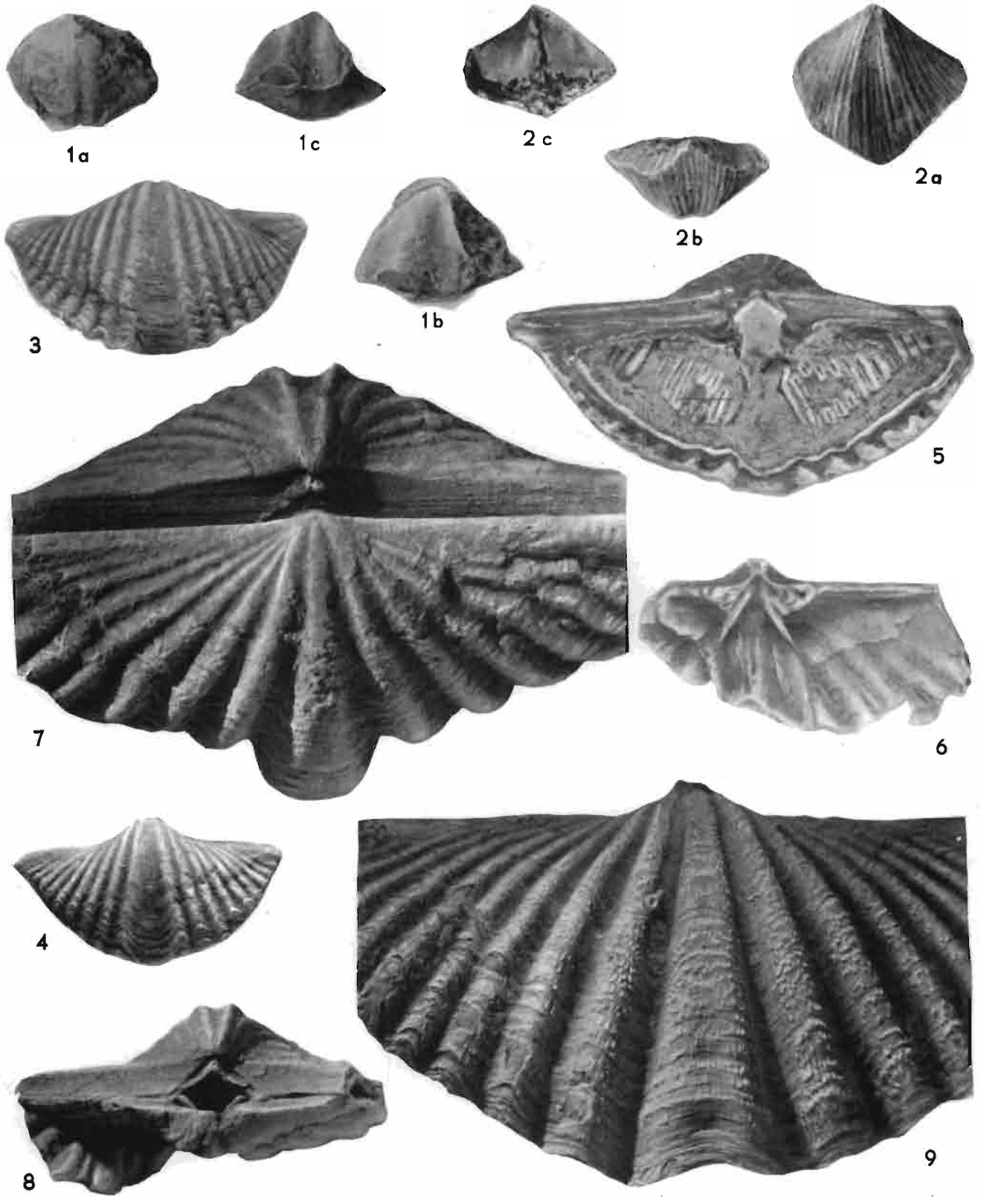
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PLATE XXVIII

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Plectospira ferita (v. BUCH) 146
(Skały beds, marls, exposure 84)

Fig. 1. Adult specimen in: *a* brachial valve, *b, c* pedicle valve, *d* posterior part, *e* side, *f* anterior commissure views (Bp. VII/663); *a, b, d-f* × 3·8, *c* × 6·4.

Undispirifer sp. cf. *Undispirifer undiferus* (ROEMER) 116
(Skały beds, limestone, exposure 84)

Fig. 2. Adult specimen in: *a* pedicle valve, *b* side views (Bp. VII/599); nat. size.
Fig. 3. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* anterior commissure, *d* posterior part, *e* side views (Bp. VII/598); nat. size.
Fig. 4. Pedicle valve view of specimen partly embedded in the limestone (Bp. VII/599*a*); nat. size.

Rensselandia cf. *circularis* (HOLZAPFEL) 148
(Skały beds, marls, exposure 112)

Fig. 5. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* anterior margin, *d* side views (Bp. VII/1222); nat. size.

Rensselandia cf. *caiqua* (D'ARCHIAC & DE VERNEUIL) 148
(Skały beds, marls, exposure 112)

Fig. 6. Adult specimen in: *a, b* brachial valve, *c* pedicle valve, *d* ventral beak, *e* side views (Bp. VII/1220); *a* nat. size, *b-e* × 2.

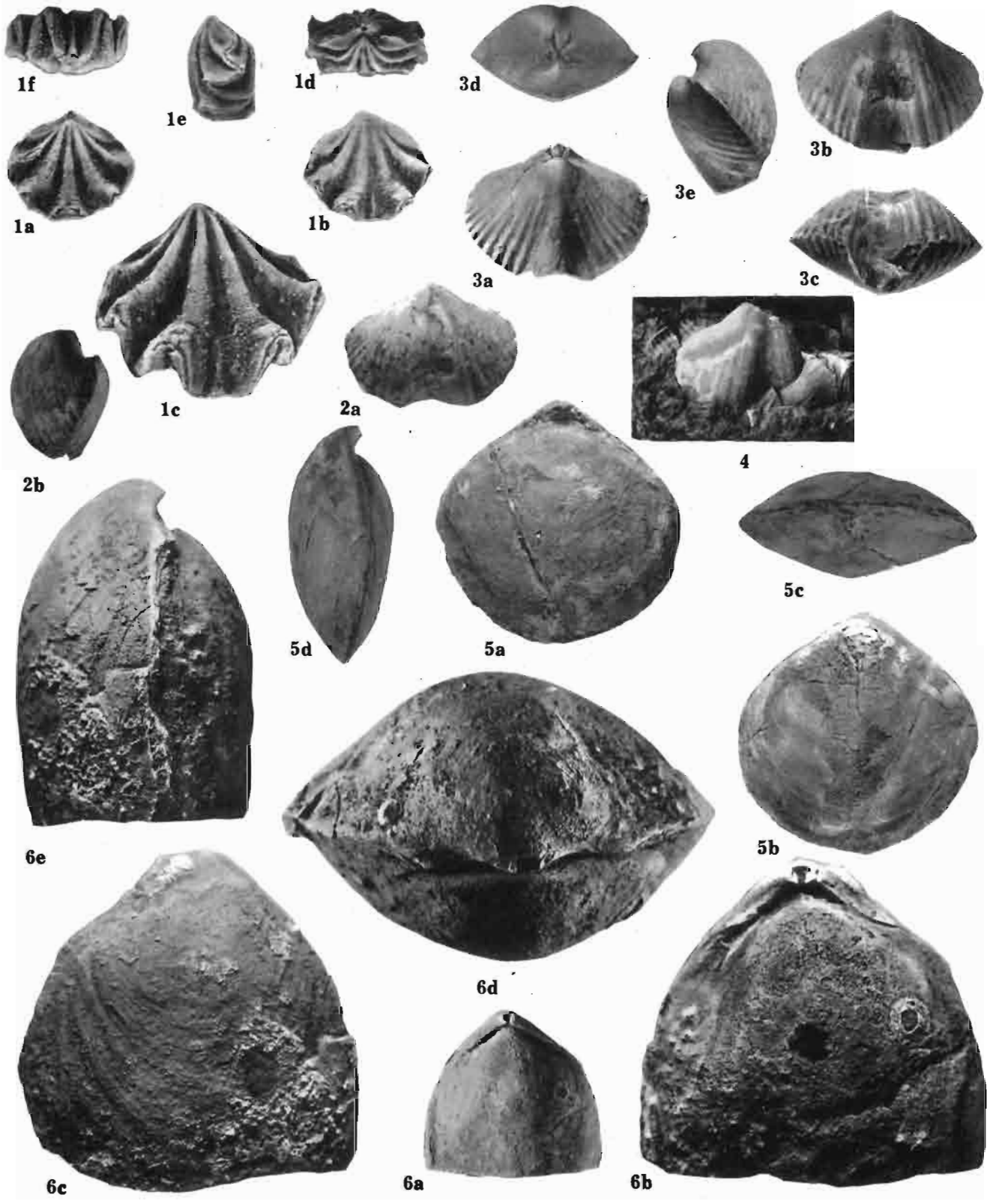
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PLATE XXIX

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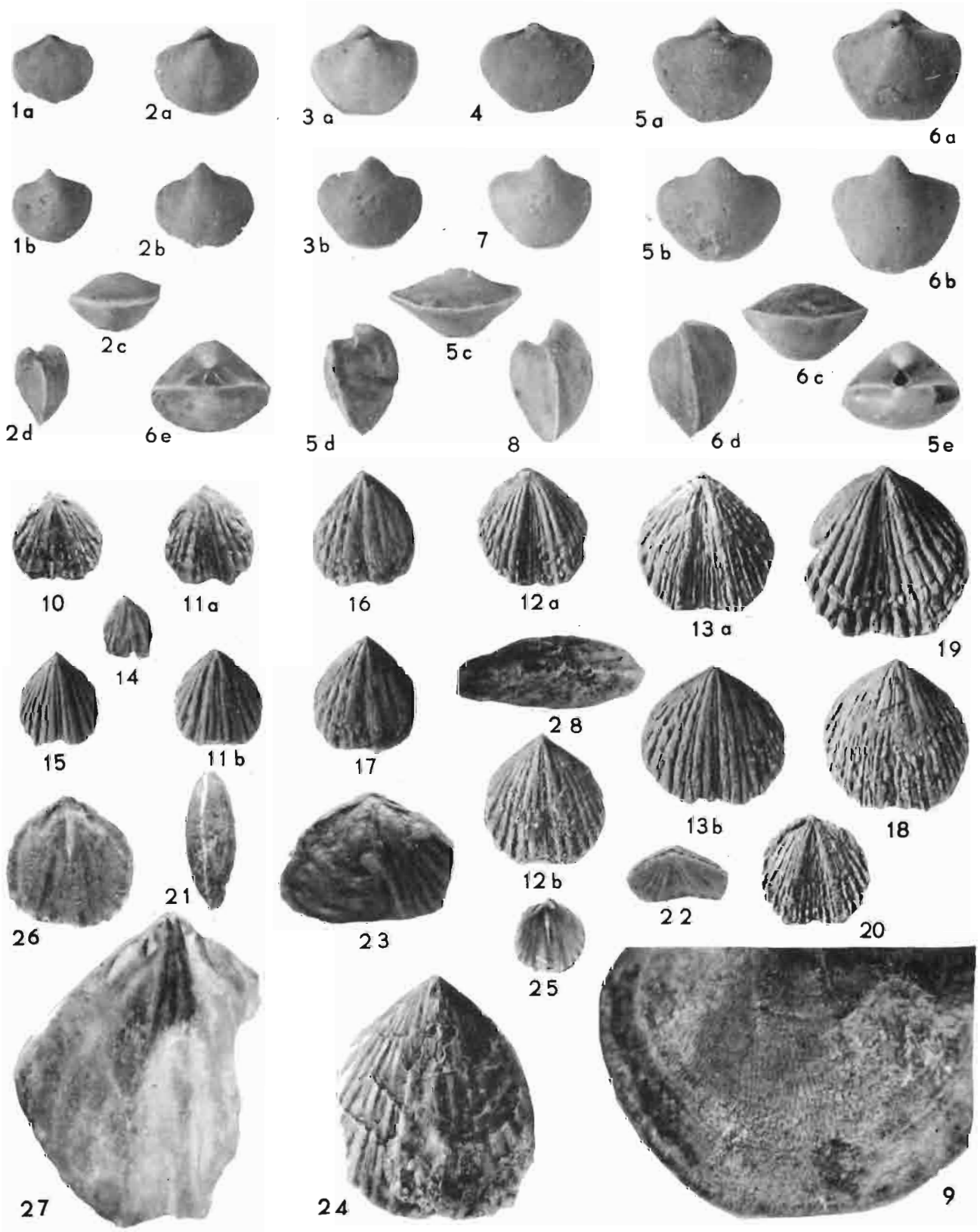
Crurithyris inflata (SCHNUR) 122
(Skały beds, marly shales, exposure 73)

Figs. 1-3, 5-6. Five specimens of different size in: *a* brachial valve, *b* pedicle valve, *c* anterior commissure, *d* side, *e* ventral area views (Bp. VII/759, 762, 765, 767, 768); × 4.
Figs. 4, 7, 8. Brachial valve view, pedicle valve view and side view of 3 different specimens (Bp. VII/768*m-o*); × 4.
Fig. 9. Surface spinosity; × 16.

Kayseria lens (PHILLIPS) 114
(Skały beds, marly shales, exposure 73)

Figs. 10-13. A range of different specimens in: *a* brachial valve, *b* pedicle valve views (Bp. VII/904, 908, 915, 130*a*); × 4.
Figs. 14-18. Pedicle valve view of 5 different specimens; × 4.
Figs. 19-20. Brachial valve view of 2 different specimens (Bp. VII/908, 915*a*); × 4.
Figs. 21-23. Side view and two posterior part views of 3 different specimens (Bp. VII/915*g-i*); × 4.
Fig. 24. Pedicle valve view of adult specimen (Bp. VII/921); × 5·5.
Figs. 25-26. Two dorsal interiors (Bp. VII/3791, 3792); × 4.
Fig. 27. Ventral interior (Bp. VII/3793); approx. × 12.
Fig. 28. Side view of adult specimen (Bp. VII/915*k*); × 4.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G. BIERNAT: MIDDLE DEVONIAN BRACHIOPODS

PLATE XXX

Page

Eoreticularia aviceps (KAYSER) 128
(Skały beds, marly shales, exposure 72)

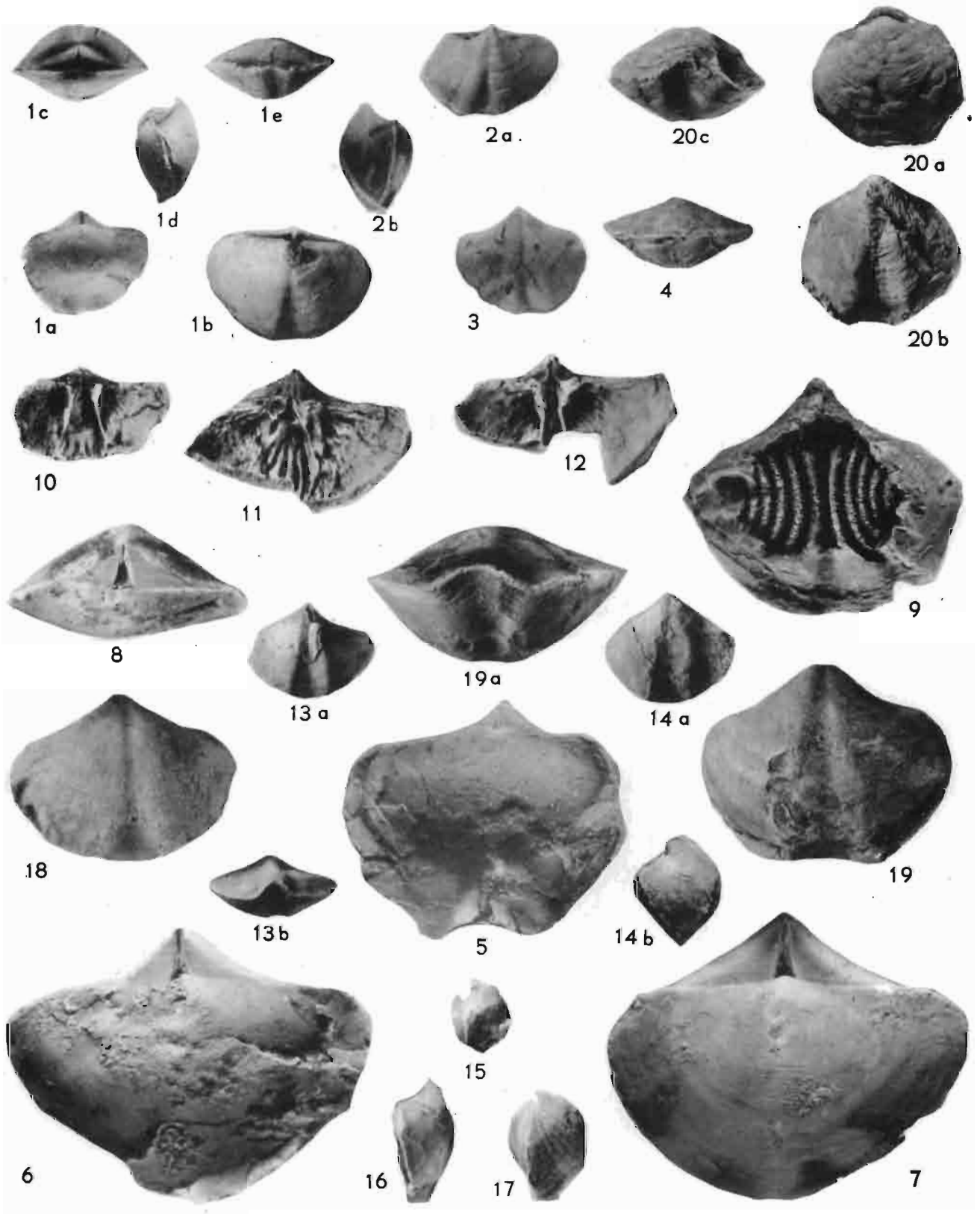
Figs. 1-2. Adult specimens in: *a* brachial valve, *b* pedicle valve, *c* ventral area, *d* side, *e* anterior commissure views (Bp. VII/4040, 4041); nat. size.
Figs. 3-4. Pedicle valve view and anterior commissure views of 2 different specimens (Bp. VII/4042, 4042*a*); nat. size.
Figs. 5-7. Brachial valve view of 3 different specimens (Bp. VII/4043-4045); × 3.
Fig. 8. Ventral area view of adult specimen (Bp. VII/4046); × 2.
Fig. 9. Adult specimens with partly exfoliated valve showing a fragment of brachidium (Bp. VII/4047); × 1·6.
Figs. 10-12. Three ventral interiors (Bp. VII/4048-4050); × 1·6.

Eoreticularia eifeliensis (FRECH) 126
(Skały beds, marls, exposure 84)

Figs. 13-14. Two different specimens in: *a* pedicle valve view, *13b* anterior commissure view, *14b* side view (Bp. VII/4051, 4052); slightly enlarged.
Figs. 15-17. Side view of 3 different specimens (Bp. VII/4053-4055); slightly enlarged.
Figs. 18, 19, 19*a*. Three different specimens, *18*, *19* pedicle valve view, *19a* anterior commissure view (Bp. VII/4057, 4058, 4058*a*); × 2.

Athyris cf. *ventrosa* (SCHNUR) 144
(Skały beds, marls, exposure 84)

Fig. 20. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* anterior commissure views (Bp. VII/4056); × 2.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14b
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PLATE XXXI

Page

Athyris concentrica (v. BUCH) 143
(Skały beds, marls, exposure 84)

Fig. 1. Brachial valve view of small specimen (Bp. VII/1401); × 3.
Fig. 2. Different specimens in: *a*, *d* brachial valve, *b* anterior margin, *c* side views (Bp. VII/1400); *a-c* approx. × 3, *d* × 6·5.

Meristella sp. 11
(Skały beds, exposure 89)

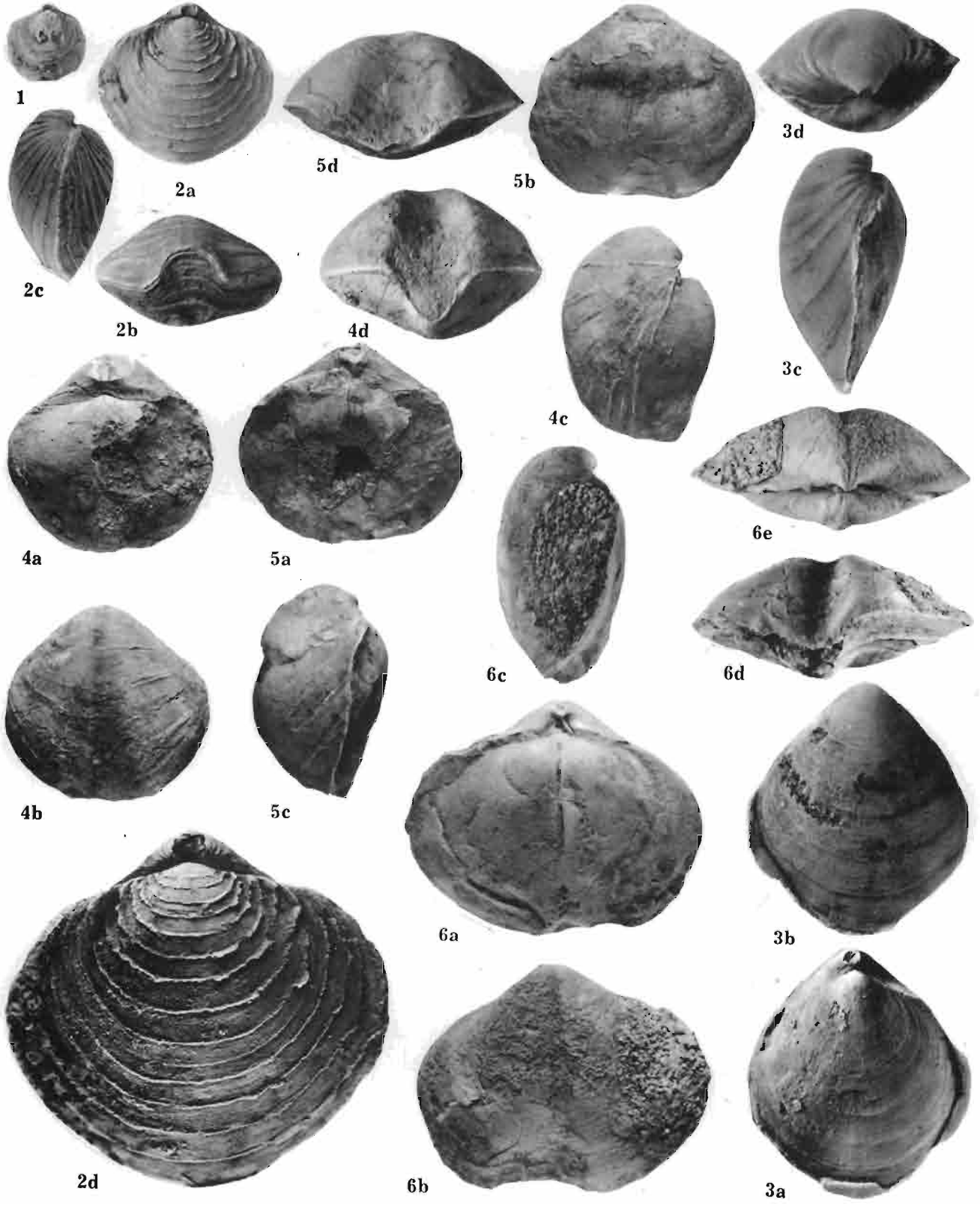
Fig. 3. Well preserved specimen in: *a* brachial valve, *b* pedicle valve, *c* side, *d* ventral umbo views (Bp. VII/3780); × 3.

Minatothyris maureri (HOLZAPFEL) 132
(Skały beds, shales, exposure 89)

Figs. 4, 5. Two specimens in: *a* brachial valve, *b* pedicle valve, *c* side, *d* anterior margin views (Bp. VII/1043, 1044); nat. size.

Minatothyris sp. cf. *Minatothyris concentrica* (SCHNUR) 133
(Skały beds, limestone, Miłoszów)

Fig. 6. Adult specimen in: *a* brachial valve, *b* pedicle valve, *c* side, *d* anterior commissure, *e* ventral beak views (Bp. VII/1045*a*); nat. size.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2d
6b
3a

G. BIERNAT: MIDDLE DEVONIAN BRACHIOPODS

PLATE XXXII

Page

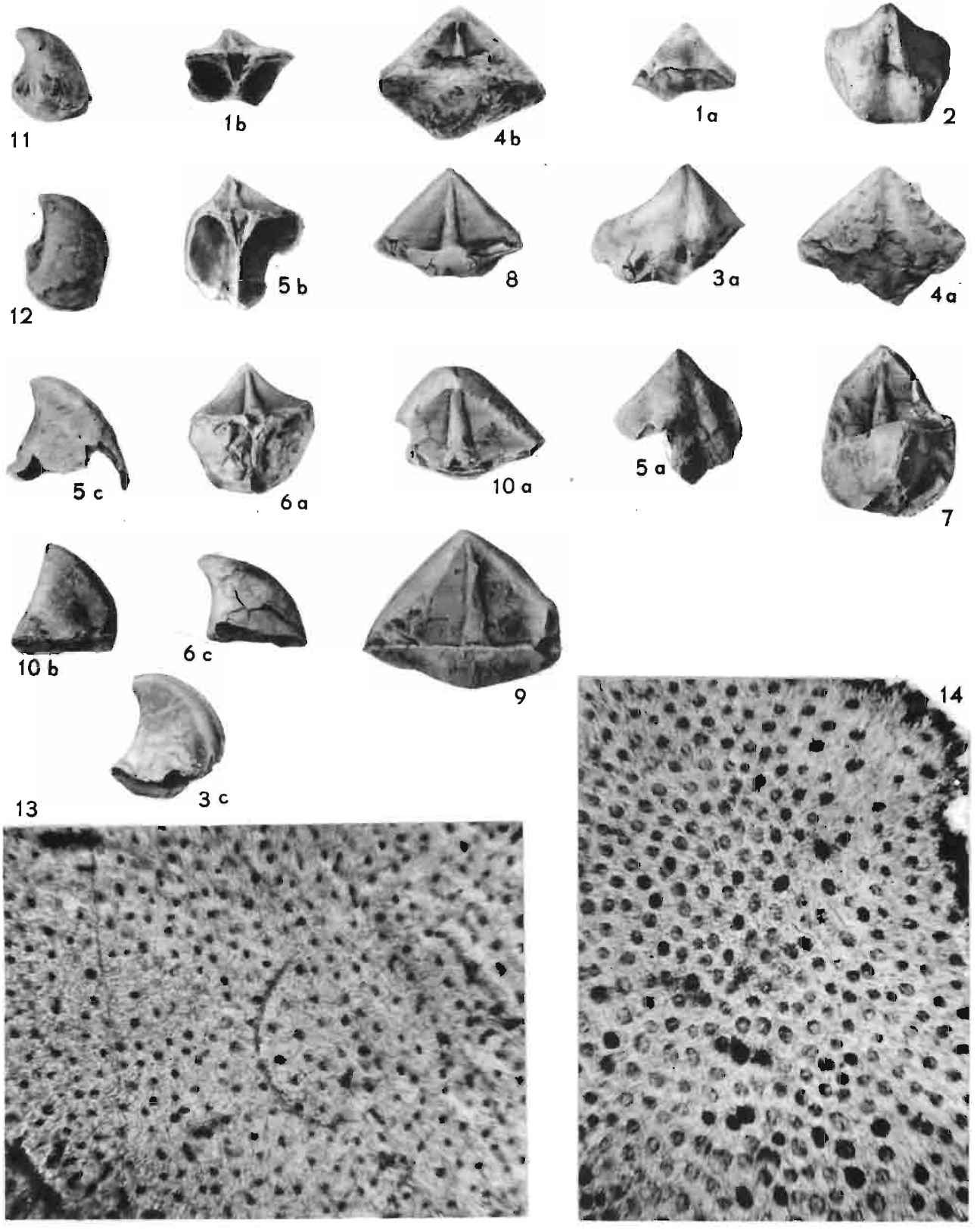
Squamulariina parva (GÜRICH) 136
(Skały beds, marly shales, exposure 84)

Fig. 1. Partly preserved pedicle valve in: *a* external view, *b* internal view (Bp. VII/3836); × 2.
Fig. 2. Pedicle valve view of specimen (Bp. VII/653); × 2.
Figs. 3-6. Well preserved specimens in: *a* pedicle valve, *b* ventral interior, *c* side views (Bp. VII/3837, 3835, 3839); × 2.
Fig. 4. Adult specimen in: *a* pedicle valve, *b* ventral area views (Bp. VII/3838); × 2.
Figs. 7-9. Ventral area view of 3 specimens (Bp. VII/3740, 3742, 652); × 2.
Fig. 10. Adult specimen in: *a* ventral area, *b* side views (Bp. VII/3742); × 2.
Figs. 11, 12. Side view of two specimens (Bp. VII/3743, 651); × 2.
Fig. 13. Thin slide of the valve with punctae; approx. × 100.

Cyrtina heteroclita intermedia OEHLERT 133
(Skały beds, marly shales, exposure 73)

Fig. 14. Thin slide of the valve showing a punctate shell; approx. × 100.

(See also Plate XXIII)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3c
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