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The Lower Devonian in the western part of the Klonów Belt (Holy Cross Mts) Part I — Upper Emsian

ABSTRACT: A biostratigraphic and lithological description is given of the Upper Emsian deposits (Rhine magnafacies) from the western part of the Klonów Belt in the northern margin of the Holy Cross Mts. A stratigraphic diagram has been worked out for these deposits on the basis of the brachiopod and lamellibranch fauna, and compared with the Upper Harz profile. Paleontological descriptions have also been given of such brachiopod and lamellibranch species which represent taxonomically doubtful or endemic forms. The chapter on lithology contains an analysis of the transport directions and the origin of clastic material. The present paper represents part I of a monograph on the Lower Devonian deposits in the Klonów Belt.

INTRODUCTION

In Poland, Upper Emsian marine deposits have not, so far, been reported from any other areas outside the Holy Cross Mts. Hence, Lower Devonian profiles from that mountain range constitute an important basis for the study in Poland of both the stratigraphy and tectonic or structural problems associated with the Caledonian orogeny, as well as those concerning the boundary between the Early and the Late Paleozoic deposits.

The maximum thickness of the Lower Devonian Holy Cross deposits is attained in the Klonów Belt, particularly so in its western part (Czarnocki 1936a) (Fig. 1-*x*). That Belt, showing a WNW-ESE strike (Lekomin-Bodzentyn) is densely wooded and has a Pleistocene cover some metres thick (Fig. 2). The relative height of the particular elevations is 80—150 m. The rock layers have a monoclinal N dip at an angle of 20—35 degrees.

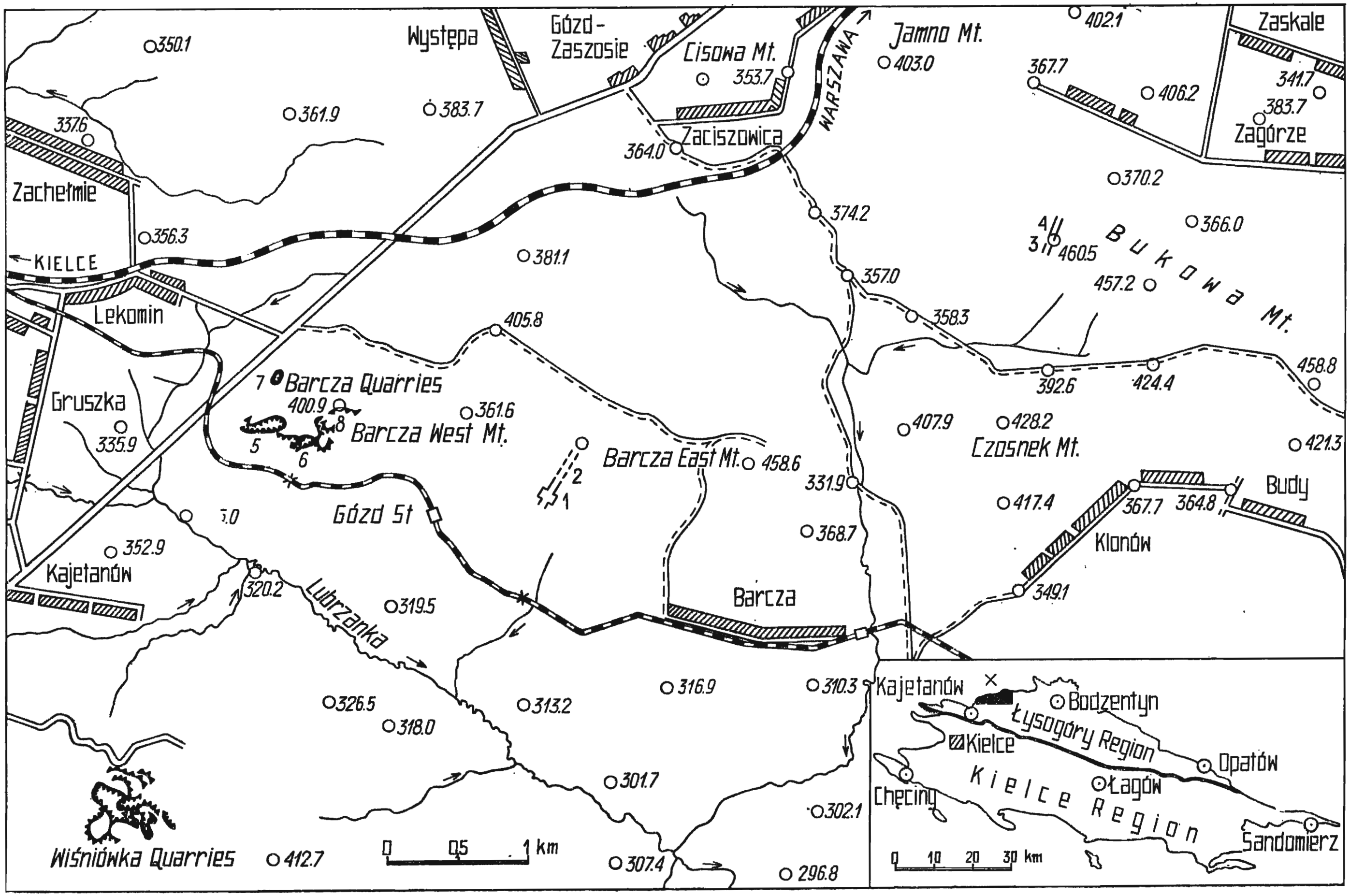


Fig. 1

Localization of exposures of the Siegenian and Emsian deposits in the western part of the Klonów Belt

Explanations: *x* area covered by investigations, *1* Sierakowski quarry, *2* excavation and test pits (I—XIII), *3* test pit No. 1, *4* gallery at Bukowa Mt., *5* Old quarry, *6* quarry with Monument, *7* Northern quarry, *8* Eastern quarry

A detailed study of the geology in this region can be made only by means of test pits. As compared with the Ardennes and the Rhine massif, the Devonian deposits here are characterized by extremely poor macrofauna which, is concentrated only in some units and this makes its discovery rather difficult.

The Lower Devonian deposits of the Holy Cross Mts were first mentioned by Pusch (1833), Zejszner (1868), Kondaki (fide Michalski 1883), Michalski (1883) and Gürich (1896). Czarnocki (1919, 1936a, 1936b, 1950) was the first to work out on modern principles the stratigraphy of these deposits. Samsonowicz (1934, 1953) and Pajchlowa (1957, 1959a, b, 1962, 1963, 1967, 1968a, b) have likewise dealt with the stratigraphic and lithological problems of that region. Some of the other investigators are: Kowalczewski (1966, 1968, 1971), Ruśkiewicz (1960), Lewowicki & Ruśkiewicz (1966), Pawłowska (1954, 1961), Tarnowska (1967, 1968, 1969a, b), Tomczykowa & Tomczyk (1970), Wróblewski (1968, 1969), also Filonowicz whose interesting observations have not, as yet, been published.

In 1957, Professor Dr. J. Samsonowicz entrusted the present writer with the elaboration of the Lower Devonian stratigraphy and lithology in the Klonów Belt. Between 1957 and 1962, investigations were confined to geological field observations of the Siegenian and the Lower and Upper Emsian in artificial exposures made accesible by various institutions and individuals. Laboratory studies were carried out between 1962 and 1965 and the work was completed in 1971.

The Siegenian and Lower Emsian, as well as the lowermost part of the Upper Emsian in the western margin of the Holy Cross Mts are represented by nonmarine sediments. The Upper Emsian is the only part of the profile developed as clastic deposits bearing a marine fauna. From the stratigraphic point of view this part of the Lower Devonian is of greatest interest. Moreover, it represents an important member for lithostratigraphic studies, not only concerning the Emsian, but the Siegenian, too.

The present paper represents Part I of a monograph on the Lower Devonian stratigraphy and lithology in the Klonów Belt, and covers only the Upper Emsian. Part II, now under preparation, will deal with the lithostratigraphy of the Siegenian and the Lower Emsian of that Belt.

All the materials used in the present paper come from two Upper Emsian profiles in the western part of the Klonów Belt, also from one profile in Barcza E. and another at Bukowa Mt. Only very few faunal remains have been collected at Barcza W. and Miejska Mt. near Bodzentyn (Fig. 1).

The petrographic descriptions of the heavy minerals, and the microscopic analyses of thin sections, used by the writer, have been carried out by Dr. A. Nowakowski, the thermal differential analyses were done

Fig. 2

Buried adit to gallery at Bukowa Mt. (photo taken in August 1960) by Dr. K. Szpila, both from the Institute of Geochemistry, Mineralogy and Petrography of the Geology Department of the Warsaw University.

The photographs of fossil remains were done by J. Modrzejewska and R. Adamik who also did the photographing of lithological samples and thin sections.

Acknowledgements. The present writer's work on the Devonian of Poland was inspired by Professor Dr. J. Samsonowicz who, from 1957 until his death in 1959, spared no time or trouble in supervising these investigations. It is, therefore, my desire in this way to pay homage to the memory of my great Master and Protector. My sincere thanks are also due to Professor Dr. E. Passendorfer for his helpful suggestions during the preparation of this paper, to Professor Dr. M. Turnau-Morawska for reading and commenting the lithological chapter, and to Professor Dr. H. Makowski for discussing the systematic part. M. Pajchlowa, Dr. J. Znosko and Z. Kowalczewski of the Polish Geological Survey must be gratefully thanked for their critical remarks and discussions concerning the stratigraphic questions of the Devonian and Paleozoic deposits in the Holy Cross Mts and the adjacent areas.

I also wish to thank all my colleagues from the Stratigraphic Laboratory of the Institute of Geological Sciences of the Polish Academy of Sciences for their generous assistance during the elaboration of the problems here presented.

DETAILED DESCRIPTIONS OF THE UPPER EMSIAN DEPOSITS

Barcza West

In the Siegenian and Lower Emsian deposits of Barcza W. there are four abandoned quarries (Fig. 1 — *5*—*8*).

One of them, the East quarry has yielded:

Schizophoria vulvaria (Schlotheim)
Schizophoria aff. *vulvaria* (Schlotheim) (Pl. 14, Fig. 2*a*—*b*)
Modiolus antiquus (Goldfuss) (Pl. 27, Fig. 6)

found near the northern edge of the quarry among cherry-red claystones intercalated by light quartzitic pure quartz sandstones.

Barcza East

An excavation, *c.* 105 m long, also a score of test pits were dug out on Barcza E. by Czarnocki, probably in 1936 (Czarnocki 1936b, Tables X and XV) (Figs 1—2).

A detailed description of the above profile has not, however, been published. Still, thanks to the incomplete burial of these test pits, it has been possible to extract some fossil remains from the blocks there strewn about. Directly before second World War, a small quarry (Fig. 1—*1*), 15 m long and 25 m wide, was started by Sierakowski near the south-western corner of Czarnocki's excavation, where sandstones were exploited for local needs. During the war years, the quarry was abandoned and its walls became overgrown. A diagram of the spatial distribution of the above mentioned test pits in Barcza E., based on Czarnocki's sketchmap (1936b, Tab. XV) is given in Fig. 3. To introduce some order into the numbering of test pits, not given in the proper succession by Czarnocki, new Roman figures have now been assigned as follows:

After Czarnocki (1936b, Tab. XV)	After the present writer (Fig. 3)
No. 9	No. I
„ 6	„ II
„ 10	„ III
„ 7	„ IV
„ 11	„ V
„ 8	„ VI
„ 14	„ VII
„ 1	„ VIII
„ 12	„ IX
„ 15	„ X
„ 13	„ XI
„ 2	„ XII
„ 3	„ XIII

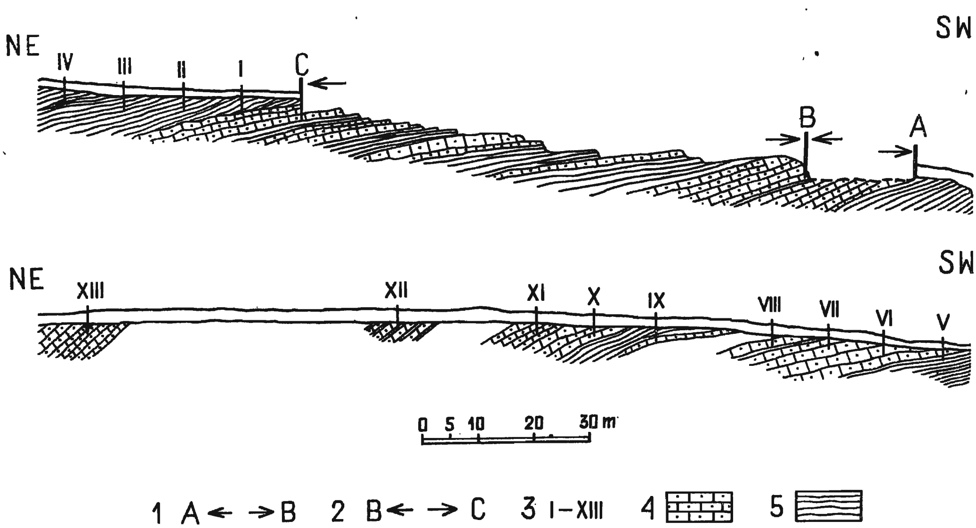


Fig. 3

Localization of artificial exposures of the Upper Emsian deposits at Barcza E. (after a sketch-map by Czarnocki, 1936b, modified and supplemented by the writer)

Explanations: *1* Sierakowski quarry, *2* excavation, *3* test pits, *4* sandstones, *5* siltstones and claystones

The Upper Emsian deposits from the profile of Barcza E. have been traced over a distance of 319 m, *i.e.* from the adit to Sierakowski's quarry to test pit XIII on the top of the mountain (Fig. 1 — *1—2;* Fig. 3). Lithologically they are light- and dark-grey quartzitic pure quartz sandstones inercalated by claystone, siltstone, sporadically by conglomerates resembling those in unit 33 in the profile of the gallery at Bukowa Mt. (Fig. 1 — *4*). Here and there also occur thin (up to a few cm) units of soft pure quartz sandstones with a yellowish colouration. The fauna occurs in great abundance on the surface of units and nearly all along the length of the profile. A characteristic feature in some units is the en masse occurrence of faunal remains representing one single genus or species.

Among the faunal remains here collected the following forms have been determined:

Pleurodictyum sp. (Pl. 13, Figs 1—2)
Petrocrania sp. (Pl. 13, Fig. 4)
Philhedra sp. (Pl. 13, Fig. 5)
Schizophoria vulvaria (Schlotheim) (Pl. 13, Fig. *6a—b;* Pl. 14, Fig. *1a—b*)
Schizophoria striatula (Schlotheim) (Pl. 14, Fig. 3)
Strophodonta taeniolata (Sandberger) (Pl. 14, Figs 4—6)
Strophodonta piligera (Sandberger) (Pl. 14, Fig. 7; Pl. 15, Fig. 1)
Strophodonta cf. *piligera* (Sandberger) (Pl. 15, Fig. 2)
Schellwienella maior (Fuchs) (Pl. 15, Figs 3—6)
Chonetes sarcinulatus (Schlotheim) (Pl. 16, Figs 1—3)
Chonetes plebejus Schnur
Chonetes subquadratus F. A. Roemer (Pl. 16, Figs 4—5)
Retzia confluentina (Fuchs) (Pl. 16, Figs 12—13; Pl. 17, Fig. 1)
Paraspirifer cultrijugatus (C. F. Roemer) (Pl. 17, Figs *4a—b*, 5)
Paraspirifer cultrijugatus (C. F. Roemer), Form *I* „cultrijugatiforme" (*sensu* Vandercammen, 1963) (Pl. 17, Fig. 6)
Paraspirifer cultrijugatus (C. F. Roemer), Form *II* „auriculatiforme" (*sensu* Vandercammen, 1963) (Pl. 17, Fig. *3a—b*)
Euryspirifer paradoxus (Schlotheim) (Pl. 17, Figs 7, *8a—b*, 9; Pl. 18, Fig. 1)
Euryspirifer arduennensis (Schnur) (Pl. 18, Fig. *2a—b*)
Euryspirifer sp. *1* aff. *E. arduennensis* (Schnur) (Pl. 18, Figs *3a—b*, *4a—b*, 5)
Euryspirifer sp. *2* aff. *E. arduennensis* (Schnur) (Pl. 18, Figs 6—7)
Spinocyrtia subcuspidata (Schnur)
Spinocyrtia aff. *bilsteiniensis* (Scupin) (Pl. 22, Fig. *3a—d*)
Alatiformia dorsocava (Spriesterbach) (Pl. 23, Figs *5a—c*, *6a—b;* Pl. 24, Figs 1—2)
Alatiformia aff. *dorsocava* (Spriesterbach) (Pl. 24, Figs 3—5)
Alatiformia sp. *1* (Pl. 24, Figs *6a—c*, 7—9)
?Alatiformia sp. *2* (Pl. 25, Fig. 1)
Reticulariopsis curvatus (Schlotheim) (Pl. 25, Fig. *4a—b*)
Cryptonella macrorhyncha (Schnur) (Pl. 25, Fig. 5)
Palaeoneilo cf. *beushauseni* (Kegel) (Pl. 26, Fig. 10)
Nuculana securiformis (Goldfuss) (Pl. 26, Fig. 9)
Nuculana cf. *ahrendi* (F. A. Roemer) (Pl. 26, Fig. 7)
?Phthonia sp. (Pl. 27, Fig. 5)
Mytilarca procera (Dienst) (Pl. 27, Fig. 4)

Leioptera (Leioptera) globosa Spriesterbach (Pl. 27, Fig. 2)
Pterinea laevis Goldfuss (Pl. 27, Fig. 7)
Ptychopteria lineata (Goldfuss)
Ptychopteria cf. *fasciculata* (Goldfuss) (Pl. 27, Fig. 11)
Ptychopteria costulata (F. A. Roemer) (Pl. 27, Fig. 10)
Pterinopecten (Pterinopecten) tenuistriatus (Spriesterbach) (Pl. 27, Fig. 12)
Pterinopecten (Pterinopecten) cf. *tenuistriatus* (Spriesterbach) (Pl. 28, Fig. 2)
Goniophora (Goniophora) nassoviensis Kayser
Myophoria inflata (F. A. Roemer) (Pl. 28, Fig. 6)
Paracyclas rugosa (Goldfuss) (Pl. 28, Figs 9—10)
?*Cimitaria striatula* (C. F. Roemer) (Pl. 29, Fig. 2)
Treveropyge rotundifrons (Emmrich)
Gastropoda
Tentaculitidae (Pl. 12, Fig. 1)
Nautiloidea
Crinoidea
Arthrodira (Pl. 29, Fig. 5)

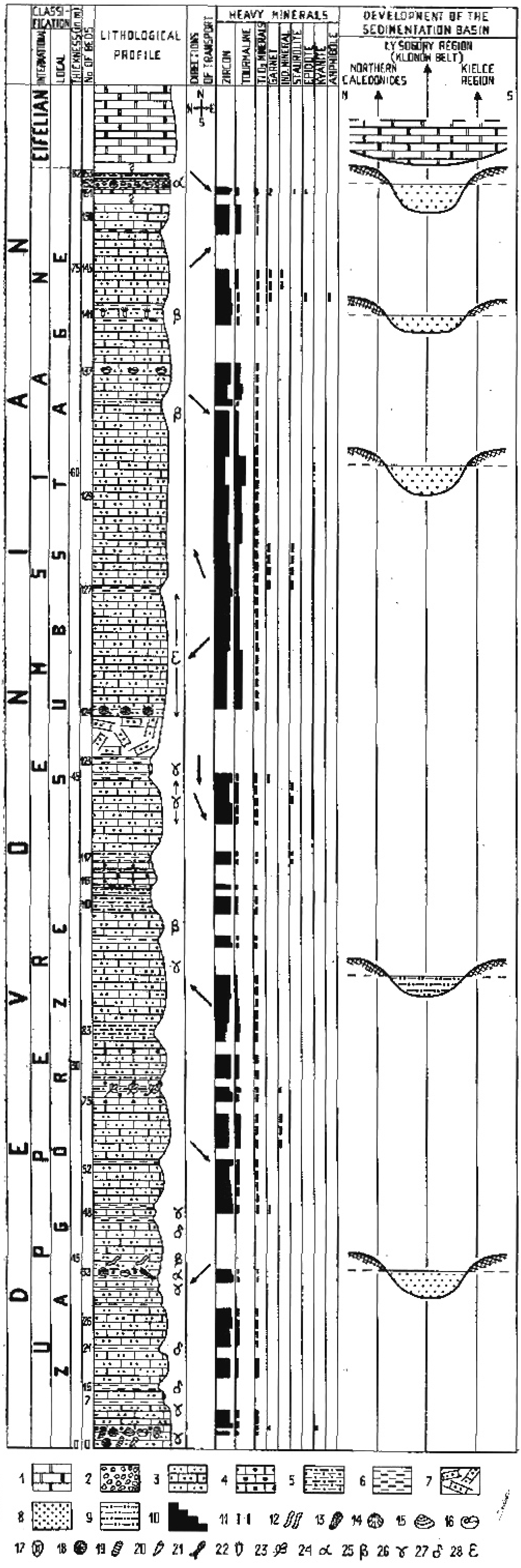
North of the top of Barcza E. (Fig. 1), the Phoronoidea-bearing units are overlaid by Upper Emsian nearly unfossiliferous deposits (Czarnocki 1936a, b) which pass into the carbonate-clayey deposits of the Middle Devonian.

Bukowa Mountain

Between 1956 and 1959, extensive earth works were carried out by the Division of Rock Raw Material of the Geological Survey of Poland in the western part of Bukowa Mt. (Fig. 1), connected with geological investigations. These works resulted in 40 excavations, 4 test pits and one gallery, four of the excavations are 250 m long each (Lewowicki & Ruśkiewicz 1966, pp. 10—11; Fig. 2). Regretfully these authors have published only some simplified profiles from the exploited area, while the profile of the gallery has been merely figured. Between 1960 and 1961 this gallery was described in detail by the present writer (Fig. 1—4) and faunal remains were collected.

The profile of the gallery at Bukowa Mt. (Lewowicki & Ruśkiewicz 1966, pp. 11—14, Fig. 2) is supplemented by test pit No. 1, which is its SW extention (Fig. 1—3). The south-westernmost section of that test pit penetrates into a complex of deposits, c. 30—50 m thick, older than those reached in the gallery. According to Ruśkiewicz (Lewowicki & Ruśkiewicz 1966, p. 14) these are compact, thick-bedded, light-grey and grey quartzitic pure quartz sandstones showing faint traces of lamination. The faunal remains collected by the present writer represent the following species:

Chonetes plebejus Schnur
Spinocyrtia sp.
?*Alatiformia* sp. *3* (Pl. 25, Fig. 2)



Profile of gallery at Bukowa Mt.

Explanations: 1 clay-carbonate deposits, 2 conglomerates, 3 quartzitic pure quartz sandstones, 4 pure quartz sandstones, 5 siltstones, 6 claystones, 7 tectonic breccia, 8 sandy deposits, 9 clayey deposits, 10 heavy minerals — > 10%, 11 idem — < 10%, 12 ?Vermes, 13 Tetracoralla, 14 Brachiopoda, 15 Bivalvia, 16 Gastropoda, 17 Trilobita, 18 Crinoidea, 19 Nautiloidea, 20 Tentaculitidae, 21 Psammosteidae, 22 Phoronoidea, 23 Psilophyta, 24 cross bedding, 25 wavy horizontal bedding, 26 ununiform horizontal bedding, 27 uniform horizontal bedding, 28 microlamination

?*Alatiformia* sp. *4* (Pl. 25, Fig. 3)
Nuculoma krachtae (F. A. Roemer) (Pl. 26, Figs 1—2)
Palaeoneilo maureri (Beushausen) (Pl. 26, Fig. 5*a*—*b*)
Palaeoneilo hercynica (Beushausen) (Pl. 26, Fig. 11)
Nuculana securiformis (Goldfuss) (Pl. 26, Fig. 8)
Goniophora sp.
Myophoria minor Beushausen
Gastropoda (Pl. 12, Fig. 2)
Tentaculitidae (Pl. 12, Fig. 2)
Crinoidea

Lithological profile of the gallery at Bukowa Mt.

The units of this profile have been numbered 0—153 going from bottom to top. The faunal remains occur most irregularly. The majority of species come from unit 0 which has also been observed in test pits and excavations E and W of the gallery (Lewowicki & Ruśkiewicz 1966, p. 14, Fig. 2). Higher up in the profile, the faunal remains are very sparse (Fig. 4).

Unit 0

0.00—0.53 m sandstone, quartzitic pure quartz, grey-brown, equi- or fine-grained. At the top grey, thin-bedded, with distinct horizontal lamination. Great abundance of outer casts and moulds of brachiopods, fewer lamellibranchs, gastropods, cephalopods and tentaculites. The microscopic analysis of thin section shows delicate regeneration rims coating the rounded quartz grains. Among the quartzes there are also rock fragments resembling hornstones or muscovite flakes. Zircon and yellow or blue tourmaline are the heavy minerals here observed. Strike and dip: 90/25 N.

The forms here identified represent the following species:
Tetracoralla (Pl. 13, Fig. 3)
Chonetes sarcinulatus (Schlotheim)
Chonetes plebejus Schnur (Pl. 16, Figs 6—9)
Camarotoechia cf. *daleidensis* (C. F. Roemer) (Pl. 16, Fig. 10)
Paraspirifer cultrijugatus (C. F. Roemer) (Pl. 17, Fig. 2*a*—*b*)
Euryspirifer paradoxus (Schlotheim)
Spinocyrtia subcuspidata (Schnur) (Pl. 18, Fig. 8; Pl. 19, Fig. 1*a*—*c*)
Spinocyrtia sp. *1* ex gr. *S. subcuspidata* (Schnur) (Pl. 19, Fig. 2*a*—*b*)
Spinocyrtia sp. *2* ex gr. *S. subcuspidata* (Schnur) (Pl. 19, Fig. 3*a*—*b*)
Spinocyrtia sp. *3* ex gr. *S. subcuspidata* (Schnur) (Pl. 19, Fig. 4*a*—*b*)
Spinocyrtia lateincisa (Scupin) (Pl. 19, Fig. 5; Pl. 20, Fig. 1*a*—*e*)
Spinocyrtia sp. *4* aff. *S. lateincisa* (Scupin) (Pl. 20, Fig. 2*a*—*b*)
Spinocyrtia sp. *5* aff. *S. lateincisa* (Scupin) (Pl. 20, Fig. 3*a*—*c*)
Spinocyrtia longeincisa (Dahmer) (Pl. 20, Fig. 4*a*—*b*)
Spinocyrtia cf. *crassifulcita* (Spriesterbach) (Pl. 21, Figs 1*a*—*d*, 2*a*—*b*, 3—4)
Spinocyrtia robustifulcita (Spriesterbach) (Pl. 21, Fig. 5*a*—*d*; Pl. 22, Figs 1*a*—*b*, 2)
Spinocyrtia cf. *tenuicosta* (Scupin) (Pl. 22, Fig. 5*a*—*b*)
Spinocyrtia sp. *6* (Pl. 22, Fig. 4*a*—*c*; Pl. 23, Fig. 1*a*—*d*)
Spinocyrtia sp. *7* (Pl. 23, Figs 2*a*—*d*, 3*a*—*b*, 4*a*—*b*)
Nuculoma krachtae (F. A. Roemer) (Pl. 26, Fig. 3)

Nuculites ellipticus (Maurer) (Pl. 25, Fig. 6)
Nuculites aff. *triqueter* Conrad (Pl. 26, Fig. 4)
Palaeoneilo maureri (Beushausen) (Pl. 26, Fig. 6)
Nuculana securiformis (Goldfuss)
Leioptera (Leioptera) globosa Spriesterbach (Pl. 27, Figs 1—3)
Ptychopteria lineata (Goldfuss) (Pl. 27, Fig. 9)
Ptychopteria costata (Goldfuss) (Pl. 27, Fig. 8)
Pterinopecten (Pterinopecten) tenuistriatus (Spriesterbach) (Pl. 28, Fig. 1*a*—*b*)
Goniophora (Goniophora) nassoviensis Kayser (Pl. 28, Figs 3, 4*a*—*b*)
Myophoria inflata (F. A. Roemer) (Pl. 28, Fig. 5)
Myophoria minor Beushausen (Pl. 28, Figs 7—8)
Grammysia sp. (Pl. 29, Fig. 1)
Treveropyge rotundifrons (Emmrich)
Gastropoda
Tentaculitidae
Nautiloidea
Crinoidea
Psammosteidae (Pl. 29, Fig. 4)

Unit 1

0.53—0.76 m sandstone, pure quartz, bluish-grey, fine-grained, thin-bedded. Thin section shows that the sharp-edged quartz grains, 0.06—0.10 mm in diameter, are cemented by a plentiful clayey substance consisting of delicate scales of hydromica. Very small amounts of muscovite flakes have been observed, too.

Unit 2

0.76—0.87 m sandstone, quartzitic pure quartz, grey, equigranular, thin-bedded. Upper side of unit uneven, smooth, showing distinct signs of outwashing.

Unit 3

0.87—1.10 m sandstone, pure quartz, grey-brown, fine-grained, thin-bedded, soft. Poorly compact near the bottom.

Units 4—12

1.10—4.44 m sandstone, quartzitic pure quartz, grey and grey-bluish, fine-grained, at the base thin-bedded, platy, in the top thick-bedded (6 units). On the upper sides of units there are signs of outwashing. The particular sandstone units separated by thin, compact bluish claystones. Unit 10 is indistinctly cross bedded, with the thickness of laminae up to 5 mm and a supposed dip of 25° E.

Units 13—15

4.44—5.61 m claystone, bluish, compact, interbedded by rusty-brown quartzitic pure quartz sandstone. Top unit of the claystone interbedded by ten, 1 cm thick, laminae of quartzitic pure quartz sandstone.

Unit 16

5.61—6.01 m sandstone, quartzitic pure quartz, grey, equigranular. Upper side smooth, showing signs of outwash. In thin section, the quartz grains, 0.2—0.25 mm in diameter, are regenerated. Sporadically the presence is noted of muscovite flakes, 0.2 mm in diameter, as well as of zircon, rutile and yellow tourmaline.

Units 17—23

6.01—9.01 m sandstone, quartzitic pure quartz, light-grey or grey, equigranular, thin- or thick-bedded, separated by four laminae of bluish compact claystones. Upper side of sandstone units smooth, with distinct signs of outwash. Strike and dip: 90/ /28 N.

Unit 24

9.01—10.28 m sandstone, quartzitic pure quartz, grey, fine-grained, thick--bedded. Under side of unit uneven, pitty, the upper one flat and smooth with distinct signs of outwash. In thin section the quartz grains encircled by regeneration rims. Detrital quartz fairly often with streaky extinction of light. Some of the grains are similar to polysynthetically twinned plagioclases. Besides quartz sparse grains are also visible with extremely fine crystalline structure resembling hornstones, also roundish grains of zircon and tourmaline.

Unit 25

10.28—10.36 m claystone, bluish-grey, compact, showing platy cleavage.

Unit 26

10.36—12.31 m sandstone, quartzitic pure quartz, grey, thick-bedded, coarse--grained, here and there passing into quartzy conglomerate, near the bottom grain diameter 0.5—1.0 mm — sporadically up to 7 mm, in the top part up to 2 mm.

Units 27—32

12.31—13.87 m sandstone, quartzitic pure quartz, grey, fine-grained, thin-bedded (9—15 cm) with numerous intercalations of bluish claystones, 0.5—5.0 cm thick.

Unit 33

13.87—14.20 m conglomerate, quartzitic, coarse-clastic, stratified by alternating layers of coarser and finer material. Small quartz pebbles are 0.5—2.0 mm in diameter, sporadically up to 10 mm. Small clay balls, up to 6 cm in diameter, are sparsely scattered throughout the unit. The microscopic analysis of thin section shows the conglomerate to consist of rounded fragments of quartz grains, with strongly developed regeneration rims, encased in a coarse-grained aggregate made up of quartz grains. Among the fragments of quartz rocks, quartzites and aggregates of cataclastic quartz grains with wavy and streaky light extinction are readily detectable. There also occur fine-crystalline quartzites and fragments of grains resembling hornstones. Most of the quartz grains throughout the rock are with wavy and streaky light extinction. In this respect the grains resemble quartz occurring in rocks subjected to cataclasis. *Spinocyrtia* ex gr. *subcuspidata* (Schnur), Gastropoda and Psammosteidae are the species identified from the abundant fossil remains here.

Unit 34

14.20—14.23 m claystone, bluish, compact.

Unit 35

14.23—14.62 m sandstone, quartzitic pure quartz, grey, with rather small and rare lenses of clay scattered in the rock.

Unit 36

14.62—14.79 m sandstone, quartzitic pure quartz, grey, fine-grained, thin--bedded, with numerous canals, perpendicular to the surface of unit and filled with clay. The canals have a diameter of 4—15 mm and are round or ovate in section.

Units 37—58

14.79—22.83 m sandstone, quartzitic pure quartz, light-grey or grey, fine--grained, thin- or thick-bedded (11 units), intercalated by bluish claystone. The bottom part of unit 42 (c. 10 cm thick) is coarser-grained, 0.5—2.0 mm in diameter. On the under side of unit 44 small sedimentary structures are visible, resembling load casts. In the claystones lamination is horizontal. The darker, thicker laminae intercalate with thinner lighter ones. Signs of outwash are seen on the upper side of sandstone units. Strike and dip: 115/30 N.

Unit 59

22.83—23.08 m sandstone, quartzitic pure quartz, grey, fine-grained, thin-bedded, with numerous perpendicular canals filled with clay. The canals have a diameter of 4—15 mm and are round in cross section.

Units 60—68

23.08—24.98 m sandstone, quartzitic pure quartz, grey, fine-grained, thin-bedded (4 units), intercalated by bluish compact claystone.

Unit 69

24.98—25.25 m sandstone, quartzitic pure quartz, grey, fine-grained, thin-bedded. Numerous streaks of bluish clay occur in the top part of the unit. In thin section regenerated quartz grains, often as regular rhombohedrons, 0.2—0.3 mm in diameter, are visible. Rare aggregates of bigger quartz grains or hornstone-like fragments. In some parts the quartz cement is replaced by a clayey substance consisting of hydromica and, less often, of limonite.

Units 70—74

25.25—27.84 m sandstone, quartzitic pure quartz, bluish-grey, fine-grained, thin- or thick-bedded, intercalated by two units of blue, compact claystone. Pure quartz, rusty-grey, very soft sandstone, with distinct cross lamination, stressed by streaks of limonite, is observable in the middle par of unit 72. The laminae are 1.5 mm.

Units 75—76

27.84—28.54 m sandstone, pure quartz, soft, dirty-cherry coloured, with numerous white spots, fine-grained, thick-bedded. In the top there is a 2 cm thick lamina of bluish siltstone, at the base very fine streaks of bluish clay.

Unit 77

28.54—28.72 m siltstone with an important admixture of coarse quartz material, at the bottom rusty-cherry coloured with numerous white spots, at the top blackish-brown. Numerous psilophyte remains are dispersed throughout the rock, arranged parallel to the surface, also muscovite flakes.

Units 78—81

28.72—30.68 m sandstone, pure quartz, soft, dirty-cherry, fine-grained, thin- or thick-bedded, with an 18 cm thick intercalation of dirty-cherry-red siltstone, spotted and streaked in white and blue.

Unit 82

30.68—31.11 m sandstone, quartzitic pure quartz, light-grey, fine-grained, poorly compact at top and bottom, resembling pure quartz sandstones.

Unit 83

31.11—32.01 m siltstone, dirty-cherry-coloured, thick-bedded with an admixture of coarser quartz material. In the middle part intercalated by 20 cm of cherry-grey pure quartz sandstone.

Units 84—109

32.01—37.74 m sandstone, quartzitic pure quartz, light-grey or grey, fine-grained, thin-bedded (13 units), intercalated by bluish compact claystone. Horizontal lamination is observed in unit 101. Sandstone laminae, 5 mm thick, divided by thin, delicate claystone laminae. Strike and dip: 135/30 N.

Unit 110

37.74—38.59 m siltstone, dark-grey, cherry-spotted, thick-bedded. In thin section stratified. The ground mass consists of a clayey substance made up of delicate scales of hydromica, grey-yellowish in colour, strongly birefringent, containing numerous quartz grains, chiefly sharp-edged, varying in diameter. Some of these grains, particularly the bigger ones, are angularly shaped and resemble quartz from pyroclastic rocks. Minute muscovite flakes are present, too.

Units 111—112

38.59—39.31 m siltstone, grey or dark-grey, with perpendicular canals filled with cherry-coloured silt.

Units 113—117

39.31—41.06 m sandstone, pure quartz, yellowish-brown, locally grey, fine-grained, thin-bedded, poorly compact, with intercalations of grey-bluish compact siltstone.

Units 118—119

41.06—42.58 m sandstone, quartzitic pure quartz grey, fine-grained, thick-bedded, with irregular intercalations and lenses of bluish claystone.

Unit 120

42.58—44.83 m sandstone, quartzitic pure quartz, light-grey, unequigranular, thick-bedded, at the bottom fine-grained, at the top coarse-grained, with horizontal lamination. Upper side of unit smooth, with signs of outwash. Thin section of the basal part shows quartz grains, 0.05—0.9 mm in diameter, with regeneration rims. Moreover, fragments (0.2—0.4 mm) of quartz schists, made up of minute quartz grains, also rare muscovite flakes. Of the heavy minerals, zircon, rutile, and bluish-green or orange-yellow tourmaline have been observed.

Unit 121

44.83—45.18 m claystone, bluish-grey, compact, with numerous muscovite flakes and a 2 cm thick intercalation of pure quartz sandstone.

Unit 122

45.18—45.38 m sandstone, quartzitic pure quartz, grey, fine-grained, thin-bedded. Negatives of flow casts (Pl. 5) on under side of unit.

Unit 123

45.38—45.88 m claystone, bluish, compact, thick-bedded.

45.88—47.88 m tectonic breccia built of variously-sized angular fragments of sandstone cemented by a siliceous substance. Strike of fault 50/40 N.

Unit 124

47.88—48.38 m sandstone, quartzitic pure quartz, grey, fine-grained, thick-bedded. At the base tectonically shattered. Upper side uneven, smooth, with distinct signs of outwash. One single brachiopod belonging to the genus *Spinocyrtia* has been found.

Unit 125

48.38—48.40 m claystone, bluish, compact.

Unit 126

48.40—54.20 m sandstone, quartzitic pure quartz, light-grey, thick-bedded, at the base and in the middle fine-grained, at the top coarse-grained. Rare intercalations of bluish claystone resembling elongated lenses. In thin section of the bottom part, the quartz grains, mostly 0.2—0.3 mm in diameter, have regeneration rims. There are also detrital microcrystalline siliceous rocks, 0.2—0.3 mm in diameter; of the heavy minerals zircon, yellow tourmaline, rutile and anatase have been found.

Unit 127

54.20—54.60 m compact claystone, at top and bottom bluish with pink-cherry streaks. In thin section it is seen to be built of thin laminae composed of delicate scales of hydromica, yellowish-grey in colour, strongly birefringent, with a common optical direction. Aggregates of poorly birefringent, kaolinite-like substance are discernible among the strongly birefringent mineral mass. Larger muscovite flakes, associated with analogous poorly birefringent ones, are inserted in the clayey groundmass.

Unit 128

54.60—56.90 m sandstone, quartzitic pure quartz, light-grey, fine-grained thick--bedded, with horizontal lamination stressed by cherry-red hematite streaks. On the upper side of unit a 5 mm thick lamina of bluisch claystone. Strike and dip: 120/25 N. Thin section shows quartz grains varying in size from 0.07—0.5 mm. Here and there detrital cryptocrystalline siliceous rocks, 0.15—0.25 mm in diameter.

Units 129—134

56.90—67.53 m sandstone, quartzitic pure quartz, light-grey, fine-grained, thick--bedded (4 units) intercalated by thin laminae of bluish claystone. In unit 129 sporadical occurrence of roundish quartz grains, pink in colour, 0.5—2.0 mm in diameter; unit 130 has indistinct wavy lamination, parallel to the surface. In unit 133 clayey balls are sparsily dispersed in the rock. The upper side of sandstone units shows signs of outwash.

Unit 135

67.53—67.81 m sandstone, quartzitic pure quartz, grey, fine-grained, thin-bedded, with distinct wavy lamination parallel to the surface. The sandstone layers, 0.5—2.0 cm thick, are intercalated by laminae of bluish claystone. At the top quartzitic pure quartz sandstone passes into poorly compact pure quartz sandstone with an admixture of clayey material. In thin section quartz grains, 0.2—0.3 mm in diameter, are with regeneration rims. Moreover, there are detrital hornstone-like rocks, as well as small amounts of fine-grained quartz rocks. Of the heavy minerals, zircon and tourmaline have been observed.

Unit 136

67.81—68.01 m siltstone, bluish, compact, at the bottom a large admixture of coarser quartz material.

Unit 137

68.01—71.06 m sandstone, quartzitic pure quartz, grey, fine-grained, thick--bedded, with sparsily dispersed bigger quartz grains (up to 7 mm in diameter). Upper side of unit greatly uneven, rough. The presence has also been observed of gastropods.

Units 138—140

71.06—72.43 m sandstone, quartzitic pure quartz, grey, fine-grained, at top and bottom delimited by thin units of bluish compact claystone. The under side of the sandstone smooth, but greatly uneven (with depressions as deep as 20 cm). On upper side of surface, outwashed traces of ripplemarks.

Unit 141

72.43—72.63 m sandstone, quartzitic, pure quartz, grey, fine-grained, thin--bedded, with an intercalation of bluish claystone in the middle part. The unit is pierced by vertical tubes (perpendicular to the surface) filled with clay (Pl. 30, Fig. 1; Pl. 31, Fig. 1). They represent remains of the Phoronoidea. The upper side of unit uneven, smooth, with distinct traces of outwashing. From the overlying unit it is separated by a 5 mm thick lamina of bluish claystone.

Unit 142

72.63—73.01 mm sandstone, quartzitic pure quartz, grey, fine-grained, thin-bedded, with wavy lamination in the bottom stressed by thin streaks of bluish claystone. The under side flat, bossed owing to the penetration of material into the ends of tubes in the underlying unit. Tubes resembling those mentioned in unit 141 have also been encountered. The upper side of unit smooth, with badly preserved ripplemarks.

Units 143—145

73.01—74.97 m sandstone, quartzitic pure quartz, light-grey, fine-grained, platy near the bottom. At top and bottom bluish claystone with dispersed mica flakes.

Unit 146

74.97—75.97 m sandstone, quartzitic pure quartz, light-grey, fine-grained, thick-bedded. Upperside of unit smooth, flat, with traces of outwash. In thin section the quartz grains are 0.06—0.25 mm in diameter and have regeneration rims. Zircon, rutile and tourmaline are the heavy minerals here present.

Units 147—150

75.97—78.25 m sandstone, quartzitic pure quartz, light-grey, fine-grained, thick-bedded, intercalated by bluish, compact claystone. Uppersides of sandstones with traces of outwashing.

78.25—80.75 m lack of data.

Unit 151

80.75—81.05 m sandstone, pure quartz, fine-grained, soft, brick-coloured. Quartzitic and hard at the top. Strike and dip: 114/30 N. In thin section of the top part the quartz grains, 0.1—0.15 mm in diameter, are with regeneration rims. Muscovite flakes, *c.* 0.22 mm in diameter are sporadical.

Unit 152

81.05—81.55 m conglomerate built of well rounded quartz pebbles, up to 3 cm in diameter, passing upwards into quartzitic pure quartz, fine-grained sandstone with conglomeratic streaks stressing the cross lamination of the unit. These streaks range from 2 mm to 4 cm in thickness. The presence has been noted in the streaks of gastropods and brachiopods — *Chonetes sarcinulatus* (Schlotheim). The upper side flat, with traces of outwashing. The thin section shows the conglomerate to be made up exclusively of fragments of quartz rocks, well rounded, mostly ovoid--shaped, seldom spherical. Most of them represent granoblastic fine-grained quartz schists. These are built of strongly elongated and horizontally arranged quartz grains. Other pebbles consist of aggregates of large quartz grains with distinctly wavy light extinction, others more strongly altered are characterized by a mosaic extinction of light, similar to that in cataclasites. On quartz pebbles and on fragments of quartz rocks, the regeneration rims are only partly developed and they interlock with the minute grains of the rockmass. The rock fragments here described belong to quartzites with preferred orientation of quartz grains and to the fine-grained quartz schists. The infilling matrix occurs as an equigranular aggregate of minute regenerated quartz grains, 0.1—0.2 mm in diameter, with a small admixture of muscovite flakes. Limonite occurs in concentrations here and there among the quartz grains.

Unit 153

81.55—81.75 m siltstone, brick-red, thin-bedded, with an admixture of coarser quartz material.

Unit 153 is overlaid by a sandstone complex, *c.* 10 m thick, which it has not been possible to expose because of the great thickness of the overlying deposits. The top of this complex ends the sedimentary cycle of Lower Devonian deposits in the western part of the Klonów Belt. It is overlaid by marly-carbonate deposits, bearing a rich Lower Eifelian fauna (Czarnocki 1936a) (Fig. 2).

PETROGRAPHIC REMARKS

A detailed microscopic analysis of the Lower Devonian deposits from quarries in Mt. Barcza West, has been presented by Zarosły (1933). His investigations covered only the Lower Emsian deposits of the Barcza substage, leaving out the Upper Emsian "Spirifer sandstones". More recently the petrographic characteristics of psammites of the Klonów Belt have been worked out by Harapińska-Depciuch (1957), Kamieński & Kubicz (1962), also by Lewowicki & Ruśkiewicz (1966).

The microscopic analyses from the gallery at Bukowa Mt. here presented have enlarged our knowledge of the mineralogical characters of the deposits under consideration. The total number of analyses is 19, out of which two deal with conglomeratic rocks, two others with clayey rocks, and the rest with quartzitic pure quartz sandstones and pure quartz sandstones (*sensu* Carozzi, 1960).

Quartzitic pure quartz sandstones display a strong grain variability, ranging from 0.07 mm in unit 128 to 0.90 mm in unit 120. The most common fraction is that with a grain diameter of 0.20—0.30 mm. On the whole, the grains are well rounded and have distinct regeneration rims, here and there strongly developed (unit 85).

The siliceous cement, in some cases (unit 69), is replaced by a clayey substance consisting of hydromica, less often of limonite. The quartz grains frequently show a wavy and streaky extinction of light, occasionally (unit 24) regular striations, giving them a resemblance to the polysynthetically twinned plagioclases. Besides quartz, the presence has been noted in the rocks of hornstone-like grains, particles of quartz schists (unit 120) made up of minute quartz grains, particles of cryptocrystalline siliceous rocks (unit 128), also an admixture of muscovite flakes.

Pure quartz sandstones differ from the quartzitic pure quartz sandstones merely in the nature of the cement which is clayey and consists of minute scales of hydromica (unit 1). By accepting the view of Morawiecki (1960) we may be led to suppose that the clayey matrix was the original one for the whole Lower Devonian complex in the Klonów Belt. To a great extent, it has, however, been secondarily replaced by a siliceous matrix, and this is reliably indicated by the regeneration rims on the grains (Pl. 7, Fig. 1 — unit 33). They likewise suggest a strong diagenetic process associated with the regeneration of grains. Some parts of the rock series (pure quartz sandstones) have not, however, been permeated with colloidal silica and this may be due to difficulties in the filtering of solutions through the clayey deposits. The process of silification may have occurred as is suggested by Moorhouse (1959) and probably took place after the deposition of the whole series.

Clayey-sandy shales (units 110 and 127) are composed mainly of

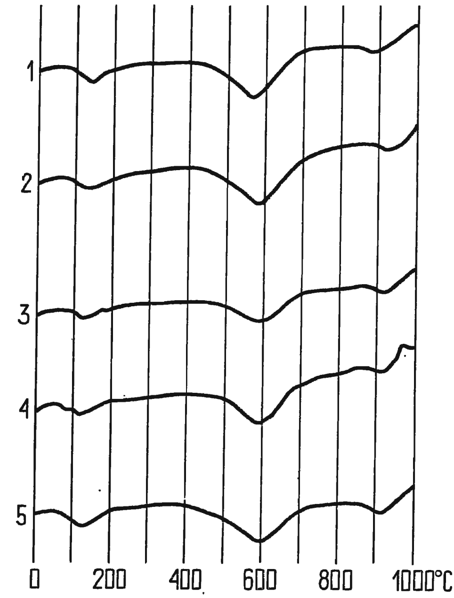


Fig. 5

DTA curves of claystones from gallery at Bukowa Mt.
Explanations: *1* unit 1, *2* — 50, *3* — 102, *4* — 127, *5* — 143

fine scales of hydromica having a preferred optical orientation and an admixture (unit 110) of angular quartz grains and muscovite flakes.

Five thermic differential analyses of claystones have been carried out from various parts of the profile (Fig. 5).

The course of the differential curves shows illite to be the chief, thermically active, constituent in a temperature of up to 1,000 degrees C. In curve 4, however, along with illite, is also indicated a distinct additional exothermic effect in a temperature of c. 970 degrees C. It is not so readily seen in the other curves, particularly so in curve 3. Exothermic effects within this range of temperature indicate the presence of subordinate kaolinite or dickite. The largest amounts of these constituents occur in sample 4, the smallest ones in sample 3.

All the samples display very weak exothermic effects in a temperature of c. 400° C, not detectable in differential curves. This may indicate the presence of rather small amounts of an organic substance. The analysed samples also contain a certain percent content of quartzitic pellite, microscopically observed, which is probably responsible for the deformation of the course of differential curves.

The most important data have been obtained from analyses of conglomerates. Namely, in units 33 and 152, the presence is noted of additional rounded rock fragments, represented by fine-grained granoblastic quartz schists (Pl. 8), also rounded fragments of quartzites and aggregates of cataclastic quartz grains with a wavy and streaky extinction of light (Pl. 7, Fig. 2; Pls 9, 10). This material undoubtedly comes from the massif of metamorphic rocks eroded during the Upper Emsian. An analysis of the transport directions indicates that it lay north of the Holy Cross Mts area.

LITHOSTRATIGRAPHIC COMPLEXES

Three main lithological complexes may be differentiated in the profile of the gallery at Bukowa Mt.

The lower one — comprising a set of sedimentary units numbered 1—74, is characterized by rather small thicknesses of the particular sandstone- and claystone units, with the boundaries separating them usually sharply indicated. Signs of outwash are frequent on the surface of the sandstone units. Grey is the predominant colour.

The middle complex — comprising a set of sedimentary units numbered 75—117, differs in lithology. There is an abundance of quartzitic pure quartz sandstones and siltstones, poorly diagenitised, even friable. The thickness of the particular units is rather small and the boundaries between them not sharp, often hardly detectable.

The upper complex comprises units numbered 118—153. The sandstone units are on the average thick, the boundaries clear-cut. Signs of outwash are frequent on the upper side of sandstone units. Grey and light-grey colour dominates.

An interesting lithological index for all the three complexes is the percent ratio of the total thickness of the siltstone and claystone units in each complex to the total thickness of sandstones. This is illustrated by the following Table 1.

Table 1

Thickness of psammites and pellites (in percent amounts) in the Zagórze substage

	Lower complex units 1—74	Middle complex units 75—117	Upper complex units 118—153
Thickness of complex	27.84 m	13.22 m	40.69 m
Thickness of sandstone units	24.88 m	9.01 m	38.39 m
Thickness of claystone and siltstone units	2.96 m	4.21 m	2.30 m
Percent thickness ratio of sandstone units to the thickness of the claystone- and siltstone units	89.4 : 10.6	69.1 : 31.9	94.3 : 5.7

The above table shows that the percent ratio of the total thickness of psammites to that of pellites differs in every complex. This cannot be regarded as conclusive evidence of the tripartition of the clastic series in the Zagórze substage. Yet, together with the lithological characters and the colouration of deposits it may reasonably suggest the differentiation of three separate complexes. In view of the varied fauna occurring in them these complexes do not represent separate stratigraphic members but merely local lithostratigraphic units.

An analysis of the lithological differences of the particular lithostratigraphic complexes clearly suggests distinct changes in the nature of material, and this probably reflects the processes taking place within the alimentary area (Botvinkina 1962). In unit 31 of the lower complex the horizontal bedding indicates a none too deep and calm sedimentary environment, while in unit 33 there is cross bedding and poorly sorted material. The units lying higher up indicate a return of calm sedimentary conditions. Hence, the whole complex had been deposited under conditions of a relatively stabile bottom of the sedimentary basin, while the coarse-grained material in unit 33 merely suggests a short-lasting episode in the sedimentary rhythm resulting from changes on the nearby land.

The middle complex is characterized by a high percent content of pellitic material and blurred boundaries between the units, moreover, by the mass occurrence of psilophytes in unit 77. This indicates a shallowing and filling in of the sedimentary basin whose shores were probably swampy and overgrown by psilophytes. A break of the normal sedimentary rhythm then set in, and the material brought by rivers was not being sorted because of the lack of currents and action of waves.

In the upper complex the pellite content decreases distinctly; the sandstone units are of considerable thickness and have sharp boundaries. This seems to suggest another deepening of the basin, associated with a greater influx of material, leading to a rapid filling in and intermittent shallowing of the basin. The last mentioned event is suggested by the presence of the Phoronoidea-bearing units, followed by another deepening of the basin (Fig. 4). This is reflected in unit 152 which displays cross bedding and may be traced over large areas of the Klonów Belt.

The development of the sedimentary basin, as described above, fits in pretty well into Nalivkin's interpretation (1955) of the formation of clastic deposits. Namely, the features observed in the lower and upper complexes reasonably suggest that they represent typical series of the transgreding sea, while the middle complex indicates stagnation in the basin. Another characteristic feature of the middle complex is the cherry colouration of deposits, most likely connected with the climatic conditions prevailing at that time (Dunbar & Rodgers 1957, Orlova 1963, Sinitzyn 1967). A hot desert climate set in on the land formed by the Caledonian cycle of orogeny, and unusually great amounts of iron compounds — causing the red colouration of the deposits — were being supplied from the eroded massifs to the sedimentary basin of the present Klonów Belt.

SEDIMENTOLOGICAL OBSERVATIONS

Various types of bedding have been observed during the elaboration of the Lower Devonian deposits in the gallery at Bukowa Mt. Unfavourable conditions have, however, prevented the investigation of all the bedding types occurring in that profile.

The only readily discernible bedding was that on recently sheared rock surfaces where the various elements were sharply delimited.

Cross bedding

Typical cross bedding occurs in units 33 and 152. In the first one it is emphasized at the bottom by the diagonal arrangement of flat clay pebbles. At the top the cross bedding is indicated by straight laminae of coarser quartz material intercalated by rather small (up to 1.5 cm in diameter) roundish clay balls, also by the presence of brachiopods, gastropods and fishes. The inclination angle of the laminae to the surface of unit ranges from 15 to 20° with a W dip.

Bedding displaying the above features could have developed only in an offshore, shallow or even very shallow marine environment (Botvinkina 1962, Table 22), while the material may have been transported by a small stormy stream (?). It is not, however, out of the question, that this type of bedding is genetically connected with a local marine ingression (Kowalczewski 1971).

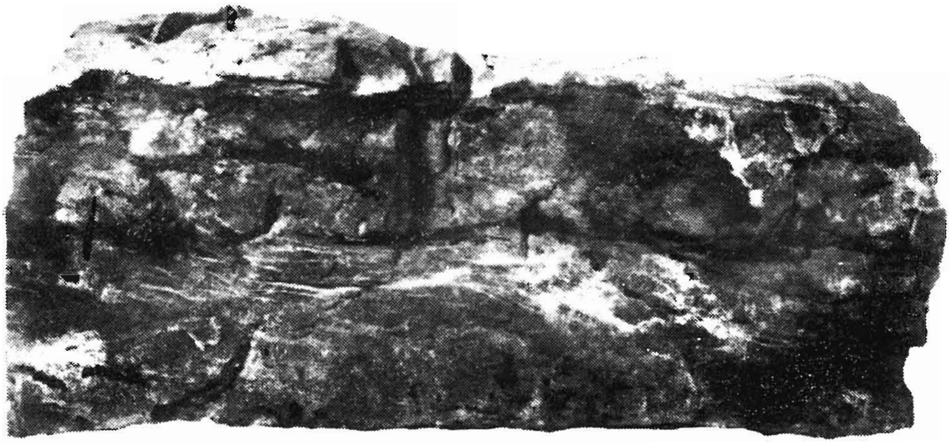
In unit 152 (Pl. 2) we may observe that laminae made up of coarser and fine material are mutually interbedded. The coarser material consists of pebbles of quartz rocks, 1—30 mm in diameter. From the base to the top, the spacing of laminae with coarser material gradually increases while the grain diameter decreases. All the laminae parallel each other and are diagonally oriented to the surface of the unit.

The inclination angle of the laminae is 10° with an E dip.

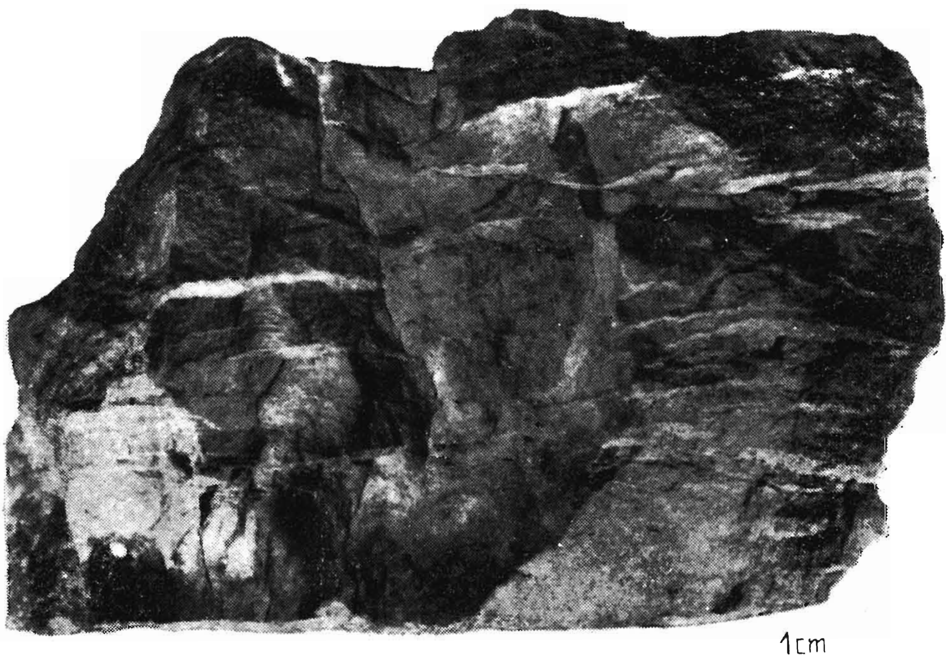
Unit 152 has been traced over a distance of at least 7 km, from Bukowa Mt. in the east as far as Chełmowa Mt. near Zagnańsk in the west. It separates the deposits of the Lower from those of the Middle Devonian. The deposition of the material composing this unit took place in an offshore but deeper zone. In the case of deposition in a shallow

Cross bedding in unit 33; gallery at Bukowa Mt.

Cross bedding in bottom part of unit 152; gallery at Bukowa Mt.

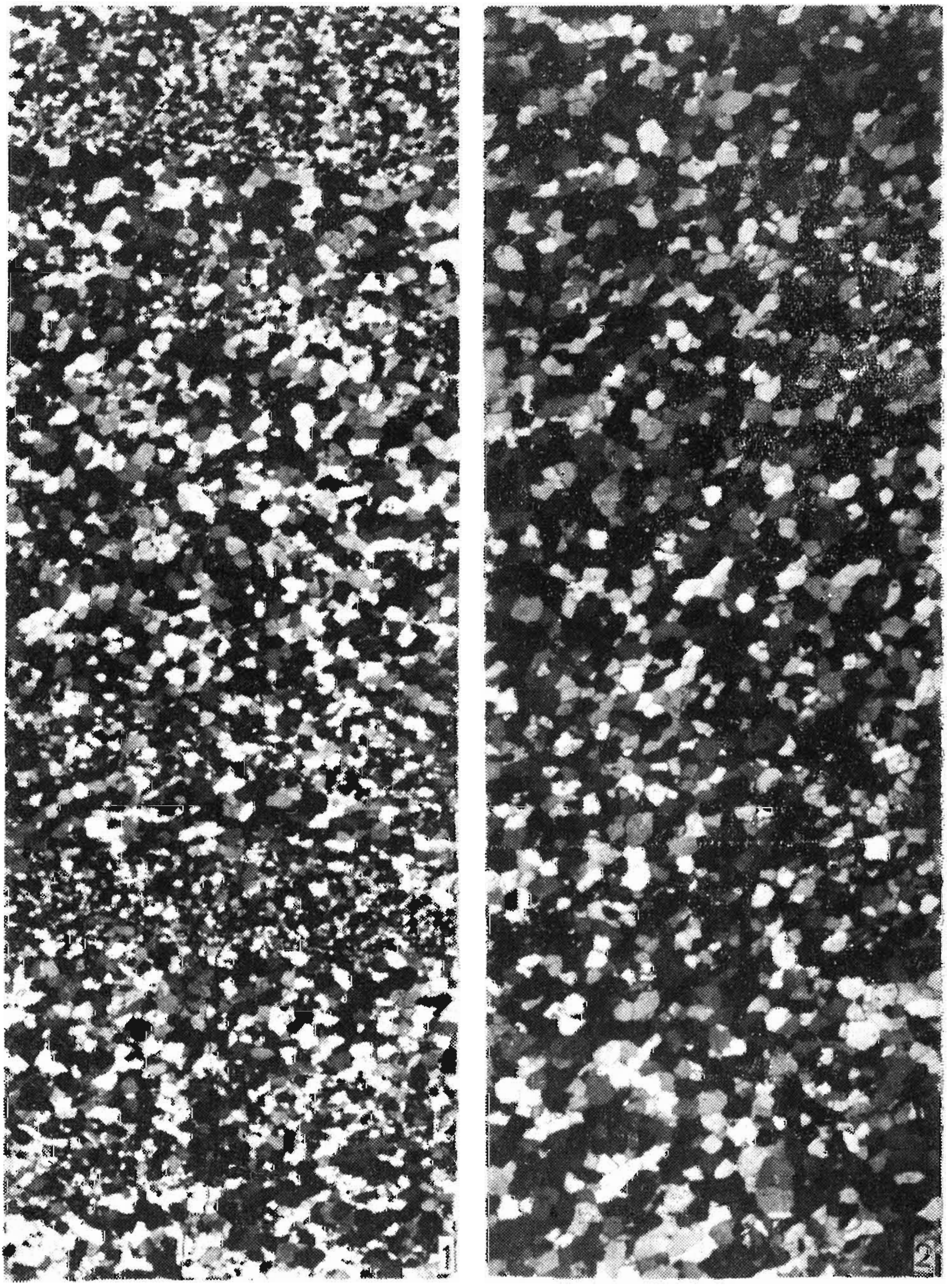


1



2

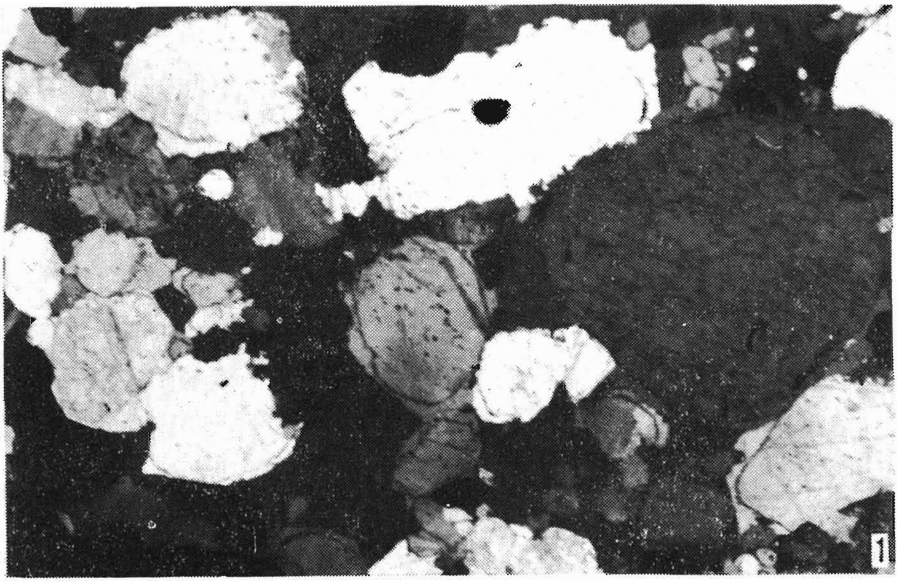
1—2 — Wavy horizontal bedding; *1* in unit 107, *2* in unit 135; gallery at Bukowa Mt.

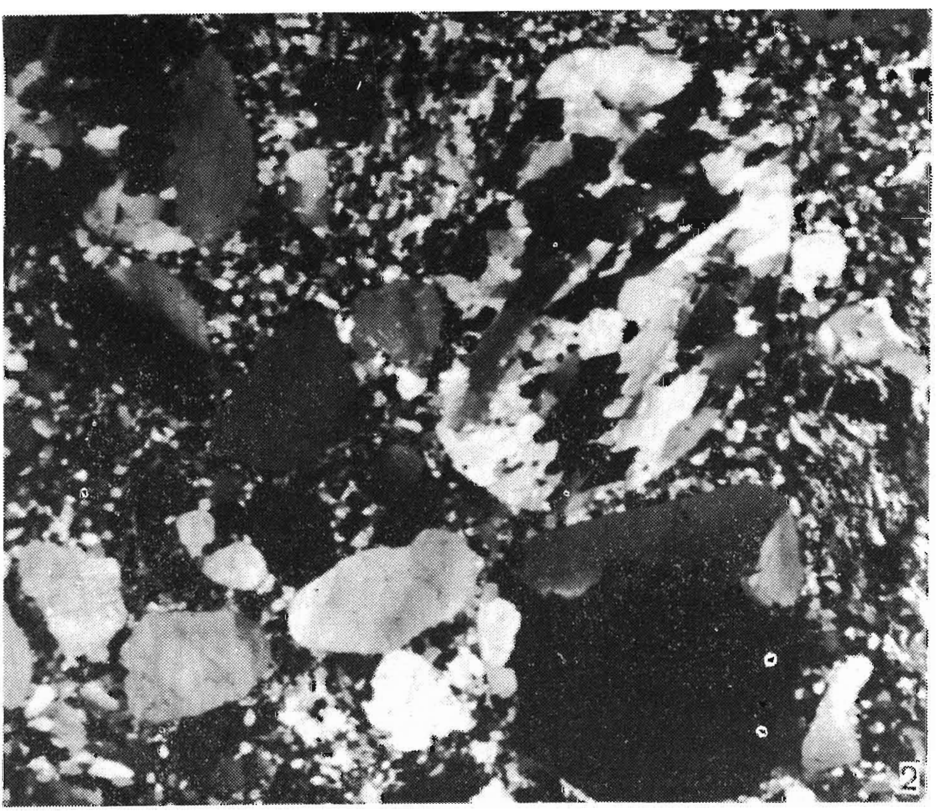


1—2 — Microlamination; *1* horizontal in unit 124, *2* cross in unit 126; gallery at Bukowa Mt. thin sections, crossed nicols, × 7.

Flow casts (negative) on the lower surface of unit 122; gallery at Bukowa Mt. *1—3* prod marks, *4* bounce mark, *5—7* groove casts
Arrow shows direction of current

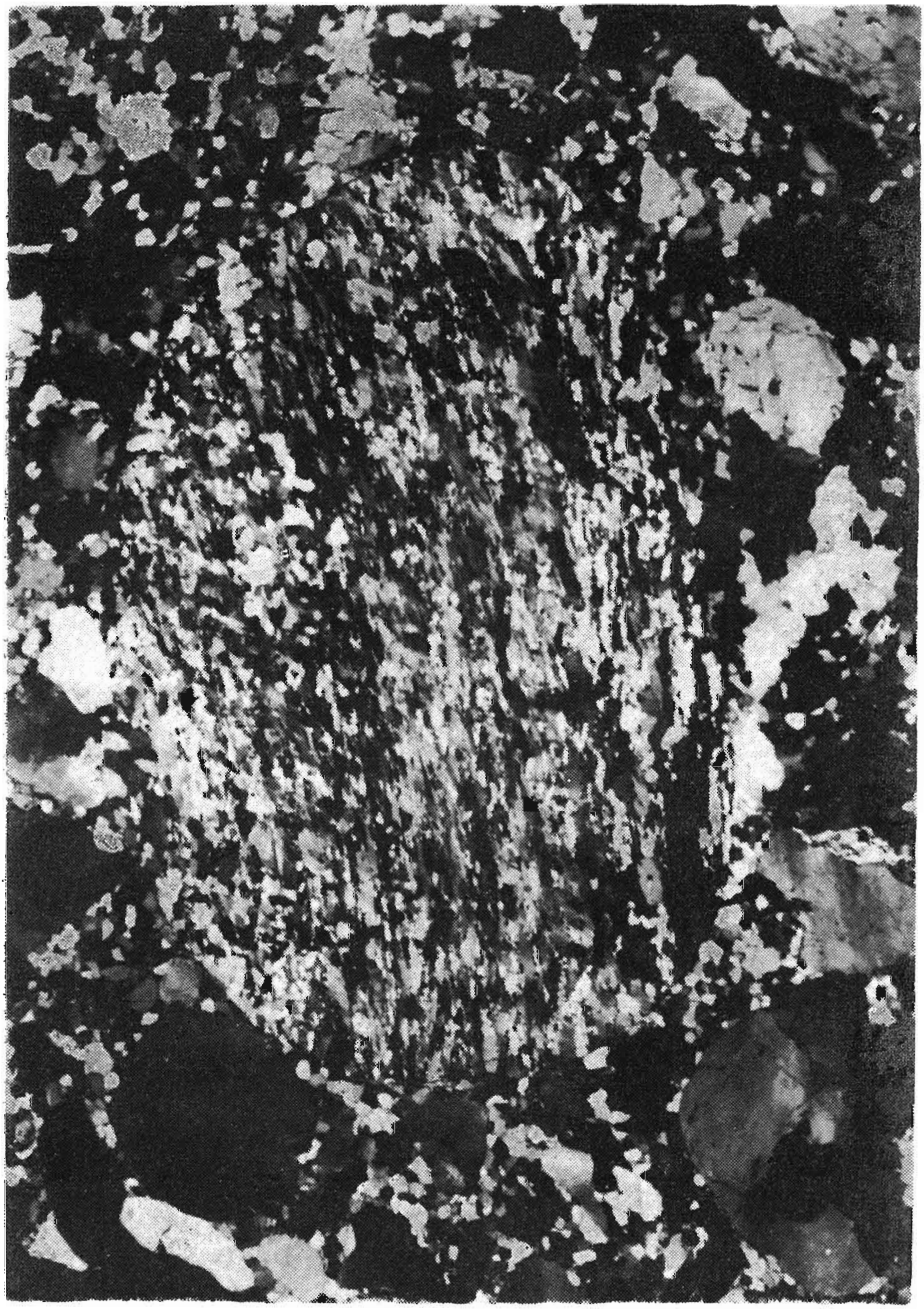
Biohieroglyphs (positive); gallery at Bukowa Mt.





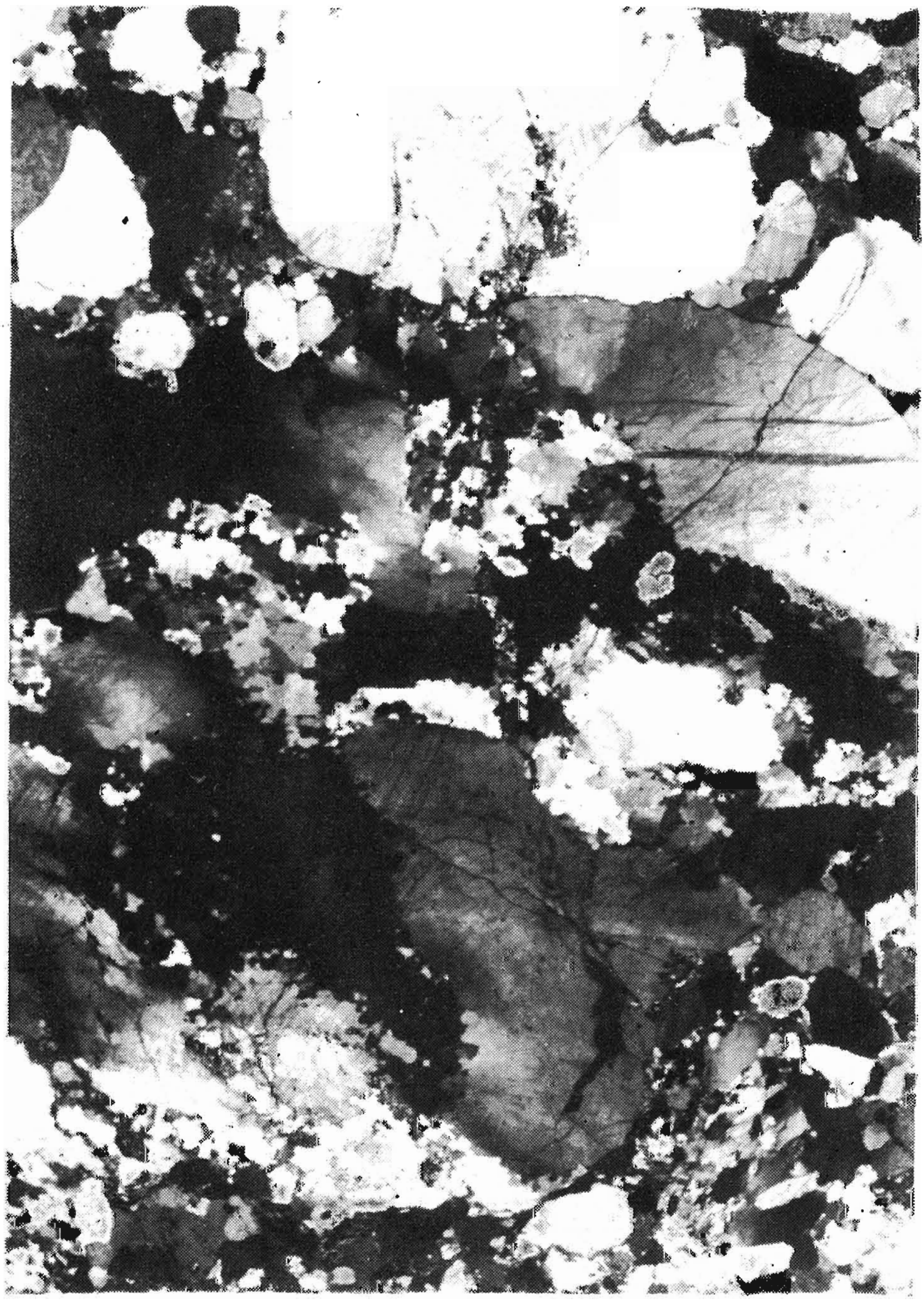
1 — Regeneration rims on quartzes from conglomerate in unit 33; gallery at Bukowa Mt., thin section, crossed nicols, × 19.

2 — Quartzite pebble and single quartz grains cemented by finegrained quartz aggregate in conglomerate from unit 152; ibidem, thin section, crossed nicols, c. × 15.



Quartzite pebble from conglomerate in unit 152; gallery at Bukowa Mt., crossed nicols, × 12.5

Quartz pebbles with wavy light extinction. Conglomerate from unit 33; gallery at Bukowa Mt., crossed nicols, c. × 16



Quartz pebbles with wavy light extinction. Conglomerate from unit 33; gallery at Bukowa Mt., crossed nicols, c. × 16 environment the material could have been outwashed by the action of waves, while in the case of a deeper environment the undisturbed cross bedding has persisted. This might suggest a lowering of the sea floor at the Upper Emsian/Middle Devonian boundary in connection with the progress of the Lower Eifelian marine transgression over the Holy Cross Mts area (Samsonowicz 1953) (Fig. 4). The coarse clastic material (pebbles) composing the unit described above had probably been brought into the sea by rather small rivers or streams. The sharp contact at the base of the unit of the coarse- and fine-grained material, as well as the continuous bottom to top reduction of the diameter of pebbles reasonably suggest a sudden increase in the kinetic energy of the transporting agent and its very gradual decrease. It is quite probable that the sedimentation process may have been connected with changes in the configuration of areas around the sedimentary basin and with the lowering of its floor, leading to erosion and increased amounts of transported material.

Wavy horizontal bedding

Within the Bukowa Mt. profile the wavy horizontal bedding (Pl. 3, Figs 1—2) has been observed in units 38, 107, 135, 142, but it is most readily detectable in units 107 and 135. In the remaining units it is either very indistinct (unit 38) or occurs only in some parts of the unit (at the base in unit 142). In units 107 and 135 the wavy horizontal bedding occurs throughout their thickness. The sandstone laminae, greatly variable in thickness (from 1 to 10 mm), are mutually parallel and undulating. The boundaries of laminae are clear-cut discontinued, not parallel, and emphasized by extremely thin claystone laminae. In the profile of the unit the laminae do not occur as distinct regular sets. Here and there (unit 137) they grow thicker and somewhat lens-like.

According to Botvinkina (1962) the wavy horizontal bedding may occur in various facies, but it is most characteristic of marine deposits subjected to very weak action of waves. An environment of this kind will occur either within a shallow sea zone where sandy sedimentation dominates, or in shallow sea of the type of watts, with the predominance of clayey deposition. In the units here described, the clayey material is subordinate, thus excluding a shallow marine environment of the type of watts. It rather seems that these units could have formed only in a shallow sea environment, under weak action of waves and with the predominance of sandy sedimentation, in isolation from the open-sea zone and resembling a narrow calm bay in character (Zenkovitch 1946, King 1959).

Horizontal bedding

Horizontal bedding has been observed in the following units: 0, 6, 15, 21, 26, 28, 29, 31, 43, 48, 89, 101, 120, 122. It occurs both in psammite and pellitic (in smaller amounts) units.

The ununiform horizontal bedding is indicated throughout the thickness of the unit (Fig. 6*a*). Fine, homogeneous sandstone laminae (1—5 mm thick) parallel each other. Their boundaries are sharp, continuous, regular and stressed by thin (0.1 mm thick) claystone laminae. They do not occur as distinct sets but are irregularly dispersed. The same type of bedding, but with different thickness of laminae, has also been observed in units 6 and 26 (on the upper side), in unit 29 (on the under side) and in units 31, 48, 89, 120, 122.

Uniform horizontal bedding has been noted throughout the thickness of unit 15 made up of compact clay, also in unit 28 representing quartzitic pure quartz sandstone. In both units thick homogeneous laminae (Fig. 6*b*—*c*) have a parallel arrangement. The boundaries of laminae are distinct and continuous, stressed by thick (10 mm) laminae of quartzitic pure quartz sandstone in claystone, or by thin (5 mm) claystone laminae in sandstone. A similar type of bedding also occurs in units 21, 43 and 101.

The paragenetic connections of the wavy horizontal bedding and the two horizontal bedding types here described (Botvinkina 1962), occurring

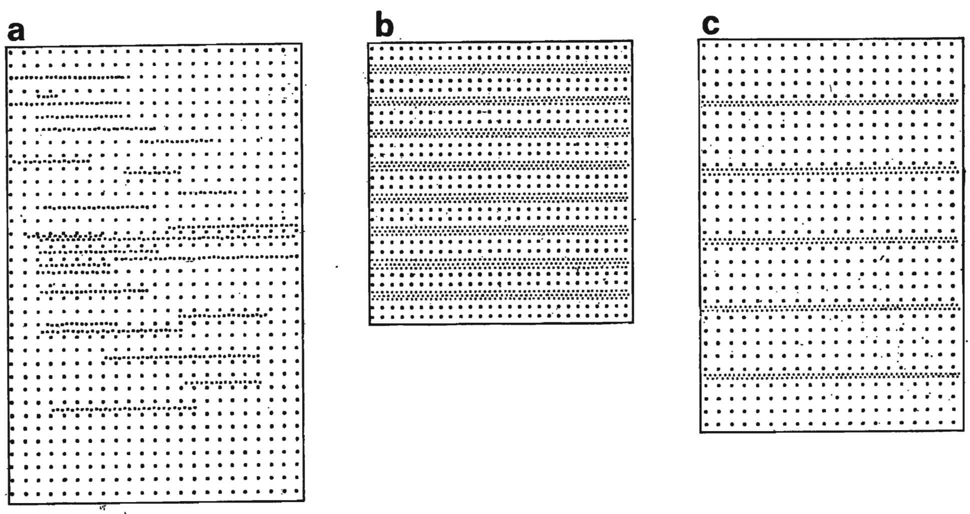


Fig. 6

Types of horizontal bedding in the profile of gallery at Bukowa Mt.

Explanations: *a* ununiform horizontal in unit 0 (1 : 3), *b* uniform horizontal in unit 15 (1 : 15), *c* uniform horizontal in unit 28 (1 : 15) in the alternating units of the Bukowa Mt. profile, suggest relatively shallow and calm, bay-like sedimentary environment. Units 15 and 21, mainly pellitic, could have formed only under exceptionally calm conditions of sedimentation.

Since the two above kinds of bedding are the basic types in the profile here discussed, being present from the base to the top, it may be reasonably supposed that the Upper Emsian sea in the Klonów Belt was a relatively shallow basin with calm sedimentation.

Cross microlamination

The cross microlamination, detected in oriented thin sections from unit 126 (Pl. 4, Fig. 2), is emphasized by the elongated quartz grains (average diameter of 0.2—0.3 mm), with their longer axis diagonally placed. The angle of orientation of the grains in relation to the upper side of the unit is 15—17°, with a NE dip. Moreover, there is also a single thin, diagonally placed lamina, made of finer material, 0.05—0.1 mm in diameter.

A similar type of microlamination has also been observed in an oriented thin section from the upper side of the unit.

More comprehensive data on the character and origin of this type of bedding are lacking in the literature. The considerable thickness of the unit (5.80 m), consisting entirely of well sorted psammite with rare pellite intercalations, suggests its formation under comparatively calm sedimentary conditions, also a prolonged and uniformly strong action of the depositing agent. The absence of wave action both on the surface of the unit and inside it reasonably refers its formation to that part of the basin where the action of waves was not a decisive factor in the morphology of the bottom. The observed cross microlamination may have resulted from the deposition by a small stream emptying into a calm marine, bay-like environment. When the current produced by a flow of fresh water was strong enough, minute particles of pellite could be transported farther on, or were laid down much earlier, on contact with sea water. This might account for the absence of pellitic intercalations.

Horizontal microlamination

In a thin section from unit 124 (Pl. 4, Fig. 1) the presence has been noted of elongated quartz grains, showing an average diameter of 0.3—0.8 mm, with their longer axis oriented parallel to the upper side of the unit. The horizontal microlamination is, moreover, stressed here by thin (2.0—3.0 mm thick) horizontal intercalations consisting of finer material (0.05—0.1 mm in diameter), shaped like irregular laminae. The intercalations are arhythmically arranged. The above features seem to suggest a rather calm sedimentary environment, while the finding of a single brachiopod specimen from the genus *Spinocyrtia* indicates a none too deep basin.

Statistical data on types of bedding in the Bukowa Mt. profile are as follows:

Type of bedding	Quantity of units	Nos of units
Cross	4	10, 33, 72, 152
Wavy horizontal	4	30, 107, 135, 142
Horizontal	14	0, 6, 15, 21, 26, 28, 29, 31, 43, 48, 89, 101, 120, 122
Cross microlamination	1	126
Horizontal microlamination	1	124

Hieroglyphs

Several types of hieroglyphs have been noted on a few poorly exposed surfaces in the Upper Emsian profile of the gallery at Bukowa Mt. Among them two represent flow casts, another one trace fossils. Flow casts occur on the under side of unit 122 consisting of quartzitic pure quartz sandstone and resting on claystone. According to Dżułyński's (1963) systematics, the hieroglyphs that can be differentiated in the area under consideration are:

1 — saltation markings,
2 — groove casts.

Saltation markings are represented by prod marks (Pl. 5 — *1—3*). On the downcurrent side these hieroglyphs are steep or overhanging, while on the upcurrent side they descend gently and fuse with the surfaces of units. The transport of the bottom-dragged material had a S-N direction. Among the saltation marks, bounce marks may also be differentiated as rather low crests with downcurrent slope more inclined (Pl. 5 — *4*).

Groove casts are represented by long, narrow and thin crests. The longest ones are up to 6 cm (Pl. 5 — *6, 7*). In one case the length is as much as 22 cm, with the maximum width of 2 cm and a height of 1 cm (Pl. 5 — *5*).

The height and width values increase with the direction of the traction current, indicating that the dragged object gradually sank deeper into the clayey substratum.

The objects dragged by currents probably represented angular rock fragments (groove cast, Pl. 5 — 5), sand grains or fragments of brachiopod or lamellibranch shells.

Biohieroglyphs

On the upper side of one of the quartzitic sandstone unit (Pl. 6) there are fairly deep grooves, *c.* 3 mm in width and *V*-shaped in profile. The margins of the grooves are raised and outwardly flanged, thus suggesting calm sedimentation. Marks of this kind may be trace fossils, *e.g.* of the lamellibranchs.

ORIGIN OF CLASTIC MATERIAL AND TRANSPORT DIRECTIONS

The first analysis of the origin of clastic material from the silicified Lower Devonian sandstones at Godów in the Holy Cross Mts was presented by Morawiecki (1960). This author has shown that most of the terrigenous material brought into the Lower Devonian basin comes from continental areas lying S and SW of Godów. He excludes the possibility of transport from the north. The correctness of the former supposition is confirmed by the results of Znosko's investigations (1962, 1963, 1964, 1965). A similar opinion has also been expressed by Pajchlowa (1963). The second one of Morawiecki's suggestions should — in the present writer's opinion — be approached with certain reserve.

The alimentary areas of the clastic materials, which built the Upper Emsian, *c.* 350 m thick rock series here considered (Czarnocki 1936a), must be looked for in the Pre-Devonian massifs lying north and south of the Klonów Belt. This is reliably indicated by the writer's analyses of the transport directions, based on cross bedding and grain imbrication of the quartzitic pure quartz sandstones.

The determination of the southern transport directions does not offer special difficulties because of the presence of an uplifted massif, known as the Caledonian Kielcides (Znosko 1962, 1965), which stretch out parallel to the margin of the Variscan geosyncline. Clay shales, sandstones, conglomerates and greywackes of the Silurian, as well as Ordovician and Cambrian quartzitic sandstones were the first to be eroded in the above massif (Morawiecki 1960). Hence, the good sorting and roundness of the material in the Upper Emsian series from the Klonów Belt is probably due not to the length of transport but rather to previous sorting. This is confirmed by the investigations of Michniak (1969) as well as by the writer's heavy minerals analysis from the profile of the gallery at Bukowa Mt. (Table 2). Among the heavy minerals the absence is noted of

Table 2

Heavy minerals (in volumetric percentages) in the Upper Emsian deposits from the gallery profile at Bukowa Mt.

No of the investigated unit	Zircon	Tourmaline	Rutile	Garnet	Indeterminate mineral	Staurolite	Epidote	Kyanite	Amphibole	Muscovite	Remarks
1 *	74.4	13.0	12.3	-	-	-	-	0.3	-	+	
3	84.0	6.7	9.2	0.1	-	-	-	-	-	-	
4	76.7	5.2	18.1	-	-	-	-	-	-	-	
18	72.0	12.0	16.0	-	-	-	-	-	-	-	
25 *	81.5	10.7	7.8	-	-	-	-	-	-	-	
26 A	78.9	13.7	7.4	-	-	-	-	-	-	-	anatase
26 B	88.6	8.4	3.0	-	-	-	-	-	-	-	anatase
32 *	96.0	2.8	1.2	-	-	-	-	-	-	+	
33	88.9	7.8	3.3	-	-	-	-	-	-	-	anatase
50 *	94.7	2.4	2.9	trace	-	-	-	-	-	trace	
51 A	90.0	2.7	7.3	-	-	-	-	-	-	-	
51 B	76.2	21.0	2.8	-	-	-	-	-	-	-	
68	94.4	2.8	2.8	-	-	-	-	-	-	-	abundant
72	70.6	21.8	4.6	-	3.0	-	-	-	-	-	
76 *	94.0	2.4	3.6	-	-	-	-	-	-	-	
77	71.6	18.2	8.1	-	2.1	-	-	-	-	-	
80	80.0	13.0	7.0	-	-	-	-	-	-	-	
83 A	67.2	29.6	3.2	-	-	-	-	-	-	-	
83 B	68.0	30.0	2.0	-	-	-	-	-	-	-	
85 A	82.5	15.0	2.5	-	-	-	-	-	-	-	
85 B	84.2	12.4	3.4	-	-	-	-	-	-	-	anatase
101	98.7	1.3	trace	-	-	-	-	-	-	trace	
102 *	92.0	3.4	4.6	-	-	-	-	-	-	-	anatase
110 *	80.3	10.6	9.1	-	-	-	-	-	-	trace	
112 *	82.0	7.0	11.0	-	-	-	-	-	-	trace	
117	87.0	5.5	7.5	-	trace	-	-	-	-	-	anatase
120 A	96.0	0.3	3.7	-	-	-	-	-	-	-	
120 B	70.5	23.4	5.8	-	0.3	-	-	-	-	-	
121 *	90.4	5.0	4.0	0.6	-	-	-	-	-	-	
126 A	59.8	38.6	1.6	-	-	-	-	-	-	-	anatase
126 B	73.0	25.1	1.9	-	-	-	-	-	-	-	
127	97.0	1.3	1.7	-	-	-	-	-	-	-	
128	81.2	15.0	1.7	0.8	-	1.3	-	-	-	+	
129 A *	61.3	34.4	4.3	-	-	-	-	-	-	-	
129 C	66.5	29.8	3.7	-	-	-	-	-	-	-	
129 B	45.4	51.6	3.0	-	-	-	-	-	-	-	
133	78.8	18.6	2.6	-	-	-	-	-	-	-	
136	90.6	4.7	4.7	-	-	-	-	-	-	-	
137 A	64.0	32.6	3.4	-	-	-	-	-	-	-	
137 B	73.7	23.3	3.0	-	-	-	-	-	-	-	
140 *	87.5	6.5	6.0	-	-	-	-	-	-	-	anatase
141	88.0	6.3	5.7	-	-	-	-	-	-	-	
142	90.5	3.4	6.1	-	-	-	-	-	-	-	
143 *	90.0	4.5	5.5	-	-	-	-	-	-	-	brookite
144 A	87.0	7.2	4.8	0.8	-	-	0.1	-	0.1	-	hornblende
144 B	85.5	11.7	2.0	0.4	0.4	-	-	-	-	-	
150	71.2	25.6	3.2	-	-	-	-	-	-	-	brookite
151 A	77.8	2.4	5.4	10.2	-	2.4	1.8	-	-	-	
151 B	79.2	14.8	5.6	0.4	-	-	-	-	-	-	

* Minerals unetched in HCl.

A - bottom, B - top, C - middle part of the unit.

Table 3

Upper Emsian fauna in the western part of the Klonów Belt correlated with selected West European profiles (after Asselberghs, Dahmer, Simon and Spriestersbach)

SPECIES	BELGIUM		GERMANY						POLAND	
	UPPER EMSIAN									
	ARDENNES		RHENISH MASSIF			UPPER HARZ MTS			HOLY CROSS MTS	
	NEUFCHÂTEAU BASIN and DINANT BASIN /southern part/		BERGISCH LAND and SAUERLAND			KAHLEBERG Sandstone			KLONÓW BELT /western part/	
									BARCZA EAST	BUKOWA MT.
	Clervaux beds and Winenne beds /Middle Emsian/	Wiltz beds and Hierges beds /Upper Emsian/	[illegible] beds	Remscheid beds	Hohenhof beds /Lower cultrijugatus beds/	[illegible] beds [illegible] tuff	[illegible] beds	Lower Speciosus beds Pentagium beds Schalke beds	Zagórze substage	
Tetracoralla sp.		+			+			+		+
Pleurodictyum sp.		+		+					+	
Petrocrania sp.		+		+			+	+	+	
Philhedra sp.									+	
Schizophoria vulvaria /Schlotheim/	+	+		+	+		+	+	+*	
Schizophoria aff. vulvaria /Schlotheim/									+**	
Schizophoria striatula /Schlotheim/		cf.		+	+			+	+	
Strophodonta taeniolata /Sandberger/		+						+	+	
Strophodonta piligera /Sandberger/		+		+					+	
Schellwienella maior /Fuchs/	+	+		+					+	
Chonetes sarcinulatus /Schlotheim/	+	+		+			+	+	+	+
Chonetes plebejus Schnur	+	+		+	+		+	+	+	+
Chonetes subquadratus F.A.Roemer				+			+	+	+	
Camarotoechia daleidensis /C.F.Roemer/		+		+			+	+		cf.
Retzia confluentina /Fuchs/	+	+		+	+				+	
Retzia robustella /Fuchs/							+		+	
Paraspirifer cultrijugatus /C.F.Roemer/, Form I "cultrijugatiformis" /sensu Vandercammen, 1963/		+		+	+				+	
Paraspirifer cultrijugatus /C.F.Roemer/, Form II "auriculatiformis" /sensu Vandercammen, 1963/		+		+	+				+	+
Euryspirifer paradoxus /Schlotheim/	+	+					+	+	+	+
Euryspirifer ardennensis /Schnur/	+	+		+					+	
Euryspirifer sp. 1 aff. E. ardennensis /Schnur/									+	
Euryspirifer sp. 2 aff. E. ardennensis /Schnur/									+	
Spinocyrtia subcuspidata /Schnur/	+	+		+	+			+	+	+
Spinocyrtia sp. 1 ex gr. S. subcuspidata /Schnur/										+
Spinocyrtia sp. 2 ex gr. S. subcuspidata /Schnur/										+
Spinocyrtia sp. 3 ex gr. S. subcuspidata /Schnur/										+
Spinocyrtia lateincisa /Scupin/		+		+			+	+		+
Spinocyrtia sp. 4 aff. S. lateincisa /Scupin/										+
Spinocyrtia sp. 5 aff. S. lateincisa /Scupin/										+
Spinocyrtia longeincisa /Schnur/								+		+
Spinocyrtia crassifulcita /Spriestersbach/				+						cf.
Spinocyrtia robustifulcita /Spriestersbach/				+						+
Spinocyrtia tenuicosta /Scupin/										aff.
Spinocyrtia bilateincisensis /Scupin/				+	+			+	aff.	
Spinocyrtia sp. 6										+
Spinocyrtia sp. 7										+
Alatiformia duradeara /Spriestersbach/		+			+				+	
Alatiformia aff. dorsoseara /Spriestersbach/									+	
Alatiformia sp. 1									+	
?Alatiformia sp. 2									+	
?Alatiformia sp. 3										+
?Alatiformia sp. 4										+
Reticulariopsis curvata /Schlotheim/		+		+			+	+	+	
Cryptonella macrorhyncha /Schnur/		+		+					+	
Nuculana krachtae /F.A.Roemer/		+						+		+
Nuculites ellipticus /Maurer/		+		+						+
Nuculites triqueter Conrad										aff.
Palaeoneilo maureri /Beushausen/		+		+						+
Palaeoneilo hercynica /Beushausen/				+				+		+
Palaeoneilo beushauseni /Kegel/									cf.	
Nuculana securiformis /Goldfuss/		+		+	+		+	+	+	+
Nuculana ahrendi /F.A.Roemer/		+		+			+	+	cf.**	
Modiolus antiquus /Goldfuss/	+	+		+			+	+	+	
?Phthonia sp.				+					+	
Mytilarca procera /Dienst/				+					+	
Pterinea laevis Goldfuss		+							+	
Leiopteria /Leiopteria/ globosa Spriestersbach	+	+		+					+	+
Ptychopteria lineata /Goldfuss/		+			+			+	+	+
Ptychopteria costata /Goldfuss/	+	+							+	+
Ptychopteria fasciculata /Goldfuss/		+							cf.	
Ptychopteria costulata /F.A.Roemer/								+	+	
Pterinopecten /Pterinopecten/ tenuistriatus /Spriestersbach/				+					+	cf.
Goniophora /Goniophora/ nassoviensis Kayser		+		+				+	+	+
Myophoria inflata /F.A.Roemer/							+	+	+	+
Myophoria minor Beushausen				+			+	+		+
Paracyclas rugosa /Goldfuss/	+	+		+				+	+	+
Grammysia sp.		+		+			+	+		+
?Cimitaria striatula /C.F.Roemer/	+			+					+	
Treveropyge rotundifrons /Emmrich/		+		+	+		+	+	+	+
Gastropoda	+	+		+	+		+	+	+	+
Tentaculitidae	+	+		+	+	+	+	+	+	+
Nautiloidea	+	+				+	+	+	+	+
Crinoidea		+				+	+	+	+	+
Phacopidea									+	+
Arthrodira									+	
Psammosteidae										+

* also BARCZA WEST, ** only BARCZA WEST.

those suggesting their origin from crystalline rocks. Though the staurolite-kyanite-garnet assemblage reasonably indicates metamorphic rocks as the source of some of the material, yet the role of older sedimentary rocks should also be taken into account. The almost complete lack of felspars in the Bukowa Mt. sandstones (Kamieński & Kubicz 1962) may also indicate redeposition of the material. Evidently, the length of route along which the material had been transported into the Lower Devonian basin may have varied strongly. This is indicated by the observed transport directions: S-N, SW-NE and SE-NW. The northern transport directions is suggested by the measured orientation of pebbles of metamorphic rocks (quartzites) encountered in units 33 and 152. In the first one they show the NE-SW direction, that in the second unit being NW-SE. This would reliably indicate the existence during the Upper Emsian of an uplifted and probably faulted massif north of the Variscan Łysogóry geosyncline. It must have been eroded throughout the Upper Emsian since unit 33 occurs in the bottom part of the profile, while unit 152 is noted in the top part. In the opinion of Turnau-Morawska (oral communication) the above massif may have been built of crystalline (vein quartzes in units 33 and 152), metamorphic and strongly diagenetised sedimentary rocks.

Judging from the size and roundness of grains in the quartzitic material, its transport route must have been fairly long. The size of pebbles seems to exclude their origin from secondary beds, while tectonic deformation indicates metamorphism of the eroded series.

The presence in unit 33 of numerous casts of fish remains constitutes an additional problem. It may be supposed that these fishes or their remains were transported by water currents from the continental area lying N of the basin now comprising the Klonów Belt.

Transport indices

Flow casts, cross bedding, also imbrication and lineation of grains, observed in oriented thin sections, are the basic direction indices in the profile of the gallery at Bukowa Mt. No particular difficulties are experienced in the determination of the transport directions on the basis of the two first indices. The third one calls, however, for very special methods. The theory as well as its practical application pertinent to this problem have been studied *i.a.* by: Graznova (1947), Schwarzacher (1951), Curray (1956), Wendler (1956), Rusnak (1957), Frazier & Osanik (1961), Potter & Pettijohn (1963), Mast & Potter (1963), Dżułyński (1963), Spotts (1964).

The present writer has based his work on Spotts' method simplified by Michniak (1969).

Oriented thin sections have been analysed for their transport direc-

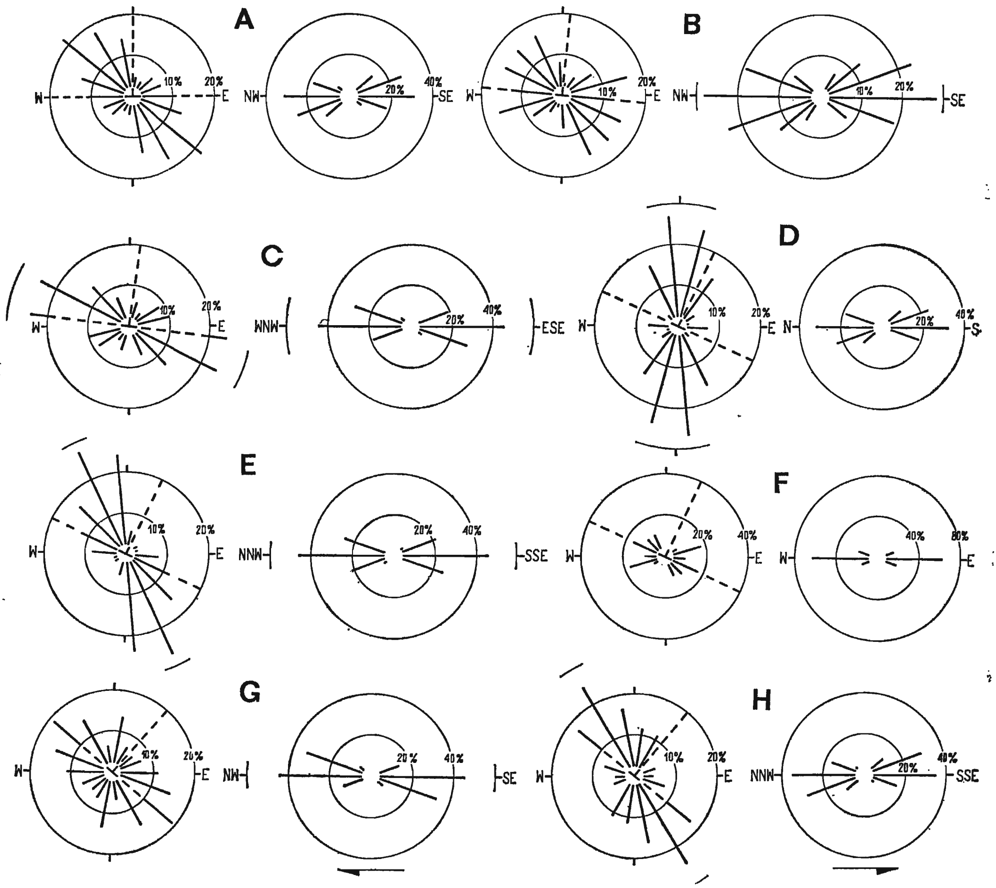


Fig. 7

Spatial orientation diagrams of long axes of quartz grains in the sandstones from the gallery at Bukowa Mt.

Explanations: Left diagram refers to a plane paralell to stratification, right diagram — perpendicular to stratification. Arrows indicate transport direction of material. *A* unit 0, *B* — 16 *C* — 24, *D* — 44, *E* — 124, *F* — 151, *G* — 85, *H* — 120

tion in the case of 13 units: 0, 16, 24, 44, 69, 85, 120, 124, 126, 128, 135, 146, 151. Absence of imbrication (horizontal arrangement of grains) has been observed in 6 units: 0, 16, 24, 44, 124, 151 (Fig. 7*a*—*f*). Indistinct imbrication occurs in units 85 and 120 (Fig. 7*g*—*h*), while readily detectable imbrication has been observed in units: 69, 126, 128, 134 and 146 (Fig. 8*a*—*e*).

Transport directions in units showing imbrication is as follows:

Unit	69	transport direction	NW-SE
„	85	„ „	SE-NW
„	120	„ „	NNW-SSE

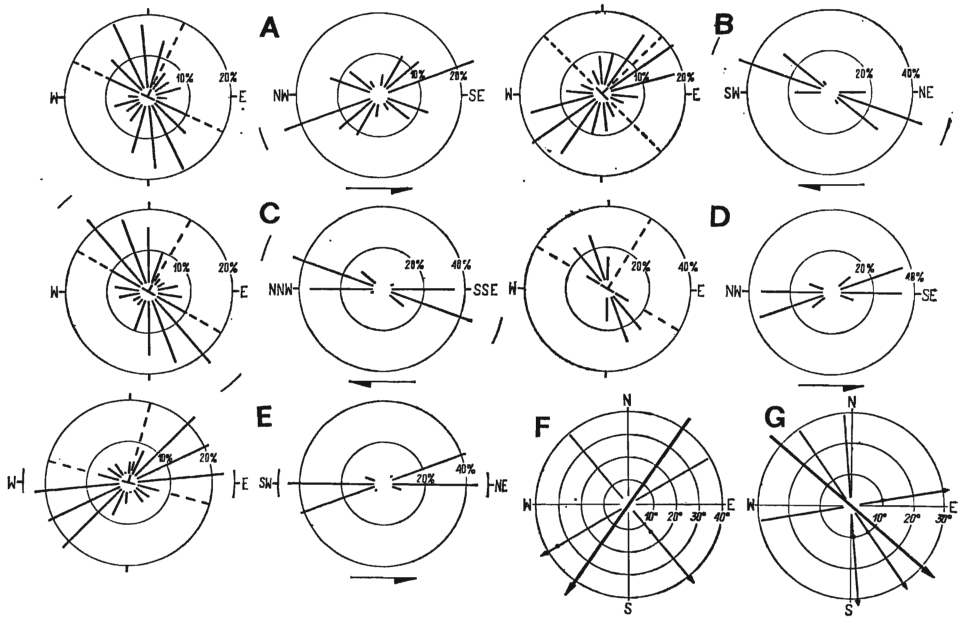


Fig. 8

Spatial orientation diagrams of long axes of quartz grains in the sandstones from the gallery at Bukowa Mt.

Explanations: Left diagram refers to a plane paralell to stratification, right diagram — perpendicular to stratification. Arrows indicate transport direction of material. *A* unit 69, *B* — 85, *C* — 120, *D* — 126, *E* — 128, *F—G* diagrams illustrating transport direction of material (thick arrows) obtained by measurements of cross bedding in units 33 and 152 (*F* — 33, *G* — 152)

Unit 126	transport direction	NE-SW
„ 128	„ „	SSE-NNW
„ 135	„ „	NW-SE
„ 146	„ „	SW-NE

Transport-direction projections based on cross bedding for units 33 and 152 (Fig. 8*f*—*g*) show that the transport direction in unit 33 is NE--SW, for unit 152 NW-SE. The flow casts analysis for unit 122 shows the transport direction to be S-N.

Thus it will be seen that out of the ten transport directions which have been measured and whose distribution in the profile of the gallery is fairly even, six are directions from the north, and four from the south. All the directions are contained in the southern and northern 90° quadrants. Such variability in the arrangement of the directions, as well as the small number of measurements for the whole profile of the gallery, may arouse certain doubts as to the correctness of the obtained data.

The following evidence speak, however, in favour of their accuracy:

a) Lack of values indicating eastern and western directions or their subequivalents throughout the profile.

b) Data concerning the transport directions obtained by measurements of the lineation and imbrication of grains in thin sections do not deviate from the measurement results for cross bedding and flow casts.

It seems that on the whole the transport-direction analysis indicates the existence of two eroded areas: in the north and in the south.

Observations and analytical results seem to indicate that:

1. No transport directions parallel to the basin, *i.e.* W-E or E-W, have been observed in the Upper Emsian deposits of the Klonów Belt.

2. In the profile of the gallery at Bukowa Mt. the greatest amounts of rock material come from the northern Caledonian massifs of the Polish Lowland (Znosko 1962, 1964, 1965; Teller 1969).

3. The southwards directions indicate transport of material from the eroded early Paleozoic rocks of the Kielcides.

4. Practically all of the material here considered owes its origin to the erosion of sedimentary rocks. Heavy minerals and analyses of thin sections confirm this supposition. Single units 33 and 152, here and there containing fragments of metamorphic rocks, are exceptions.

STRATIGRAPHY

The Lower Devonian deposits of the Holy Cross Mts reach their maximum thickness in the western part of the Klonów Belt (Czarnocki 1936a) (Fig. 1—x) and its particular stratigraphic members are here most completely developed, up to the Middle Devonian. The Gedinnian, Siegenian and Lower Emsian in the Klonów Belt occur as a sandy-clayey complex of limnic and lagoonal origin. Only a part of the Upper Emsian deposits are developed as non-calcareous terrigenous sediments bearing a marine fauna related to that of the Upper Harz, the Rhine Massif and the Ardennes. They represent the classical Rhine magnafacies (Erben 1962a) and indicate its easternmost range since they have never been encountered in boreholes E of the Holy Cross Mts, or N or S of that region.

Barcza East

In the Upper Emsian profile of Barcza E., faunal remains occur all along its length, from the southern edge of the Sierakowski quarry up to the Middle Devonian (Czarnocki 1936a, b). Those of stratigraphic value, however, have been encountered only up to the top of Barcza E. (Fig. 3,

Table 4

Correlation of the Lower Devonian deposits in the western part of the Klonów Belt with those in the Upper Harz Mts (after Dahmer and Simon)

Classification: international				Classification: local	UPPER HARZ MTS	Local classification		HOLY CROSS MTS — KLONÓW BELT: Barcza East profile	HOLY CROSS MTS — KLONÓW BELT: Bukowa Mt. profile
DEVONIAN	Middle	EIFELIAN			Upper Speciosus beds corbis-Bank /Kozlowskiella corbis/			Kozlowskiella corbis	
DEVONIAN	Lower	EMSIAN	Upper	Lower Speciosus beds	"Spirifer" mosellanus steiningeri Homalonotus gigas	Zagórze substage	Upper	Chonetes sarcinulatus Gastropoda Phoronoidea	
DEVONIAN	Lower	EMSIAN	Upper	Festenburg beds	Ptychopteria costulata Schizophoria vulvaria	Zagórze substage	Upper	Cryptonella macrorhyncha Paracyclas rugosa Euryspirifer arduennensis Euryspirifer paradoxus Alatiformia dorsocava Ptychopteria lineata Ptychopteria costulata	Spinocyrtia robustifulcita Spinocyrtia cf. crassifulcita Spinocyrtia longeincisa Spinocyrtia lateincisa Ptychopteria lineata Palaeoneilo hercynica
DEVONIAN	Lower	EMSIAN	Upper	Schalke beds	Sellanarcestes wenkenbachi Ptychopteria lineata Spinocyrtia longeincisa Spinocyrtia lateincisa	Zagórze substage	Upper		
DEVONIAN	Lower	EMSIAN	Upper	Hessigi beds	Spinocyrtia lateincisa Murchisonia hessigi Retzia robustella /?/ "Spirifer" goslariensis Schizophoria vulvaria /?/	Zagórze substage	Lower	Retzia robustella Schizophoria vulvaria non marine white sandstones tuff	?
DEVONIAN	Lower	EMSIAN	Upper	Giengelsberg beds	Pleurotomaria giengelsbergiensis Retzia laevicosta	Zagórze substage	Lower	white, gray and red non marine sediments	
DEVONIAN	Lower	EMSIAN	Upper	Keratophyric tuff	Agaste schmidti Tentaculites fuhrmanni	Zagórze substage	Lower		
DEVONIAN	Lower	EMSIAN	Lower		not exposed	Barcza substage		? with Ostracodermi and Placodermi	
DEVONIAN	Lower	SIEGENIAN			not exposed	Klonów substage	Upper /?/	Pteraspis sp. non marine	
DEVONIAN	Lower	GEDINNIAN			not exposed	Klonów substage	Lower /?/	? red sediments	
SILURIAN	Upper				not exposed			? dark shales	

test pit XIII). As is seen from Tab. 3, the faunal assemblage of Barcza E. does not closely resemble any one of the typical Upper Emsian assemblages in Western Europe. The northern edge of the Northern and Eastern quarries bearing a marine fauna should be regarded as the lowermost part of the Upper Emsian profile of Barcza W. (Fig. 1—*7, 8*) (Czarnocki 1936a and the writer's own observations). The fauna here (Czarnocki 1936a) comes very close to the assemblage of Barcza E. (Tab. 3). The writer has not succeeded to trace the base of that complex in the last named profile. However, on the ground of data from Barcza W., the faunal succession may be traced throughout Barcza E. The index forms, in the successive order of their occurrence, from the oldest units in Barcza W. to the youngest ones at the top of Barcza E. (Fig. 1—*8, 1, 2*) are represented by:

Schizophoria vulvaria (Schlotheim) — Barcza W.
Modiolus antiquus (Goldfuss) — Barcza W.
Schizophoria striatula (Schlotheim) — Barcza E.: 5 m of excavation
Strophodonta taeniolata (Sandberger) — Barcza E.: 13 m of excavation
Retzia robustella (Fuchs) — Barcza E.: 33 m of excavation
Ptychopteria costulata (F. A. Roemer) — Barcza E.: 55 m of excavation
Paraspirifer cultrijugatus (C. F. Roemer) — Barcza E.: 63 m of excavation
Goniophora (Goniophora) nassoviensis Kayser — Barcza E.: 63 m of excavation
Alatiformia aff. *dorsocava* (Spriesterbach) — Barcza E.: 75 m of excavation
Alatiformia dorsocava — Barcza E.: 75 m of excavation
Ptychopteria lineata (Goldfuss) — Barcza E.: 75 m of excavation
Paracyclas rugosa (Goldfuss) — Barcza E.: 80 m of excavation
Pterinopecten (Pterinopecten) tenuistriatus (Spriesterbach) — Barcza E.: 87 m of excavation
Spinocyrtia aff. *bilsteiniensis* (Scupin) — Barcza E.: test pit No. III
Euryspirifer arduennensis (Schnur) — Barcza E.: test pit No. VI
Reticulariopsis curvatus (Schlotheim) — Barcza E.: test pit No. X
Cryptonella macrorhyncha (Schnur) — Barcza E.: test pit No. XIII

In this assemblage as well as among the other faunal remains from both Barcza W. and Barcza E., the absence is noted of species characteristic of the lowermost part of the Upper Emsian from the Rhine magnafacies of Belgium and Germany. Such forms as *Schizophoria vulvaria, Retzia robustella* and *Modiolus antiquus* are known in the Upper Harz from the Nessigi beds. The index value of the two first ones is not, however, quite doubtless (Dahmer 1946). According to this author *Schizophoria striatula* and *Strophodonta taeniolata* have not been encountered before the younger beds of Schalke. The faunal assemblage in the profile of Barcza E., starting at meter 55 of the excavation (*Ptychopteria costulata*) may be regarded as representative of the younger Upper Emsian, foremost because of the presence of the species *Phychopteria lineata* which is an index form for the Schalke beds (Dahmer 1946). Hence, it may be reasonably supposed that the lowermost horizons of the Upper Emsian (the Keratophyric tuff, Giengelsberg beds of the Upper Harz, Dahmer

1946) are represented in the Lower Devonian of the Klonów Belt by limnic deposits with fish remains (Tab. 4). It is hardly possible to determine the boundary of the limnic deposits with the Lower Emsian Barcza substage analogously developed in the Klonów Belt. It seems most probable, however, that it should underlie or overlie(?) the tuffite unit in the northern walls of the Northern and Eastern quarries (Fig. 1 — *7, 8*) at Barcza W. On the other hand, the higher Upper Emsian members at Barcza E. occur starting at meter 55 of the excavation as far as test pit XIII (Fig. 3), where *Cryptonella macrorhyncha* has been found. This is an index species for the higher Upper Emsian (E_3) horizons in the Ardennes (Asselberghs 1946). In Sauerland, however, it occurs somewhat lower down (Remscheid beds, Spriesterbach 1942) and from the Olkenbach syncline it is cited by Solle (1937, 1942), with an interrogation mark, from the higher part of the Upper Emsian. Of the other index fossils from the Barcza E. profile, the species *Paracyclas rugosa* in the Upper Harz marks the highermost part of the Upper Emsian (lower Speciosus beds) (Dahmer 1946), but in Sauerland it is known from the lower part (Remscheid beds, Spriesterbach 1942). Neither do the other fossils allow a close stratigraphic correlation with the Upper Harz profile (Dahmer 1946). In the complex of deposits occurring in our profile north of test pit XIII (Fig. 1 — *1, 2;* Fig. 3) up to the Middle Devonian, there is a complete lack of index forms (Czarnocki 1936a). On the above evidence it may be accepted that:

The rock complex at the base of the profile, as far as meter 55 of the excavation, is most likely an age equivalent of the top part of the Nessigi beds and of the bottom part of the Schalke beds from the Upper Harz (Dahmer 1946).

On the other hand, the top complex of the same profile, starting at meter 55 of the excavation as far as the lithological boundary with the Middle Devonian (Czarnocki 1936a) corresponds to the Schalke beds, the Festenburg beds and the lower Speciosus beds from the Upper Harz (Dahmer 1946, Simon 1954b) and to their stratigraphic equivalents from the Ardennes and the Rhine Massif.

Bukowa Mountain

In the Bukowa Mt. profile the fauna consists mainly of forms characteristic for the Upper Emsian profiles in the Upper Harz (Dahmer 1946) and Sauerland (Spriesterbach 1942) (Tab. 3). This is probably connected with the fact that, at that time, both the above areas lay in the northern margin of the uplifted Caledonian massifs (Fig. 9) favouring faunal migration. Moreover, within the faunal Upper Emsian assemblage of the Klonów Belt there occur species characteristic for deposits of the same

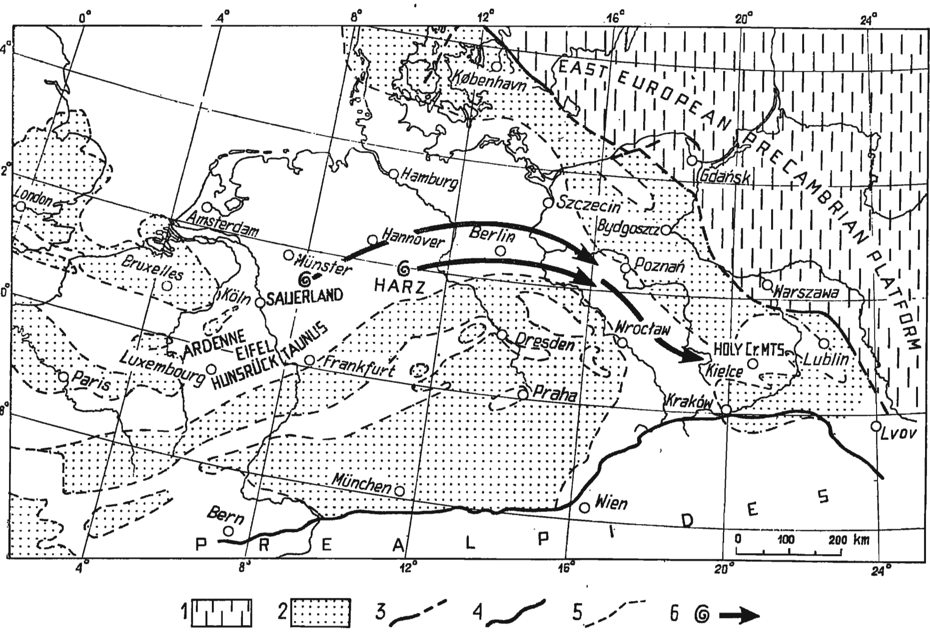


Fig. 9

Paleogeography of Europe in the Upper Emsian (after a map by Hoth & Hirschmann, 1970, modified by the writer)

Explanations: *1* uplifted Precaledonian massifs, *2* uplifted Caledonian massifs, *3* Precaledonian/Caledonian structures boundary in Eastern Europe, *4* same boundary in Southern Europe, *5* hypothetical outlines of uplifted Caledonian massifs, *6* directions of faunal migrations

age in Sauerland, but unknown from the Upper Harz. The faunal migration, therefore, must have led via at least two routes. The presence within the genus *Spinocyrtia* of numerous endemic forms (Tab. 3) is due to the Upper Emsian basin of the Klonów Belt being a peripheral branch of the Variscan geosyncline of Europe which caused its ecological isolation. *Palaeoneilo hercynica,* reported from test pit No. 1 is an index form for the Schalke beds in Upper Harz (Dahmer 1946).

The other fossils of any correlative significance occur almost exclusively in the bottom part of the profile (Lewowicki & Ruśkiewicz 1966) (Fig. 4). Hence, a closer stratigraphic correlation with the Upper Emsian profile of the Upper Harz is hardly possible. It may only be accepted that the complex of deposits, exposed in test pit No. 1, as well as in the gallery (Fig. 1 — *3, 4;* Fig. 4), from the site of appearance of *Palaeoneilo hercynica* as far as the Middle Devonian (Czarnocki 1936a), represents the higher part of the Upper Emsian and is an age equivalent of the Schalke beds, the Festenburg beds, and the lower Speciosus beds (Dahmer 1946). Upper Emsian deposits below *Palaeoneilo hercynica* have not been exposed and are unknown (Tab. 4).

UPPER EMSIAN/MIDDLE DEVONIAN BOUNDARY IN THE KLONÓW BELT

The boundary between the terrigenous Upper Emsian deposits and the clay-carbonate complex of the Middle Devonian in the Łysogóry region of the Holy Cross Mts has been discussed by Czarnocki (1936a, 1950) and Pajchlowa (1957). In the profile of the gallery at Bukowa Mt., at the base of the clay-carbonate Middle Devonian deposits resting on the terrigenous Upper Emsian rocks (Czarnocki 1936a), poorly preserved ostracod remains have been encountered. Among them, F. Adamczak has identified *Kozlowskiella corbis* (Dahmer). This species indicates a fairly accurate Lower/Middle Devonian boundary, most probably running at the base of the clay-carbonate complex. Owing to the strong facial homogeneity in the lowermost Middle Devonian (Lower Eifelian) in the Holy Cross Mts area (Czarnocki 1950, Samsonowicz 1953) it may reasonably be supposed that such a boundary occurs throughout the Klonów Belt. The species *Kozlowskiella corbis,* moreover, suggests the „Gracilis" type of boundary (Simon & Dahmer 1954, Erben 1962b) characteristic of Upper Harz. It seems, however, that this boundary will never, be applicable within the Klonów Belt because of the lack here of index forms typical of the Upper Harz and the southern part of the Rhine Massif.

REMARKS

A number of erroneous views concerning the Lower Devonian stratigraphy of the Holy Cross Mts now prevail in the geological literature in Poland and abroad. Neither has the pertinent terminology been clearly determined and this often accounts for misinterpretations of the stratigraphy of these deposits. Czarnocki (1936a, Tab. XXVII) has observed that the unfossiliferous Upper Silurian deposits are conformably overlaid by cherry-red terrigenous deposits of the Gedinnian which he differentiates as the Klonów beds (after the name of the locality). Nor do these deposits provide paleontological evidence.

The base of the Klonów beds is not clear (Kowalczewski 1968). In the top they are in direct contact with the Barcza beds. The present writer has observed that in the quarry with Monument at Barcza W. (Fig. 1—*6*), on cherry-red variegated thin-bedded terrigenous deposits with *Pteraspis* sp. (det. J. Kulczycki), lamellibranchs and psilophytes, there rests a complex of light, thick-bedded sandstones and claystones containing representatives of Ostracodermi and Placodermi (det. J. Kulczycki). Thus, the *Pteraspis* sp. bearing deposits most likely represent the top of the Klonów beds. By accepting the continuity within the Klonów Belt of the Lower Devonian sedimentation from the Upper Silurian up to the Middle Devonian (Czarnocki 1950; Pajchlowa 1959a, b, 1967, 1968a, b) we shall recognize that the top part of the Old Red Klonów beds, observed by the writer in the Old and the with Monument quarries (Fig. 1 — *5, 6*) may represent only the Upper Siegenian. Czarnocki (1936a) postulates the complete absence of Siegenian deposits in the Klonów Belt. Nevertheless, the Klonów beds, differing in age and lithology from the overlying Barcza beds (*sensu* Czarnocki 1936a), may not be united with the latter into one member called the Barcza series (Czarnocki 1950) as is still practised by a number of authors (Pajchlowa 1959a, 1967, 1968b; Kowalczewski 1968; Tomczykowa & Tomczyk 1970), because actually they represent separate stratigraphic units.

The Klonów beds are overlaid by those of Barcza, Lower Emsian in age, differentiated by Czarnocki (1936a) and named so after Barcza West.

In Czarnocki's opinion most of these deposits formed in a limnic environment and only a small part in a marine one. This is suggested by the presence of fish remains (Placodermi), locally by a marine fauna. Czarnocki often refers to the above deposits as the „placoderm sandstones", believed to represent the „placoderm facies". Among the marine faunal assemblage mentioned by him from Mt. Czostek but neither figured nor described, the absence is noted of index species typical of the Lower Emsian Rhine magnafacies of Western Europe. Hence, it is not excluded that the above assemblage is analogous with the Upper Emsian one from Barcza E. In 1950, however, Czarnocki modified his views on the presence of marine fauna in the Barcza beds, postulating that they are characterized by its absence and that only placoderms are present. This fact has also been confirmed by the observations of the present writer. Czarnocki's earlier (1936a) opinion, however, still prevails in the Polish literature (Samsonowicz 1953; Pajchlowa 1959a, b, 1962, 1963). In 1950 Czarnocki likewise modified his views on the Lower Devonian stratigraphy throughout the Holy Cross Mts. He namely raised the Barcza beds to the rank of series and postulated its correspondence to the Gedinnian, Siegenian and Lower Coblenzian. The differentiation here of the Siegenian still lacks documentation. Other authors continue to maintain this view (Pajchlowa 1959a, b, 1967, 1968a, b; Pawłowska 1961; Kowalczewski 1968, 1971; Tomczykowa & Tomczyk 1970), without adequate documentation differentiating the Siegenian and Lower Emsian within the Barcza series. Pajchlowa (1968b) is the only one to quote after Czarnocki (1936a) a list of Lower Emsian(?) marine fauna assigning it to the Siegenian.

The Barcza beds in the Klonów Belt are overlaid by a complex of psammites and pelites containing a marine fauna. Czarnocki (1936a) distinguished here two series: at the base the „spirifer sandstone" series with a brachiopod fauna from the superfamily Spiriferacea of Middle Emsian age and, at the top the Upper Emsian „scolithus- and joint sandstone" series. The „scolithus sandstone" represents an assemblage with vertical canals burrowed by worms (Scolithus) and lacking the brachiopod fauna, while the „joint sandstone" has been distinguished on lithological criteria. Hence, it may be reasonably supposed that Czarnocki used two different criteria in his division of the top of the Lower Devonian in the Klonów Belt, viz. a biostratigraphic one for the lower part and a lithostratigraphic one for the higher part. Moreover, Czarnocki (1936a) uses the term „spirifer sandstone" to signify another meaning than that implied by its author, Sandberger (1847, 1889). In the differentiation of the „joint sandstone" Czarnocki also disregarded the occurrence (rare as it was) in this complex of a fauna belonging to the superfamily Spiriferacea, though he himself quotes it. It rather seems that the differentiation of the „spirifer sandstone" as a separate member was not fully justified. On the other hand, when differentiating the „scolithus sandstone" Czarnocki (1936a) correctly stated that this is a rock complex with a stable stratigraphic position in the profile of the Klonów Belt, but he neither figured nor described his scolithus. As the above deposits are accessible in the Klonów Belt only in test pits, very few geologists had the opportunity to examine them. As a result, some authors (Tokarski 1962, Konior 1969) compare deposits containing true worm-like organisms from the non-marine Lower Devonian of the Carpathian substratum with the „scolithus sandstone" from the Klonów Belt and suggest far reaching stratigraphic correlations. Comparisons of this kind have led to somewhat uncorrect paleogeographic conclusions.

Detailed lithological investigations of the „spirifer" and the „joint" sandstones undertaken by the present writer have not disclosed very definite genetic differences. This was actually recognized by Czarnocki (1950) when he referred all the three above sandstone types to the Upper Emsian, and also confirmed by Pajchlowa (1959a, b, 1962, 1968a, b).

CONCLUSIONS

On the basis of earlier investigations and the writer's own observations, the following stratigraphic subdivisions are suggested for the Lower Devonian deposits of the western part of the Klonów Belt in the Holy Cross Mts:

1. The *Klonów substage* is the name proposed for the oldest and lithologically uniform complex of variegated clastic deposits, lacking a marine fauna, equivalent to the Gedinnian and the Siegenian. Its lower boundary has not been determined while the upper one fits into the disappearance of *Pteraspis* sp. and into a distinctly marked transition of the variegated thin-bedded deposits into light thick-bedded ones. Should it prove possible to separate the Gedinnian from the Siegenian, the former could be distinguished as the *Lower Klonów substage*, and the latter as the *Upper Klonów substage*.

2. The *Barcza substage* is the name suggested for the overlying lithological complex, probably representing the Lower Emsian in the non--marine facies but containing representatives of the Ostracodermi and Placodermi. Its lower boundary fits in with the upper boundary of the Klonów substage, while its upper one probably underlies or overlies(?) the tuffite unit observed in the Northern and Eastern quarries.

3. The *Zagórze substage* is proposed as name (after the locality Zagórze lying N of the western side of Bukowa Mt.) for the Upper Emsian complex of light deposits with a marine fauna (absent only at the base) and encountered in the profiles at Barcza E. and Bukowa Mt. They rest directly on the non-marine deposits of the Barcza substage without a distinct lithological boundary, and their upper boundary is marked by a transition of the clastic deposits into the clay-carbonate ones, as well as by the appearance of a „Cultrijugatus" type of fauna and the ostracod *Kozlowskiella corbis* (Dahmer).

The name *Lower Zagórze substage* is proposed for the lowermost part of the Zagórze substage, without marine fossils, also for the overlying beds with *Retzia robustella* (Fuchs) as the index form, up to the appearance of *Ptychopteria costulata* (F. A. Roemer), *Ptychopteria lineata* (Goldfuss) and *Palaeoneilo hercynica* (Beushausen).

The name *Upper Zagórze substage* is suggested for the top part of the profile in the Zagórze substage, the index forms here being those occurring in the Upper Harz profile, from the Schalke beds to the Middle Devonian boundary.

4. The *Phoronoidea-bearing complex* may also be useful for correlation throughout the Klonów Belt because of its stable position in the Upper Emsian profiles there.

5. It seems recommendable to give up such terms as: „placoderm series", „placoderm facies" (cf. Kowalczewski 1971), „spirifer sandstone", „scolithus sandstone", „joint sandstone" with reference to stratigraphic subdivisions within the Lower Devonian complex of the Holy Cross Mts, and to cease arbitrary interpretations of the terms „Klonów beds", „Barcza beds" and „Barcza series" introduced by Czarnocki (1936a, 1950).

PALEONTOLOGICAL PART

Introduction

The fauna encountered in the Lower Devonian deposits of the Holy Cross Mts has since long been collected by numerous investigators, but so far, it has never been paleontologically worked out. Very few of the previously identified forms have been described or figured; moreover, all the fossil remains housed by the Geological Survey of Poland in Warsaw were burnt in the course of the Second World War.

The relatively small collection of fossil remains, put together by the present writer between 1959 and 1962 from the Upper Emsian profiles at Barcza E. and Bukowa Mt., consists chiefly of brachiopods, and lamellibranchs, also a few gastropods, ostracods, cephalopods, tentaculites, trilobites, nodals and internodals of crinoids, fishes, and Phoronoidea.

The above fossil remains are preserved mainly as moulds, only exceptionally as the external casts of the surface of shells. The state of preservation is, on the whole, satisfactory (Pl. 11, 12) but no micro-ornamentation has been observed on any of the available brachiopods. This is probably due to the coarse granulation of the material of the moulds and casts (Pl. 25, Fig. 6) as well as to the diagenetic processes.

From his collection the writer has identified 42 brachiopod species representing 11 families and 14 genera, also 25 lamellibranch species belonging to 11 families and 16 genera. The forms described in the literature have only been figured here. Descriptions are given of only 16 brachiopod species belonging to 3 families and 4 genera, also of one lamellibranch specimen and the Phoronoidea group.

In the writer's opinion the majority of the forms here described represent new endemic species and subspecies. In view, however, of the small number of specimens available and their none too good state of preservation (absence of micro-ornamentation) no new taxons have been created but merely consecutive numbers given to specimens within the same genus.

In paleontological descriptions of Lower Devonian brachiopods from the magnafacies of the Rhine province micro-ornamentation is one of the dominant systematic features. In its absence from the material under investigation, the descriptions of the morphology of the valves have — for the sake of comparison — been supplemented biometrically on the basis of diagrams used by Solle (1953) and Simon (1954a, b). These measurements allowed a comparison of the numerical indices of the Lower Devonian species from Germany with those from Poland. Owing to the lack in the investigated material of complete brachiopod shells, descriptions have only been given of the moulds of pedicle valves. In the biometric measurements the following symbols have been used with reference to the particular elements of the pedicle valve:

W — width of mould,
We — width of mould the cardinal extremities excluded,
WC_2 — width of mould at a point between the second costa on one side of the median sulcus and the corresponding costa on the opposite side of the median sulcus,
WD — width of diductors,

WL — width of median sulcus at base of the linguiform extension,
WA — width of cardinal area,
L — length of mould,
LD — length of diductors,
LDa — length of the portion of diductors above the hinge line,
LDb — length of the portion of diductors below the hinge line,
LDp — length of dental plates,
T — thickness of mould,
HA — height of cardinal area,
TD — thickness of diductors,
SA — angle of median sulcus,
RN — number of costae on one half of mould.

Representatives of other fossil groups figured in the text have been identified by: Dr. A. Stasińska — corals, Dr. F. Adamczak — ostracods, Dr. J. Kulczycki — fishes.

The faunal collection is housed in the Geological Museum of the Holy Cross Branch of the Geological Institute at Kielce, Zgoda street 21.

Ecological remarks

The fauna observed in the profiles of Barcza E. and Bukowa Mt. occurs almost exclusively in great concentrations on the surface of sandstone units (Pl. 11; Pl. 12, Figs 1, 2) or in mass occurrence of moulds. The presence of representatives of diverse animal groups is here the characteristic feature. The nature of the faunal concentrations in the profiles of Barcza E. and Bukowa Mt. reasonably suggest that they represent a typical allochthonous fossil tanatocoenosis (*sensu* Müller, 1951). This is indicated by a number of observations, *i.a.*:

1. No complete brachiopod or lamellibranch shells have been found, but only single valves.

2. The fossil remains are sometimes crushed or broken (Pl. 12, Fig. 2).

3. The brachiopod remains are associated with single specimens of *Tetracoralla* (Pl. 11; Pl. 13, Fig. 3) and *Pleurodictyum* (Pl. 13, Fig. 1—2) which, before death had probably occupied other ecological zones of life than some of the brachiopod genera.

Since no observations could be made of the necrocoenosis here considered of its life position in the Upper Emsian profiles of the Klonów Belt it is hardly possible to restore such environmental conditions as the character of the bottom, the depth of the basin, action of water masses, or the probable original composition of the coenosis.

Only some brachiopod genera have been taken into account in speculations as to the depth of the Upper Emsian basin. The observations of Ivanova (1962) and Ivanova & al. (1964) on the abundant Devonian material were accepted in the present paper.

Only the predominant genera of *Schellwienella, Euryspirifer* and *Alatiformia* were taken into consideration from the profile of Barcza E., also those of *Spinocyrtia* and *Chonetes* from the profile of Bukowa Mt.

When comparing these with forms that are analogous, the genus *Alatiformia* excepted, it may be reasonably supposed that the Upper Emsian basin in the western part of the Klonów Belt was shallow, in places even very shallow, from a few to some dozen metres in depth, and with a very much uneven coastline. This morphological factor favoured the ecological isolation of the two zones of life, represented, on the one hand, by Barcza W. and Barcza E., on the other hand by Bukowa Mt.

No ecological data concerning the genus *Alatiformia* are available in the literature. Observations in the Barcza E. and Bukowa Mt. profiles reasonably suggest that the above genus does not like the vicinity of „crowded" individuals of the genus *Spinocyrtia*. Similarly as in the case of the genus *Euryspirifer* more room is required by individuals from the genus *Alatiformia* because of the length of its cardinal extremities. Hence, and, moreover, in view of interspecific competition, brachiopods of the above genus abound in the profile of Barcza E., while in that of Bukowa Mt. they occur in smaller numbers. In this case generic differentiation in what concerns the ecological requirements fits in into the taxonomic one.

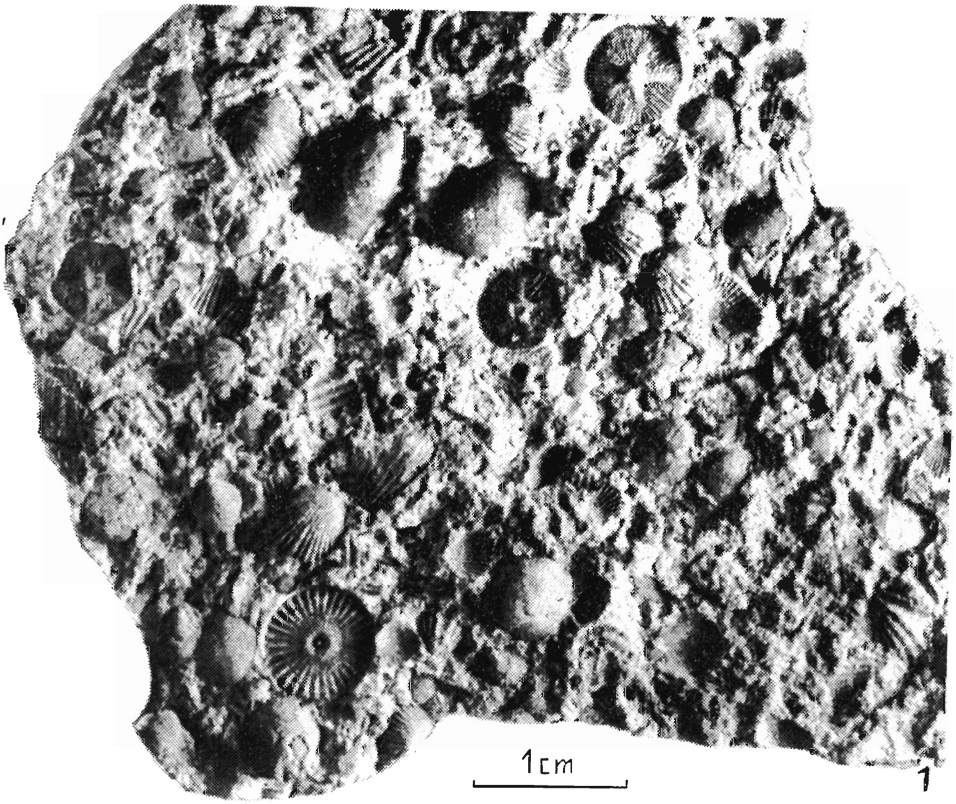
The remaining faunal groups here present: the tetracorals, trilobits and particularly nautiloids, also needed good aeration and rather small depths (Nalivkin 1956, Ager 1963). This also confirms the results obtained by analysis.

As compared with the fauna of the Ardennes and the Rhine Slate Mts, the Upper Emsian fauna of the Klonów Belt is specifically extremely poor.

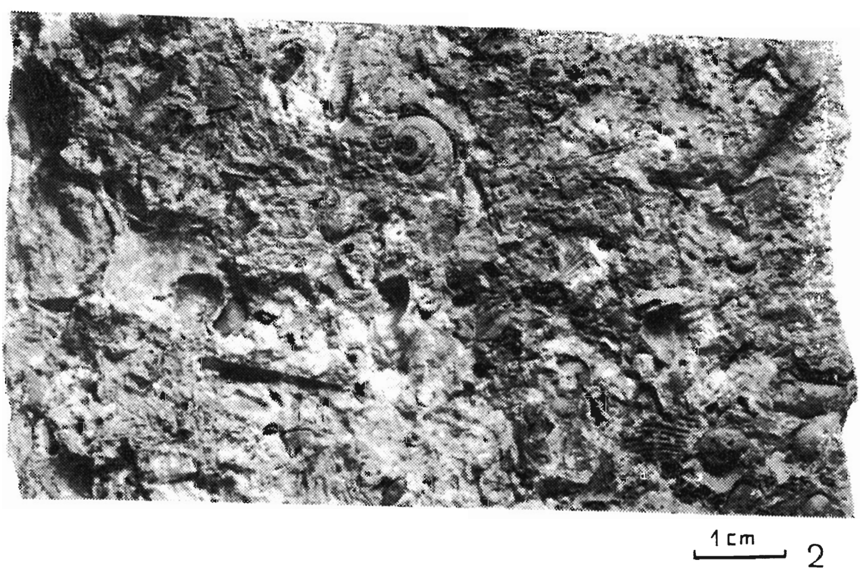
In the Bukowa Mt. gallery profile, fairly numerous species of the various animal groups are encountered only at the bottom. Higher up, in the middle and top parts, the fauna is sparse. The predominant forms are brachiopods from the genus *Chonetes,* also gastropods and lamellibranchs (Czarnocki 1936a, and the writer's own observations). Above the Phoronoidea-bearing unit No. 141, the Spiriferacea are altogether absent both from Bukowa Mt. and Barcza E. profiles (Czarnocki 1936a, and the writer's own observations). Only the brachiopod genus *Chonetes,* the gastropods and lamellibranchs are present.

On the views of Efremov (1950), Nalivkin (1956), Odum (1959), Shapovalova (1961) it may be reasonably supposed that the brachiopods from the family of Chonetidae were the dominant group in the Upper Emsian

Fossil allochthonous tanatocoenosis composed of moulds of various mature forms; Barcza E.



1



2

1 — Fossil allochthonous tanatocoenosis composed of moulds of various young forms; Barcza E.

2 — Fossil allochthonous tanatocoenosis composed of complete or crushed moulds; test pit No. 1 at Bukowa Mt.

coenosis at Bukowa Mt., thus suggesting a slight desalination of the basin in the top part of the profile.

Alongside with the interspecific competition (Odum 1959), the above fact is most likely responsible for the impoverishment of the brachiopod fauna. At the bottom of this profile it is represented mainly by two genera: the *Spinocyrtia* and *Chonetes*, the latter being the only one present at the top.

The gastropods and lamellibranchs associated with the above genus were probably more resistant to changes in the salinity of the basin while other brachiopods, as well as tetracorals and nautiloids failed to adapt themselves to these conditions. The euryhalic Phoronoidea were the only forms to flourish in this environment.

In the faunal assemblage of the Barcza E. profile, the genus *Chonetes* is numerically less predominant than in the Bukowa Mt. profile. Specimens of young individuals (Pl. 12, Fig. 1), belonging to the superfamily Spiriferacea have, however, been encountered as concentrations on the surface of beds, while no such concentrations have been observed in the ceonosis of Bukowa Mt.

The en masse occurrence of minute young forms on the surface of some sandstone units in the Barcza E. profile may partly be explained by Olson's (1957) views. Unfavourable life conditions may have resulted from some slight local changes in the chemical pattern of waters in an environment inhabited by other animal groups. These changes may be referred to a short-lasting decrease in the salinity of sea water resulting from an intermittent supply of fresh river water into the basin.

Systematic descriptions

BRACHIOPODS

Superfamily **Enteletacea** Waagen, 1884

Family **Enteletidae** Waagen, 1884

Subfamily **Schizophorinae** Schuchert & Le Vene, 1929

Genus *SCHIZOPHORIA* King, 1850

Schizophoria aff. *vulvaria* (Schlotheim, 1820)

(Pl. 14, Fig. 2*a*—*b*)

1820. *Hysterolites vulvarius;* Schlotheim, Die Petrefaktenkunde..., p. 247, Pl. 29, Fig. 2.
1941. *Schizophoria vulvaria* (Schlotheim); Maillieux, Brachiopodes..., p. 21.

Material. — One fragmentary pedicle valve.

Dimensions (in mm):

W	L	WD	LD	L:W	WD:W	LD:L	LD:WD
c. 42.0	29.0	13.5	20.5	*c.* 0.69	*c.* 0.32	0.70	1.5

Description. — Pedicle valve flat, anteriorly strongly concave. Hinge line short, rounded. Margin of valve convex, with ringlike thickenings. Median sulcus broad, shallow. Diductor muscles big, ellipsoidal in outline, with length *c.* two-thirds of the total valve length.

Remarks. — The above specimen comes closest to the species *Schizophoria vulvaria* (Schlotheim). As compared with other specimens from the Zagórze substage (Pl. 13, Fig. 6*a*—*b*) the muscle field is broader in relation to the complete width of valve. Also the length/width ratio of the muscle field is here 1.5, while in other specimens of this species from the Klonów Belt this ratio is 2.0. The base of the muscle field has an anterior blunt end while in other specimens it terminates sharply.

Very likely the muscle-field cast of the above specimen is slightly deformed by compaction, owing to which it is more ellipsoidal in shape as compared with the Barcza E. specimens. In the Barcza W. profile the described form has been found in older rocks than the specimens from Barcza E. These characters suggest certain differences as compared with the typical representatives of the species.

Occurrence. — Upper Emsian (Zagórze substage — Barcza W.) of the Klonów Belt.

Superfamily **Spiriferacea** King, 1846
Family **Delthyrididae** Waagen, 1883
Subfamily **Paraspiriferinae** Pitrat, 1965
Genus *EURYSPIRIFER* Wedekind in Salomon 1926
Euryspirifer sp. *1* aff. *E. arduennensis* (Schnur, 1853)
(Pl. 18. Figs 3*a*—5)

1853. *Spirifer Arduennensis;* Schnur, Brachiopoden..., p. 199, Pl. 32, Fig. 3*a*—*e;* non Pl. 32, Fig. 2*a*—*d* (= *paradoxus*).
1953. *Hysterolites (Acrospirifer) arduennensis arduennensis* (Schnur, 1853); Solle, Spiriferen..., p. 30, Pl. 1—2, Figs 1—28.
1963. *Euryspirifer arduennensis* (J. Schnur, 1853); Vandercammen, Spiriferidae..., p. 83, Pl. 8, Figs 10—20.

Material. — Two pedicle valves (one of them fragmentary) and one fragmentary brachial valve.

Dimensions (in mm) specimen on Pl. 18, Fig. 4:

W	L	We	WL	WC_2	LD	LDa	LDb	WD
63.2	21.6	40.9	12.5	19.8	10.5	5.0	5.5	10.8

RN	TD	W:L	We:W	$WL:WC_2$	LD:L	LDb:L	LDb:LD	LD:WD
8	3.8	2.93	0.65	0.62	0.49	0.25	0.52	0.97

Description. — Pedicle valve moderately convex, rhomboidally elongated, with an *S*-shaped hinge line. Cardinal extremities long, regularly narrowing, with pointed end. Median sulcus broad, *U*-shaped, moderately deep, smooth. Linguiform extension short, rounded, delthyrium broad. Top of delthyrium bearing a rhomboidal-like cast of top of deltidium. Hinge teeth and dental plates short.

Adductor and diductor muscles large, oval, transversely striated.

Brachial valve less convex than the pedicle one. Fold high, conical. Costae low and smaller than in the pedicle valve. The latex cast of the mould shows a broad triangular notothyrium. Dental sockets indicated as horizontal elongated apertures; from the interior of the valve they are separated by the socket walls. At base of notothyrium there is a pair of finely striated posterior adductors. A pair of smooth anterior adductors is faintly indicated in the central part of fold.

Remarks. — The morphological characters and biometric measurements of the above form reasonably suggest distinct differences from the type species *Eury-*

spirifer arduennensis (Schnur) (Pl. 18, Fig. 2*a*—*b*), consisting in a shallower and broader median sulcus and in greater size of the muscle scars. This form may represent a new local subspecies.

Occurrence. — Upper Emsian (Zagórze substage — Barcza E.) of the Klonów Belt.

Euryspirifer sp. *2* aff. *E. arduennensis* (Schnur, 1853) (Pl. 18, Figs 6—7)

Material. — 3 fragmentary pedicle valves.

Dimensions (in mm) specimen on Pl. 18, Fig. 7:

W	We	WL	WC_2	LD	LDa	LDb	WD	RN
80.4	54.3	*c.* 13.0	*c.* 21.8	11.9	5.3	6.6	2.8	9

We:W	WL:WC_2	LDb:LD	LD:WD
0.66	*c.* 0.60	0.55	0.93

Description. — Pedicle valve moderately convex, strongly elongated along the hinge line. Cardinal extremities terminating in long narrow pointed ears. Hinge line straight, long. Costae on valve and diductors provided with sharp ends. Median sulcus broad, deep, *U*-shaped, smooth. Linguiform extension not visible. Large adductor and diductor casts.

Remarks. — The morphological characters of the above form distinguishing it from *Euryspirifer* sp. *1* (Pl. 18, Figs 3*a*—5) are as follows: larger dimensions of valve, straight hingeline, cardinal extremities ending in long (11—15 mm) ears, and radial costae on the diductor muscle casts. *Euryspirifer* sp. *2* also occurs higher up in the Upper Emsian profile at Barcza E. than does *Euryspirifer* sp. *1.*

Occurrence. — Upper Emsian (Zagórze substage — Barcza E.) of the Klonów Belt.

Family **Spinocyrtiidae** Ivanova, 1959
Genus *SPINOCYRTIA* Frederiks, 1916
Spinocyrtia sp. *1* ex gr. *S. subcuspidata* (Schnur, 1853) (Pl. 19, Fig. 2*a*—*b*)

1853. *Spirifer subcuspidatus;* Schnur, Brachiopoden..., p. 202, Pl. 34, Fig. 1*e*—*g;* Pl. 33, Fig. 3*a*—*d*?; Pl. 34, Fig. 1*a*—*d*?

1954. *Spirifer (Spinocyrtia) subcuspidata* Schnur; Simon, Spiriferen..., pp. 208, 219; Pl. 6, Fig. 5; Tab. 7, 8.

Material. — One pedicle valve.

Dimensions (in mm):

W	L	T	WA	HA	RN	LDp	WL	SA
32.5	19.5	22.3	28.2	11.9	16	17.4	11.5	23°

L:W	LDp:L	WL:W	WA:HA
0.6	0.38	0.35	1:2.4

Description. — Pedicle valve strongly convex, pyramidally vaulted, rhomboid in shape. Cardinal extremities short, ending in short (1 mm), pointed ears. Hinge line short, anteriorly truncated on both sides. Beak large, curving to the commissure. Cardinal area high, slightly concave, posteriorly inclined, meeting the commissural plane at an obtuse, nearly right, angle. Costae on the valve with rounded umbo. 8—9 costae occur along a distance equal to the width of median sulcus measured at the margin of valve from the median sulcus to one side of the valve. Median sulcus broad, moderately deep, semicircular in section. Linguiform extension of moderate length, rounded. Dental plates short (0.38 of the length of valve), cuneiform, extending anteriorly along the third costa (counting from the median sulcus).

Remarks. — The morphological characters distinguishing our specimen from the species *Spinocyrtia subcuspidata* (Schnur) (Pl. 18, Fig. 8; Pl. 19, Fig. 1*a*—*c*) are as follows: cardinal extremities ending in ears, dental plates of different size and shape, median sulcus broad.

Occurrence. — Upper Emsian (Zagórze substage — Bukowa Mt.) of the Klonów Belt.

Spinocyrtia sp. *2* ex gr. *S. subcuspidata* (Schnur, 1853) (Pl. 19, Fig. 3*a*—*b*)

Material. — One pedicle valve.

Dimensions (in mm):

W	L	WA	RN	LDp	WL	SA	L:W	LDp:L	WL:W
37.0	20.8	29.5	17	10.5	10.0	20°	0.56	0.5	0.27

Description. — Pedicle valve moderately convex, ellipsoidal in shape. Cardinal extremities ending in very distinct blunt ears, 3.5 mm long. Hinge line slightly anteriorly truncated. Cardinal area concave, posteriorly inclined, at an obtuse angle to the commissural plane. 7 costae occur along a distance equal to the width of the median sulcus measured at the margin of valve from the margin of the sulcus to one side of valve. Median sulcus deep, *V*-shaped, with rounded bottom. Linguiform extension semi-circular, moderately long. A latex cast of the interior of mould shows a triangular delthyrium. Hinge teeth delicate. Fine dental plates occurring along the third costa are with length up to half that of the valve. Pedicle callist very big, rhomboidal-like, bisecting the beak part of valve. Median ridge narrow, near the beak transected by pedicle callist. Length of median ridge less than half the length of valve.

Remarks. — The above specimen does not, in any of its characters, resemble any of the species or subspecies from the genus *Spinocyrtia* described in the literature. It is characterized by a great number of costae on one half of the valve, and by long distinct ears.

Occurrence. — Upper Emsian (Zagórze substage — Bukowa Mt.) of the Klonów Belt.

Spinocyrtia sp. *3* ex gr. *S. subcuspidata* (Schnur, 1853) (Pl. 19, Fig. 4*a*—*b*)

Material. — One pedicle valve.

Dimensions (in mm):

W	L	T	RN	LDp	WL	SA	L:W	LDp:L	WL:W
30.0	21.2	19.3	17	12.1	9.0	20°	0.7	0.57	0.3

Description. — Pedicle valve moderately convex, rhomboid in shape. Cardinal extremities short, pointed, without ears. Cardinal angles sub-rectangular. There are 7 costae over a distance equal to the width of the median sulcus measured on the margin of valve from the margin of the median sulcus to one side of the valve. Median sulcus moderately broad, deep, *V*-shaped in section, with a rounded base. Linguiform extension of median sulcus extremely short, semicircular. Hinge teeth fine, delicate. Dental plates along third costa thin, with length slightly more than half the length of valve.

Remarks. — Morphological characters of the above specimen suggest that it cannot be referred to any of the *Spinocyrtia* species known to the writer.

Occurrence. — Upper Emsian (Zagórze substage — Bukowa Mt.) in the Klonów Belt.

Spinocyrtia sp. 4 aff. *S. lateincisa* (Scupin, 1900) (Pl. 20, Fig. 2*a*—*b*)

1900. *Spirifer subcuspidatus* var. *lateincisa;* Scupin, Die Spiriferen..., Scupin, p. 19, Pl. 1, Figs 13, 14*a*—*c*.

1954. *Spirifer (Spinocyrtia) lateincisa Scupin;* Simon, Spiriferen..., p. 196, Pl. 6, Figs 6—9; p. 194, Figs 1—17.

Material. — One pedicle valve.

Dimensions (in mm):

W	L	T	WA	HA	RN	LDp	WL	SA
32.3	17.5	14.0	28.2	9.3	13	8.2	9.8	30°

L:W	LDp:L	WL:W	WA:HA
0.54	0.47	0.30	1:3.0

Description. — Pedicle valve rather small, shaped like an elongated rhomboid. Cardinal extremities ending in short spinose ears. Hinge line long, arched and obliquely anteriorly truncated. Cardinal angles rectangular. Median sulcus deep, *V*-shaped in section. Linguiform extension of median sulcus long, rounded. Dental plates thin, long (one third total length of valve), wedging in anteriorly along *3rd* costa. Median ridge of median sulcus wide, extending from near the beak to mid--valve.

Remarks. — In morphology and biometric measurements the above specimen resembles the species *Spinocyrtia lateincisa* (Scupin), also occurring in the Zagórze substage (Pl. 20, Fig. 1*a*—*e*) at Bukowa Mt. It differs in having a wider (30°) and deeper median sulcus than that in *S. lateincisa,* also a differently shaped hinge line.

Occurrence. — Upper Emsian (Zagórze substage — Bukowa Mt.) in the Klonów Belt.

Spinocyrtia sp. 5 aff. *S. lateincisa* (Scupin, 1900) (Pl. 20, Fig. 3*a*—*c*)

Material. — One pedicle valve.

Dimensions (in mm):

W	L	T	WA	HA	RN	LDp	WL	SA
c. 33.0	17.3	15.6	29.5	9.5	13	7.6	11.5	26°

L:W	LDp:L	WL:W	WA:HA
0.52	0.44	0.35	1:3.1

Description. — Pedicle valve convex, sub-semicircular in shape. Hinge line long, nearly straight and very slightly anteriorly truncated. Cardinal angles rectangular. Median sulcus deep, broad, *V*-shaped in cross section. Linguiform extension rounded. Dental plates short, thick, running anteriorly along *3rd* costa.

Remarks. — The above specimen comes closest to the species *Spinocyrtia lateincisa* (Scupin) (Pl. 20, Fig. 1*a*—*e*) from the Zagórze substage at Bukowa Mt. In some morphological details, however, such as the straight hinge line, short dental plates and a broad median sulcus, it differs from the type species *S. lateincisa.* The two first characters also reasonably suggest that it differs from *Spinocyrtia* sp. *4* (Pl. 20, Fig. 2*a*—*b*).

Occurrence. — Upper Emsian (Zagórze substage — Bukowa Mt.) in the Klonów Belt.

Spinocyrtia sp. 6
(Pl. 22, Fig. 4*a*—*c*; Pl. 23, Fig. 1*a*—*d*)

Material. — Two complete pedicle valves.
Dimensions (*in mm*) specimens on Pl. 22, Fig. 4 and Pl. 23, Fig. 1:

W	L	WA	HA	RN	LDp	WL	SA	L:W
26.2	15.0	24.0	6.0	14	7.8	7.2	24°	0.57
27.3	15.9	25.0	6.2	15	7.8	7.4	24°	0.58

LDp:L	WL:W	WA:HA
0.52	0.27	1:4
0.49	0.27	1:4

Description. — Pedicle valve moderately convex. Cardinal extremities ending in short (1 mm) spine-like ears. Both sides of hinge line arcuately anteriorly curved. Angles of hinge line acute. Beak prominent, strongly bent towards the commissure. Cardinal area low, concave, posteriorly inclined, at an obtuse angle to the commissural plane. Costae on valve oval. Six costae occur along a distance equal to the width of median sulcus measured on margin of valve from margin of median sulcus to one side of valve. Median sulcus fairly deep, *V*-shaped in cross section. Linguiform extension fairly long, rounded. A triangular delthyrium indicated on latex cast of the interior of valve. Conspicuous deltidial grooves in the delthyrial chamber. Dental plates thin, about half the length of the valve, extending anteriorly from the beak, between the scond and third costae.

Remarks. — The morphological characters and biometric measurements prevent the assignment of the above form to any of the *Spinocyrtia* species described in the literature. It rather seems that our specimens may represent a new endémic one.

Occurrence. — Upper Emsian (Zagórze substage — Bukowa Mt.) in the Klonów Belt.

Spinocyrtia sp. 7
(Pl. 23, Figs 2*a*—4*b*)

Material. — Three pedicle valves. One of them with broken off ends of the cardinal extremities.
Dimensions (in mm) specimens on Pl. 23, Figs 3 and 2:

W	L	T	WA	HA	RN	LDp	WL	SA
43.0	21.2	*c.* 20.0	38.0	11.5	19	8.8	10.0	20°
43.4	19.3	19.5	38.2	—	18	9.8	10.0	19°

L:W	LDp:L	WL:W	WA:HA
0.49	0.40	0.23	1:3.3
0.49	0.50	0.23	—

Description. — Pedicle valve moderately convex. Cardinal extremities ending in short (1 mm) spinose ears. Both sides of hinge line anteriorly cuneiformly truncated. Angles of hinge line acute, subrectangular. Cardinal area moderately high, posteriorly inclined, meeting the commissure at an obtuse angle. Costae on valve minute. There are 8 costae along a distance equal to the width of median sulcus measured on anterior margin of valve from margin of median sulcus to one side of valve. Median sulcus shallow, smooth, not very broad. Linguiform extension of the median sulcus moderately long, rounded.

A triangular delthyrium indicated on the latex cast of the interior of valve. Hinge teeth robust. Dental plates thin, moderately long (*c.* 0.4 the length of valve), extending along 3*rd* costa counting from the beak, to anterior part of valve. Pedicle callist rather small, narrow, bisecting the beak region. Median ridge narrow, near the beak cut by the pedicle callist, with length *c.* half that of valve.

Remarks. — Some of the morphological characters of the above form reasonably suggest its relationship to the group (*sensu lato*) of *Spinocyrtia crassifulcita* (Spriesterbach). Four species belonging to this group are known from the Upper Emsian of Sauerland (Spriesterbach 1915, 1925). Two other have also been reported from the Zagórze substage at Bukowa Mt. (Pl. 21, Figs 1*a*—5*d*; Pl. 22, Figs 1*a*—2).

Other morphological characters, however, of the described form *i.e.* number of costae on one half of the valve, their relatively close spacing, subrectangular cardinal angles, short pointed ears at ends of cardinal extremities, also a shallow and narrow median sulcus, all forbid its assignment to one of the four species belonging to the *S. crassifulcita* group. Most likely it is a new, possibly endemic one.

Occurrence. — Upper Emsian (Zagórze substage at Bukowa Mt.) of the Klonów Belt.

Spinocyrtia aff. *bilsteiniensis* (Scupin, 1900) (Pl. 22, Fig. 3*a*—*d*)

1900. ***Spirifer bilsteiniensis;*** Scupin, Die Spiriferen..., p. 16, Pl. 1, Fig. 11.
1954. *Spirifer (Spinocyrtia) bilsteiniensis* Scupin; Simon, Spiriferen..., pp. 206, 217, Tab. 7, Fig. 11; Tab. 8*e*.

Material. — One pedicle valve.
Dimensions (in mm):

W	L	T	WA	HA	RN	LDp	WL	SA
26.2	17.2	20.2	25.0	7.8	13	8.5	11.2	32°

L:W	LDp:L	WL:W	WA:HA
0.66	0.49	0.40	1:3.2

Description. — Pedicle valve strongly convex, with short cardinal extremities. Both sides of hinge line cuneiformly anteriorly truncated. Cardinal angles rectangular. Beak sharp, narrow, strongly bent towards the commissure. Cardinal area high. Costae minute. There are 9—10 costae along a distance equal to width of median sulcus measured at anterior margin of valve from margin of median sulcus to one side of valve. Median sulcus smooth, broad, moderately deep, *V*-shaped. Linguiform extension of median sulcus long, rounded. Hinge teeth delicate. Dental plates extremely thin, placed between 1*st* and 2*nd* costa. Length of dental plates half that of valve.

Remarks. — The morphological characters and the biometric measurements of the above specimen reasonably suggest that it represents the species *Spinocyrtia bilsteiniensis* (Scupin). In shape of delthyrium, beak and cardinal area it resembles the German specimens described by Kayser (1895 — Pl. 4, Fig. 5—5*a*) as *Spirifer micropterus* Goldfuss, and as *Spirifer subcuspidatus* var. *bilsteiniensis* Scupin by Spriesterbach & Fuchs (1909 — Pl. 9, Fig. 14—14*a*). According to Simon (1954a, Tab. 8*e*), in this species the length ratio of the dental plates to that of the valve never exceeds the 0.4 figure, there being no more than 6—7 costae along a distance equal to the width of median sulcus measured at the anterior margin of valve. In our specimen the corresponding figures are 0.49 and 9—10 respectively.

However, since our material consists of but one specimen, it is hardly possible to determine how constant these characters may be, or accurately to determine the systematic position of his form.

Occurrence. — Upper Emsian (Zagórze substage at Barcza E.) of the Klonów Belt.

Alatiformia aff. *dorsocava* (Spriesterbach, 1915)
(Pl. 24, Figs 3—5)

1915. *Spirifer dorsocavus;* Spriesterbach, Lenneschiefer..., pp. 11—12, Pl. 4, Figs 2—6.
1964. ?*Alatiformia dorsocava* (Spriesterbach, 1915); Struve, Alatiformia-Arten..., pp. 337—338, Figs 8—12 (ex Spriesterbach, 1915).

Material. — Several pedicle valves.
Dimensions (in mm) specimens on Pl. 24, Figs 3 and 5:

W	L	WA	HA	RN	LDp	WL	SA	L:W
c. 64.0	21.6	—	—	19	—	12.0	26°	0.34
56.4	*c.* 16.7	46.0	8.0	19	6.5	7.2	26°	0.29

LDp:L	WL:W	WA:HA
—	0.19	—
0.39	0.13	1:5.7

Description. — Pedicle valve rhomboid in shape. Cardinal extremities long, regularly narrowing and ending in long, spade-like blunt ears. Hinge line on either side of beak cuneiformly truncated and slightly arched to the anterior of valve. Cardinal angles acute. Beak pointed, curving towards the commissure. Cardinal area low, concave, meeting the commissural plane at a nearly right angle. Costae rounded. 18—20 costae occur on one half of valve. There are 8—9 of them over a distance equal to the width of the median sulcus measured on the anterior margin of valve from the margin of median sulcus to one side of valve. Median sulcus moderately broad, deep, *V*-shaped in cross section. Linguiform extension moderately long, rounded. Delthyrium an equilateral triangle in outline. Dental plates thin; extending along the *3rd* costa, in length *c.* one third that of the total length of valve.

Remarks. — Most of the morphological characters in the above form are identical with those in the species *Alatiformia dorsocava* (Spriesterbach) (Pl. 23, Fig. 5*a*—*e*; Pl. 24, Figs 1—2). Our form has, however, a deep, *V*-shaped median sulcus while the sulcus in *A. dorsocava* is rather shallow and *U*-shaped. Two of the described specimens are also with spade-like blunt (Pl. 24, Fig. 4) ends of the cardinal extremities while this character has not been observed in *A. dorsocava.* Quite probably, however, the above character may not be constant, since in another of our specimens no such end of the cardinal extremities has been observed. The form here described may be a new subspecies, but the unsatisfactory preservation of the specimen hardly justifies its creation.

Occurrence. — Upper Emsian (Zagórze substage at Barcza E.) of the Klonów Belt.

Alatiformia sp. 1
(Pl. 24, Figs 6*a*—9)

Material. — Several pedicle valves.
Dimensions (in mm) specimens on Pl. 24, Figs 6 and 7:

W	L	T	WA	HA	RN	LDp	WL	SA
35.4	14.0	12.3	30.8	4.3	18	6.4	6.3	21°
39.7	16.6	—	—	—	19	8.0	7.2	18°

L:W	LDp:L	WL:W	WA:HA
0.40	0.46	0.18	1:7.2
0.42	0.48	0.18	—

Description. — Pedicle valve strongly convex, distinctly rhomboidally elongated in shape. Cardinal extremities long, narrow, ending in short ears. Hinge line cuneiformly truncated and anteriorly arched on either side of beak. Cardinal angles acute. Beak pointed, strongly curved towards the commissure. Cardinal area low, strongly concave, slightly posteriorly inclined, meeting the commissural plane at an obtuse angle. Number of costae on one half of valve ranges from 18 to 22. There are 5—6 costae along a distance equal to the width of median sulcus measured at the anterior margin of valve from the margin of median sulcus to one side of valve. Umbo of costae rounded. Median sulcus narrow, deep, *V*-shaped in the beak part, anteriorly *U*-shaped. Linguiform extension moderately long, rounded. Delthyrium an equilateral triangle in outline. Hinge teeth delicate. Dental plates thin, extending along the interspace between 1*st* and 2*nd* costa about one third the length of total length of valve.

Remarks. — In the shape of valve the above form resembles the species *Alatiformia dorsocava* (Spriesterbach) but differs in the following characters:

1. Both sides of margin anteriorly arched.

2. Up to 22 costae on one half of valve while in *A. dorsocava* their number never exceeds twenty.

3. Median sulcus narrow and deep while in *A. dorsocava* it is rather broad.

Occurrence. — Upper Emsian (Zagórze substage at Barcza E.) of the Klonów Belt.

?*Alatiformia* sp. 2
(Pl. 25, Fig. 1)

Material. — One pedicle valve.

Dimensions (in mm):

W	L	RN	LDp	WL	SA	L:W	LDp:L	WL:W
54.4	20.0	18	7.4	9.7	27°	0.37	0.37	0.18

Description. — Pedicle valve moderately convex. Cardinal extremities ending in elongated ears (7.8 mm long). Hinge line slightly truncated, anteriorly arched on either side of beak. Beak pointed, slightly inclined to the commissure. There are 8 costae along a distance equal to width of median sulcus measured on the anterior margin of valve from the margin of median sulcus to one side of valve. Costae pointed. Median sulcus broad, *V*-shaped. Linguiform extension extremely short, rounded. Dental plates thin, extending along interspaces between 1*st* and 2*nd* costa, in length c. one third that of valve.

Remarks. — Exceptionally long ears, not typical of the genus *Alatiformia,* are a characteristic feature of the above specimen. Its other features, however, reasonably suggest that it may be a representative of that genus.

Occurrence. — Upper Emsian (Zagórze substage at Barcza E.) of the Klonów Belt.

?*Alatiformia* sp. 3
(Pl. 25, Fig. 2)

Material. — One pedicle valve with the anterior part broken off.

Dimensions (in mm):

W	WA	HA	LDp	RN	WA:HA
50.0	38.0	7.0	7.6	17	1:5.4

Description. — Pedicle valve moderately convex. Cardinal extremities long, regularly narrowing, ending in elongated (7 mm long) narrow, spine-like ears. Hinge line cuneiformly truncated, arched anteriorly on either side of beak. Beak pointed, slightly curved to the commissure. Cardinal area low, concave, meeting the commissural plane at an obtuse angle. Costae minute with rounded umbo. Median sulcus posteriorly moderately broad, *V*-shaped. Latex cast of the interior of valve showing a rather small delthyrium shaped like an equilateral triangle. Delthyrial chamber shallow, with deltidial grooves on side walls. Hinge teeth robust, long. Dental plates long, robust, extending anteriorly along the first interspace.

Remarks. — The morphology of the valve seems to justify the tentative identification of the above specimen as a representative of the genus *Alatiformia.*

Occurrence. — Upper Emsian (Zagórze substage at Bukowa Mt.) of the Klonów Belt.

?*Alatiformia* sp. 4
(Pl. 25, Fig. 3)

Material. — One pedicle valve.

Dimensions (in mm):

W	L	T	RN	LDp	WL	SA	L:W	LDp:L	WL:W
41.4	16.0	*c.* 11.5	14	7.4	8.0	24°	0.39	0.46	0.19

Description. — Pedicle valve of average size, moderately convex. Cardinal extremities ending in narrow (4.3 mm long) spine-like ears. Hinge line slightly cuneiformly truncated anteriorly and arched on either side of beak. Beak pointed, hooked towards the commissure. Costae minute, pointed. There are 6 costae along a distance equal to width of median sulcus measured anteriorly from the margin of median sulcus to one side of valve. Median sulcus moderately broad, deep, *V*-shaped. Linguiform extension short, rounded. Hinge teeth robust. Dental plates robust, long, extending along the *3rd* costa.

Remarks. — In morphology of valve the above specimen resembles ?*Alatiformia* sp. 3 (Pl. 25, Fig. 2) from which it differs in the hooked beak, slightly different shape of cardinal extremities and fewer costae present on one half of valve.

Occurrence. — Upper Emsian (Zagórze substage at Bukowa Mt.) of the Klonów Belt.

BIVALVIA

Superfamily **Nuculanacea** H. Adams & A. Adams, 1858

Family **Malletiidae** H. Adams & A. Adams, 1858

Genus *NUCULITES* Conrad, 1841

Nuculites aff. *triqueter* Conrad, 1841
(Pl. 25, Fig. 6)

1841. *Nuculites triqueter;* Conrad, Fifth annual report..., p. 50.
1895. *Cucullella* cf. *triquetra* Conrad; Beushausen, Lamellibranchiata..., p. 102, Pl. 5, Figs 2—3.
1963. *Nuculites* cf. *triqueter Conrad;* Krasilova, Pelecypody..., p. 115, Pl. 1, Figs 16—17; Fig. 12.

Material. — One left valve.

Dimensions (in mm):

Height	Length
5.3	8.2

Description. — Valve small, triangularly oval in shape, strongly convex. Greatest convexity at mid-height of valve. Hinge line long, gently arcuate in outline. Dentition not preserved. Umbo wide and high, curving to the symmetry plane of valve, also shifted and anteriorly inclined. Anterior margin short, uniformly rounded, smoothly passing into the long, gently curving lower margin. Posterior margin short, straight, meeting the hinge line and the lower margin at obtuse angles. Keel concpicuous, with rounded margin extending from umbo to the lower posterior angle of valve. A groove perpendicular to the lower margin occurs between the umbo and anterior margin. In the plasteline cast of the interior of valve the above groove is indicated as a short, thick septum.

Remarks. — The above specimen comes closest to the species *Nuculites triqueter* Conrad, by Beushausen (1895) described from the Lower Devonian of Germany. Our form differs from the German one only in a shorter internal septum and less prominent keel. The specimens described by Krasilova (1963) from the Siegenian in the vicinity of lake Balkhash are also provided with a longer internal septum and a more conspicuous umbo than those in our specimen.

Occurrence. — Upper Emsian (Zagórze substage at Bukowa Mt.) of the Klonów Belt.

PHORONIDA
Class Phoronoidea
(Pl. 30, Fig. 1; Pl. 31, Figs 1—2; Pl. 32, Fig. 1)

Material. — Some tens of outer casts preserved as tubes, either straight or with upper parts widening out, perpendicular or oblique to the upper side of the rock unit, and mostly filled with clay.

Diagnosis. — Tubes straight, circular or ellipsoidal in cross section. Average length of tube *c.* 10 cm, the diameter 1—9 mm, depending on place of measurement.

Description. — Our material consists of external casts varying in shape. Some tubes, *c.* 100 mm long, are 3 mm in diameter at the upper end and 1 mm at the lower end. In shape they resemble a long tube slightly narrowing towards the base (Pl. 30, Fig. 1). Other tubes, relatively narrow at the upper end (5 mm in diameter), gradually widen out to the lower end over a distance of 20 mm to attain a diameter of 8 mm, and then grow narrower again and funnel-like, so that at the lower end their diameter is reduced to 1 mm (Pl. 30, Fig. 1). Still another type of tubes is characterized all along their length (up to 100 mm) by a 6 mm diameter and a blunt end. Frequently, at mid-length of the tube, the diameter is reduced to 3 mm. The tubes described above occur in unit 141 in the profile of the gallery at Bukowa Mt. (Fig. 4; Pl. 30, Fig. 1). The upper side of the unit 141 is flat but somewhat rough. The particular tubes on the surface of the unit are spaced from 6 to 20 mm (Pl. 31, Fig. 1). In the specimen from Miejska Mt. near Bodzentyn (eastern part of the Klonów Belt (Fig. 1), the tubes differ somewhat in shape. Namely, near to the upper side of the unit they widen out in a calyx-like fashion. The calyx is 17 mm in length, 12 mm in diameter at the upper margin. Faint impressions of the lophophore tentacles are preserved at the margin of the calyx (Pl. 31, Fig. 2 — *A*). Base of calyx 5 mm in diameter. A straight, funnel-like, narrowing tube extends from the base to the under side of layer. It is 80 mm long, at the lower end 2 mm in diameter. On a very rough surface of the unit (Pl. 32, Fig. 1), calyces have been observed with a diameter of 23 mm at the upper margin and a height of 22 millimetres. Others extend obliquely across the rock to the upper end of the unit.

Remarks. — The systematic position of the Phoronoidea has been discussed by numerous investigators (James 1892; Cori 1933, 1939; Becker 1937; Dawydoff &

Grasse 1959; Hecker 1960, and others), but no conclusive interpretations have, so far, been reached.

An analysis of the material from the Upper Emsian of the Klonów Belt shows that the diagnostic characters fit in into those from the literature. This applies particularly to the specimen figured in Pl. 31, Fig. 2 showing impressions of lophophore tentacles and its shape. On this evidence they have been assigned to the Phoronoidea. Czarnocki (1936a) referred them undoubtedly to traces of worms (Scolithus).

An analysis of the material bearing fossil remains of the Phoronoidea will reasonably suggest a tentative description of the life conditions of these animal forms from the Upper Emsian sea then occupying the present Klonów Belt. No impressions of the lophophore calyces have been found in the near-to-the-top part of the unit (Pl. 31, Fig. 1). We may suppose that the sea floor was then relatively flat and hard. The lophophore calyces of the particular individuals protruded above the sea floor, as is shown by Dawydoff & Grasse (1959 — Pl. V) and in Abb. 1 of Voigt's paper (1970).

The under-side of the unit with Phoronoidea from Miejska Mt. near Bodzentyn (Pl. 32, Fig. 4) must have been uneven and variable. This may have been connected with the continuous displacement of sandy material on the sea floor by traction currents. The organisms living there were probably being repeatedly buried, so that the lophophores had sunk deep into the sea floor, and their impressions have thus persisted.

On Czarnocki's (1936a) and the present writer's observations from the Klonów Belt on the Phoronoidea-bearing deposits, it may be reasonably supposed that the presence of this animal group in the higher part of the Upper Emsian was associated with the extinction of the brachiopod superfamily Spiriferacea which did not reappear in this profile until the Lower Eifelian (Czarnocki 1936a).

This may be referred to interspecific competition and probably also to the ecological changes within the basin.

The restoration of the physico-chemical conditions in the basin, based on recent ecological data concerning that animal-group (Dawydoff & Grassé 1959) and on their rather limited ecofacial variability during their life history (Fenton & Fenton 1934, Shrock & Twenhofel 1953) suggests that the sea floor was sandy, in some parts flat and hard, in others uneven and variable, while the basin itself was extremely shallow (Fig. 4).

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H. ŁOBANOWSKI

DEWON DOLNY W ZACHODNIEJ CZĘŚCI PASMA KLONOWSKIEGO (GÓRY ŚWIĘTOKRZYSKIE) CZĘŚĆ I — EMS GÓRNY

(Streszczenie)

W rozprawie przedstawiono charakterystykę utworów górnego emsu w zachodniej części Pasma Klonowskiego (Fig. 1).

Przeprowadzono obserwacje litologiczno-sedymentologiczne skał oparte na analizach: płytek cienkich, krzywych termicznych oraz minerałów ciężkich.

Analiza typów warstwowań i obserwacje ekologiczne pozwoliły ustalić zmiany w głębokości zbiornika zachodzące w czasie sedymentacji osadów (fig. 4). Przekątne warstwowanie oraz pomiary lineacji i imbrykacji ziaren kwarcu w orientowanych płytkach cienkich umożliwiły odtworzenie kierunków transportu materiału do górnoemskiego zbiornika w Paśmie Klonowskim. Stwierdzono, że materiał nanoszony był nie tylko z południa (z obszaru Kielcydów), ale również z północy z wyniesionych masywów kaledońskich, gdzie niszczone były zarówno skały osadowe jak i metamorficzne.

W części dotyczącej stratygrafii przedstawiono biostratygrafię omawianych utworów w oparciu o faunę brachiopodów i małżów, oraz przeprowadzono korelację profilów z Barczy Wschodniej i Bukowej Góry z najbliżej położonym profilem dolnego dewonu w Górnym Harcu (tab. 4). Stwierdzono, że niższa część górnego emsu na badanym obszarze reprezentowana jest, podobnie jak ems dolny i zigen, przez utwory lagunowe bądź limniczne, a jedynie młodszy górny ems wykształcony jest w klasycznej magnafacji reńskiej z fauną morską.

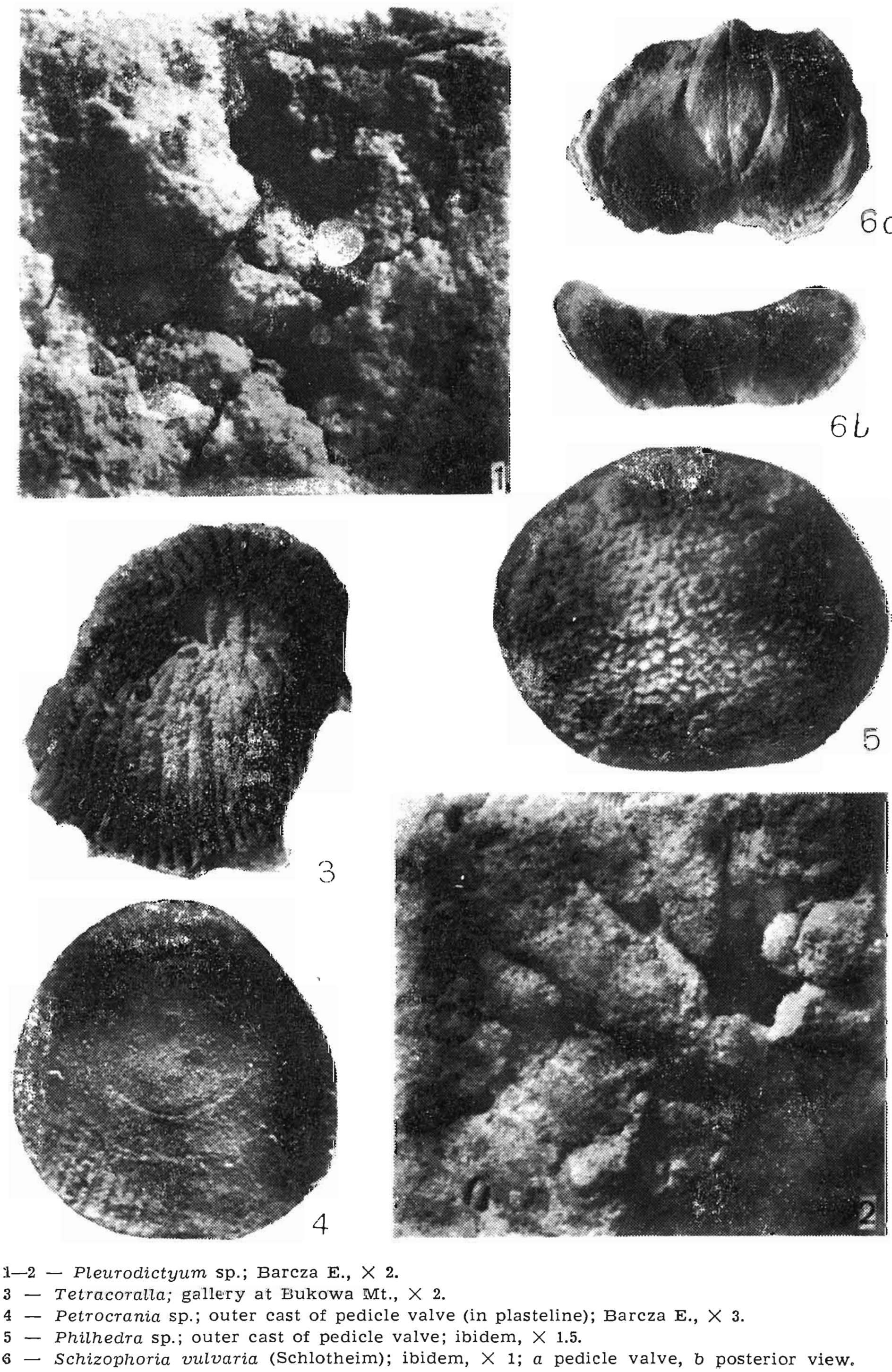
Proponuje się również następujący lokalny podział dla poszczególnych ogniw dewonu dolnego w zachodniej części Gór Świętokrzyskich (tab. 4):

Żedyn — *dolne(?) podpiętro klonowskie*
Zigen — *górne(?) podpiętro klonowskie*
Ems dolny — *podpiętro barczańskie*
Ems górny — *podpiętro zagórzańskie*

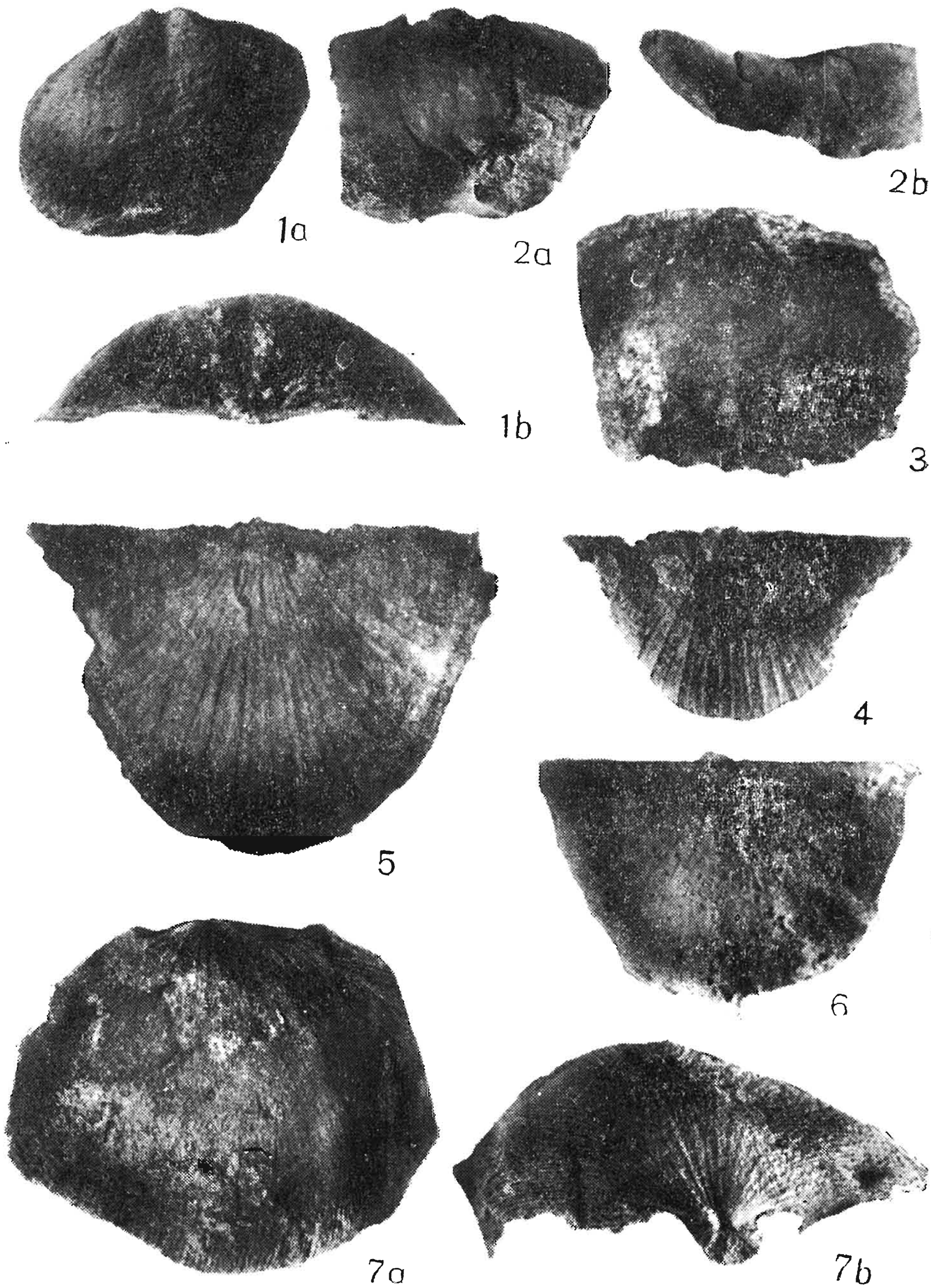
W części paleontologicznej opisano 16 gatunków brachiopodów i jednego małża, reprezentujących prawdopodobnie nowe endemiczne formy. Skamieniałości wymienione w pracy, a opisane wcześniej, zostały jedynie zilustrowane. Opisano również skamieniałości z nadrodziny Phoronoidea, określane dotychczas przez J. Czarnockiego (1936a) jako „skolitusy".

Praca stanowi część I monografii utworów dolnodewońskich w zachodniej części Pasma Klonowskiego. W części II, znajdującej się w przygotowaniu do druku, omówiona zostanie litostratygrafia utworów zigenu i emsu dolnego, oraz paleogeografia.

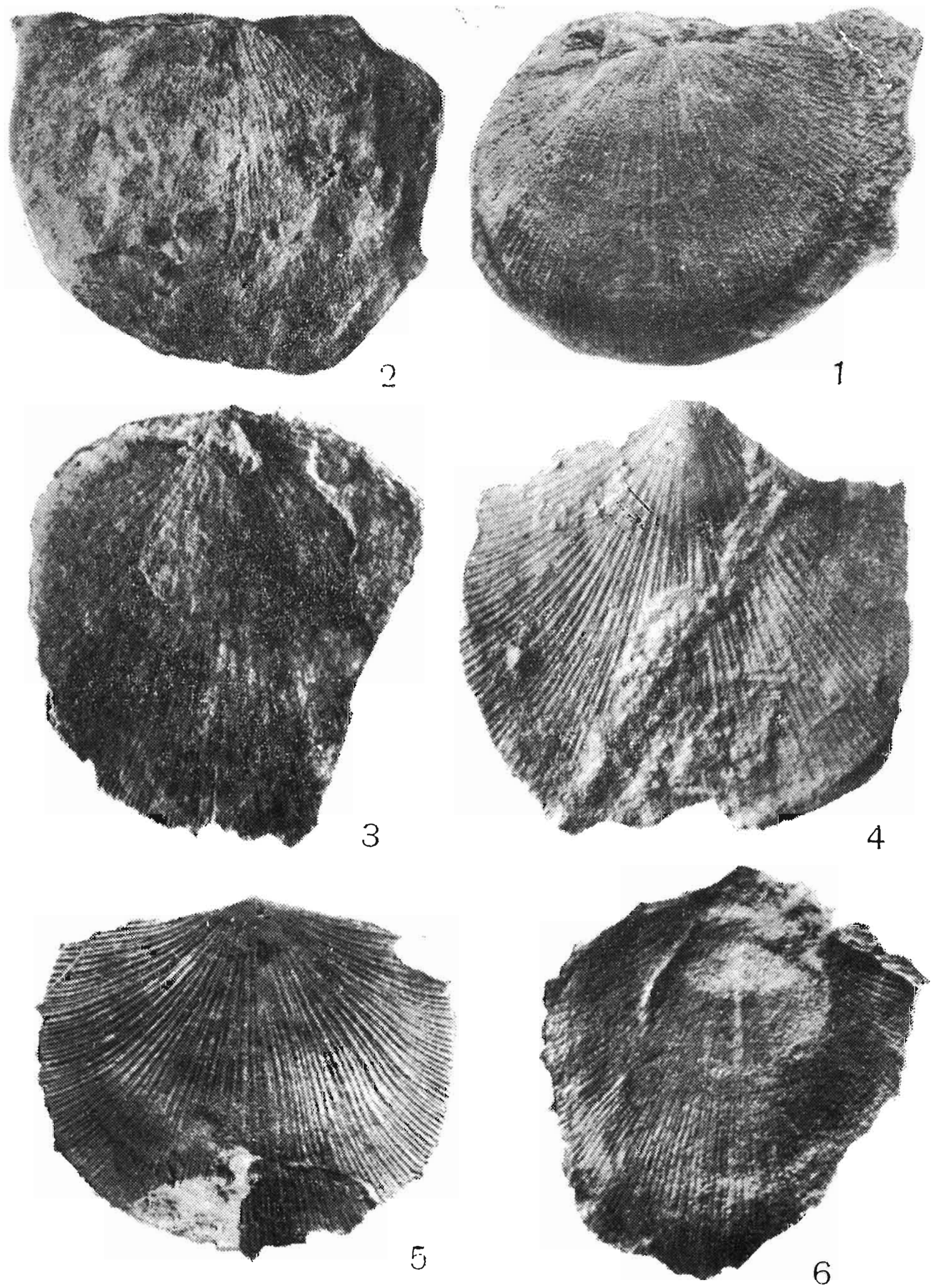
Pracownia Stratygrafii
Zakładu Nauk Geologicznych PAN
Warszawa 22, Al. Żwirki i Wigury 93
Warszawa, w kwietniu 1971 r.



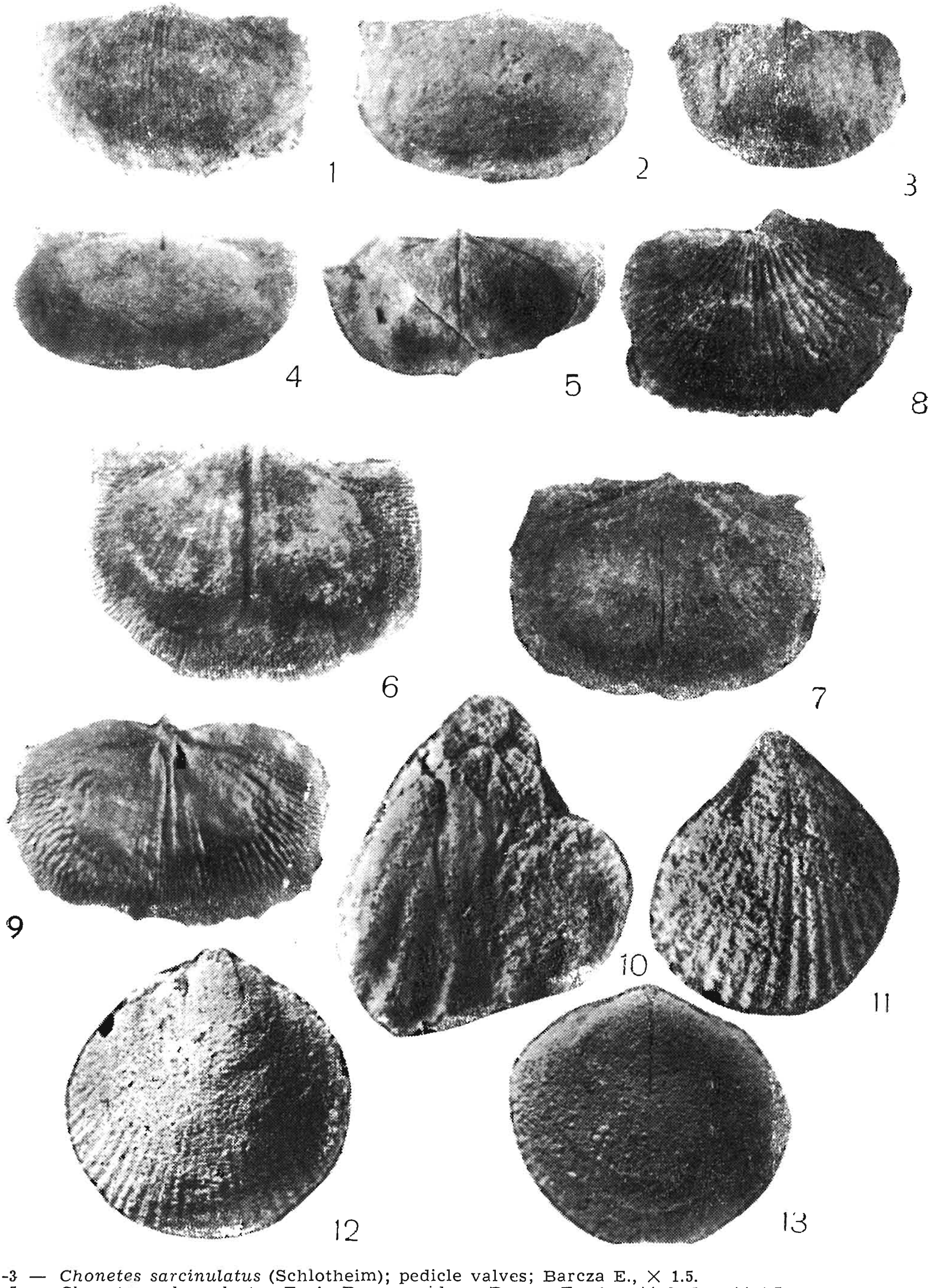
1—2 — *Pleurodictyum* sp.; Barcza E., × 2.
3 — *Tetracoralla;* gallery at Bukowa Mt., × 2.
4 — *Petrocrania* sp.; outer cast of pedicle valve (in plasteline); Barcza E., × 3.
5 — *Philhedra* sp.; outer cast of pedicle valve; ibidem, × 1.5.
6 — *Schizophoria vulvaria* (Schlotheim); ibidem, × 1; *a* pedicle valve, *b* posterior view.



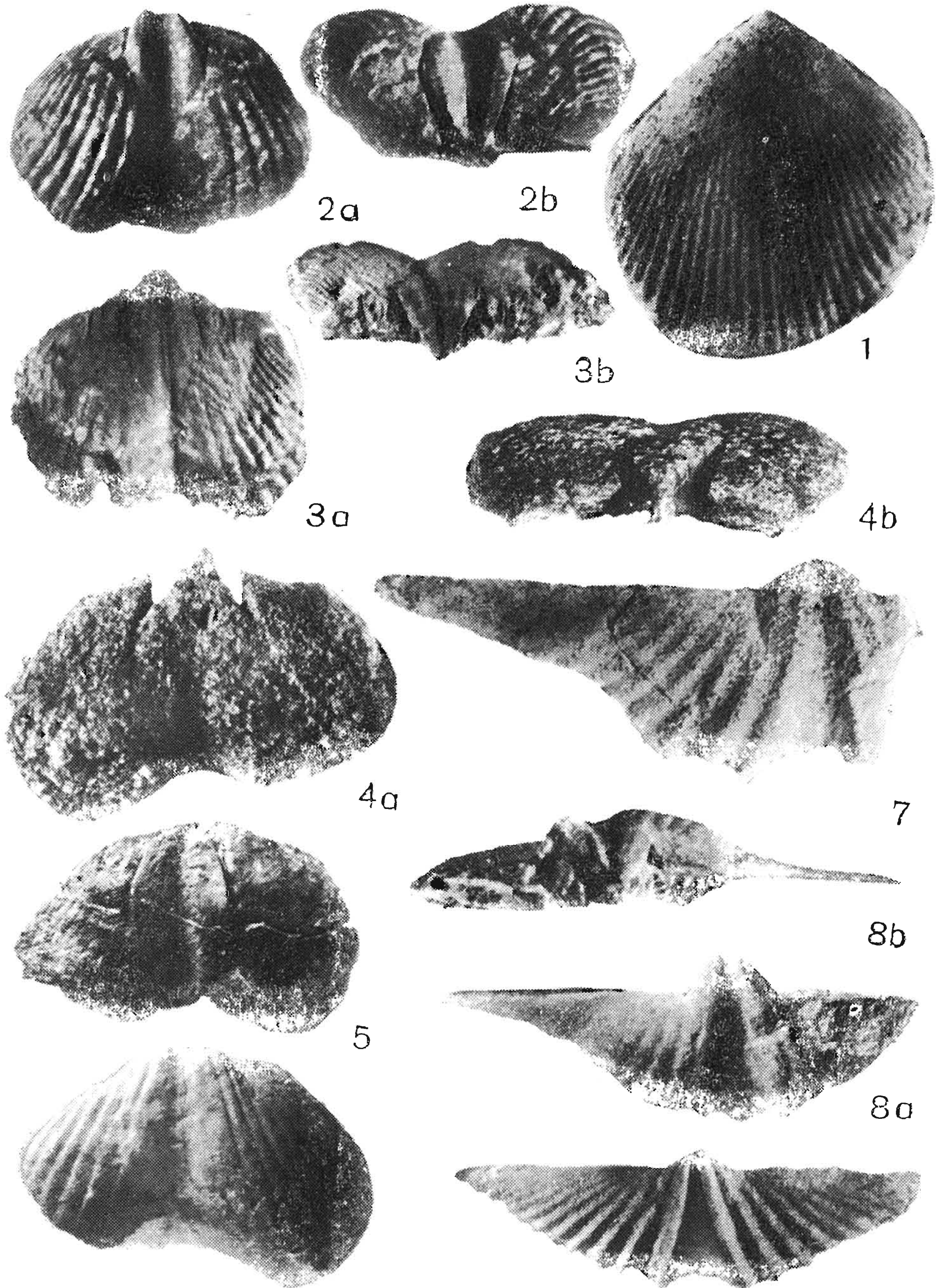
1 — *Schizophoria vulvaria* (Schlotheim); Barcza E., × 1; *a* brachial valve, *b* posterior view.
2 — *Schizophoria* aff. *vulvaria* (Schlotheim); Barcza W., × 1; *a* pedicle valve, *b* posterior view.
3 — *Schizophoria striatula* (Schlotheim); pedicle valve; Barcza E., × 2.
4—6 — *Strophodonta taeniolata* (Sandberger); ibidem; *4* outer cast of pedicle valve (in plasteline), × 3; *5* brachial valve, × 2; *6* idem, × 1.5.
7 — *Strophodonta piligera* (Sandberger); ibidem, × 1.5; *a* pedicle valve, *b* posterior view.



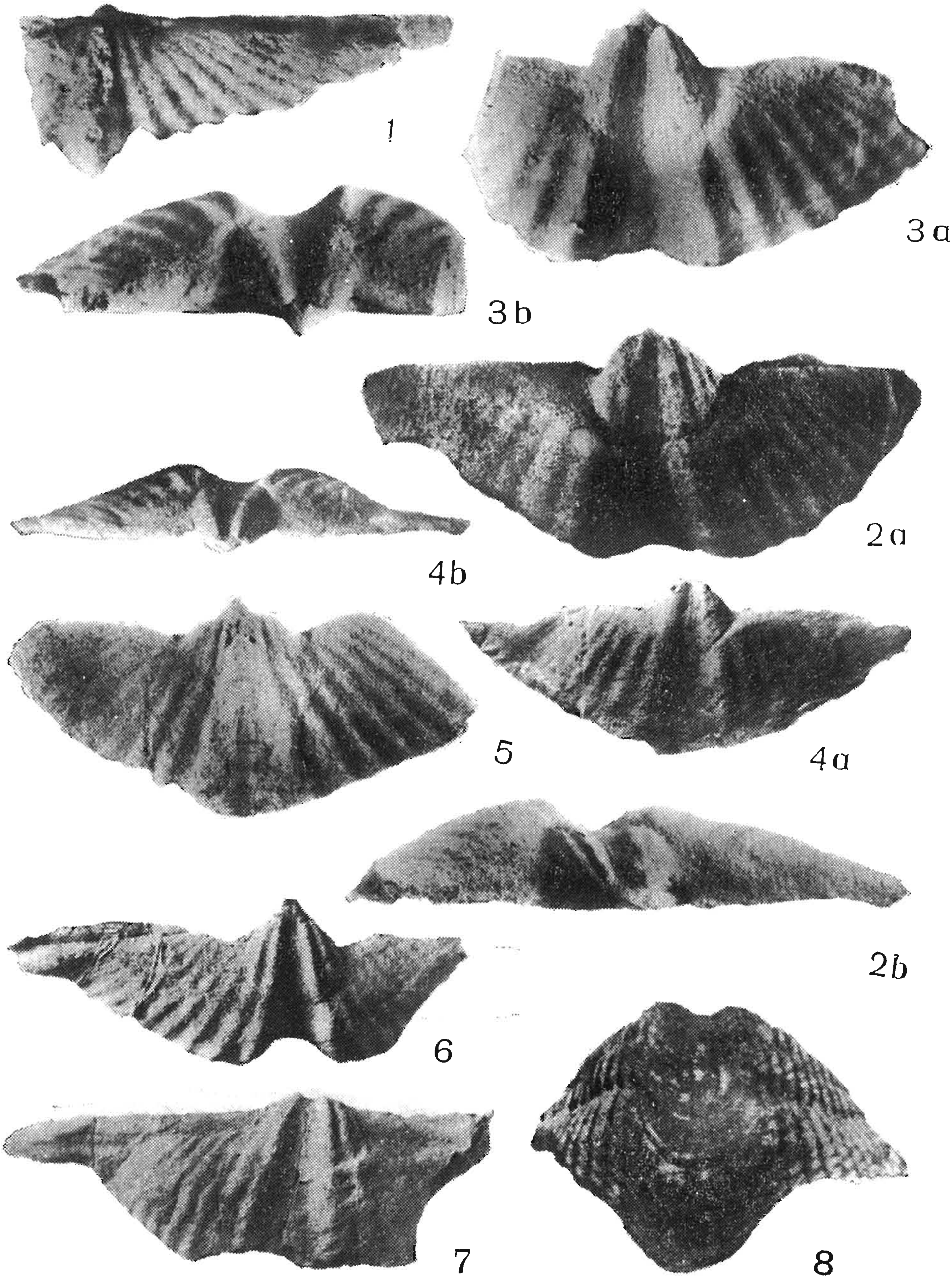
1 — *Strophodonta piligera* (Sandberger); pedicle valve; Barcza E., × 1.5.
2 — *Strophodonta* cf. *piligera* (Sandberger); idem; Barcza E., × 1.5.
3—6 — *Schellwienella maior* (Fuchs); ibidem, × 1.5; *3* pedicle valve, *4—5* outer casts of pedicle valves (in plasteline), *6* cast of the inside of pedicle valve (in plasteline).



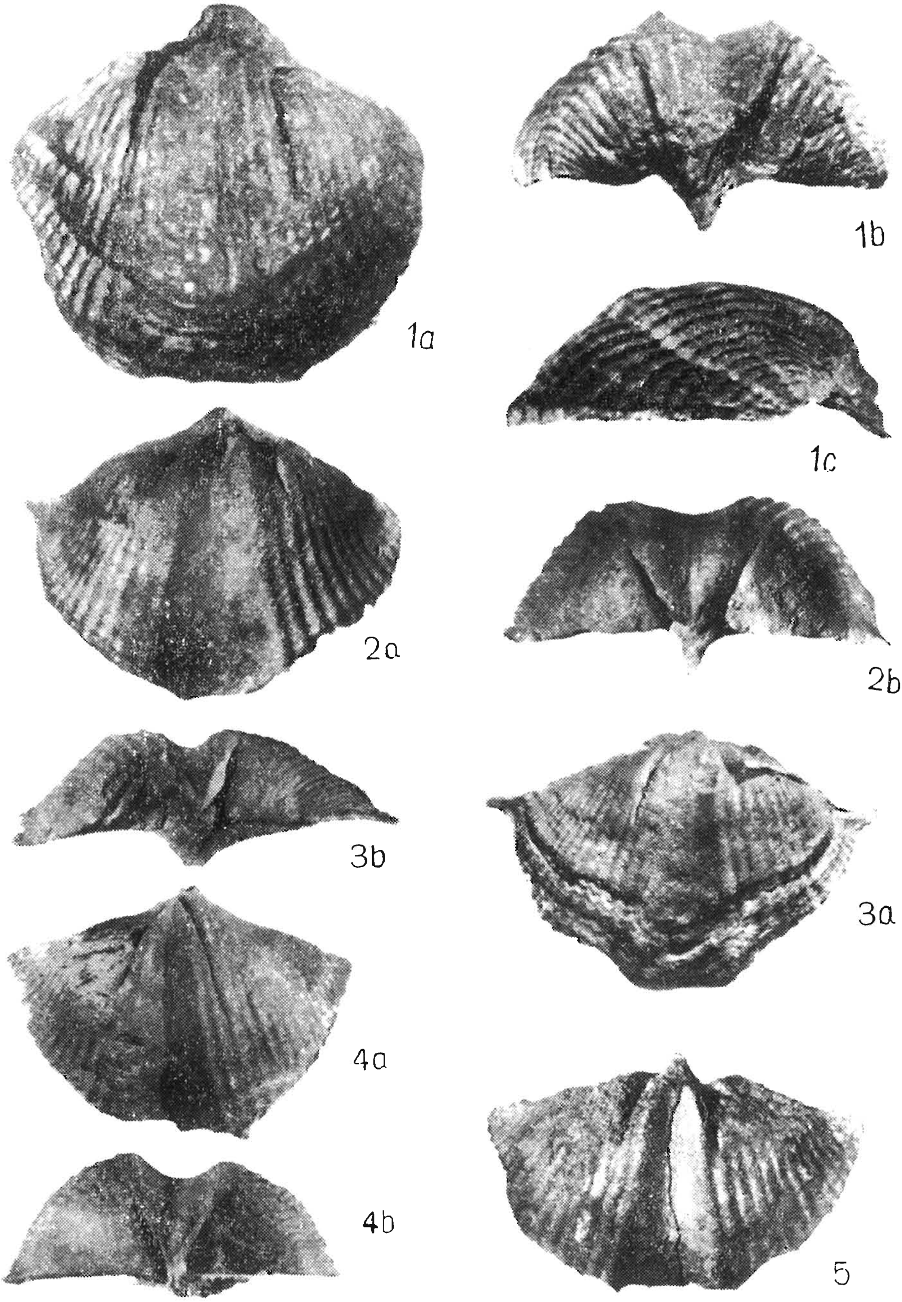
1-3 — *Chonetes sarcinulatus* (Schlotheim); pedicle valves; Barcza E., × 1.5.
4-5 — *Chonetes subquadratus* F. A. Roemer; idem; Barcza E.; *4* — × 2, *5* — × 1.5.
6-9 — *Chonetes plebejus* Schnur; gallery at Bukowa Mt.; *6* pedicle valve, × 2.5; *7* idem, × 2; *8* outer cast of brachial valve, × 2; *9* brachial valve (in plasteline), × 2.
10 — *Camarotoechia* cf. *daleidensis* (C. F. Roemer); pedicle valve; ibidem, × 2.5.
11 — *Retzia robustella* (Fuchs); pedicle valve; Barcza E., × 6.
12-13 — *Retzia confluentina* (Fuchs); Barcza E.; *12* pedicle valve, × 5, *13* brachial valve, × 4.



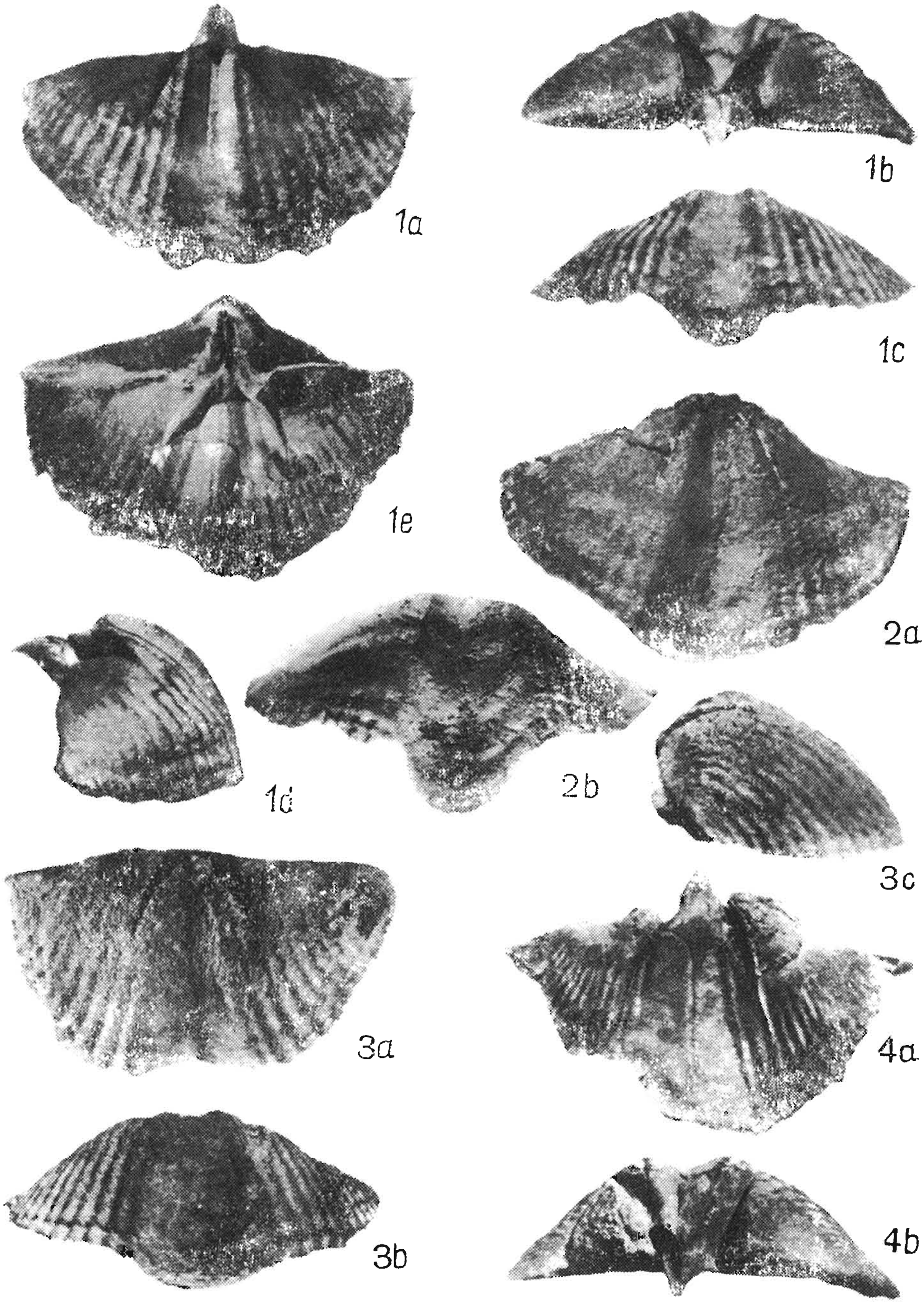
1 — *Retzia confluentina* (Fuchs); pedicle valve; Barcza E., × 3.
2 — *Paraspirifer cultrijugatus* (C. F. Roemer); gallery at Bukowa Mt., × 1; *a* pedicle valve, *b* posterior view.
3—6 — *Paraspirifer cultrijugatus* (C. F. Roemer); Barcza E., × 1, *3* Form II „auriculatiforme" (sensu Vandercammen, 1963), *a* pedicle valve, *b* posterior view; *4a* pedicle valve, *b* posterior view; *5* pedicle valve (senile stage); *6* Form I „cultrijugatiforme" (sensu Vandercammen, 1963), pedicle valve.
7—9 — *Euryspirifer paradoxus* (Schlotheim); ibidem; *8* mature stage, × 1, *a* pedicle valve, *b* posterior view; *9* youthful stage, pedicle valve, × 2.



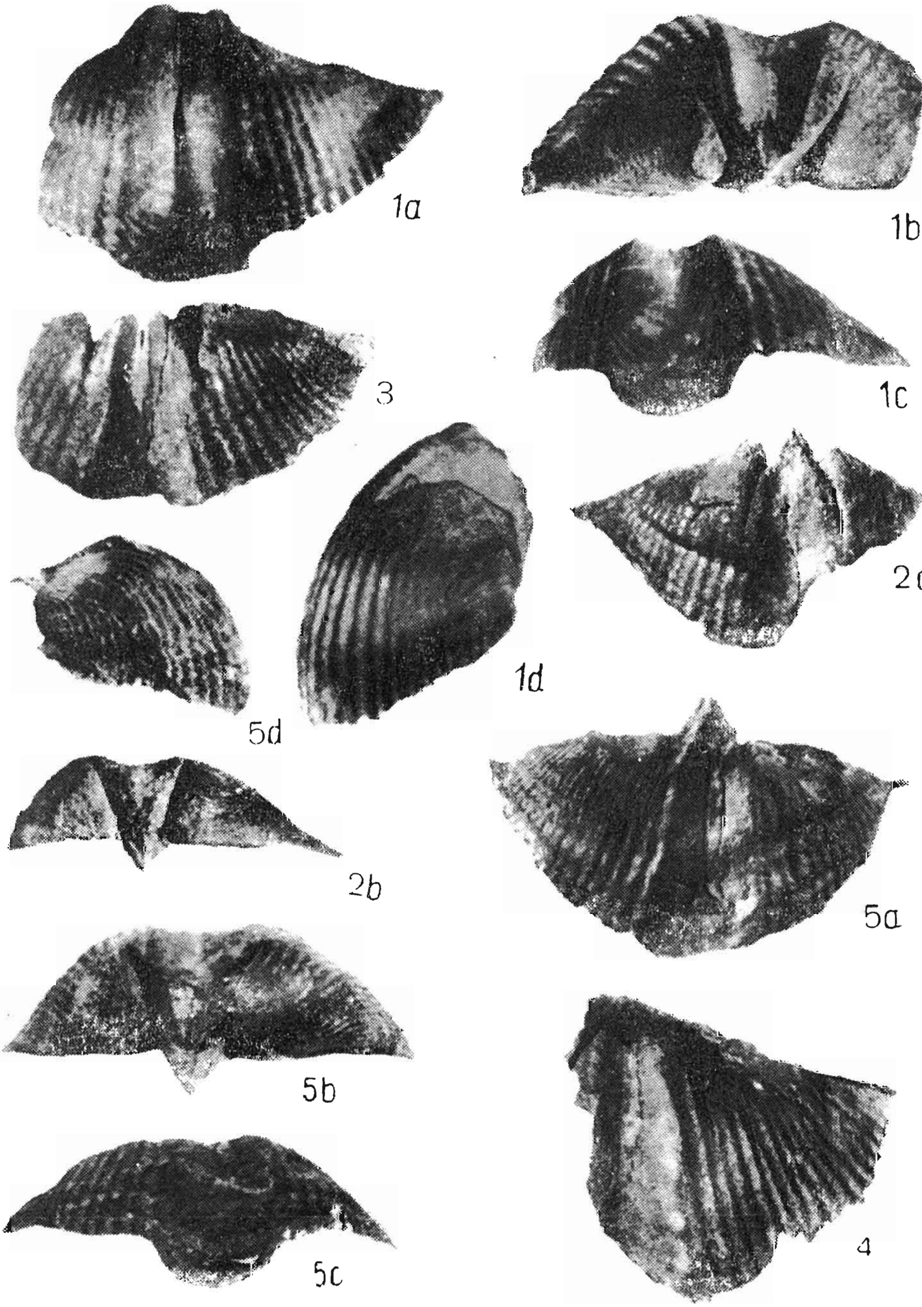
1 — *Euryspirifer paradoxus* (Schlotheim); Barcza E., brachial valve, × 1.5.
2 — *Euryspirifer arduennensis* (Schnur); ibidem, × 1.5; *a* pedicle valve, *b* posterior view.
3—5 — *Euryspirifer* sp. *1* aff. *E. arduennensis* (Schnur); ibidem; *3a* pedicle valve, *b* posterior view, × 1.5; *4a* pedicle valve, *b* posterior view, × 1; *5* brachial valve, × 1.5.
6—7 — *Euryspirifer* sp. *2* aff. *E.arduennensis* (Schnur); ibidem, pedicle valves, × 1.
8 — *Spinocyrtia subcuspidata* (Schnur); pedicle valve; anterior view of specimen shown on Pl. 19, Fig. 1a—c; × 2.



1 — *Spinocyrtia subcuspidata* (Schnur); gallery at Bukowa Mt., × 2; *a* pedicle valve, *b* posterior, *c* side views.
2 — *Spinocyrtia* sp. *1* ex gr. *S. subcuspidata* (Schnur); ibidem, × 1.5; *a* pedicle valve, *b* posterior view.
3 — *Spinocyrtia* sp. *2* ex gr. *S. subcuspidata* (Schnur); ibidem, × 1.5; *a* pedicle valve, *b* posterior view.
4 — *Spinocyrtia* sp. *3* ex gr. *S. subcuspidata* (Schnur); ibidem, × 1.5; *a* pedicle valve, *b* posterior view.
5 — *Spinocyrtia lateincisa* (Scupin); ibidem, pedicle valve, × 1.5.

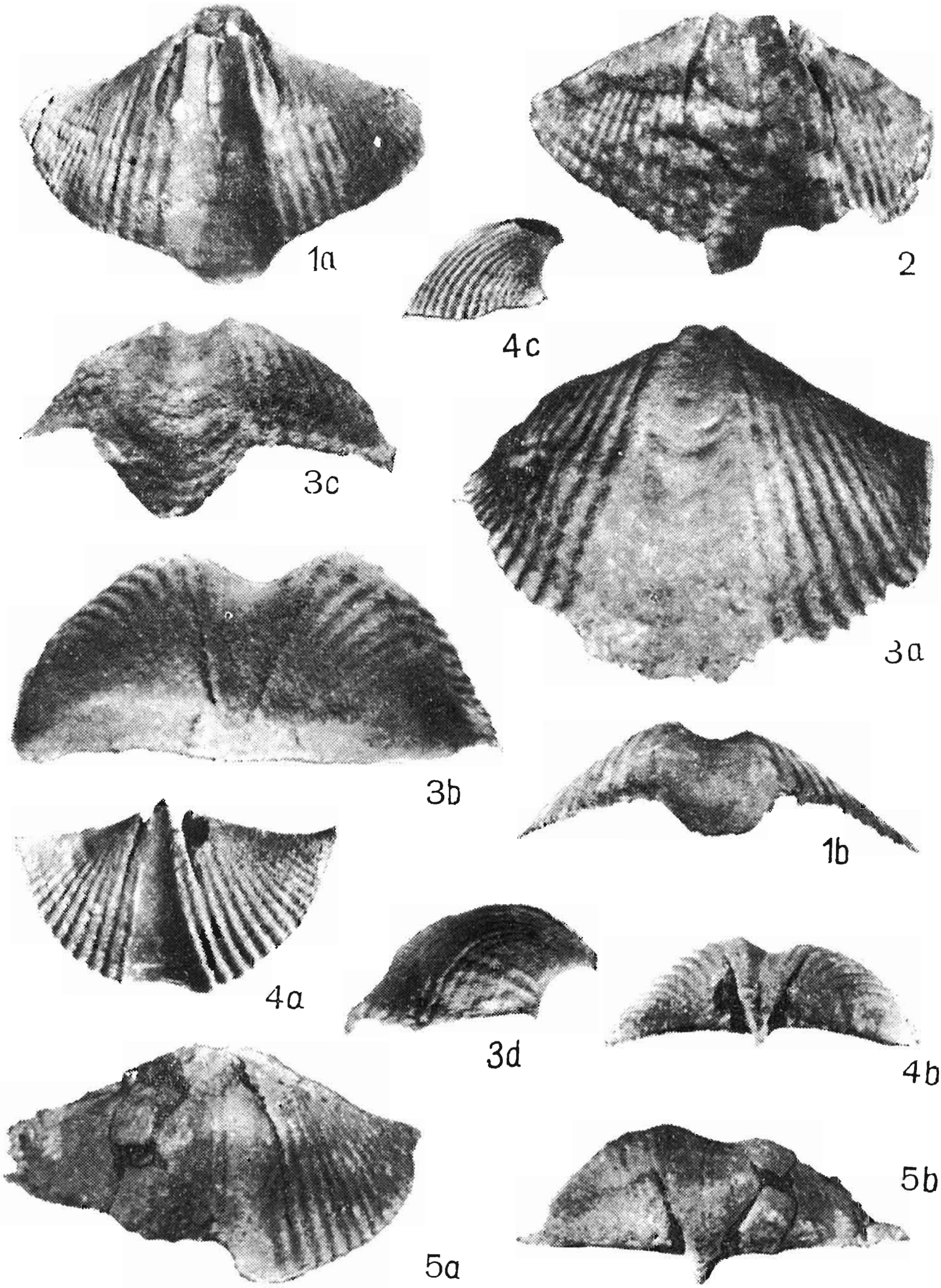


1 — *Spinocyrtia lateincisa* (Scupin); gallery at Bukowa Mt., × 1.5; *a* pedicle valve, *b* posterior, *c* anterior, *d* side views, *e* latex cast of the inside of valve.
2 — *Spinocyrtia* sp.4 aff. *S. lateincisa* (Scupin); ibidem, × 1.5; *a* pedicle valve, *b* anterior view.
3 — *Spinocyrtia* sp. 5 aff. *S. lateincisa* (Scupin); ibidem, × 1.5; *a* pedicle valve, *b* anterior, *c* side views.
4 — *Spinocyrtia longeincisa* (Dahmer); ibidem, × 1.5; *a* pedicle valve, *b* anterior view.

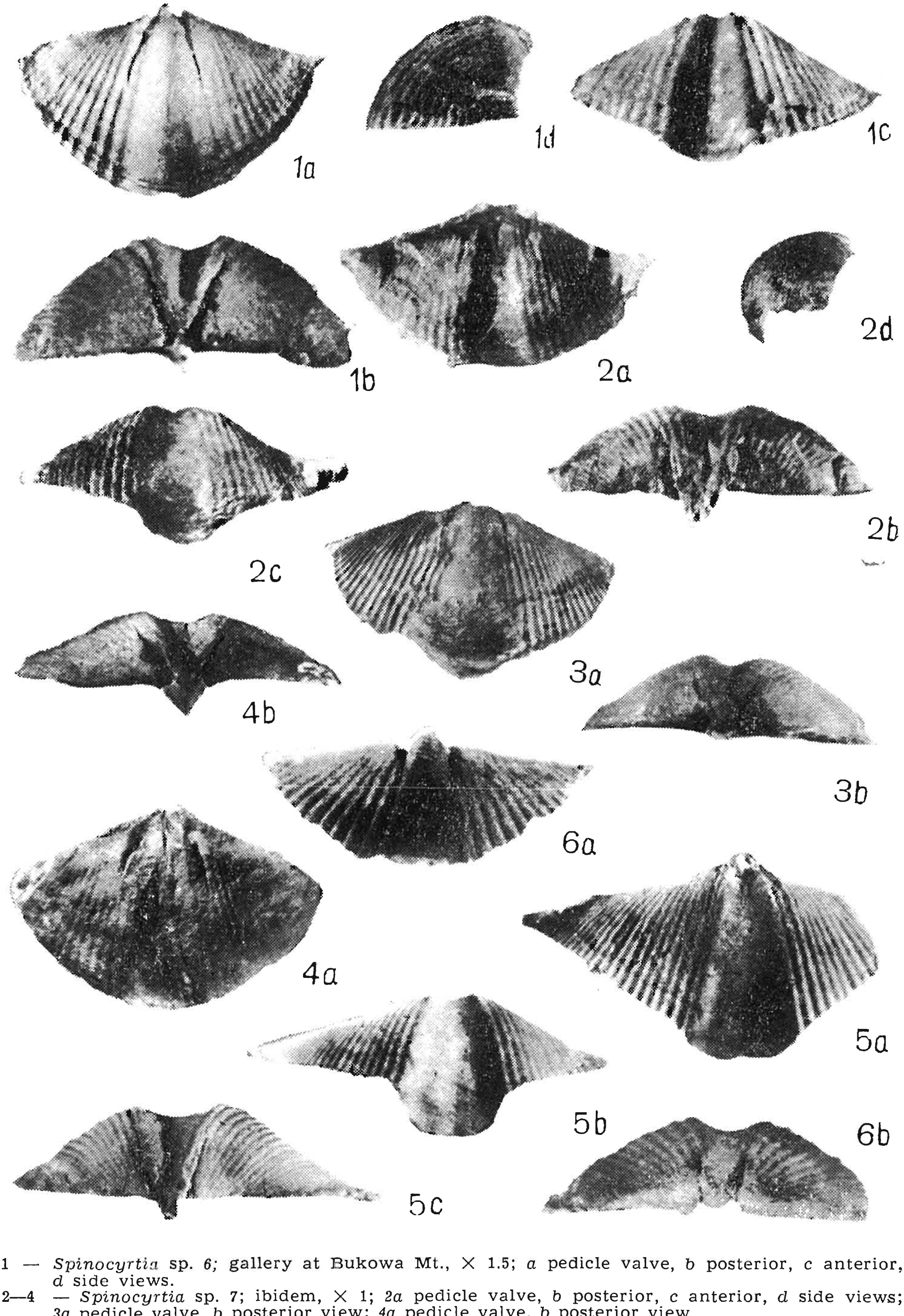


1—4 — *Spinocyrtia* cf. *crassifulcita* (Spriesterbach); gallery at Bukowa Mt., × 1.5; *1a* pedicle valve, *b* posterior, *c* anterior, *d* side views; *2a* pedicle valve, *b* posterior view; *3—4* pedicle valves.

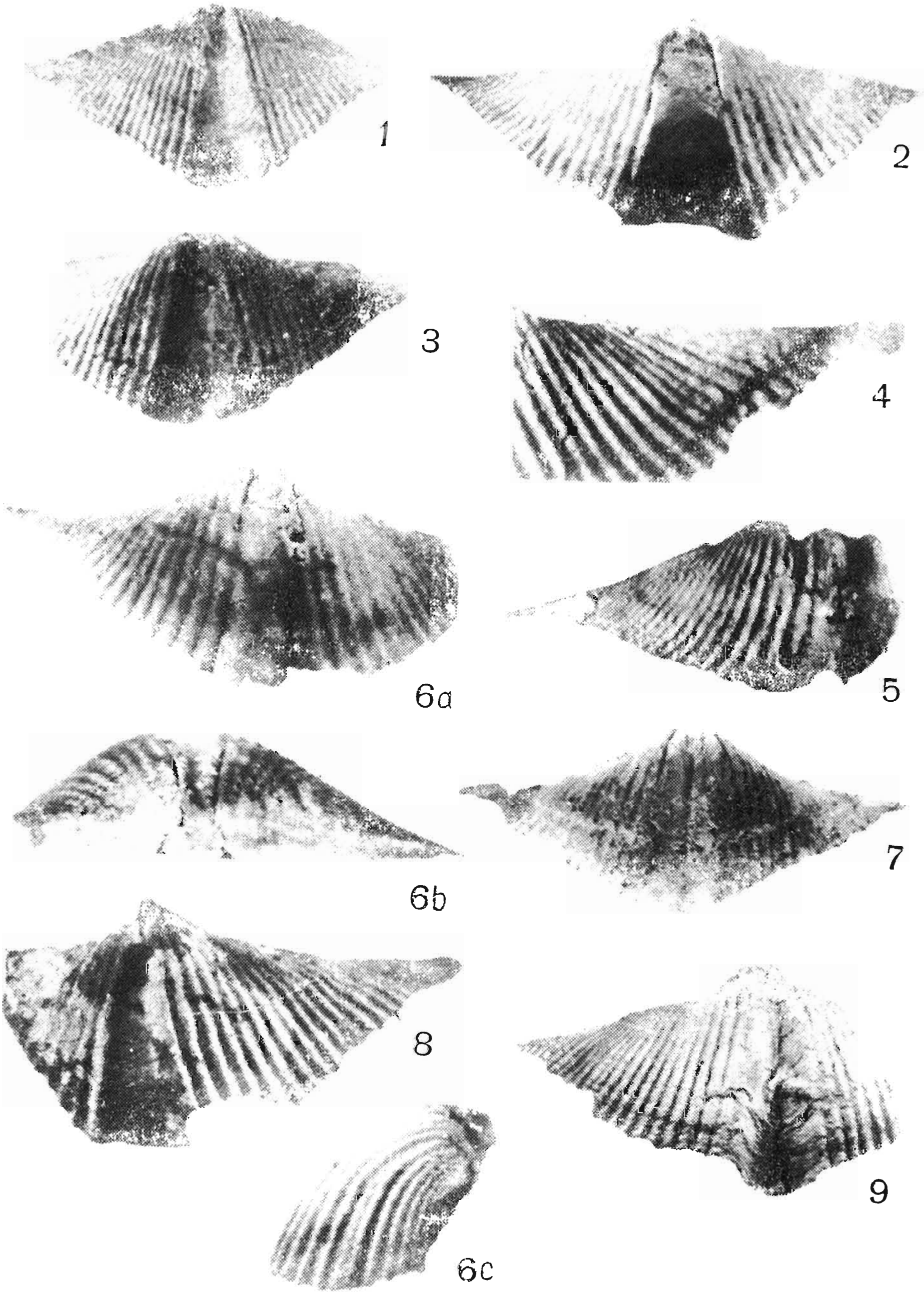
5 — *Spinocyrtia robustifulcita* (Spriesterbach); ibidem, × 1.5; *a* pedicle valve, *b* posterior, *c* anterior, *d* side views.



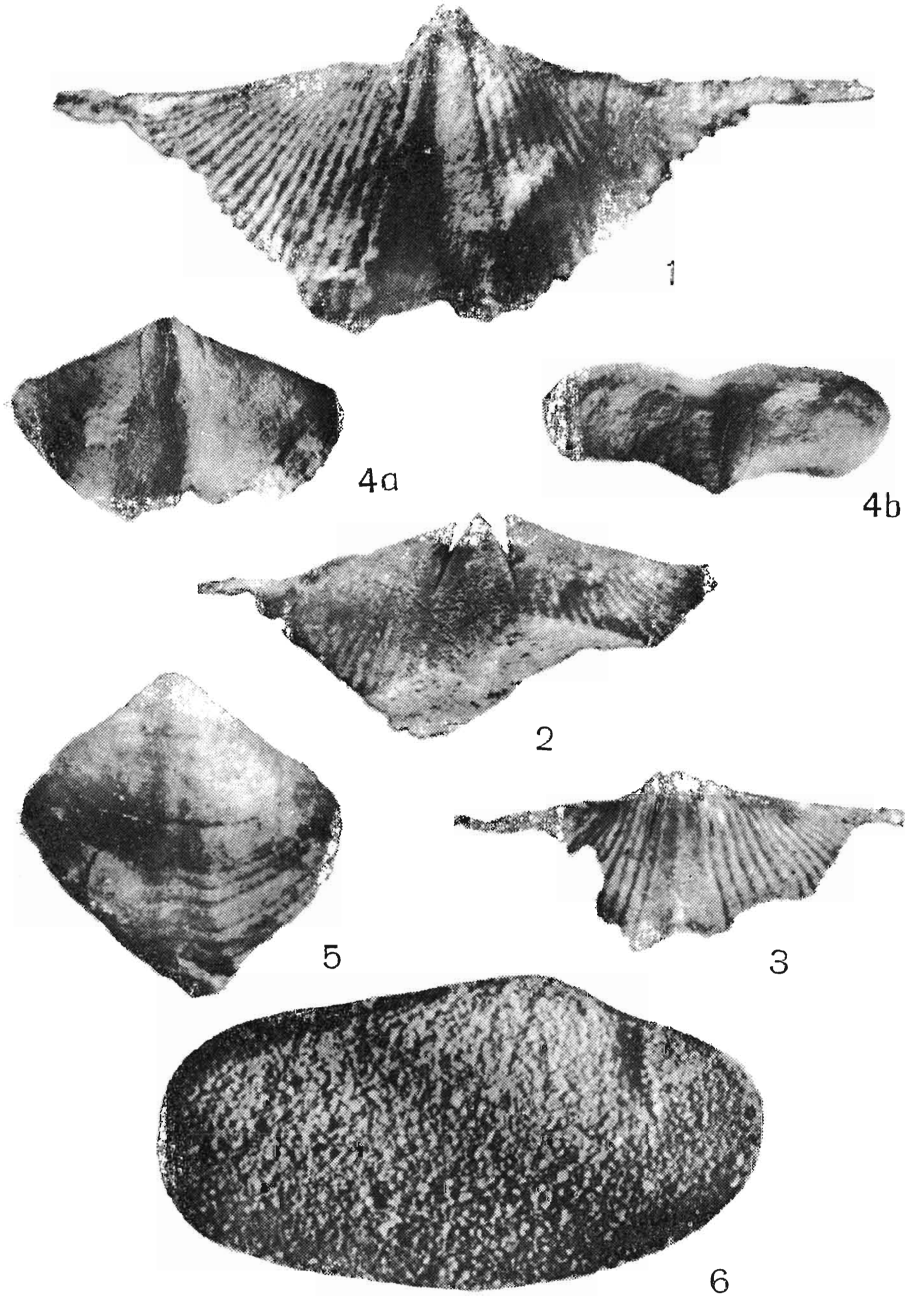
1—2 — *Spinocyrtia robustifulcita* (Spriesterbach); gallery at Bukowa Mt., × 1.5; *1a* pedicle valve, *b* anterior view; *2* pedicle valve.
3 — *Spinocyrtia* aff. *bilsteiniensis* (Scupin); Barcza E., × 2; *a* pedicle valve, *b* posterior, *c* anterior, *d* side views.
4 — *Spinocyrtia* sp. *6*; gallery at Bukowa Mt., × 1.5; *a* pedicle valve, *b* posterior, *c* anterior.
1—2 — *Spinocyrtia robustifulcita* (Spriesterbach); gallery at Bukowa Mt., × 1.5; *1a* pedicle



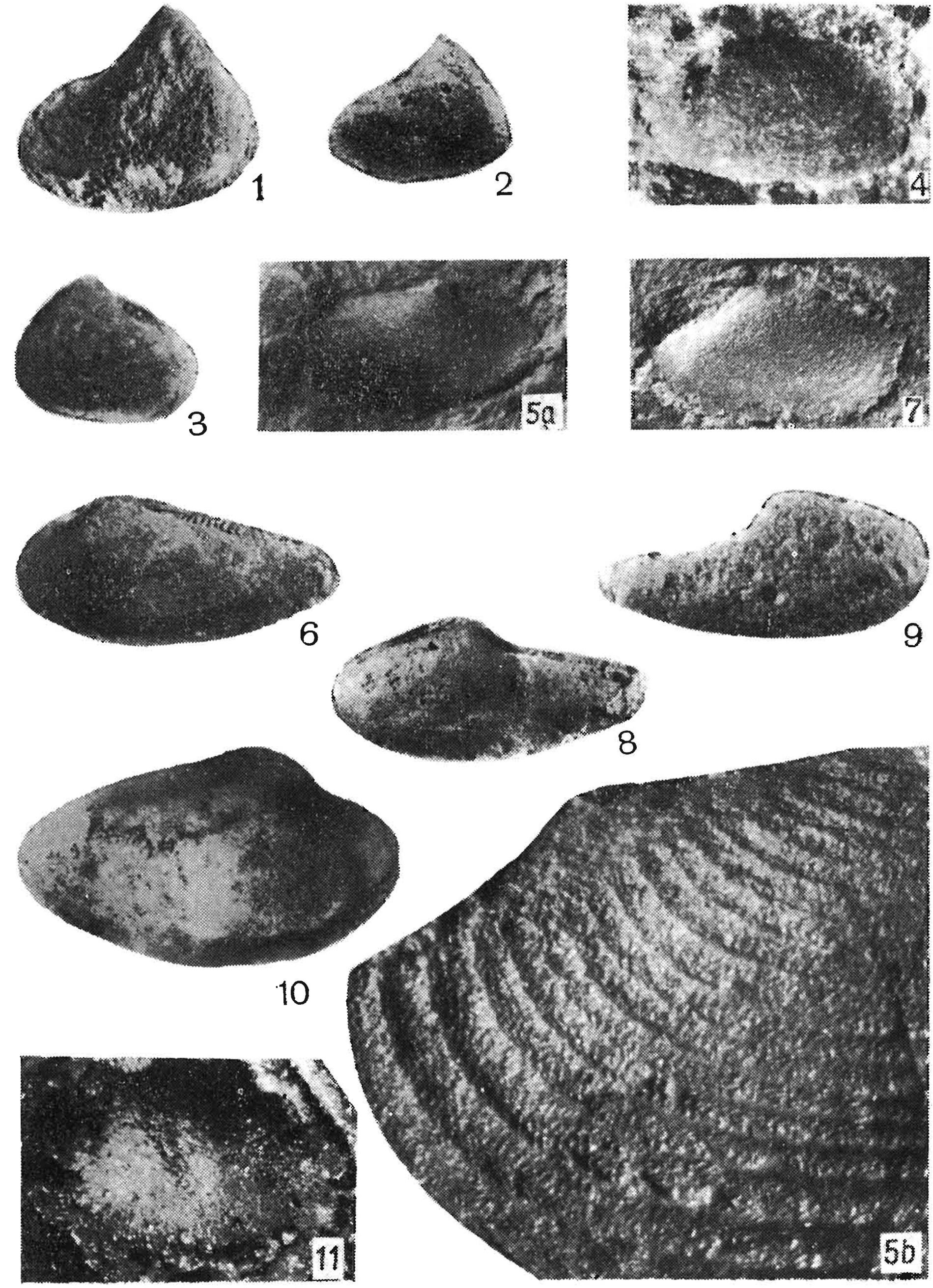
1 — *Spinocyrtia* sp. *6;* gallery at Bukowa Mt., × 1.5; *a* pedicle valve, *b* posterior, *c* anterior, *d* side views.
2—4 — *Spinocyrtia* sp. 7; ibidem, × 1; *2a* pedicle valve, *b* posterior, *c* anterior, *d* side views; *3a* pedicle valve, *b* posterior view; *4a* pedicle valve, *b* posterior view.
5—6 — *Alatiformia dorsocava* (Spriesterbach); Barcza E., × 1; *5a* pedicle valve, *b* anterior, *c* posterior views; *6* youthful stage, × 2; *a* pedicle valve, *b* posterior view.



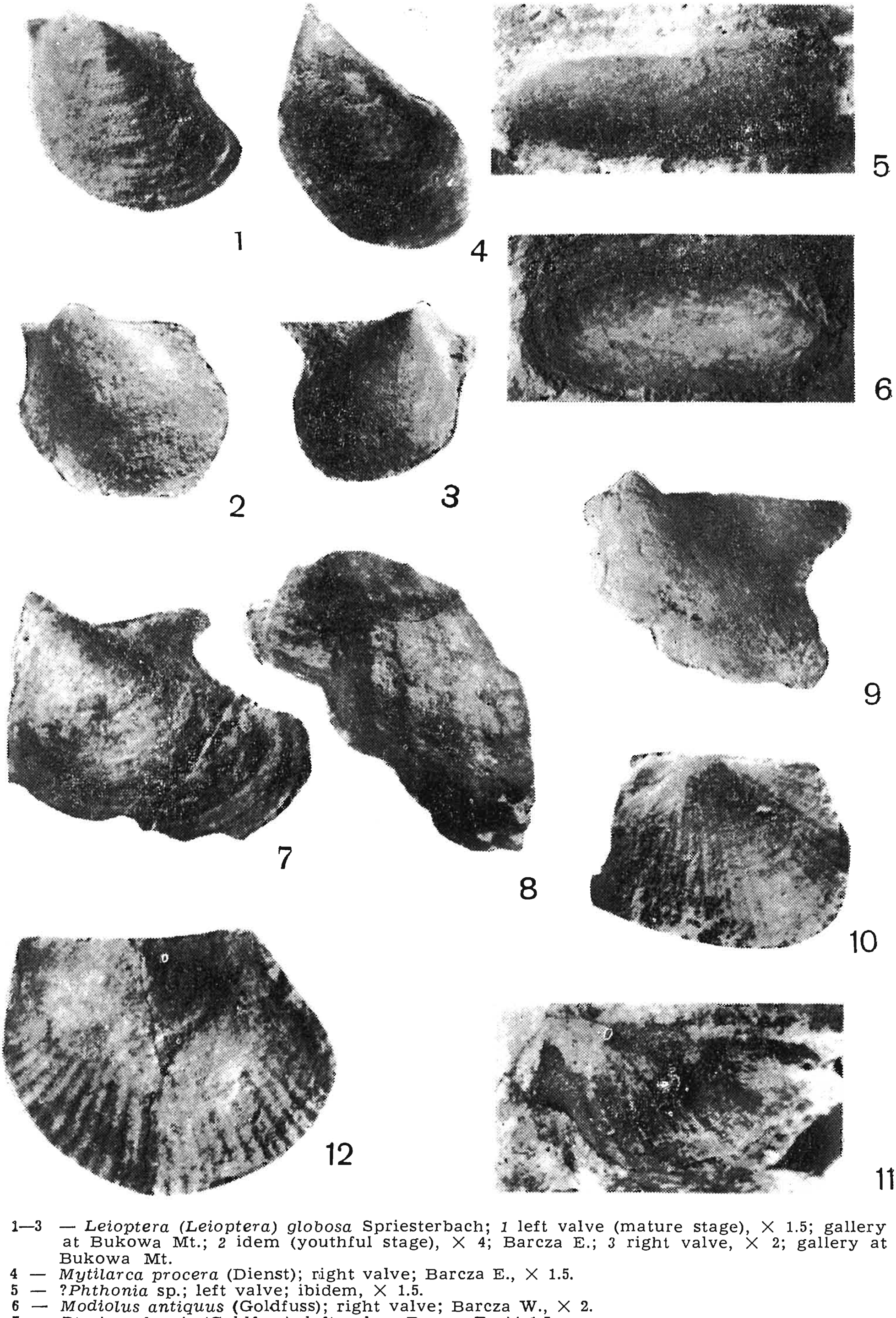
1—2 — *Alatiformia dorsocava* (Spriesterbach); pedicle valves, Barcza E., × 1.
3—5 — *Alatiformia* aff. *dorsocava* (Spriesterbach); ibidem; *3* pedicle valve, × 1.5; *4* cardinal extremity on pedicle valve, × *2;* 5 pedicle valve, × 1.5.
6—9 — *Alatiformia* sp. *1;* Barcza E.; *6a* pedicle valve, *b* posterior, *c* side views, × 2; *7—8* pedicle valves, *7* — × 1.5, *8* — × 2; *9* plasteline outer cast of pedicle valve, × 1.5.



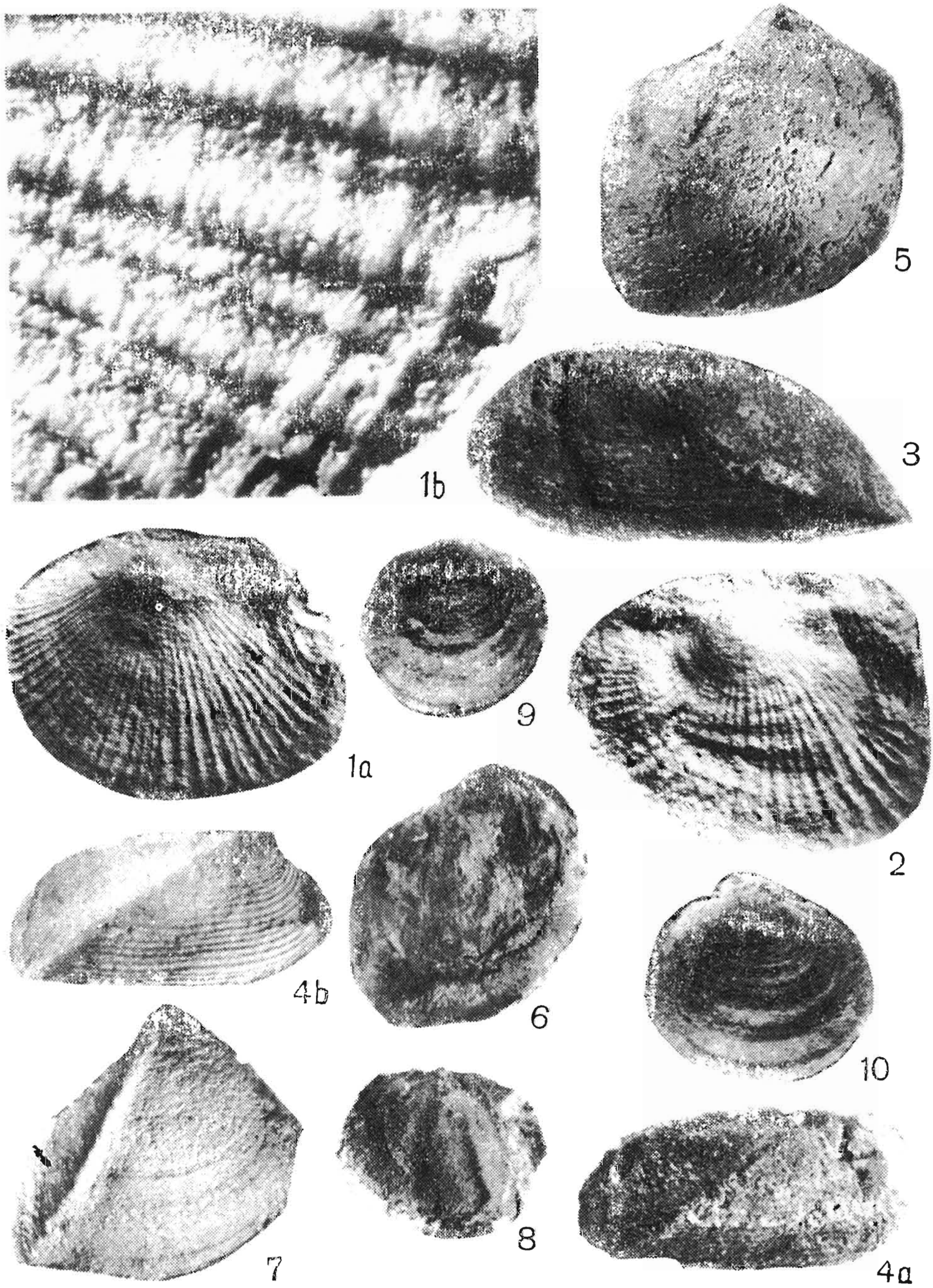
1 — ?*Alatiformia* sp. *2;* pedicle valve; Barcza E., × 2.
2 — ?*Alatiformia* sp. *3;* pedicle valve; test pit No. 1 at Bukowa Mt., × 1.5.
3 — ?*Alatiformia* sp. *4;* pedicle valve; ibidem, × 1.
4 — *Reticulariopsis curvatus* (Schlotheim); Barcza E., *a* pedicle valve, *b* posterior view, × 1.
5 — *Cryptonella macrorhyncha* (Schnur); ibidem, pedicle valve, × 1.5.
6 — *Nuculites ellipticus* (Maurer); right valve; gallery at Bukowa Mt., × 5.



1—2 — *Nuculoma krachtae* (F. A. Roemer); left valves; test pit No. 1 at Bukowa Mt., *1* — × 4, *2* — × 2.5.
3 — idem, right valve; gallery at Bukowa Mt., × 2.5.
4 — *Nuculites* aff. *triqueter* Conrad; right valve; ibidem, × 4.
5 — *Palaeoneilo maureri* (Beushausen); test pit No. 1 at Bukowa Mt.; *a* plasteline outer cast of right valve, × 3; *b* detail of ornamentation on the same valve, × 25.
6 — idem; left valve; gallery at Bukowa Mt., × 2.
7 — *Nuculana* cf. *ahrendi* (F. A. Roemer); right valve; Barcza E., × 2.
8 — *Nuculana securiformis* (Goldfuss); left valve; test pit No. 1 at Bukowa Mt., × 2.
9 — idem; right valve; Barcza E., × 3.
10 — *Palaeoneilo* cf. *beushauseni* (Kegel); right valve; ibidem, × 1.5.
11 — *Palaeoneilo hercynica* (Beushausen); left valve, test pit No. 1 at Bukowa Mt., × 6.



1—3 — *Leioptera (Leioptera) globosa* Spriesterbach; *1* left valve (mature stage), × 1.5; gallery at Bukowa Mt.; *2* idem (youthful stage), × 4; Barcza E.; *3* right valve, × 2; gallery at Bukowa Mt.
4 — *Mytilarca procera* (Dienst); right valve; Barcza E., × 1.5.
5 — ?*Phthonia* sp.; left valve; ibidem, × 1.5.
6 — *Modiolus antiquus* (Goldfuss); right valve; Barcza W., × 2.
7 — *Pterinea laevis* (Goldfuss), left valve; Barcza E., × 1.5.
8 — *Ptychopteria costata* (Goldfuss); idem; gallery at Bukowa Mt., × 1.5.
9 — *Ptychopteria lineata* (Goldfuss); idem; gallery at Bukowa Mt., × 1.5.
10 — *Ptychopteria costulata* (F. A. Roemer); idem; Barcza E., × 3.
11 — *Ptychopteria* cf. *fasciculata* (Goldfuss); idem; Barcza E., × 2.
12 — *Pterinopecten (Pterinopecten) tenuistriatus* (Spriesterbach); idem; Barcza E., × 2.



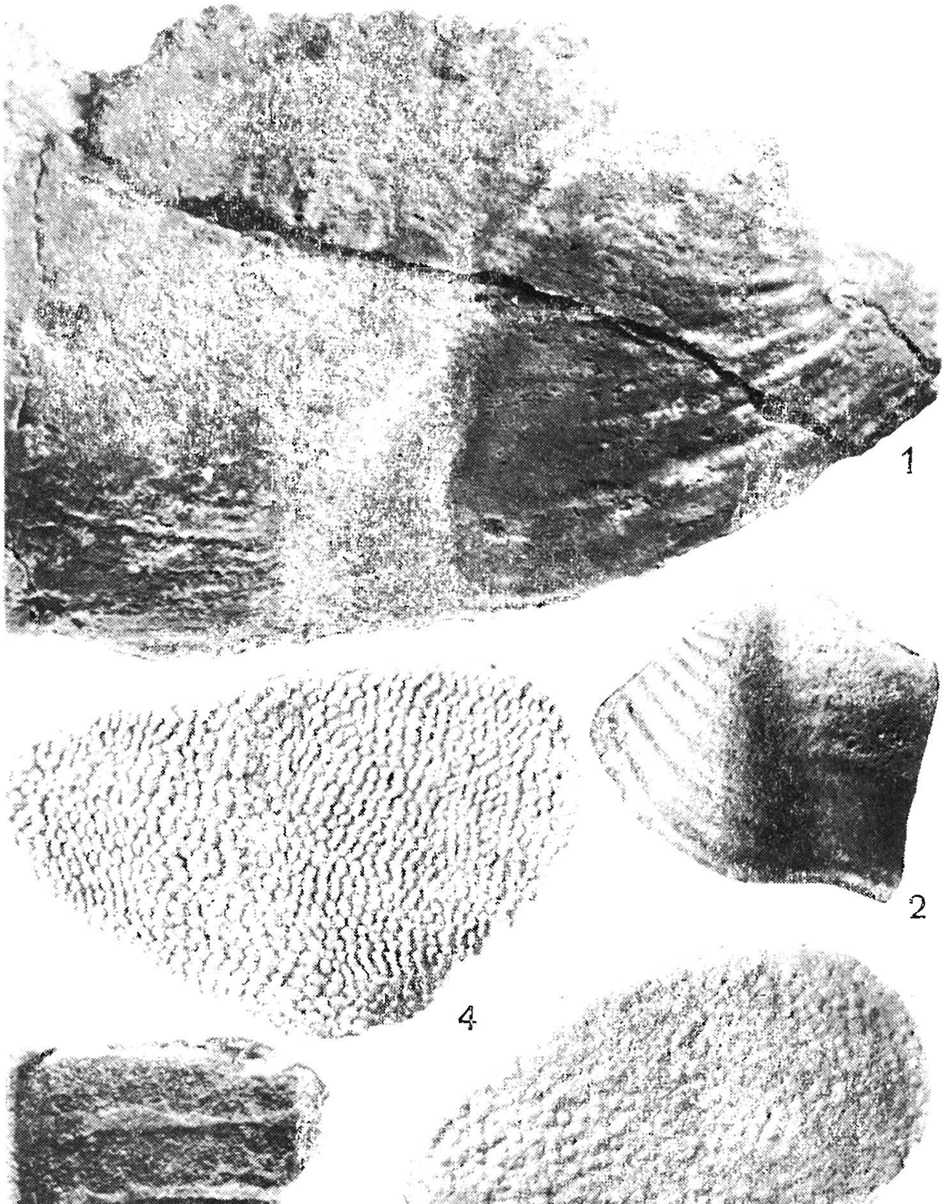
1—2 — *Pterinopecten (Pterinopecten)* cf. *tenuistriatus* (Spriesterbach); *1a* plasteline outer cast of left valve, × 1.5, *b* detail of ornamentation, × 13; gallery at Bukowa Mt.; *2* plasteline outer cast of left valve; Barcza E., × 1.5.

3—4 — *Goniophora (Goniophora) nassoviensis* Kayser; gallery at Bukowa Mt.; *3* left valve, × 2; *4a* right valve, *b* plasteline outer cast of the same valve, × 2.

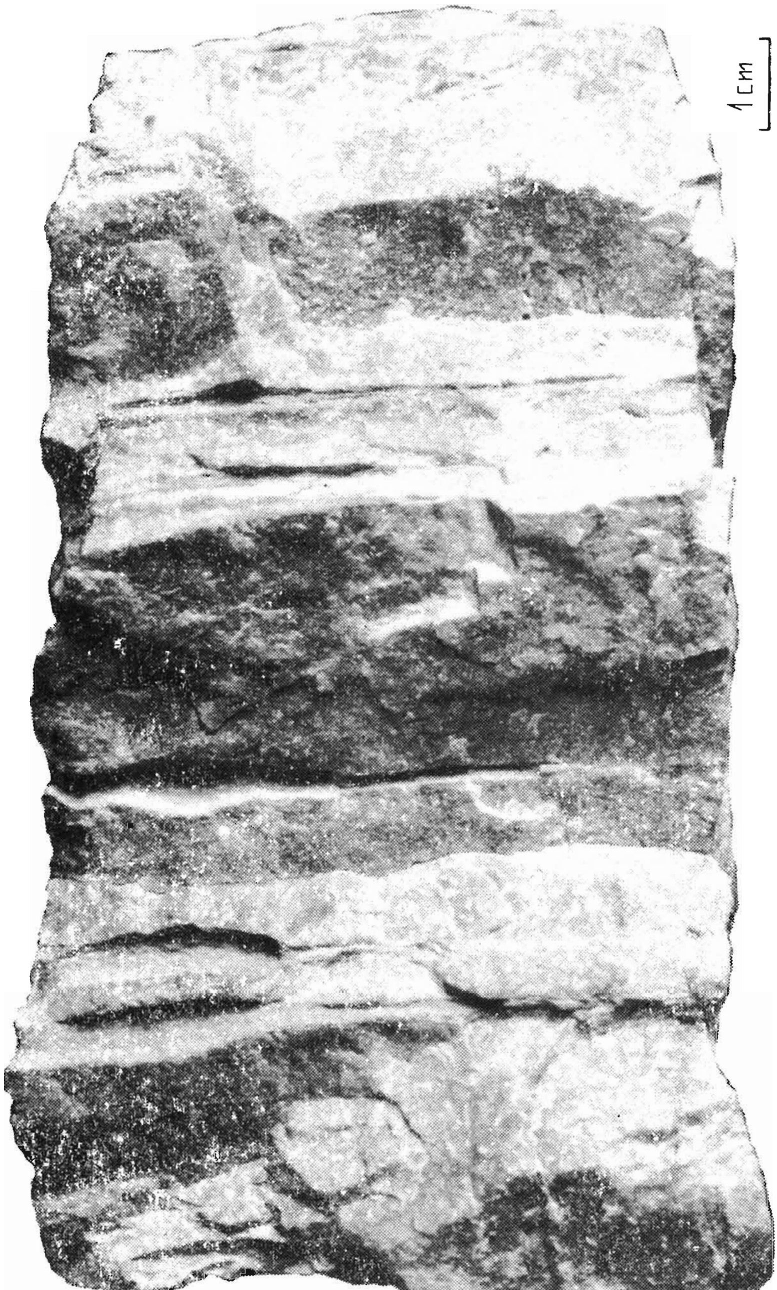
5—6 — *Myophoria inflata* (F. A. Roemer); right valves; *5* gallery at Bukowa Mt., × 1.5; *6* Barcza E., × 1.

7—8 — *Myophoria minor* Beushausen; gallery at Bukowa Mt.; *7* plasteline outer cast of right valve, × 2.5; *8* left valve, × 2.

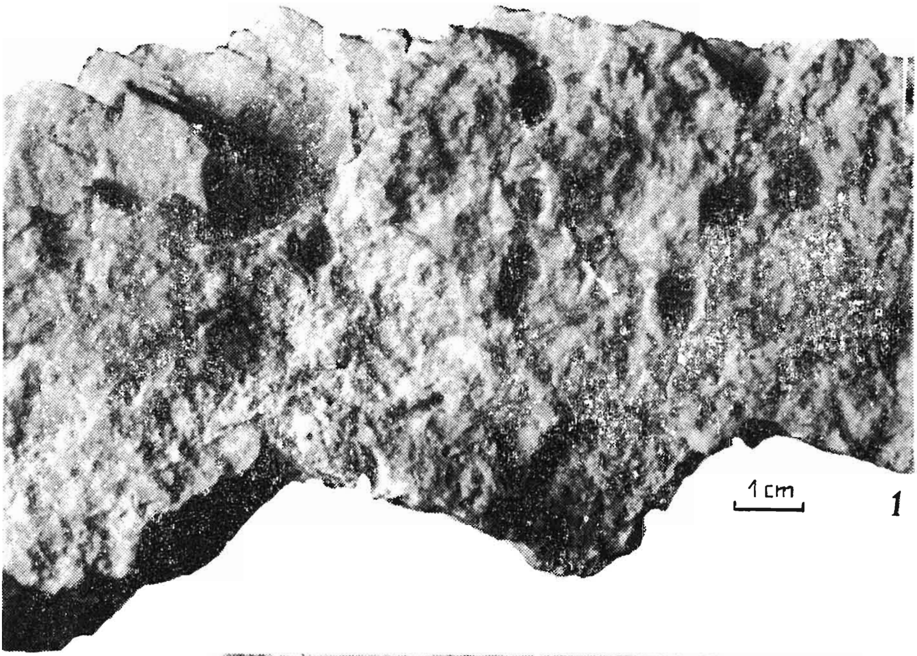
9—10 — *Paracyclas rugosa* (Goldfuss); Barcza E.; *9* right valve, × 3; *10* left valve, × 2.

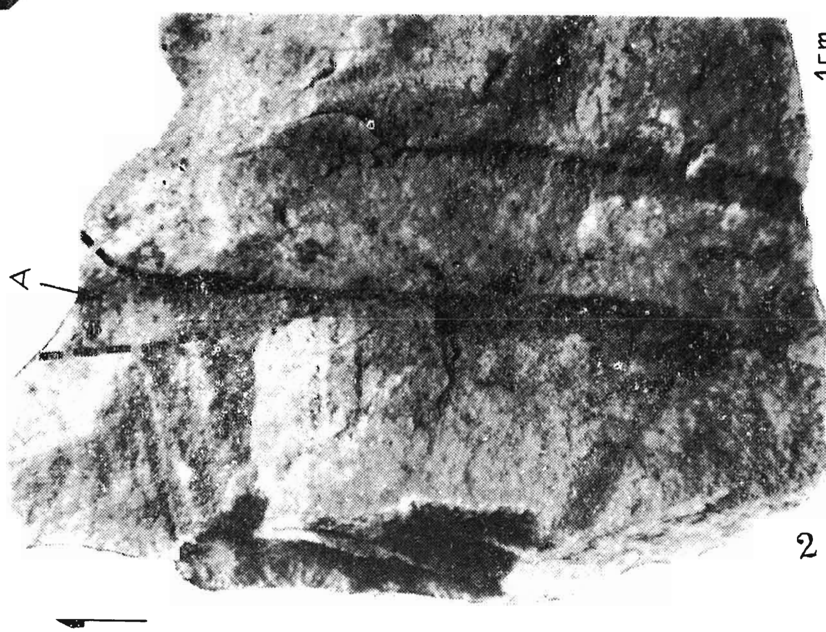


1 — *Grammysia* sp.; right valve; gallery at Bukowa Mt., × 1.
2 — ?*Cimitaria striatula* (C. F. Roemer); posterior part of left valve; Barcza E., × 2.
3 — Nautiloidea; ibidem, × 2.
4 — Psammosteidae; plasteline cast of bone plate; gallery at Bukowa Mt., unit 33, × 2.
5 — Arthrodira; plasteline cast of bone plate; Barcza E., × 1.



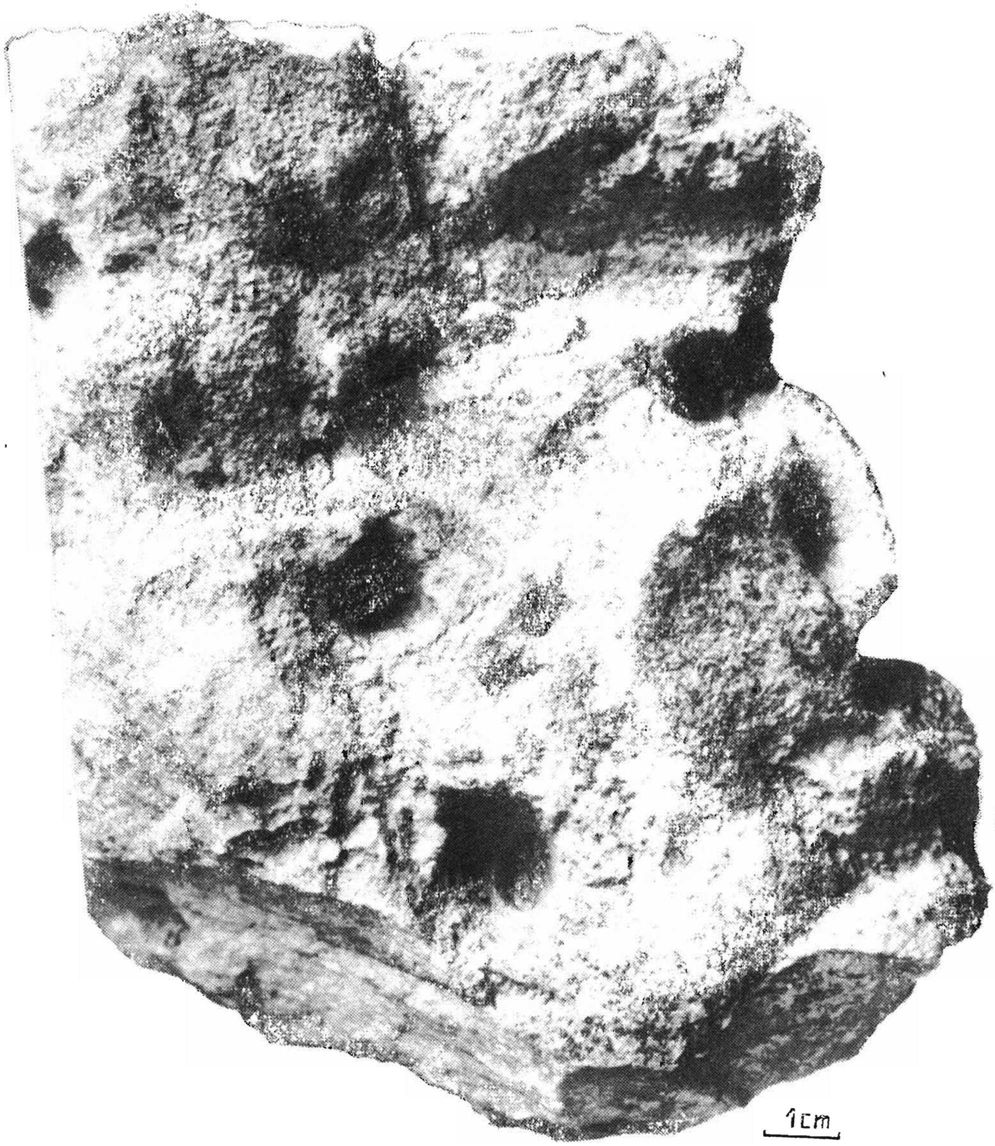
Phoronoidea; tubes of individual specimens; gallery at Bukowy Mt., unit 141





1 — Phoronoidea — apertures of tubes on upper surface of unit 141 from Pl. 30; gallery at Bukowa Mt.

2 — Phoronoidea; single vertical tube of individual specimen: *A* upper widening out end of tube with tentacles (not detectable on photo); Miejska Mt. near Bodzentyn.



Phoronoidea; upper, uneven side of unit with funnel-like apertures of the individual specimens; Miejska Mt. near Bodzentyn