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BRACHIOPODS AND CONODONT BIOSTRATIGRAPHY OF THE FAMENNIAN FROM THE DĘBNIK ANTICLINE, SOUTHERN POLAND

(RAMIENIONOGI I BIOSTRATYGRAFIA KONODONTOWA FAMENU ANTYKLINY DĘBNIKA, POŁUDNIOWA POLSKA)

by

ANDRZEJ BALIŃSKI

(WITH 24 TEXT-FIGURES AND 22 PLATES)

WARSZAWA 1995

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BRACHIOPODS AND CONODONT BIOSTRATIGRAPHY OF THE FAMENNIAN FROM THE DĘBNIK ANTICLINE, SOUTHERN POLAND

ANDRZEJ BALIŃSKI

Baliński, A. 1995. Brachiopods and conodont biostratigraphy of the Famennian from the Dębnik anticline, southern Poland. — *Palaeontologia Polonica* **54**, 3–88.

Thirty-nine brachiopod species are described from the Famennian of the Dębnik anticline. Two brachiopod genera, *Iloerhynchus* and *Minirostrella*, and eight species proposed are new. The new species are *Mesoplica*? *costata*, *Iloerhynchus mesoplicatus*, *Minirostrella rara*, *Cavatisinurostrum longilinguis*, *Athyris area*, *Cyrtospirifer carinatus*, *Dmitria gibbosa*, and *Cyrtiorina*? *depressa*. Fourty-nine conodont species and subspecies are tabulated and illustrated. One new conodont species, *Polygnathus rarus*, is proposed. Eight new brachiopod intervals are defined as local informal biostratigraphic units.These are the *Iloerhynchus mesoplicatus*, *Cyrtospirifer wesgensis*, *Dimitria gibbosa*, *Cavatisinurostrum longilinguis*, *Cyrtiorina*? *depressa* and *Sphaenospira*? sp. intervals. They are based on clearly-defined brachiopod assemblages and correlated with the standard conodont zones and local lithostratigraphic units. The succession of brachiopod faunas and conodont biofacies in the Upper Devonian of the Dębnik anticline and the sequence of events are as follows. The earliest Late Devonian transgressive pulse drowned the extensive Middle Devonian carbonate platform of southern Poland. During the *Plionoptycherhynchus cracoviensis* Zone, the brachiopod faunas were at the most diverse in the whole Frasnian (20 species) and dominant conodont biofacies have polygnathid-icriodontid to palmatolepid-polygnathid assemblages. The Frasnian sequence terminates with the *Caryorhynchus tumidus* Zone which marks the beginning of stagnant and poorly-oxygenated water conditions. Conodont assemblages were dominated by palmatolepids and polygnathids. Following the Frasnian-Famennian biotic crisis, the brachiopods become less abundant and diverse and consist of a few, mainly dwarf, forms. The lowest Famennian (*Orbiculatisinurostrum laeve* Zone through *Cyrtospirifer brodi* interval) was deposited under poorly oxygenated bottom conditions. Higher, in the *Cyrtospirifer wesgensis* interval, a strong regressive pulse in the basin is observed. In the *Dmitria gibbosa* interval a transgressive event occurred which terminated basinal anoxia. Brachiopods were diverse (13 species). In the *Cavatisinurostrum longilinguis* interval, the brachiopods flourished (14 species). Conodont biofacies indicate a probable maximum for the Famennian transgression. A sea-level drop and more turbulent conditions occurred in the *Cyrtospirifer carinatus* interval. In the *Cyrtiorina*? *depressa* interval, brachiopods and conodonts became rare and less diverse and laminar stromatoporoids reappear. In the uppermost Famennian, represented by *Sphaenospira*? sp. interval, brachiopods are extremely rare and massive stromatoporoids are the most characteristic feature.

K e y w o r d s: brachiopods, conodonts, taxonomy, biostratigraphy, faunal successions, Devonian, Poland.

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CONTENTS

INTRODUCTION

The Polish Upper Devonian was deposited in the proximal part of an intracratonic basin trending NW-SE and varying from 150 to 600 km in width (NARKIEWICZ 1985; NARKIEWICZ and HOFFMAN 1989). The basin was bordered on the north and east by the Belorussian and Ukrainian uplifts of the East European Platform and on the south by pre-Carpathian Land. On the west and south-west, it merged with the deeper basin of the Moravo-Silesian part of the Variscan trough (NARKIEWICZ and HOFFMAN 1989).

The Devonian rocks in the vicinity of Dębnik represent the southern facies of this epicontinental basin and were deposited near the pre-Carpathian Land. They are part of a relatively small anticline that is connected structurally with the north-eastern margin of the Upper Silesian Coal Basin. The anticline is modified by faults and originated as results from a magma intrusion (ZAJĄCZKOWSKI 1968). The outcrops of the Devonian near Dębnik are usually small and poorly exposed and are limited to an isolated area, about 3 km square, in the center of which the village of Dębnik is located (Text-fig. 1). Nevertheless, the outcrops are very important in understanding the geology of Poland and have been recognized in the literature since ROMER (1863) (for a review see SIEDLECKI 1954; NARKIEWICZ and RACKI 1984).

In recent decades, several papers have been published on the Devonian of Dębnik, a stratigraphic interval which used to be neglected by geologists and paleontologists. Several collections of fossil groups have been studied and results have been published by NOWIŃSKI (1976) on Tabulata, BALIŃSKI (1977, 1979, 1980, 1990, 1993) on Brachiopoda and Conodonta, and RACKI and BALIŃSKI (1981) on Brachiopoda. In addition, lithostratigraphic divisions have been proposed for the Devonian of the Dębnik anticline (ŁAPTAŚ 1982; NARKIEWICZ and RACKI 1984, 1987). Facies development of the Devonian has been analyzed against a broader historical background of the shelf basin in southern Poland (RACKI and BALIŃSKI 1981; NARKIEWICZ and RACKI 1985; NARKIEWICZ 1988, 1987; NARKIEWICZ and HOFFMAN 1989).

The main scope of this report is a detailed taxonomic re-examination of the brachiopods from the Famennian of the Dębnik anticline. The brachiopods, as well as other fossils from the area, were previously described by GÜRICH (1903) in his thorough monograph "Das Devon von Dębnik bei Krakau". In 1979, the present author published the results of his re-examination of the Frasnian brachiopods from Dębnik together with a biostratigraphic framework based on conodonts (BALIŃSKI 1979). This report now describes the Famennian brachiopod fauna and conodont biostratigraphy and concludes the revision of the Upper Devonian brachiopods from the Dębnik anticline.

The taxonomic overview of brachiopods in the present paper has been combined with a biostratigraphical analysis of associated conodonts. This has permitted reconstruction of the succession of brachiopod assemblages in the Upper Devonian of Dębnik and their correlation with global and local biological events.

Acknowledgements. — The author expresses his warmest thanks to Professor Gertruda BIERNAT (Institute of Paleobiology, Warsaw) for her interest in the study and for critically reading the manuscript. Special thanks go to Dr. Ed LANDING (New York State Geological Survey, Albany, N.Y.) for his editorial help and improvement of English of final version of the typescript. I am also grateful to Dr. Grzegorz RACKI (Silesian University, Sosnowiec) for his constructive discussions.

ABBREVIATIONS USED

Lvv	— length of pedicle valve
Ldv	— length of brachial valve
W	— width of shell
T	— thickness of shell
lAr/W%	— length of cardinal margin index
HArvv	— height of the interarea of pedicle valve
Aa°	— apical angle
Nr/su	— number of costae on sulcus
Nr/fo	— number of costae on fold
Nr/fl	— number of costae on flanks
Wsu/W%	— width of sulcus index
lt	— length of tongue of pedicle valve
wfo	— width of fold at the anterior margin

GEOLOGICAL SETTING

NORTHERN OUTCROPS

In the northern limb of the Dębnik anticline, there are only a few, typically very poor outcrops of the Famennian (Text-figs 1–2). The oldest Famennian limestone containing a poor brachiopod assemblage was excavated on the eastern slope of Boża Męka hill (trench Żar-4). A rich brachiopod fauna was collected from a somewhat younger limestone at locality Pałkowa Góra (PG). The youngest Famennian deposits yield very scarce brachiopods and crop out between the Rokiczany and Żarnówczany Dół ravines. (This youngest Famennian is known as Stromatoporoid Rock).

Trench Żar-4 (Text-fig. 1C)

This is a small pit dug near a dirt road that leads from Dębnik to Paczółtowice and runs on the eastern slope of Boża Męka hill. A few weathered, thin layers which crop out there consist of light gray-brown micrites and yield a poor brachiopod fauna characteristic of the *Iloerhynchus mesoplicatus* interval. They represent the middle part of the Platy Limestone unit (lithostratigraphic units after NARKIEWICZ and RACKI 1984).

Pałkowa Góra (PG, Text-fig. 1C)

The latest information confirming the existence of a small quarry known as Pałkowa Góra is found in GÜRICH (1903). RUTKOWSKI (1928: 634) did not find the outcrop and stated that it had been filled in and plowed over. In this study, an interesting and relatively rich brachiopod fauna was collected from loose blocks dug up in a dirt road near the upper end of Żarnówczany Dół ravine (locality PG). This site is the only one in the northern part of the Dębnik anticline where the brachiopod species described by GÜRICH from Pałkowa Góra can be found. The most characteristic brachiopods of the blocks are *Cavatisinurostrum longilinguis* sp. n., *Eobrachythyris palkowae* (GÜRICH), *Dmitria globosa* (GÜRICH) and *D. angustirostris* (GÜRICH). In addition, *Schizophoria* sp., *Athyris area* sp. n., *A. tau* NALIVKIN, *Cyrtospirifer* sp., and fragments of lingulids are present. Other elements of the fauna include remnants of holothuroids, crinoids, ostracods, and fish remains.

The lithology containing this fauna represents the Grained and Micritic Limestone unit (Text-fig. 3). Relatively numerous conodonts (see Table 2) represent the Middle or Upper *P. crepida* Zone.

Stromatoporoid Rock (SS, Text-fig. 1C)

This natural outcrop is located on the western side of Racławka river valley and between the mouths of two ravines, Rokiczany Dół and Żarnówczany Dół (Text-fig. 1C). This locality and the fauna occurring there (which consists mainly of stromatoporoids and brachiopods) were described in detail by GÜRICH (1904) and JAROSZ (1918). The latter author described, among others, three new brachiopods from the locality: *Productus suprafamenniensis* (JAROSZ 1918: 93–95, Pl. 7: 6–6a), *Productus (Productella?)* sp. n. (*ibidem*: 96–97, Pl. 7: 9–9b), and *Camarophoria (Leiorhynchus) crenulata* GOSSELET var. *minor* (*ibidem*: 106–107, Pl. 8: 21–22). These were poorly illustrated and fragmentarily preserved forms, however, and cannot be recognized in the present collections. At present, a few isolated, partially overgrown outcrops of unbedded or poorly bedded, light bio-intrasparite with very rare and very poorly preserved brachiopods are present. The brachiopods include *Sentosia* sp., rhynchonellacean gen. et sp. indet. and *Sphaenospira*? sp. The most interesting part of this limestone, however, is the occurrence of numerous colonies of *Stromatoporella cracoviensis* GÜRICH (GÜRICH 1904). According to NARKIEWICZ and RACKI (1984), these limestone represent the upper part of the Grained and Micritic Limestone unit. Absence of biostratigraphically valuable forms makes it impossible at present to determine the exact age of this unit. It probably lies in the upper part of the Famennian and evidently above the *P. rhomboidea* conodont Zone.

SOUTHERN OUTCROPS

There are no natural outcrops of the Famennian in the southern limb of the Dębnik anticline. As part of the search for Famennian brachiopods, 34 trenches were dug, mostly in the eastern slope of Żbik ravine. These trenches run from north to south through the forest (Text-fig. 1D–E). A few old, small quarries and pits were encountered but these are partially filled up and overgrown and did not supply useful collections of brachiopods.

Trenches Z-8 to -9 (Text-fig. 1E)

These were dug east of the Żbik ravine at locations 50 m (Z-8) and 120 m (Z-9) west of the road that leads from Dębnik to Siedlec. Thin-bedded, dark micrites were exposed, which are similar to those from the uppermost part of section Z-2. They yield rare brachiopods of a fauna characteristic of the *Iloerhynchus mesoplicatus* interval: *Minirostrella rara* gen. et sp. n., *Iloerhynchus mesoplicatus* gen. et sp. n., *Colophragma* sp., and *Cyrtospirifer minor* (GÜRICH). The layers represent the Platy Limestone unit.

Trenches Z.bis-1 to -4 (Text-fig. 1E)

These trenches were dug on the east slope of Żbik ravine at its upper end. Three of them cut through Quaternary deposits and reached the Famennian limestones. Medium-bedded, dark-gray marly micrites exposed in the trenches yield rare brachiopods that represent only a few species: *Nigerinoplica* sp., *Cyrtospirifer brodi*, and fragments of lingulids. The associated fauna is represented by scarce holothuroids, ophiuroids, and conodonts (samples Z.bis-1 to -2 and -4). JAROSZ (1926) was the first to find the locality and to give a list of brachiopods derived from it. He mistakenly identified a cyrtospiriferoid characteristic of these limestones as *Spirifer Archiaci* var. *bisellata* GÜRICH (=*Cyrtospirifer bisellatus*) which is now considered an important index species for the lowermost part of the Frasnian (see BALIŃSKI 1979: 18–19, 65–66). In fact the present study proves that the cyrtospiriferoid in question is the lower Famennian species *Cyrtospirifer brodi* WENJUKOV. Conodonts from samples Z.bis-1 to -2 and -4 are very rare but confirm a Famennian age and permit a more precise correlation of the limestones with the *P. triangularis* Zone. The layers exposed here are correlated lithostratigraphically with the Platy Limestone unit.

Trenches Z.tent-1 to -3 (Text-fig. 1E)

These trenches are located on the east slope of Żbik ravine and approximately 250 m to the south of trenches Z.bis-1 to -3. The layers exposed here consist of a thin-bedded, dark-gray, sandy limestone that is very poor in fossils. Accumulations of many disarticulated specimens do occur, however, in trenches 1 and 3. They belong to *Nigerinoplica* sp., *Sentosia profunda* MCKELLAR, and *Cyrtospirifer wesgensis* ZHEIBA. A few specimens of conodonts were found in sample Z.tent-3 (see Table 1) and represent the *P. triangularis* Zone (probably the highest part).

JAROSZ (1926: 141–142, 145) erroneously referred to these layers as equivalents of the much younger Stromatoporoid Rock on the basis of misidentified brachiopods. However, the limestones in these trenches belong to the Platy Limestone unit.

Trench Z.orb-9 (Text-fig. 1E)

The trench was located ca. 120 m south of trenches Z.tent-1 to -3. The rock exposed here is very similar to that described above from trenches Z.tent-1 to -2 but is more weathered and lighter in color. Only a few poorly preserved specimens of *Centrorhynchus* cf. *letiensis* (GOSSELET) have been found. Conodonts were not recovered, but the layers may represent the upper part of the *P. triangularis* Zone or the lower part of the *P. crepida* Zone. Lithostratigraphically, the layers represent the highest part of the Platy Limestone unit.

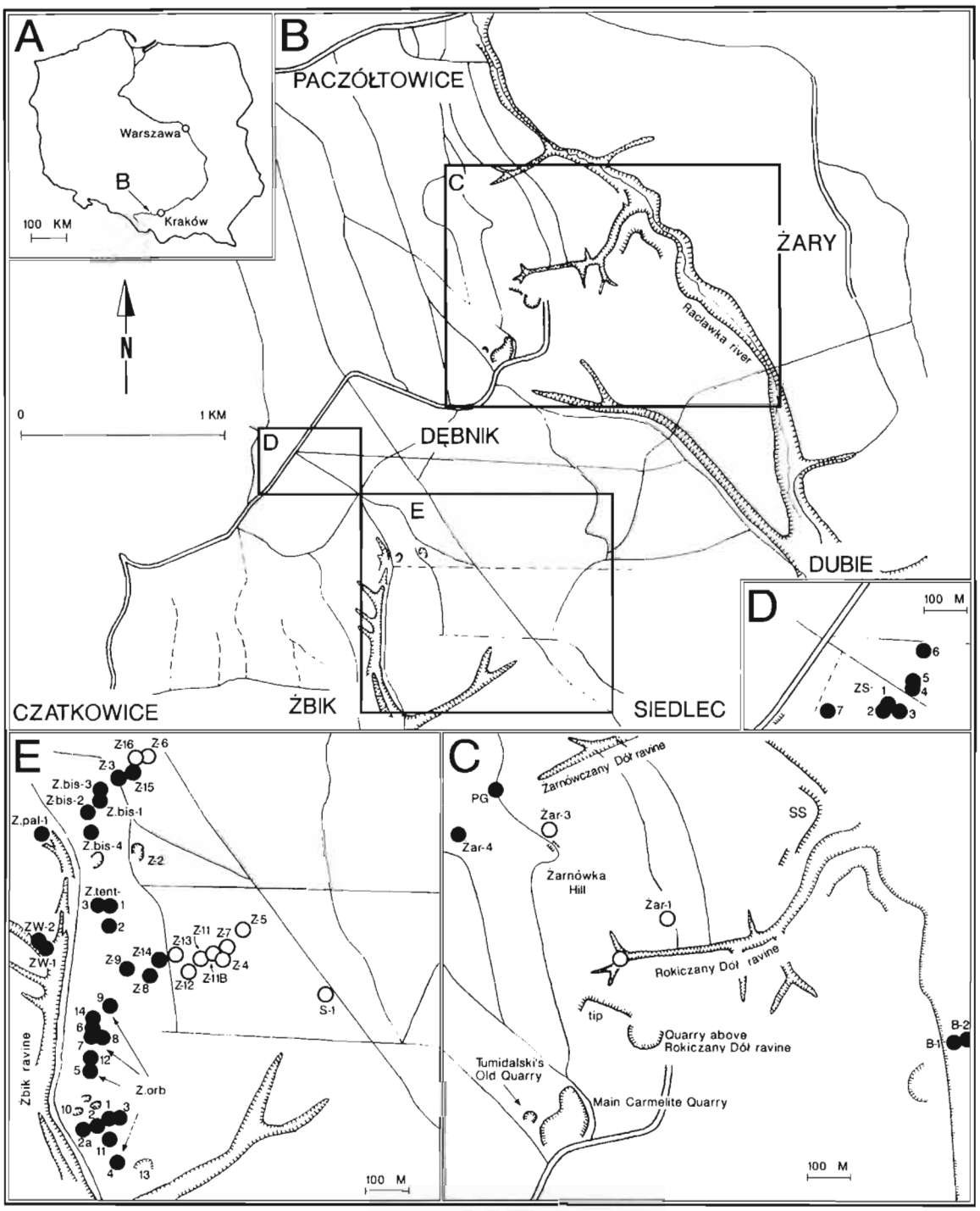

Fig. 1.
General map of Poland (A) and sketch-map of the Dębnik area (B) enclosing sectors C, D and E studied in details and showing the collection site of brachiopods and conodonts. Light circles denote Frasnian and dark circles Famennian trenches (after BALIŃSKI 1979, modified). Abbreviations in text.

Trenches Z.orb-6 to -8 and -14 (Text-fig. 1E)

These trenches were located on the steep eastern slope of Żbik ravine about 50 m south-west of Z.orb-9 and exposed gray, medium-bedded bio-micrites with crinoids, echinoids, ostracods, scoleco-

donts, bryozoans, algae (*Solenopora*), and conodonts (see Table 2). Brachiopods are mainly represented by *Ptychomaletoechia* sp., *Cyrtospirifer* cf. *acutus* (NALIVKIN), *Cyrtiopsis famenniane* (PAECKELMANN), and *Dmitria gibbosa* sp. n. These limestones, which were not noted by earlier students of this area, represent the Lower or Middle *P. crepida* conodont Zone and can be assigned to the lowest part of the Grained and Micritic Limestone unit.

Trenches Z.orb-5 and -12 (Text-fig. 1E)

Trench Z.orb-12 was dug about 60 m south of Z.orb-8, and trench Z.orb-5 was dug 20 m further to the south of Z.orb-12. Medium-bedded, gray limestone was exposed, which is similar to that from locality PG and represents the Grained and Micritic Limestone unit. Brachiopods that occur here are dominated by *Eobrachythyris palkowae* (GÜRICH). Other faunal elements are represented by remains of fishes, holothuroids, sponges, and gastropods. Conodonts allow exact correlation of the layers with the Middle *P. crepida* Zone.

Quarry Z.orb-10 (Text-fig. 1E)

This locality lies close to the road that runs near the bottom of Żbik ravine and is known in the earlier literature as "old quarries" (JAROSZ 1926). It is poorly exposed and filled up at present. Medium-bedded, light-gray limestone from the locality did not yield brachiopods, and new trenches (Z.orb-1 to -2a) were dug close by to study this part of the section in detail (see below). Conodont sample (Z.orb-10; see Table 2) allowed correlation of the interval with the Middle or Upper *P. crepida* Zone (the Grained and Micritic Limestone unit).

Trenches Z.orb-1 to -2a (Text-fig. 1E)

These trenches were dug in the eastern slope of Żbik ravine, about 12 m south of locality Z.orb-10. Medium-bedded, gray bio-pelmicrites with oncoids yielded an interesting brachiopod assemblage dominated by *Mesoplica costata* sp. n., *Evanescirostrum seversoni* (MCLAREN), *Athyris sulcifera* (NALIVKIN), and *Cyrtospirifer carinatus* sp. n. JAROSZ (1926: 142–143, 149) erroneously referred these layers to the uppermost Famennian and regarded them as boundary beds between the Devonian and Carboniferous. He also mistakenly claimed that they are younger than "Stromatoporoid Rock" from the western slope of Racławka valley. However, the layers represent the lower part of the Grained and Micritic Limestone unit.

Trench Z.orb-11 (Text-fig. 1E)

This excavation was situated 15 m south of Z.orb-1. Medium-bedded, gray micritic limestones represent the lower part of the Grained and Micritic Limestone unit and yield rare crinoids, nautiloids, and unrecognizable fragments of productids and spiriferoids. Conodonts refer the layers to the Uppermost *P. crepida*, or the Lower *P. rhomboidea* Zones.

Quarry Z.orb-4 (Text-fig. 1E)

This exposure was situated at the end of the eastern slope of Żbik ravine and about 35 m south of Z.orb-11. Thick-bedded, light-gray limestone at this locality are referable to the Grained and Micritic Limestone unit but did not yield recognizable brachiopods. The residue of a conodont sample taken from the limestone yielded fragments of gastropods, ophiuroids, holothuroids, crinoids, and scolecodonts. Conodonts determine a correlation of the limestone with the Lower *P. rhomboidea* Zone.

Trench Z.pal-1 (Text-fig. 1E)

This trench was dug in the western slope of Żbik ravine just opposite trenches Z.bis-1 and -2. Medium-bedded, light-gray bio-pelmicrites referred to the lower part of the Grained and Micritic Limestone unit yield a complex brachiopod assemblage characteristic of the interval from Pałkowa Góra. The assemblage is dominated by *Cavatisinurostrum longilinguis* sp. n., *Loborina lobata* BALIŃSKI, *Athyris area* sp. n., *Dmitria globosa* (GÜRICH), and *Eobrachythyris palkowae* (GÜRICH). A rich

fauna is present in conodont sample residues and consists of bryozoans, gastropods, pelecypods, nautiloids, annelids (*Spirorbis*), ostracods, crinoids, echinoids, holothuroids, ophiuroids, ophiocystoids, and sponges. Numerous conodonts indicate the Middle *P. crepida* Zone.

Trenches ZW-1 to -2 (Text-fig. 1E)

These excavations in the western branch of Żbik ravine were opposite of trenches Z.tent-1 to -3. The two trenches exposed medium-bedded, gray bio-pelmicrites (lower part of the Grained and Micritic Limestone unit) which contain *Cyrtospirifer carinatus* sp. n. as the characteristic brachiopod. Conodonts indicate the Lower to Upper *P. crepida* Zone (ZW-2) and the Upper *P. crepida* to Lower *P. rhomboidea* Zone (ZW-1), respectively. This part of the section was first described in brief by JAROSZ (1926: 142, Tab. 1: 9a).

Trench ZS-6 (Text-fig. 1E)

This trench was dug south-west of Dębnik near a road that runs from west to east through a forest, about 200 m east of a main road that leads from Dębnik to Czatkowice. It exposed limestones correlative with those from trenches Z.orb-1 to -2a (the Lower *P. rhomboidea* Zone; the lower part of the Grained and Micritic Limestone unit). Brachiopods are rare and represented by *Mesoplica costata* sp. n., *Athyris sulcifera*, and *Cyrtospirifer carinatus* sp. n. This locality is not noted in earlier studies on the area.

Trench ZS-5 (Text-fig. 1D)

This excavation was located about 100 m south of ZS-6 and did not expose bedrock. A few loose blocks yielded a poor conodont fauna that indicates the Lower *P. rhomboidea* Zone.

Trenches ZS-1 to -3 (Text-fig. 1D)

These excavations were located 0.7 km south-west of Dębnik, and about 30 m south of a gravel road that branches from the main road to Siedlec. Trenches ZS-1 and -2 were dug by geologist W. ZAJĄCZKOWSKI and were later reopened by the present author. Trench ZS-3, which was dug 14 m east of trench ZS-1 exposed limestone with very rare specimens of *Cyrtiorina? depressa* sp. n. and conodonts that indicate the Lower to Upper *P. rhomboidea* Zone. Thin-bedded, gray bio-pelsparites exposed in trenches ZS-1 and -2 yielded rare brachiopods such as *Eoschuchertella* sp., *Mesoplica* cf. *praelonga* (SOWERBY), *M.* sp., *Leioproductus* cf. *pauperculus* COOPER *et* DUTRO, *Cyrtospirifer wesgensis* ZHEIBA, and *Cyrtiorina? depressa* sp. n. The associated fauna is composed of scarce ostracods, gastropods, crinoids, and laminar stromatoporoids. The conodonts indicate the Lower to Upper *P. rhomboidea* Zone. These layers represent lower part of the Grained and Micritic Limestone unit.

Locality ZS-7 (Text-fig. 1D)

This is an old pit that has not been mentioned in earlier literature. It is situated about 100 m east of the main road that leads from Dębnik to Czatkowice and about 120 m west of trench ZS-2. No brachiopods have been found in the bio-intrasparite exposed in the pit. The most characteristic feature of the limestone is the occurrence of massive stromatoporoids. Silicified gastropods occur sporadically. Conodonts are extremely rare and not significant biostratigraphically. It can be assumed that the exposed limestone may represent an interval from the Lower *P. marginifera* to Lower *P. expansa* Zone.

This very important locality is the only one in the southern part of the anticline where an equivalent of the "Stromatoporoid Rock" is exposed. This equivalent forms the middle part of the Grained and Micritic Limestone unit.

Trenches B-1 and B-2 (Text-fig. 1D)

These trenches were dug in the western slope of Racławka valley, 1 km east of Dębnik, near an old quarry called Marmurowa Góra. Trench B-2 was dug 30 m down the slope from B-1. Both trenches did not reach bedrock. Loose blocks which were excavated in both trenches consist of light bio-in-

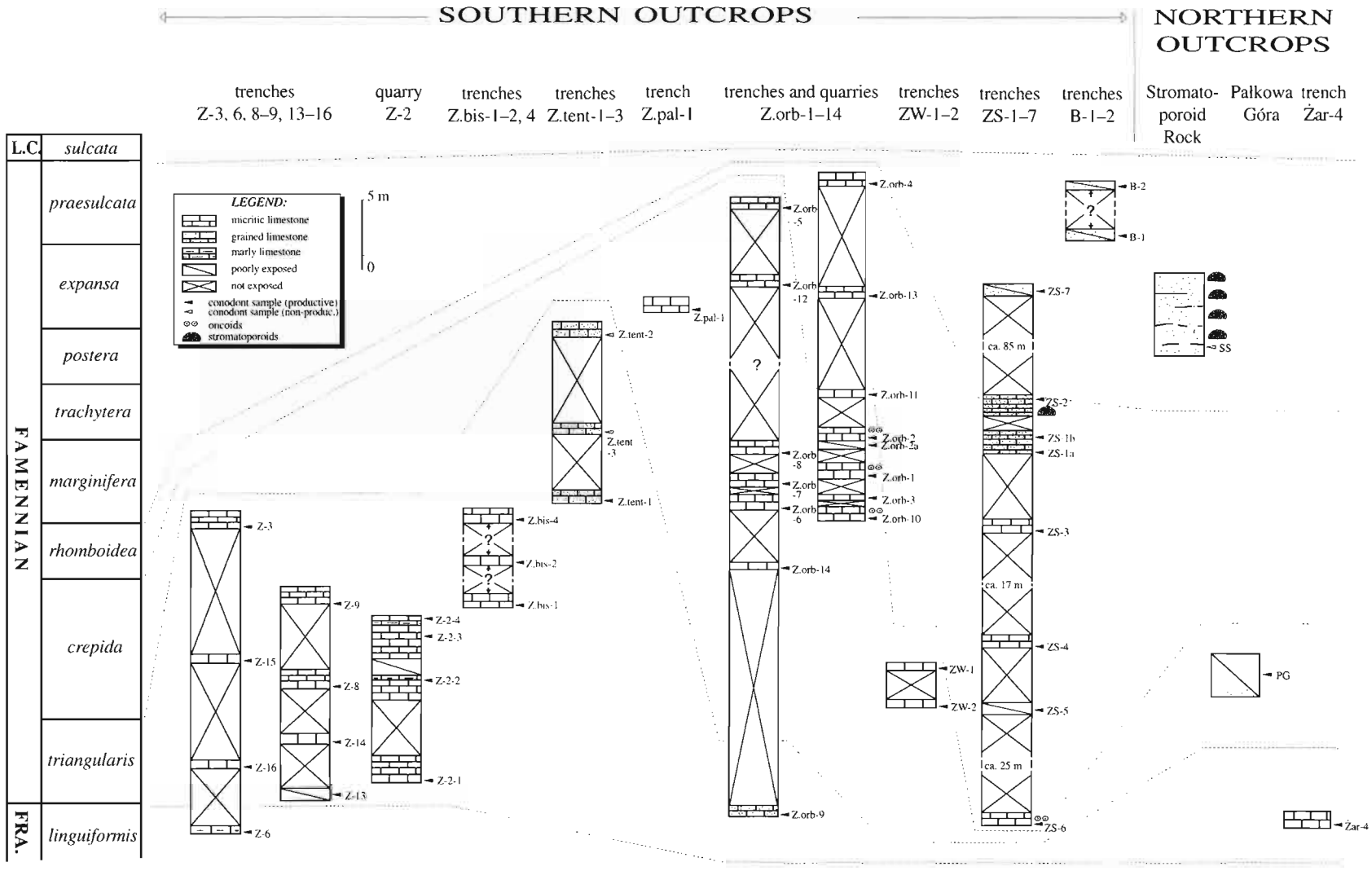

Fig. 2.
Correlated stratigraphic section of the Famennian rocks of the Dębnik anticline.

trasparite with very rare and crushed specimens of *Sphaenospira*? sp. Conodonts are very rare and probably indicate a reference to horizons younger than the Lower *P. expansa* Zone (see discussion in the description of the *Sphaenospira*? sp. interval). A conodont sample LB (see Table 1) was collected from a loose block of crinoid limestone found in proximity of trench B-1. It is evident that the limestones from the localities are referable to the upper part of the Grained and Micritic Limestone unit.

LOCAL BRACHIOPOD ZONES AND INTERVALS

In an earlier monograph on the Frasnian brachiopods from the Dębnik anticline, seven local brachiopod zones were established, and these were correlated with standard conodont zones (BALIŃSKI 1979). Recently, several major changes and decisions have been made concerning the Devonian standard conodont zonation and the position of chronostratigraphic unit boundaries (e.g., COWIE 1989; ZIEGLER and SANDBERG 1990). As a result the lowermost brachiopod zones erected in the Frasnian of Dębnik (i.e., the *Desquamatia (Seratrypa) oneidensis* Zone and the *Spinatrypina (Spinatrypina)* sp. Zone) should be now included into the Givetian. On the other hand, the redefinition of the Frasnian-Famennian boundary and its placement at the base of the Lower *P. triangularis* Zone means that the *Leiorhynchus laevis* (=*Orbiculatisinurostrum laeve*) brachiopod Zone should be now included wholly in the Famennian.

In this monograph, an attempt has been made to complement the Upper Devonian zonation on the basis of a brachiopod succession. However, unlike the earlier monograph (BALIŃSKI 1979), new biostratigraphic units are defined as informal, local brachiopod intervals following the concept of JOHNSON (1977). The newly established brachiopod intervals are based on clearly-defined brachiopod assemblages and are correlated with the standard conodont zones and lithostratigraphic units (Text-figs 2–3). The brachiopod intervals may have an important practical significance in stratigraphic analysis of the Upper Devonian in boreholes from the marginal zone of the Upper Silesian Coal Basin.

The general low frequency of conodonts in the studied section and frequent changes in the brachiopod assemblages (see Tables 1–2) mean that the brachiopod succession here allows a greater resolution than the zonation based on conodonts. It should be realized, however, that this does not indicate that brachiopods have a greater biostratigraphic significance but is due to their greater sensitivity to facies and bottom conditions. Nevertheless, in a given local area, brachiopod intervals may have greater practical stratigraphic resolution, especially when the conodont assemblages are very poor in species, as at Dębnik.

Orbiculatisinurostrum laeve Range Zone

Outcrops and boundaries. — This range zone was recognized and described in detail as the *Leiorhynchus laevis* Zone (BALIŃSKI 1979: 22). Recently, SARTENAER (1984) erected a new genus *Orbiculatisinurostrum* with *Leiorhynchus laevis* GÜRICH from Dębnik as the type species. Consequently, this zone should be renamed the *Orbiculatisinurostrum laeve* Zone.

Fauna. — The brachiopods characteristic of the zone are represented by *Barroisella campbelli*, *Lingulipora* sp., *Orbiculoidea* sp., *Praewaagenoconcha* cf. *speciosa, Orbiculatisinurostrum laeve* (index species), and *Cyrtospirifer minor*. Associated fauna elements include rare foraminifers, conodonts (see Table 2), and fish remains.

Age. — The conodont fauna, with *Icriodus alternatus*, *Palmatolepis triangularis*, *Polygnathus brevilaminus*, and *P. angustidiscus*, generally indicates the *P. triangularis* Zone (probably the lowermost part).

Remarks. — When the paper on the Frasnian brachiopods of the Dębnik anticline was published, the Frasnian-Famennian boundary was placed between the Lower and Middle *P. triangularis* Zone. Consequently, the *O. laeve* brachiopod Zone was correlated mainly with the uppermost Frasnian.

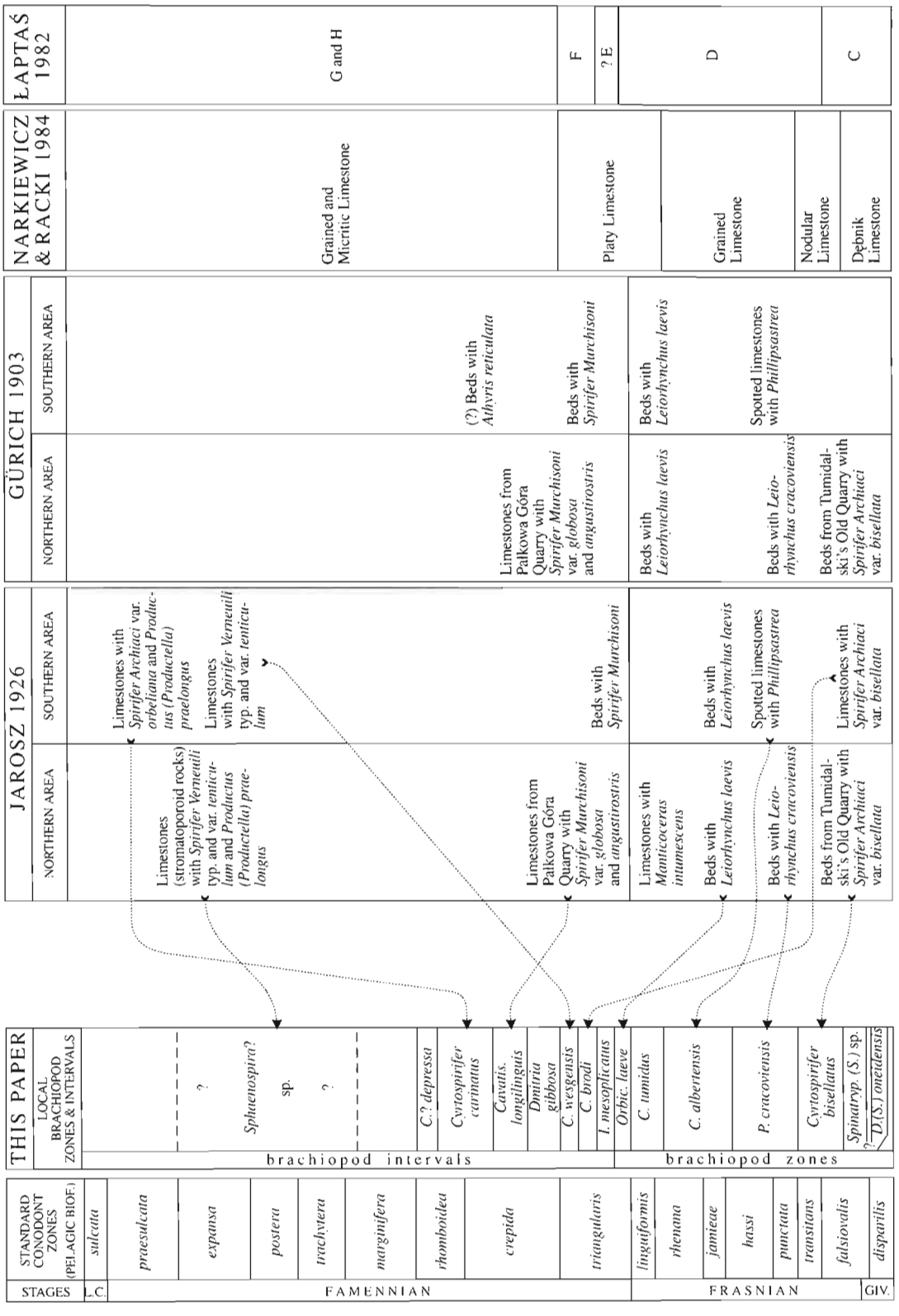

Fig. 3.

Correlation chart of GÜRICH's (1903), JAROSZ's (1926), ŁAPTAŚ's (1982), NARKIEWICZ and RACKI's (1984) and present autor's stratigraphic schemes of the Upper Devonian of the Dębnik anticline and conodont zonation (partially after BALIŃSKI 1979, modified).

However, the recent redefinition of the Frasnian-Famennian boundary (COWIE and ZIEGLER 1989) requires re-assignment of the entire *O. laeve* brachiopod Zone to the lowermost Famennian.

Iloerhynchus mesoplicatus interval

Outcrops and boundaries. — The layers representing the *I. mesoplicatus* interval were found in trenches Z-8 and Z-9 located to the south of Dębnik and in trench Żar-4 on the northern limb of the anticline. The uppermost 1 meter of the section of quarry Z-2 (see detailed description in BALIŃSKI 1979) also contains the fauna diagnostic for the interval.

The lower boundary of the *I. mesoplicatus* interval is defined by the lowest appearance of the index species and *Minirostrella rara* gen. et sp. n. The upper boundary is defined by the lower boundary of the succeeding *Cyrtospirifer brodi* interval.

Due to the lack of adequate outcrops of the *Iloerhynchus mesoplicatus* interval, it is impossible to establish precisely its thickness. It is estimated, however, at 30 m.

Fauna. — The brachiopods of the interval include *Iloerhynchus mesoplicatus, Minirostrella rara* gen. et sp. n., *Colophragma* sp., *Cyrtospirifer minor*, and fragmentary lingulids (Table 1). Holothuroids, fish remains, and conodonts (Table 2) are also present.

Age and correlation. — The interval contains brachiopod species which are known only from the study area. Some of them, however, display morphologic affinity to forms known from western Europe, Russia and Afghanistan. Thus, *Minirostrella rara* gen. et sp. n. shows some unique external shell features also developed in *Eoparaphorhynchus triaequalis triaequalis* (GOSSELET) and *E. triaequalis praetriaequalis* (SARTENAER) (SARTENAER 1957; see also taxonomic part of this report). Both subspecies occur in the lower Famennian of Belgium, France, and Germany. SARTENAER (1967, 1969, 1985) established the *Eoparaphorhynchus* Zone and correlated it with the upper part of the *P. triangularis* to the Lower *P. crepida* Zones. *Cyrtospirifer minor*, which is characteristic of the *I. mesoplicatus* interval and underlying *Orbiculatisinurostrum laeve* Zone, is related to *Cyrtospirifer asiaticus* BRICE from the lower Famennian of Afghanistan and the East European Platform (BRICE 1970). Thus, the brachiopods occurring in the interval suggest an early Famennian age of the assemblage.

The above correlations are fully confirmed by conodonts (Table 2) found in the *Iloerhynchus mesoplicatus* interval, which indicate the *P. triangularis* Zone (probably lower part). The characteristic species recorded here are *Palmatolepis triangularis, P. protorhomboidea, Polygnathus brevilaminus, P. angustidiscus*, and *Icriodus iowaensis iowaensis*.

Cyrtospirifer brodi interval

Outcrops and boundaries. — The strata assigned to the *C. brodi* interval crop out in three trenches (Z.bis-1, -2 and -4) that are located in the eastern slope of Żbik ravine. This interval is marked by the occurrence of the index species and *Nigerinoplica* sp. The lower boundary of the interval corresponds to the first appearance of *Cyrtospirifer brodi*. The upper boundary of the interval is defined by the lower boundary of the succeeding *Cyrtospirifer wesgensis* interval.

The thickness of the interval is not known exactly. However, it is estimated at 22 meters.

Fauna. — The fauna includes the index species *C. brodi* and *Nigerinoplica* sp. Rare lingulids, holothuroids, ophiocystoids, and conodonts (see Table 2) are also present.

Age and correlation. — *Cyrtospirifer brodi* and *Nigerinoplica* sp. (described in the Russian literature as *Productella herminae* FRECH; e.g., MARKOVSKI and NALIVKIN 1934; LYASHENKO 1959), among others, are very characteristic fossils for the Eletz Beds (lower Famennian) of the East European Platform (NALIVKIN and MARKOVSKI 1934; SARYTCHEVA and SOKOLSKAYA 1952). Faunal similarity between the *C. brodi* interval and the Eletz Beds are striking but biostratigraphic data suggest that they have a slightly different age. Conodonts collected in Dębnik indicate the *P. triangularis* Zone (probably the middle part) whereas the Eletz Beds are correlated with the *P. rhomboidea* Zone (RZHONSNITSKAYA 1988; ARISTOV 1988).

Cyrtospirifer wesgensis interval

Outcrops and boundaries. — Strata assigned to the *C. wesgensis* interval have been located in trenches Z.tent-1 to -3 and Z.orb-9. All outcrops of the interval are found in the southern limb of the anticline.

The lower limit of the *C. wesgensis* interval is defined by the first occurrence of the index species. The characteristic brachiopods of the interval include *Nigerinoplica* sp., *Sentosia profunda*, and the index species. The upper limit of the interval is defined by the lowest occurrence of *Dmitria gibbosa* at the lower limit of the succeeding *Dmitria gibbosa* brachiopod interval.

The layers representing the interval are very poorly exposed in the Dębnik area, and the thickness of the whole interval is impossible to establish. It can be estimated at about 20 meters.

Fauna. — The brachiopods include the index species, which is associated in trenches Z.tent-1 to -3 with *Nigerinoplica* sp., and *Sentosia profunda*. In higher layers exposed in trench Z.orb-9, the brachiopod fauna is very sparse and only includes the index species and *Centrorhynchus* cf. *letiensis*. This part of the section probably represents the youngest part of the *C. wesgensis* interval. Other faunal elements from the interval includes very rare pelecypods and conodonts (Table 2).

Age. — Conodonts were found only in one sample (Z.tent-3). They are very rare and include *Palmatolepis triangularis, Polygnathus brevilaminus, P. angustidiscus*, and *Icriodus iowaensis*. They generally indicate the *P. triangularis* Zone (probably the upper part).

Remarks. — As was pointed out above, JAROSZ (1926: 141–142, 145) was the first to find the outcrop representing this part of the section. He identified a spiriferoid occurring there as being the same which is characteristic for the much younger "Stromatoporoid rock" (i.e., *Spirifer Verneuili* typ. and var. *tenticulum*). On that basis, he erroneously referred this part of the section at Żbik ravine as equivalent to the much younger Stromatoporoid Limestones to the north of Dębnik.

Dmitria gibbosa interval

Outcrops and boundaries. — Trenches Z.orb-6 to -8 and -14 which are located in the eastern slope of Żbik ravine, are the only localities for this interval in the Dębnik area. The assemblage of brachiopods characteristic for the interval consists of *Nigerinoplica* sp., *Ptychomaletoechia* sp., *Athyris* aff. *area*, *Cyrtospirifer* cf. *acutus, Cyrtiopsis famenniana* and *Dmitria gibbosa*, the index species. The lower boundary of the interval is defined by the first occurrence of the index species. The upper boundary coincides with the lower boundary of the overlying *Cavatisinurostrum longilinguis* interval (Table 1). The thickness of the interval can be estimated to be at least 8 meters.

Fauna. — Although poorly preserved, the brachiopod fauna is represented by 13 species, and attains one of the highest diversities in the Famennian of the area (Table 1, Text-fig. 4). Besides the brachiopods mentioned above, *Schizophoria shubarica, Sentosia profunda, Rhytialosia* sp., *Donalosia* sp., *Coeloterorhynchus* sp., *"Athyris"* aff. *reticulata* and *Eobrachythyris palkowae* occur. The accompanying fossils include algae, scolecodonts, ostracods, echinoids and conodonts (Table 2).

Age. — The most characteristic conodonts for the interval include *Palmatolepis circularis, Polygnathus volhynicus, P. squalidus* and *P. delenitor*. Because higher strata contain conodonts that define the Middle *P. crepida* Zone, the *Dmitria gibbosa* interval can be correlated with the Lower to Middle *P. crepida* Zone.

Cavatisinurostrum longilinguis interval

Outcrops and boundaries. — The strata representing the *C. longilinguis* interval were found in both the northern and southern limbs of the Dębnik anticline. In the north, the interval was previously exposed in the Pałkowa Góra quarry, which no longer exists. During the present investigation, limestones which were probably derived from the quarry were found as loose blocs at locality PG (see details in the previous section). To the south of Dębnik, equivalent layers have been found in trenches Z.orb-5, -12 and Z.pal-1.

The most characteristic brachiopod species for the interval is *Cavatisinurostrum longilinguis* (the index species). The other species defining the interval are *Loborina lobata, Athyris area, Dmitria angustirostris, D. globosa* and *Eobrachythyris palkowae* (the last species also occurs sporadically in

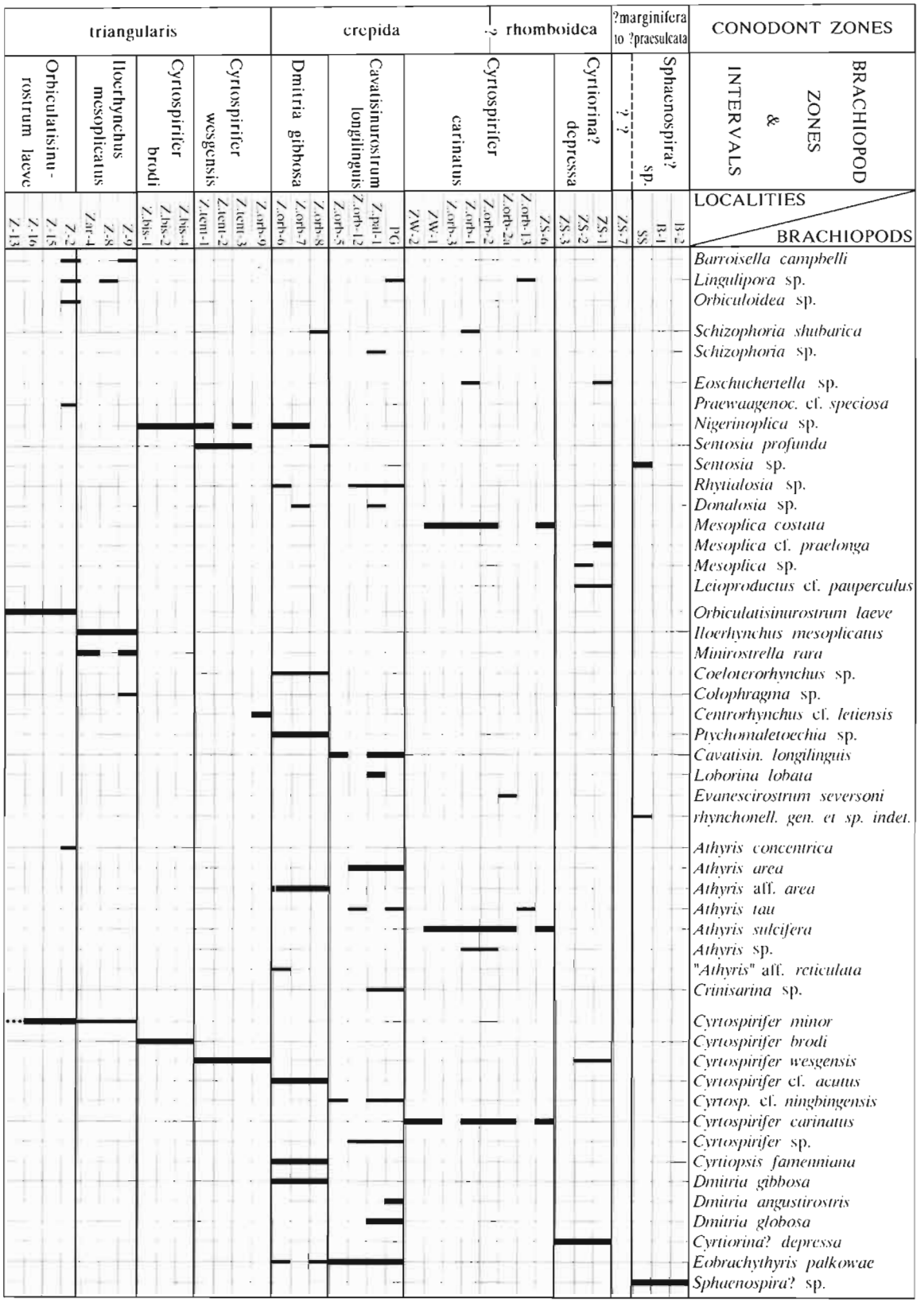

Table 1.

Stratigraphic distribution of brachiopods in the Famennian of the Dębnik anticline. Index species and species defining the brachiopod intervals are marked by thicker lines.

the underlying *Dmitria gibbosa* interval). The lower limit of the interval is defined by the lowest appearance of the index species. The upper limit is defined by the lowest appearance of *Cyrtospirifer carinatus*, the index species of the succeeding brachiopod interval. The thickness of the *C. longilinguis* interval probably amounts to about 17 meters.

Fauna. — The limestones from the interval yield the richest brachiopod fauna (13 species) in the whole Famennian of the area (Table 1, Text-fig. 4). Besides the species listed above, *Schizophoria* sp., *Rhytialosia* sp., *Donalosia* sp., *Athyris tau, Crinisarina* sp., *Cyrtospirifer* cf. *ningbingensis* and *C.* sp. occur here. They are accompanied by sponge spicules, gastropods, holothuroids, ophiuroids, echinoids, fish remains, and conodonts (see Table 2).

Age. — The conodont samples taken from the interval contain the richest and the most diverse assemblages of all of the Famennian strata of the Dębnik anticline. They indicate a precise correlation with the Middle *P. crepida* Zone. The most characteristic species are *Palmatolepis crepida, P. minuta minuta, P. minuta wolskae, P. quadrantinodosalobata, P. termini, Polygnathus volhynicus*, and *P. lauriformis*.

Remarks. — The *C. longilinguis* interval corresponds to the "Limestones from Pałkowa Góra" in the stratigraphic scheme of GÜRICH (1903) and JAROSZ (1926).

Cyrtospirifer carinatus interval

Outcrops and boundaries. — The *C. carinatus* interval has been recognized south of Dębnik in trenches Z.orb-1 to -4, -10 to -11, -13, ZS-6 and ZW-1 to -2. The lower and the upper boundaries of the interval presumable coincides with the range of the index species, *C. carinatus*. The other brachiopods that are characteristic for the interval include *Mesoplica costata* and *Athyris sulcifera*. The thickness of the interval probably amounts to about 25 meters.

Fauna. — Brachiopods, in addition to those given above, include *Schizophoria shubarica, Eoschuchertella* sp., *Evanescirostrum seversoni, Athyris tau*, and *A.* sp. The accompanying fauna consists of rare ostracods, nautiloids, crinoids, holothuroids, echinoids, ophiuroids, and conodonts (see Table 2).

Age. — The sample taken from the lowermost part of the interval (Z.orb-10) contains conodonts characteristic of the Middle to Upper *P. crepida* Zone: *Palmatolepis crepida, P. minuta wolskae, P. quadrantinodosalobata, Polygnathus lauriformis, P. delenitor* and *Polylophodonta confluens*. The middle part of the interval exposed in trenches Z.orb-1 to -2 has yielded *Palmatolepis minuta minuta, P. quadrantinodosalobata, P. glabra prima, Polygnathus semicostatus, P. bouckerti*, and *P. glaber glaber*. This indicates a general correlation with the Upper *P. crepida* to Lower *P. rhomboidea* Zone. The upper strata of the *C. carinatus* interval exposed in trenches Z.orb-4 and -13, as well as in ZS-6, yield *Palmatolepis glabra pectinata* morph., *P. poolei, P. klapperi, Polygnathus bouckerti* and *P. communis communis*, among others. These conodonts precisely indicate the Lower *P. rhomboidea* Zone.

Remarks. — The *C. carinatus* interval corresponds to the "Schichten mit *Athyris reticulata*" of GÜRICH (1903: 162) and includes those layers which contain *Spirifer archaci* var. *orbeliana* (*ibidem*: 159) (here described as *C. carinatus*). This brachiopod interval can be correlated with the "Limestone with *Spirifer Verneuili* typ., *Spirifer Archiaci* WENJUKOV, *Spirifer Archiaci* var. *Orbeliana* and *Productus (Productella) praelongus*" of former stratigraphic scheme (JAROSZ 1926); he listed (*ibidem*: 142) fossils characteristic for that limestone. Based on a wrong identification of brachiopods and an incorrect correlation, he (*ibidem*: 143) determined the age of the strata as the latest Famennian and believed they were younger than the "Stromatoporoid Rock" (*ibidem*: 143).

Cyrtiorina? *depressa* interval

Outcrops and boundaries. — Trenches ZS-1 to -3 are the only localities for this interval in the Dębnik anticline. The lower and upper boundaries of the interval are determined by the range of *C.*? *depressa*. The thickness of the interval amounts to at least 10 meters.

Fauna. — Brachiopods are rare in the *C.*? *depressa* interval and are represented by *Eoschuchertella* sp., *M.* cf. *praelonga, M.* sp., *Leioproductus* cf. *pauperculus, Cyrtospirifer wesgensis* and *Cyrtiorina*?

Zone	Lower triangularis - Upper triangularis												M.tr.-?L.cr.	Lower crepida -Middle crepida				M. crep.	M.-U. crep.	U. crep. -L. rhom.			Ust.cr.-L.rh.	Lower rhom.			Middle rhom.		L.-U.crep.	U.crep.-L.rh.	Lower rhom.	Lower-Upper rhomboidea						L.mar.-?L.ex.	?L. exp. - ?		
SAMPLES	Z -					Z-2-				Z.bis-			Z.tent-1	Z.orb-														PG	Z.pal-1	ZW-		ZS-								B-		
CONODONTS	14	15	16	8	9	1	2	3	4	1	2	4		6	7	8	14	5	12	10	1	2	2a	11	4	13			2	1	6	5	3	2	1a	1b	7	LB	1	2
Palmatolepis	106	10	49	42	4	14	7	7	7	15	3	2	2	21	1	3	-	53	27	24	27	10	2	96	14	13	98	493	5	4	73	10	24	3	5	73	-	2	-	-
triangularis	106	10	47	37	4	14	7	7	7	15	3	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
triangularis clarki	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
protorhomboidea	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
circularis	-	-	-	-	-	-	-	-	-	-	-	-	-	17	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
tenuipunctata	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	10	3	7	-	-	-	-	-	-	19	185	-	-	-	-	-	-	-	-	-	-	-
crepida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	2	13	-	-	-	-	-	-	2	120	5	-	-	-	-	-	-	-	-	-	-
minuta minuta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	2	-	1	-	-	-	1	1	9	31	-	-	-	-	-	-	1	-	-	-	-
minuta wolskae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	1	1	-	-	-	-	1	-	27	10	-	-	-	-	-	-	-	-	-	-	-
minuta loba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
subperlobata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	12	-	-	-	-	-	1	2	-	64	-	-	-	7	-	-	-	-	-	-	-
quadrantinodosalobata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	3	3	6	2	1	5	-	-	13	79	-	2	7	-	-	-	-	-	-	-	-
termini	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-	-	-	28	4	-	-	-	-	-	-	-	-	-	-	-
glabra prima	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	8	1	-	3	-	-	-	-	2	18	3	-	-	-	2	-	-	-
glabra pectinata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
glabra pectinata morph.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	91	-	10	-	-	-	-	42	-	-	-	-	-	-	-	-
poolei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
klapperi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-
rhomboidea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23	3	4	71	-	-	-
gracilis sigmoidalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Polyganthus	6	6	11	16	8	14	13	2	2	7	5	2	4	29	-	2	-	56	17	50	47	44	23	51	66	25	7	186	8	6	57	13	2	9	2	17	31	3	11	2
brevilaminus	6	6	11	14	5	14	2	-	-	5	5	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
angustidiscus	-	-	-	2	3	-	11	2	2	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
flaccidus	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
volhynicus	-	-	-	-	-	-	-	-	-	-	-	-	-	19	-	-	-	-	16	-	-	-	-	-	-	-	4	147	-	-	-	-	-	-	-	-	-	-	-
squalidus	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
delenitor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	48	-	40	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-
lauriformis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	4	-	-	-	-	-	-	-	35	-	-	-	-	-	-	-	-	-	-	-
nodocost. nodocostatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	31	8	5	-	3	-	1	5	1	-	-	-	1	-	-	-
semicostatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32	30	14	11	40	13	-	-	-	3	36	8	1	3	1	2	-	-	-
bouckerti	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	4	9	6	-	6	-	-	-	-	10	-	-	-	-	-	-	-	-
glaber glaber	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	3	-	3	1	1	-	-	-	-	3	3	1	1	-	7	-	-	-
sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	7	-	-	-	-	-	-	-	2	3	-	-	-	-	-	-	-	-
communis communis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	1	-	-	-	6	-	-	-
szulczewskii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	1	7	-	-	-	-
rarus sp. n.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24	-	-	-
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znepolensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	9	2
cf. *longiposticus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
Polylophodonta confluens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alternognathus? sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
Polygnathella? sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Omolonogn. transformis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	5	8
Ancyrognathus sinelamina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Branmehla cf. *werneri*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Icriodus	-	16	12	5	-	13	22	1	-	1	-	1	1	11	-	1	-	-	-	-	4	2	-	-	-	1	1	-	-	-	-	1	-	-	-	-	-	-	-	-
alternatus alternatus	-	16	12	3	-	13	22	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
alternat. morph. III	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
iowaensis iowaensis	-	-	-	2	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
io. io. narrow morph.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
aff. *cornutus*	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-	-	4	2	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Pelekysgnathus inclinatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	1	1

Table 2.
Location and conodont contents of samples from the Famennian of the Dębnik anticline.

depressa (Table 1). The accompanying fauna consists of laminar stromatoporoids, ostracods, gastropods, crinoids, and conodonts (see Table 2).

Age. — The most characteristic conodonts from samples ZS-1 to -3 are *Palmatolepis rhomboidea, Polygnathus semicostatus, P. glaber glaber* and *P. szulczewskii*. They indicate that the *C.*? *depressa* interval correlates with the Lower to Upper *P. rhomboidea* Zone.

Sphaenospira? sp. interval

Outcrops and boundaries. — Strata belonging to the *Sphaenospira*? sp. interval are exposed in the "Stromatoporoid Rock" to the north of Dębnik and in the western slope of Racławka river valley near Marmurowa Góra quarry (locality B-1 and -2). The lower and upper limits of the interval probably coincide with the lower and upper range of the index species. Due to very limited outcrops, the thickness of the interval cannot be measured. It probably attains several dozen meters.

Fauna. — During the late Famennian, the brachiopod fauna in the Dębnik area became more and more impoverished as the shallowing of the sedimentary basin progressed. In the limestones representing the *Sphaenospira*? sp. interval, brachiopods are extremely rare and fragmentarily preserved. The most characteristic species is *Sphaenospira*? sp. (index species), which is associated sporadically with *Sentosia* sp. and rhynchonellacean gen. et sp. indet. Other forms include stromatoporoids, rare foraminifers, and conodonts (see Table 2).

Age. — It is difficult to correlate the *Sphaenospira*? sp interval into the standard conodont zonation. No conodonts have been found in the "Stromatoporoid Rock". In the limestones from trenches B-1 and -2, conodonts are represented by very rare specimens of *Polygnathus znepolensis, P.* cf. *longiposticus, Omolonognathus transformis*, and *Pelekysgnathus inclinatus*. In addition, *Branmehla* cf. *werneri* and *Palmatolepis gracilis sigmoidalis* occur in sample LB from the limestone found near trenches B-1 and -2. This limestone probably belongs to the *Sphaenospira*? sp. interval, but no brachiopods have been found there. The majority of the conodont species listed above are typical of the upper Famennian.

The presence in the samples of *Omolonognathus transformis* is astonishing. *Omolonognathus* was previously known only from the lowermost Carboniferous (lower Tournaisian) of the Omolon Massif, NE Russia, which is about 8 000 kilometers from the study area. This occurrence of forms which are mixed in stratigraphic meaning cannot be explained at present with certainty. It is also probable that the conodont fauna is not mixed and *Omolonognathus* demonstrates its local earliest occurrence. It seems reasonable, however, that the *Sphaenospira*? sp. interval can be correlated with the latest Famennian.

Remarks. — As noted above, the "Stromatoporoid Rock" of old stratigraphic scheme (JAROSZ 1926) is equivalent to the *Sphaenospira*? sp. interval.

SUCCESSION OF BRACHIOPOD FAUNAS AND CONODONT BIOFACIES

SUCCESSION OF FRASNIAN BRACHIOPOD FAUNAS

Although the main subject of this report is a study of Famennian brachiopods, it is reasonable to give also a short review of the Frasnian history of brachiopod faunas against the background of important biological events in the Upper Devonian of Dębnik.

Lowest Frasnian brachiopod faunas

It is generally assumed that a broad carbonate platform which was built mainly of coral-stromatoporoid biostromes existed in the Middle Devonian of southern Poland (e.g., NARKIEWICZ 1985; NARKIEWICZ and HOFFMAN 1989) This stage of Devonian sedimentation is well represented in the Dębnik area by the Dębnik Limestones.

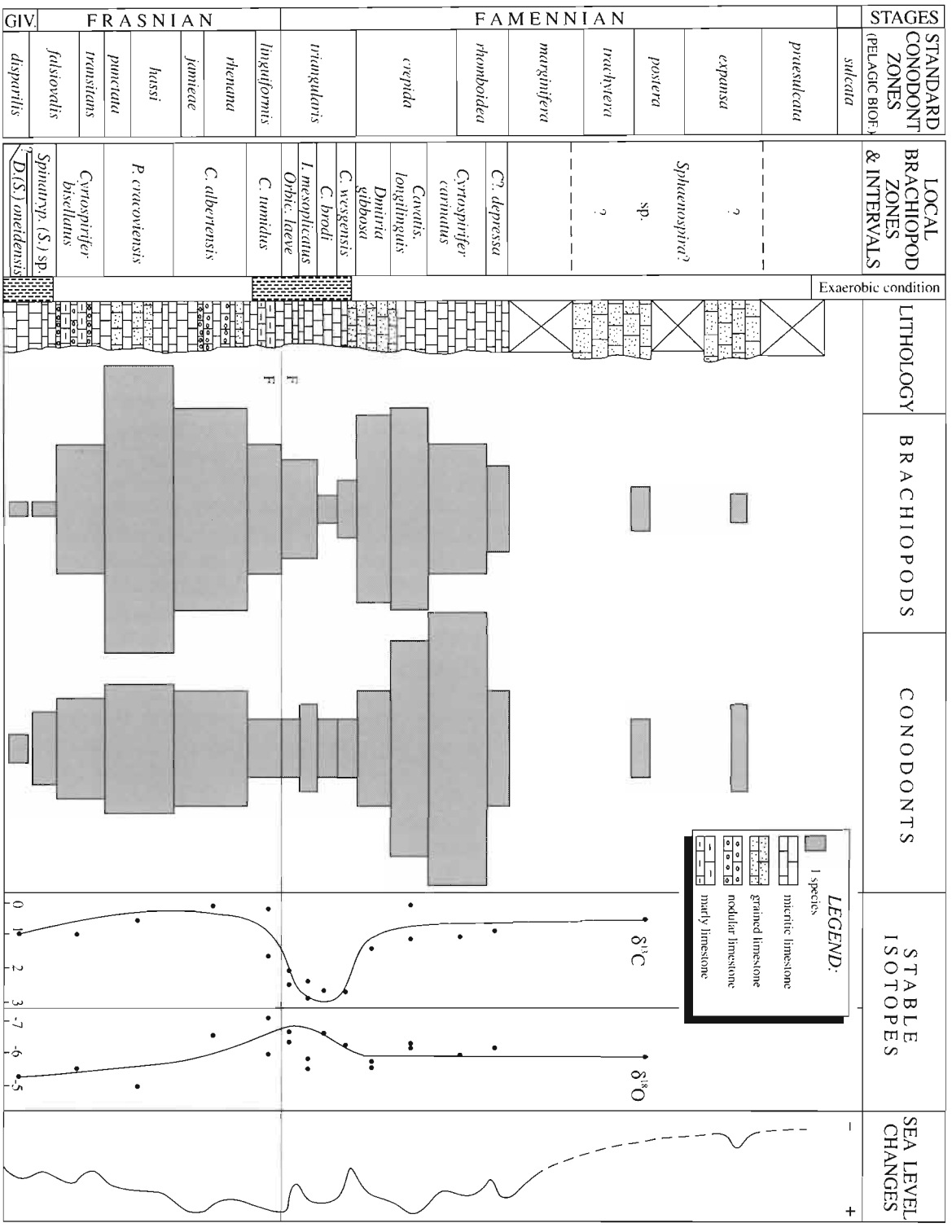

Fig. 4.

General columnar section of the Upper Devonian of the Dębnik anticline and correlation of local brachiopod zones and intervals with standard conodont zones after ZIEGLER and SANDBERG (1990). Distribution of brachiopod and conodont species after data from BALIŃSKI (1979) and this paper. Stable isotope record after HAŁAS *et al.* (1992). Supposed sea level changes based on Text-fig. 5.

The lowest part of the Dębnik Limestone, which crops out at the Main Carmelite Quarry and New Quarry, among other localities, is dark and poorly fossiliferous. RACKI and BALIŃSKI (1981) supposed that this part of the section represents a stagnant water area immediate between the dysaerobic and aerobic zones of the basin. The rich accumulation of *Desquamatia (Seratrypa) oneidensis* in one layer and the occurrence of *Spinatrypina (Spinatrypina)* sp. in the bed laying 7 m above in this section (BALIŃSKI 1979) represent rather short episodes of improved water circulation. The conodont assemblage from the layer with *Desquamatia (S.) oneidensis* is dominated by *Polygnathus* (86 to 94%) whereas *Icriodus* constitutes only 6 to 14% (Text-fig. 5). Higher, in the bed with *Spinatrypina (S.)* sp., species of *Polygnathus* compose only 18 to 36% and *Icriodus* dominates. The distinct rise in the proportion of *Icriodus* elements in the samples may be interpreted as a result of more agitated, better oxygenated water conditions (e.g., SANDBERG *et al.* 1989: 208) for the layer belonging to the *Spinatrypina (Spinatrypina)* sp. Zone.

Cyrtospirifer bisellatus Zone

In the *Cyrtospirifer bisellatus* Zone, the brachiopod fauna (Text-fig. 4) is more diverse, and thus suggests better environmental conditions. The most characteristic brachiopods are *Cyrtospirifer bisellatus, Eleutherocomma zarecznyi, Spinatrypa (Spinatrypa) semilukiana* and *Douvillina (Douvillina)* sp. Less frequent are *Lingula* sp., *Corbicularia cracoviensis, Desquamatia (Neatrypa) velikaya* and *Spinatrypina (S.)* sp. These brachiopods are accompanied by pelecypods, gastropods and rare nautiloids. In the conodont fauna, polygnathid and icriodontid elements dominate. *Ancyrodella* and wide forms of *Mesotaxis* occur sporadically and make up not more than 5% of the assemblage. Generally, the samples can be assigned to the relatively shallow polygnathid-icriodontid biofacies.

Lithologically, this part of the section represents the Nodular Limestone unit, which is characterized by rhythmically bedded limestones and nodular marly limestones (BALIŃSKI 1979, Fig. 9). According to NARKIEWICZ and RACKI (1987) and NARKIEWICZ (1988), the Nodular Limestone represents the basal Upper Devonian transgressive pulse which drowned the extensive Middle Devonian carbonate platform (SCHLAGER 1981; MCGHEE 1989; NARKIEWICZ and RACKI 1987). According to the T-R (i.e., Transgressive-Regressive) model proposed by JOHNSON *et al.* (1985), this deepening event corresponds probably to eustatic rise IIb.

Plionoptycherhynchus cracoviensis Zone

The lowest part of the Grained Limestone unit features a brachiopod assemblage which is the most diverse of all in the Frasnian of the Dębnik area (Text-fig. 4). The assemblage is made up of twenty species and represents the *Plionoptycherhynchus cracoviensis* Zone (=*Calvinaria cracoviensis* Zone). The most important feature is the appearance of rhynchonellids (7 species), which immediately become the dominant group in the association. *Hypothyridina ascendoides, H.* sp., *Coeloterorhynchus schucherti, C.* sp., *Plionoptycherhynchus cracoviensis, Lateralatirostrum athabascense* and *Flabellisinurostrum guerichi* occur here. Other brachiopods are represented by strophomenoids (4 species), spiriferoids (2 species), inarticulates (4 species), and atrypoids, orthids and pentameroids (each represented by a single species). The associated fauna is also diverse and comprises sponges, tabulate corals, tetracorals, receptaculids, tentaculites, crinoids, nautiloids, and fish remains.

The conodont fauna documents an increasing proportion of palmatolepids and deep-water, wide platform polygnathids (*Klapperina*). The dominant conodont biofacies are polygnatid-icriodontid to the deeper palmatolepid-polygnathid. In some samples (e.g., RD-6 RD-7) an important form is *Ancyrodella*, which makes up to 13 to 34.5% of the assemblages. According to SANDBERG *et al.* (1989), *Ancyrodella* had its optimum habitat in neritic settings occupied by the polygnathid-ancyrodellid and polygnathid biofacies. Occurrence of detrital deposits (bio-intrasparite) as well as tabulate corals, tetracorals, and other diverse benthic faunal elements indicate better oxygenated, more turbulent waters. According to NARKIEWICZ and RACKI (1987) and NARKIEWICZ and HOFFMAN (1989), a shallowing trend began in the basin in this interval (i.e., Middle to Late *assymmetricus* Chron (*P. punctata* to Early *P. hassi* Chron in the revised zonation).

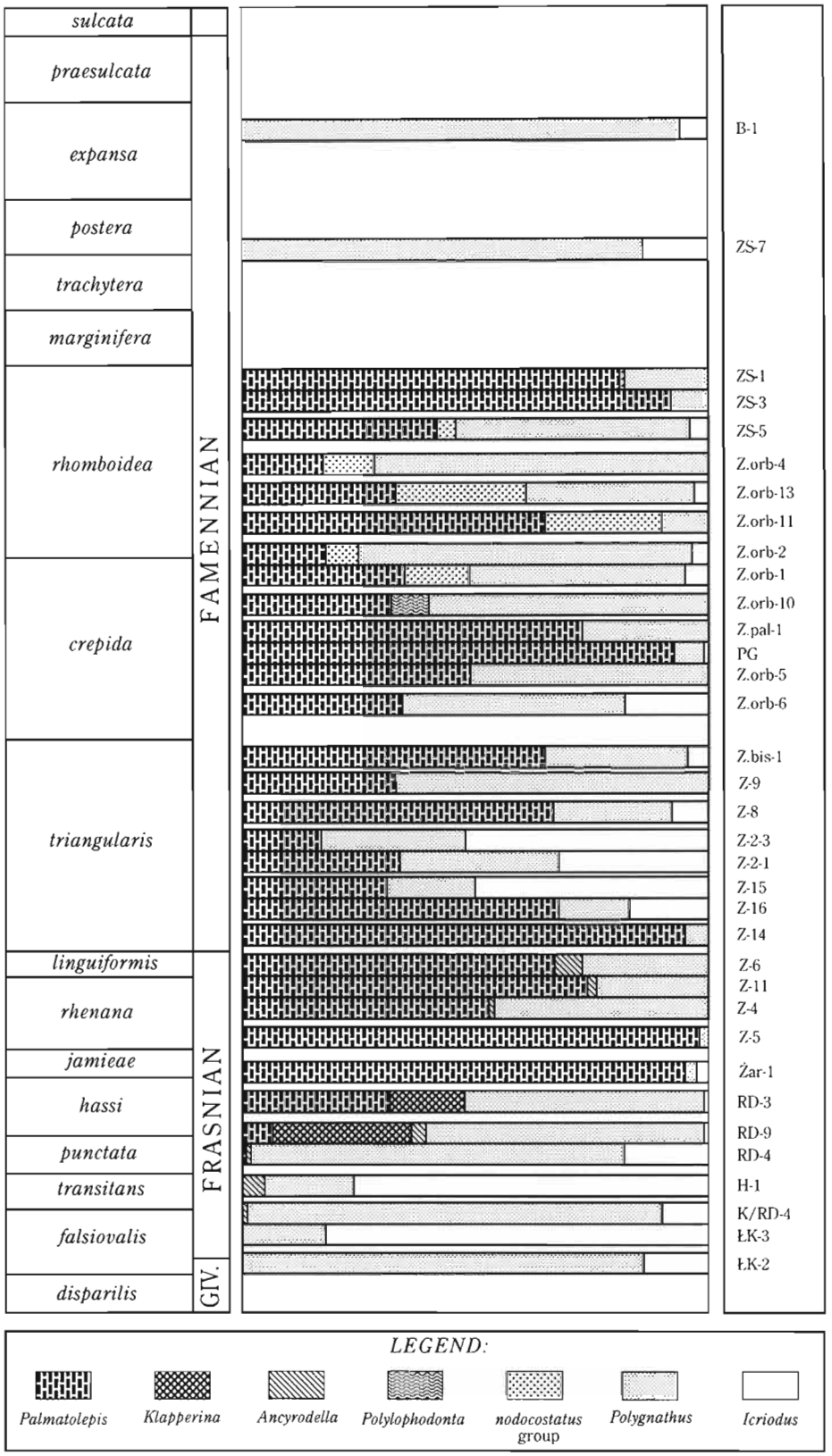

Fig. 5.
Distribution of platform conodont groups in selected samples from the Upper Devonian of the Dębnik anticline.

Calvinaria albertensis Zone

The beds representing the zone are very poorly exposed at Dębnik, and the data collected from this part of the section are definitely incomplete. The brachiopod assemblages consist of 13 species, of which the most characteristic are *Calvinaria albertensis albertensis, C. a. minor, Caryorhynchus tumidus, Anatrypa alticola, Iowatrypa markowskii*, and *Biernatella polonica*. The associated fauna consists of stromatoporoids, tabulate corals, tetracorals, gastropods, tentaculites, crinoids, and fish remains. The conodont fauna is dominated by palmatolepids and polygnathids and suggests the palmatolepid-polygnathid biofacies. In two samples (Żar-1 and Z-5), however, *Palmatolepis* makes up 95 and 98% of the conodont fauna, and this indicates a deep-water palmatolepid biofacies. It is worth noting that these are the highest per cent values of palmatolepid occurrences in all of the Frasnian samples, and thus suggests the maximum Frasnian transgression in Dębnik. This event can be correlated with event 6 of SANDBERG *et al.* (1988) and with the T-R cycle IId of JOHNSON *et al.* (1985). This event was initiated in the Early *P. gigas* Chron (Early *P. rhenana* according to the new zonation), and is the greatest Late Devonian eustatic rise which drowned bioherms and biostromes and thus led to at least local extermination of both frame-building and reef-dwelling faunas (NARKIEWICZ and HOFFMAN 1989: 20; SANDBERG *et al.* 1988: 196).

This part of the section represents the upper part of the Grained Limestone unit and consists of gray intrasparites and intramicritosparites locally with intraclasts up to several centimeters in width. In the uppermost part of the *C. albertensis* Zone exposed at trench Z-4 (the Late *rhenana* conodont Chron), distinct signs of sealevel drop are suggested by an admixture of quartz sand in the sediment and a shift in conodont biofacies from the deep water palmatolepid to the shallower palmatolepid-polygnathid. This regressive pulse in southern Poland was also noticed by NARKIEWICZ and RACKI (1985, 1987), and NARKIEWICZ (1988) but according to them, the sea level drop occurred slightly earlier (i.e., in the Early *P. gigas* Chron). According to NARKIEWICZ and HOFFMAN (1989: 19), the rapid regressive pulse in the Early *P. gigas* Chron was probably an eustatic event and could have had lethal effects on many reef communities.

Caryorhynchus tumidus Zone

The layers belonging to this zone represent the uppermost part of the Grained Limestone unit and the basal part of the Platy Limestone unit. In terms of chronostratigraphy, the layers represent the uppermost part of the Frasnian known from the Dębnik area. The brachiopod fauna is sparse. However, the youngest beds exposed in trench Z-6 have abundant and well-preserved rhynchonellids (i.e., *Caryorhynchus tumidus*). Rare faunal elements include lingulids, linguliporids, *Anatrypa alticola, Biernatella polonica, Athyris concentrica, Cyrtospirifer minor*, and *Tenticospirifer cyrtinaformis*. The accompanying fauna includes foraminifers, stromatoporoids, tabulate corals, tetracorals, gastropods, tentaculitids, crinoids, and fish remains. Conodont samples are dominated by palmatolepids (28 to 74%) and polygnathids (24 to 72%). The last local occurrences of *Ancyrodella* is recorded in two samples (2 and 6% of the assemblage). Worthy of mention is a total absence of *Icriodus* in this part of the section. According to SANDBERG *et al.* (1989: 208), the absence of *Icriodus* may be caused by dysaerobic conditions in a basin. The conodont assemblages from this part of the section generally indicate the palmatolepid-polygnathid biofacies.

The Frasnian-Famennian transition

The Frasnian-Famennian boundary occurs at Dębnik between the *Caryorhynchus tumidus* Zone and the *Leiorhynchus laevis* (=*Orbiculatisinurostrum laeve*) Zone. Thus, the layers exposed four meters above trench Z-6 (i.e., in trench Z-16), as well as those from trench Z-14, belong to the lowermost Famennian. The brachiopod fauna is very limited and documents the evident crisis at the F-F boundary. Among rhynchonellids and cyrtospiriferoids, which were the dominant groups during the Frasnian, only two species survived: *Orbiculatisinurostrum laeve* and *Cyrtospirifer minor*.

Conodont samples collected from these localities also document the known global turnover in conodont faunas. Only one species of *Palmatolepis* and one species of *Polygnathus* survived the F-F extinction at Dębnik. In sample Z-16 and younger ones, *Icriodus alternatus* joins the assemblage and

gradually increases in abundance. Thus, six to nine meters above the F-F boundary (Z-15), icriodontid elements constitute 50% of the sample. According to many conodont workers a distinct shift in conodont biofacies (known as the "*Icriodus* peak" or "icriodontid anomaly") can be observed at the base of the Famennian (e.g., DREESEN and THOREZ 1980; SANDBERG *et al.* 1987; NARKIEWICZ and RACKI 1987; SANDBERG *et al.* 1988; NARKIEWICZ and HOFFMAN 1989; JOHNSON 1990; MATYJA and NARKIEWICZ 1992). This change in conodont biofacies is interpreted as a global event reflected by a shallowing pulse at the F-F boundary. QIANG (1989) and SANDBERG *et al.* (1987), however, suggest, that in some instances icriodontid elements were flushed or washed away from the nearshore shelf into deeper basin settings, a sorting caused presumably by such events as tsunami, storms or earthquakes.

Thus, the brachiopod and conodont faunas occurring above the F-F boundary at Dębnik represent characteristic relic assemblages (*sensu* URBANEK 1970, 1993) that exhibit very low taxic diversity. What is more, brachiopods are represented by small-dimensioned, stunted phenotypes exhibiting the "Liliput effect". The term "Liliput effect" was introduced by URBANEK (1993) for stunted, subnormal phenotypes that occur frequently in post-event assemblages. In Dębnik, as an instance, *C. minor* from the earliest Famennian usually attains only 10 mm in length (BALIŃSKI 1979: 67). This stunting appears to be a phenotypic reaction to the unfavorable, poorly-oxygenated bottom conditions.

Although the F-F boundary is not exposed in the study area, it is evident that there is no distinct lithologic change between the uppermost Frasnian (Z-6) and the lowermost Famennian (Z-15, Z-16 and Z-2). This portion of the section represents the basal part of the Platy Limestone, which is developed mainly as dark marly micrites, frequently with pyrite. Sparse brachiopods and other faunal elements and available lithological data discussed above suggest that this time interval was dominated by exaerobic conditions (see also NARKIEWICZ and RACKI 1987). This may explain the unexpected delay in the location of the *Icriodus* peak at the base of the Famennian in Dębnik (Text-fig. 5). Exaerobic conditions may have inhibited this phenomenon for some time.

Interesting results were obtained from analysis of stable isotopes derived from brachiopod shell material of the Upper Devonian of Dębnik (HAŁAS *et al.* 1992). The curve for the carbon isotopic composition of shells from the *Orbiculatisinurostrum laeve* Zone through the *Cyrtospirifer wesgensis* interval shows a substantial and rapid positive shift of 2 per mil (*ibidem*: Fig. 2; see also Text-fig. 4). In the superjacent *Dmitria gibbosa* interval, the curve returns to its previous level. This unusual paleoceanographic condition expressed in elevated ^{13}C values persisted during the *P. triangularis* conodont Chron (ca. 1.5 Myr). HAŁAS *et al.* (1992) explained the observed isotopic pattern by the appearance of a regional upwelling system which circulated anoxic water from the lower part of a stagnant sea up onto the shelf. This hypothesis is supported by the widespread occurrence of Kellwasser facies in Europe and Morocco. JOACHIMSKI and BUGGISCH (1992: 58–59) recorded comparable carbon isotope shifts at the F-F boundary in the Steinbruch Schmidt and Benner (Rheinisches Schiefergebirge) sections as well as in the Wolayer Glacier (Carnic Alps) section.

SUCCESSION OF FAMMENIAN BRACHIOPOD FAUNAS

Orbiculatisinurostrum laeve Zone

As noted above, this zone represents the earliest Famennian. The brachiopods are very rare and represented by *Orbiculatisinurostrum laeve, Cyrtospirifer minor*, lingulids, and extremely rare *Praewaagenoconcha* cf. *speciosa*, and *Athyris concentrica*. This inconspicuous assemblage is characterized by small, stunted forms. Sparse benthic faunal elements, including stunted brachiopods, dark limestones, and the occurrence of pyrite suggest that this part of the section was deposited under quiet, poorly oxygenated bottom conditions well below wave base. The conodont assemblages are also very poor and monotonous, at first dominated by palmatolepids and polygnathids but later with an increasing proportion of *Icriodus* (Text-fig. 5). In some samples (Z-15 and Z-2-1), all three genera are nearly equally represented, and this suggests mixed assemblages. This interval is characterized by a high stand of sea-level, as recorded by the continuing deposition of dark marly micrites.

Iloerhynchus mesoplicatus interval

The limestones representing this interval were deposited in the same facies conditions as the *Orbiculatisinurostrum laeve* Zone. The brachiopod assemblages, however, although still poor, include a few new species. *Cyrtospirifer minor* is still present, but *O. laeve* is replaced by another rhynchonellid, *Iloerhynchus mesoplicatus*. Much less frequent are two other rhynchonellids (*Minirostrella rara* and *Colophragma* sp.) and lingulids. Conodont samples from the interval are generally very poor and consist of only two to three species. *Palmatolepis* and *Polygnathus* predominate, and this allows assignment to the palmatolepid-polygnathid biofacies.

Cyrtospirifer brodi interval

The facies of this interval also belong to the Platy Limestone unit. As the last two intervals described above, the *Cyrtospirifer brodi* interval features platy, micritic, dark gray limestones deposited in exaerobic conditions. The brachiopod assemblage from the interval consist of only two species: *Nigerinoplica* sp. and *Cyrtospirifer brodi*, the successor to *C. minor*. A total absence of rhynchonellids is characteristic here. The conodont assemblages consist only of two to three species, exactly the same as those from the *O. laeve* Zone and the *I. mesoplicatus* intervals. They can be assigned to the palmatolepid-polygnathid biofacies.

Cyrtospirifer wesgensis interval

This interval records a distinct facies change expressed mainly by an increase in quartz sand. Brachiopods, although still rare, are abundant in some layers (trench Z.tent-1 and -3). Many specimens collected from these layers are represented by complete, articulated shells. Some have delicate, hair-like spines, and this precludes long transport. The most characteristic brachiopod is *Cyrtospirifer wesgensis*, which possesses a long hinge margin, very variable ventral area and asymmetric, twisted ventral beak. These quite unusual features of the shell seem to be adaptations to more turbulent, unstable conditions at the bottom. Two other productids (i.e., *Nigerinoplica* sp. and *Sentosia profunda*) have long spines on the pedicle valve and were also well adapted to these environmental conditions. Conodonts are extremely rare; only one sample contained platform elements assigned to *Palmatolepis triangularis, Polygnathus brevilaminus, P. angustidiscus* and *Icriodus iowaensis iowaensis*. This part of the section, which probably still represents the *P. triangularis* Chron (the uppermost part) documents a distinct, strong regressive pulse in the basin or epeirogenic rise of base level. At this time fine quartz sand was shed from the emergent pre-Carpathian Land to the south.

Dmitria gibbosa interval

The brachiopod assemblages from this interval indicate a distinct improvement in bottom conditions in the basin. Carbonate sedimentation returned, and stagnant, poorly-oxygenated water conditions were replaced by environments more favorable to the benthic fauna. The brachiopod fauna is one of the most diverse in the Famennian of Dębnik and comprises 13 species belonging to the Productida, Spiriferida, Athyridida, Rhynchonellida, and Orthida (Table 1, Text-fig. 4). Other biotic elements are represented by algae, scolecodonts, ostracods and echinoids. Conodonts from sample Z.orb-6 are dominated by *Polygnathus* (47.5%) and *Palmatolepis* (34.5%), while *Icriodus* makes up 18% of all platform elements (Text-fig. 5). This indicates a relatively deep-water, palmatolepid-polygnathid biofacies.

The limestones of the *Dmitria gibbosa* interval marks the base of the Grained and Micritic Limestones unit. They indicate a deepening pulse in the basin and termination of the basinal dysoxia which continued probably through the entire *P. triangularis* Chron. The deepening may be correlated with the base of cycle IIe of eustatic curve (see JOHNSON *et al.* 1985), however, an epeirogenic cause cannot be excluded.

Cavatisinurostrum longilinguis interval

During this interval, brachiopods flourished and achieved the greatest species diversity of the whole Famennian in the Dębnik region (Text-fig. 4). In some layers (e.g., locality PG) they also occur in relatively great numbers. The majority of species are short-lived forms limited to this interval. The

most characteristic are spiriferids, athyridids and rhynchonellids, some are represented by medium to large-sized specimens that attain a shell length of more than 4 cm. On the other hand, there are numerous juvenile specimens in the collection, which start from 1 mm in shell length as well as tiny micro-brachiopods (i.e., *Loborina lobata*) that do not exceed 2 mm in length. The accompanying fauna is also rich and diverse. Conodont sample Z.pal-1, which was taken from a layer with marked silicification, yielded numerous remains of many fossil groups (e.g., sponges, gastropods, holothuroids, ophiuroids, echinoids and fish scales). The conodont fauna is also relatively rich and is dominated by palmatolepid and polygnathid elements. The palmatolepid elements in sample PG constitute 92.5% of the platform elements, and this probably marks the maximum time of the transgression (deep water palmatolepid biofacies). The other samples from the *C. longiliguis* interval can be assigned to the palmatolepid-polygnathid biofacies. They contain 49 to 61% of palmatolepids and 39 to 51% of polygnathids, whereas icriodontid elements are totally absent (Text-fig. 5). To sum up, the limestones of the *C. longilinguis* interval were deposited in an off-shore setting in oxygenated waters rich in nourishment, very favorable for brachiopods and other fauna.

Cyrtospirifer carinatus interval

The brachiopods of the *C. carinatus* interval, although less numerous than in the underlying interval are still diverse and quite common. The most important in the assemblages are medium- to large-sized species represented by *Cyrtospirifer carinatus* sp. n., *Athyris sulcifera*, and *Mesoplica costata* sp. n. Less frequent are lingulids, *Schizophoria shubarica, Eoschuchertella* sp., *Evanescirostrum seversoni, Athyris tau*, and *A.* sp. Almost all brachiopods possessed a strong, well-developed pedicle, which is regarded as an adaptation to turbulent water conditions. The only exception is the productoid *Mesoplica? costata* sp. n. which did not possess a pedicle. Instead, the species had a strongly convex pedicle valve with a very long trail and spines that enabled the animal to rest firmly on the sea bottom.

The accompanying fauna is represented by ostracods, nautiloids, crinoids, holothuroids, echinoids, and ophiuroids. The conodont samples demonstrate an increasing abundance of polygnathids with narrow platforms in the *C. carinatus* interval, and they make up to 71% of the assemblages (samples Z.orb-2 and -4; see Table 2 and Text-fig. 5). The most common polygnathid in this interval is the nearshore, presumably nectobenthic species *P. semicostatus*. Polygnathids with wide platforms, such as *P. nodocostatus nodocostatus* and *P. bouckerti*, from pelagic or off-shore environments are less common but still constitute 7 to 28% of the assemblages. Palmatolepids are generally less numerous than polygnathids and constitute 17.5 to 33% of the assemblage. They predominate in only one sample (Z.orb-11), and make up 65% of the assemblage. *"Icriodus"* elements are rare in the samples, and do not exceed 5% of all platform elements (sample Z.orb-1). Interesting is the occurrence of *Polylophodonta confluens* in one sample (Z.orb-10) in which it constitute 8% of the assemblage. Thus, all conodont samples taken from the *C. carinatus* interval represent a deep water palmatolepid-polygnathid biofacies. In comparison to the underlying layers described above from the *C. longilinguis* interval there is a distinct percentage decrease in palmatolepids and an increase in polygnathids and icriodontids. This may indicate a relative sea-level drop. Lithologically, this part of the section is dominated by medium-bedded, gray bio-pelmicrites with very common oncoids. Thus, the conodont biofacies as well as the lithology strongly suggest a sea-level drop and more vigorous, turbulent conditions during the *C. carinatus* interval.

Cyrtiorina? depressa interval

During the *C.? depressa* interval, the brachiopods became rare and less diverse taxonomically. The most important elements in the assemblage are spiriferoids and productoids, whereas rhynchonellids are totally absent. The most characteristic are *Cyrtiorina? depressa, Mesoplica* cf. *praelonga, M.* sp., and *Leioproductus pauperculus. Cyrtospirifer wesgensis* and *Eoschuchertella* sp. are rare, but the latter species may, however, occur in greater numbers in some layers.

The thin-bedded, gray bio-pelsparites of the *C.? depressa* interval also contain scarce ostracods, gastropods, crinoids and, most interestingly laminar stromatoporoids. The conodont fauna is dominated by palmatolepids which make 81 to 92% of the samples (ZS-1b and -3), whereas polygnathids

constitute the rest (i.e., 8 to 19%). In general, this represents a deep-water palmatolepid-polygnathid biofacies and thus may indicate (because of the high percentage of palmatolepid elements) a short episode of sea-level rise.

The upper Famennian and the *Sphaenospira*? sp. interval

Beds between the *C? depressa* interval and the *Sphaenospira*? sp. interval are very poorly exposed. This part of the section is probably exposed only at localities ZS-7 and in a small pit situated ca. 100 m west of ZS-7 and along the road leading from Dębnik to Czatkowice. At both localities, brachiopods are absent. The only fossils found at ZS-7 are rare gastropods, massive stromatoporoids, and very rare conodonts. Narrow-platformed polygnathids dominate (83.3%) and are admixed with wide-platformed species (2.8%) and *Pelekysgnathus inclinatus* (13.9%). According to SANDBERG (1976) and SANDBERG and ZIEGLER (1979), *P. inclinatus* indicates an even shallower environment than *Icriodus* and represents subtidal to peritidal conditions. Generally, conodonts indicate the polygnathid-pelekysgnathid biofacies (i.e., a shallow, turbulent-water, near-shore setting). At the pit near the road from Dębnik to Czatkowice, neither brachiopods nor representatives of other fossil groups were found. Thin-bedded, light-gray, pure intrasparudites (calcareous sand) are exposed here. To sum up, this part of the section exposed at both localities indicates a distinct sea-level drop and presence of a high-energy, shallow-water episode in the basin with sedimentation of calcareous sand on the shoals.

The highest part of the section with brachiopods which is studied in this report represents the *Sphaenospira*? sp. interval. The brachiopods are extremely rare and only three species were found. The most characteristic are *Sphaenospira*? sp. and *Sentosia* sp. Other fossils are represented by stromatoporoids and rare foraminiferans. Rare conodonts were found only at localities B-1 to -2 and LB. In samples B-1 and -2, *Polygnathus* and *Omolonognathus* dominate (16 and 10 specimens, respectively), whereas *Pelekysgnathus inclinatus* is represented in both samples by single specimens. Slightly different but poor conodont assemblage occur in sample LB where the most important is *Palmatolepis gracilis sigmoidalis* (allochthonous?).

Beginning in the Late *P. crepida* Chron, the late Famennian at Dębnik shows a gradual regressive tendency with probably two short transgressive pulses, first in the Late *P. rhomboidea* Chron and the second in the uppermost Famennian (*P. expansa* Chron?). This regressive sequence seem to correlate with the Famennian successions of Pomerania (NW Poland) and the Ardennes (i.e., with localities along the southern periphery of the Old Red Continent (MATYJA 1987, 1993; SANDBERG and DREESEN 1984). The upper Famennian at Dębnik is generally characterized by a scarcity of brachiopod and conodont faunas due to a major facies change to more shallow, perilittoral settings (regressive stage of the second cycle — according to NARKIEWICZ and RACKI 1985). During that time, a structure rimmed by shoals developed, with sandy barriers and stromatoporoid patch reefs (NARKIEWICZ and RACKI 1987). The prevailing regressive condition was probably briefly interrupted by a transgressive pulse represented by the sample LB. Recognition of the time of the deepening episode at Dębnik is difficult (see Table 2) but, it is highly probable that it may be correlated with transgressive episodes noted in Belgium, Germany, North America, Morocco and Poland. In North America, a strong transgression began at the base of the Early *P. expansa* Chron (JOHNSON *et al.* 1985; SANDBERG *et al.* 1988). A similar transgression occurred in Morocco (BEŁKA 1991). In Pomerania (NW Poland), the transgressive pulse occurred in the Late *P. expansa* Chron (MATYJA 1988, 1993), as in the Ardennes and the Rhenish Mountains where it correlates with the Epinette Shale and Wocklum Limestone (JOHNSON *et al.* 1985, 1986; JOHNSON and SANDBERG 1989).

One of the most characteristic features of the Famennian of the Dębnik anticline is the reappearance of stromatoporoids in the upper part of the section. The first laminar stromatoporoids occur as early as the later part of the *P. rhomboidea* conodont Chron. However, the most important and best known occurrences of massive stromatoporoids at Dębnik are the Stromatoporoid Rocks and those at locality ZS-7, which are younger than the *P. rhomboidea* Chron. The reappearance of stromatoporoids in the upper part of the Famennian has been noted also in other regions of the world. In western Europe, stromatoporoid biostromal banks occur in the higher parts of the Epinette Shales and in the succeeding Comblain-au-Pount or Etroeungt Formation of France (DREESEN *et al.* 1988). This might be explained by post-glacial warming of the ocean waters at the end of the Famennian glaciation (PAPROTH *et al.*

1986) or by the survival of genera better adapted to cool water (STEARN 1987). Stromatoporoids have also been identified at the same stratigraphic level in the Western Pomerania (MATYJA 1993), in the westernmost Rheinishes Schiefergebirge (Aachen area) (CONIL *et al.* 1964) Novaya Zemlya, the Urals, the Russian Platform, the Omolon area (eastern Siberia), the Donetsk Basin, Kazakhstan, northern Caucasus, northern Russia, and China (BOGOYAVLENSKAYA 1982).

Problem of the latest Famennian at Dębnik section

As shown in this report, the brachiopod fauna of the Dębnik anticline is quite common throughout the lower Famennian until the *P. rhomboidea* conodont Zone. Co-occurring conodonts permit a more-or-less precise determination of the age of the brachiopod assemblages. From the *P. rhomboidea* Chron, however, a continuous shallowing took place in the basin which, probably in conjunction with other environmental changes, caused an extermination of the brachiopod fauna in the area (Text-fig. 4). What is more, these changes also affected the conodonts and any attempt to determine the age of the upper Famennian rocks more precisely is difficult. The youngest brachiopods found in the Famennian of Dębnik are rare and come from the "Stromatoporoid Rock" and from trenches B-1 to -2. At present, the age of these layers can be estimated imprecisely as definitely younger than the *P. rhomboidea* Chron.

Thus, the facies development in the highest Famennian as well as the identification of Devonian-Carboniferous boundary beds remain an unresolved question. There are suggestions that several emersion episodes took place at that time (PASZKOWSKI 1980, oral comm.).

CONCLUSIONS

The Middle Devonian of the Dębnik anticline represents part of a broad carbonate platform which existed in southern Poland and which was built mainly of coral-stromatoporoid biostromes. The Dębnik Limestone (mainly the uppermost part of the Middle Devonian) is a dark, and poorly fossiliferous limestone deposited in a stagnant, poorly oxygenated waters (RACKI and BALIŃSKI 1981). The layers which belong to the *Desquamatia (Seratrypa) oneidensis* and *Spinatrypina (Spinatrypina)* sp. Zones represent a more agitated, better oxygenated water condition in the basin.

Beginning in the *Cyrtospirifer bisellatus* Zone, the brachiopod fauna is more diverse, and this suggests improved environmental conditions. This part of the section (the Nodular Limestone unit) represents a rapid, although not catastrophic, earliest Late Devonian transgressive pulse which drowned the extensive Middle Devonian carbonate platform (NARKIEWICZ and RACKI 1987; NARKIEWICZ 1988).

During the *Plionoptycherhynchus cracoviensis* Zone, the brachiopod faunas were the most diverse in the whole Frasnian (20 species). Rhynchonellids were a dominant group in the assemblage. The conodont fauna documents an increasing abundance of palmatolepids and wide platformed polygnathids (*Klapperina*). The dominant conodont biofacies are polygnathid-icriodontid to palmatolepid-polygnathid.

During the *Calvinaria albertensis* Zone, the brachiopod fauna was still diversified and included 13 species. Conodont faunas were dominated by palmatolepids and polygnathids and suggest the palmatolepid-polygnathid or even deeper, palmatolepid biofacies in the lower part of the zone. In the uppermost part of the zone there are distinct signs of a sea-level drop, as shown by an admixture of quartz sand in the sediment and a shift in conodont biofacies from a deep-water palmatolepid to a shallower, palmatolepid-polygnathid biofacies.

The *Caryorhynchus tumidus* Zone represents the uppermost part of the Frasnian. Generally, the brachiopod fauna is scarce, but there are abundant occurrences of *Caryorhynchus tumidus* in strata exposed at trench Z-6. The conodont fauna is dominated by palmatolepids and polygnathids, whereas *Icriodus* is totally absent. This part of the section at the base of the Platy Limestone unit marks the beginning of stagnant and poorly-oxygenated water conditions.

The Frasnian-Famennian boundary at Dębnik can be defined between the *Caryorhynchus tumidus* and *Orbiculatisinurostrum laeve* Zones.

Following the F-F crisis, the brachiopod faunas become less abundant and diverse and consist of a few, mainly dwarf forms. This part of the section (the *Orbiculatisinurostrum laeve* Zone through *Cyrtospirifer brodi* interval) was deposited under quite poorly oxygenated bottom condition well below a wave base. This indicates development of the Kellwasser facies which was widespread in Europe and Morocco).

The layers of the *Cyrtospirifer wesgensis* interval record a strong regressive pulse in the basin.

The *Dmitria gibbosa* interval marks the base of the Grained and Micritic Limestone unit and documents a transgressive event in the basin and termination of basinal anoxia which continued during probably the whole *P. triangularis* Chron. The brachiopod fauna is diverse (13 species) and marks the return of more favorable environmental conditions.

During the *Cavatisinurostrum longilinguis* interval, the brachiopods flourished and achieved the greatest species diversity in the Famennian of the Dębnik anticline. The conodont fauna, which can be assigned to the palmatolepid-polygnathid or palmatolepid biofacies, indicates the probable maximum of the Famennian transgression.

Within the *Cyrtospirifer carinatus* interval, conodont biofacies and lithology strongly suggest a sea-level drop and more rigorous, turbulent conditions with sedimentation of bio-pelmicrites with oncoids.

During the *Cyrtiorina*? *depressa* interval, the brachiopods became scarce and less diverse. The conodont fauna was dominated by palmatolepids (81 to 92%) and indicate a short sea-level rise. The first laminar stromatoporoids reappear in this part of the section.

In the upper part of the Famennian, brachiopods are extremely rare or absent. The highest part of the section which yields brachiopods represents the *Sphaenospira*? sp. interval. A reappearance of massive stromatoporoids in this part of the section is one of the most characteristic features of the Famennian of the Dębnik anticline.

Beginning in the Late *P. crepida* Chron, there is a strong regressive tendency in the basin which was interrupted probably by two short transgressive pulses: the first in the Late *P. rhomboidea* Chron and the second in the latest Famennian (*P. expansa* Chron?). Continuing shallowing caused an extermination of brachiopod and conodont faunas in the area. Several emersion pulses took place in the latest Famennian (PASZKOWSKI 1980, oral comm.).

SYSTEMATIC PART

Brachiopoda DUMÉRIL, 1806
Class **Inarticulata**, HUXLEY, 1869
Order **Lingulida** WAAGEN, 1885
Superfamily **Lingulacea** MENKE, 1828
Family **Lingulidae** MENKE, 1828
Genus *Barroisella* HALL *et* CLARKE, 1892
Barroisella campbelli COOPER, 1942
(Pl. 1: 10, 14, 16)

Remarks. — This is a widely distributed lingulid in the Upper Devonian of Dębnik. Thirty three fragments of valves have been found in several Famennian samples taken for conodonts (i.e., Z-8, Z-9, Z.bis-4, Z.orb-5 and -12, PG, and Z.pal-1). The specimens are referred to the genus on the basis of internal muscle markings (Pl. 1: 10, 14, 16).

Occurrence. — The species occurs in Dębnik in the *P. triangularis* and *P. crepida* conodont Zones. Single specimens has been recorded in the lower Frasnian (BALIŃSKI 1979).

Genus *Dignomia* HALL, 1871
Dignomia sp.
(Pl. 1: 15)

Remarks. — Two fragments of single valves from conodont sample Z.orb-2 are referred to the genus *Dignomia* HALL based on the internal markings in both specimens. Only the anterior halves of the valves are preserved. They show a distinct, long median ridge that reaches the vicinity of the anterior margin (Pl. 1: 15).

Occurrence. — *Dignomia* sp. was found only in a sample from trench Z.orb-2 (*Cyrtospirifer carinatus* interval; Upper *P. crepida* to Lower *P. rhomboidea* conodont Zones).

Genus *Lingulipora* GIRTY, 1898
Lingulipora sp.
(Pl. 1: 9)

Remarks. — Several small fragments of valves from the residue of conodont samples appear to be assignable to the genus on the basis of shell punctation. None of the specimens is preserved well enough to be worthy of description. Although they are unsuited for taxonomic study, they are very valuable for investigation of the shell structure (see BALIŃSKI 1988).

Occurrence. — In the Famennian of Dębnik, the species was found in samples from the quarry Z-2.4 and trenches Z-8 and -9, PG, Z.pal-1, Z.orb-12 and -13.

Order **Orthida** SCHUCHERT *et* COOPER, 1932
Suborder **Orthidina** SCHUCHERT *et* COOPER, 1932
Superfamily **Enteletacea** WAAGEN, 1884
Family **Enteletidae** WAAGEN, 1884
Subfamily **Schizophoriinae** SCHUCHERT *et* LEVENE, 1929
Genus *Schizophoria* KING, 1850
Schizophoria shubarica MARTYNOVA, 1961
(Pl. 1: 1)

1961. *Schizophoria shubarica* sp. nov.; M.V. MARTYNOVA: 73–74; Pl. 1: 1–4.

Material. — One slightly damaged shell from trench Z.orb-8 and one strongly exfoliated brachial valve from trench Z.orb-1.

Description. — Shell small for the genus, 14.3 mm in length, ca. 16.2 mm in width, and 9.6 mm in thickness, transversally elliptical in outline, dorsibiconvex; hinge margin straight and reaches 60% of the shell width.

Pedicle valve with slightly concave interareas and suberect beak; sulcus wide, shallow, developed at anterior half of the valve. Brachial valve much more convex than pedicle valve except at postero-lateral extremities where it becomes concave.

Shell covered with thin costellae, 3 to 3.5 per 1 mm at anterior margin.

Remarks. — This is a very rare species in the Famennian of Dębnik. Although the collection is very small and the identification of the species is somewhat tentative, the specimens strongly suggest *Schizophoria shubarica* MARTYNOVA from the Meister beds (Famennian) of Kazakhstan (MARTYNOVA 1961). Both forms attain similar shell dimensions and have the same shape and ornamentation of the shell.

Occurrence. — *Schizophoria shubarica* MARTYNOVA was described from the Meister beds (Famennian) of Kazakhstan (MARTYNOVA 1961). At Dębnik, the species was recovered in trenches Z.orb.-8 and -1 in the *Dmitria gibbosa* interval and the *Cyrtospirifer carinatus* interval, respectively (the *P. crepida* and probably the Lower *P. rhomboidea* conodont Zones).

Schizophoria sp.
(Pl. 1: 6)

Remarks. — Fifteen silicified valve fragments found in residue of a conodont sample from trench Z.pal-1 (*Cavatisinurostrum longilinguis* interval; the Middle *P. crepida* conodont Zone). Of them, 14 represent juvenile stages and measure 1.5 to 6 mm in width. Although the specimens are very fragmentary, they preserve satisfactory details of the internal shell structure (Pl. 1: 6).

Order **Strophomenida** ÖPIK, 1934
Suborder **Strophomenidina** ÖPIK, 1934
Superfamily **Davidsoniacea** KING, 1850
Family Uncertain
Genus *Eoschuchertella* GRATSIANOVA, 1964
Eoschuchertella sp.
(Pl. 1: 2–5, 7–8)

Material. — Two slightly damaged shells from trench Z.orb-7, and 29 exfoliated fragments from trenches Z.orb-1, -6 to -8 and ZS-1. In addition, 32 silicified and etched specimens from trench ZS-1; these are mostly very fragmentary but frequently showing details of the internal structure.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	lAr/W %	HArvv
122b	10.8	8.7	11.8	(4.0)	(88)	2.6
366a	17.6	14.1	19.3	6.8	88	5.1
122d	18.2	14.0	(18.8)	8.0	96	5.6
366b	18.9	16.0	23.4	7.4	78	4.7

Description. — Shell medium sized for the genus, up to 25 mm in maximum length but rarely exceeds 18 mm; semicircular in outline, slightly wider than long, cardinal margin straight and long, attaining 78 to 96% of the maximum shell width; antero-lateral margins smoothly rounded, anterior commissure with very weak uniplication.

Pedicle valve gently convex with very shallow, broad sulcus or median flattening developed in anterior half of large specimens. Umbonal region deformed, perforated by pedicular fibers (koskinoides). Interareas high, flat to slightly concave, usually asymmetrical. Delthyrium covered entirely by pseudodeltidium, which is convex, and is divided into three radial sectors: one median and two lateral areas bordered by delicate ribs; each sector is defined by a flattened or gently concave area (Pl. 1: 8) that gives the tripartite appearance to the pseudodeltidium.

Brachial valve weakly convex to flat except at cardinal extremities where it becomes slightly concave. Interareas very low, linear; chilidium small, double, with median depression or notch.

Interior of pedicle valve without dental plates (Pl. 1: 5). Interior of brachial valve with bilobed cardinal process. A small node or tubercle is frequently developed between the lobes and anterior to them. Other details of cardinalia are illustrated in photographs of etched specimens (Pl. 1: 7). Shell impunctate.

Shell covered with costellae, 10 to 12 in 5 mm at anterior margin; costellae added by intercalation, developed in several generations. Micro-ornament consists of very fine, concentric growth lines.

Remarks. — GRATSIANOVA (1964) proposed the genus *Eoschuchertella* for "schuchertellids" with impunctate shell substance. COOPER and DUTRO (1982) established a second impunctate genus, *Floweria*. According to the latter authors, *Schuchertella* GIRTY should not be classified with impunctate forms. On the other hand, the separation of *Eoschuchertella* from *Floweria* seems to be rather difficult, and differences between them are not quite clear. According to COOPER and DUTRO (1982: 54), *Floweria* differs from *Eoschuchertella* in having cuplike cardinalia and a more strongly developed cardinal process. This is, however, not evident because the illustrated specimens of *Eoschuchertella*

popovi GRATSIANOVA have damaged cardinalia (GRATSIANOVA 1964; Pl. 13: 3, 5–7). Moreover, the interior of *F. parva* (HALL) has not been reillustrated.

Externally, the studied specimens are very close, if not conspecific with, *Streptorhynchus (=?Eoschuchertella) matyricus* NALIVKIN from the Elets beds (Lower Famennian) of the Russian Platform (NALIVKIN and MARKOVSKI 1934: 18; Pl. 2: 7–10; LYASHENKO 1959: 211; Pl. 80: 1–3). Both forms display similar shell outline and ornamentation. The specimens described here differ by having slightly larger shell dimensions and higher ventral interareas. The specimens of this report differ by their smaller shells and slightly thinner costellae from *Eoschuchertella ferquensis* BRICE from the Frasnian of Ferques, Boulonnais, France (BRICE 1988: 341–343; Pl. 41: 15–23) .

Occurrence. — The species occurs in several trenches in the southern part of the Dębnik anticline. It is rather rare in trenches Z.orb-6 to -8 and -1, where it occurs in the *Dmitria gibbosa* interval and the *Cyrtospirifer carinatus* interval, respectively (the *P. crepida* to Lower *P. rhomboidea* conodont Zones). It is a common fossil in limestones from trench ZS-1 that represent the *Cyrtiorina? depressa* interval (Upper *P. rhomboidea* conodont Zone).

Suborder **Productidina** WAAGEN, 1883
Superfamily **Strophalosiacea** SCHUCHERT, 1913
Family **Araksalosiidae** LAZAREV, 1989
Subfamily **Donalosiinae** LAZAREV, 1989
Genus *Donalosia* LAZAREV, 1989
Donalosia sp.
(Pl. 1: 11–13, 17)

Material. — Eight, very fragmentary single valves and complete shells embedded in rock; specimens come from trench Z.pal-1 and Z.orb-7.

Remarks. — The specimens are medium-sized to large, up to ca. 40 mm in width, pedicle valve gently convex with rather flattened umbonal part and cicatrix of attachment. Both valves with interareas; pseudodeltidium and chilidium present. Spines occur only on pedicle valve, situated on slightly elongated spine bases.

Although the specimens are very fragmentary, their external character suggests that they represent species belonging to the genus *Donalosia* LAZAREV. According to LAZAREV (1989: 35), *Donalosia* is represented in Russia by four late Frasnian through late Famennian species.

Occurrence. — The studied specimens were found in limestones from trenches Z.orb-7 (the *Dmitria gibbosa* interval; the *P. crepida* conodont Zone) and Z.pal-1 (*Cavatisinurostrum longilinguis* interval; the *P. crepida* conodont Zone).

Subfamily **Rhytialosiinae** LAZAREV, 1989
Genus *Rhytialosia* LAZAREV, 1989
Rhytialosia sp.
(Pl. 2: 1–3)

Material. — Three damaged shells and 32 fragments of shells and valves; some silicified specimens from trench Z.pal-1 were isolated from the rock with acetic acid and show details of internal shell structure (Pl. 2: 3). The majority of the collection comes from trench Z.pal-1; a few specimens were found in trenches Z.orb-6 and -12 as well as in locality PG.

Description. — Shell medium sized for the genus, up to 14 mm in width, transversally elliptical in outline; hinge long, straight; ears short.

Pedicle valve with cicatrix of attachment and low but distinct interareas; delthyrium closed by pseudodeltidium. Brachial valve with interareas and chilidium.

Teeth and sockets present; cardinal process bilobed, median septum low, higher anteriorly, not reaching cardinal process; dorsal adductor scars set on slightly elevated muscle platforms (Pl. 2: 3).

Both valves ornamented by concentric, irregular, undulose rugae, 2.5 to 3 per 1 mm; spines scattered on pedicle valve only; row of laterally directed spines present near hinge margin of the pedicle valve.

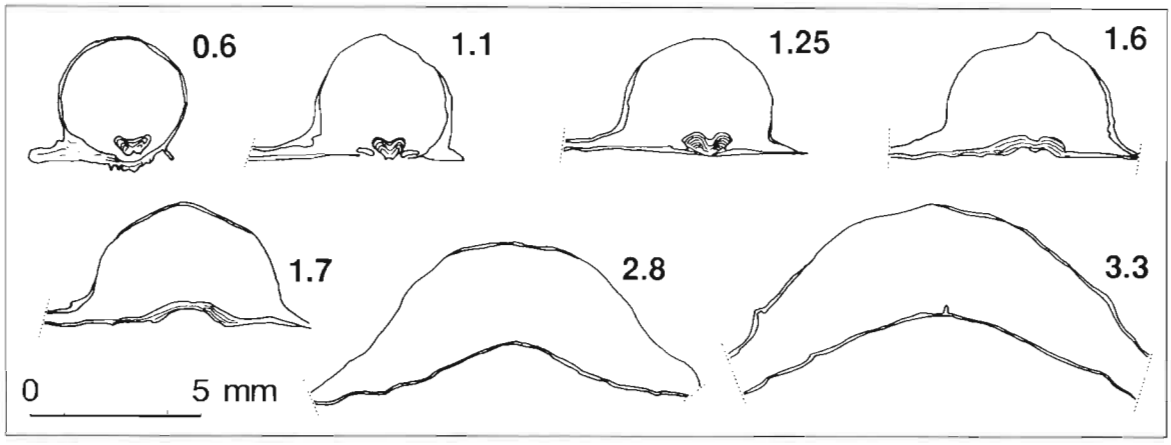

Fig. 6.
Transverse serial section of *Nigerinoplica* sp. (trench Z.bis-4). Numbers refer to distance in mm from ventral apex.

Remarks. — The specimens from Dębnik possess a very characteristic shell ornamentation of irregular undulose rugae and spines scattered on the pedicle valve only. In this respect, they are very similar to *Rhytialosia petini* (NALIVKIN) from the Frasnian of the Russian Platform, a form earlier reported as *Chonetipustula petini*. They are also similar to members of *Agramatia* SOKOLSKAYA from the Famennian of the Russian Platform, but the latter have spines on both valves.

It seems that the specimens from Dębnik represent a new species, but the collection is insufficient to establish a new taxon.

Occurrence. — The specimens here described come from trench Z.pal-1 situated on the west slope of Żbik ravine and from locality PG located north of Dębnik (the *Cavatisinurostrum longilinguis* interval; the *P. crepida* conodont Zone). They occur sporadically in limestones from trenches Z.orb-6 (the *Dmitria gibbosa* interval; the *P. crepida* conodont Zone) and trench Z.orb-12 (the *Cavatisinurostrum longilinguis* interval; the *P. crepida* conodont Zone) located in the eastern slope of Żbik ravine.

Superfamily **Productacea** GRAY, 1840
Family **Productellidae** MUIR-WOOD *et* COOPER, 1960
Subfamily **Productinae** MUIR-WOOD *et* COOPER, 1960
Genus *Nigerinoplica* LAZAREV, 1986
Nigerinoplica sp.
(Pl. 2: 8, 10; Pl. 5: 9; Text-fig. 6)

Material. — Four more-or-less complete pedicle valves embedded in rock, six damaged shells, and 51 fragments. This fragmentary and poorly preserved collection comes mainly from trenches Z.bis-1 to -2 and -4 and Z.tent-1 to -3; a few fragments were found also in trenches Z.orb-6 and -7.

Remarks. — This very fragmentary collection comprises specimens very characteristic for assemblages from the lowermost part of the Famennian of Dębnik. The species is medium sized, productellid in appearance, with strongly convex pedicle valve and short ears; spines rarely scattered, situated on elongated spine bases which anteriorly form short but distinct radial ribs. Weak median sulcus or flattening frequently occurs on the pedicle valve.

The specimens are probably conspecific with *Productella herminae* FRECH from the Elets beds (lower Famennian) of the Russian Platform, where it is a very characteristic fossil for this interval (MARKOVSKI and NALIVKIN 1934: 22; Pl. 1: 5–9; SARYTCHEVA and SOKOLSKAYA 1952: 86; Pl. 13: 82). They are identical with *Productella herminae* described by ŻAKOWA (1965: 529–532; Pl. 1: 1–4; Pl. 2: 5–7; Pl. 3: 9–11) from the lower Famennian of borehole Karniowice 3 situated ca. 6 km to the east of Dębnik.

The specimens reported as *P. herminae* from the lower Famennian of Dębnik and Karniowice 3, as well as from the Russian Platform, although being very similar, are not identical with typical

specimens of *Productella herminae* FRECH from the Iberger Kalk (Frasnian) of western Germany (FRECH 1891: 677–678; Pl. 47: 3, 5–6, 10–11). The formers differ by being larger and usually wider and by having a median depression or sulcus in the pedicle valve. It seems that the lower Famennian form reported as *P. herminae*, including specimens from Dębnik, represent a different species but the present collection precludes the proposal of a new species. LAZAREV (1986: 67) suggested that the Famennian specimens reported as *P. herminae* belong to the genus *Nigerinoplica* LAZAREV.

Occurrence. — *Nigerinoplica* sp. occurs in several trenches situated to the south of Dębnik in the eastern slope of Żbik ravine. It is a common fossil in trenches Z.bis-1 to -2 and -4 (*Cyrtospirifer brodi* interval; *P. triangularis* conodont Zone) as well as in younger layers that were exposed in trenches Z.tent-1 to -3 (*Cyrtospirifer wesgensis* interval; *P. triangularis* conodont Zone). This is a rare species in trenches Z.orb-6 and -7 (*Dmitria gibbosa* interval; *P. crepida* conodont Zone).

Family **Leioproductidae** MUIR-WOOD *et* COOPER, 1960
Subfamily **Leioproductinae** MUIR-WOOD *et* COOPER, 1960
Genus *Leioproductus* MUIR-WOOD *et* COOPER, 1960
Leioproductus cf. *pauperculus* COOPER *et* DUTRO, 1982
(Pl. 2: 4–7)

cf. 1982. *Leioproductus pauperculus* new species; G.A. COOPER and J.T. DUTRO: 64; Pl. 12: 21–28; Pl. 13: 2–9.

Material. — One damaged shell, nine pedicle valves, two brachial valves, and 16 fragments; all of the collection came from trenches ZS-1 and -2 located to the southwest of Dębnik.

Description. — Shell small to medium sized for the genus, subcircular to squarish in outline, wider than long; hinge shorter than maximum width, ears small; interareas absent.

Pedicle valve strongly convex, ornamented with weak concentric wrinkles posteriorly and concentric lines anteriorly; scattered spine-bases occur on the anterior ridges in some specimens. Median row of spines indistinct.

Brachial valve regularly concave with flattened cardinal extremities, ornamented with shallow pits and concentric wrinkles best developed at hinge and ears.

Interior poorly known; breviseptum in brachial valve, bilobed cardinal process and shallow alveolus are present.

Remarks. — The specimens are very close to *Leioproductus pauperculus* COOPER *et* DUTRO, which was described from the Percha Formation (Box Member) of New Mexico, USA (COOPER and DUTRO 1982: 64; Pl. 12: 21–28; Pl. 13: 2–9). Both have similar shell forms with strongly convex pedicle valve and comparable shell ornamentation. The former differs by occasionally attaining greater shell dimensions and by lacking a clearly developed median row of spines on the pedicle valve. According to COOPER and DUTRO (1982: 64), this row, although indistinct, sometimes occurs in *L. pauperculus*. Despite these rather minor differences, both forms seem to be very close.

Occurrence. — *Leioproductus* cf. *pauperculus* is a rather rare species in limestones from trenches ZS-1 and -2 that represent the *Cyrtiorina*? *depressa* Zone (Upper *P. rhomboidea* conodont Zone). In the USA, *L. pauperculus* occurs in the Percha Formation (Box Member) of New Mexico (COOPER and DUTRO 1982).

Genus *Mesoplica* REED, 1943
Mesoplica costata sp. n.
(Pl. 3: 4–9; Text-fig. 7A–B)

Holotype: ZPal Bp XXIII/110, illustrated in Pl. 3: 4–9.

Type horizon: *Cyrtospirifer carinatus* interval, the Lower *P. rhomboidea* conodont Zone.

Type locality: Dębnik, trench Z.orb-2 in the eastern slope of Żbik ravine.

Derivation of the name: *costata* — to draw attention on the strong shell costation.

Diagnosis. — Shell medium sized for the genus, subrectangular to subtrapezoidal in outline, wider than long, with distinct ears, geniculated; pedicle valve deeply sulcate with long trail ornamented by strong radial costae; visceral discs ornamented by rugae and spine bases (pedicle valve) or pits (brachial valve); trail costate with median fold; small linear ventral interareas present. Brachial interior

width median septum, large bilobate cardinal process and alveolus; rudiments of dentition sometimes present.

Material. — Twenty-one complete to nearly complete specimens usually with brachial valve embedded in a rock and with exposed pedicle valve; 160 additional fragments. The majority of the collection comes from trenches Z.orb-1 to -3; a few specimens were also found in trenches Z.orb-5 and ZW-1. Five fragments were found in trench ZS-6 located to the east of Dębnik.

Description. — Shell medium sized for the genus (up to 30 mm in width), subrectangular to subtrapezoidal in outline, wider than long; hinge long, straight; ears distinct, subrectangular, convex; interareas present but very low, linear, sometimes discernible only at the middle, strongly inclined.

Pedicle valve strongly convex, medially sulcate, and with long trail; umbo slightly swollen and protrudes beyond hinge line; sulcus starts at 5 to 6 mm from the umbo and is wide, often deep.

Brachial valve gently concave on visceral disc, becoming more concave in postero-median region and flattened or even slightly elevated at antero-lateral part (i.e., near geniculation where a weak fold develops; valve geniculated, with fairly long trail; broad fold on trail corresponds to ventral sulcus; concave ears elevated above visceral disc.

Interior studied mainly in serial section (Text-fig. 7A–B). Muscle scars are very well developed inside the pedicle valve, and high radial ridges well developed in some sections (Text-fig. 7B); rudiments of teeth are seen in one sectioned specimen.

Brachial valve with large bilobate cardinal process; small alveolus present; median septum low and broad posteriorly, slender and sharp anteriorly, usually not extending to the base of cardinal process; brachial ridges present.

Visceral disc of pedicle valve with low, rounded rugae and spine bases which are elongated anteriorly and eventually form costae starting at geniculation; capillation is seen on decorticated specimens. Trail covered by rather strong, rounded costae, often irregularly spaced, 2 to 4 in 5 mm, those in sulcus frequently weaker; Median costae on some specimens have tendency to converge anteriorly. Spines scattered over visceral disc and in a sparse row close to the hinge margin; those on trail situated on costae. Brachial valve ornamented by low rugae and circular pits on the visceral disc and by costae in the trail; no spines.

Remarks. — *Mesoplica costata* sp. n. is characterized by its large size, distinctly sulcate and costate trail, and lack of strong median costa or spine row. The presence of small linear ventral interareas and rudiments of teeth suggest that the species represents a more primitive stage than other representatives of the family Leioproductidae. This can be explained, however, by the stratigraphic position of the present collection, which is evidently older than majority of other specimens of the family. *Mesoplica* species are found typically in the uppermost Famennian.

The present definition of the genus *Mesoplica* REED is very broad. The species included in the genus have, for example, a great variability in shell costation. On the one hand, there are species with a very weak radial ornamentation, such as *M. praelonga* from Afghanistan (BRICE 1970; Pl. 14: 1) or *M.? jeremiahensis* ROBERTS from northwestern Australia (ROBERTS 1971; Pl. 14: 17–26), as well as such strongly costate forms as *Mesoplica kosmuruni* (SIMORIN) (MARTYNOVA and LITVINOVICH 1975; Pl. 7: 33–35; Pl. 8: 1–3) or *Mesoplica? hillae* MCKELLAR (MCKELLAR 1970; Pl. 7: 14–26). Taking this variation into consideration, it is appropriate to assign the new species to *Mesoplica*.

Mesoplica costata sp. n. differs from many other leioproductids by the development of strong shell costation. It is very close, however, to some species described from the Famennian of Kazakhstan as representatives of the genus *Plicatifera* (MARTYNOVA 1961). The Polish specimens have a costation very similar to that of specimens described as *Plicatifera praelonga* (SOWERBY) (*ibidem*: 80–82, Pl. 3: 5–11). The former differ by having a much deeper ventral sulcus and by lacking a median costa. *Plicatifera semisbugensis* (NALIVKIN) (*ibidem*: 84, Pl. 3: 12–14), which is also strongly costate, differs from *M. costata* sp. n. by its larger shell and has a weaker sulcus with a median costa. The specimens described herein show the closest similarity to *Plicatifera simplicior* var. *nigeraeformis* MARTYNOVA, a form described later as *Mesoplica kosmuruni* (SIMORIN) from the upper Famennian and the lower Tournaisian of central Kazakhstan (MARTYNOVA 1961: 86–87; Pl. 4: 16; Pl. 5: 1–4; MARTYNOVA and LITVINOVICH 1975: 63; Pl. 17: 33–35; Pl. 18: 1–3). Externally, the only distinct difference is the lack

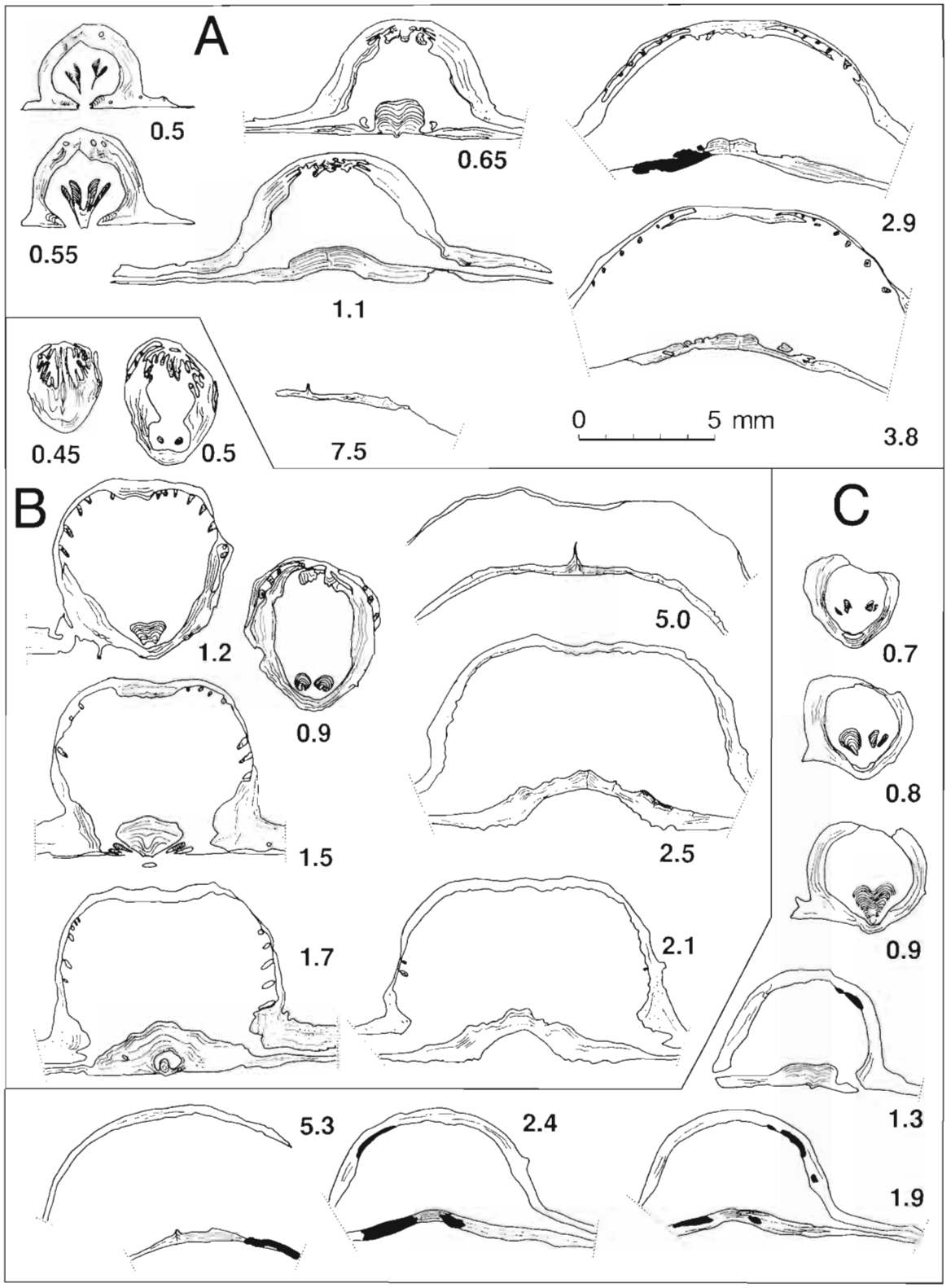

Fig. 7.
Transverse serial section of *Mesoplica costata* sp. n. (A — trench Z.orb-1; B — trench Z.orb-2) and *Mesoplica* cf. *praelonga* (SOWERBY) (C — trench ZS-1). Numbers refer to distance in mm from ventral apex.

of a ventral sulcus in the Kazakhstan form. According to LAZAREV (1986: 63), *M. kosmuruni* belongs to the genus *Spinocarinifera* ROBERTS and is characterized by the absence of teeth and sockets.

Mesoplica costata sp. n. is also similar externally to *Mesoplica*? *hillae* MCKELLAR from the Famennian of Queensland (MCKELLAR 1970: 23–24; Pl. 7: 14–26). The Polish species resembles the latter not only in shell ornamentation but also in some primitive aspects of the internal structure of the shell such as the presence of an alveolus and a rudimentary articulation. The Polish species differs by having a longer median septum, a deeper ventral sulcus and by lacking a median costa.

The specimens from Dębnik differ also from *Productus (Avonia) praelongus* SOWERBY described by DEHÉE (1929: 41–43; Pl. 6: 13–16) from the Etroeungtian and lowermost Dinantian of France and Belgium. The former are much smaller and have a stronger costation and a deeper sulcus.

The specimens listed by JAROSZ (1926: 142) as *Productus (Productella) praelongus* SOWERBY from old quarries in the eastern slope of Żbik ravine belong to *Mesoplica costata* sp. n.

Occurrence. — *Mesoplica costata* sp. n., together with *Athyris sulcifera* NALIVKIN and *Cyrtospirifer carinatus* sp. n. is a very characteristic fossil of the limestones that crop out on the west slope of Żbik ravine in trenches Z.orb-1 to -3 and -5 and in trench ZS-1 situated in western branch of Żbik ravine. The equivalent of this interval was found in this study to the east of Dębnik in trench ZS-6. All of these occurrences represent the *Cyrtospirifer carinatus* interval (Lower *P. rhomboidea* conodont Zone).

Mesoplica cf. *praelonga* (SOWERBY, 1840)
(Pl. 9, 11; Text-fig. 7C)

cf. 1840. *Leptaena praelonga*; J. SOWERBY: Pl. 53: 29.

cf. 1897. *Productus praelongus*, SOWERBY, sp.; G.F. WHIDEBORNE: 168–169; Pl. 20: 12–13.

cf. 1960. *Mesoplica praelonga* (J. de C. SOWERBY); H. MUIR-WOOD and G.A. COOPER: 175; Pl. 44: 1–5.

Material. — Three more-or-less complete pedicle valves and seven fragments of shells and isolated valves from trench ZS-1 and from loose blocks of limestone scattered in the vicinity of the trench.

Description. — Shell medium sized for the genus, trapezoidal to subquadrate in outline. Pedicle valve strongly convex, always with median sulcus starting at some distance from umbo; ears up to 6 mm in length, convex, tapering laterally. Brachial valve not found.

Interior with large bilobed cardinal process and breviseptum (see serial sections in Text-fig. 7C).

Pedicle valve ornamented with very weak concentric wrinkles in posterior part and weak to very weak radial costae anteriorly. Distinct median ridge or costa with row of spines always present on the bottom of median sulcus. Spines scattered, occur usually on radial costae.

Remarks. — The existing definition of the species *Mesoplica praelonga* (SOWERBY) is very broad, as is the definition of the genus. The specimens included in the species show a great variability in shell costation. There are specimens with very weak radial costae, as those from Afghanistan (BRICE 1970; Pl. 14: 1), and strongly costate specimens, as those from Kazakhstan (MARTYNOVA 1961; Pl. 3: 5–11). However, SOWERBY's (1840; Pl. 53: 29) original figures do not show any trace of shell costation (for more discussion see ROBERTS 1971: 91–92). The specimens from Dębnik are very close in shell ornamentation to *M. praelonga* described from Afghanistan (BRICE 1970). They are slightly smaller and usually have weaker costae than the specimens of the species from north Devonshire, England which were illustrated by MUIR-WOOD and COOPER (1960; Pl. 44: 1–3).

It is evident that reports of *Mesoplica praelonga* include collections that represent different species. The relationships of these to the type specimens designated by SOWERBY are impossible to establish at present. The specimens from Dębnik can be referred to *M. praelonga* only tentatively because of these taxonomic problems.

Occurrence. — *Mesoplica praelonga* is regarded as a characteristic species for the Famennian and, especially, for the uppermost Famennian (Strunian) of England, France, Germany, Kazakhstan and Afghanistan. It occurs in the Chojnice 2 and 4 boreholes (western Pomerania) in Poland, where it was found in the *P. rhomboidea* through *P. marginifera* Zones (MATYJA 1972) and the *P. marginifera* through *S. velifer* Zones (MATYJA 1975), respectively. The species was also reported in the Famennian

of the Lublin Basin in the Minkowice 1 borehole in the *P. crepida* Zone (MATYJA 1954) and in the Niedrzwica 2 borehole in the *Wocklumeria* Zone (KALIŚ 1969). SAMSONOWICZ (1951: 441; Pl. 2: 5) illustrated a specimen of *Productus praelongus* (SOWERBY) from the Busk borehole in Wolhynia, Poland.

Mesoplica cf. *praelonga* occurs at Dębnik in trench ZS-1, where it is one of the characteristic fossils (the *Cyrtiorina*? *depressa* interval; the *P. rhomboidea* conodont Zone). The specimens found by JAROSZ at Żbik ravine to the south of Dębnik and listed as *Productus (Productella) praelongus* SOWERBY (JAROSZ 1926: 142–143) are referred above to *Mesoplica costata* sp. n.

Mesoplica sp.
(Pl. 2: 12)

Material. — One incomplete pedicle valve from trench ZS-2.

Remarks. — This specimen is characterized by its size (up 25 mm in width, measured without ears), development of distinct but low radial costae, and by the presence of very weak to obsolescent median sulcus. It differs from *Mesoplica* cf. *praelonga* by larger size, stronger costation, and weaker median sulcus. It seems to be very close to the specimens of *M. praelonga* illustrated by MUIR-WOOD and COOPER (1960; Pl. 44: 1–3), but differs slightly by having wider, less numerous costae. It seems to be very close to *Productus (Avonia) praelongus* SOWERBY, which was described by DEHÉE (1929: 41–43; Pl. 6: 13–16), but differs by its usually smaller shell, weaker and thicker costation, and shorter trail.

Occurrence. — The specimen studied in this report was found in the uppermost layers in trench ZS-2 that represent the *Cyrtiorina*? *depressa* interval (*P. rhomboidea* conodont Zone).

The specimens most probably are conspecific with *Productella herminae* FRECH from boreholes in the lower Famennian: Karniowice 3, Cracow region (ŻAKOWA 1965), Chojnice 2 and 3, west Pomerania, and Minkowice 1, Lublin Basin (MATYJA 1972, 1975; MATYJA and ŻBIKOWSKA 1974) as well as from the Russian Platform.

Superfamily **Echinoconchacea** STEHLI, 1954
Family **Sentosiidae** MCKELLAR, 1970
Genus *Sentosia* MUIR-WOOD *et* COOPER, 1960
Sentosia profunda MCKELLAR, 1970
(Pl. 3: 1–3; Pl. 5: 9)

1970. *Sentosia profunda* sp. nov.; R.G. MCKELLAR: 28–29; Pl. 9: 1–13.
1965. *Plicatifera fallax* (PANDER); H. ŻAKOWA: 532–535; Pl. 4: 13–17; Pl. 5: 18; Fig. 4.

Material. — One damaged shell, 26 complete to slightly damaged single valves embedded in rock, and 37 fragments from trenches Z.tent-1 to -3. One pedicle valve fragment was found in trench Z.orb-8. The specimens are poorly preserved, fragmentary, exfoliated, and sometimes partly silicified.

Description. — Shell medium sized for the genus, up to 30 mm in width, suboval to semicircular in outline, wider than long, widest at or near hinge; ears very short, poorly defined; hinge long, straight.

Pedicle valve strongly convex, globose in mature specimens, with steep flanks; flattened medially, occasionally with weak sulcus; umbo slightly swollen; interareas very short and low but observed in only one specimen. Brachial valve moderately concave with a little triangular depression at umbonal region.

Interior of the pedicle valve with flabellate adductor scars divided by a low myophragm which arises about 3 mm from the umbo and extends up to 9 mm. Another median ridge is confined to umbonal region and measures up to 2 mm in length.

Interior of the brachial valve poorly known; there is a very fine median septum about 6 mm long; a shallow alveolus is present on some specimens at the base of the cardinal process.

Both valves ornamented with spines, concentric lines, and rugae; rugae indistinct, irregular, better defined on flanks. Spine bases denser on the pedicle valve, more or less quincuncially arranged, with tendency to form rows anteriorly; irregular and short ribs are developed near anterior margin of some large specimens.

Remarks. — The species is represented by rather fragmentary and poorly preserved specimens. Nevertheless, it is a very characteristic species of an assemblage occurring in trenches Z.tent-1 to -3. The form is characterized by a suboval to semicircular outline of the shell, strongly convex, an often globose pedicle valve with median flattening or very weak sulcus, and a concave brachial valve. The specimens from Dębnik are similar in many respects to *Sentosia profunda* McKELLAR from the Famennian (do III to do IV) of Queensland (McKELLAR 1970: 28–29; Pl. 9: 1–13). Both forms have the same shell shape, strong convexity of the pedicle valve and occasional shell costation at the anterior margin.

The species was listed by JAROSZ (1926: 142) as *Strophalosia (Productella) productoides* MURCHISON from the left (eastern) slope of Żbik ravine and by ŻAKOWA (1965: 532–535; Pl. 4: 13–17; Pl. 5: 18; Text-fig. 4) as *Plicatifera fallax* (PANDER) from the Karniowice 3 borehole, located ca. 6 km to the east of Dębnik.

Occurrence. — *Sentosia profunda* McKELLAR occurs in the Famennian (do III to do IV) of Queensland. The species was found at Dębnik in dolomitic limestones from trenches Z.tent-1 to -3 in the *Cyrtospirifer wesgensis* interval (*P. triangularis* conodont Zone) and in trench Z.orb-8 in the *Dmitria gibbosa* interval (*P. crepida* conodont Zone). The species was reported as *Plicatifera fallax* (PANDER) from the Karniowice 3 borehole (Cracow region).

Sentosia sp.
(Pl. 5: 7)

1918. *Strophalosia productoides* MURCHISON; J. JAROSZ: 97–98; Pl. 7: 10–11.

Material. — One impression of a brachial valve from the Stromatoporoid Rock.

Remarks. — The specimen, although badly preserved, shows characteristic ornamentation, regular subcircular outline, and gentle concavity of the valve. JAROSZ (1918: 97–98; 1927: 121) described the species from the same locality as *Strophalosia productoides* MURCHISON.

Occurrence. — This is a very rare species in light gray, very hard limestone from Stromatoporoid Rock to the north of Dębnik between Rokiczany Dół and Żarnówczany Dół ravines.

Order **Rhynchonellida** KUHN, 1949

Superfamily **Rhynchonellacea** GRAY, 1848
Family **Trigonirhynchiidae** McLAREN, 1965
Genus *Centrorhynchus* SARTENAER, 1970
Centrorhynchus cf. *letiensis* (GOSSELET, 1879)
(Pl. 4: 8–10)

cf. 1887. *Rhynchonella letiensis*; J. GOSSELET: 206–210; Pl. 1: 9–19.

Material. — One fragment of exfoliated shell and two fragmentary specimens of pedicle and brachial valves; one silicified fragment of the posterior part of a pedicle valve from conodont residue. All specimens from trench Z.orb-9.

Description. — Shell reaches approximately 18 mm in length, dorsibiconvex. Pedicle valve slightly convex posteriorly, becomes slightly concave toward the anterior parts of flanks. Costae simple, strong, two to three in the sulcus, seven on each flank; those on the flanks form spurs at the antero-lateral margins. Brachial valve almost two times as deep as pedicle valve. Three to four simple costae on fold, six on flanks. Parietal costae not observed. Dental plates present inside pedicle valve.

Remarks. — The specimens of this report are very close, if not identical, to *Centrorhynchus letiensis* (GOSSELET) in general shape of shell and details of the shell ornament. Unfortunately, these specimens are so poorly preserved that they cannot be definitely identified.

Occurrence. — According to GOSSELET (1887), *C. letiensis* occurs in the upper Famennian of Belgium. SARTENAER (1970: 13) recorded the stratigraphic range of the species from the upper part of the lower Famennian into the lower part of the upper Famennian.

The specimens studied in this report come from trench Z.orb-9 (uppermost part of the *P. triangularis* or the lowermost part of the *P. crepida* conodont Zone).

Genus *Ptychomaletoechia* SARTENAER, 1961
Ptychomaletoechia sp.
(Pl. 4: 1–3; Text-fig. 8)

Material. — Three complete, four slightly damaged and 13 fragmentary shells. This small and rather fragmentary collection comes mainly from trench Z.orb-6; a few additional specimens came from trenches Z.orb-7 and 8.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	Aa°	Nr/su	Nr/fo	Nr/fl
36b	12.8	11.5	14.6	10.6	112	5	6	(8)
36c	14.8	13.5	16.3	(9.0)	106	6	6	15
36a	(16.3)	(15.0)	16.2	11.6	–	7	8	12
381a	17.4	16.3	20.0	19.3	119	6	7	14

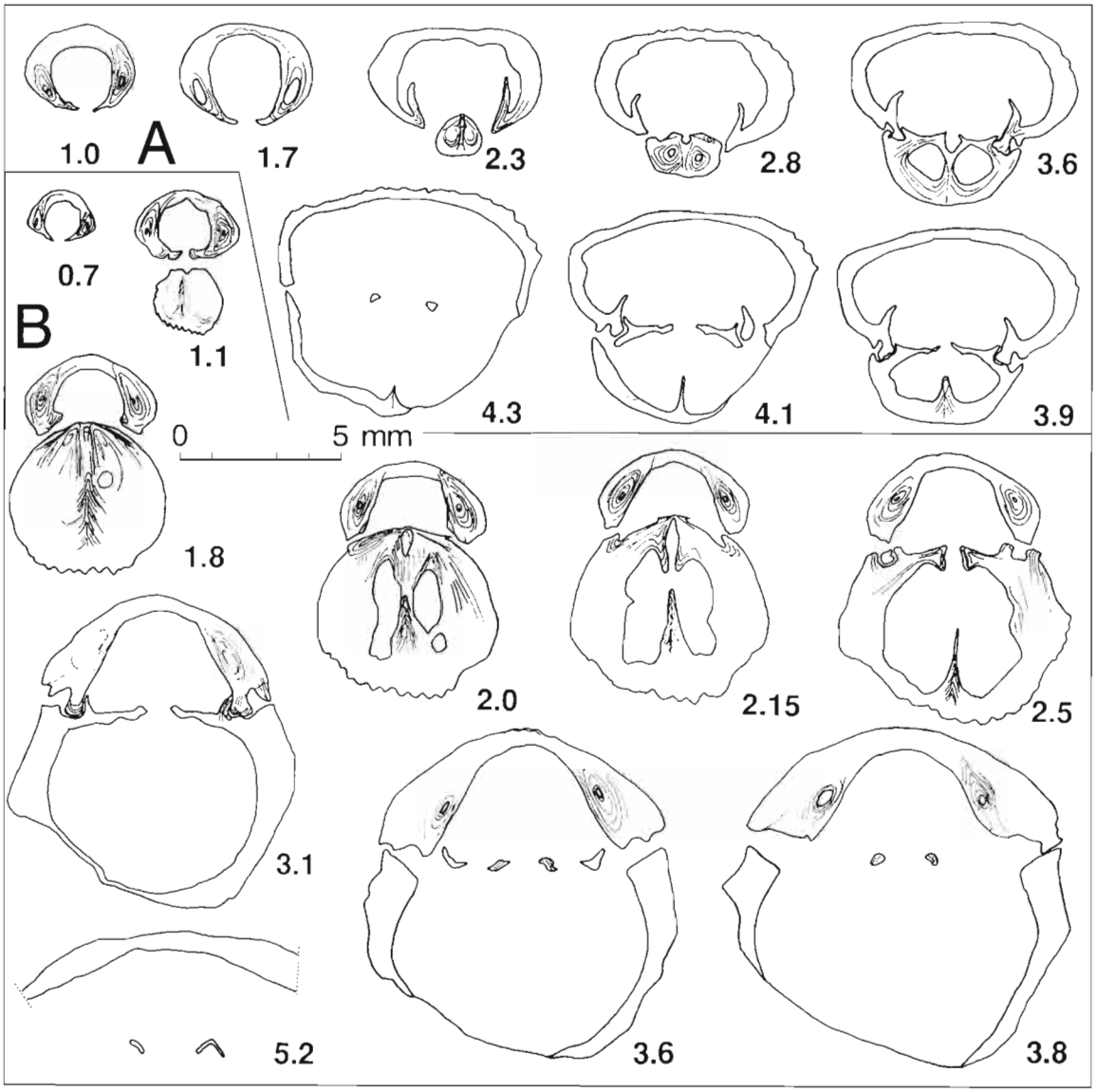

Fig. 8.
Transverse serial section of *Ptychomaletoechia* sp. (A — trench Z.orb-6; B — trench Z.orb-7). Numbers refer to distance in mm from ventral apex.

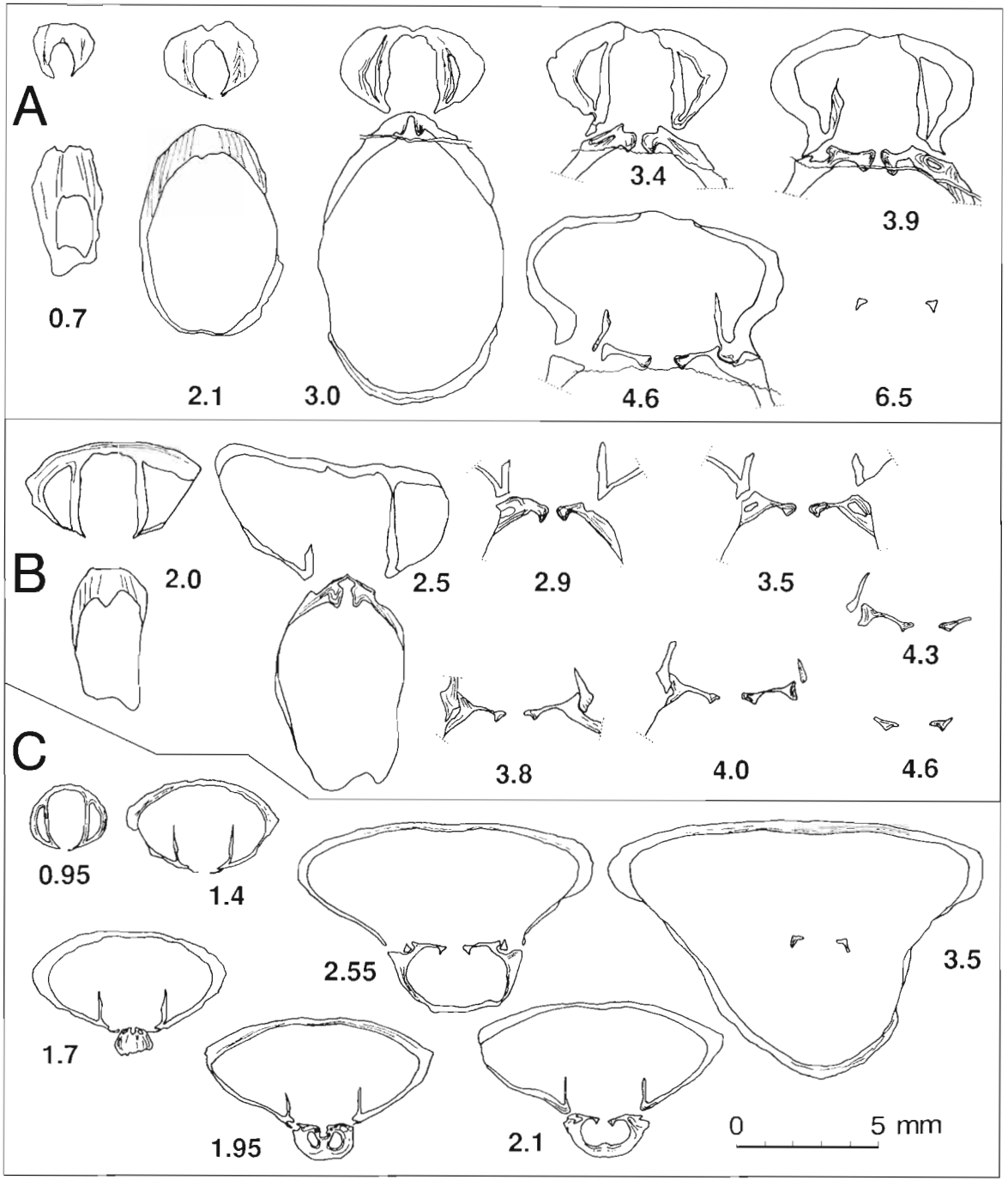

Fig. 9.
Transverse serial section of *Cavatisinurostrum longilinguis* sp. n. (A–C — locality PG). Numbers refer to distance in mm from ventral apex.

Description. — Shell medium sized for the genus, dorsibiconvex, rather wider than long, transversally elliptical in outline with protruding umbonal region; lateral margins arched, anterior margin truncated by the flat tongue, anterior commissure uniplicate.

Pedicle valve slightly convex; sulcus begins at mid-length and widens slowly to attain 49 to 53% of the shell width at the commissure. The bottom of the sulcus is flat to slightly concave; each slope bears one parietal costa. Tongue trapezoidal, sometimes recurved slightly posteriorly.

Brachial valve almost twice as deep as pedicle valve. The fold starts at about mid-length; its top is slightly arched.

There are 5 to 7 costae on the sulcus, 6 to 8 costae on fold, and up to 15 costae on each flank of a valve. One parietal costa usually occurs on each slope of fold and sulcus; they do not indent the commissure.

Long dental plates are present inside the pedicle valve; deltidial plates may be seen in transverse section (Text-fig. 8). Interior of the brachial valve as for the genus; connectivum not preserved.

Remarks. — This small and fragmentary collection comprises specimens which are characterized by quite large variability in shell shape and ornamentation. The specimens are similar externally in many respects to *Camarotoechia turanica* (ROMANOVSKI) (= *Ptychomaletoechia turanica*) from the Famennian of Kazakhstan (MARTYNOVA 1961). They differ, however, in the shell ornamentation; *C. turanica* has fewer costae on flanks. *Camarotoechia brodica* NALIVKIN (MARKOVSKI and NALIVKIN 1934) is another species from the Famennian of Russia that is comparable to the specimens from Dębnik. Both have similar ornamentation of the shell and shape of the tongue. The former seems to be a little larger and wider. SARTENAER (1966) suggested that *C. brodica* NALIVKIN may belongs to his genus *Ripidiorhynchus*, although he now thinks that the species is closer to the genus *Ptychomaletoechia* (pers. commun.).

The specimens from Dębnik are very close in shell shape to *Rhynchonella omaliusi* GOSSELET (GOSSELET 1887: 202–206; Pl. 2: 1–10). They differ, however, by having more costae on the flanks and in the middle region of the shell. They are also more finely costate than *Rhynchonella gonthieri* GOSSELET which has been described from the Famennian of Belgium (*ibidem*: 218–220; Pl. 3: 14–16).

Occurrence. — The collection comes from trenches Z.orb-6 to 8 situated on the east slope of Żbik ravine and represents the *Dmitria gibbosa* interval (lower part of the *P. crepida* conodont Zone).

Family **Pugnacidae** RZHONSNITSKAYA, 1956
Genus *Cavatisinurostrum* SARTENAER, 1972
Cavatisinurostrum longilinguis sp. n.
(Pl. 5: 1–6; Pl. 6: 8; Text-fig. 9–10)

1903. *Rhynchonella acuminata* MARTIN; G. GÜRICH: 147.

Holotype: ZPAL Bp XXIII/390, illustrated in Pl. 5: 3.

Type horizon: *Cavatisinurostrum longilinguis* interval, the *P. crepida* conodont Zone.

Type locality: Dębnik, loose blocks at locality Pałkowa Góra (PG) near the western end of Żarnówczany Dół ravine.

Derivation of name: *longilinguis*, Lat. *longus* — long, *lingua* — tongue, from a long tongue on the pedicle valve.

Diagnosis. — Shell medium to large sized for the genus, as wide as long, attains the greatest width at or forward of mid-length; tongue long with its antero-dorsal end rounded to slightly crenulated; anterior parts of fold and sulcus costate, rest of the shell smooth.

Material. — 17 complete or slightly damaged specimens and 84 fragmentary shells from locality PG; two additional specimens from trench Z.orb-5, and another two from trench Z.pal-1.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	Aa°	Nr/su	Nr/fo	Nr/fl
388	18.6	17.4	19.5	10.3	127	0	0	0
399	24.9	24.1	22.8	17.4	117	1	2	0
396	26.1	25.1	(29.3)	15.1	128	–	–	0
389	26.5	25.5	24.3	18.0	121	2	3	0
390 (holotype)	27.0	25.2	25.2	19.3	129	1	2	0
391	27.3	26.6	25.2	27.3	100	2	3	0
394	27.9	25.7	28.4	23.3	–	2	3	0
392	32.0	30.2	29.1	27.2	110	2	3	0

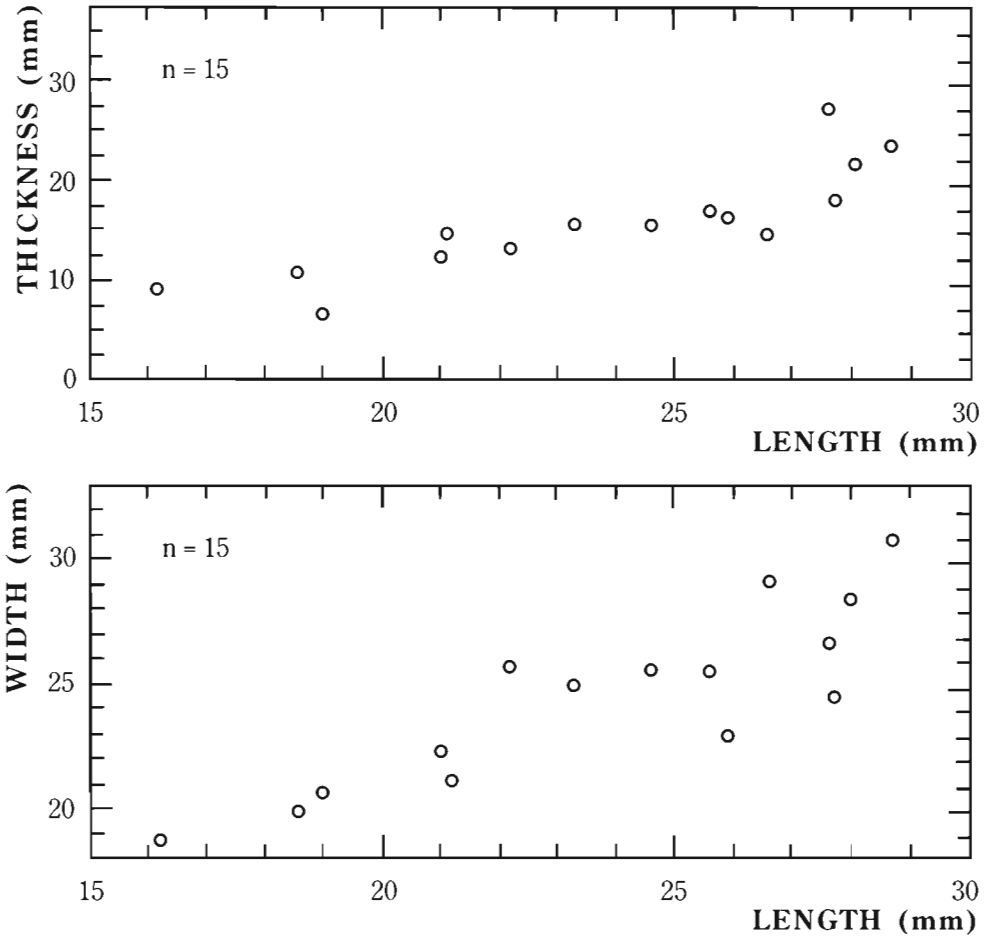

Fig. 10.
Scatter diagram of thickness versus length (A) and width versus length of shell (B) in *Cavatisinurostrum longilinguis* sp. n.

Description. — Shell medium to large sized for the genus, strongly dorsibiconvex, as wide as long (Text-fig. 10), heart-like in outline; cardinal margin strongly curved, lateral margins rounded, anterior margin truncate, anterior commissure uniplicate.

Pedicle valve slightly convex only in posterior part and medially excavated along the rest of its length; postero-lateral margins bent dorsally. Sulcus wide and deep, gently concave, begins near the umbo; tongue high, particularly in adult and gerontic specimens, antero-dorsal end of tongue rounded to slightly crenulated.

Brachial valve very deep, V-shaped in transverse section with swollen umbonal region; fold high but laterally smoothly grades into flanks; lateral parts of valve strongly expanded ventrally.

Shell surface smooth except for anterior parts of fold and sulcus of adult and gerontic specimens where a few radial costae are developed, usually two to three on brachial and one or two on pedicle valve; exceptionally at least four costae are visible in the sulcus of one poorly preserved specimen. Micro-ornamentation poorly preserved due to exfoliation; very weak radial striae, 5 per 1 mm, are visible on one specimen.

Interior of the pedicle valve with long and relatively parallel dental plates (Text-fig. 9). Hinge plates distinct and flat in the brachial valve (Pl. 5: 6); median septum absent, a very low and short median ridge may be visible in some serial sections (Text-fig. 9).

Remarks. — This species is one of the most characteristic element of the fauna of the limestones from Pałkowa Góra. It was described (but not illustrated) by GÜRICH (1903: 147) as *Rhynchonella*

acuminata MARTIN. The present study indicate that the specimens from Dębnik are very similar in internal structure as well as in general shape of the shell to the type species of the genus *Cavatisinurostrum* (i.e. *C. faniae* SARTENAER). The species from Dębnik is, however, a larger form than the one from Belgium and France. It has also a less acute commissure of the tongue in anterior view, more arcuate curvature of the brachial valve in lateral view, and smooth non costate lateral parts of the shell (more than 60% of specimens of *C. faniae* have one to six lateral costae: SARTENAER 1972: 10). Despite the differences, *C. longilinguis* sp. n. has a strong resemblance to *C. faniae*, and both species are very close.

The specimens from Dębnik are also externally similar to *Pugnax biloba* ROZMAN (*Physetorhyncha biloba*) from the Upper Famennian of the northern Mugodjary (ROZMAN 1960: 369–370; Pl. 86: 13; Pl. 28: 1–6; Text-fig. 48); they differ by a somewhat larger and narrower shell which is rather more oval than pentagonal in outline. The essential differences are, however, in the internal structure of the pedicle valve; species of the genus *Physetorhyncha* lack the dental plates (SARTENAER and ROZMAN 1968: 138; Text-fig. 1).

Occurrence. — The species occurs in loose blocks in the dirt road that leads from Dębnik to Paczółtowice, near the western end of Żarnówczany Dół ravine (locality PG). It also occurs to the south of Dębnik in trenches Z.pal-1 and Z.orb-5. All occurrences represent the *Cavatisinurostrum longilinguis* interval (*P. crepida* conodont Zone).

Genus *Coeloterorhynchus* SARTENAER, 1966

Coeloterorhynchus sp.

(Pl. 4: 6–7; Text-fig. 11A)

Material. — Six very fragmentary shells from trenches Z.orb-6 to -8 (two specimens from each trench).

Remarks. — These very fragmentary specimens differ from the pugnoid *Colophragma*? sp. described below by having a more excavated median part of the pedicle valve. In this respect, they are similar to *Coeloterorhynchus*. One sectioned specimen from trench Z.orb-6 shows the presence of dental plates and lack of dorsal median septum; a low median ridge is developed, however (Text-fig. 11A).

Occurrence. — All specimens come from layers representing the *Dmitria gibbosa* interval (middle part of the *P. crepida* conodont Zone).

Genus *Colophragma* COOPER *et* DUTRO, 1982

Colophragma? sp.

(Pl. 4: 4–5; Text-fig. 11B)

Material. — Six complete or slightly damaged and 20 fragmentary shells from quarry Z-2 (upper part of the section); three other shells and four fragments from trench Z-9. The collection is rather fragmentary; some specimens are partially silicified.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	Aa°	Nr/su	Nr/fo	Nr/fl
383c	(7.9)	7.3	8.8	6.4	(110)	1	2	2
401a	9.8	9.0	10.7	8.6	120	2	3	2
401b	11.1	10.3	12.7	8.3	113	2	3	2
401c	10.8	10.4	13.0	10.0	120	3	4	3
383a	11.3	10.5	13.0	9.6	115	3	4	2
383b	12.3	11.7	15.0	11.8	118	2	3	2

Description. — Shell medium sized for the genus, dorsibiconvex, wider than long, transversally elliptical in outline; cardinal margin curved, lateral margins rounded, anterior margin truncated, anterior commissure uniplicate and strongly crenulated by costae.

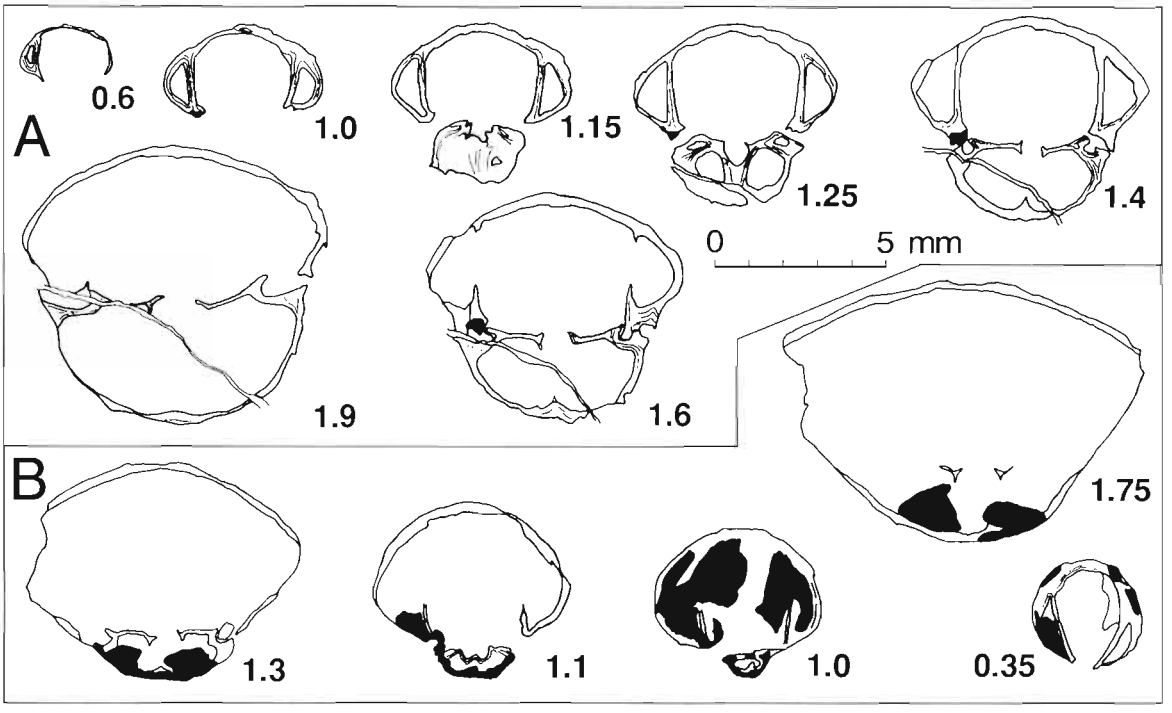

Fig. 11.
Transverse serial section of crushed shell of *Coeloterorhynchus* sp. (A — trench Z.orb-6) and partially silicified shell of *Colophragma* sp. (B — quarry Z-2). Numbers refer to distance in mm from ventral apex.

Pedicle valve slightly convex in posterior part, flanks gently convex to almost flat, remains of the valve medially excavated by wide but rather shallow sulcus. Sulcus starts some distance from the umbo and measures up to a half of the valve length. Its width is 61 to 75% of the shell width at the anterior margin. The bottom of the sulcus is slightly concave, flat to slightly convex, crenulated by costae. Tongue trapezoidal, long, often recurved posteriorly; its top is slightly convex and strongly crenulated by costae. Beak suberect to erect, protuberant.

Brachial valve convex, becomes concave near postero-lateral margins and is almost semicircular in transverse section. Sinus rather low, starting at about midvalve.

There are one to four (usually two to three) costae in the sulcus, two to five (usually three or four) costae on fold, and up to three costae on flank. Median and lateral costae start at about midlength of the shell or closer to the anterior margin; costae in sulcus start usually nearer to the beak than those on fold. The costae are rounded in their posterior part and become more angular but with rounded tops at anterior margin. Parietal costae absent. Shell surface covered by fine, flat radiating capillae and crossed by very fine concentric lines.

Thin dental plates are present in the pedicle valve; they are divergent in their apical part and become parallel to convergent anteriorly (Text-fig. 11B).

Outer hinge plates broad and flat to slightly convex inside the brachial valve; median septum absent although low, broadly angular median ridge or myophragm is present in transverse section. Distal parts of crura "L"-shaped in transverse section.

Intraspecific variability. — Although the collection is very fragmentary, some differences in the external appearance of the specimens can be observed. Some shells are wider than others and have more flattened flanks of the pedicle valve (Pl. 4: 4–5). The number of median ribs ranges from two to five on the sinus. The smallest mature shell in the collection measures only 7.6 mm whereas the largest one is 14.5 mm in length.

Remarks. — Serial sections reveal that a dorsal median ridge or myophragm is present in the studied specimens (Text-fig. 10B). This ridge is low and is not more than 0.1 to 0.2 mm in height.

Nevertheless, this ridge is confluent with the basal part of the hinge plates on some of the sections through the apical part of the brachial valve. In this way, the structure is very suggestive of a dorsal median septum and septalium. A similar condition is observed in some other Upper Devonian pugnacids (i.e., *Coeloterorhynchus* and *Colophragma*). However, BIERNAT (1972) noted the absence of a dorsal septum in specimens of *Parapugnax breccie* from the Frasnian of Kadzielnia in the Holy Cross Mountains, Poland. SARTENAER (1966: 43) stressed that distinctions of *Coeloterorhynchus* and *Parapugnax* that are based on the presence or absence of a septum should not be overemphasized. In the light of this considerations, the taxonomy of some pugnoid brachiopods should be carefully re-examined on the basis of serial sections, and intraspecific variability of the internal shell structure should be taken into consideration.

The specimens from Dębnik are referred questionably to the genus *Colophragma*. They have similarly flattened lateral flanks, and the dorsal median ridge resembles the short median septum of *Colophragma ellipticum* COOPER *et* DUTRO (1982: 78; Pl. 42: 11–19). Some of the illustrated specimens (see Pl. 4: 5) are almost identical externally to *C. ellipticum*; the former is only a little smaller. The other specimens from Dębnik are much smaller, are proportionally longer, and frequently have more ribs in the sulcus and fold. They may represent a new species but the material is inadequate to make any definite decision.

Occurrence. — The studied collection comes from the uppermost part of the profile of quarry Z-2 and from trench Z-9. Stratigraphically, the species occurs at the base of the Famennian (*Iloerhynchus mesoplicatus* interval). It is possible, however, that the species may occur also in the lowermost Famennian in the *Leiorhynchus laevis* Zone (=*Orbiculatisinurostrum laeve* Zone).

Family **Camarotoechiidae** SCHUCHERT, 1929

Genus *Iloerhynchus* gen. n.

Type species: *Iloerhynchus mesoplicatus* sp. n.

Diagnosis. — Shell medium sized, subelliptic to suboval in outline, almost as long as wide, uniplicate to parasulcate; fold and sulcus start some distance from the beak; lateral parts of valves usually nonornamented, fold and sulcus bear a few strong costae; interior with short septalium supported by long thin median septum; dental plates absent.

Remarks. — This genus is characterized by its subelliptic to suboval outline, usually smooth postero-lateral parts of shell, strongly costate fold and sulcus, and the absence of dental plates. Externally, it resembles slightly species of *Leiorhynchus*, but the new genus is distinctly different because of its stronger ornamentation on the median parts of the shell and by the absence of dental plates.

The new genus is quite close externally to *Camarotoechia* sp. ind. from Napier Formation, W Australia (VEEVERS 1959). It resembles especially one of the two illustrated there specimens (*ibidem*: 94–96; Pl. 10: 12–16). The Australian form, attributed by SARTENAER (1979) to the newly erected genus and species *Parvulaltarostrum veeversi* SARTENAER, is different because it has very distinct dental plates. Internally, the new genus is close to *Caryorhynchus* CRICKMAY; both genera have a short septalium and lack dental plates in the pedicle valve. *Iloerhynchus* gen. n. has a distinct general shell form and ornamentation and less thickened posterior parts of both valves. The new genus also differs also markedly from the Famennian rhynchonellid genus *Tenuisinurostrum* which does not possesses dental plates. The former genus is much smaller and less extended laterally and has much stronger shell ornamentation.

As far as it is known, the new genus is known from the type species only.

Iloerhynchus mesoplicatus gen. et sp. n.
(Pl. 6: 1–6; Text-fig. 12)

Holotype: ZPAL Bp XXIII/169e; illustrated in Pl. 6: 2.

Type horizon: Dark gray, marly micrites of *P. triangularis* Zone.

Type locality: Trench Z-9, situated south of Dębnik, Cracow Region, southern Poland.

Derivation of the name: *mesoplicatus* — from costate fold and sulcus.

Diagnosis. — As for the genus.

Material. — Three complete, 19 slightly damaged and 162 fragmentary shells; most of the collection comes from trench Z-9 and quarry Z-2 (top layers of the profile); some additional specimens come from trenches Z-8 and Żar-4. Although the collection includes nearly two hundred specimens, only a small number of them have a satisfactory state of preservation; the specimens are usually crushed and fragmented and the shell interiors frequently recrystallized.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	Aa°	Nr/su	Nr/fo	Nr/fl
169d	–	8.6	11.2	(5.2)	–	3	4	0
169a	(10.3)	(9.6)	(12.6)	(10.2)	108	2	3	0
171c	10.8	9.8	11.0	6.4	114	1	2	0
169c	11.6	10.3	(12.0)	(7.7)	113	3	4	0
169e (holotype)	11.9	10.5	12.0	7.7	108	2	3	0
169b	(12.7)	(11.5)	14.8	8.6	(110)	3	4	0–2
169f	13.7	12.8	(14.6)	8.5	123	3	4	0

Description. — Shell medium sized (up to 14 mm in length), biconvex to dorsibiconvex, width somewhat greater than length or subequal, subelliptic to suboval in outline; cardinal margin angular to nearly straight, lateral and anterior margins rounded; anterior commissure uniplicate to parasulcate and distinctly crenulated by costae.

Pedicle valve with well marked umbo and slightly flattened flanks; beak incurved; the wide and well marked sulcus starts some distance from the beak; it is separated from the flanks by rounded and well marked ridges; tongue low and trapezoidal, rarely becomes vertical in its upper part.

Brachial valve usually slightly more convex than the pedicle valve. The flanks are regularly convex but become concave near the postero-lateral commissure; fold low but distinct and starts some distance from the well marked, slightly inflated umbo.

Shell smooth in umbonal region. Well defined, usually high, angular costae with rounded top are present in fold and sulcus; they start some distance from the umbo. The number of costae in fold vary as follows: two costae in 3.5% of specimens, three costae in 66.5%, four costae in 30%. There are usually no lateral costae; very weak lateral costae (up to two) are present on some shells and cause gentle but well marked indentations of the antero-lateral commissure. Micro-ornamentation not developed except for very delicate concentric growth lines.

Dental plates are not developed inside the pedicle valve; the teeth are stout and supported by low, ventrally directed ridges. The hinge plates in the brachial valve are very short and divided into stout socket ridges and crural bases. The outer hinge plates are slightly concave; septalium short and supported by long median septum reaching 30 to 50% of the valve length. The crura are stout and strongly curved ventrally (Text-fig. 12).

Remarks. — The species externally resembles *Leiorhynchus laevis* GÜRICH (=*Orbiculatisinurostrum laeve*) which occurs immediately below in the section at Dębnik. The two forms are similar to each other in size, general form and proportion of shell. Despite the differences in internal shell structure, *I. mesoplicatus* differs in having strong costae in the fold and sulcus. A form that is somewhat morphologically transitional between these two species is *Leiorhynchus laevis* var. *lentiformis* GÜRICH (questionably included in the synonymy of *L. laevis* by the present author: BALIŃSKI 1979) in which a weak costae can be observed in the fold and sulcus. As pointed out earlier (BALIŃSKI 1979), a gradual strenghtening of median costae occurs with simultaneous reduction of their number in *L. laevis*. This association of features may allow the discrimination of the new form. This species also features a reduction of the dental plates.

Occurrence. — The species occurs in dark gray marly micrites in the uppermost part of the section at quarry Z-2 as well as in a few trenches located to the north (Żar-4) and to the south (Z-8 to -9) of Dębnik. Stratigraphically, those layers probably represent the lowest Famennian (i.e., *P. triangularis* Zone).

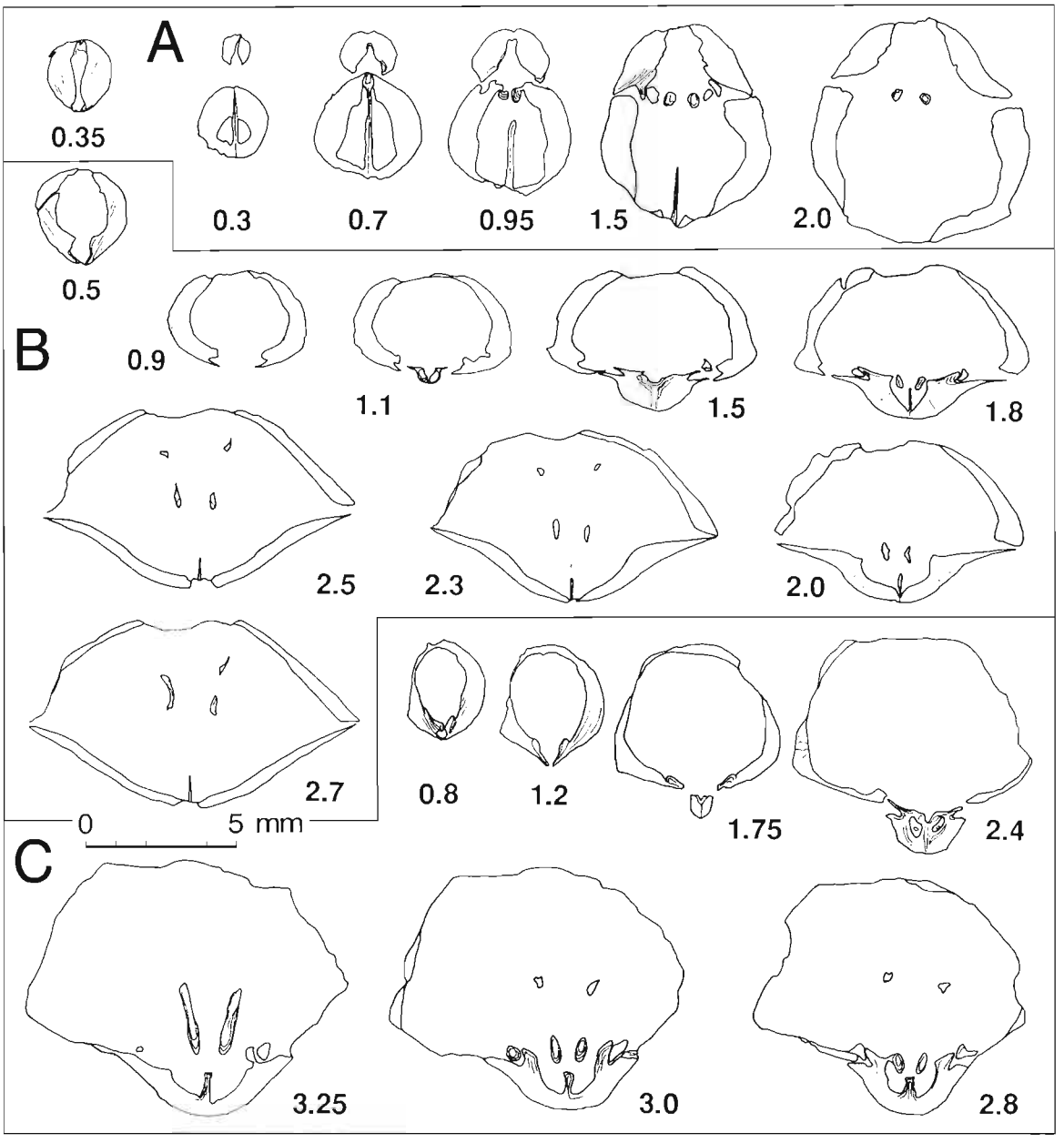

Fig. 12.
Transverse serial section of *Iloerhynchus mesoplicatus* gen. et sp. n. (A–C — trench Z-9). Numbers refer to distance in mm from ventral apex.

Family **Yunnanellidae** RZHONSNITSKAYA, 1959
Genus *Evanescirostrum* SARTENAER, 1965
Evanescirostrum seversoni (MCLAREN, 1954)
(Pl. 6: 7, 9)

1954. *Nudirostra gibbosa seversoni* MCLAREN, n. subsp.; D.J. MCLAREN: 180; Pl. 1: 4–8.
1962. *"Nudirostra" seversoni* MCLAREN; D.J. MCLAREN, *in* D.J. MCLAREN *et al.*: 32; Pl. 15: 4–6.
1965. *Evanescirostrum seversoni* (MCLAREN); P. SARTENAER: 10; Pl. 1: 7; Pl. 2: C.
1969. *Evanescirostrum seversoni* (MCLAREN); P. SARTENAER: 126–132; Pl. 17: 1–11; Text-fig. 30.

Material. — One complete, highly exfoliated shell and two fragments from trench Z.orb-2A.

Dimensions (in mm) of the specimen (cat. no. ZPAL Bp XXIII/138a): Lvv = 19.8, Ldv = 18.0, W = 25.4, T = 17.1, Nr/su = 1, Nr/fo = 2, Nr/fl = 2–3.

Description. — Shell medium sized for the genus, dorsibiconvex, wider than long, broadly heart-shaped in outline; cardinal margin arched, lateral margins rounded; anterior commissure truncate, para-sulciplicate.

Pedicle valve with well defined umbo and slightly convex flanks which become concave near the postero-lateral commissure; the wide and distinct sulcus starts ca. 5 mm from the umbo; tongue trapezoidal, 12 mm long in the single complete specimen.

Brachial valve with convex flanks which become concave near the postero-lateral commissure as in the pedicle valve. Fold high, well marked, starts a few mm from the umbo.

Shell smooth in umbonal region; median costae start near the umbo; there are two to three costae in the fold and one to two in the sulcus; the flanks have two costae in the brachial valve and three in the pedicle valve.

Because the single complete specimen in the collection (Pl. 6: 7) has not been sectioned, the internal structure of the shell is poorly known. However, the presence of dental plates and a long dorsal median septum can be easily detected as a result of exfoliation.

Remarks. — Although the internal structure of the specimens is not known in detail, they most probably represent the genus *Evanescirostrum* SARTENAER. Externally, they strongly resemble the type species of the genus (i.e., *E. seversoni* (MCLAREN)) because they have the same size and shell proportions and a very similar costation. Because there is only one complete specimen, the specific identification in this case may be somewhat tenuous, but similarity to Canadian species is possible. The specimens from Dębnik are very similar to *E.* cf. *seversoni* from the upper part of the Upper Famennian of Afghanistan (BRICE 1970: 68–71; Pl. 4: 4; Text-fig. 15B). The later form differs by a slightly less inflated dorsal umbonal region and a more sharply rounded ventral umbo.

The specimens from Dębnik can be readily distinguished from *E. glabraventrum* (STAINBROOK) from the Famennian of the West Range Limestone of Nevada, USA (JOHNSON, RESO, and STEPHENS 1969: 1357–1358; Pl. 158: 1–15; Text-fig. 3) by their very different outline and costation of the shell. The specimens described here seem to be very close to *E. alblini* SARTENAER from the Lower Famennian of the Dinant Basin (SARTENAER 1956, 1967) and differ mainly by having a wider shell.

Occurrence. — According to SARTENAER (1969), *E. seversoni* (MCLAREN) occurs in the Rocky Mountains of Canada and Idaho. The species is restricted, with some possible exceptions to the upper part of the Palliser Formation (upper part of the lower Famennian to the lower part of the upper Famennian). MCLAREN (1954) introduced a zone based on the species (*"Nudirostra" gibbosa seversoni* Zone = *Evanescirostrum seversoni* Zone). Similar specimens were described as *E.* cf. *seversoni* from the upper part of the Upper Famennian of Afghanistan (BRICE 1970).

The species occurs at Dębnik in limestones from trench Z.orb-2A that represent the *Cyrtospirifer carinatus* interval (the Lower *P. rhomboidea* conodont Zone).

Genus *Minirostrella* gen. n.

Type species: *Minirostrella rara* gen. et sp. n.

Diagnosis. — Medium sized rhynchonellid with somewhat trapezoidal outline, uniplicate to sulciplicate anterior commissure, flat or concave fold, shell costate with very small beak closely appressed onto the dorsal umbo; interior without distinct dental plates and with thick median septum supporting uncovered septalium.

Description. — See description of type species.

Remarks. — The genus differs from the majority of the Upper Devonian rhynchonellids in character of shell ornament, by a broadly inflated ventral umbo, and by a very low, small beak which is appressed to the dorsal umbo. These features, combined with the absence of dental plates, clearly separate the new genus from other genera. For additional comments, see remarks accompanying the description of the type species.

As far as is known, the new genus is represented only by the type species.

Occurrence. — As for the type species.

Minirostrella rara gen. et sp. n.
(Pl. 7: 1–7, 10–11; Text-fig. 13)

Holotype: ZPAL Bp XXIII/403e; figured in Pl. 7: 6.

Type horizon: *Iloerhynchus mesoplicatus* interval, the conodont *P. triangularis* Zone.

Type locality: Dębnik, the uppermost layers at quarry Z-2.

Derivation of the name: *rara* — after very rare occurrence of the species.

Diagnosis. — A species of *Minirostrella* having usually two costae in the sulcus, three on the fold, and one to two on the flanks.

Material. — Ten complete or almost complete shells and thirty two fragments of shells from quarry Z-2; two additional specimens from trench Z-8 and one complete shell from trench Z-9.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	Aa°	Nr/su	Nr/fo	Nr/fl	Wsu/W %
403a	8.1	7.7	9.0	5.0	126	3	4	1–2	–
404	9.4	9.1	11.9	7.6	126	2–3	3–4	1–2	70
403d	10.4	10.0	12.5	7.0	132	2	3	1–2	72
403g	10.8	10.6	13.7	8.1	135	2	3	2	63
403f	11.0	10.7	13.2	9.5	123	2	3	2–3	64
403e (holotype)	11.0	10.7	13.6	7.7	127	2	3	1–3	71
405	11.5	11.2	16.4	7.8	125	3	4	1–3	73
406a	12.9	12.4	15.4	8.6	131	2	3	1–2	68

Description. — Shell medium sized, the largest specimens in the collection reach 12.9 mm in length; biconvex to dorsibiconvex, wider than long and somewhat trapezoidal in outline; the greatest width near the anterior margin of the shell; cardinal margin curved, lateral margins gently arched to

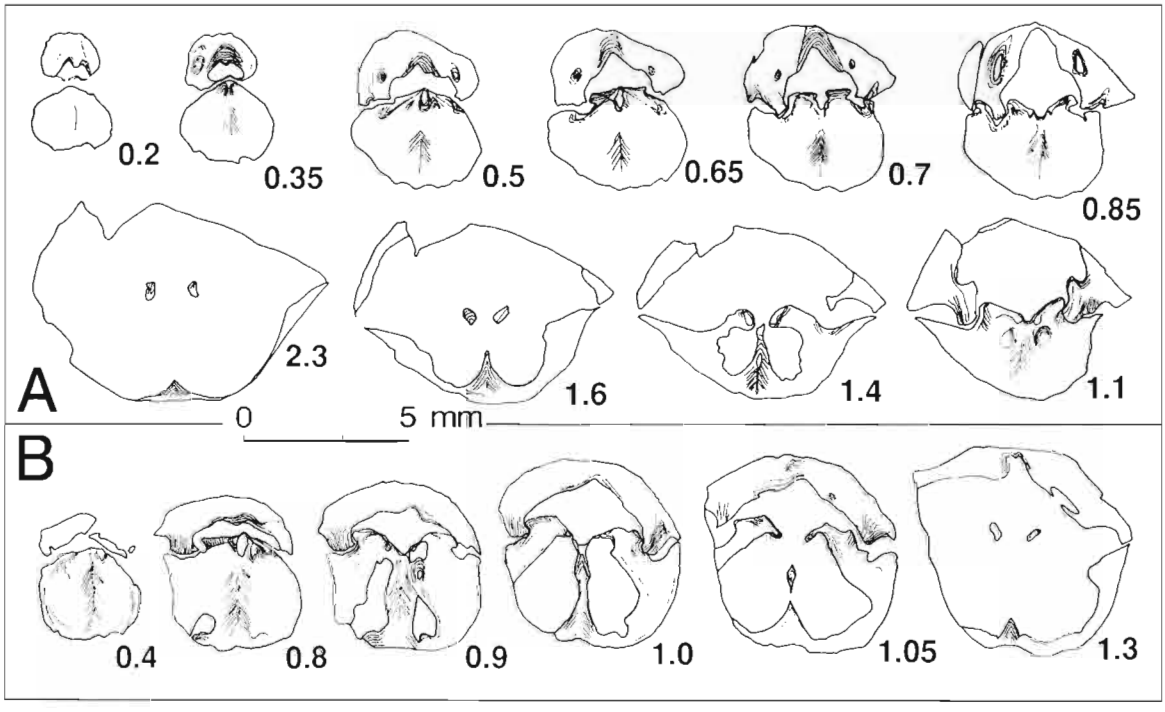

Fig. 13.
Transverse serial section of exfoliated and crushed shell of *Minirostrella rara* gen. et sp. n. (A–B — quarry Z-2). Numbers refer to distance in mm from ventral apex.

almost straight, anterior margin truncate, anterior commissure uniplicate to sulciplicate and strongly crenulated by the costae.

Pedicle valve convex, flanks gently convex except in the postero-lateral part where they are concave near the commissure; umbonal part broadly inflated but weakly defined; beak slightly incurved, very low and usually closely appressed to the dorsal umbo (Pl. 7: 10–11). Sulcus wide, rather shallow, starting at some distance from the beak and reaching up to 73% of the shell width at the front; it is clearly delimited by bordering costae.

Brachial valve usually slightly more convex than pedicle valve, with broadly gibbous umbonal region; flanks slightly convex to almost flat, commissure gently concave in postero-lateral area. Low and wide fold starts some distance from the umbo, it is separated from the flanks on each side by higher costae and deeper and wider intercostal grooves which continue onto the slopes of the fold; summit of the fold is flat or concave; this concavity may begin as a median furrow just at the beak.

Ornamentation. There are two to three costae in the sulcus and three to four costae on the fold. Median costae start at the beaks; one of the median costa in the sulcus does not reach the anterior margin on two specimens and disappears at about two third of the shell length from the beak. There are up to three lateral costae; some of them start at the beaks, and some start in the anterior half of the shell (intercalated costae), other are formed as a prolongation of two costae marked in the posterior part of the shell. Lateral costae may divide; two lateral costae are formed from one at distance of 3 mm from anterior commissure on one specimen. Some of the lateral costae on the posterior part of the shell (umbonal region) are only confined to this region of the shell. Micro-ornament not preserved.

Short dental plates are seen inside the pedicle valve in one of the two sectioned specimens (Text-fig. 13A); in the second sectioned specimen, dental plates are not clearly recognized (Text-fig. 13B). The teeth are short and massive. The deltidial plates and deeply impressed ventral muscle field may be seen in transverse serial sections. The valve is thickened in the umbonal region.

Brachial valve interior with thick median septum that supports an uncovered septalium; the outer hinge plates are broad, flat or slightly concave.

Remarks. — There are only a few species similar to the specimens representing the new genus. Among those are some species (but not all) of the genera *Gastrodetoechia* SARTENAER and *Eoparaphorhynchus* SARTENAER.

The species from Dębnik species has some external features shared with *Gastrodetoechia utahensis rugosa* SARTENAER from the Famennian of Canada (SARTENAER 1969). The two forms have similar the umbonal regions in both valves and similar character of the macro-ornamentation. The specimens from Dębnik differ distinctly by being up to four times smaller than members of *Gastrodetoechia* and have a much wider shell. They differ internally by having much smaller dental plates and an uncovered septalium.

The new species is also similar to some, but not all, representatives of the genus *Eoparaphorhynchus* (i.e., *E. triaequalis triaequalis* (GOSSELET) and *E. triaequalis praetriaequalis* (SARTENAER) from the Lower Famennian of Belgium, W Germany and France (SARTENAER 1957: 20)). The Polish species differs from the both mentioned above subspecies by a much smaller and wider shell and distinctly wider sinus and sulcus. Internally, *M. rara* is similar to *E. triaequalis*, but the former has less distinct or obsolescent dental plates. In comparison to the species from Dębnik, other species of *Eoparaphorhynchus* have a more prominent ventral beak, longer and larger shell, and longer and more distinct dental plates.

Occurrence. — *Minirostrella rara* gen. et sp. n. is a very rare species in dark gray marly micrites and bio-pelmicrites in the uppermost part of the section of quarry Z-2 and in trenches Z-8 to 9 (lowermost part of the *Cyrtospirifer brodi* interval; the *P. triangularis* conodont Zone). Stratigraphically, these beds probably represent the lowest Famennian.

Family **Cardiarinidae** COOPER, 1956
Genus *Loborina* BALIŃSKI, 1982
Loborina lobata BALIŃSKI, 1982
(Pl. 6: 10)

1982. *Loborina lobata* n. g. n. sp.; A. BALIŃSKI: 131–133, Figs 1–3.

Material. — 15 more-or-less complete shells and 50 fragments of shells and valves, some of them with preserved internal structures. All material comes from the residuum of a conodont sample Z.pal-1 (ca. 35 kg in weight) that was dissolved in acetic acid.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	W	T	angle between lateral margins
351	1.2	1.4	0.4	99°
352	1.5	1.6	0.5	96°
353	1.5	1.9	0.5	107°
362	1.7	2.0	0.6	104°

Description. — See BALIŃSKI (1982).

Remarks. — This unusual micro-brachiopod has been described in detail (BALIŃSKI 1982). It is the only Devonian representative of the family Cardiarinidae COOPER and differs markedly from other known members of the family i.e., *Cardiarina cordata* COOPER (1956 — Pennsylvanian of the USA), *Lambdarina manifoldensis* BRUNTON *et* CHAMPION (1974 — Lower Visean of Britain) and *Lambdarina granti* NAZER (1983 — Upper Visean of Australia), *L. iota* GRANT (1988 — Upper Permian of Greece), *Minysphenia conopia* GRANT (1988 — Upper Carboniferous of New Mexico) and *L. glaphyra* BASSETT *et* BRYANT (1993 — upper Tournaisian of Belgium).

Occurrence. — All collections come from trench Z.pal-1 located in the western slope of Żbik ravine from outcrops representing the *Cavatisinurostrum longilinguis* interval (the Middle and/or Upper *P. crepida* conodont Zone).

Rhynchonellacean gen. et sp. indet.
(Pl. 5: 8)

Remarks. — The form is known from one very fragmentary shell (ZPAL Bp XXIII/46) from the Stromatoporoid Rock, north of Dębnik. It measures 9 mm in length and 7.9 mm in thickness. The wide sulcus on the pedicle valve has two thicker costae that probably start near the umbo (umbonal part of the pedicle valve destroyed) and three intercalated costae that start 5 mm from the beak. The posterior part of the brachial valve is smooth; the rest of valve is ornamented with strong costae: three simple on flank and three bifurcating on sinus. The bifurcating costae give a characteristic appearance to the shell ornamentation; it suggests the ornamentation of some upper Famennian rhynchonellids described by ABRAMIAN (1957) from southwestern Armenia (i.e., *Camarotoechia*(?) *araratica* ABRAMIAN, *C. araratica schamamensis* ABRAMIAN, *Liorhynchus dichotomians* ABRAMIAN and *L. dichotomians kasakhstanica* ABRAMIAN). SARTENAER and PLODOWSKI (1975) included these species in the genus *Araratella* ABRAMIAN, PLODOWSKI, and SARTENAER.

Order **Spiriferida** WAAGEN, 1883
Suborder **Athyrididina** Boucot, JOHNSON *et* STATON, 1964
Superfamily **Athyridacea** DAVIDSON, 1881
Family **Athyrididae** DAVIDSON, 1881
Genus *Athyris* M'COY, 1844
Athyris sulcifera NALIVKIN, 1937
(Pl. 8: 3–6; Text-figs 14, 15)

1903. *Athyris reticulata* GOSSELET; G. GÜRICH: 147.

1937. *Athyris sulcifera* n. sp.; D.V. NALIVKIN: 122, Pl. 35: 9; Pl. 37: 8–10.

1957. *Athyris sulcifera* NALIVKIN; M.S. ABRAMIAN: 92–94, Pl. 14: 4–5.

1961. *Athyris sulcifera* NALIVKIN; M.V. MARTYNOVA: 142–143, Pl. 26: 3; Pl. 29: 7–8.

1986. *Athyris sulcifera* NALIVKIN; T.A. GRUNT: Pl. 3: 8–9.

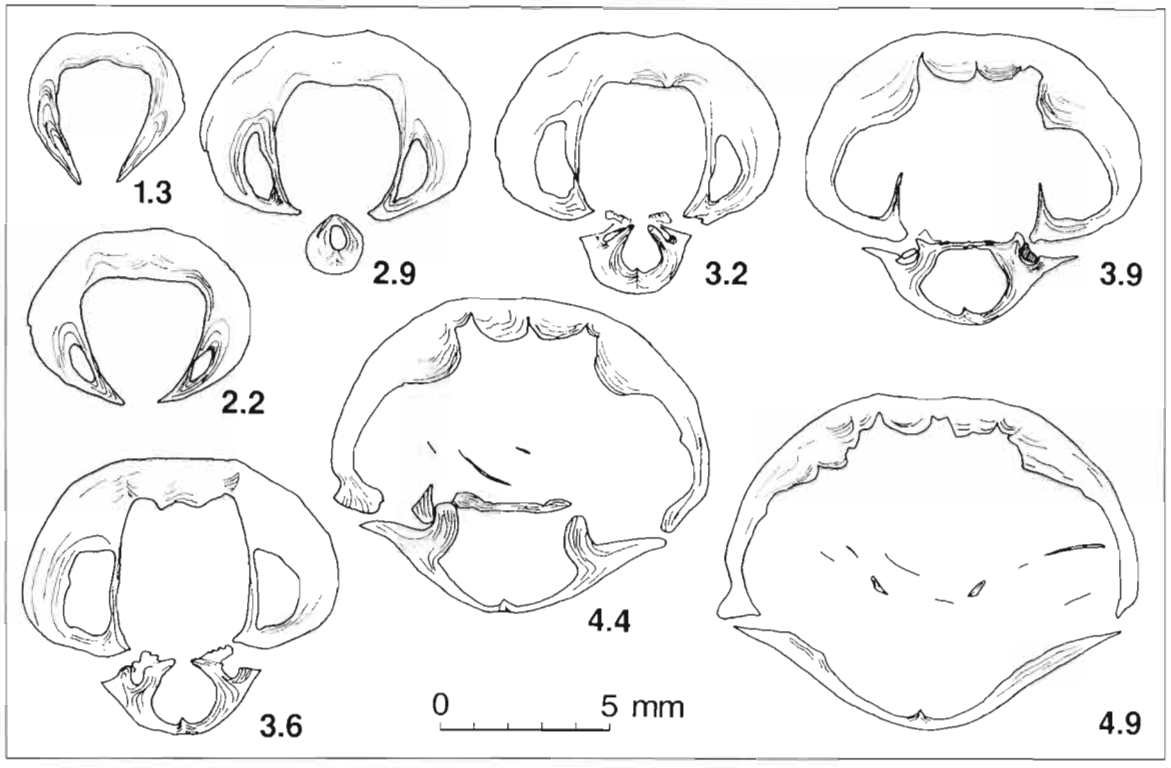

Fig. 14.
Transverse serial section of *Athyris sulcifera* NALIVKIN (trench Z.orb-1). Numbers refer to distance in mm from ventral apex.

Material. — Thirty-five complete or slightly damaged shells and sixty-six fragments of shells and valves. Most of the collections come from trenches Z.orb-1 and -2. A few other specimens were found in trenches Z.orb-2B and -3, ZW-1, and ZS-6. The specimens are usually strongly decorticated and sometimes preserved as internal moulds.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	It
95h	9.7	9.0	(9.6)	4.7	0.2
95c	16.1	14.0	16.8	8.5	1.5
95b	21.0	19.4	20.4	12.8	4.0
116n	22.8	20.7	(22.0)	16.1	6.5
116f	23.0	21.6	24.3	16.4	5.7
93d	24.6	22.2	24.3	20.0	9.0
116e	26.0	22.4	23.5	18.8	8.4
116a	28.7	26.3	29.3	22.1	11.7
116b	33.3	30.5	31.2	23.2	(9.6)

Description. — Shell medium to large for the genus, sometimes attaining more than 30 mm in width, biconvex to strongly biconvex, as wide as long, heart-shaped in outline (Text-fig. 15); cardinal margin curved to form an angle of 123 to 139°; lateral margins rounded, anterior margin truncate, anterior commissure uniplicate to parasulcate.

Pedicle valve regularly convex with massive umbo, and beak truncated by circular foramen; sulcus starting at the beak and is distinct, sometimes bordered by wide ridges resulting in parasulcate anterior commissure; tongue present, up to 11.7 mm in length.

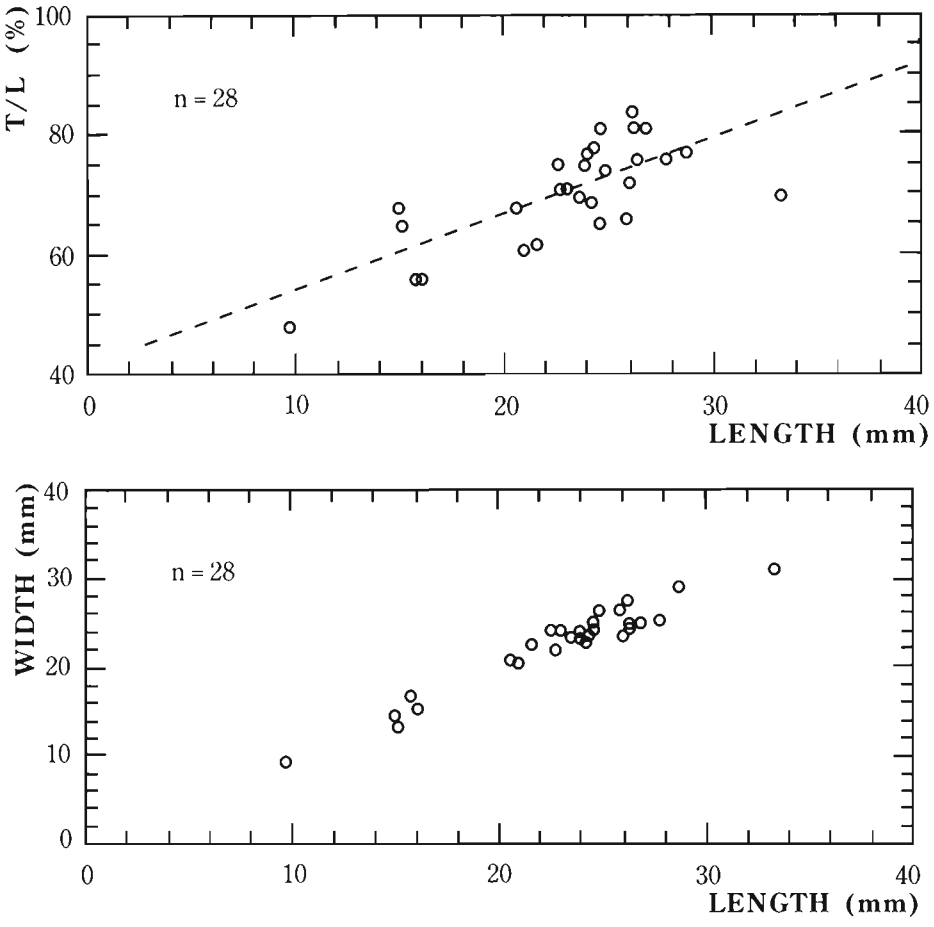

Fig. 15.
Scatter diagram of thickness index of shell versus length (A) and width versus length (B) of shell in *Athyris sulcifera* NALIVKIN.

Brachial valve as deep as pedicle valve, subcircular in outline; fold starting at midlength, not clearly separated laterally, high at front.

The specimens are usually strongly decorticated, but a few shells show characteristic ornament in the form of concentric lamellae that form frills up to 3 mm long. Shells that have been shorn of their frills and partially exfoliated have a reticulate ornament consisting of concentric growth lines and delicate radial striae.

Long and parallel dental plates are present in the pedicle valve. Muscle scars deeply impressed (Text-fig. 14). Interior of brachial valve with strong, flat, apically perforated hinge plate; dorsal myophragm always present. Shell substance very thick in umbonal region of both valves.

Remarks. — The specimens have a very characteristic shell form which differs them from the majority of species of the genus *Athyris* M'COY. Their heart-like or ovate outline and globose form (Pl. 8: 3–6) is similar to representatives of the genus *Composita* BROWN. The presence of growth lamellae in the Polish form, however, differentiates them from all *Composita* species.

The specimens closely correspond in shape and ornamentation to those of *A. sulcifera* NALIVKIN which were described from the Sulcifer Beds of Kazakhstan (NALIVKIN 1937: 122; Pl. 35: 9; Pl. 37: 8–10). The differences between them are minor and consist only in the slightly greater shell dimensions reached by the specimens from Dębnik.

The two specimens of *Athyris reticulata* GOSSELET noted by GÜRICH (1903: 147) from limestones that crop out at Żbik ravine probably represent the species described here.

Occurrence. — *Athyris sulcifera* NALIVKIN occurs in the Upper Famennian of many regions of the former USSR (e.g. NALIVKIN 1937, 1947; ABRAMIAN 1957; MARTYNOVA 1961; GRUNT 1986). It occurs at Dębnik in dark gray bio-pelmicrites, frequently with oncoids in trenches Z.orb-1 to -3, ZW-1 and ZS-6. These occurrences represents the *Cyrtospirifer carinatus* interval (the Lower *P. rhomboidea* conodont Zone).

Athyris area sp. n.
(Pl. 9: 1–6, 10, 12, 14)

Holotype: ZPAL Bp XXIII/414, illustrated in Pl. 9: 5.

Type horizon: *Cavatisinurostrum longilinguis* interval; the *P. crepida* conodont Zone.

Type locality: Dębnik, western slope of Żbik ravine, trench Z.pal-1.

Derivation of the name: *area* — to draw attention to the area of the pedicle valve that is developed into the form of a palintrope.

Diagnosis. — Shell small sized for the genus, usually up to 12 mm in length; subpentagonal to subcircular in outline. Sulcus shallow; fold weak, developed at the anterior margin only. Delthyrium very wide; palintrope well developed.

Material. — The most important part of the collection come from trench Z.pal-1 where many fossils are silicified. There are 22 complete shells; some of them represent early stages of growth, and more than a hundred fragments of valves and shells come from the outcrop. The majority of the specimens are silicified and were etched out with acetic acid. Eleven additional specimens come from loose blocks of limestones excavated from the dirt road at upper end of Żarnówczany Dół ravine. Two specimens come from trench Z.orb-12.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	Aa°
416	2.5	2.4	2.4	0.7	93
417	2.8	2.6	2.8	1.4	107
418	4.2	3.8	4.5	2.0	129
410	4.9	4.5	5.8	2.9	100
411	6.4	5.9	7.5	3.5	101
412	8.5	7.5	10.0	5.0	99
413	9.4	8.2	9.6	5.5	107
414 (holotype)	11.9	10.2	11.7	7.8	108
415	11.7	10.0	12.0	7.4	102

Description. — Shell small for the genus, ventri-biconvex to biconvex, subcircular to transversally elliptical in outline, usually almost as long as wide, sometimes wider; widest at midlength; cardinal margin arched, nearly straight in wide specimens; lateral margins arched, anterior margin arched or truncated, anterior commissure uniplicate.

Pedicle valve equal or slightly deeper than the brachial valve. Sulcus begins near the umbo but is very weak and is merely a flattening. Sulcus more distinct in anterior half of adult shells where it is shallow and not clearly separated from flanks. Beak rather small and pierced by minute round foramen; delthyrium triangular, very broad and open; palintropes flat, well differentiated, long.

Brachial valve lacks distinct fold or has a very low and weak fold at anterior margin of the valve of large specimens. Umbo low, incurved, and partially fills delthyrium of the pedicle valve.

Shell ornamented with closely spaced (2 per 1 mm), imbricating concentric lamellae that distally bear dense sheets of flattened spines, 12 per 1 mm; lamellae may be crowded in anterior part of large specimens.

Interior of pedicle valve with thick dental plates and sometimes with deep muscle scars; other details illustrated in photographs of silicified specimens (Pl. 9: 12). Brachial valve interior with thick, triangular, concave cardinal plate that is perforated at apex by small foramen; antero-median margin of the cardinal plate sometimes elevated to form protruding tubercle (Pl. 9: 10); median ridge arises

from beneath cardinal plate, broadens posteriorly, and becomes lower and narrower anteriorly where it divides elongated, deeply impressed adductor muscle scars.

Remarks. — The species differs from many other known representatives of the genus by its small size. *Athyris area* sp. n. externally resembles *A. uchtensis* LYASHENKO and differs from it by its slightly smaller size, a less strongly developed fold and sinus and by its shorter tongue. The latter, however, is much older stratigraphically because it was described from the Lower Frasnian of north Timan and Volga-Ural region (LYASHENKO 1973: 140–141; Pl. 46: 8–12).

The new species is similar also to some small athyridids from the Lower Frasnian of Ferques, France, that were described by RIGAUX (1908) and revised recently by BRICE (1988). The species from Dębnik differs from *A. davidsoni* (RIGAUX) and *A. oehlerti* RIGAUX by having a less developed sinus and fold and tongue, and has a more elongated and densely ornamented shell.

Occurrence. — *Athyris area* sp. n. occurs in limestones excavated in trenches Z.pal-1 and Z.orb-12, as well as in loose blocks from the dirt road at the upper end of Żarnówczany Dół ravine (locality PG). All occurrences represent the *Cavatisinurostrum longilinguis* interval (the *P. crepida* conodont Zone).

Athyris aff. *area* sp. n.
(Pl. 8: 1–2)

Material. Ten more-or-less complete shells that are usually strongly exfoliated and 46 fragments from trenches Z.orb-6 to 8.

Remarks. — This is rather small and fragmentary collection, but a few better preserved specimens show distinct affinity to *Athyris area* sp. n., described above, which occurs in the immediately overlying brachiopod zone. The specimens here described are similar in average shell dimensions although there are also a few larger shells. The main difference, however, is in the ventral sulcus which is frequently more strongly developed in this form. Contrary to *Athyris area* sp. n., no palintrope has been seen.

Occurrence. — The collection comes from trenches Z.orb-6 to 8 closely situated to each other in W slope of Żbik ravine. The layers that crop out there represent the *Dmitria gibbosa* Zone (the *P. crepida* conodont Zone).

Athyris tau NALIVKIN, 1937
(Pl. 10: 1–2)

1903. *Athyris concentrica* L. v. B.; G. GÜRICH: 147 (*partim*).
1937. *Athyris tau* n. sp.; D.V. NALIVKIN: 123, Pl. 36: 1–2.
1947. *Athyris tau* NALIVKIN; D.V. NALIVKIN: 129, Pl. 31: 12.
1961. *Athyris tau* NALIVKIN; M.V. MARTYNOVA: 143, Pl. 29: 10.
1986. *Athyris tau* NALIVKIN; T.A. GRUNT: 192, Pl. 4: 1–2.

Material. — Four damaged shells and ten fragments of shells and valves from trench Z.orb-12 to -13 and an outcrop in the dirt road from Dębnik to Paczółtowice at the upper end of Żarnówczany Dół ravine.

Description. — Shell large, attains 37 mm in width in collection studied herein, subequally biconvex, as wide as long or slightly wider; subcircular in outline; anterior commissure uniplicate.

Pedicle valve with a narrow sulcus that begins at some distance from the umbo. Brachial valve circular to slightly transversally elliptical; a very low fold begins at the anterior part of the valve.

Shell ornamented by dense and narrow concentric lamellae; a few long spines are preserved in one specimen.

Remarks. — This small and fragmentary collection includes large shells that are strongly suggestive of *Athyris tau* NALIVKIN. Although the specimens do not attain maximum dimensions as large as the Russian species, their general appearance is fully comparable to the latter.

Occurrence. — *Athyris tau* NALIVKIN is known from the late Famennian of Kazakhstan and Ural Mountains. A similar form was described in Poland as *Athyris* aff. *tau* from the Minkowice 1 borehole in the Lublin Basin of southeastern Poland (MATYJA 1974: 677, Pl. 3: 3). The collection of this report

comes from trenches Z.orb-12 and -13 that were dug in the eastern slope of Żbik ravine. To the North of Dębnik, it occurs in correlative strata, and fragments were found at the upper end of Żarnówczany Dół ravine (locality PG). Both occurrences represent the *Cavatisinurostrum longilinguis* interval (the *P. crepida* conodont Zone).

"Athyris" aff. *reticulata* (GOSSELET, 1877)
(Pl. 9: 7, 13)

aff. 1877. *Spirigera reticulata*, nov. sp. Var *Carinata*. J. GOSSELET: 312–313; Pl. 3: 3.

Material. — Two damaged shells that are extensively exfoliated from trench Z.orb-6.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	It
35b	(13.0)	11.8	13.4	9.4	5.4
35m	14.4	12.8	15.5	11.2	7.2

Description. — Shell rather small for the genus, ventri-biconvex, subquadrate to pentagonal in outline, slightly wider than long, widest near the hinge; cardinal margin long, nearly straight to slightly angular, lateral margin straight, anterior margin straight to indented, anterior commissure strongly parasulcate and forms a zig-zag outline in one of the two specimens (Pl. 9: 7).

Pedicle valve with flattened flanks, slightly convex posteriorly and concave at anterior margin. V-shaped, deep sulcus begins at beak, and is distinctly bordered from the flanks by costae; tongue long.

Brachial valve with fold that begins near midlength and is bordered by sulcus on each side near anterior margin; these sulci forms pointed and ventrally directed tongues or spurs (Pl. 9: 7e).

Shell ornamentation not preserved, but less exfoliated areas show traces of reticulate ornament.

Shell interior with distinct, subparallel dental plates; other features not studied.

Remarks. — The characteristic external morphology of the shell suggests that this is probably a representative of a genus related to *Athyris* M'COY. The form studied here is externally very close to the Lower Carboniferous *Pseudopentagonia injensis* BESNOSOVA (BESNOSOVA 1963: 316–317; Pl. 60: 4; Text-fig. 140). Both species have a deep sinus that is bordered in anterior half by costae and have a parasulcate anterior commissure. The specimens from Dębnik have a deeper sulcus that begins at the beak and a much stronger developed parasulcation.

The Polish specimens differ from *Athyris angelicoides* MERRIAM of the Upper Devils Gate Formation, Nevada, USA (MERRIAM 1940: 84–85; Pl. 10: 1–4) by having a less convex shell, a deeper sulcus and more profound development of the parasulcation.

The Polish specimens show the closest affinity to *Spirigera reticulata* GOSSELET from the Lower Famennian of Belgium (GOSSELET 1877: 312–313; Pl. 3: 3). In his paper, GOSSELET discriminated three varieties; only one of them, *S. reticulata* var. *carinata* was figured (*ibidem*: Pl. 3: 3). The Polish and the Belgian forms have a very similar shell shape and an almost identical development of the parasulcation. There is no doubt that both forms are very closely related. The specimens from Dębnik differ by having a more subquadrate to subpentagonal shell outline by comparison with the transversally elliptical shape of *S. reticulata*, and they are not as wide shell as the latter.

Occurrence. — This is a very rare species in limestones from trench Z.orb-6 (western slope of Żbik ravine) that represents the *Dmitria gibbosa* interval (the *P. crepida* conodont Zone).

Athyris sp.
(Pl. 7: 8–9)

Material. — Eight complete and 21 damaged shells from trenches Z.orb-1 to -2 and ZS-1 to -2.

Remarks. — Some of the specimens representing this form come from the same layers as *Athyris sulcifera* NALIVKIN which was described above. They have identical shell ornamentation and development of the fold and sulcus. They differ, however, in having a slightly wider, transversally elliptical

to circular, and somewhat less convex shell and a nearly straight hinge margin. These specimens probably represent a separate species closely related to the former.

Occurrence. — The specimens were found in trenches Z.orb-1 and -2 (*Cyrtospirifer carinatus* interval, the Lower *P. rhomboidea* conodont Zone).

Genus *Crinisarina* COOPER *et* DUTRO, 1982
Crinisarina sp.
(Pl. 9: 8–9, 11, 15)

Material. — Four complete but juvenile shells and 15 small fragments of valves are known. These specimens have a characteristic shell ornamentation. All of the specimens are silicified and were etched from limestone with acetic acid.

Remarks. — It is impossible at present to identify the described specimens precisely because there is only one specimen that represents an adult growth stage; it is very fragmentary and largely covered by a bryozoan colony (Pl. 9: 15). All specimens, however, show very characteristic features which permit them to be differentiated without any doubt from the co-occurring and externally very similar *Athyris area* sp. n. Specimens of *Crinisarina* sp. have a distinctly larger pedicle foramen than the latter. They also have a different shell ornamentation; their concentric lamellae are very fine and bear spines that are not as tiny and densely arranged as in *A. area*. There are 4 to 5 spines per 1 mm in the specimens studied in comparison to 12 in 1 mm per the latter.

The specimens are very close in shell form and ornamentation to *Crinisarina reticulata* (STAINBROOK) as redescribed by COOPER and DUTRO (1982: 92–93; Pl. 26: 31–51; Pl. 45: 1–15) from the Thoroughgood Formation and Rhodes Canyon Formation (Famennian) of New Mexico, USA.

Occurrence. — All of the specimens came from trench Z.pal-1 on the eastern slope of Żbik ravine, south of Dębnik (*Cavatisinurostrum longilinguis* interval; the *P. crepida* conodont Zone).

Suborder **Spiriferidina** WAAGEN, 1883
Superfamily **Spiriferacea** KING, 1846
Family **Cyrtospiriferidae** TERMIER *et* TERMIER, 1949
Genus *Cyrtospirifer* NALIVKIN, 1924
Cyrtospirifer wesgensis ZHEIBA, 1980
(Pl. 11: 1–8, 10, 14)

1980. *Cyrtospirifer wesgensis* ZHEIBA (in litt.); S. ZHEIBA: 54–55; Pl. 1: 8; Pl. 2: 1–3.

Material. — Sixteen complete to slightly damaged and 20 damaged shells as well as 89 fragments of shells and valves. Additionally, 35 etched fragments of silicified valves preserve elements of the internal structure. The specimens are mostly exfoliated and partially silicified.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W*	T	wfo	HArvv
86k	8.4	7.4	(13.3)	5.6	3.7	3.3
80c	13.3	14.5	22.7	15.4	7.2	11.6
73k	11.1	11.1	18.9	11.2	7.0	8.0
73i	14.6	14.3	21.5	15.0	10.0	9.8
73e	(18.9)	18.5	32.7	17.4	12.9	10.0
72	19.6	16.3	32.0	(16.3)	10.1	7.4

* The shell width is measured without ears (mucrons)

Description. — Shell medium sized for the genus, ventri-biconvex to biconvex, wide-hinged to semicircular in outline, wider than long, with extended cardinal extremities; cardinal margin long and straight, lateral margins rounded to nearly straight, anterior margin truncated and sometimes indented; anterior commissure uniplicate.

Pedicle valve with well developed sulcus; height and concavity of interareas highly variable, apsacline to catacline, rarely slightly procline. Flanks gently convex and become concave at cardinal extremities where then form sharp protruding edges which expand the interareas laterally.

Brachial valve gently convex in lateral profile; fold well marked and clearly separated from flanks, with convex top except in a few specimens which have a fold with a median furrow.

Shell ornamented with 16 to 25 simple costae on flank and about 15 bifurcating costae on the sinus and fold. Costae on flanks rounded and separated by grooves that are narrower than costae; costae on sinus and fold lower, usually flattened. Micro-ornament consists of fine radial striae and poorly visible concentric lines that form granules at their intersections.

Interior of pedicle valve with long divergent dental plates; delthyrium open except for rather small apical plate (Pl. 11: 8, 10). Interior of brachial valve as for the genus (Pl. 11: 5).

Intraspecific variability. — The specimens display unusual variability in the shape of the ventral interareas. Specimens with triangular, high, slightly concave, catacline ventral interareas predominate in the collection (Pl. 11: 1–2). There are also shells with an almost completely flat, very highly proclined interareas; this condition strongly resembles that in *Tenticospirifer* (Pl. 11: 6). However, other specimens possess a very low and wide, strongly concave apsacline interareas (Pl. 11: 3, 7). The demonstrated range of variability in the shape of the interareas is quite unusual for cyrtospiriferoid brachiopods. This striking feature of the species is enhanced by a frequent asymmetry of the interareas and twisting of the umbonal region of the valve (Pl. 11: 2).

Remarks. — The outcrop where the main part of the collection came from (trenches Z.tent-1 to -3) was discovered by JAROSZ (1926: 142). He cited two spriferoids in the list of fossils from that place: *Spirifer Verneuili* MURCHISON *typ.* and *Spirifer Verneuili* var. *tenticulum* VERNEUIL. It is obvious that the first name was applied to specimens with a wide, concave ventral interareas, and the second one was for specimens with high and flat interareas. This study of the fauna reveals that the spiriferoid brachiopods from this outcrop belong to one species which is very variable in shell shape. It is even difficult to make a definite generic assignment. The percentage of shells with flat, high, *Tenticospirifer*-like interareas is practically the same as shells with concave, wide, *Cyrtospirifer*-like interareas in this collection.

On the basis of the shell shape as well as its variability, the specimens have a striking resemblance to *Spirifer disjunctus* var. *animasensis* GIRTY which was described from the Ouray Limestone (Upper Famennian) of Colorado, western USA (GIRTY 1900). A similar shell ornamentation and a characteristic shape of ventral interareas that includes asymmetry and twisting occur in both forms. A great range of variability of ventral interareas is especially characteristic in both collections. According to COOPER and DUTRO (1982), however, *Cyrtospirifer? animasensis* is often misidentified. Moreover, there is suspicion that GIRTY's specimens include more than one species (*ibidem*: 105). The specimens from Dębnik differ by having more ribs on dorsal fold as well as lacking the tendency to become more quadrate (elongated) in large specimens. It is worth noting that the specimens from Dębnik are much older than the specimens from the Ouray Limestone.

The specimens from the present collection are almost identical externally with *Cyrtospirifer wesgensis* ZHEIBA described from several boreholes on the western border of the East European Platform (ZHEIBA 1980). Both forms have the same shell shape and ornamentation as well as a very similar development of the ventral interareas. It is difficult to compare the range of the intraspecific variability in both collections because the form from the boreholes comprises only 20 specimens. Nevertheless, ZHEIBA (1980: 55) stressed in his paper the variability of the hinge margin, ventral umbo, and interareas in *C. wesgensis*.

Occurrence. — The species occurs at Dębnik in dolomitic sandy limestone from trenches Z.tent-1 to -3 and Z.orb-9 which are located on the eastern slope of Żbik ravine. It is a characteristic fossil of the *Cyrtospirifer wesgensis* brachiopod interval (probably the upper part of the *P. triangularis* conodont Zone). The species also occurs sporadically in higher strata excavated in trenches ZS-1 and -2 which are located west of Żbik ravine (the *Cyrtiorina? depressa* interval, the Upper *P. rhomboidea* conodont Zone). In the eastern Europe *C. wesgensis* is known from several borehole sections in Lithuania and the southern Latvia. It occurs there in the Lower Famennian deposits representing Ionishkis horizon (ZHEIBA 1980).

Cyrtospirifer cf. *acutus* NALIVKIN, 1960
(Pl. 11: 9, 11–13)

cf. 1960. *Cyrtospirifer acutus* NALIVKIN sp. nov.; D.V. NALIVKIN: 385–386; Pl. 89: 3–4.

Material. — Five nearly complete shells and 14 fragments of shells and valves. Most of the specimens come from trench Z.orb-6; five specimens were found also in trench Z.orb-7 and two specimens in trench Z.orb-8. This small collection is rather fragmentary, and the specimens are usually exfoliated.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W*	T	wfo	HArvv
42g	7.4	7.2	14.0	6.9	4.7	4.7
42f	13.0	12.4	(23.0)	12.4	7.6	6.6
425b	13.3	12.3	22.8	12.5	7.6	7.9

* The shell width is measured without ears (mucrons).

Description. — Shell small to medium sized for the genus (up to 20 mm in length) ventri-biconvex, trapezoidal in outline, much wider than long, widest at hinge; cardinal margin straight and very long; ears distinct, sometimes expanded into short mucrons (Pl. 11: 13); lateral margins straight to arched, anterior margin indented, anterior commissure uniplicate.

Pedicle valve subpyramidal; sulcus deeply excavated, begins at the beak, and sharply bounded laterally; flanks slightly convex but become flat or concave toward the cardinal extremities. Interareas high and very wide, weakly concave, sometimes nearly flat, with sharp lateral borders, catacline. Delthyrium rather narrow, open except at apex where it is closed by an apical (delthyrial) plate.

Brachial valve less convex than pedicle valve; fold low, broadly convex, clearly separated laterally by a pair of stronger intercostal grooves.

Shell ornamented with 18 to 25 simple costae on each flank; costae bifurcate in sulcus and fold, slightly finer or equal in width with those on flanks. Micro-ornament not preserved.

Interior with long divergent dental plates and flat delthyrial plate.

Remarks. — The specimens are similar to some cyrtospiriferoids with expanded shell and high ventral interareas which are known from the Upper Devonian of North America and Asia. The specimens from Dębnik differ slightly from *Cyrtospirifer convexus* COOPER *et* DUTRO from the Percha Formation (Box Member) of New Mexico, USA (COOPER and DUTRO 1982: 106; Pl. 31: 1–10) by having a less convex brachial valve, narrower and lower dorsal fold, and an indented anterior margin. The species differs from *C.* cf. *thalattodoxa* CRICKMAY from the Sly Gap Formation of New Mexico (*ibidem*: 107–108; Pl. 30: 24–29) by its narrower fold and indented anterior margin. The Polish species is completely different, however, from *C. thalattodoxa* which has been described from the Frasnian of Canada (CRICKMAY 1952: 601–602; Pl. 72: 1–8; GREINER 1973; Pl. 1: H).

The specimens have the closest resemblance to *Cyrtospirifer acutus* NALIVKIN from the Frasnian of Novaya Zemlya, Russia (NALIVKIN 1960: 385–386; Pl. 89: 3–4). Both forms have a wide-hinged shell, high and slightly concave ventral interareas, narrow delthyrium, and deep ventral sulcus. Minor differences are seen only in the finer shell ornamentation of the specimens from Dębnik.

Occurrence. — *Cyrtospirifer acutus* NALIVKIN is known from the Frasnian of Novaya Zemlya (NALIVKIN 1960: 386). Polish specimens which resemble that species were found at Dębnik on the eastern slope of Żbik ravine, in trenches Z.orb-6 to 8 (*Dmitria gibbosa* interval; Middle *P. crepida* conodont Zone).

Cyrtospirifer brodi (VENJUKOV, 1886)
(Pl. 12: 1–7)

1886. *Spirifer Brodi*. P.N. VENJUKOV: 486; Pl. 3: 6; Pl. 4: 2.

1926. *Spirifer Archiaci* var. *bisellata* GÜRICH; J. JAROSZ: 144.

1934. *Spirifer (Cyrtospirifer) Brodi* VENJUKOV; B. MARKOVSKI and D. NALIVKIN: 25–26; Pl. 6: 1–11.

1959. *Cyrtospirifer brodi* WENJUKOFF; A.I. LYASHENKO: 213; Pl. 82: 1–3.

1974. *Cyrtospirifer brodi* (VENJUKOV); H. MATYJA and B. ŻBIKOWSKA: 678; Pl. 5: 1, 3.
1979. *Cyrtospirifer* aff. *minor* GÜRICH; A. BALIŃSKI: 67–69.

Material. — Twenty-eight complete to nearly complete shells and 270 more-or-less fragmentary specimens of shells and valves. In addition, about 60 juvenile specimens ranging in size from 0.6 mm in length were obtained from the residue of conodont sample Z.bis-4. Most of the specimens are exfoliated to some extent; some of them are partially silicified, especially those from trenches Z.bis-2 and -4.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W*	T	wfo	HArvv
427a	5.2	4.6	7.9	3.6	2.1	1.2
427b	8.7	8.2	13.2	6.5	4.6	3.1
427c	13.6	11.7	19.4	11.1	7.1	4.5
426g	14.2	11.9	19.3	11.0	7.8	3.0
426a	18.8	14.8	23.2	13.6	9.3	5.5
426c	19.1	16.3	27.4	16.7	10.5	4.6
426d	(20.3)	14.3	20.9	13.7	10.7	(7.4)
426h	28.3	19.2	(29.0)	19.1	(16.0)	6.4

* The shell width is measured without ears (mucrons).

Description. — Shell medium sized for the genus, ventri-biconvex, subpentagonal in outline, wider than long, usually widest at hinge; cardinal margin straight and long; ears, when preserved, are generally short but some shells are mucronate (Pl. 12: 3). Lateral margin nearly straight posteriorly to rounded anteriorly; anterior margin truncate or indented, anterior commissure uniplicate to sulciplicate.

Pedicle valve with a deep sulcus that begins at the beak and is distinctly separated from lateral areas of shell; interareas concave; beak erect to incurved.

Brachial valve subtrapezoidal in outline; fold low with flattened top or, more frequently, with median groove and distinct from lateral areas of shell.

Shell covered with 16 to 22 simple costae on each flank and up to 18 bifurcating costae on sinus and fold. Costae on flanks rounded, wider than width of interspaces; costae on fold and sulcus finer and lower than those on flanks and may be irregular or partially obliterated on some shells. Microornamentation consists of fine radial to subradial striae; concentric growth lines rather weak and irregular. Fine pustules developed on one specimen.

Interior of pedicle valve with long dental plates; delthyrium open except at apex where it is closed by a short apical plate. Brachial valve interior as for the genus.

Intraspecific variability. — This species is characterized by its dimensions, subpentagonal shell shape, ornamentation, high concave ventral interareas, and dorsal fold which usually bears a very distinct median furrow (Pl. 12: 6–7). This furrow, or at least a median flattening of the top of the fold occurs in 70 to 91 per cent of the specimens from trenches Z.bis-1, -2 and -4. The furrow occurs much less frequently (in 23 to 30% of specimens) in specimens from lower interval which are morphologically transitional, if not conspecific with *C. minor* (GÜRICH) (trenches Z-8 and 9, the uppermost part of a section of quarry Z-2). These older specimens are also smaller and resemble the uppermost Frasnian *C. minor*.

The specimens have considerable variability in shell shape and concavity and height of ventral interareas. Some shells are elongated (Pl. 12: 5, 7), and the length slightly exceeds the shell width. A few other shells are much wider and this is additionally emphasized by the presence of distinct ears (Pl. 12: 1, 3). The variability in height and concavity of the ventral interareas is well seen on the illustrated specimens (Pl. 12: 1–3, 5–7).

Remarks. — JAROSZ (1926: 144) listed the fossils which he collected from the same locality as the present collection comes from. He identified the cyrtospiriferoid that occurs there as *Spirifer Archiaci* var. *bisellata* GÜRICH (= *Cyrtospirifer bisellatus*). It is now certain that this cyrtospiriferoid

has nothing in common with the Lower Frasnian *C. bisellatus* (for further discussion see the description of the *Cyrtospirifer brodi* interval on page 15).

The specimens from Dębnik have considerable external resemblance to *C. brodi* (VENJUKOV) from the Yeletz Beds of the Russian Platform. Both species have thick shell, strongly concave interareas, and a dorsal fold with median flattening or furrow. The specimens of this report are sometimes as elongated as typical *C. brodi*, but they are frequently wider. This shell form, however, is seen occasionally in Russian specimens. Many of the wider specimens from Dębnik have proportions that resemble *C. asiaticus* BRICE (= *C. archiaci* in Russian literature) from the Zadonsk Beds of the Russian Platform. *Cyrtospirifer asiaticus*, however, has a dorsal fold with a convex top. By comparison with *C. brodi*, the specimens from Dębnik have broader costae. The latter has 4 to 5 ribs per 5 mm at the anterior margin whereas there are 5 to 6 ribs in *C. brodi*. In summary, the differences between the Russian specimens of *C. brodi* and those here described are rather trivial and may reflect subspecies differences.

Occurrence. — The species occurs in the Yeletz Beds of the Russian Platform (Lower Famennian). SAMSONOWICZ (1950: 440–441) found two specimens of, what he believed was, *C. brodi* in the Upper Famennian of Wolhynia. VANDERCAMMEN (1959: 87–89; Pl. 3: 8–15) described *C. brodi* from the Frasnian of Belgium, but, most probably, those specimens represent another species. *Cyrtospirifer brodi* is known in Poland from boreholes in the Lublin Basin (KALIŚ 1969: 809; MATYJA and ŻBIKOWSKA 1974: 678). Two fragments of valves were described as *C.* cf. *brodi* from a borehole in Kraków region (ŻAKOWA 1965: 539–540: Pl. 6: 22).

The species occurs at Dębnik in dark-gray marly micrites and bio-pelmicrites from trenches Z.bis-1, -2 and -4 (*Cyrtospirifer brodi* interval, *P. triangularis* Zone.

Cyrtospirifer carinatus sp. n.
(Pl. 13: 1–10, Text-fig. 16)

1903. *Spirifer Archiaci* var. *Orbeliana* GOSSELET; G. GÜRICH: 142; Pl. 14: 13a, b, c.

Holotype: ZPAL Bp XXIII/118c, illustrated in Pl. 13: 3.

Type horizon: *Cyrtospirifer carinatus* interval, the Lower *P. rhomboidea* conodont Zone.

Type locality: Dębnik, eastern slope of Żbik ravine, trench Z.orb-1.

Derivation of the name: *carinatus*, *carina* — ridge shaped structure; from acute profile of the brachial valve fold.

Diagnosis. — Shell medium sized for the genus, thick, trapezoidal to subpentagonal in outline with high, concave ventral interareas. Sulcus deep and "V"-shaped; fold high, acute, usually with one pair of deeper and/or wider intercostal grooves at its mid-height which causes a characteristic two-stage appearance of the fold in cross-section. Delthyrium closed by large and convex pseudodeltidium.

Material. — Twenty-three complete to nearly complete shells and 170 fragments of shells and valves. Most of the collection comes from the eastern slope of Żbik ravine (trenches Z.orb-1, -2 and -2B); a few specimens were found also in the western slope of the ravine (trench ZW-1 and -2) and in trench ZS-6. Specimens often exfoliated.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W*	T	wfo	HArvv
97o	10.0	9.5	14.3	9.7	5.4	4.4
118c (holotype)	23.0	21.4	34.7	22.9	12.6	9.3
98	24.0	20.0	29.5	20.3	12.5	6.0
97b	(28.0)	27.8	(43.0)	(29.0)	16.2	10.6
99	29.0	24.9	(43.0)	26.2	13.6	7.4
118m	30.0	24.8	(36.4)	26.7	9.3	10.3

* The shell width is measured without ears (mucrons).

Description. — Shell medium-sized for the genus (up to 43 mm in width); strongly biconvex, trapezoidal to subpentagonal in outline, wider than long, widest at hinge; cardinal margin straight and

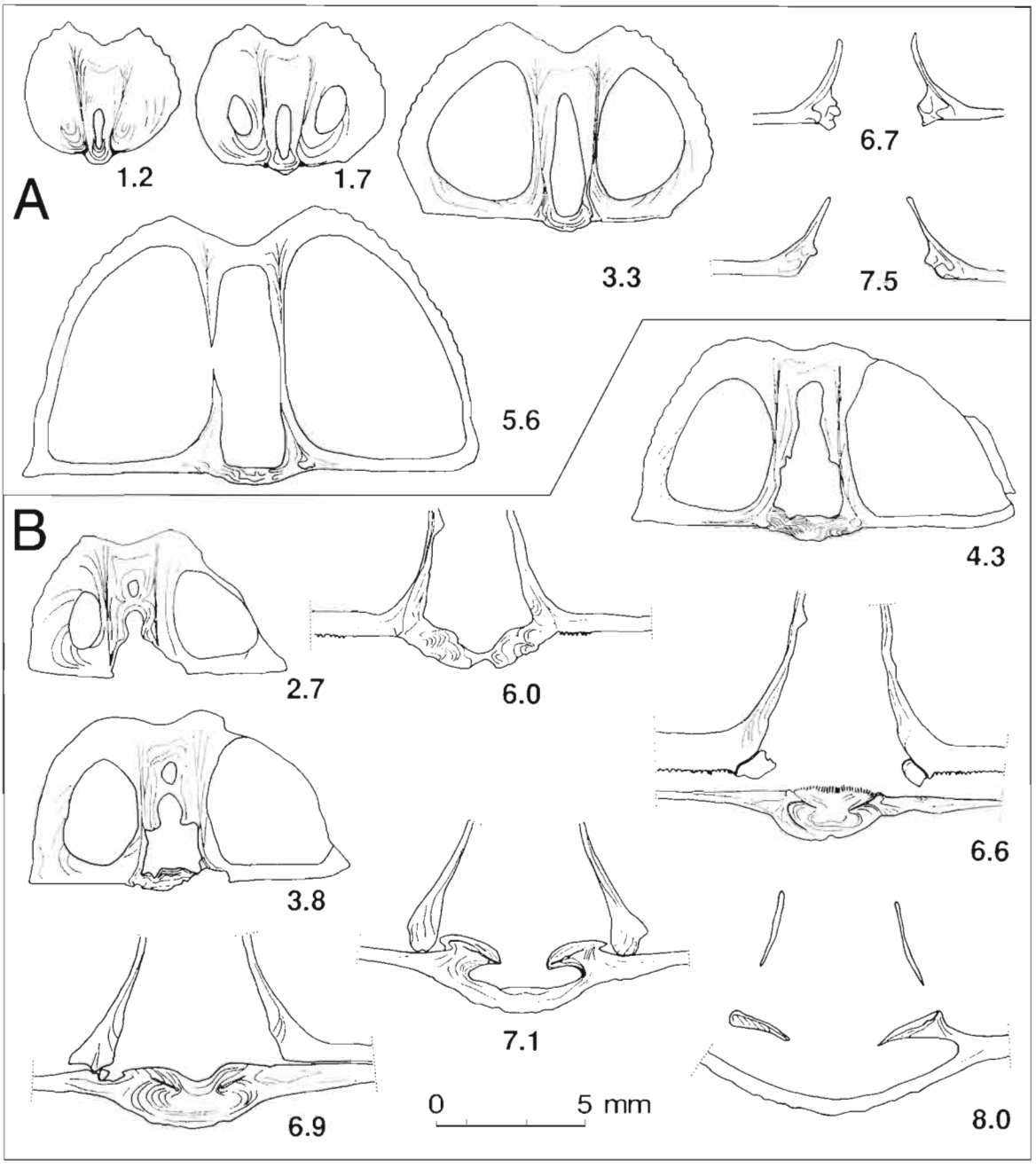

Fig. 16.
Transverse serial section of *Cyrtospirifer carinatus* sp. n. (A–B — trench Z.orb-2a). Numbers refer to distance in mm from ventral apex.

long; ears short but rarely preserved. Lateral margins slightly arched except at mucrons where they become concave; anterior margin indented angularly, anterior commissure uniplicate.

Pedicle valve as deep as brachial valve; sulcus deep and "V"-shaped, begins at the beak, and clearly separated from lateral areas of shell; tongue short and triangular. Interareas usually high, concave, and sometimes strongly concave with sharp lateral borders; beak suberect to incurved. Some better preserved specimens reveal the delthyrium almost completely closed by a large convex pseudodeltidium (Pl. 13: 7); inadequate preservation of pseudodeltidium precludes a definite statement whether it is pierced apically by the foramen.

Brachial valve trapezoidal in outline with high fold that is clearly delineated laterally and acutely angular in cross-section. Top half of the fold separated by one pair of deeper and/or wider intercostal grooves resulting in two-stage profile of the fold; well defined and more acute top of the fold resembles a keel-like structure (Pl. 13: 8, 10).

Shell covered with 20 to 25 simple costae on each flank and up to 17 bifurcating costae on sulcus and fold; costae on flanks approximately as wide as those on fold and sulcus. Costae rounded and separated by grooves slightly narrower than costae. Micro-ornament usually not preserved; fine radial striae noticeable on a few specimens.

Pedicle valve interior with long nearly parallel dental plates and distinct delthyrial plate. Brachial valve interior as for the genus (Text-fig. 16).

Remarks. — GÜRICH (1903) described this form as conspecific with specimens from the basal part of the Frasnian of the Dinant Basin which had been described by GOSSELET (1880) as *Spirifer Orbelianus* ABICH. It is now rather evident that the specimens from Belgium do not belong to ABICH's species (e.g. PAECKELMANN 1942: 129; ABRAMIAN 1957: 72; SARTENAER 1982: 168). The specimens from Dębnik are much younger than those from Dinant Basin. On the other hand *Cyrtospirifer carinatus* sp. n. has nothing in common with *Spirifer orbelianus* ABICH from Armenia.

The Polish specimens somewhat resemble the genus *Cyrtiopsis* GRABAU in the development of the extensive delthyrial cover. The presence of a sharp dorsal fold and triangular tongue of the pedicle valve recalls some of the species of GRABAU's genus (e.g., *C. kayseri* GRABAU and *C. intermedia* GRABAU; see GRABAU 1931: 443–451, 460–466; Pl. 46: 6–9; Pl. 47: 5–7; Pl. 48: 1). The specimens of this report, unlike *Cyrtiopsis*, possess a long cardinal margin and a distinct delthyrial plate inside the pedicle valve.

Cyrtospirifer carinatus sp. n. is characterized by a the presence of a quite sharp, triangular dorsal fold and a "V"-shaped ventral sulcus. In this respect, it is closest to *Cyrtospirifer kurban* NALIVKIN from the Sulcifer Beds (Upper Famennian) of Kazakhstan (NALIVKIN 1937: 94–95; Pl. 23: 1–4; MARTYNOVA 1961: 125–126; Pl. 25: 1–3; SIDATCHENKO 1962: 92–93; Pl. 16: 4–5). Although both species are very close morphologically, *C. carinatus* is easily distinguished by the presence of one stronger intercostal groove on each slope of the dorsal fold and by costae on the fold and sulcus which are as wide as those on the rest of valves. The median costae are narrower in *C. kurban.*

Occurrence. — *C. carinatus* sp. n. is known from the southern limb of the Dębnik anticline. It is a very characteristic fossil for the uppermost part of the section exposed in Żbik ravine (trenches Z.orb-1, -2, -2B and ZW-1 to -2). It was also found during the present study to the west of Żbik ravine in trench ZS-6. *Cyrtospirifer carinatus* occurs in dark gray bio-pelmicrites, frequently with oncoids, and is associated with *Mesoplica costata* sp. n. and *Athyris sulcifera* NALIVKIN (*Cyrtospirifer carinatus* interval; Lower *P. rhomboidea* conodont Zone).

Cyrtospirifer cf. *ningbingensis* ROBERTS, 1971
(Pl. 12: 8–10; Pl. 16: 5–6)

1903. *Spirifer Murchisonianus* VERNEUIL *typus*.; G. GÜRICH: 144; Pl. 2: 3–4.

cf. 1971. *Cyrtospirifer ningbingensis* sp. nov.; J. ROBERTS: 188–194; Pl. 41: 1–24; Pl. 42: 1–16; Pl. 43: 1–16; Text-fig. 47–50.

Material. — Two complete shells and 14 fragments of shells and valves; all of these are extensively decorticated. Most of the collection came from trenches Z.pal-1 and Z.orb-5 located south of Dębnik at Żbik ravine; one specimen comes from a loose block of limestone dug up from the dirt road at the upper end of Żarnówczany Dół ravine (locality PG).

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	wfo	HArvv
58c	18.0	16.6	(25.8)	12.6	10.7	7.4
431	28.5	22.7	30.8	24.3	14.9	9.1
130e	30.7	23.9	31.5	22.0	(14.4)	10.6

Description. — Shell medium sized for the genus, ventri-biconvex, subpentagonal in outline, slightly wider than long, widest at hinge; cardinal margin straight and long, ears very short; lateral margins almost straight or concave posteriorly and become arched anteriorly; anterior margin straight, anterior commissure uniplicate.

Pedicle valve nearly two times as deep as brachial valve; sulcus distinct but usually shallow and begins at the beak; tongue short and rounded. Interareas high, concave to strongly concave; beak suberect to incurved. Delthyrium rather narrow and closed by convex pseudodeltidium (Pl. 16: 5)

Brachial valve subrectangular in outline; fold wide and low to very low and sometimes not clearly differentiated from lateral areas of shell.

Shell ornamented with 24 to 29 simple costae on each flank and up to 24 bifurcating costae in the sulcus and fold. Micro-ornament consists of fine (9 per 1 mm) radial striae and still finer, very weak concentric lines.

Sections through the umbonal region of two pedicle valves reveal slightly divergent dental plates and a delthyrial plate; similar structures occur in one silicified pedicle valve from trench Z.orb-5 (Pl. 16: 5).

Remarks. — This small and fragmentary collection comprises shells which are characterized by subpentagonal outline, short ears, convex pseudodeltidium, high but concave ventral interareas, and low dorsal fold. They resemble, in many respects, *Cyrtospirifer ningbingensis* ROBERTS from the Famennian of the Bonaparte Gulf Basin, northwestern Australia (ROBERTS 1971). Specimens from Dębnik more often have a higher ventral interareas and a usually narrower dorsal fold, as well as covered delthyrium.

The specimens from Pałkowa Góra quarry illustrated by GÜRICH (1903, Pl. 2: 3–4) as *Spirifer Murchisonianus* VERNEUIL *typus* most likely represent the same species. The complete shell depicted by him (*ibidem*: Pl. 2: 3) has a much shorter cardinal margin than specimens collected during this study, but it is possible that GÜRICH's shell has incomplete cardinal extremities.

Occurrence. — The specimens occur in the southern part of the Dębnik anticline in dark gray limestones from trenches Z.orb-5 and Z.pal-1. In northern part of the anticline, the species occurs locally in loose blocks of light gray limestone found in the dirt road at the upper end of Żarnówczany Dół ravine (locality PG). All occurrences represent the *Cavatisinurostrum longilinguis* interval (Middle and/or Upper *P. crepida* conodont Zone). *Cyrtospirifer ningbingensis* ROBERTS occurs in the Famennian of the Ningbing Limestone and the Button Beds (Bonaparte Gulf Basin, northwestern Australia) (ROBERTS 1971).

Cyrtospirifer sp.
(Pl. 10: 3)

Material. — Three damaged shells and two very fragmentary valves (one brachial and one pedicle).

Remarks. — This is a medium sized cyrtospiriferoid with subpentagonal shell outline and high concave interareas that is sharply demarcated from the flanks. The shell is ornamented with rather coarse ribs: about 16 on each flank and 10 to 12 in sulcus and fold.

The general morphology of these specimens slightly resembles *Cyrtospirifer carinatus* sp. n. which occurs several meters higher in the section. *Cyrtospirifer* sp. differs mainly by having coarser shell ornamentation and a rather low, non-carinate dorsal fold.

Occurrence. — The species is very rare; it occurs in trenches Z.orb-12 and Z.pal-1 and in loose blocks of light gray limestone found at the upper end of Żarnówczany Dół ravine (locality PG). These occurrences are in the *Cavatisinurostrum longilinguis* interval (Middle and/or Upper *P. crepida* conodont Zone).

Genus *Cyrtiopsis* GRABAU, 1923
Cyrtiopsis famenniana (PAECKELMANN, 1942)
(Pl. 14: 4–6; Text-fig. 17)

1931–1933. *Cyrtiopsis murchisoniana* (DE KONINCK): A.W. GRABAU: 430–434; Pl. 45: 1–5; Text-fig. 48B–F.

1942. *Spirifer (Cyrtiopsis) davidsoni* GRABAU, nov. em., var. n. *famenniana*; W. PAECKELMANN: 174–178; Pl. 8: 5–10; Text-figs 80–86.

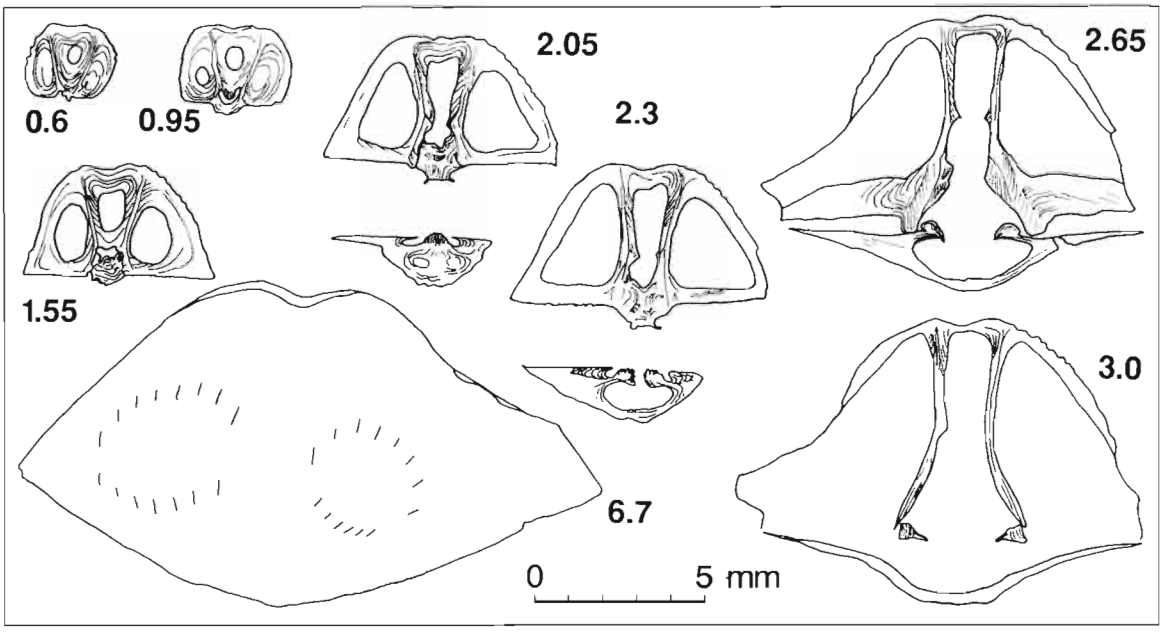

Fig. 17.
Transverse serial section of *Cyrtiopsis famenniana* (PAECKELMANN) (trench Z.orb-6). Numbers refer to distance in mm from ventral apex.

Material. — Nine complete to nearly complete shells and twenty fragments of shells and valves. Most of the specimens came from trench Z.orb-6; several others were found in two nearby trenches, Z.orb-7 and -8. Specimens are typically exfoliated.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	wfo	HArvv
40j	14.7	11.7	(16.8)	9.8	7.0	3.1
40i	20.3	14.3	19.2	15.3	8.9	5.9
430a	22.7	17.5	22.7	18.6	12.3	5.1
430c	22.7	17.9	24.3	16.4	(11.4)	4.3
430b	26.0	19.8	27.1	19.6	12.1	5.4

Description. — Shell small to medium sized for the genus (up to 26 mm in length), strongly biconvex, pentagonal in outline, as wide as long and widest at mid-length or at hinge; cardinal margin straight and long, usually only slightly shorter than maximum shell width, ears very short or absent, lateral margin slightly arched, anterior margin indented, anterior commissure uniplicate.

Pedicle valve very deep with weakly convex to almost flat flanks; sulcus begins at the beak and is deep to very deep, "V"-shaped in cross-section, quite sharply separated from flanks; short and rounded tongue sometimes present. Interareas of medium-height, concave, apsacline to orthocline; beak erect; delthyrium narrow, covered with thick, convex pseudodeltidium which is pierced apically by foramen.

Brachial valve almost as deep as pedicle valve and trapezoidal in outline; fold low to very low, rounded, separated from flanks by a pair of slightly deeper intercostal grooves.

Shell ornamented with 19 to 25 simple costae on each flank, 6 to 7 costae per 5 mm at anterior margin of large specimens, and 9 to 13 bifurcating costae on sulcus and fold. Costae rounded, separated by slightly narrower spaces. Micro-ornament not preserved but traces suggesting radial striae are seen locally.

Interior of pedicle valve with long and divergent dental plates that reach nearly to mid-valve. Delthyrial plate distinct and thick. Interior of brachial valve with stout outer hinge plates and wide cardinal process (Text-fig. 17).

Remarks. — The specimens from Dębnik have a close affinity to specimens from the Upper Devonian (Famennian) of Belgium that were described by GRABAU (1931–1933: 430–434; Pl. 45: 1–5) as *Cyrtiopsis murchisoniana* (VERNEUIL). A similar form from Germany was described by PAECKELMANN (1942: 174–178; Pl. 8: 5–10; Text-figs 80–86) as *Spirifer (Cyrtiopsis) davidsoni* var. *famenniana* PAECKELMANN. The specimens described here, as those from Belgium and Germany, have the same dimensions and shape of the shell, a strong ventral sulcus and weak dorsal fold, a covered delthyrium and similar shell ornamentation. It was demonstrated by SARTENAER (1965, 1973: 2–3) that *Spirifer Murchisonianus* VERNEUIL belongs to the genus *Uchtospirifer* LYASHENKO, occurs only in in the Lower Frasnian of Russia and has nothing in common with Lower Famennian specimens often identified as that species. PAECKELMANN (1942) erected the new variant *Spirifer (Cyrtiopsis) davidsoni* var. *famenniana* for the specimens described by him from Germany and by GRABAU from Belgium. In this report, PAECKELMANN's variant is regarded as a species level taxon.

GRABAU proposed the new "mutation" *Cyrtiopsis murchisoniana* mut. *barrauxensis* (GRABAU 1931–1933: 434–435; Pl. 45: 6–7; Text-fig. 48A, G) for larger specimens of *Cyrtiopsis murchisoniana* (=*Cyrtiopsis famenniana*) from the Famennian of Belgium. According to GRABAU (*ibidem*), this "mutation" differs by having a more transverse brachial valve, a better defined fold, flatter ventral interareas, shorter hinge margin, and obtuse cardinal extremities. PAECKELMANN (1942: 178–179; Pl. 8: 11–12; Text-figs 87–89) described the same variant among specimens from Germany. However, his *Spirifer (Cyrtiopsis) davidsoni* var. *barrauxensis* possesses a longer hinge margin and has angular cardinal extremities. Specimens externally identical to typical *Cyrtiopsis famenniana* (PAECKELMANN) occur, in both cases, among the illustrated shells (GRABAU 1933; Pl. 45: 6; PAECKELMANN 1942; Pl. 8: 12). These inconsistencies in description make the understanding of the taxa under discussion difficult; this problem could be solved on the basis of larger collections from Belgium and Germany.

A similar, although not identical, variation in shell shape can be observed in the Polish specimens. The dominant form of shell has strongly convex valves (Pl. 14: 4–5) although slightly larger and flatter shells also occur (Pl. 14: 6). However, it seems in the present collection that both forms represent the same species, and they should be treated as a intraspecific variation.

Occurrence. — *Cyrtiopsis famenniana* is known from the Famennian of Belgium and Germany. It occurs at Dębnik in dark gray limestones in trenches Z.orb-6 to -8 on the eastern slope of Żbik ravine, south of Dębnik. These layers represent the *Dmitria gibbosa* interval (middle part of the *P. crepida* conodont Zone).

Genus *Cyrtiorina* COOPER *et* DUTRO, 1982
Cyrtiorina? depressa sp. n.
(Pl. 14: 1–3; Pl. 15: 6–7; Text-fig. 18)

1993. *Cyrtiorina* sp.; A. BALIŃSKI: Fig. 1A–O.

Holotype: ZPAL Bp XXIII/123a, illustrated in Pl. 15: 7.

Type horizon: *Cyrtiorina? depressa* interval, the conodont Upper *P. rhomboidea* Zone.

Type locality: Dębnik, trench ZS-2.

Derivation of the name: *depressa* — to draw attention on the low fold in the brachial valve.

Diagnosis. — Shell up to 33 mm long, wider than long, thick, ventri-biconvex, with short hinge margin and rounded cardinal extremities; ventral interareas deeply concave, beak of pedicle valve incurved; dorsal fold weak, ventral sulcus slightly better marked. Delthyrium open except in upper one-third to one-half of shell where it is covered by delthyrial plate.

Material. — Five complete shells and 21 fragments of shells and valves from trenches ZS-1 and ZS-2; one pedicle valve from trench ZS-3. In addition, eight partially silicified fragments of shells and valves were etched from limestone of trench ZS-1.

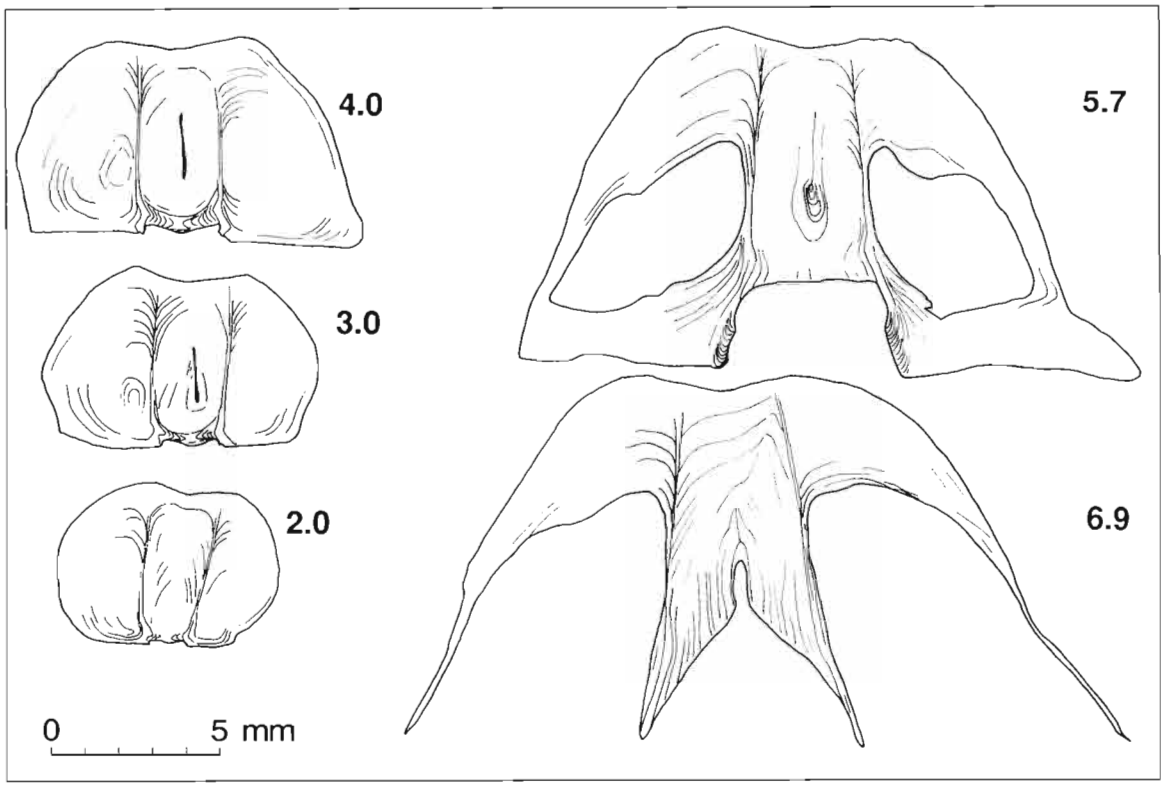

Fig. 18.
Transverse serial section of *Cyrtiorina? depressa* sp. n. (trench ZS-2). Numbers refer to distance in mm from ventral apex.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	wfo	HArvv
123c	27.0	22.0	(28.6)	22.3	12.3	6.7
123d	28.0	21.8	32.0	23.0	15.4	5.2
123b	32.0	27.5	36.9	26.4	16.3	5.6
123a (holotype)	33.0	27.0	38.4	31.0	19.5	5.0

Description. — Shell medium sized for the genus, ventri-biconvex, pear-shape in outline, wider than long, widest at one-half to two-thirds of shell length from umbo. Cardinal margin straight but short, attaining 64 to 75% of the shell width; lateral margins rounded and continue into rounded cardinal extremities; anterior margin straight to indented, anterior commissure uniplicate.

Pedicle valve deep with massive umbonal region; beak incurved to strongly incurved and sometimes slightly twisted; interareas high but deeply concave; delthyrium open except in upper one-third to one-half of its height where it is closed by delthyrial plate (Pl. 15: 6). Sulcus begins at the beak and is distinct along all its length up to anterior margin but not very deep, separated from flanks by rounded borders; tongue short and rounded.

Brachial valve slightly shallower than the pedicle valve, elliptical in outline with swollen umbonal part; fold low to very low, but clearly separated laterally by deeper intercostal grooves.

Shell ornamented with up to 26 simple costae on each flank (3.5 to 4 costae per 5 mm at anterior margin of adult shells); costae low, slightly flattened and separated by spaces narrower than costae. Costae on fold and sulcus bifurcating, up to 15 at anterior margin, on some shells costae are partially obliterated. Micro-ornamentation not preserved except as very dense concentric growth lines.

Interior of pedicle valve with subparallel dental plates and delthyrial plate (Pl. 15: 6; Text-fig. 18).

Remarks. — These specimens are questionably attributed to the genus *Cyrtiorina* COOPER *et* DUTRO on the basis of their external similarity to the type species *Cyrtiorina kindlei* (STAINBROOK) from the Famennian of New Mexico, USA (STAINBROOK 1947; COOPER and DUTRO 1982). Both forms have the same shell shape, shell ornamentation, character of ventral interareas, and delthyrial plate. The specimens from Dębnik, however, do not possess the pseudodeltidium which was regarded by COOPER and DUTRO (*ibidem*: 111, mistakenly named as a "pseudospondylium") as a diagnostic character of the genus.

The specimens from Dębnik are also similar to some Famennian forms described by SIDATCHENKO (1962) from the Karatau region. The Polish species differs from *Cyrtospirifer (Cyrtospirifer) communis* SIDATCHENKO (*ibidem*: 57–62; Pl. 9: 1–5; Pl. 10: 3–4) only by its wider shell. In addition, *C. (C.) avis* SIDATCHENKO (*ibidem*: 63–64; Pl. 10: 1–2), has a similarly short hinge margin, weak dorsal fold and same character of shell ornamentation. However, the species from Dębnik differs by its deeper shell and lower, more concave ventral interareas.

Cyrtiorina? depressa sp. n. also resembles *Choristites glennfoxi* CRICKMAY from the Palliser Formation, Alberta (CRICKMAY 1952: 607–608; Pl. 77: 6–12) in its short hinge margin, massive ventral umbo, and rather weak ventral sulcus. It differs, however, from the latter by its much larger and wider shell and by the absence of pseudodeltidium which is well developed in *C. glennfoxi* and in *Cyrtiorina kindlei*.

The specimen of *Spirifer Murchisonianus* typus (DE VERNEUIL) from Dębnik that was illustrated by GÜRICH (1903, Pl. 15: 3) is very similar to *C? depressa* sp. n. but has a less inflated dorsal umbo and sharply demarcated ventral sulcus. As pointed out above, this specimen, as well other ones found by GÜRICH at Żbik ravine and Pałkowa Góra quarry (*ibidem*: 144), belong to *Cyrtospirifer* cf. *ningbingensis* ROBERTS rather. During the present study *C? depressa* sp. n. has been recovered only in higher layers that crop out in trenches ZS-1 to -3; these layers were not available during GÜRICH's study.

Occurrence. — The species was found only in trenches ZS-1 to -3 located southwest of Dębnik and west of Żbik ravine in limestones that belong to *Cyrtiorina? depressa* interval (Upper *P. rhomboidea* conodont Zone).

Genus *Dmitria* SIDATCHENKO, 1961

Dmitria angustirostris (GÜRICH)

(Pl. 15: 1–2; Text-fig. 19)

1903. *Spirifer Murchisonianus* VERNEUIL var. *angustirostris* GÜRICH: 145–146; Pl. 1: 13–34; Pl. 2: 1–2, 5.

Material. — Two complete and well preserved shells and six fragments of shells and valves; all specimens came from loose blocks of limestones that contain a brachiopod fauna characteristic of the strata at Pałkowa Góra (locality PG).

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	wfo	HArvv
432a	33.6	28.9	32.1	23.1	15.0	3.5
432b	35.0	28.8	34.0	25.8	15.0	4.7

Description. — Shell medium-sized for the genus (up to 35 mm in length in the collection studied in this report), strongly ventri-biconvex, oval in outline, slightly longer than wide, widest at two-thirds of the shell length from the umbo; cardinal margin short and straight and reaches 61 to 65% of the shell width, ears very short; lateral margins gently arched, anterior margin straight, anterior commissure uniplicate.

Pedicle valve deeper than the brachial valve, with inflated posterior part and slightly concave at ears; sulcus begins at the beak where it is well defined and becomes wide and shallow anteriorly, where it is still perceptible; tongue developed in large specimens but is short and rounded. Interareas rather low, almost flat, apsacline; delthyrium closed by pseudodeltidium. Beak small but pointed.

Brachial valve with fold barely perceptible except at the front where it is better defined.

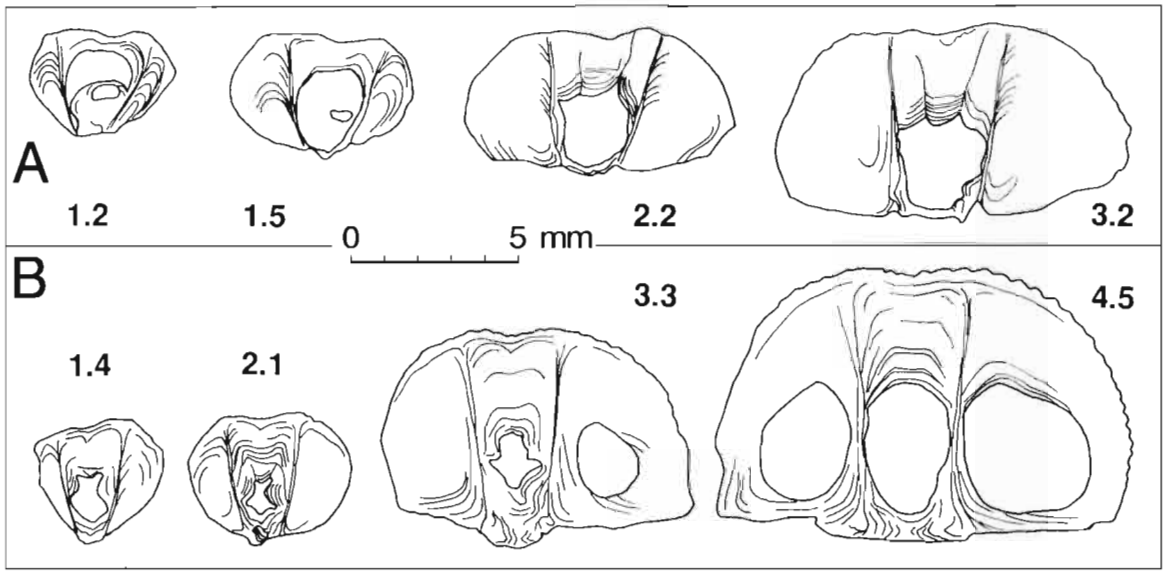

Fig. 19.
Transverse serial section of *Dmitria angustirostris* (GÜRICH) (A–B — locality PG). Numbers refer to distance in mm from ventral apex.

Shell ornamented with about 22 simple costae on each flank, 4 costae per 5 mm at the anterior margin of large specimens. Costae rounded in umbonal region and flatten anteriorly, separated by narrow interspaces; costae in sulcus and fold are bifurcating and slightly finer. Micro-ornament is distinct and consists of fine radial striae that cover the costae as well as the interspaces; there are 8 striae per mm. The striae are crossed by yet finer (18 per 1 mm) growth lines which are better preserved on the bottom of the intercostal grooves.

Interior of pedicle valve with slightly divergent to subparallel dental plates. In the sectioned specimens (Txt-fig. 19), the delthyrium is closed by a plate located in the position of the delthyrial plate; this plate, however, is convex and is seen as a pseudodeltidium externally (compare with Pl. 15: 2); it seems that the plate is a fused structure consisting of the delthyrial plate and the pseudodeltidium. The suturing might have place because there was neither a functional pedicle in adult individuals nor a foramen in the apical part of the delthyrium. Posterior part of the valve very thickened medially (Text-fig. 19).

Interior of the brachial valve not studied.

Remarks. — Several specimens in the collection possess a small hole in the vicinity of the ventral beak. This characteristic hole may destroy the beak (Pl. 15: 1–2) or may be located subapically on its ventral side. The hole may be confluent with the internal shell cavity (see sections in Text-fig. 19A) or may be clogged on the interior by shell substance. The function and origin of the hole is somewhat uncertain. Its position suggests that it acted as a pedicle opening, but good preservation of a beak in one specimen (Pl. 15: 2) makes this explanation rather impossible. The other explanation is that it is a boring made by an unknown organism.

Dmitria angustirostris (GÜRICH) is quite different from co-occurring specimens of *D. globosa* (GÜRICH). The distinction between these species is discussed under the remarks on *D. globosa*.

Dmitria angustirostris is similar to the type species of the genus, *D. romanovski* (NALIVKIN), from the Famennian of Turkestan and the Karatau region (NALIVKIN 1930: 197–198; Pl. 9: 2–3, 6; SIDATCHENKO 1962: 101–104; Pl. 24: 1–3; Text-figs 20–21). The Polish form differs mainly by having straight hinge margin and almost flat ventral interareas.

Dmitria angustirostris also resembles *D. seminoi* (VERNEUIL) from the Upper Devonian of Tuva, Iran (VANDERCAMMEN 1967: 4–14; Pl. 1: 1–11; Pl. 2: 1–16; Pl. 3: 1–7; Text-figs 3–6) and the Famennian of Armenia (ABRAMIAN 1957: 78–81; Pl. 10: 3; Pl. 11: 1–2; Text-figs 15–16) and Afghan-

istan (BRICE 1970: 163–167; Pl. 8: 1–2; Text-fig. 38). *Dmitria seminoi* is a larger form with concave ventral interareas, better defined ventral umbo, longer hinge margin, and finer shell ornamentation.

Occurrence. — GÜRICH (1903: 145) described this species from limestones of Pałkowa Góra. The collection of this study came from loose blocks of limestone (locality PG) which most probably came from the now nonexistent small quarry earlier named Pałkowa Góra (*Cavatisinurostrum longilinguis* interval; Middle and/or Upper *P. crepida* conodont Zone).

Dmitria gibbosa sp. n.
(Pl. 16: 1–4; Text-fig. 20)

Holotype: ZPAL Bp XXIII/435b, illustrated in Pl. 16: 2.

Type horizon: *Dmitria gibbosa* interval, the *P. crepida* conodont Zone.

Type locality: Dębnik, trench Z.orb-6 in the eastern slope of Żbik ravine.

Derivation of the name: *gibbosa* — to draw attention on the strong convexity of both valves.

Diagnosis. — Shell small for the genus, very thick, oval to subcircular in outline, with strongly concave ventral interareas. Ventral sulcus very shallow; dorsal fold indistinct and very low. Costae simple on flanks; those in sulcus and fold with tendency to bifurcation. Long dental plates inside pedicle valve and delthyrial plate present.

Material. — Nine complete to nearly complete shells and 24 fragments of shells and valves. All collection comes from the eastern slope of Żbik ravine (trenches Z.orb-6 to -8).

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	wfo	HArvv
435a	18.5	15.3	17.5	14.5	6.3	1.6
41b	18.1	14.2	17.6	12.7	8.4	2.0
436a	24.2	20.0	22.6	(18.7)	9.5	1.1
435c	28.5	21.0	23.7	23.0	12.8	1.1
435b (holotype)	29.0	22.7	26.7	21.3	12.0	4.4

Description. — Shell small for the genus (up to ca. 30 mm in length), strongly ventri-biconvex, oval to subcircular in outline, approximately as wide as long, widest at one-half to two-thirds of the shell length from umbo; cardinal margin nearly straight, shorter than maximum width of the shell; short ears present; anterior and lateral margins arched, anterior commissure gently uniplicate.

Pedicle valve very deep, sometimes nearly two times as deep as brachial valve, with massive and swollen umbonal area (Pl. 16: 1–4); sulcus very shallow, not clearly separated from flanks, and begins at the beak where it is even better defined; tongue very short and semicircular. Interareas strongly concave; delthyrium open except in apical region where it is closed by well defined delthyrial plate; pseudodeltidium not observed. Beak strongly incurved.

Brachial valve with very low fold that is sometimes barely visible, and delineated from each flank by a slightly deeper intercostal furrow.

Shell covered with rather fine costae, up to 30 simple ones on each valve flank, 5.5 to 7 costae per 5 mm at the anterior margin of large specimens. Costae low, anteriorly flattened or widely convex, separated by narrow interspaces. Costae in sulcus and fold bifurcating, usually finer than those on flanks, although sometimes both types of costae may occur (i.e. wide and narrow): their total number is 10 to 14. Micro-ornamentation rarely preserved; radial striae and lengthened granules are visible on one specimen.

Interior of pedicle valve with long, slightly divergent dental plates (Text-fig. 20) that reach nearly to midvalve. Delthyrial plate distinct and fairly long; pseudodeltidium not observed. Muscle area deeply impressed. Strong cardinal process inside the brachial valve supported by short and thick median ridge.

Remarks. — The Polish species has all the features diagnostic for the genus *Dmitria* (i.e. thick biconvex shell, massive ventral umbo, short cardinal margin, very weak ventral sulcus and dorsal fold,

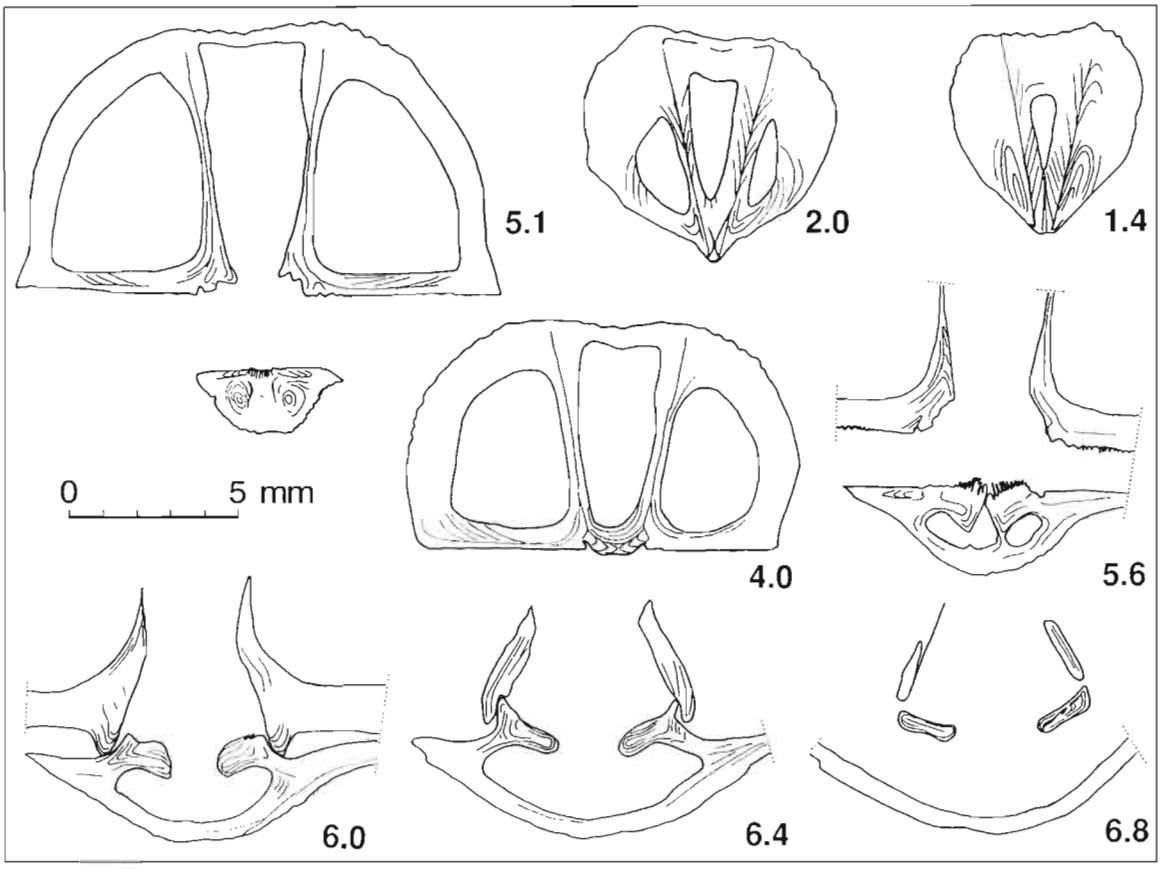

Fig. 20.
Transverse serial section of *Dmitria gibbosa* sp. n. (trench Z.orb-8). Numbers refer to distance in mm from ventral apex.

low costae separated by narrower interspaces). The species is distinguished, however, from almost all other members of the genus by a relatively smaller shell that reaches not more than 30 mm in length in the collection. *Spirifer (Cyrtospirifer) dada* NALIVKIN (1937: 97; Pl. 24: 4–5) which was described from the Sulcifer-Beds of northeastern Kazakhstan and later assigned by SIDATCHENKO (1962: 101) to his genus *Dmitria* is only a little larger but differs from species at Dębnik in many other respects. These include a longer hinge line, smaller ventral umbo, and less convex pedicle valve. SIMAKOV (1970: 86–87) later transferred *S. (C.) dada* to his new genus *Omolonospirifer*.

Dichospirifer BRICE is another genus that resemble the Polish specimens. They are especially similar to the type species of that genus, *Dichospirifer thylakistoides* BRICE from the Upper Famennian and Etroeungtian of Afghanistan (BRICE 1970: 194–198; Pl. 5: 10; Pl. 12: 1–2; Text-fig. 47). Despite the striking resemblance between these forms, this species of *Dichospirifer* differ in having bifurcating lateral costae and a short, rudimentary delthyrial plate.

Dmitria gibbosa sp. n. is a very characteristic brachiopod species in the limestones that crop out on the eastern slope of Żbik ravine in trenches Z.orb-6 to -8. Among the Famennian brachiopod faunas from Dębnik, it is the oldest representative of the genus. The species is replaced higher in the section by two larger ones: *D. globosa* (GÜRICH) and *D. angustirostris* (GÜRICH) which are revised in this report.

Occurrence. — *Dmitria gibbosa* sp. n. occurs in dark-gray limestones in trenches Z.orb-6 to -8 on the eastern slope of Żbik ravine south of Dębnik. These layers represent the *Dmitria gibbosa* brachiopod interval (middle part of the *P. crepida* conodont Zone).

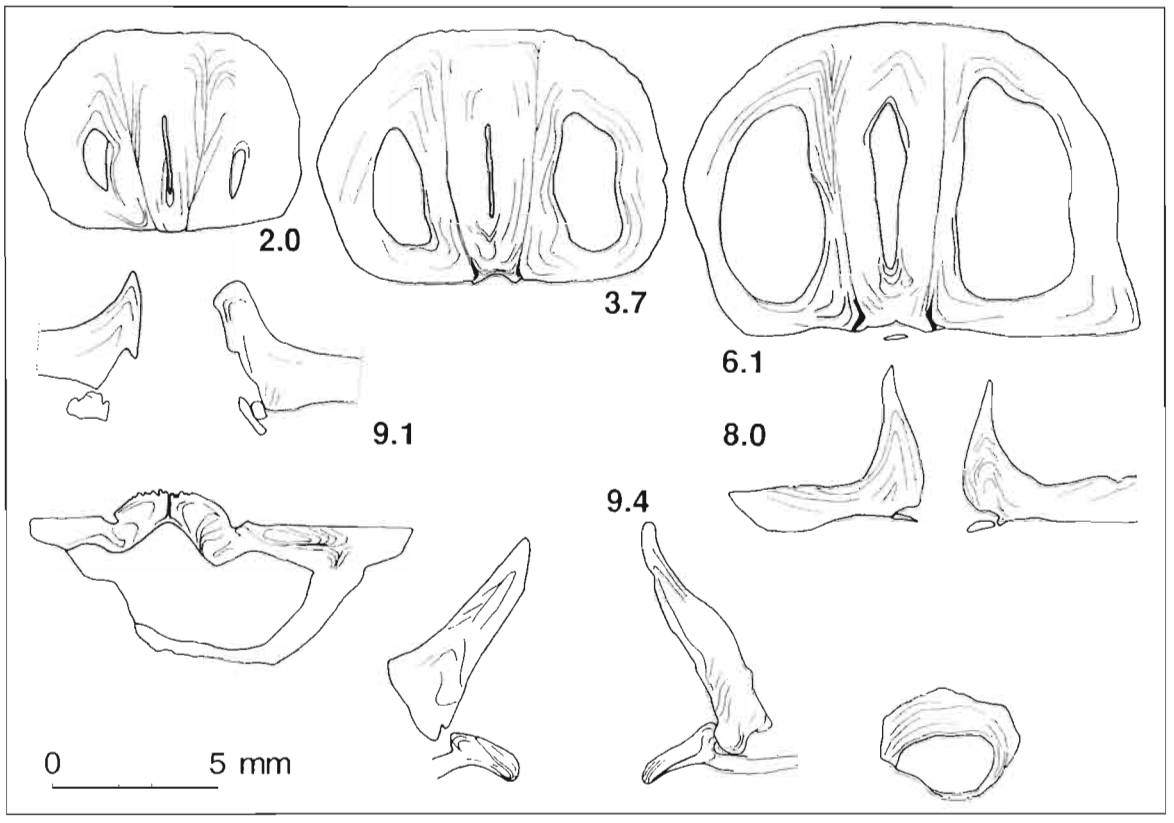

Fig. 21.
Transverse serial section of *Dmitria globosa* (GÜRICH) (locality PG). Numbers refer to distance in mm from ventral apex.

Dmitria globosa (GÜRICH, 1903)
(Pl. 17: 1–5; Text-fig. 21)

1903. *Spirifer Murchisonianus* VERNUIL var. *globosa* GÜRICH: p. 144–145, Pl. 1: 10–12.

Material. — Nine complete to nearly complete shells and 62 fragmentary shells and valves. Most of the collection came from loose blocks of limestones excavated from dirt road at the upper end of Żarnówczany Dół ravine (locality PG). A few additional specimens came from trench Z.pal-1 that was excavated in the western slope of Żbik ravine south of Dębnik.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	wfo	HArvv
433a	29.4	25.1	30.8	19.8	10.9	8.9
57c	30.9	27.0	30.4	23.0	–	5.4
433b	32.6	27.7	35.8	25.1	17.0	10.0
433c	36.8	32.4	35.0	30.7	19.3	8.9
433e	37.0	33.2	39.0	29.7	17.9	6.0
433f	(39.0)	33.6	41.4	31.6	18.8	8.9
433d	42.3	36.7	44.7	34.6	19.5	10.7

Description. — Shell medium sized for the genus (reaches slightly more than 40 mm in length), strongly ventri-biconvex, subcircular in outline, slightly wider than long, widest at midlength; cardinal

margin straight, reaches 83 to 85% of the shell width; ears very short; lateral margins arched except at ears where they become concave; anterior margin arched to straight, anterior commissure uniplicate.

Pedicle valve deep, slightly deeper than the brachial valve, with rather massive umbonal region; sulcus begins at the beak where it is better defined, sulcus anteriorly very shallow and poorly defined or sometimes barely perceptible; tongue, if present, short flat and rounded. Interareas concave and rather high; delthyrium open in majority of specimens; a few specimens show delthyrium closed by pseudodeltidium (Pl. 17: 5). Beak erect to incurved.

Brachial valve with very low and frequently poorly defined fold which is better developed at the uniplicate anterior commissure.

Shell covered with 34 to 40 simple costae on each flank, 4 to 5 costae in 5 mm at the anterior margin of large specimens. Costae rounded in umbonal part, flattened anteriorly, separated by narrow interspaces. Costae in sulcus and fold bifurcate and are usually slightly finer than those on flanks; their total number is on average 20. Micro-ornament consists of fine and densely distributed granules; radial striae not observed.

Long, thick and subparallel dental plates are developed inside the pedicle valve (Text-fig. 21). Delthyrial plate present. A wide cardinal process and narrow hinge plates are observed in the brachial valve.

Remarks. — This species is readily distinguished from other species of the genus *Dmitria* by its relatively high, moderately concave ventral interareas and long hinge margin that is only slightly shorter than the maximum shell width. However, several other morphological features of the species, such as a poorly defined fold and sulcus and the thickness of the shell and its ornamentation, agree with the diagnosis of the genus *Dmitria*.

Dmitria globosa slightly resembles *Spirifer (Cyrtospirifer) dada* NALIVKIN (later transferred to the genus *Dmitria* and then to the genus *Omolonospirifer* and finally to the genus *Tensia*) from the Famennian of Russia in its long hinge margin, but the latter species has low, strongly concave ventral interareas and thicker shell costation. *D. globosa* differs from co-occurring *D. angustirostris* (GÜRICH) by its longer hinge margin, higher ventral interareas and distinctly finer shell costation.

Occurrence. — *Dmitria globosa* (GÜRICH) is known only from the Dębnik anticline where it occurs in the light-gray limestones at Pałkowa Góra quarry. This outcrop no longer exists, but loose blocks of the limestones can be found in a nearby dirt road at the upper end of Żarnówczany Dół ravine (locality PG). The species occurs in the southern part of the anticline in correlative layers from trench Z.pal-1. Both occurrences represent the *Cavatisinurostrum longilinguis* interval (Middle and/or Upper *P. crepida* conodont Zone).

Genus *Sphaenospira* COOPER, 1954

Sphaenospira? sp.

(Pl. 15: 3–5; Text-fig. 22)

1918. *Spirifer Verneuili* MURCHISON var. *tenticulum* VERNEUIL; J. JAROSZ: 100–102; Pl. 8: 2, 2a–c, 3, 3a–b, 4–7.
1918. *Spirifer Verneuili* MURCHISON typus; *ibidem*: 98–100; Pl. 8: 1, 1a–c.

Material. — Three damaged shells and 15 fragments of valves from the Stromatoporoid Rock; an additional 21 fragments came from trenches B-1 and -3. All of the collection is very fragmentary and poorly preserved; the specimens are usually crushed and deformed and very difficult to isolate from surrounding rock.

Description. — It is very difficult to provide an adequate description of the species because of the very fragmentary and poorly preserved collection. The largest of the specimens reaches length of about 27 mm (brachial valve) and 32 mm (pedicle valve). Pedicle valve pyramidal with high to very high, weakly concave to completely flat interareas ornamented with distinct striae (4 to 6 per 1 mm) that are perpendicular to the hinge margin (Pl. 15: 5). In some specimens, the ventral interareas are not much shorter than the valve (Pl. 15: 3). Sulcus deep, sharply differentiated from the flanks and begins at the beak; triangular tongue sometimes present. Brachial valve trapezoidal with rather high fold.

Interior of the shell poorly known, but a sectioned pedicle valve has long dental plates and a delthyrial plate that closes the apical part of the delthyrium (Text-fig. 22). The delthyrial plate

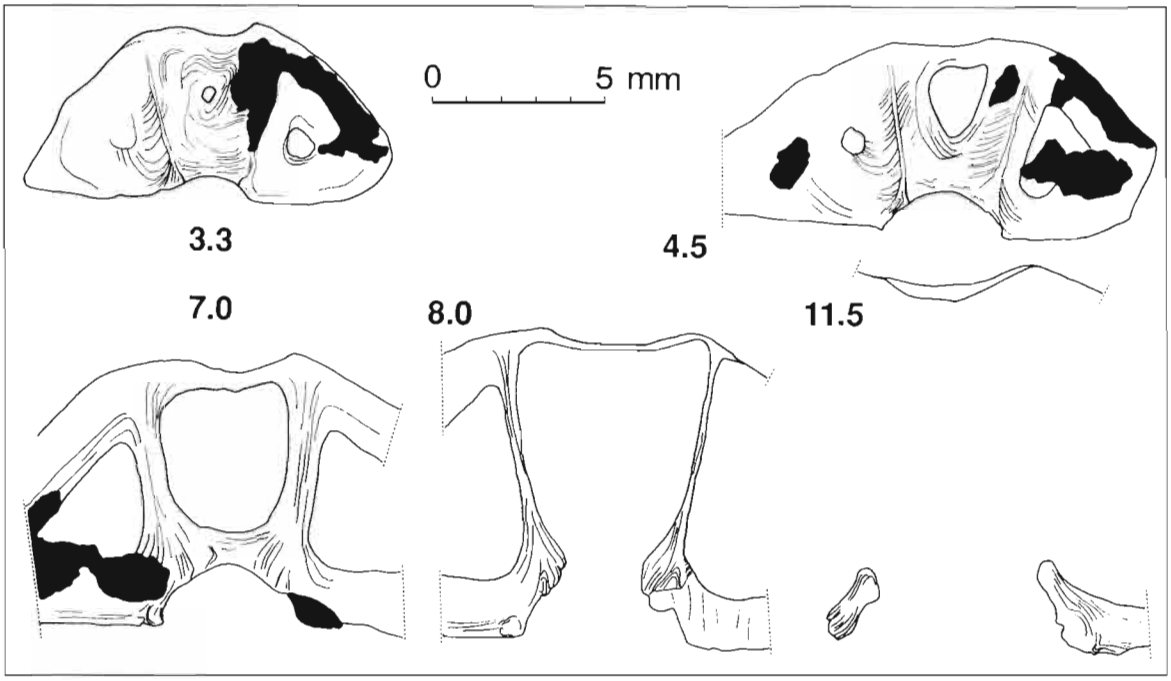

Fig. 22.
Transverse serial section of incompltete and partially silicified pedicle valve of *Sphaenospira*? sp. (trench B-3). Numbers refer to distance in mm from ventral apex.

reaches about 7.5 mm in length. Another pedicle valve shows a delthyrial plate that reaches at least 9 mm in length. Stegidium not observed.

Shell ornamented with strong ribs, usually 14 to 15 on each flank, and 8 to 10 in sulcus and fold.

Remarks. — JAROSZ (1918) was the first who described and illustrated the brachiopod fauna from the Stromatoporoid Rock situated between Rokiczany Dół and Żarnówczany Dół ravines. He found two characteristic forms among spiriferoids, namely *Spirifer Verneuili* typ. and *S. Verneuili* var. *tenticulum*. Earlier GÜRICH (1905) mentioned from the site only doubtful fragments of *Syringothyris cuspidata* (MARTIN) and *Spirifer tornacensis* KON. The study of the now collected specimens from Stromatoporoid Rock suggests that, the most probably, both forms described by JAROSZ (1918) represent a single species with differently developed ventral area.

The species is very interesting because it occurs in presumably the highest part of the studied Devonian section. Unfortunately, it is extremely difficult to get any satisfactory collection thus making the detailed study of the species impossible. Many external and internal features of the studied specimens, however, suggest some spiriferoids known from the Devonian-Carboniferous transition beds of Europe and Russia. One of them is *Spirifer julii* DEHÉE (=*Sphaenospira julii*) known from the Strunian of France (DEHÉE 1929: 19–21; Pl. 2: 1–8), Armenia (ABRAMIAN 1957: 88–91; Pl. 13: 2–3; Text-fig. 17) and Kuznetsk Basin (SARYTCHEVA *et al.* 1963: 263–265; Pl. 43: 1–5; Text-figs 112–113). The specimens from Dębnik have the same shell ornamentation and shape, deep ventral sulcus, and high ventral area. However, *Sphaenospira julii* often attains a larger dimensions than the form described here. These specimens also differs from *Cyrtospirifer tarandrus* NALIVKIN from the Famennian of the Arctic Russia (NALIVKIN 1960: 384–96385; Pl. 88: 6–7) by larger shell, wider ventral area, and delthyrium.

Some specimens from Dębnik are similar externally to *Tenticospirifer tychtensis* BESNOSOVA from the lowermost Tournaisian of the Kuznetsk Basin (SARYTCHEVA 1963: 262; Pl. 42: 4); the former differ mainly by a deeper ventral sulcus and usually have a much higher ventral area.

Because the studied specimens are very fragmentary and poorly preserved, as mentioned above, they are tentatively referred to *Sphaenospira* COOPER.

Occurrence. — The species occurs sporadically in light-gray detritic limestones, often with stromatoporoids, that crop out on the western slope of Racławka valley between Rokiczany Dół and Żarnówczany Dół ravines (=Stromatoporoid Rock) and in trenches B-1 and B-3 (*Sphaenospira*? sp. interval).

Family **Brachythyrididae** FREDERICKS, 1919
Genus *Eobrachythyris* BRICE, 1970
Eobrachythyris palkowae (GÜRICH, 1903)
(Pl. 18:1–12; Text-figs 23–24)

1903. *Spirifer Palkowae* n. sp.; G. GÜRICH; 143–144, Pl. 1: 8a–e.

Material. — Forty complete to nearly complete shells and 300 fragmentary shells and valves. Most of the specimens came from loose blocks of limestones that were excavated along the dirt road at the upper end of Żarnówczany Dół ravine. Additional specimens came from trench Z.pal-1 on the western slope of Żbik ravine. A few specimens were found on the eastern slope of the ravine in trenches Z.orb-5, -6, -8 and -12. Partial silification has taken place in the specimens from trenches Z.pal-1 and Z.orb-5; many of these specimens were etched in acetic acid and show well preserved internal details of both valves.

Dimensions (in mm):

Cat. no. ZPAL Bp XXIII	Lvv	Ldv	W	T	wfo	HArvv
444a	1.54	1.41	1.54	0.77	0.77	0.12
444b	2.62	2.50	3.01	1.73	1.09	0.64
437a	9.8	8.3	(13.0)	6.9	4.9	1.28
437b	10.0	8.8	11.3	7.6	7.6	1.2
438	12.5	9.3	12.9	11.3	7.2	2.3
443b	13.2	10.8	14.4	9.2	6.3	1.8
439	14.6	11.8	14.3	12.6	6.8	2.4
441	15.3	12.0	15.7	11.3	7.6	3.0
443a	16.0	11.8	14.4	11.4	7.0	2.0

Description. — Shell medium-sized for the genus, ventri-biconvex to strongly biconvex, subpentagonal to heart-like in outline, usually slightly wider than long but there are also more elongated specimens; widest at midlength; cardinal margin straight and reaches 77 to 88% of the shell width; ears poorly defined; lateral margins arched, anterior margin angularly indented, anterior commissure uniplicate.

Pedicle valve deep, slightly deeper than the brachial valve; sulcus starts at the beak, deep to very deep, "V"-shaped, and sharply separated from lateral areas of the valve. Interareas rather low, triangular, sometimes almost linear, weakly concave, orthocline; delthyrium narrow and almost completely covered by convex, thick pseudodeltidium — there is only a narrow slot between the dorsal end of the pseudodeltidium and dorsal umbo (Pl. 18: 20). Beak erect to incurved.

Brachial valve regularly convex except at cardinal extremities where it becomes slightly concave; fold very low, but clearly separated from flanks by usually deeper intercostal grooves.

Shell covered with 12 to 16 simple, rounded, and thick costae on each flank that are separated by narrower interspaces; costae in fold and sulcus bifurcating and intercalated, weaker than those on flanks, occasionally obsolescent, costae variable in number but usually up to 8. Micro-ornamentation consisting of very fine and dense concentric lines (24 to 26 per 1 mm) and fine radial striae (14 to 16 per 1 mm). Costae covered with densely distributed minute granules or microspines (Pl. 18: 9).

The shell interior was studied in sectioned specimens (Text-fig. 23) as well as in silicified and etched specimens (Pl. 18: 7–8, 10–11). Slightly divergent dental plates are present inside the pedicle valve. They are up to 5.5 mm long in adult specimens and reach 37% of the shell length. A pair of

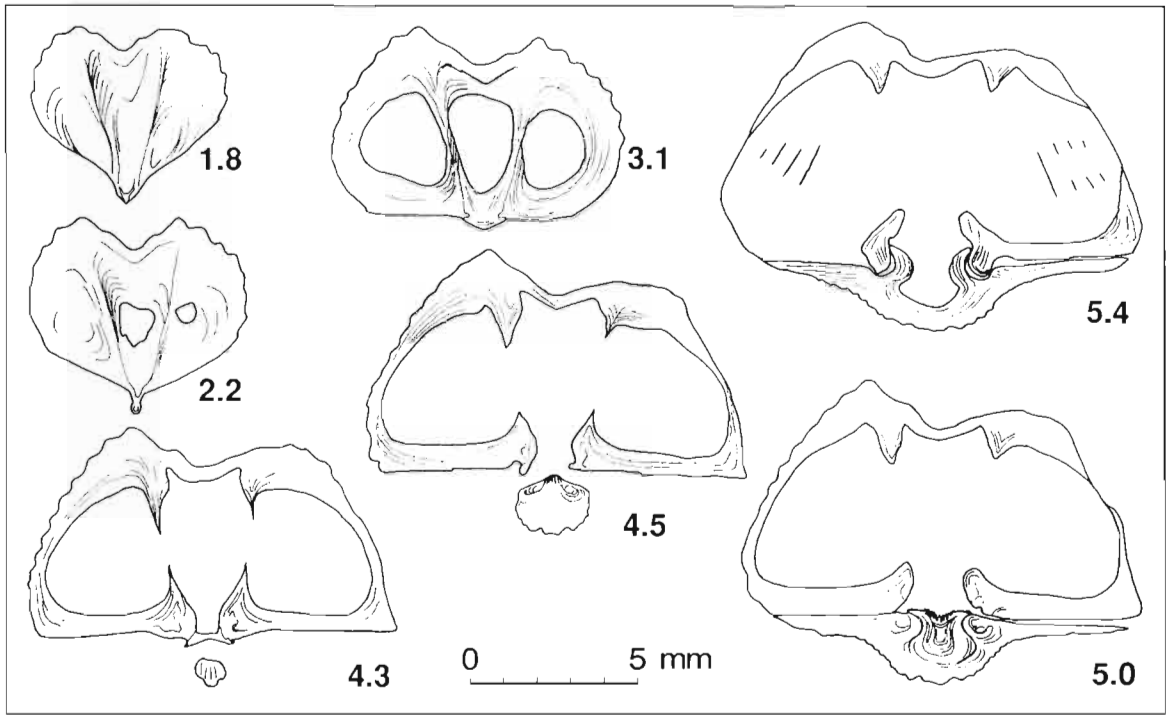

Fig. 23.
Transverse serial section of *Eobrachythyris palkowae* (GÜRICH) (locality PG). Numbers refer to distance in mm from ventral apex.

muscle scars that are deeply entrenched at their posterior ends are located between the dental plates one third of their length from the umbo (Pl. 18: 8, 11).

Interior of brachial valve with strong hinge plates forming an angle of 87° to 100° and striated cardinal process (Pl. 18: 10; Text-fig. 23). Spiralia directed postero-laterally and slightly ventrally (Pl. 18: 7, 12).

Growth. — The smallest specimen in the collection reaches only 1.54 mm in length, but it has very well developed pseudodeltidium, which is strongly convex at this stage of growth.

Juvenile shells have distinctly different relative convexity of the valves by comparison with adult specimens. The brachial valve in the smallest shells is proportionally flatter and reaches only 17 to 32% of the total shell thickness (Text-fig. 24). Shells larger than 10 mm in length have brachial valves that are much more convex and with a distinct tendency to nearly equal-bicovexity (36 to 50% of the shell thickness).

Remarks. — This small spiriferoid is a very characteristic form for the beds that previously cropped out at Pałkowa Góra quarry. Its general appearance is quite strange and this caused GÜRICH (1903: 143) to compare it both to *Cyrtospirifer minor* and to cyrtinids. *Eobrachythyris palkowae* is characterized by a thick, coarsely costate shell up to 17 mm in length, low ventral interareas, short hinge margin, convex pseudodeltidium, and very deep "V"-shaped sulcus which, in combination with low dorsal fold, causes a characteristic indentation of the anterior shell margin.

Eobrachythyris palkowae is externally very similar to *E. proovalis* BRICE (1970: 183–186, Pl. 13: 1–3; Text-fig. 43) from the Upper Famennian of Afghanistan. Both species have similar shell shape, ornamentation and dimensions, low ventral interareas, and short hinge margin. The species from Dębnik differs mainly by having a very well developed pseudodeltidium which is rather weak, as in *E. proovalis*, as well as in lacking a median groove on the top of dorsal fold.

The species from Dębnik is also similar in some external features to *Brachythyris bisbeensis* STAINBROOK from the Percha Formation of Arizona, USA (STAINBROOK 1947: 321–322, Pl. 47: 23,

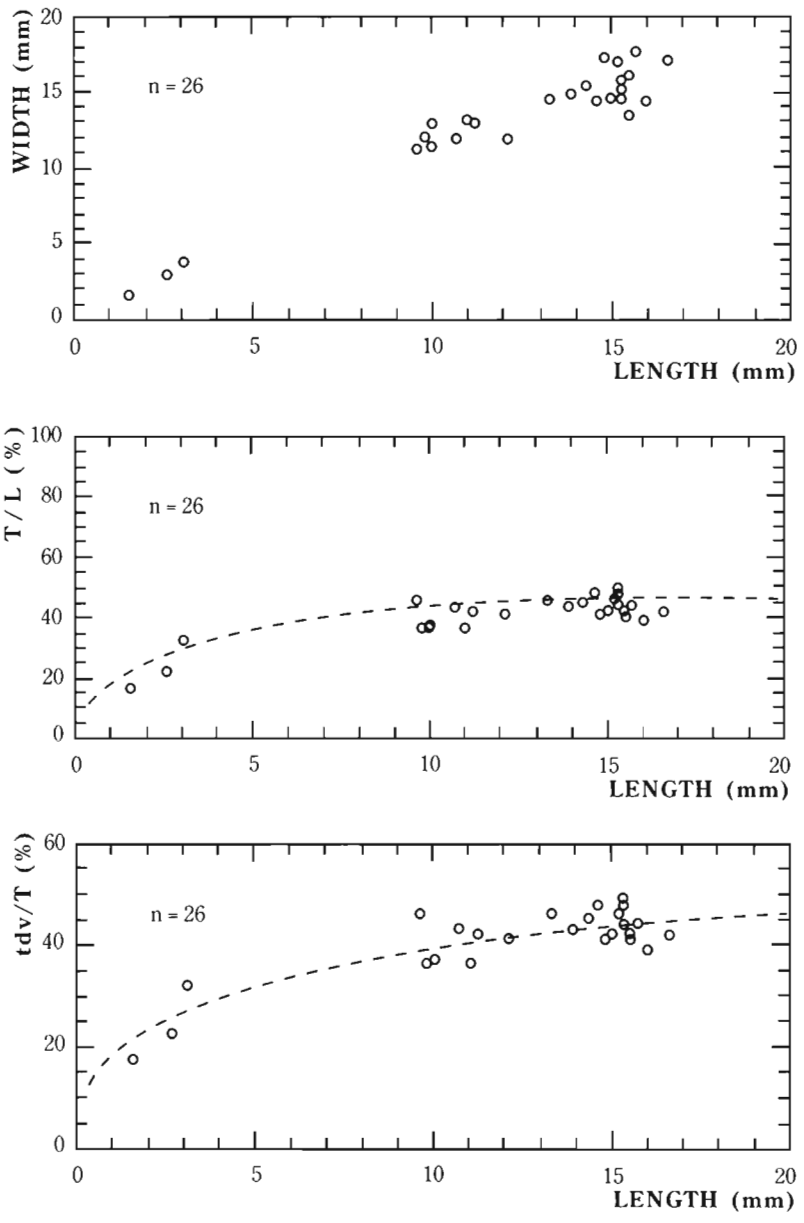

Fig. 24.
Scatter diagram of width versus length (A), thickness index of shell (T/L) versus length (B) and thickness index of brachial valve (tdv/T) versus length of shell in *Eobrachythyris palkowae* (GÜRICH).

29–30). Although the Arizona species differs by its smaller size, higher fold, and shallower gently concave sulcus among other features, it is possible that it belongs to *Eobrachythyris* BRICE. This assignment is bolstered by its dental plates (COOPER and DUTRO 1982: 122).

Occurrence. — *Eobrachythyris palkowae* is a characteristic fossil of the limestone from Pałkowa Góra quarry. As noted above, the quarry no longer exists, but blocks of limestones that most probably came from there can be still found in the field road at upper end of Żarnówczany Dół ravine (locality PG). Most of the collection of this report came from this locality. To the South of Dębnik, *E. palkowae* occurs in the western slope of Żbik ravine in trench Z.pal-1 as well as in the eastern slope of the ravine in trenches Z.orb-5, -6, -8 and -12. All occurrences represent the *Cavatisinurostrum longilinguis* interval (the *P. crepida* conodont Zone).

Conodonta PANDER, 1856

The collection of the Famennian platform conodonts studied in this report were extracted from limestons using acetic, or less frequently, formic acid. Nearly 2,000 platform elements were obtained, which represent 49 species and subspecies. Their frequency distribution is shown in Table 2 (see page 19), and all of them are figured in plates 19 to 22 in order to provide complete biostratigraphic documentation. Two species of *Polygnathus* are described; one of them is proposed as new.

Genus *Polygnathus* HINDE, 1879

Polygnathus rarus sp. n.

Holotype: ZPAL C VIII/232; illustrated in Pl. 20: 15.

Type horizon: the stromatoporoid limestone representing a difficult to precise interval between *P. rhomboidea* to ?Lower *P. expansa* Zones.

Type locality: Dębnik, locality ZS-7 situated to the southwest of the village.

Derivation of the name: *rarus* — to stress a very low frequency of the species in the studied strata.

Diagnosis. — A species of *Polygnathus* with subrectangular platform strongly ornamented by nodes which are arranged in longitudinal rows. Carina nodose, at the posterior tip denticualte, frequently bent and twisted, projects behind the plate.

Material. — see Table 2.

Description. — The platform of *P. rarus* sp. n. is relatively broad, subrectangular in outline, tapered posteriorly. Adcarinal troughs are deep anteriorly, become shallow at midlength and extending into the posterior platform. Ornament is characterized by longitudinal rows of isolated strong nodes. At least one longitudinal row of nodes occurs on each side, but commonly one more short row or at least a single node occurs on expanded laterally parts of the platform; sometimes a lobe-like lateral extension of the platform is formed (Pl. 20: 15, 17).

Moderately high blade consists of 3 to 4 denticles. Carina is well marked and consists of fused denticles, which at posterior tip, however, becoming isolated and much higher. The posterior tip of the carina extends posteriorly well beyond the plate and is bent laterally; in many specimens the denticles forming a tip of the carina are additionally twisted (Pl. 20; 15, 19). In lower view the pit is located one-third of the platform length anteriorly (Pl. 20: 12).

Remarks. — *Polygnathus rarus* sp. n. differs evidently from majority of species of the genus. It demonstrates, however, some morphological similarity to the two Famennian species, namely *Polygnathus* nov. sp. B DREESEN from the Theux Basin, Belgium (DREESEN 1987) and *Polygnathus* sp. nov. A ARISTOV from the Russian Platform (ARISTOV *at al.* 1983: 82, pl. 2: 4). The described species differs from *P.* nov. sp. B by having larger, more rectangular platform, stronger ornamentation and posterior free tip of the carina which is composed from isolated denticles. *P. rarus* is very close in a general appearance to *P.* sp. nov. A ARISTOV. The Polish species differs in details of platform ornamentation and a posteriorly located basal pit.

Occurrence. — *P. rarus* is a very rare species in the stromatoporoid limestone from locality ZS-7 situated to the southwest of Dębnik.

Polygnathus sp. A
(Pl. 22: 3, 16–17)

Remarks. — The species is characterised by long platform with stright, parallel margins to the carina in its one-half to two-third of the anterior part. The posterior part of the platform is triangular and sharply ended. Carina is high, flanked by rather shallow adcarinal troughs. Upper surface of the platform ornamented by distinct ridges, more or less perpendicular to carina, in gerontic specimens desintegrated to tubercles and short ridges (Pl. 22: 17). The species is closest morphologically to *P. pennatulus* ULRICH and BASSLER but differs in having distinctly parallel margins of the anterior part of the platform.

Occurrence. — The species occurs in medium-bedded biopelmicrites in trenches Z-orb-1 to -2, ZW-1 and ZS-6 (*Cyrtospirifer carinatus* interval; Upper *P. crepida* to Lower *P. rhomboidea* conodont Zones).

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INDEX OF GENERIC AND SPECIFIC NAMES

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PLATES

PLATE I

Schizophoria shubarica MARTYNOVA, 1961 1

Fig. 1. Nearly complete shell in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/364, trench Z.orb-8, *Dmitria gibbosa* interval, × 1.5.

Eoschuchertella sp. 32

Figs 2–4. Three shells in *a* dorsal, *b* ventral and *c* lateral views; Bp XXIII/366a, 122d, 366b, trench Z.orb-7, *Dmitria gibbosa* interval (Figs 2, 4), trench ZS-1a, *Cyrtiorina? depressa* interval (Fig. 3), × 1.5.

Fig. 5. Interior of the pedicle valve; Bp XXIII/122e, locality and horizon as in Fig. 3, × 1.5.

Fig. 7. Interior of the brachial valve; Bp XXIII/122f, locality and horizon as in Fig. 3, × 1.5.

Fig. 8. Detailed view of the ventral interareas and convex pseudodeltidium; Bp XXIII/122h, locality and horizon as in Fig. 3, × 2.5.

Schizophoria sp. 32

Fig. 6. Interior of the incomplete brachial valve; Bp XXIII/365a, trench Z.pal-1, *Cavatisinurostrum longilinguis* interval, × 4.

Lingulipora sp. 31

Fig. 9. Internal view of the incomplete pedicle valve; Bp XXIII/368, trench Z.orb-12, *Cavatisinurostrum longilinguis* interval, × 35.

Barroisella campbelli COOPER, 1942 30

Fig. 10. Interior of the brachial valve; Bp XXIII/369, locality and horizon as in Fig. 9, × 30.

Figs 14, 16. Interior of two pedicle valves; Bp XXIII/370–371, Palkowa Góra (PG) (Fig. 14) and trench Z.pal-1 (Fig. 16), *Cavatisinurostrum longilinguis* interval, × 20 and × 30.

Donalosia sp. 33

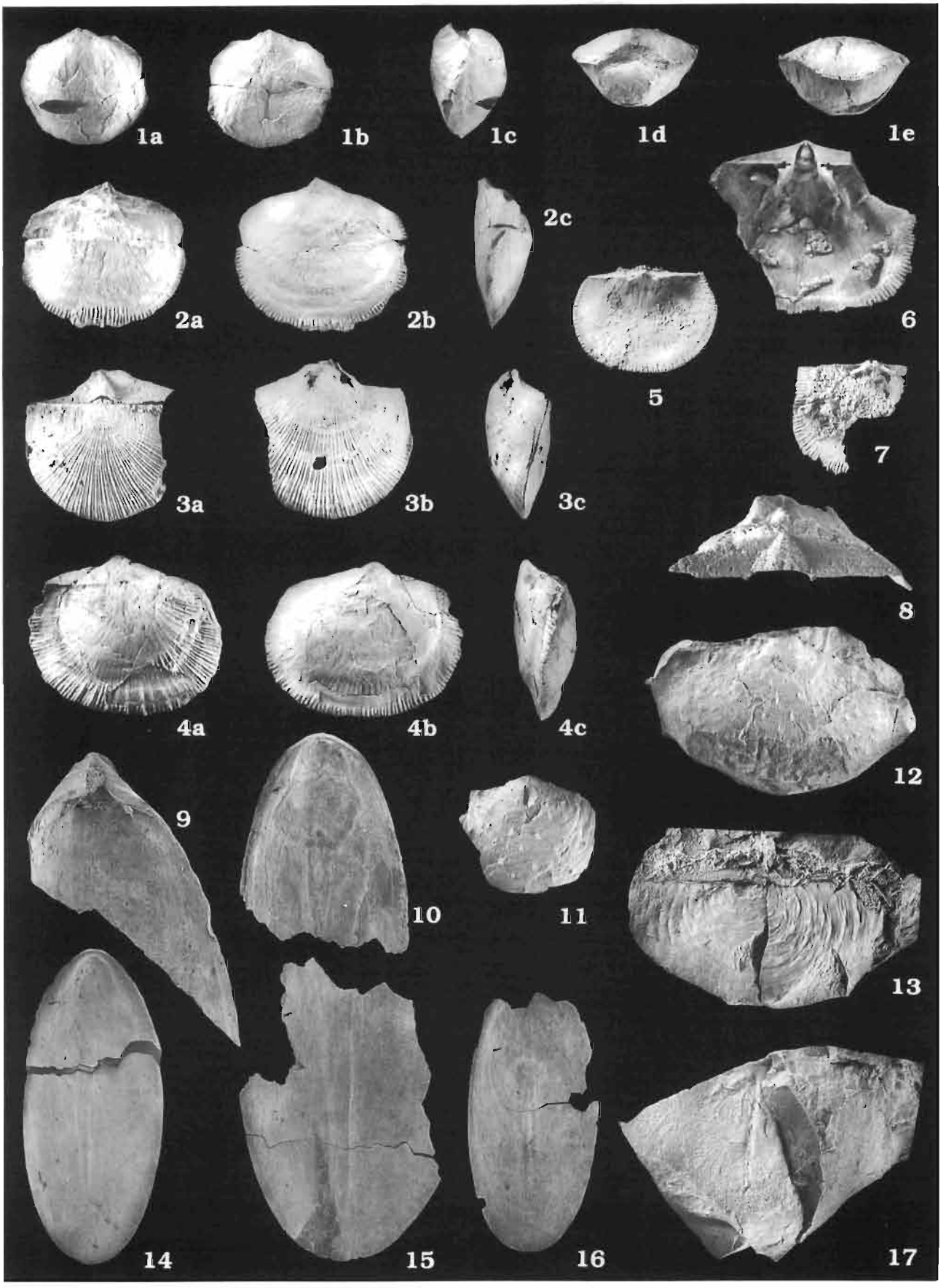
Figs 11–12. Ventral views of two incomplete specimens; Bp XXIII/372a–b, trench Z.orb-7, *Dmitria gibbosa* interval, × 1.5.

Fig. 13. Posterior part of the brachial valve in internal view; Bp XXIII/372c, locality and horizon as in Fig. 11, × 1.5

Fig. 17. Fragmentary preserved shell with partially removed pedicle valve showing interior of brachial valve; Bp XXIII/372d, locality and horizon as in Fig. 11, × 1.5.

Dignomia sp. 31

Fig. 15. Interior of a single incomplete valve; Bp XXVIII/447, trench Z.orb-2, *Cyrtospirifer carinatus* interval, × 25.



BALIŃSKI: BRACHIOPODS AND CONODONT BIOSTRATIGRAPHY
OF THE FAMENNIAN FROM THE DĘBNIK ANTICLINE, SOUTHERN POLAND

PLATE 2

Rhytialosia sp. 33

Fig. 1. Shell in *a* dorsal and *b* ventral views; Bp XXIII/373a, trench Z.pal-1, *Cavatisinurostrum longilinguis* interval, × 1.5.

Fig. 2. Juvenile specimen in ventral view; Bp XXIII/ 373b, locality and horizon as in Fig. 1, × 1.5.

Fig. 3. Interior of the brachial valve in *a* general and *b* enlarged views; Bp XXIII/373c, locality and horizon as in Fig. 1, × 1.5 and × 4.

Leioproductus cf. *pauperculus* COOPER *et* DUTRO, 1982 35

Fig. 4. Silicified specimen in *a* dorsal and *b* ventral views; Bp XXIII/374, trench ZS-1, *Cyrtiorina*? *depressa* interval, × 1.5.

Figs 5–7. Three specimens in *a* dorsal, *b* lateral and *c* posterior views; Bp XXIII/119g, 126, 129e, trench ZS-1 (Figs 5, 7) and trench ZS-2 (Fig. 6), *Cyrtiorina*? *depressa* interval, × 1.5.

Nigerinoplica sp. 35

Figs 8, 10. Two specimens in *a* dorsal, *b* lateral and *c* posterior views; Bp XXIII/378, 70e, trench Z.bis-4, *Cyrtospirifer brodi* interval (fig.8) and Z.tent-3, *Cyrtospirifer wesgensis* interval (Fig. 10), × 1.5.

Mesoplica cf. *praelonga* (SOWERBY, 1840) 38

Figs 9, 11. Two incomplete specimens in *a* ventral, *b* lateral and *c* posterior views; Bp XXIII/129d, g, trench ZS-1a, *Cyrtiorina*? *depressa* interval, × 1.5.

Mesoplica sp. 39

Fig. 12. External view of partially exfoliated pedicle valve in *a* ventral, *b* lateral and *c* posterior views; Bp XXIII/375, trench ZS-2, *Cyrtiorina*? *depressa* interval, × 1.5.

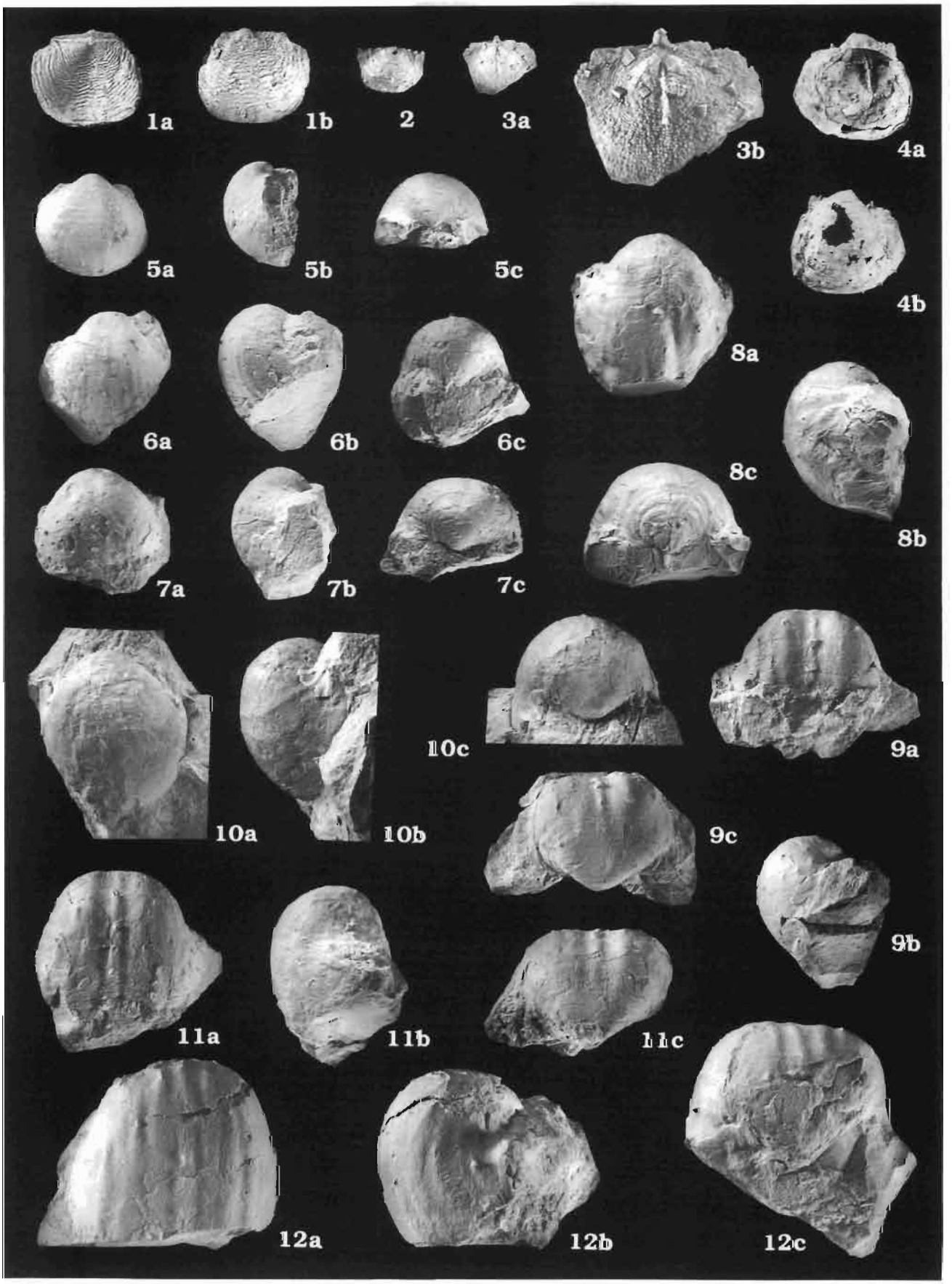


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PLATE 3

Sentosia profunda McKELLAR, 1970 39

Figs 1–2. Two shells in *a* dorsal, *b* ventral, *c* lateral and *d* posterior views; Bp XXIII/379, 82a, trench Z.tent-3 (Fig. 1) and Z.tent-2 (Fig. 2), *Cyrtospirifer wesgensis* interval, × 1.5.

Fig. 3. Partially exfoliated pedicle valve in *a* ventral, *b* lateral and *c* posterior views; Bp XXIII/82h, locality and horizon as in Fig. 2, × 1.5.

Mesoplica costata sp. n. 35

Figs 4–5. Two shells in *a* dorsal, *b* ventral, *c* lateral and *d* posterior views; Bp XXIII/110 (holotype), 106b, trench Z.orb-2 (Fig. 4) and Z.orb-1 (Fig. 5), *Cyrtospirifer carinatus* interval, × 1.5.

Figs 6–7. Two pedicle valves in *a* ventral, *b* lateral and *c* posterior views; Bp XXIII/120e, a, locality and horizon as in Fig. 4, × 1.5.

Fig. 8. Posterior view of the weathered shell showing muscle scars; Bp XXIII/136d, near trench Z.orb-1, *Cyrtospirifer carinatus* interval, × 1.5.

Fig. 9. Posterior view of the crushed shell showing dorsal median septum; Bp XXIII/136c, locality and horizon as in Fig. 8, × 1.5.

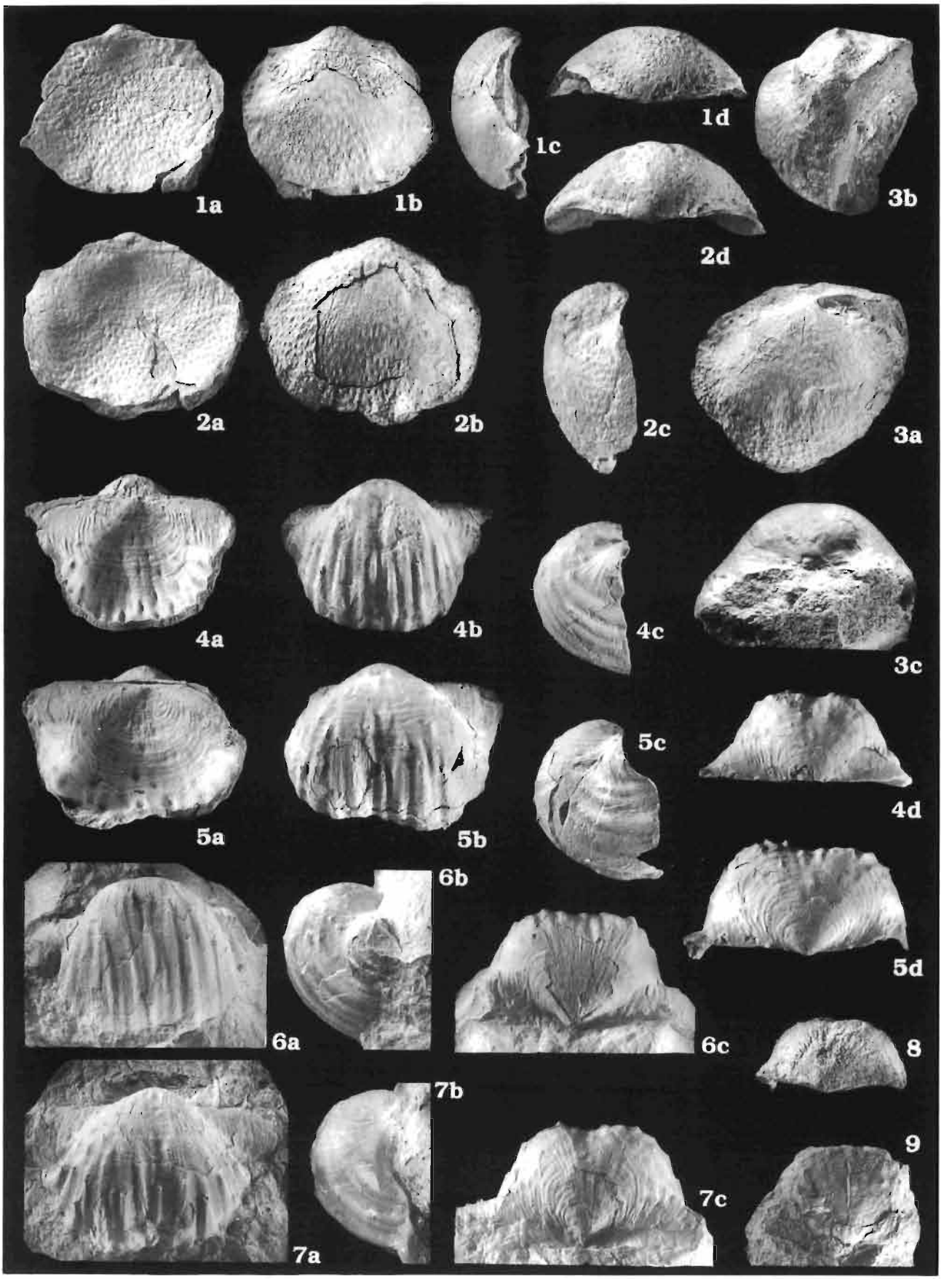

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PLATE 4

Ptychomaletoechia sp. 41

Figs 1–3. Three shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/36a, c, 381a, trench Z.orb-6 (Fig. 1–2) and Z.orb-8 (Fig. 3), *Dmitria gibbosa* interval, × 1.5.

Colophragma? sp. 45

Figs 4–5. Two shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/383a–b, quarry Z-2, *Iloerhynchus mesoplicatus* interval, × 2.

Coeloterorhynchus sp. 45

Figs 6–7. Two incomplete shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/385a, 37c, trench Z.orb-7 (Fig. 6) and Z.orb-6 (Fig. 7), *Dmitria gibbosa* interval, × 2.

Centrorhynchus cf. *letiensis* (GOSSELET, 1879) 40

Figs 8–9. Two fragmentary pedicle valves in ventral view; Bp XXIII/384a–b, trench Z.orb-9, *Cyrtospirifer wesgensis* interval, × 1.5.

Fig. 10. Internal view of silicified pedicle valve; Bp XXIII/387, locality and horizon as in Fig. 8, × 4.

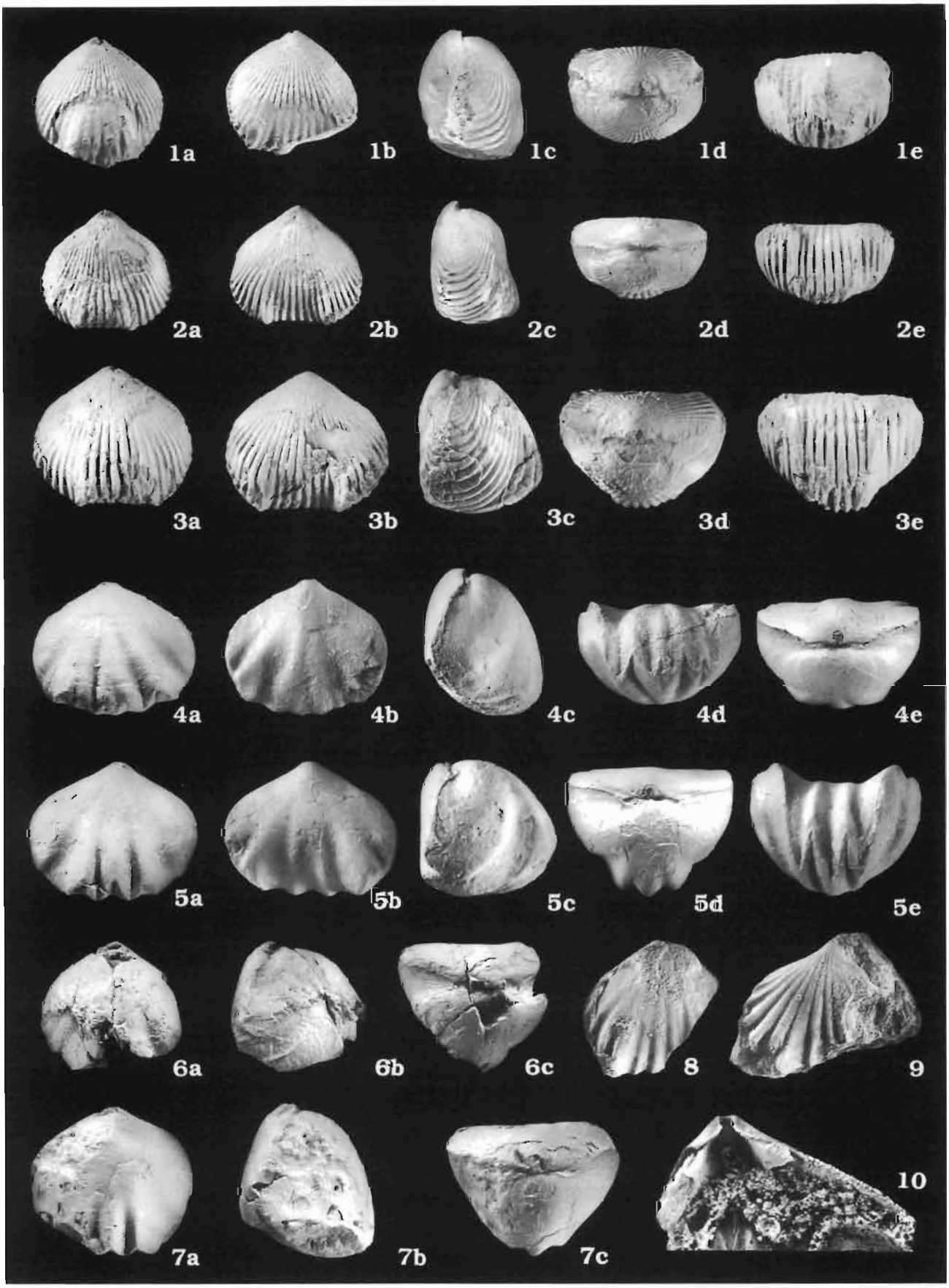

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PLATE 5

Cavatisinurostrum longilinguis sp. n. 43

Figs 1–5. Five shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/388–393 (390 – holotype), Pałkowa Góra (PG), *Cavatisinurostrum longilinguis* interval, × 1.

Fig. 6. Silicified brachial valve in posterior view; Bp XXIII/400, trench Z.orb-5, *Cavatisinurostrum longilinguis* interval, × 3.

Sentosia sp. 40

Fig. 7. Poorly preserved pedicle valve exterior; Bp XXIII/54a, Stromatoporoid Rock, *Sphaenospira*? sp. interval, × 1.5.

Rhynchonellacean gen. et sp. indet. 53

Fig. 8. Incomplete shell in *a* dorsal, *b* ventral and *c* lateral views; Bp XXIII/49, locality and horizon as in Fig. 7, × 2.

Sentosia profunda McKELLAR, 1970 39

Fig. 9. A slab showing three specimens of *Sentosia profunda* and one specimen of *Nigerinoplica* sp.; Bp XXIII/84, trench Z.tent-1, *Cyrtospirifer wesgensis* interval, × 1.

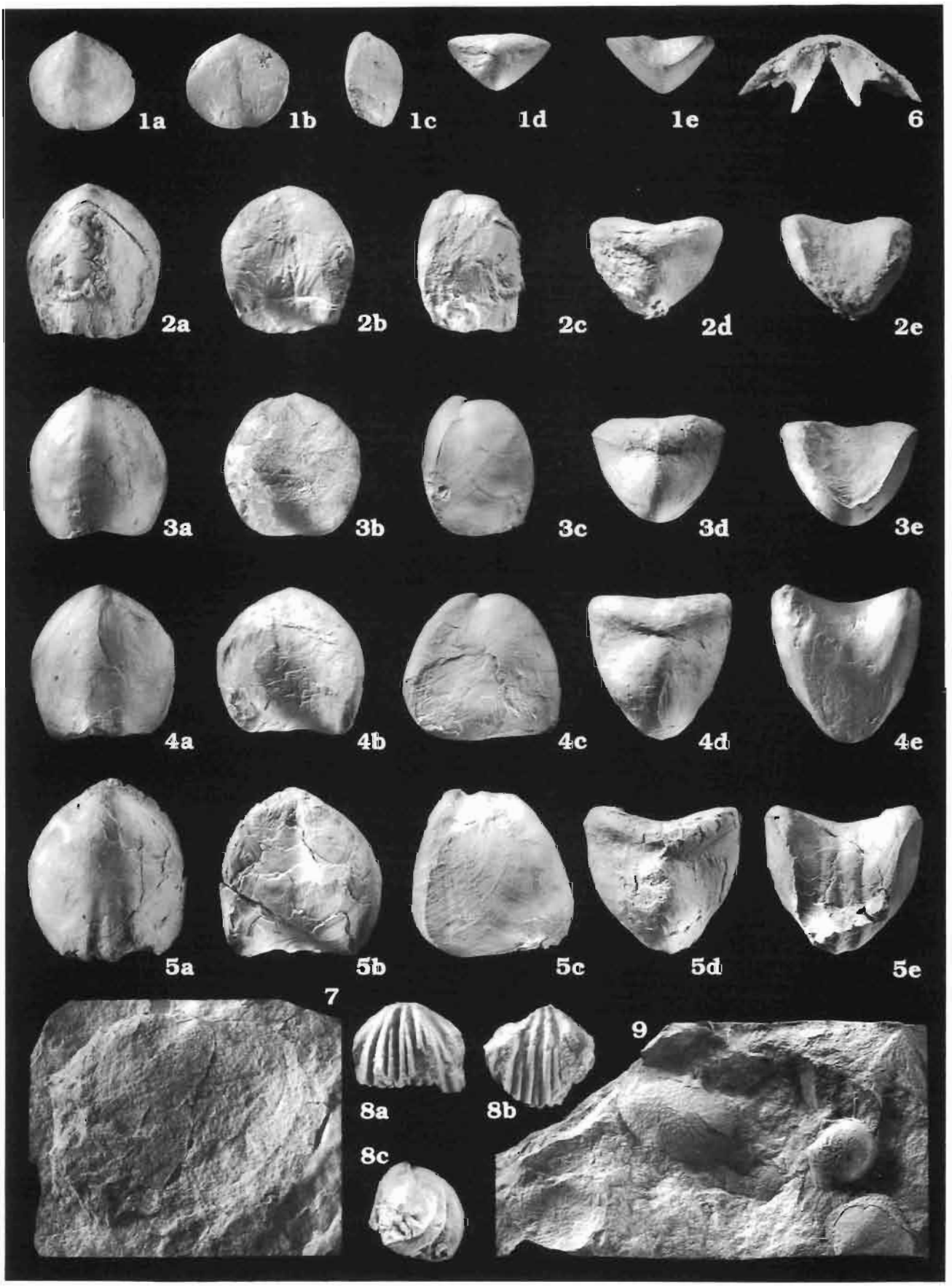

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PLATE 6

Iloerhynchus mesoplicatus gen. et sp. n. 47

Figs 1–4. Four specimens showing variability of the shell exterior in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/171c, 169e (holotype), d, f, quarry Z-2 (Fig. 1) and trench Z-9 (Figs 2–4), *Iloerhynchus mesoplicatus* interval, × 2.

Fig. 5. Nearly complete shell in *a* dorsal, *b* lateral and *c* posterior views; Bp XXIII/196c, locality and horizon as in Fig. 2, × 2.

Fig. 6. A damaged shell in dorsal view, locality and horizon as in Fig. 2, × 2.

Evanescirostrum seversoni (McLAREN, 1954) 49

Fig. 7. A complete shell in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/138a, trench Z.orb-2a, *Cyrtospirifer carinatus* interval, × 1.5.

Fig. 9. A crushed shell in *a* dorsal and *b* ventral views; Bp XXIII/138c, locality and horizon as in Fig. 7, × 1.5.

Cavatisinurostrum longilinguis sp. n. 43

Fig. 8. An exfoliated shell in ventral view showing ornamentation of the interal mould; Bp XXIII/393, Palkowa Góra (PG), *Cavatisinurostrum longilinguis* interval, × 2.

Loborina lobata BALIŃSKI, 1982 52

Fig. 10. Nearly ciompleted shell in dorsal view; Bp XXIII/402, trench Z.pal-1, *Cavatisinurostrum longilinguis* interval, SEM × 25.

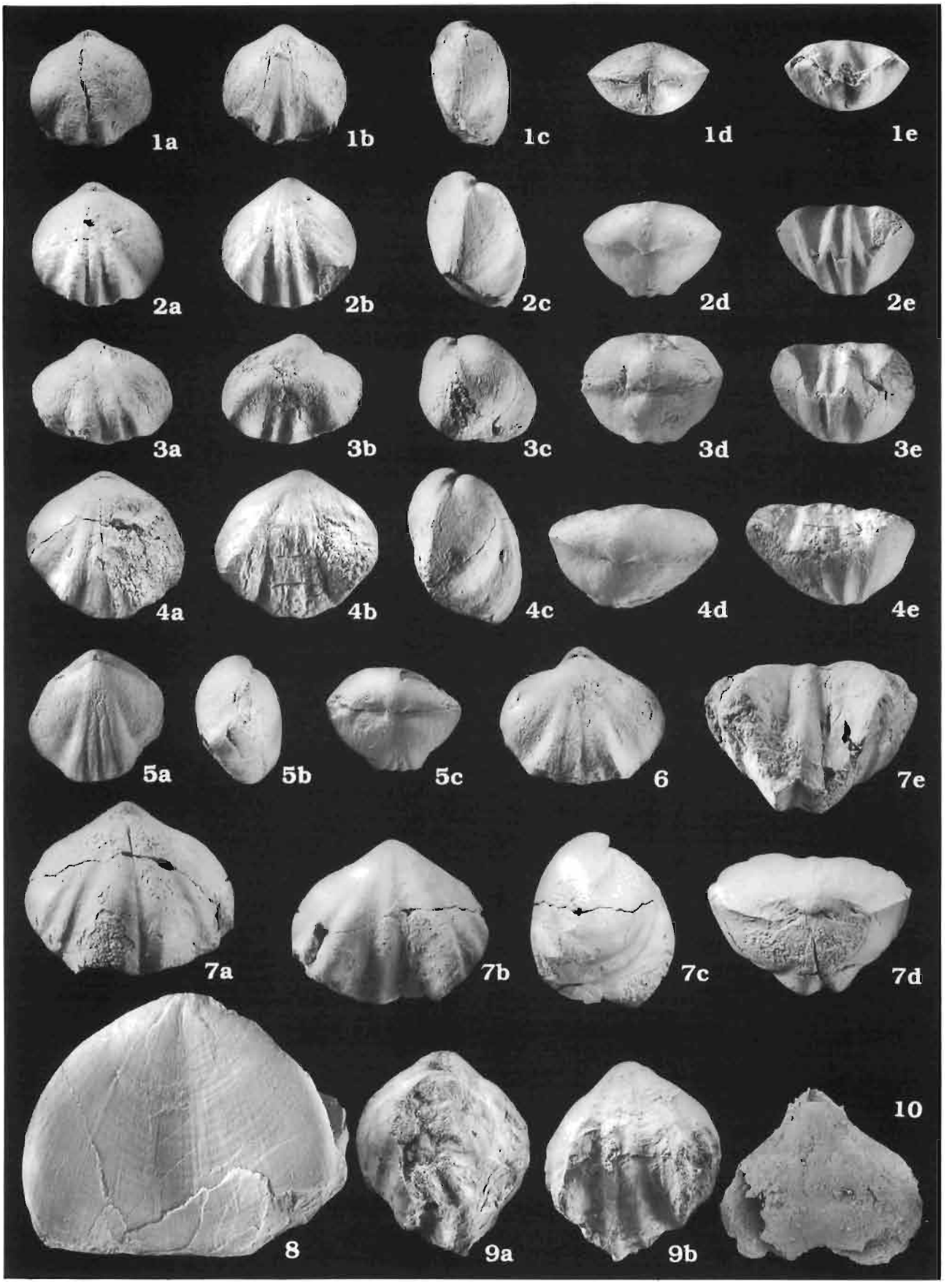

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PLATE 7

Minirostrella rara gen. et sp. n. 51

Figs 1–7. Seven shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/403a–b, 404, 403c–f (403e – holotype), quarry Z-2, *Hoerhynchus mesoplicatus* interval, × 2.

Fig. 10. Posterior part of the shell in dorsal view; Bp XXIII/403e, locality and horizon as in Fig. 1, × 4.

Fig. 11. Lateral view of the posterior part of a shell showing very low ventral beak; Bp XXIII/406a, trench Z-8, *Hoerhynchus mesoplicatus* interval, × 4.

Athyris sp. 58

Figs 8–9. Two shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/95c–d, trench Z.orb-1, *Cyrtospirifer carinatus* interval, × 1.5.

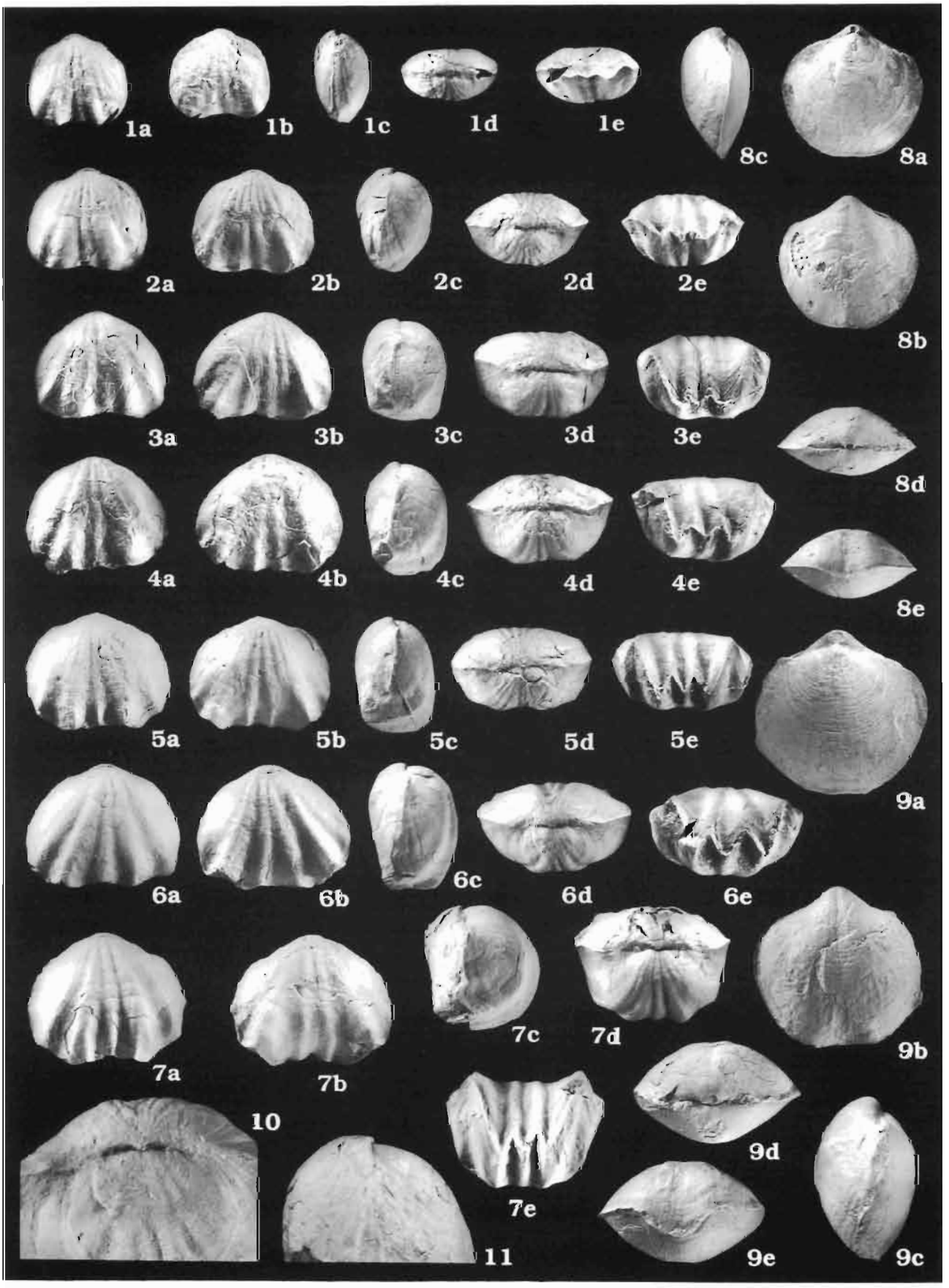

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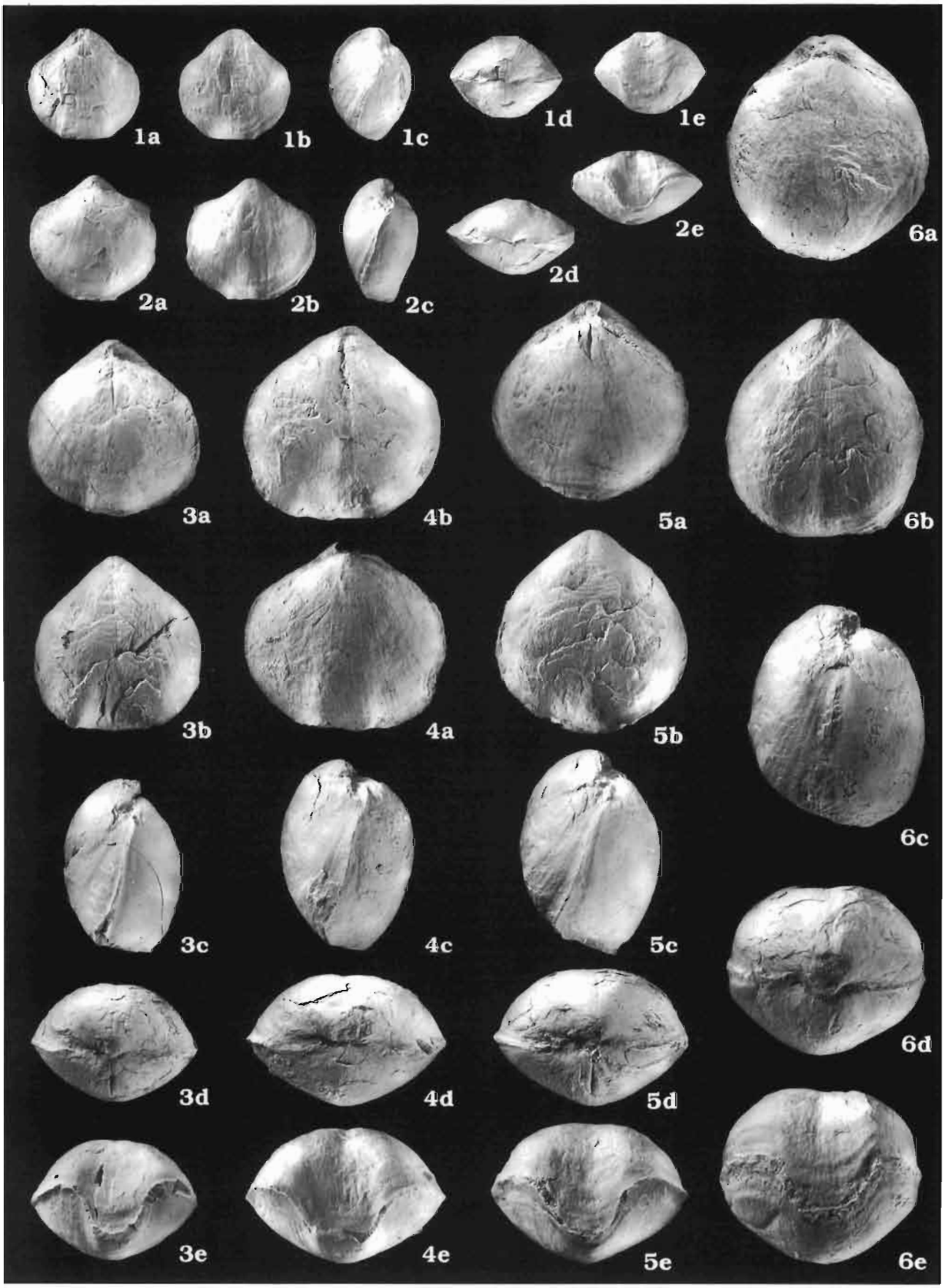
PLATE 8

Athyris aff. *area* sp. n. 57

Figs 1–2. Two shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/407a–b, trench Z.orb-6, *Dmitria gibbosa* interval, × 1.5.

Athyris sulcifera NALIVKIN, 1937 53

Figs 3–6. Four mostly exfoliated shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/116l, f, k, 93f, trench Z.orb-2 (Figs 3–5) and Z.orb-1 (Fig. 6), *Cyrtospirifer carinatus* interval, × 1.5.



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OF THE FAMENNIAN FROM THE DĘBNIK ANTICLINE, SOUTHERN POLAND

PLATE 9

Athyris area sp. n. 56

Figs 1–6. Six specimens illustrating variability of the shell exterior in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/410–415 (414 – holotype), trench Z.pal-1, *Cavatisinurostrum longilinguis* interval, × 2.

Figs 10, 14. Interior of two brachial valves; Bp XXIII/419, 421, locality and horizon as in Fig. 1, × 3.

Fig. 12. Interior of the pedicle valve; Bp XXIII/420, locality and horizon as in Fig. 1, × 3.

"Athyris" aff. *reticulata* (GOSSELET, 1877) 58

Figs 7, 13. Two nearly complete shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/35b, m, trench Z.orb-6, *Dmitria gibbosa* interval, × 2.

Crinisarina sp. 59

Figs 8–9. Ventral view of two silicified pedicle valves; Bp XXIII/408a, b, locality and horizon as in Fig. 1, × 3.

Fig. 11. Internal view of the silicified pedicle vlave; Bp XXIII/408b, locality and horizon as in Fig. 1, × 4.

Fig. 15. An incomplete large shell preserving shell ornamentation (partly covered by bryozoan colony; Bp XXIII/409, locality and horizon as in Fig. 1 × 2.

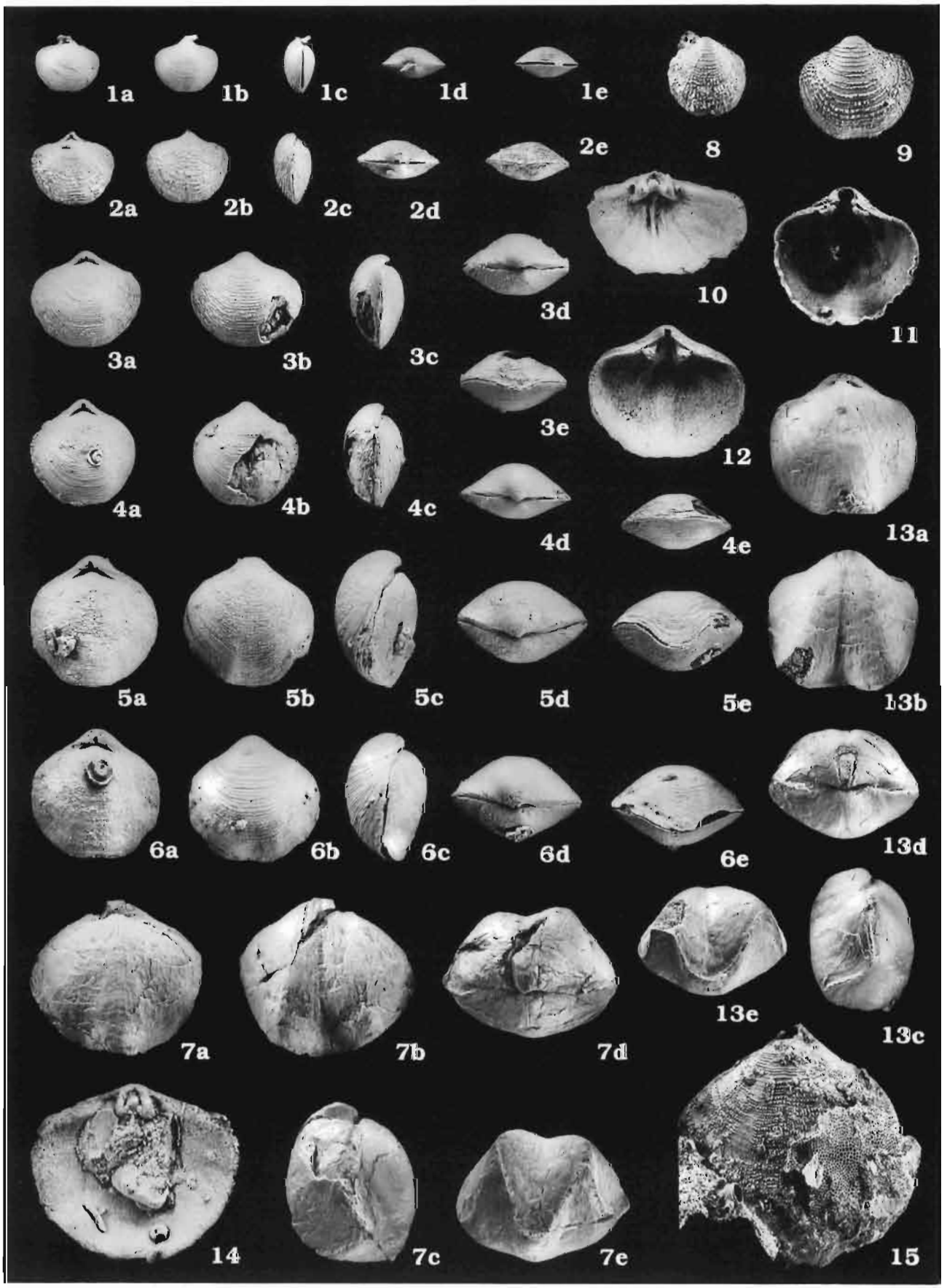

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PLATE 10

Athyris tau (NALIVKIN, 1937) 57

Figs 1–2. Two slightly damaged shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/422a–b, trench Z.orb-12, *Cavatisinurostrum longilinguis* interval, × 1.5.

Cyrtospirifer sp. 66

Fig. 3. Shell in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/377, locality and horizon as in Fig. 1, × 1.

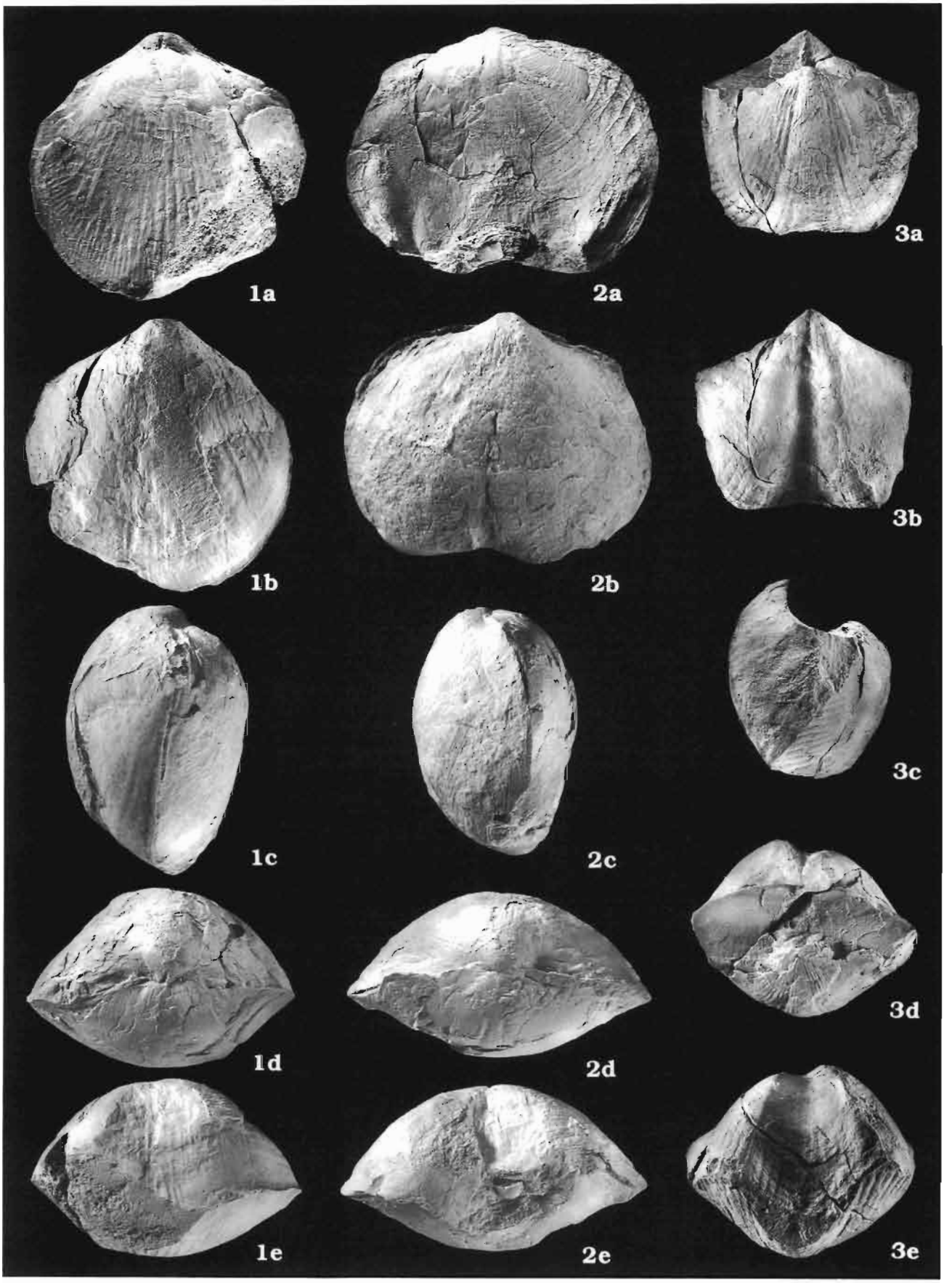

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PLATE 11

Cyrtospirifer wesgensis ZHEIBA, 1980 59

Figs 1–4. Four shells showing variability of the external morphology in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/73k, i, d, 89, trench Z.tent-1 (Figs 1–3) and Z.tent-3 (Fig. 4), *Cyrtospirifer wesgensis* interval, × 1.5.

Fig. 5. Interior of the brachial valve; Bp XXIII/88q, locality and horizon as in Fig. 4, × 2.

Figs 6–7. Two shells in posterior view illustrating variability in the height of the ventral interareas; Bp XXIII/92c, 73l, trench Z.tent-1 (Fig. 6) and Z.tent-4 (Fig. 7), *Cyrtospirifer wesgensis* interval, × 1.5.

Figs 8, 10. Interior of two silicified pedicle valve; Bp XXIII/88r, 90a, locality and horizon as in Fig. 4, × 1.5.

Fig. 14. Elongated shell in dorsal valve; Bp XXIII/73c, locality and horizon as in Fig. 1, × 1.5.

Cyrtospirifer cf. *acutus* NALIVKIN, 1960 61

Figs 9, 11. Two shells in posterior view; Bp XXIII/42e, d, Z.orb-6, *Dmitria gibbosa* interval, × 1.5.

Fig. 12. A damaged shell in dorsal view; Bp XXIII/425a, Z.orb-8, *Dmitria gibbosa* interval, × 1.5.

Fig. 13. Nearly complete shell in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/42f, locality and horizon as in Fig. 9, × 1.5.

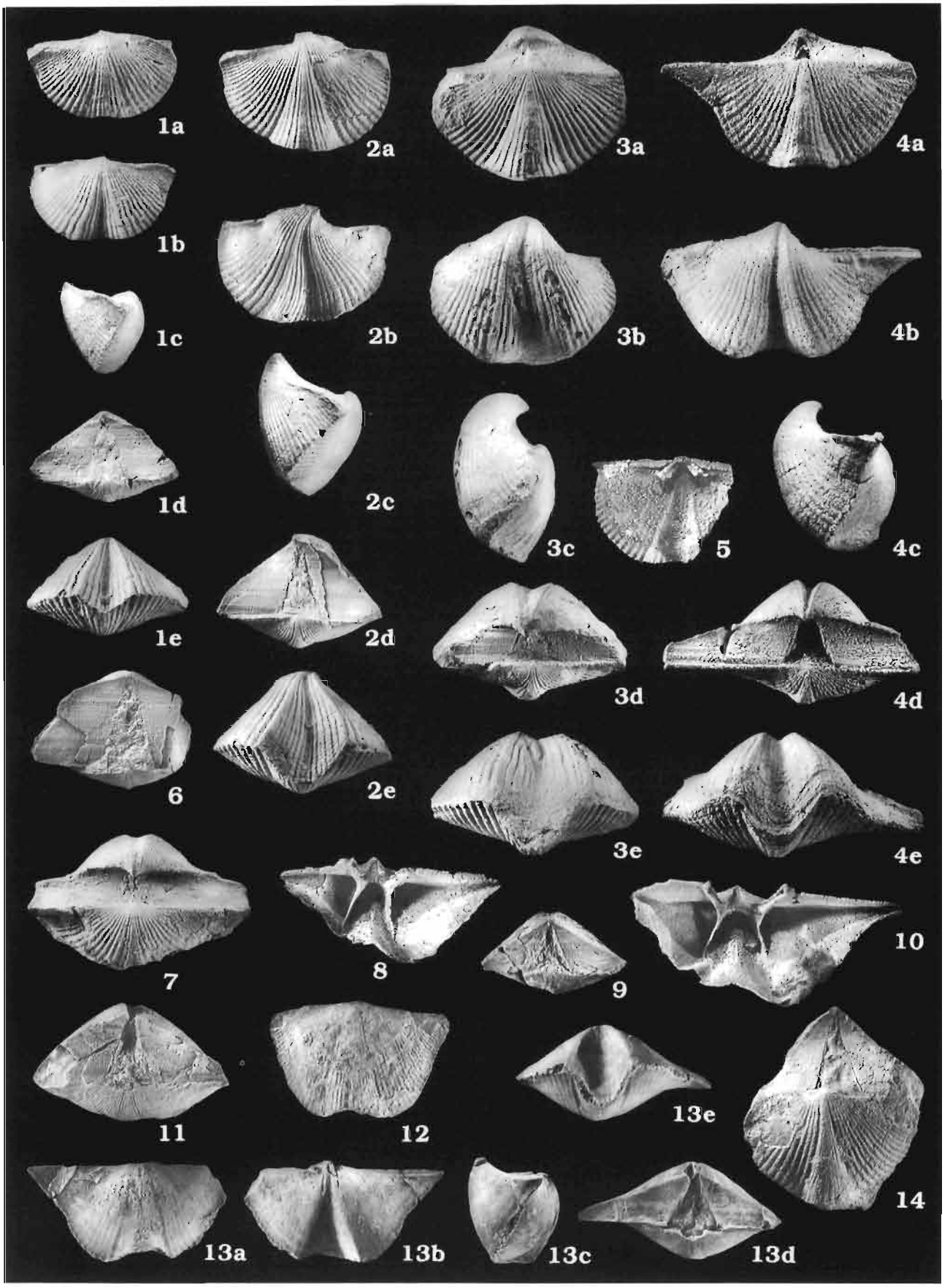

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PLATE 12

Cyrtospirifer brodi (VENJUKOV, 1886) 61

Figs 1–3. Three shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/426a–c, trench Z.bis-4, *Cyrtospirifer brodi* interval, × 1.5.

Fig. 4. A juvenile shell in dorsal view; Bp XXIII/427, locality and horizon as in Fig. 1, × 1.5.

Figs 5–7. Three shells in dorsal view; Bp XXIII/426d–f, locality and horizon as in Fig. 1, × 1.5.

Cyrtospirifer cf. *ningbingensis* ROBERTS, 1971 65

Fig. 8. An incomplete shell in *a* dorsal and *b* posterior views; Bp XXIII/58b, trench Z.pal-1, *Cavatisinurostrum longilinguis* interval, × 1.

Fig. 9. Shell in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/130e, trench Z.orb-5, *Cavatisinurostrum longilinguis* interval, × 1.

Fig. 10. A large specimen in ventral view; Bp XXIII/130b, locality and horizon as in Fig. 9, × 1.

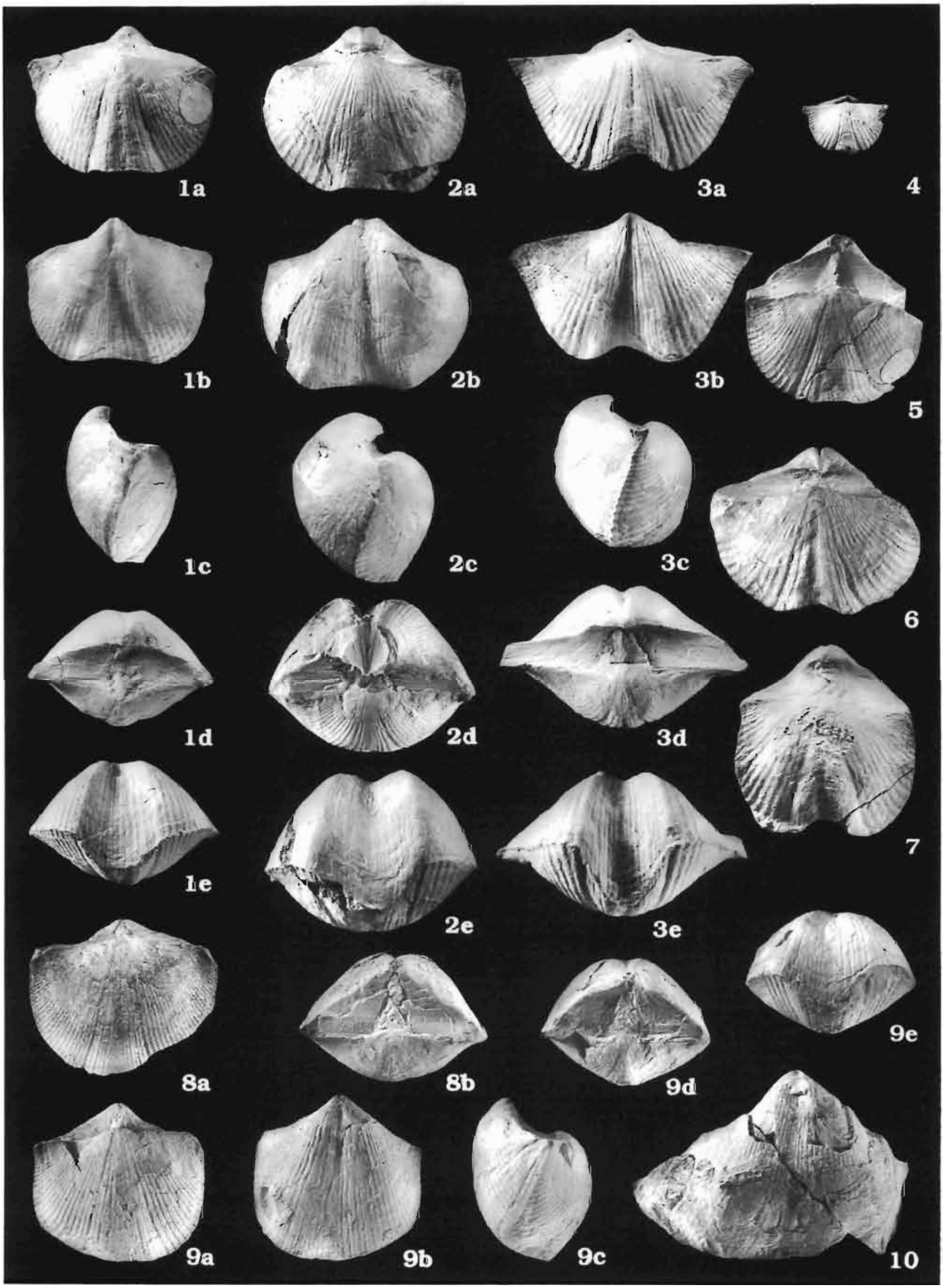

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PLATE 13

Cyrtospirifer carinatus sp. n. 63

Figs 1–5. Five shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/118k, a, c (holotype), 98–99, trench Z.orb-2 (Figs 1–2, 4) and Z.orb-1 (Figs 3, 5), *Cyrtospirifer carinatus* interval, × 1.

Fig. 6. A wide shell in dorsal view; Bp XXIII/126d, trench Z. orb-3, *Cyrtospirifer carinatus* interval, × 1.

Fig. 7. A narrow shell in posterior view; Bp XXIII/97k, locality and horizon as in Fig. 3, × 1.

Figs 8, 10. Two specimens showing details of the brachial fold in posterior view; Bp XXIII/98, 100f, locality and horizon as in Fig. 3, × 2.5.

Fig. 9. Interior of the brachial valve; Bp XXIII/429, near trench ZW-1, *Cyrtospirifer carinatus* interval, × 1.

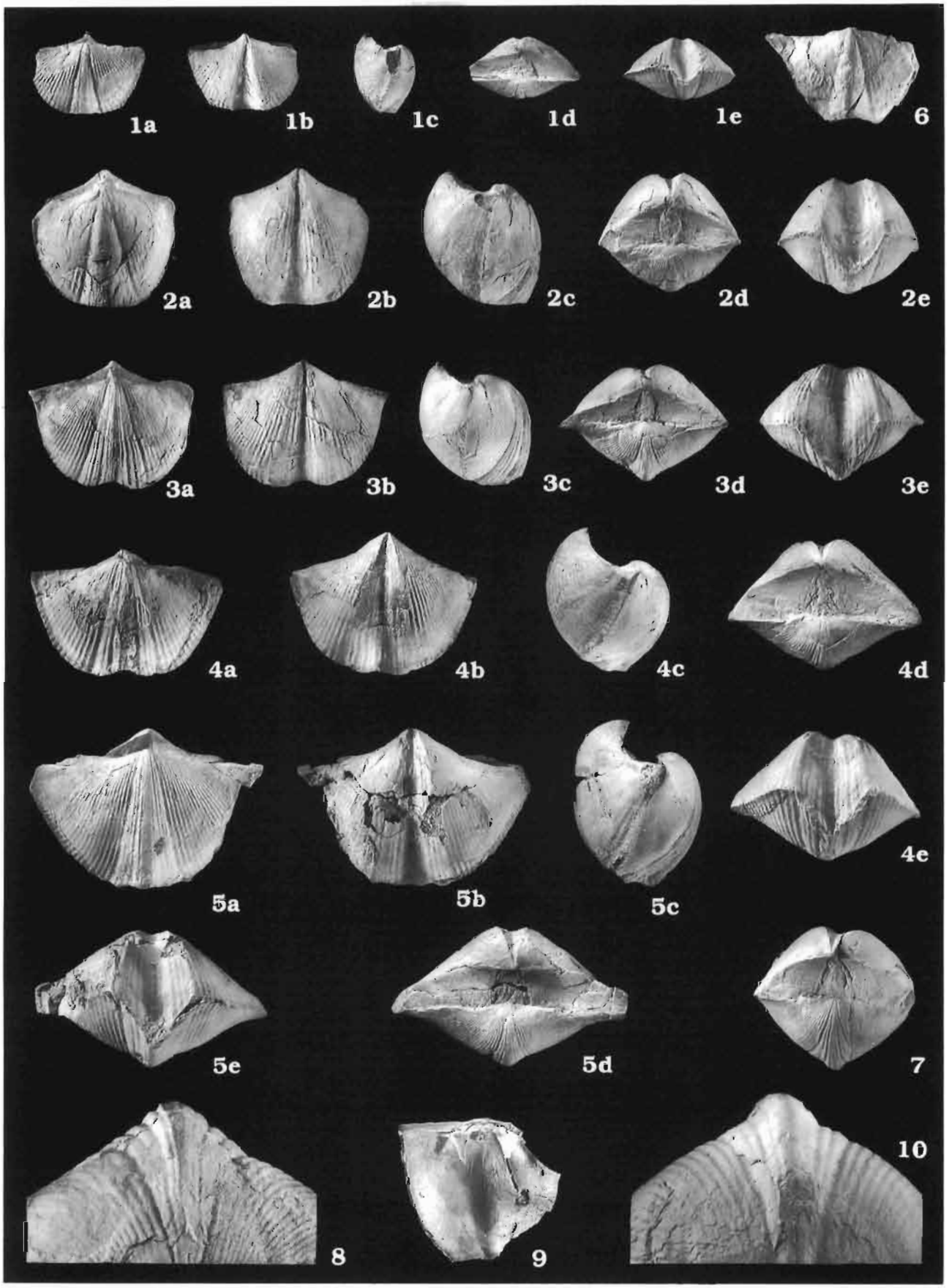

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PLATE 14

Cyrtiorina? depressa sp. n. 68

Figs 1–3. Three shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/123c–d, b, trench ZS-2, *Cyrtiorina? depressa* interval, × 1.

Cyrtiopsis famenniana (PAECKELMANN, 1942) 66

Figs 4–6. Three specimens illustrating variability of the shell exterior in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/40i, 430a–b, trench Z.orb-6 (Fig. 1) and Z.orb-7 (Figs 5–6), *Dmitria gibbosa* interval, × 1.5.

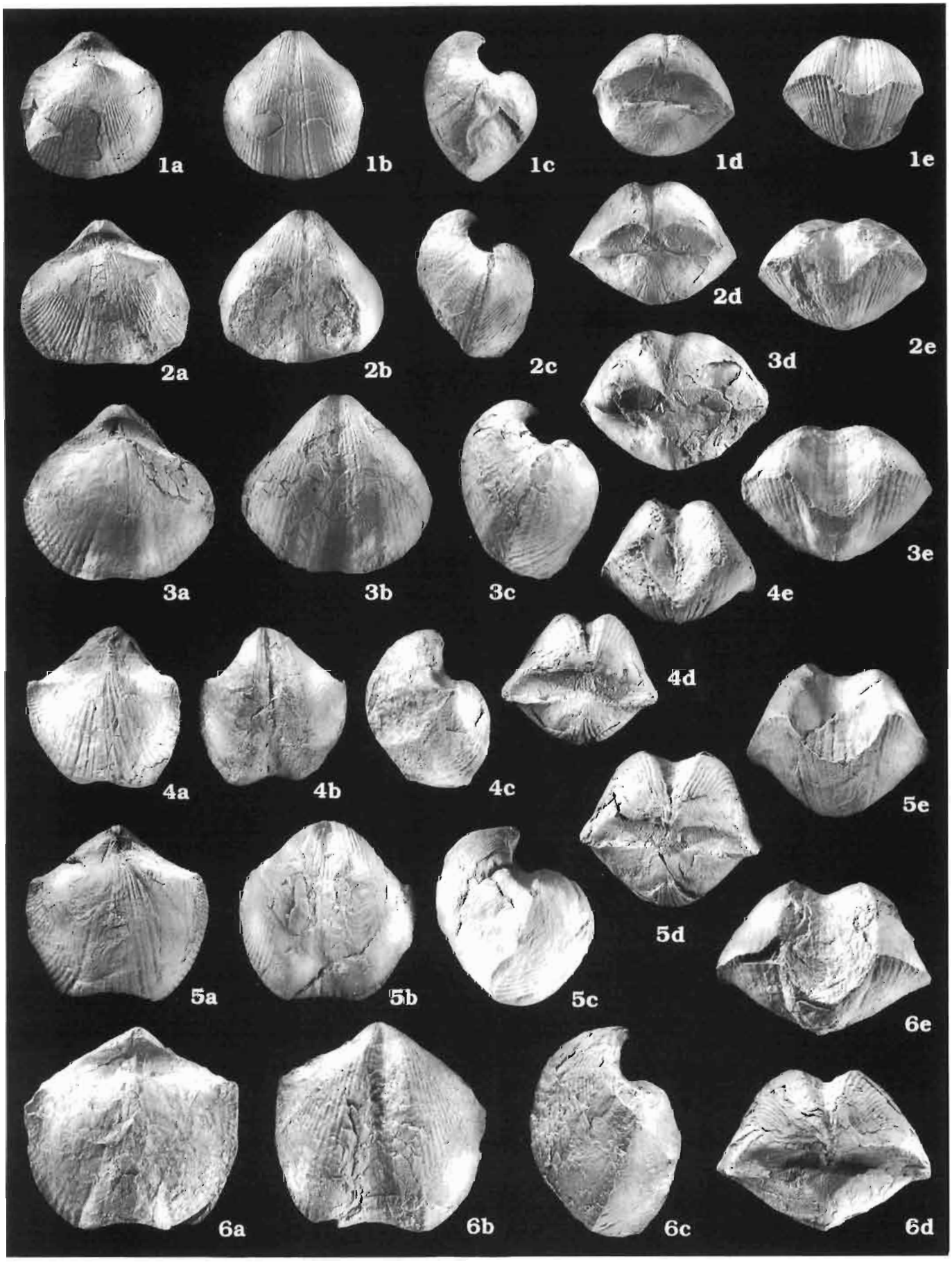

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PLATE 15

Dmitria angustirostris (GÜRICH, 1903) 70

Figs 1–2. Two complete shellls in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII432a, b, Pałkowa Góra (PG), *Cavatisinurostrum longilinguis* interval, × 1.

Sphaenospira? sp. 75

Figs 3–4. Two crushed shells in *a* dorsal, *b* ventral and *c* lateral views; Bp XXIII/44b–a, Stromatoporoid Rock, *Sphaenospira*? sp. interval, × 1.5.

Fig. 5. Ventral interareas of large specimen; Bp XXIII/434, trench B-1, *Sphaenospira*? sp. interval, × 1.5.

Cyrtiorina? *depressa* sp. n. 69

Fig. 6. Silicified pedicle valve in dorsal view; Bp XXIII/376a, trench ZS-1, *Cyrtiorina*? *depressa* interval, × 1.5.

Fig. 7. Holotype in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/123a, trench ZS-2, *Cyrtiorina*? *depressa* interval, × 1.

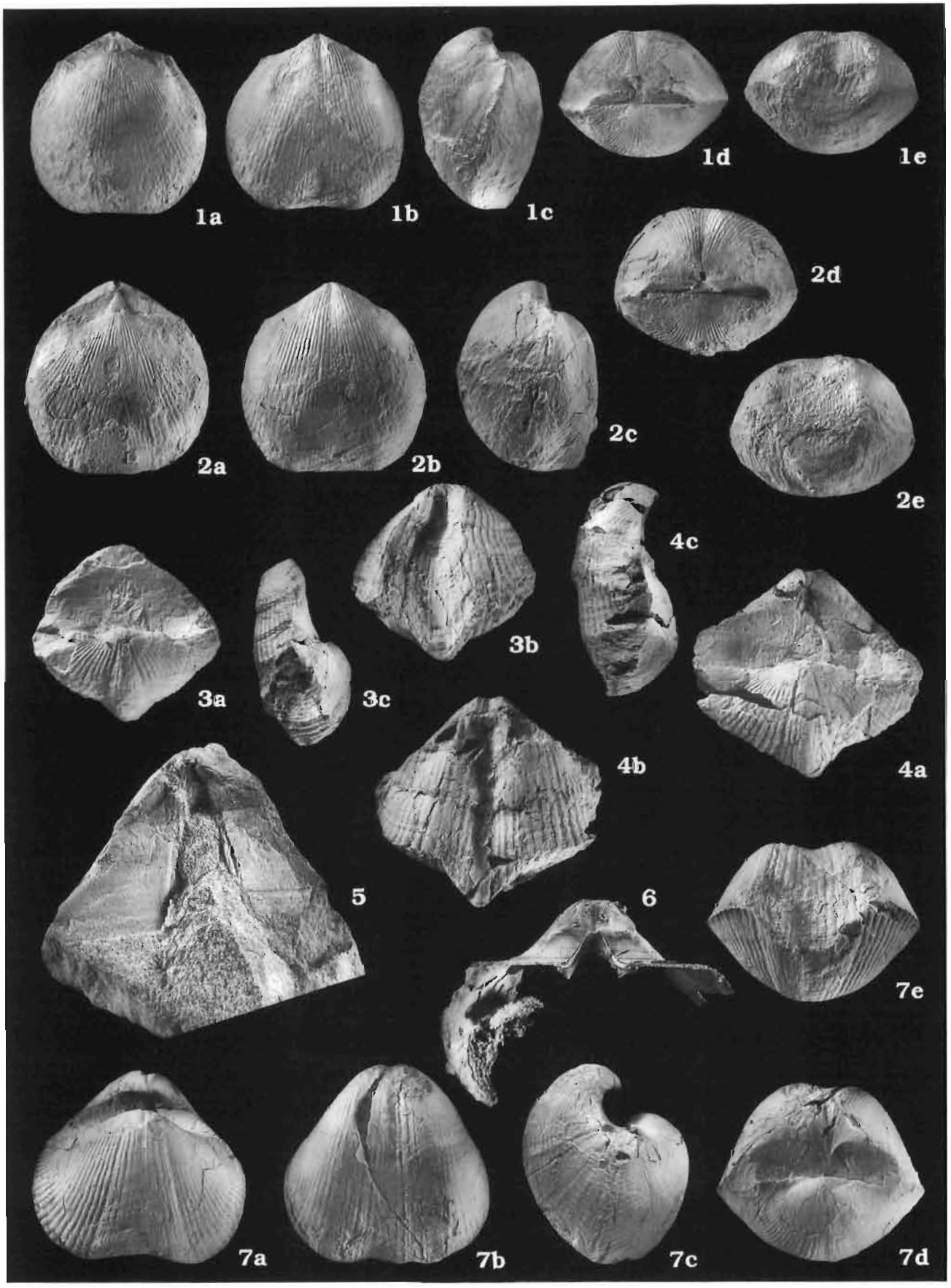

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PLATE 16

Dmitria gibbosa sp. n. 72

Figs 1–4. Four shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/435a, b (holotype), c, 436a, trench Z.orb-6 (Figs 1, 3–4) and Z.orb-7 (Fig. 2), *Dmitria gibbosa* interval, × 1.5.

Cyrtospirifer cf. *ningbingensis* ROBERTS, 1971 65

Fig. 5. Interior of the pedicle valve; Bp XXIII/428, trench Z.orb-5, *Cavatisinurostrum longilinguis* interval, × 1.
Fig. 6. Fragment of a large shell in dorsal view; Bp XXIII/130a, locality and horizon as in Fig. 5, × 1.

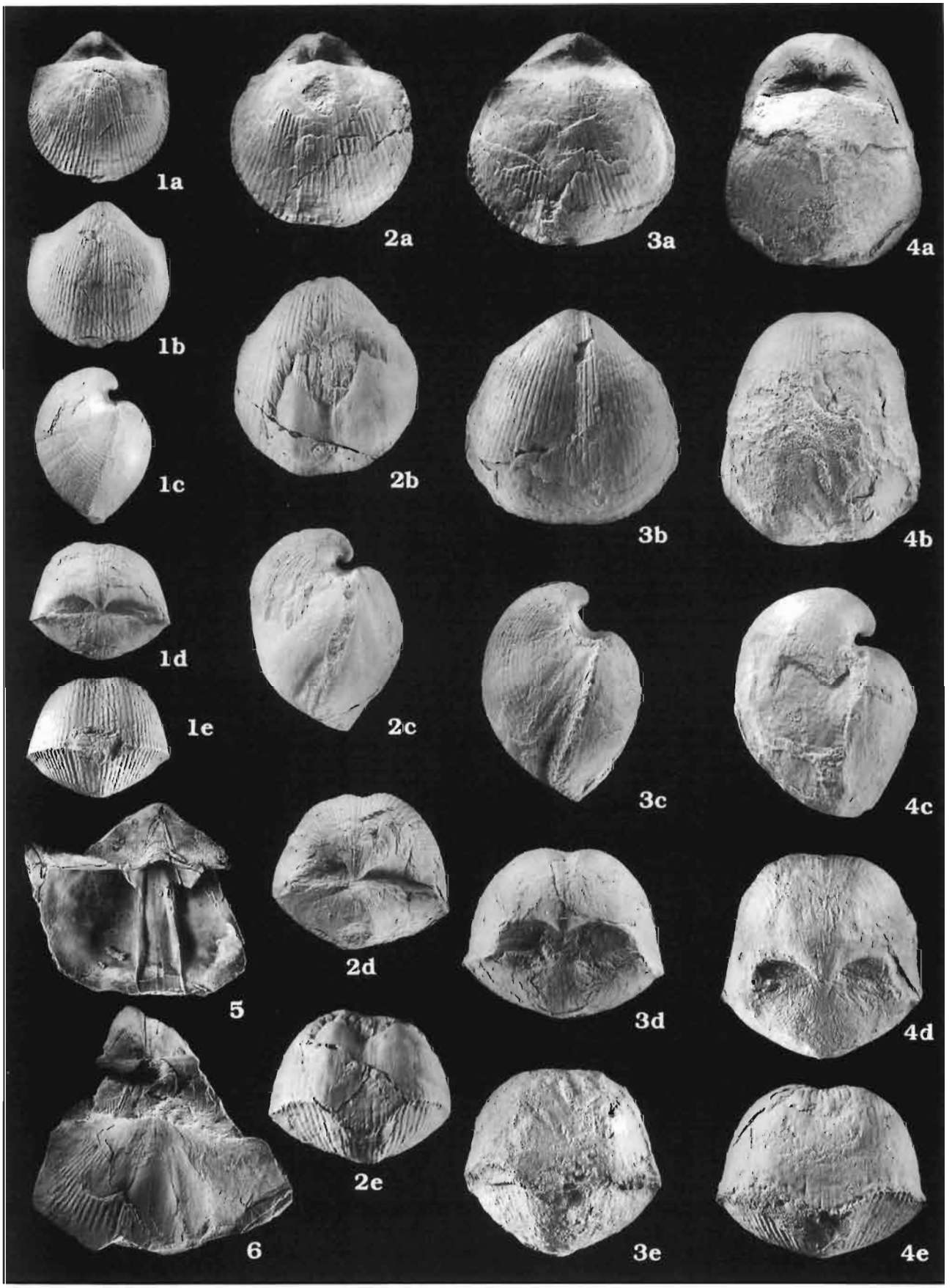

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PLATE 17

Dmitria globosa (GÜRICH, 1903) 74

Figs 1–4. Four shells in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/433a–d, Pałkowa Góra (PG), *Cavatisinurostrum longilinguis* interval, × 1.

Fig. 5. Posterodorsal view of the silicified shell; Bp XXIII/57c, trench Z.pal-1, *Cavatisinurostrum longilinguis* interval, × 2.

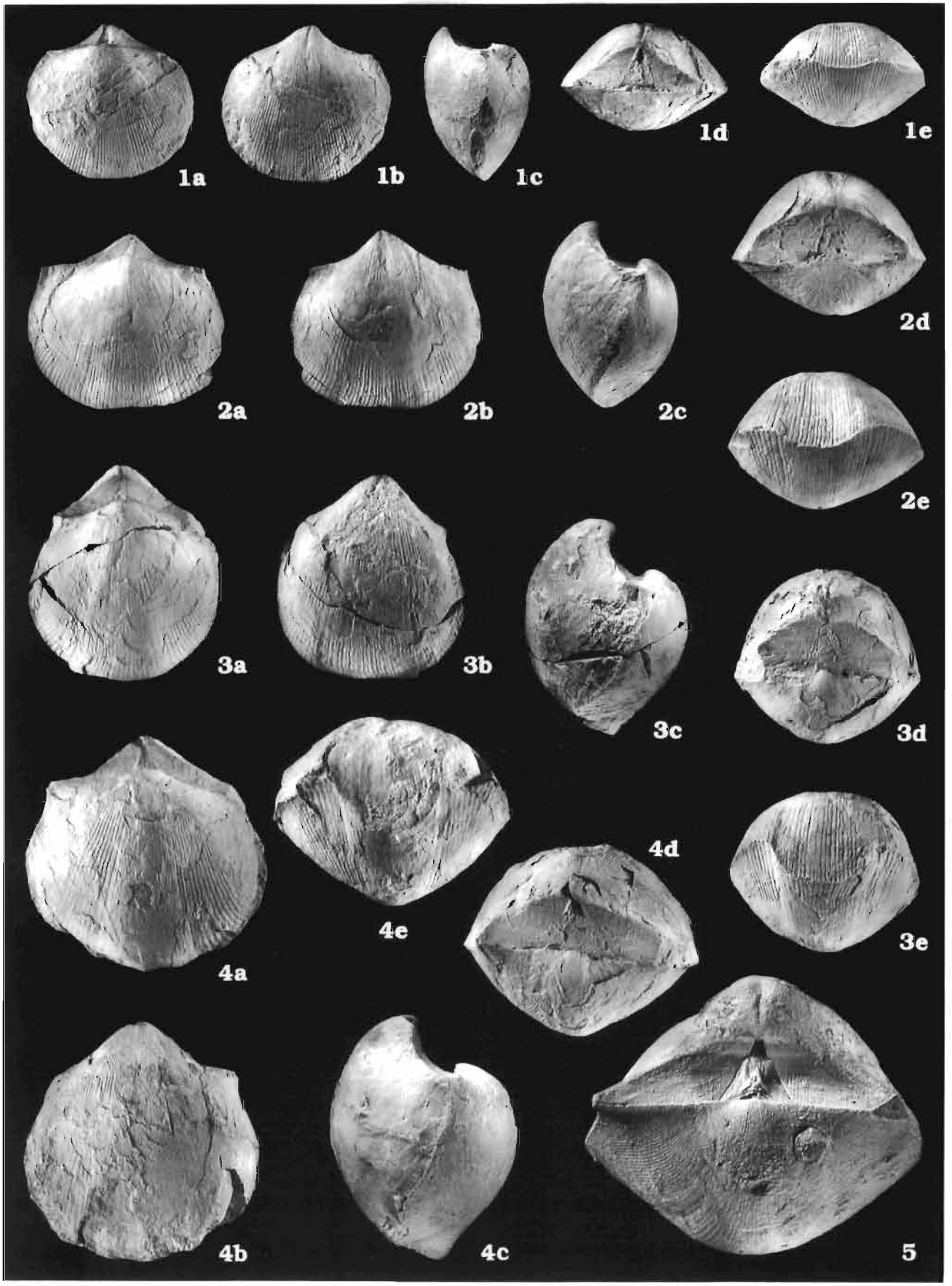

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PLATE 18

Eobrachythyris palkowae (GÜRICH) 77

Figs 1–6. Six shells illustrating variability in external morphology in *a* dorsal, *b* ventral, *c* lateral, *d* posterior and *e* anterior views; Bp XXIII/437a, 438–441, trench Z.pal-1 (Fig. 1), Pałkowa Góra (PG) (Figs 2–5) and trench Z.orb-5 (Fig. 6), *Cavatisinurostrum longilinguis* interval, × 1.5.

Fig. 7. Dorsal view of fragmentary preserved shell with spiralia; Bp XXIII/55 locality and horizon as in Fig. 1, × 1.5.

Figs 8, 11. Interior of two pedicle valves; Bp XXIII/445a–b, locality and horizon as in Fig. 1, × 3.

Fig. 9. Juvenile shell in ventral view; Bp XXIII/446, locality and horizon as in Fig. 1, SEM × 25.

Fig. 10. Interior of the brachial valve; Bp XXIII/445c, locality and horizon as in Fig. 1, × 3.

Fig. 12. Incomplete shell in dorsal view; Bp XXIII/445d, locality and horizon as in Fig. 1, × 2.

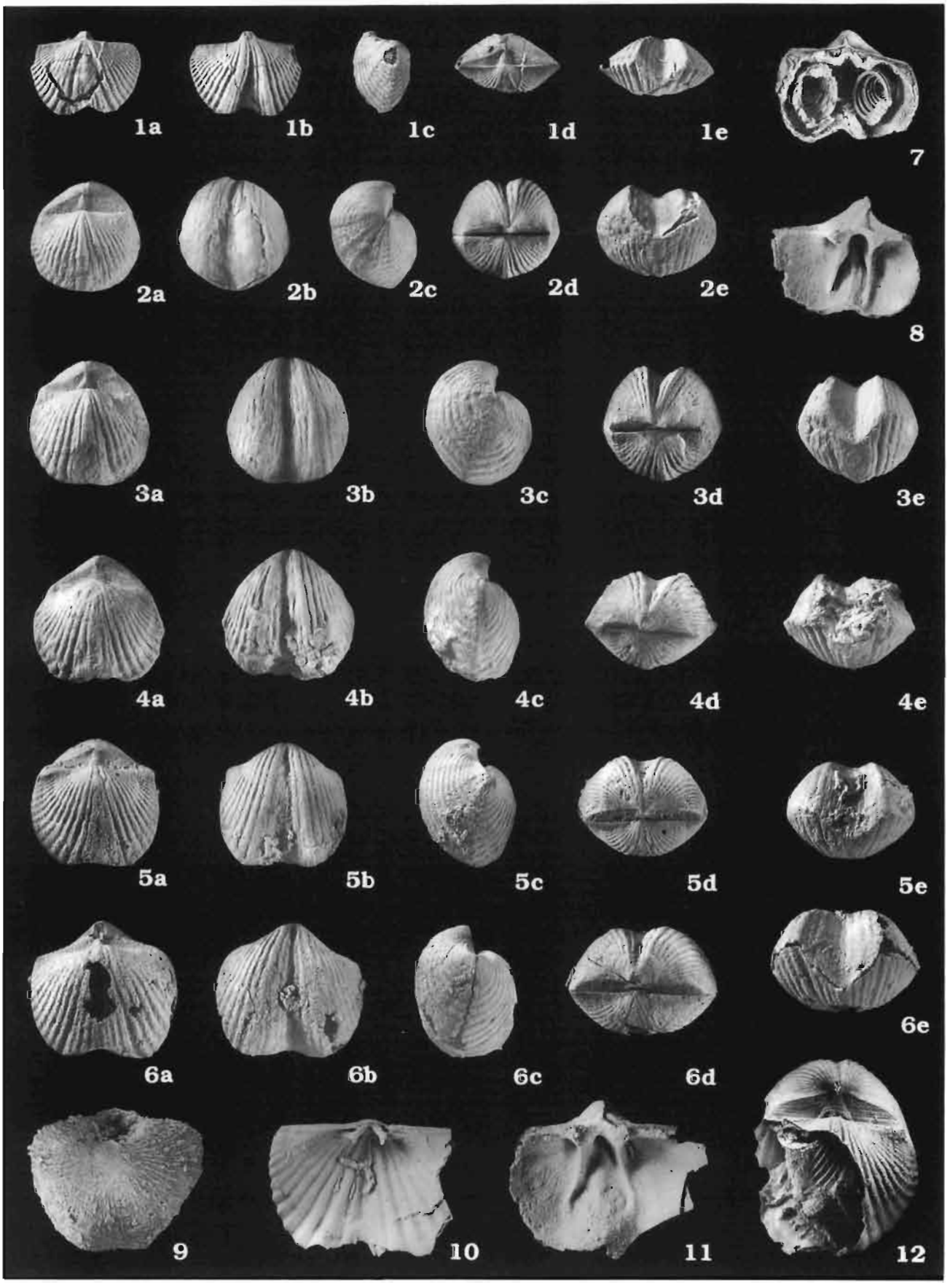

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PLATE 19

Icriodus alternatus alternatus BRANSON *et* MEHL, 1924

Figs 1–2. Upper views of C VIII/244, 278, trench Z.bis-1, *Cyrtospirifer brodi* interval (Fig. 1) and Z.orb-13, *Cyrtospirifer carinatus* interval (Fig. 2, morphotype III of DREESEN and HOULLEBERGHS, 1980), × 80 and × 100.

Icriodus aff. *cornutus* SANNEMENN, 1955

Fig. 3. Upper view of C VIII/241, trench Z.orb-1, *Cyrtospirifer carinatus* interval, × 100.

Icriodus iowaensis iowaensis YOUNGQUIST *et* PETERSON, 1947

Figs 4, 20. Upper views of C VIII/211, 247, trench Z.tent-3, *Cyrtospirifer wesgensis* interval (Fig. 4), trench ZS-5, between *Cyrtospirifer carinatus* and *Cyrtiorina? depressa* intervals (Fig. 20, narrow morphotype), × 80.

Pelekysgnathus inclinatus THOMAS, 1949

Fig. 5. Upper view of C VIII/246, trench ZS-7, between *Cyrtiorina? depressa* and *Sphaenospira?* sp. intervals, × 40.

Palmatolepis glabra prima ZIEGLER *et* HUDDLE, 1969

Figs 6–7. Upper views of C VIII/226 and 229, trench ZS-1a, *Cyrtiorina? depressa* interval (Fig. 6), trench Z.orb-1, *Cyrtospirifer carinatus* interval (Fig. 7), × 40.

Palmatolepis minuta minuta BRANSON *et* MEHL, 1934

Fig. 8. Upper view of C VIII/243, trench Z.orb-13, *Cyrtospirifer carinatus* interval, × 80.

Palmatolepis glabra pectinata ZIEGLER, 1962

Fig. 9. Upper view of C VIII/228, trench ZS-3, *Cyrtiorina? depressa* interval, × 40.

Palmatolepis quadrantinodosalobata SANNEMANN, 1955

Fig. 10. Upper view of C VIII/222, trench Z.pal-1, *Cavatisinurostrum longilinguis* interval, × 40.

Palmatolepis gracilis sigmoidalis ZIEGLER, 1962

Fig. 11. Upper view of C VIII/277, near trench B-1, *Sphaenospira?* sp. interval, × 100.

Palmatolepis minuta wolskae SZULCZEWSKI, 1971

Figs 12–14. Upper views of C VIII/223, 238 and 237, trench Z.pal-1, *Cavatisinurostrum longilinguis* interval, × 80.

Palmatolepis glabra pectinata ZIEGLER, 1962, morphotype

Fig. 15. Upper view of C VIII/231, Z.orb-11, above *Cyrtospirifer carinatus* interval, × 80.

Palmatolepis poolei SANDBERG *et* ZIEGLER, 1973

Fig. 16. Upper view of C VIII/279, Z.orb-4, above *Cyrtospirifer carinatus* interval, × 40.

Palmatolepis termini SANNEMANN, 1955

Fig. 17. Upper view of C VIII/240, Pałkowa Góra (PG), *Cavatisinurostrum longilinguis* interval, × 80.

Palmatolepis subperlobata BRANSON *et* MEHL, 1934

Fig. 18. Upper view of C VIII/225, trench Z.pal-1, *Cavatisinurostrum longilinguis* interval, × 40.

Icriodus aff. *cornutus* SANNEMANN, 1955

Fig. 19. Upper view of C VIII/286, trench Z.orb-6, *Dmitria gibbosa* interval, × 100.

Palmatolepis crepida SANNEMANN, 1955

Fig. 21. Upper view of C VIII/260, trench Z.orb-5, *Cavatisinurostrum longilinguis* interval, × 40.

Palmatolepis rhomboidea SANNEMANN, 1955

Fig. 22. Upper view of C VIII/227, trench ZS-1a, *Cyrtiorina? depressa* interval, × 80.

Palmatolepis minuta loba HELMS, 1963

Fig. 23. Upper view of C VIII/281, trench Z.orb-12, *Cavatisinurostrum longilinguis* interval, × 80.

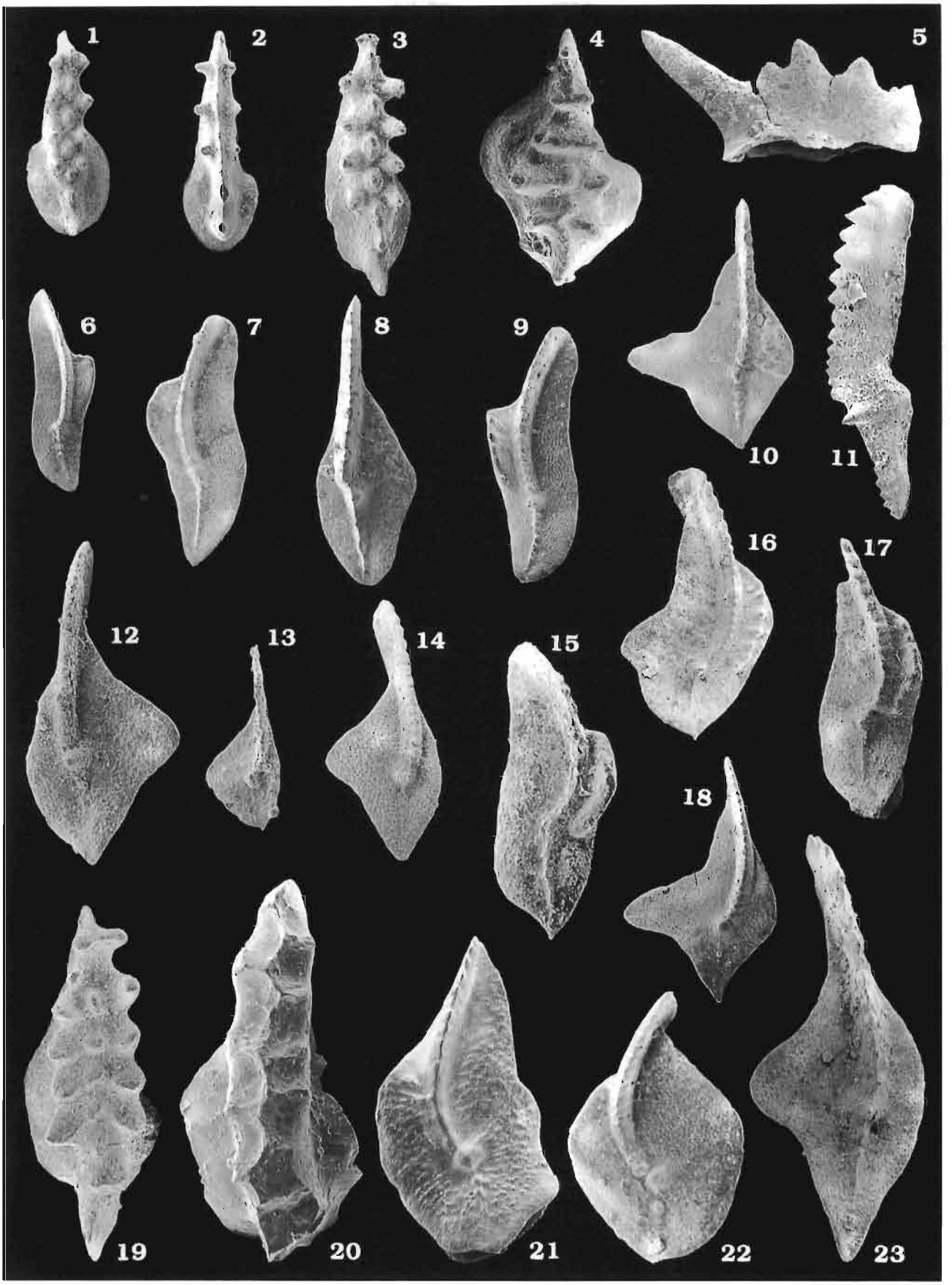

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PLATE 20

Polygnathus squalidus DRYGANT, 1986

Figs 1–2. Two Upper view of C VIII/214, 213, trench Z.orb-6, *Dmitria gibbosa* interval, × 80 and × 40.

Palmatolepis circularis SZULCZEWSKI, 1971

Figs 3, 8, 13. Upper views of C VIII/212, 257–258, locality and horizon as in Fig. 1, × 80 (Fig. 3) and × 40 (Figs 8, 13).

Polygnathus communis communis BRANSON *et* MEHL, 1934

Fig. 4. Upper view of C VIII/242, trench ZS-4, below *Cyrtiorina? depressa* interval, × 80.

Polygnathus volhynicus DRYGANT, 1986

Figs 5–6, 10. Upper views of C VIII/224, 216 and 215, trench Z.pal-1, *Cavatisinurostrum longilinguis* interval, × 40 (Fig. 5), trench Z.orb-6, *Dmitria gibbosa* interval, × 80 (Figs 6, 10).

Palmatolepis tenuipunctata SANNEMANN, 1955

Fig. 7. Upper view of C VIII/262, trench Z.pal-1, *Cavatisinurostrum longilinguis* interval, × 40.

Palmatolepis triangularis SANNEMAN, 1955

Fig. 9. Upper view of C VIII/245, trench Z.bis-1, *Cyrtospirifer brodi* interval, × 40.

Polygnathus rarus sp. n. 80

Figs 11–12, 15–19. Upper (Figs 11, 15–19) and lower (Fig. 12) views of C VIII/248, 250, 232 (holotype), 249, 282, 251 and 233, trench ZS-7, between *Cyrtiorina? depressa* and *Sphaenospira*? sp. intervals, × 80.

Palmatolepis klapperi SANDBERG *et* ZIEGLER, 1973

Fig. 14. Upper view of C VIII/283, trench ZS-6, *Cyrtospirifer carinatus* interval, × 40.

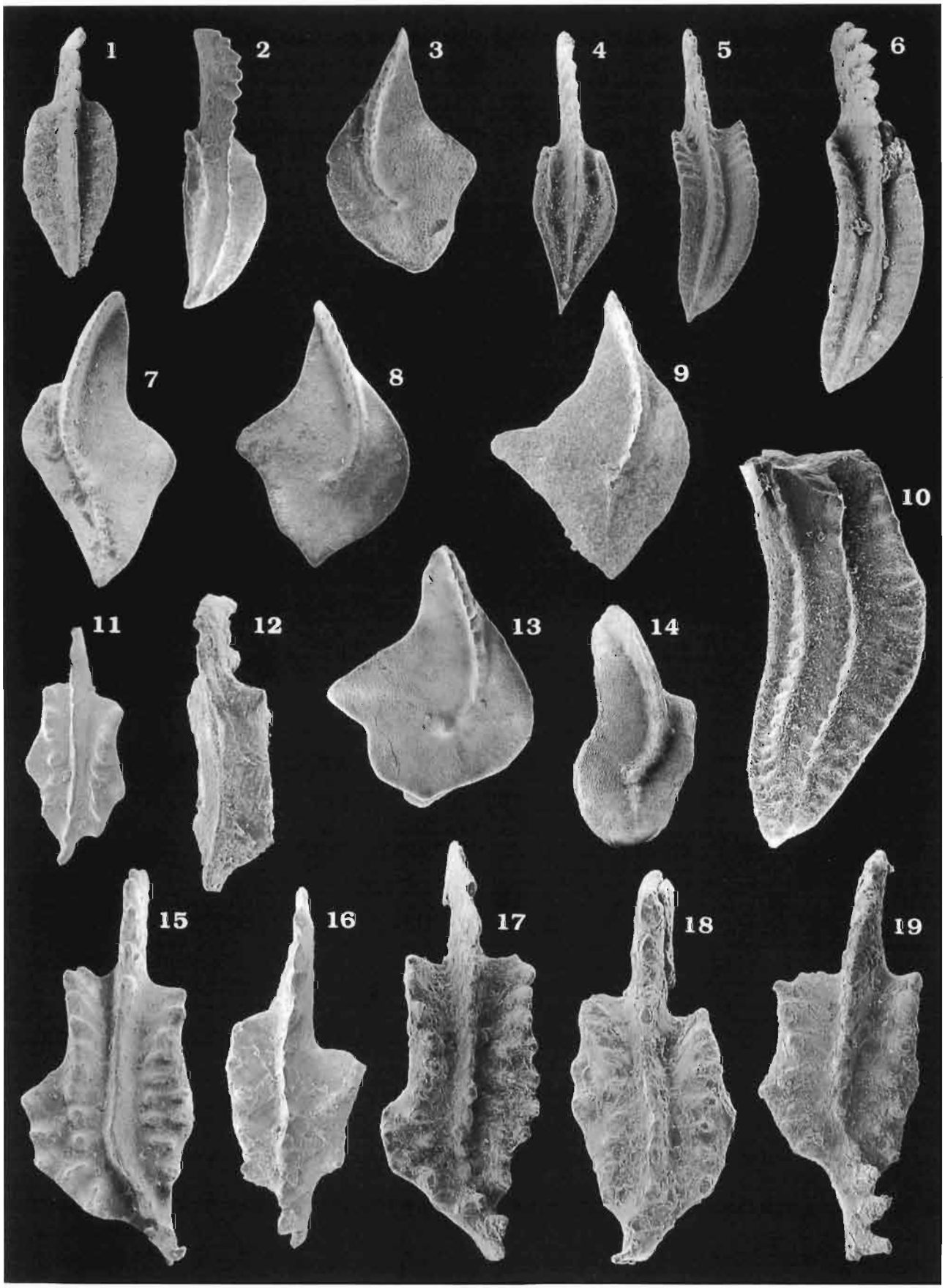

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PLATE 21

Polygnathus nodocostatus nodocostatus BRANSON *et* MEHL, 1934

Figs 1–2. Upper views of C VIII/266 and 230, trench Z.orb-11, *Cyrtospirifer carinatus* interval, × 40.

Polygnathus brevilaminus BRANSON *et* MEHL, 1934

Fig. 3. Upper view of C VIII/210, trench Z.bis-1, *Cyrtospirifer brodi* interval, × 80.

Ancyrognathus sinelamina (BRANSON *et* MEHL, 1934)

Fig. 4. Upper view of C VIII/236, trench Z.orb-14, *Cyrtospirifer carinatus* interval, × 40.

Polygnathus lauriformis DREESEN *et* DUSAR, 1974

Fig. 5. Upper view of C VIII/261, Z.orb-6, *Dmitria gibbosa* interval, × 40.

Polygnathus bouckerti DRESSEN *et* DUSAR, 1974

Figs 6, 11, 14. Upper views of C VIII/234, 267–268, trench ZS-6, *Cyrtospirifer carinatus* interval (Figs 6, 14) and trench Z.orb-1, *Cyrtospirifer carinatus* interval (Fig. 11), × 40.

Polygnathus delenitor DRYGANT, 1986

Figs 7–8, 12, 15. Upper (Figs 7–8,15) and lower (Fig. 12) views of C VIII/219, 217, 218 and 255, trench Z.orb-5, *Cavatisinurostrum longilinguis* interval (Fig. 7), Z.orb-10, *Cyrtospirifer carinatus* interval (Figs 8, 12, 15), × 80 (Fig. 7) and × 40 (Figs 8, 12, 15).

Alternognathus? sp.

Fig. 9. Upper view of C VIII/221, Palkowa Góra (PG), *Cavatisinurostrum longilinguis* interval, × 40.

Polygnathus angustidiscus YOUNGQUIST, 1945

Fig. 10. Lateral view of C VIII/256, trench Z.bis-1, *Cyrtospirifer brodi* interval, × 40.

Polygnathus semicostatus BRANSON *et* MEHL, 1934

Fig. 13. Upper view of C VIII/265, trench Z.orb-1, *Cyrtospirifer carinatus* interval, × 40.

Branmehla werneri ZIEGLER, 1962

Fig. 16. Lateral view of C VIII/287, near trench B-1, *Sphaenospira*? sp. interval, × 40.

Polygnathus aff. *experplexus* SANDBER *et* ZIEGLER, 1979

Fig. 17. Upper view of C VIII/269, trench ZS-7, between *Cyrtiorina*? *depressa* and *Sphaenospira*? sp. intervals, × 40.

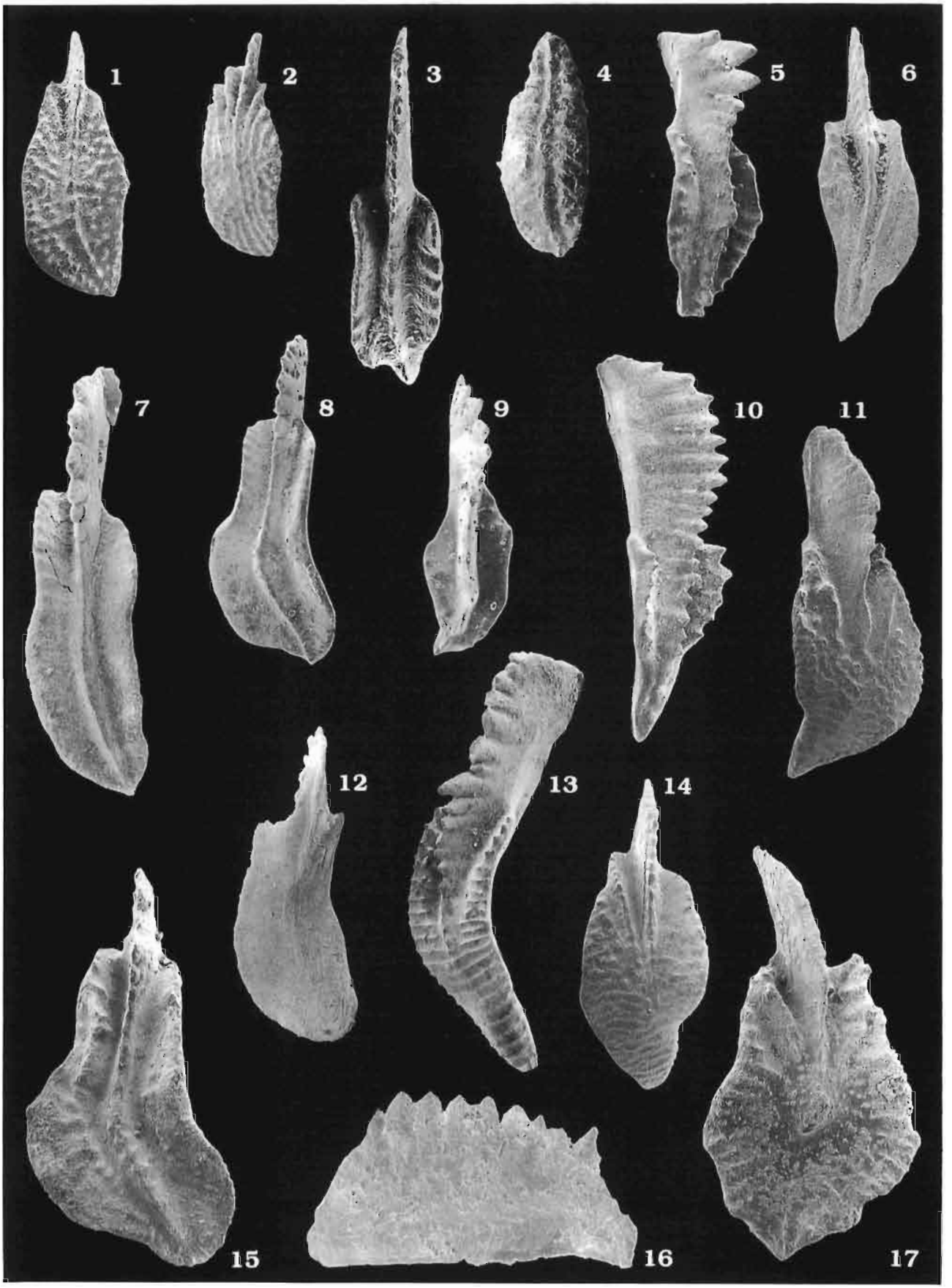

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PLATE 22

Polygnathus szulczewskii MATYJA, 1974

Figs 1–2, Upper views of C VIII/264 and 263, trench ZS-1a (Fig. 1) and ZS-2 (Fig. 2), *Cyrtiorina*? *depressa* interval, × 40.

Polygnathus sp. A 80

Figs 3, 16–17. Upper views of C VIII/271, 280 and 272, trench ZS-6 (Fig. 3), Z.orb-2 (Figs 16–17), *Cyrtospirifer carinatus* interval, × 40 (Figs 3, 17) and × 80 (Fig. 16).

Polygnathus znepolensis SPASSOV, 1965

Figs 4–5. Upper views of C VIII/253–254, trench B-2 (Fig. 4) and B-1 (Fig. 5), *Sphaenospira*? sp. interval, × 100.

Polygnathus flaccidus HELMS, 1961

Fig. 6. Upper view of C VIII/270, trench ZS-6, *Cyrtospirifer carinatus* interval, × 40.

Omolonognathus transformis GAGIEV, 1979

Figs 7, 12–13. Upper views of C VIII/273–274 and 252, trench B-2, *Sphaenospira*? sp. interval, × 40.

Polygnathus cf. *longiposticus* BRANSON *et* MEHL, 1934

Fig. 8. Upper view of C VIII/235, trench B-1, *Sphaenospira*? sp. interval, × 40.

Polygnathus glaber glaber ULRICH *et* BASSLER, 1926

Fig. 9. Upper view of C VIII/220, trench Z.orb-10, *Cyrtospirifer carinatus* interval, × 40.

Alternognathus? sp.

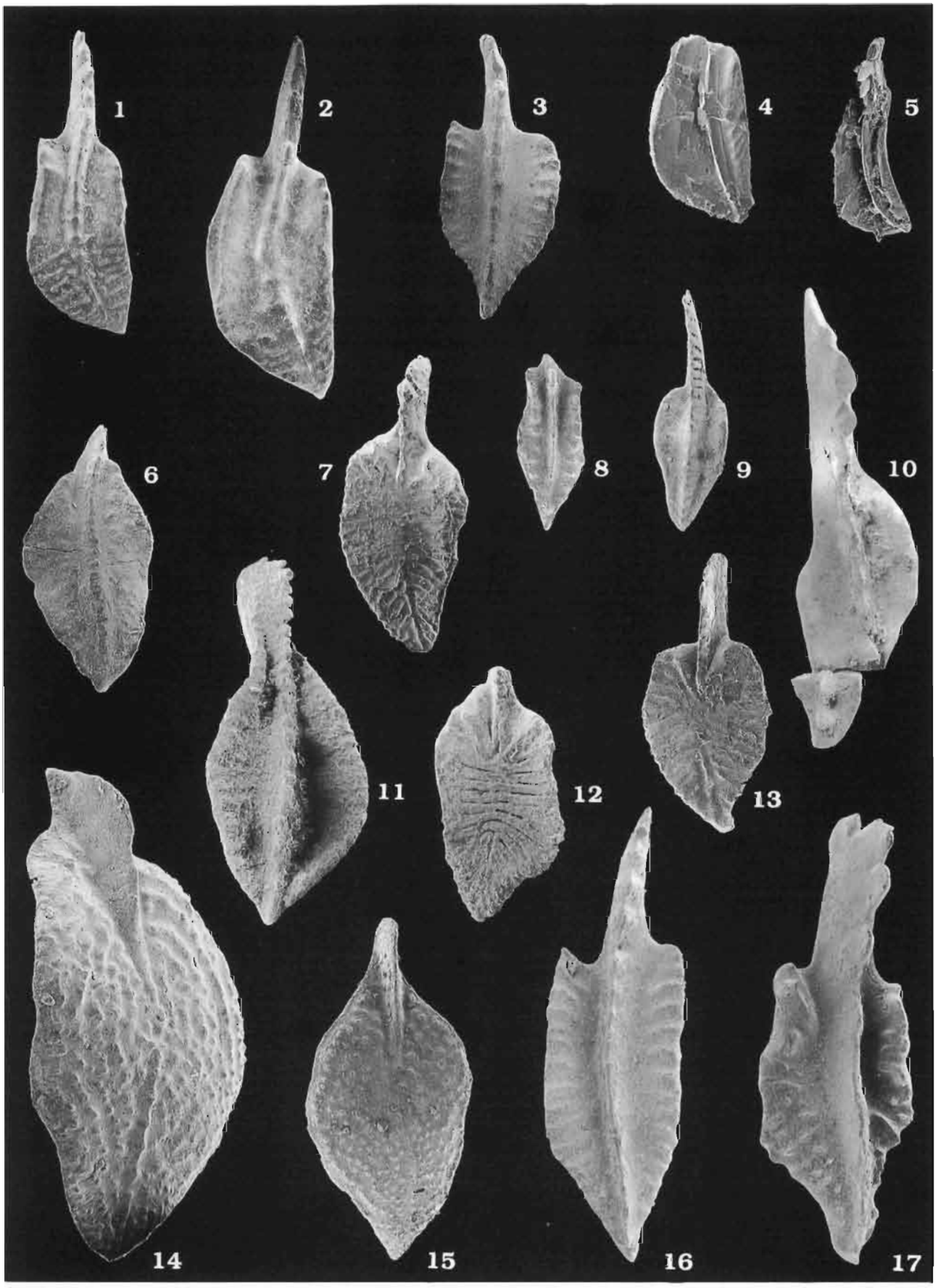
Fig. 10. Upper view of C VIII/284, trench Z.orb-12, *Cavatisinurostrum longilinguis* interval, × 80.

Polygnathella? sp.

Fig. 11. Upper view of C VIII/285, trench Z.pal-1, *Cavatisinurostrum longilinguis* interval, × 80.

Polylophodonta confluens (ULRICH *et* BASSLER, 1926)

Figs 14–15. Upper views of C VIII/259 and 276, Z.orb-10, *Cavatisinurostrum longilinguis* interval, × 40.



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