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BIERNATELLA — A NEW DEVONIAN DOUBLE-SPIRED
BRACHIOPOD

Abstract. — A double-spined brachiopod *Biernatella polonica* gen. et sp.n. is described for the first time from the Upper Devonian of Southern Poland. A new family Biernatellidae has been established for it within the Dayioidea.

INTRODUCTION

Brachiopods that possess a double-spined brachidium are extremely rare in the Paleozoic. So far two such genera are known: *Helenathyris* Alekseeva — a representative of the Athyrididina and *Kayseria* Davidson belonging to the Dayioidea. *Helenathyris* is known from the Lower Devonian of the USSR (Alekseeva 1969), and *Kayseria* from the Middle Devonian (Eifelian) of Europe and Asia (Copper 1973).

A new, double-spined brachiopod, *Biernatella* gen. et sp.n., is described from the Paleozoic rocks of southern Poland. This new genus is represented by only one species *B. polonica* gen. et sp.n. which occurs in the Upper Devonian (Frasnian) in the vicinity of Dębnik near Cracow (S Poland). On gross morphology *Biernatella*, like *Kayseria*, is assigned to the suborder Dayioidea.

GEOLOGIC SETTING AND PALEOECOLOGICAL IMPLICATIONS

The beds with *Biernatella polonica* gen. et sp.n. were exposed in the Z-IV, Z-VI and Z-VII trenches situated to the south of Dębnik, and in the Zar-I trench and in a small exposure by the road from Dębnik to Paczółtowice situated to the north of Dębnik (Cracow area in S Poland) (fig. 1). On the basis of brachiopods and conodonts the above beds range in age from the *Ancyrognathus triangularis* Zone up to the *Palmatolepis gigas* Zone (do I γ — do I δ) (Baliński — in press).

The lower beds with *B. polonica* (trenches Z-VII, Zar-I and the exposure by the road) consist of grey, thinly bedded, well sorted biointraspar-

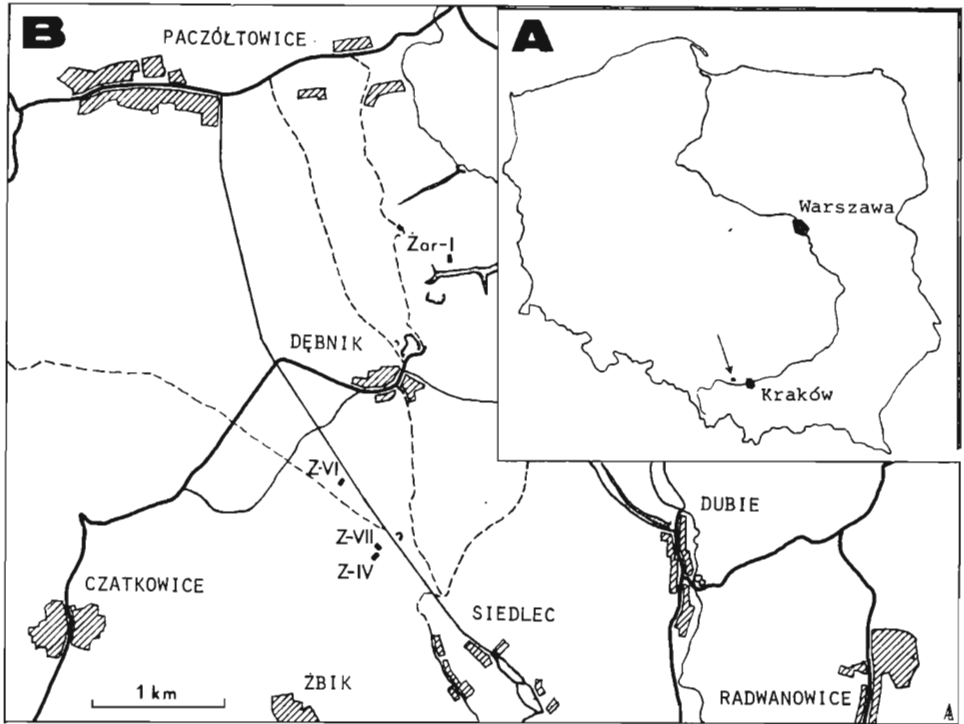


Fig. 1. General map of Poland (A) and a sketch map (B) of the vicinity of Dębnik. Noted the excavations with the layers containing *Biernatella polonica* gen. et sp.n.

ites with very poorly sorted biointrasparite the intraclasts of which attain several centimeters in diameter. Fossils in these beds are rare but diversified. Most common are the following brachiopods: *Devonoproductus* sp., *Calvinaria albertensis albertensis*, *Biernatella polonica* gen. et sp.n., *Anatrypa alticola*, *Iowatrypa markovskii*, *Theodossia* cf. *hungerfordi*, *Tenticospirifer cyrtiniformis* and *Athyris concentrica*. There are also stromatoporoids, tabulates, tetracorals, crinoid ossicles, gastropods, conodonts and fish remains.

Higher up the sequence there are several meters of grey, thinly bedded (a few centimeters thick) sparitic grainy limestones with abundant organic detritus (trench Z-IV). This rock shows very good sorting of grains. Brachiopods are represented by *Lingula* sp., *Calvinaria albertensis* subsp. n., *Biernatella polonica* gen. et sp.n., *Iowatrypa markovskii*. They are accompanied by tentaculites, conodonts and fish remains.

The youngest beds with *B. polonica* (trench Z-VI) consist of black, marly sparitic organodetrital limestones containing fine well sorted intraclasts. Besides *B. polonica* the brachiopods: *Lingula* sp., *Lingulipora* sp., *Caryorhynchus tumidus*, *Athyris concentrica*, *Tenticospirifer cyrtiniformis* and *Cyrtospirifer minor* are present. Other fossils include foraminifers, tentaculitids, conodonts and fish remains.

Biernatella polonica is most common in the beds exposed in trench Z-IV where it occurs in large numbers. However, in the lower and uppermost parts of the section here described it is much less common. The state of preservation of specimens of *B. polonica* seems to suggest that they have undergone only slight post mortem transport. This species occupied probably shallow parts of the basin from several down to some tens of meters characterized by periodical strong currents.

Occurrence of lingulids in their life (vertical) positions in some beds in the trench Z-IV also supports such a supposition. Studies of contemporary bathymetric distribution of lingulids show that most of them occur at depth of 20—30 m (Zezina 1976:102). Paine (1970:30) concluded that recent lingulids are physiologically adapted to conditions in the intertidal zone.

The shells of *B. polonica* are small, the valves being strongly thickened and their mass proportionately large hence they must have been resistant to mechanical damage and could show an increased resistance to currents. Other brachiopods associated with *B. polonica* in the beds of trench Z-IV are also small and such a size of shells should be taken as adaptive character. The shells of, i.e., *Calvinaria albertensis* subsp. nov. seldom exceed 10 mm in size, and those of *Iowatrypa markovskii* — 15 mm in length. The last mentioned species shows similar size in other known areas of its occurrence (Timan, Ural, the Volga-Ural area in the USSR) (Lyaschenko 1973). Dwarfing of fossil brachiopod fauna has been noted by Cloud (1948:59) in the Salem limestone (Mississippian), Indiana, North America. Recently, Zezina (1976:33) considering the dwarfed populations of recent brachiopods suggested that diminishing of shell size is an adaptation to increased water mobility. Contrary to dwarfed populations described by Cloud and Zezina in which studying of shell are of phenotypic character, the small dimensions of *B. polonica* and of other cooccurring small brachiopods can be regarded as genotypically established.

AFFINITIES OF DOUBLE-SPIRED BRACHIOPODS

The earliest known double-spired brachiopod is *Helenathyris* Alekseeva from the Lower Devonian of the USSR. The internal structure of its shell and the presence of a perforated cardinal plate in particular explicitly shows that it is a representative of the suborder Athyrididina. According to Alekseeva (1969) the diplospirium of *Helenathyris* has developed quite independently from the Triassic Diplospirellinae.

Another brachiopod genus possessing a diplospirium is *Kayseria* Davidson which is known from the Middle Devonian of Eurasia. This genus is completely different both externally and internally from *Helenathyris* and is regarded as a representative of the suborder Dayioidea. Clearly the diplospirium evolved quite independently in both forms. This is suggested by the mode of development of the accessory spires apart from

basic morphological differences and a stratigraphic gap between them. In *Kayseria* the accessory lamellae develop near the distal ends of the crura through bifurcation of a long, single jugal process which is posteriorly directed (Copper 1973: figs 2, 4). In *Helenathyris* the accessory lamellae develop from two symmetrical, dorsally pointing jugal processes (Aleksieva 1969: fig. 2B). One branch of the lamellae points backwards and ends near the crura, and the second one points forwards and continues till the terminations of the main lamellae.

Biernatella gen.n. described in this paper is another Devonian double-spired brachiopod. The mode of development of the diplospirium is very similar in this new genus to that of *Helenathyris*. Nevertheless *Biernatella* lacks the cardinal plate which makes its assignment to the Athyrididina unlikely. This genus is similar externally to some representatives of the suborder *Dayioidea* and in particular to *Anoplothea* Sandberger and *Bifida* Davidson.

It shows also the same as in *Dayia navicula* double-sided growth pattern of the spiral lamellae which is quite different from that in the Athyrididina (MacKinnon 1974:245, pl. 29:1). The only character that does not coincide with the diagnosis of the Dayioidea given by Johnson (1974: 438—9) is the presence of very small, narrow ventral interareas in *Biernatella*. This feature, however, may not be of great taxonomic value as the only representative of this genus *B. polonica* gen. et sp.n. occupies an isolated stratigraphic position in comparison to other known forms of Dayioidea (*Ancyrognathus triangularis* Zone — *Palmatolepis gigas* Zone; Frasnian do I γ — do I δ).

The above data appear to indicate that a diplospirium developed several times independently within two different groups of Spiriferida: namely the Dayioidea and Athyrididina. This might suggest a close affinity of these two groups as they are characterized by the same peculiar structure of the initial part of brachidium (Copper 1973:120). In both groups the primary lamellae of the main spires are not a simple prolongation of crura (as in Spiriferidina and Atrypidina) but grow from the crura in the opposite direction, i.e. posteriorly then dorsally. Such morphological similarities, with others, prompted Copper (1973) to transfer the Dayiaceae from the Atrypidina to the Athyrididina. Johnson (1974) has pointed out considerable differences existing between the Dayiaceae and Athyrididina and established a new suborder, Dayioidea.

Comparing the mode of development of the diplospirium in the Devonian *Helenathyris* Aleksieva, *Kayseria* Davidson and *Biernatella* gen.n. with that of the Triassic Diplospirellinae one finds that the structure of the diplospirium in *Helenathyris* is almost identical to that of *Biernatella* but different from that of the Triassic Diplospirellinae. In turn, the structure of the diplospirium in *Kayseria* is in general the same as that of the Triassic Diplospirellinae, but different from that of *Biernatella*. Actually

it is difficult to explain this phenomenon as we have limited paleontological data at our disposal.

The new genus *Biernatella* described in this paper differs distinctly from other Dayioidea in its characteristics as well as in its isolated stratigraphic position. These differences make it possible to establish a new family Biernatellidae fam.n.

DESCRIPTION

Suborder **Dayioidea** Johnson, 1974 Family **Biernatellidae** fam.n.

Type genus: Biernatella gen.n.

Diagnosis and occurrence: as for the genus.

Remarks.— This is a monotypic family. It is represented by the genus *Biernatella* gen.n. Considerable differences in morphology and internal structure (see below) as compared with other Dayioidea justify the creation of a new family for this genus.

Genus *Biernatella* gen.n.

Type species: Biernatella polonica gen. et. sp.n.

Derivation of the name: in honour of Prof. Dr. Gertruda Biernat.

Diagnosis.— Small smooth shelled, ventri-biconvex Dayioidea with pedicle valve strongly convex in its posterior part; very small ventral interareas present. Dental plates and median septum absent within pedicle valve; no septum in brachial valve. Spiridium directed lateroventrally; accessory lamellae extending from the posterior part of jugum and continuing till the termination of the main spirals.

Occurrence.— As for the type species.

Remarks.— This genus differs from other representatives of the suborder Dayioidea in its smooth, nonribbed shell (with the exception of some genera of the family Dayiidae) and from all genera of Dayioidea with the exception of *Kayseria* in the presence of a double spiridium. *Biernatella* gen.n. differs from other Dayioidea in its stratigraphic range as the Dayioidea known so far do not pass the Middle-Upper Devonian boundary. Hence a stratigraphic gap occurs between *Biernatella polonica* and all other Dayioidea. It embraces do I α and do I β (this gap, however, may only be apparent).

Biernatella polonica gen. et. sp.n.

(pl. 9:1-4; pl. 10:1-5; figs 2-4)

Holotype: ZPAL Bp XXIII/31g; pl. 9:2; pl. 10:4-5.

Type horizon: thin bedded biopelintrasperte with *Calvinaria albertensis*, *Palmatolepis gigas* Zone (Frasnian do I δ).

Type locality: Dębnik, a trench Z-IV situated south of it, Cracow area, southern Poland.

Derivation of name: *polonica*— found in Poland.

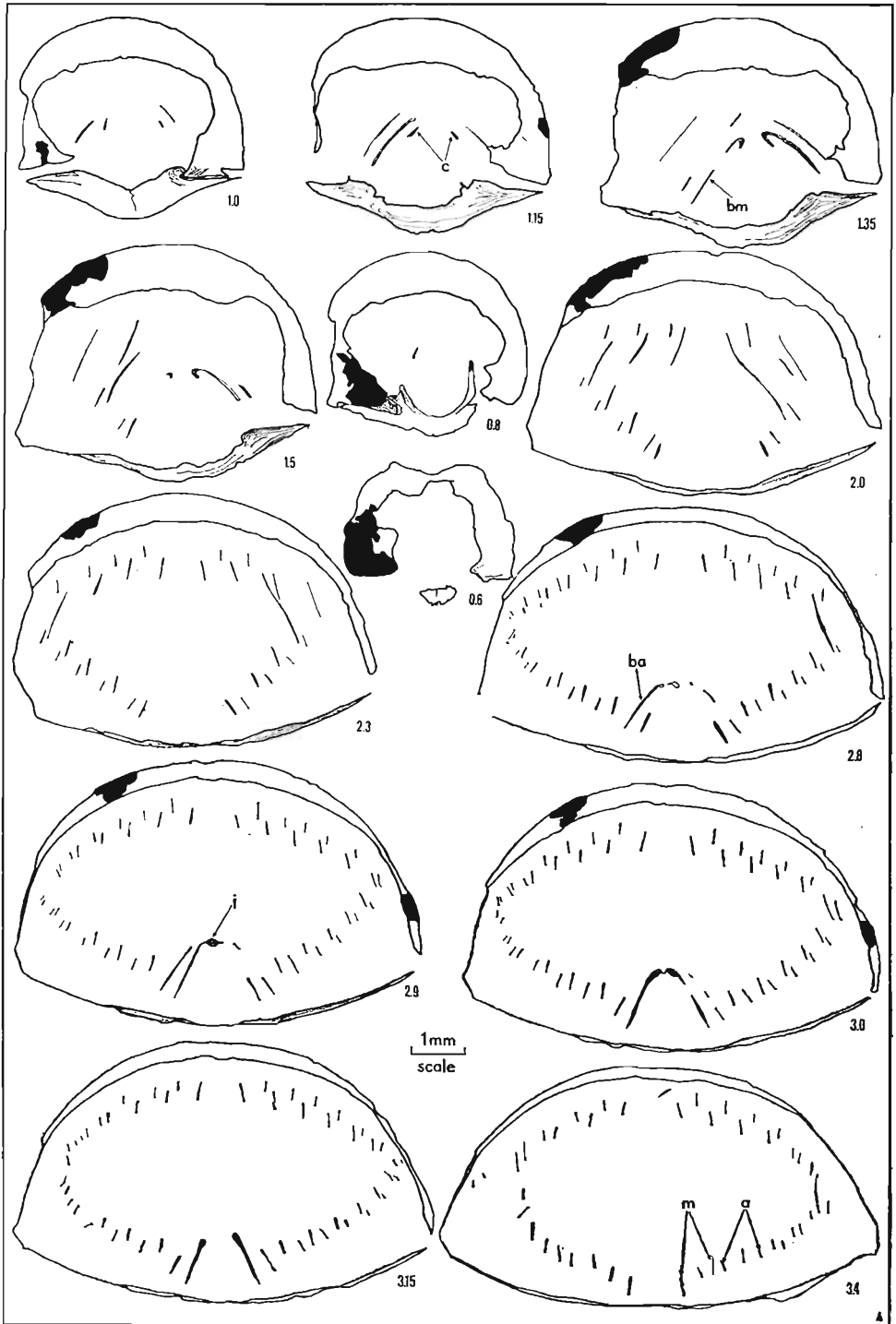


Fig. 2. Serial sections of paratype *Biernatella polonica* gen. et sp.n. (Bp XXIII/30e) from locality Z-IV. Numbers refer to distance in mm from ventral apex. Abbreviations: *a*—accessory lamellae, *ba*—beginning of accessory lamella, *bm*—beginning of main lamella, *c*—crura, *j*—jugum, *m*—main lamellae.

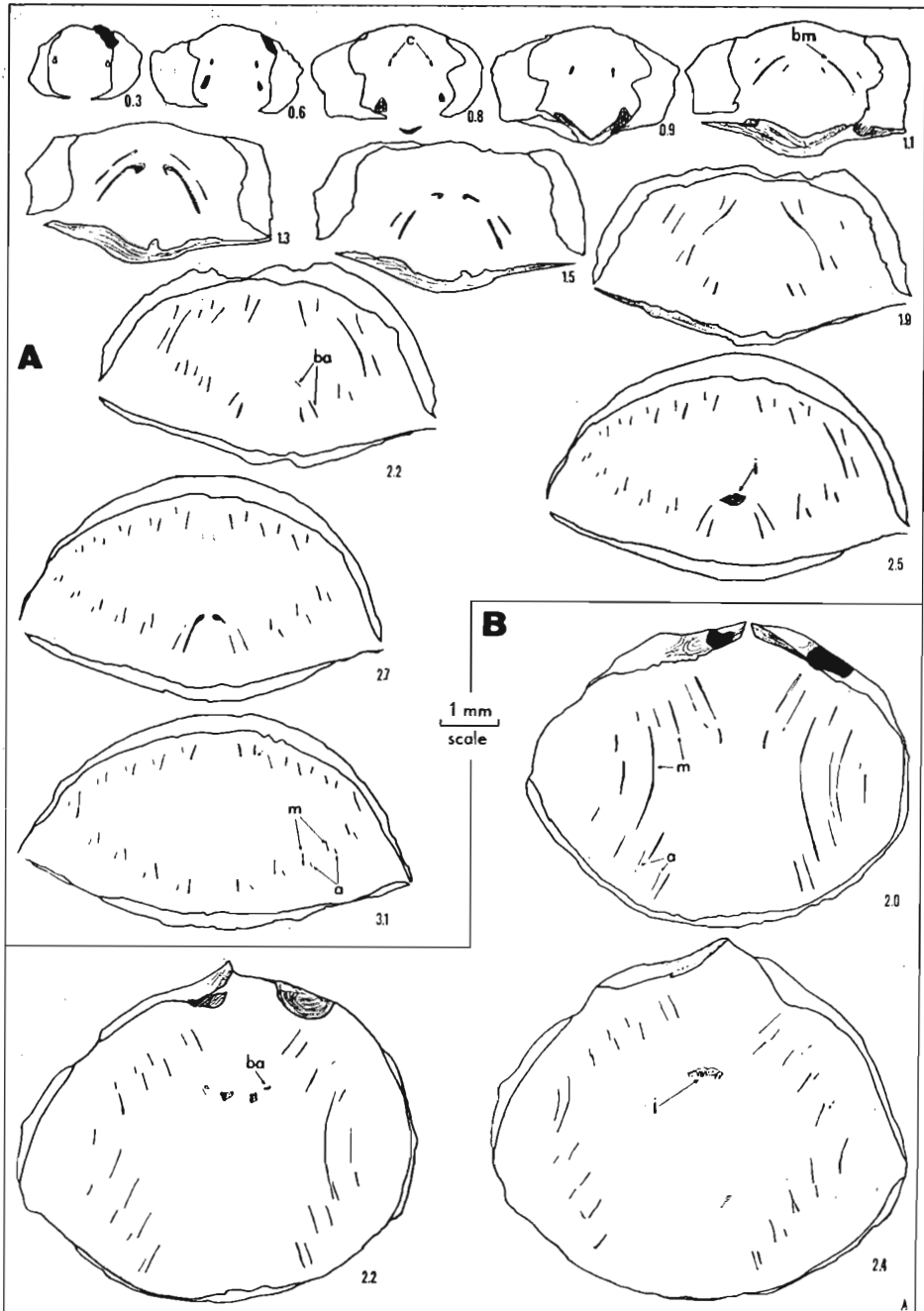


Fig. 3. Serial sections of two paratypes of *Biernatella polonica* gen. et sp.n. (Bp XXIII/30d, 30c) from locality Z-IV. A — specimen sectioned in the standard position; numbers refer to distance in mm from ventral apex. B — specimen sectioned parallel to the commissural plane; numbers refer to distance in mm from external surface of brachial valve.

Abbreviations: see fig. 2.

Diagnosis.—Small shell usually up to 9 mm in length, elongate-oval to round in outline, as broad as long; ventral interareas very narrow.

Material.—Over 20 complete shells and 30 damaged shells and over 80 fragments; some single valves etched with acetic acid (conodont samples). Specimens with exfoliated valves; some exhibit local silicification.

Dimensions (in mm):

| ZPAL Bp XXIII | length | | width | thickness | width | thickness |
|------------------|------------------|-------------------|-------|-----------|--------|-----------|
| | pedicle valve | brachial valve | | | length | length |
| 31a | 6.1 | 5.6 | 6.2 | 3.7 | 1.02 | 0.61 |
| 31b | 6.3 | 6.0 | 6.7 | 3.3 | 1.06 | 0.52 |
| 31c | 6.7 | 6.2 | 6.7 | 4.1 | 1.00 | 0.61 |
| 31d | 7.0 | 6.5 | 6.8 | 3.5 | 0.97 | 0.50 |
| 31e | 7.3 | 6.6 | 7.0 | 4.4 | 0.96 | 0.60 |
| 31f | 7.4 | 6.7 | 7.8 | 4.4 | 1.05 | 0.60 |
| 31g | 8.7 | 7.9 | 8.7 | 4.6 | 1.00 | 0.53 |

Description.—Small, rarely more than 9 mm in length, as long as wide, oval to rounded in outline, ventri-biconvex in side view, hinge line short, straight to somewhat arched, anterolateral margins rounded. Shell smooth, microornamentation consisting of weak but densely arranged concentric lines (about 20 per 1 mm). Pedicle valve more convex posteriorly, deep; median sulcus rare, weakly marked at the anterior margin of larger specimens (i.e. holotype, pl. 9:2). Interarea low, very small, concave (pl. 10:5); beak small, suberect to erect. Valve, proportionally to the general shell size, very thick, attaining, in adult and gerontic stages, to about 0.9 mm of thickness. Brachial valve weakly convex to almost flat, median fold lacking.

Interior. *Pedicle valve.* Dental plates and medium septum absent; muscle scars and pallial sinuses deeply marked (pl. 10:3). *Brachial valve.* Crural plates and median septum absent, crural bases long, perpendicular to the pedicle valve (fig. 2—3). Crura directed forwards, giving rise to the main lamellae which run backwards and dorsally. From the primary lamellae of main spires (at a distance of about 2.5—3 mm from the ventral apex) small and arched blades arise, joining together to form a jugum (fig. 2—3). Two additional very thin blades starting from jugum run dorsally and give rise to the beginning stage of accessory spires. One branch of accessory lamella is directed backwards extending parallelly to the umbonal blade of main lamella ending at the umbonal region of the shell. The second one directed forwards runs parallelly to the main lamella right to the spirulum apex (fig. 4).

The plains of main and accessory lamellae are ankylosed one to another at acute angle with its apex directed internally. Coils consisting of 4—7 spires.

The surface of lamellae is finely nodulous to spinose and their margins bordered by long, rare spinose processes (pl. 10:1-2).

Remarks.—The discussed specimens are so characteristic in their external and internal appearance that it is difficult to make any comparison with the known species of dayioids. Some features of external morphology (size, shape, the very deep, especially posteriorly, pedicle valve and the flattened brachial valve) make the above form close to the members of *Bifida* and *Anoplotheca*. However, the other external and internal features differ distinctly from the members of the above mentioned genera.

Occurrence.—S of Poland, Cracow Region, environs of Dębnik, Upper Devonian

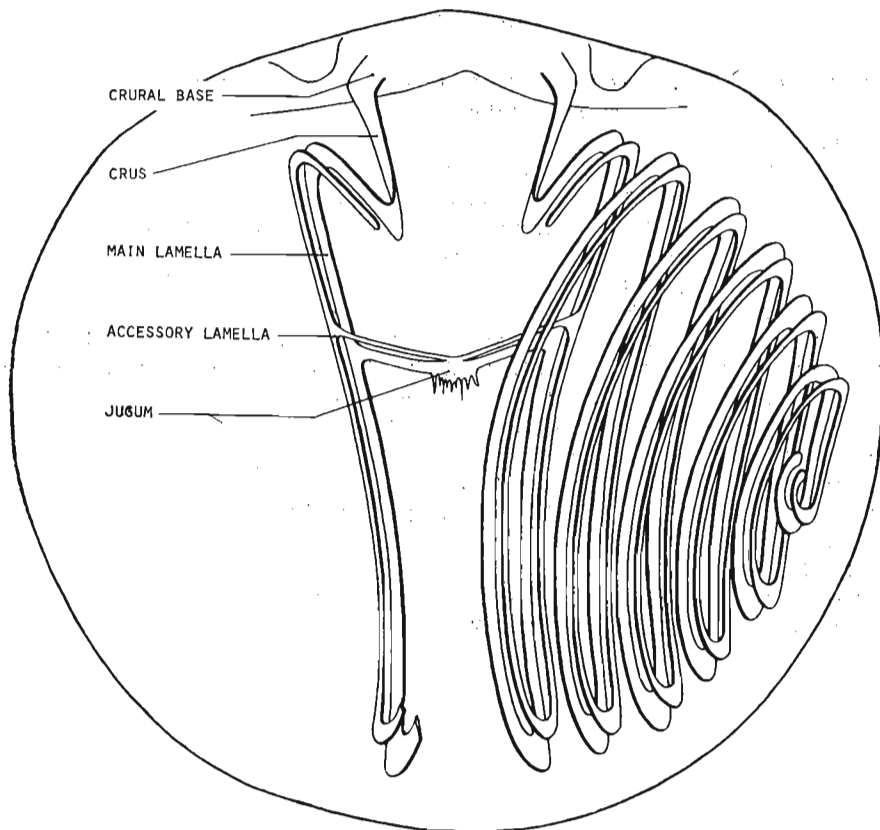


Fig. 4. Reconstruction of the brachial valve interior of *Biernatella polonica* gen. et sp.n. based on serial sections.

(Frasnian), *Ancyrognathus triangularis* Zone to *Palmatolepis gigas* Zone (do I γ —do I δ).

Acknowledgement.—My grateful thanks are due to prof. dr Getruda Biernat (Institute of Paleobiology, Warsaw) for the discussion and critical reading of the manuscript and to dr R. E. Alekseeva (Palaeontological Institute, Moscow) and dr A. S. Dągis (Institute of Geology and Geophysics, Novosibirsk) for the discussions on the studied collection. To dr D. MacKinnon many thanks for his valuable alterations to the English of the script. Scanning electron micrographs were made at the Laboratory of Electron Microscopy of the Nencki Institute of Experimental Biology, Warsaw.

The studied collection is housed at the Institute of Paleobiology of the Polish Academy of Sciences in Warsaw (abbr. ZPAL).

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September, 1976

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BIERNATELLA — NOWY DEWOŃSKI RAMIENIONÓG Z DIPLOSPIRALIMUM

Streszczenie

Wśród paleozoicznych ramienionogów formy ze szkieletem ramion wykształconym w postaci diplospiraliów są niezmiernie rzadkie. Dotychczas znane były jedynie dwa takie rodzaje: *Helenathyris* Alekseeva z dolnego dewonu ZSRR i *Kayseria* Davidson z środkowego dewonu (eiflu) Europy i Azji. W niniejszej pracy opisano nowy, trzeci z paleozoiku, rodzaj ramienionoga z diplospiraliów, *Biernatella* gen.n. Rodzaj ten jest reprezentowany przez jeden gatunek *B. polonica* gen. et sp.n. występujący w górnym dewonie (franie) okolic Dębника, (Region Krakowski), i, podobnie jak *Kayseria*, jest przedstawicielem podrzędu Dayioidea. Gatunek ten wyraźnie różni się od pozostałych Dayioidea morfologią zewnętrzną i budową wewnętrzną, a także izolowaną pozycją stratygraficzną, co przemawia za ustanowieniem nowej rodziny, Biernatellidae fam.n.

Biernatella polonica jest gatunkiem, który zasiedlał prawdopodobnie płytkie partie basenu, od kilku do kilkudziesięciu metrów głębokości, charakteryzujące się podwyższoną ruchliwością wody. Muszle tego gatunku, jak i innych współwystępujących ramienionogów, charakteryzowały się niewielkimi rozmiarami, silnie zgrubiałymi skorupkami i proporcjonalnie dużą masą, a więc zwiększonym oporem na prądy wody oraz znaczną odpornością na uszkodzenia mechaniczne. Podobne przypadki skarłowacenia fauny ramienionogowej znane są zarówno w stanie kopalnym (Cloud 1948:59) jak i z współczesnych mórz (Zezina, 1976:33).

Praca wykonana w ramach problemu MR. II/3.

АНДЖЕЙ БАЛИНСКИ

BIERNATELLA — НОВЫЙ ДЕВОНСКИЙ БРАХИОПОД С ДИПЛОСПИРАЛИУМ

Резюме

Среди палеозойских брахиоподов исключительно редко встречаются формы со скелетом ручного аппарата, представленным в виде diplospiraliium. До сего времени были известны только два таких рода, а именно *Helenathyris* Alekseeva из нижнего девона СССР и *Kauseria* Davidson из среднего девона (Эйфель) Европы и Азии. В настоящей работе описан новый, третий, палеозойский род брахиопода с diplospiraliium, *Biernatella* gen. n. Этот род представлен одним видом *B. polonica* gen. et sp. n., встречающимся в верхнем девоне (фране) окрестности Дембника (Краковское воеводство). Он также как и *Kauseria* является представителем подотряда Dayioidea. Этот вид резко отличается от остальных Dayioidea как внешней морфологией и внутренним строением, так и особой стратиграфической позицией, что указывает на установление нового семейства Biernatellidae fam. n. *Biernatella polonica* является видом, который, по всей вероятности, существовал в мелких участках бассейна, характеризующихся повышенной подвижностью вод и глубиной от нескольких до несколько десятков метров. Раковины этого вида, а также и других сопутствующих ему брахиоподов имеют небольшие размеры с сильно утолщенными створками и пропорционально большой массой, это значит, что они обладали повышенным сопротивлением токам воды и соответственно значительной устойчивостью на механическое повреждение. Похожие примеры карликовости известны в ископаемом виде (Cloud 1948:59), и в современных морях (Зезина 1976:33).

EXPLANATION OF PLATES

Plate 9

Biernatella polonica gen. et sp.n.

conodont *gigas* Zone (Frasnian do I δ); trench Z-IV, Dębnik

- 1—2. Paratype (Bp XXIII/31b) and holotype (Bp XXIII/31g) in dorsal, ventral, lateral, posterior and anterior views, $\times 4$.
3. Paratype (Bp XXIII/30a); gaping shell in dorsal and lateral views, $\times 4$.
4. Section of paratype (Bp XXIII/30b) showing jugum and double spiranium, $\times 20$.

Plate 10

Biernatella polonica gen. et sp.n.

conodont *gigas* Zone (Frasnian do I δ); trench Z-IV, Dębnik

1. Paratype (Bp XXIII/30f) with preserved ornamentation on a fragment of spiral lamella. 1a — $\times 8$; 1b — scanning electron micrograph, more detailed view of part of fig. 1a, $\times 60$. Abbreviations to fig. 1b and 2b: *a* — accessory lamella, *m* — main lamella, *s* — spines.
2. Paratype (Bp XXIII/30g) with preserved double spiranium. 1a — $\times 12$; 1b — scanning electron micrograph, more detailed view of part of fig. 2a, $\times 100$.
3. Internal mould of pedicle valve (paratype Bp XXIII/31o) with preserved impressions of pallial sinuses, $\times 4$.
- 4—5. Holotype (Bp XXIII/31g) (see also pl. 9:2). 4 — dorsal view, nat. size; 5 — hinge margin and small interareas observed, $\times 8$.

