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Biostratigraphy of the Devonian-Carboniferous passage beds from some selected profiles of NW Poland

ABSTRACT: The results are here presented of the biostratigraphic and lithological investigations of the uppermost Devonian and Lower Carboniferous from the Chojnice region. They are based chiefly on a detailed analysis of brachiopod and conodont assemblages. The Upper Famennian (Fa2) with deposits equivalent to the Etroeungt beds of France and Belgium (Tn1a), also the proper Tournaisian (sensu Heerlen 1935) have been distinguished. The stratigraphic position of the Devonian/Carboniferous passage beds of Europe are discussed in the light of paleontological studies. Consideration is given to the sediments of this age in Poland. A description is given of the facial-paleogeographic development in the sedimentary basin of the Chojnice region at the Devonian/Carboniferous turn, two sedimentary zones being differentiated there. All the faunal remains here worked out have been figured, but descriptions are given only of forms whose generic or specific assignment is controversial. A survey of all the phenomena noted on the Devonian/Carboniferous passage beds, also the exceptionally great depth of the sediments — the age equivalents in the Chojnice area of the Etroeungt beds (Tn1a) — reasonably suggest that this area is of essential all-European importance for the clearing up of the problems of the Devonian/Carboniferous passage beds and the boundary between these two systems.

INTRODUCTION

As a result of intensified geological prospecting in search of bitumens, undertaken in Western Pomerania during the last ten years by the Polish Geological Survey and the Petroleum Research Enterprise at Piła, new, very important borehole materials have been obtained. They have enriched our — so far inadequate — knowledge of the deep geological structures of this region.

The results are here given of the lithological and stratigraphic investigations of the uppermost Devonian and Lower Carboniferous deposits encountered in the Chojnice region in the borehole profiles Babilon *1*, Brda *1*, Brda *2*, Rzeczenica *1*, Biały Bór *1* and Biały Bór *3*.

The biostratigraphy here is based mainly on a detailed analysis of a brachiopod and conodont assemblage, supported by the study of other faunas (Korejwo 1975, 1976) and microflora (Turnau 1975 a, b).

The paper has been performed within the M. R. I. 16 Problem "Geodynamics of Poland".

Among the brachiopods the presence has been observed of 84 species belonging to 48 genera and of 32 conodont species representing 6 genera. This fauna has been partly described and figured in 24 plates, while the vertical range of the particular species from the profiles here considered is shown in 6 tables.

In our profiles, besides Upper Devonian sediments, there have also been differentiated age equivalents of the Etroeungt beds of France and Belgium (Tn1a) as well as the proper Tournaisian (sensu Heerlen 1935) and lower Viséan sediments.

The study of the Tn1a sediments, which is the main purpose of the present paper, has provided most interesting and unlooked for results showing that no such rich and strongly differentiated brachiopod assemblage has, so far, been reported in Poland from the passage beds of the Devonian/Carboniferous boundary. It even seems to be the unique one throughout Europe. The rich benthonic fauna together with the character of the deposits, developed mainly in the carbonate facies, reasonably suggest that their sedimentation had taken place in the shallow neritic zone of an epicontinental basin. At the turn of the Upper Devonian and Lower Carboniferous this area must have been subjected to strong subsidence compensated by rapid sedimentation resulting in exceptionally great thickness of the deposits, sometimes up to several hundred meters.

This paper has been prepared in the Stratigraphic Laboratory of the Institute of Geologic Sciences of the Polish Academy of Sciences under the scientific guidance of Dr. hab. Krystyna Korejwo, to whom the writer owes special thanks for the initiative, valuable comments, helpful discussions and materials.

Much friendly help has been contributed for the completion of this work. Most sincere thanks must be here expressed to the Union of Petroleum Mining in Warsaw and the Petroleum Research Enterprise of Piła for accession to their borehole materials and archival data.

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During her stay in the U.S.S.R. the writer was kindly enabled to discuss with a number of specialists the interesting but most difficult problems of the Devonian-Carboniferous passage beds, as well as to acquaint herself with monographic brachiopod collections. For all this help most sincere thanks are once again here tendered.

To Dr. hab. L. Teller the writer is deeply grateful for his instructive comments and help throughout the preparation of this paper.

STRATIGRAPHIC POSITION OF THE DEVONIAN-CARBONIFEROUS PASSAGE BEDS OF EUROPE IN THE LIGHT OF PALEONTOLOGICAL INVESTIGATIONS

The correct stratigraphic position of the Devonian-Carboniferous passage beds, as well as the boundary between these two systems still remain controversial problems in spite of the many-years discussions and conclusions reached at the Carboniferous Congresses.

This is connected with the presence of different fossil groups in the Carboniferous Limestone and Culm facies which either impedes or altogether prohibits the correlation of profiles in these contrasting facies.

The orthostratigraphic subdivision of the Carboniferous is established on cephalopods. On their basis, at the First Carboniferous Heerlen Congress in 1927, the bottom of the Wocklumeria Stage was accepted as the lower boundary of the Carboniferous, but this was emended during the Second Heerlen Congress in 1935 (vide Paproth 1964). The resolution taken at the latter Congress, still in force, recommends to assign the lower boundary of the Carboniferous to the first appearance of the species *Gattendorfia subinvoluta*, i.e. between the Wocklumeria and Gattendorfia stages, hence slightly higher up than it had been previously accepted.

In most of the European profiles, however, cephalopods are absent from sediments on the Devonian/Carboniferous boundary and this has led to base the stratigraphy on other fossil groups, particularly on corals, brachiopods and trilobites. During the recent years special attention is being paid to microorganisms (foraminifers, ostracods, conodonts and spores). The parastratigraphic subdivision established on microorganisms, however, presents difficulties in their correlation with the orthostratigraphic one.

The majority of West-European authors, engaged in the biostratigraphic studies of sediments of the Carboniferous Limestone, where brachiopods, corals and foraminifers dominate, refer the lower boundary of the Carboniferous to the bottom of the foraminiferal Quasiendothyra kobeitusana Zone. This more or less corresponds to the base of the Etroeungt beds (Tn1a — Strunian calcaire = T n 1 a γ sensu Conil 1964) and their analogues, at the same time fitting into the cephalopod Wocklumeria Stage. Hence, this is nearer to the resolutions taken at the First Heerlen Congress.

In the USSR the lower boundary of the Carboniferous system is by some authors placed at the base of the Wocklumeria Stage because of distinct changes in the faunal assemblages most readily detectable among benthonic organisms. At the Devonian/Carboniferous boundary these organisms are of a mixed character. The co-occurrence may be observed of Upper Devonian forms with typically Tournaisian ones, as well as that of forms characteristic only of the Etroeungt beds with their equivalents (Yuferev 1974).

Some authors believe (i.a. Rotay & Stepanov 1975) that also the cephalopods encountered in the Wocklumeria Stage are transitory in last. The last clymeniids are still present here, i.e. Devonian elements, though the cephalopod assemblage of that zone differs from the typically Famennian one. Namely, special families (Wocklumeriidae, Glatziellidae and Parawocklumeriidae) make their appearance in association with genera characteristic already of the Carboniferous (*Imitoceras* and *Balvia*).

Yuferev (1974) supposes that the development of the fauna characteristic of the Etroeungt beds in the Dinant Basin had begun already at the close of the Famennian and persisted to the Middle Tournaisian (including Tn2b). It flourishes in the lowermost Tournaisian, from Tn1a to Tn1b. An analysis of the development of the fauna in the Russian Platform has suggested similar conclusions to Yuferev. The fauna characteristic of the Etroeungt beds and of their equivalents first appears here at the end of the Famennian, its acme takes place in the upper part of the Zavolzhsky and Malevsky horizons, the extinction in the Upinsky horizon. Yuferev believes that the maximum development of the Etroeungt fauna (including foraminifers, corals and brachiopods) took place at the base of the Quasiendothyra kobeitusana Zone (upper part of the Zavolzhsky horizon — the Ozersko-Khovanske beds) where most of the USSR authors postulate to place the Devonian/Carboniferous boundary. It is namely in this zone that a peculiar foraminiferal assemblage — Septaglomospiranella -Quasiendothyra — makes its appearance, as well as minute corals from the *Caninia* group and Carboniferous brachiopods (i.a. the genera *Avonia, Ovatia, Unispirifer*). A new ostracod assemblage, however, appears — in the opinion of Chizhova 1967 (fide Yuferev 1974) somewhat earlier — in the bottom parts of the Zavolzhsky horizon (Turgenevske beds).

Conodonts, occurring both in the Culm and the Carboniferous Limestone are, besides spores, an important group of fossils useful in the correlation of the particular European profiles.

In the Rhine Schiefergebirge the Upper Devonian conodont fauna has been worked out chiefly by Ziegler (1962, 1969), while Bischoff (1957) and Voges (1959) have dealt with the Lower Carboniferous one.

The uppermost Devonian in the typical Hönnetal profile contains the last conodonts from the genus *Palmatolepis* and the *Bispathodus costatus* group. Younger conodonts have, however, been found in the calcareous lenses of the Stockum profile in the Hengenberg shales. They occur above the beds with *Cymaclymenia euryomphala* and below the limestones of the Gattendorfia Stage and make up the peculiar assemblage described by Ziegler (1969) called the "Protognathodus-Fauna". This assemblage occurs in association with the cephalopods: *Prionoceras (Imitoceras) prorsum prorsum* and *P.* (Im.) *carinatum*. The "Protognathodus-Fauna" differs distinctly from the forms observed in the upper Bispathodus costatus Zone as well as from the lowermost conodont zone Protognathodus kockeli — Siphonodella sulcata of the Gattendorfia Stage. The stratigraphic position of the "Protognathodus-Fauna", therefore, corresponds in Ziegler's opinion (1969) to the top part of the Upper Devonian, i.e. it occurs just below the Tournaisian base (sensu Heerlen 1935).

Conodonts are much rarer in the uppermost Famennian of Belgium and France than they are in the Rhine Schiefergebirge.

In France, beds referred to Fa2d and Tn1a have the greatest thickness and probably they are most complete in the Avesnois region (the Etroeungt, Avesnelles and St. Hilaire profiles). The type profile of the Etroeungt Limestones (Tn1a) was chosen by Gosselet in 1857, in the Parq quarry located in the Etroeungt vicinity of Northern France (fide Mamet, Mortelmans & Sartenaer 1965). A description of the macrofauna from these beds has been given by Dehée (1929). The Etroeungt Limestones occur here in the uppermost parts of the profile and it has been accepted that the Tn1a/Tn1b boundary runs between the boundary of the Etroeungt Limestones and that of the black Avesnelles Limestones (Bouckaert & al. 1970). However, the conodonts from the limestones in the Etroeungt beds are not known. But, in the St. Hilaire profile, at the base of the Avesnelles Limestones, the presence has been observed of *Protognathodus kockeli* (Austin & Rhodes 1970).

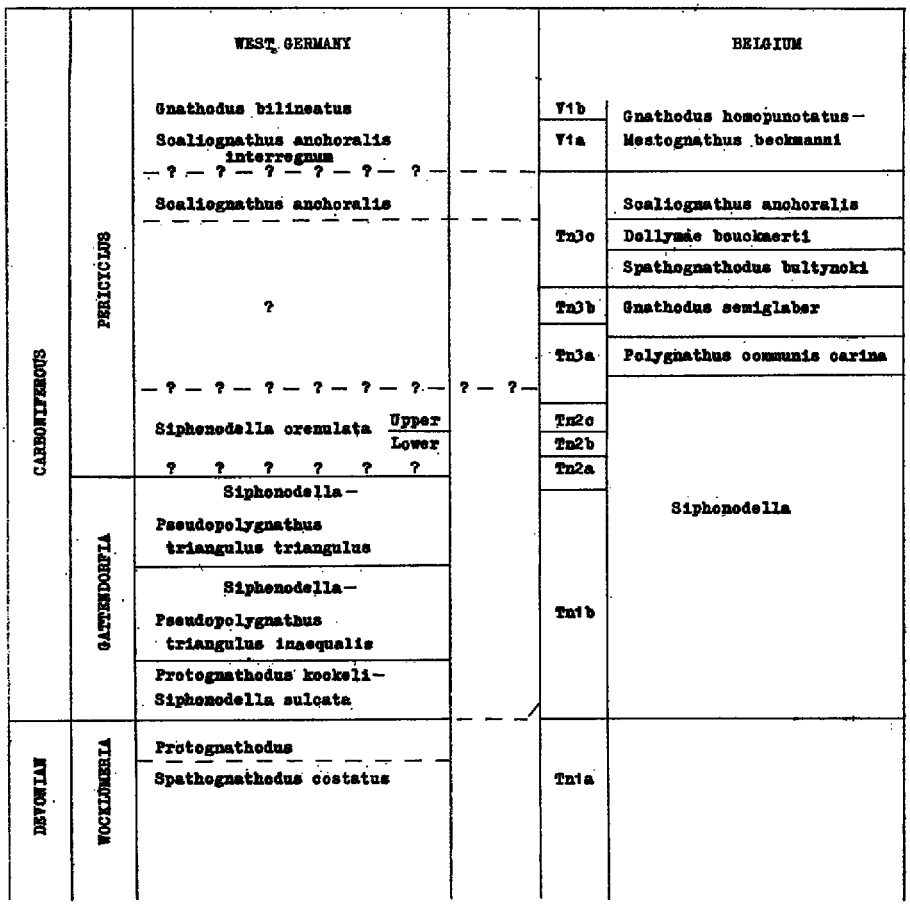
In the Ourthe valley in Belgium, the base of Tn1a has been assigned to the Chanxhe and Rivage profiles. It corresponds approximately to the bottom of the Comblain-au Pont formation sensu Mourlon 1875 and to Tn1a γ sensu Conil 1964 (Conil, Pirlet & Lys 1969, Mamet 1968). Below Tn1a the sediments occurring here are referred to by Conil (1964) as Tn1a β ("strunian greseux") and Tn1a α ("strunian schisteux") or Fa2d by Bouckaert, Streel & Thorez (1968). Their base is indicated by the appearance of spores from the Spelaeotriletes lepidophytus assemblage. The presence has also been noted here of *Spathognathodus costatus ultimus* (= *Bispathodus ultimus*), a species characteristic of the middle and upper conodont Bispathodus costatus Zone in the Rhine Schiefergebirge (doVI, Wocklumeria Limestones).

Bouckaert & Ziegler (1965) have described the conodont fauna from the Huy profile in Belgium from beds referred to Tn1a. It is supposed that this is a younger fauna than that described by Ziegler (1962) from the Wocklumeria Stage, but older than the conodont fauna from the base of the Carboniferous described from the Rhine Schiefergebirge by Bischoff (1957) and by Voges (1959) (vide Austin, Druce, Rhodes & Williams 1970).

Representatives of the Carboniferous genus *Siphonodella* have been observed in the lower parts of Tn 1 b in the Hastiere Limestones of the Hoyoux valley (Austin, Conil, Rhodes & Streel 1970). Hence in the Dinant synclinorium the base of Tn1b approximately corresponds to that of the Gattendorfia Stage in the Rhine Schiefergebirge.

The conodont fauna observed at the base of the coral "K" zone in the Bristol region (the Avon valley) of SW England does not contain the forms described by Ziegler (1962) from the Wocklumeria Stage, or forms identical with those observed by Voges (1959) in the lowermost Carboniferous (vide Austin, Druce, Rhodes & Williams 1970). Austin, Druce & al. (1970) suppose that the lowermost conodont zone actually present in the Bristol area (Patrognathus variabilis — Spathognathodus plumulus)

Table 1. Conodont zonation of Lower Carboniferous in Germany and Belgium (after Austin 1974) *



Spathognathodus costatus Zone = Bispathodus costatus Zone.

probably corresponds to the upper part of the first Carboniferous zone of the Rhine Schiefergebirge (Protognathodus kockeli — Siphonodella sulcata; vide Table 10 in the paper by Austin & al. 1970). On the other hand, the oldest conodont fauna observed in the northern part of Devonshire (the uppermost parts of the Baggy Beds and the lowermost ones of the Pilton Beds) is probably older than the Bristol fauna but younger than the conodont assemblage from the Bispathodus costatus Zone in the Rhine Schiefergebirge (Austin, Druce & al. 1970, Table 10).

* The stratigraphic subdivision of the Upper Tournaisian in Belgium (Tn3a--Tn3c) is obsolete. The actual subdivision is as follows:
Scaliognathus anchoralis Zone (=Tn3c)
Polygnathus communis carina Zone (=Tn3a to lower part of Tn3c) (*comp.* Groessens, Conil & Lees 1973, Conil & Groessens 1975).

In the USSR the bottom of the Wocklumeria Stage (with rare *Q. kobeitusana*) cannot be accurately traced because of the few occurrence sites of cephalopods, the sporadical and non-simultaneous appearance of the first *Q. kobeitusana*, also the inadequate knowledge of conodonts. From among these, *Spathognathodus costatus ultimus*, common in the Rhine Schiefergebirge and in Belgium, has so far been reported in the USSR only from the bottom of the Wocklumeria Stage in the Urals (Kononova & Lipina 1971). The base of the upper part of the Wocklumeria Stage (with *Cymaclymenia euryomphala)* corresponds in the USSR to the base of beds with *Quasiendothyra konensis* of the Southern Urals (Kononova & Lipina 1971), to the middle part of the Novotroicky horizon in the Donetz basin and to the bottom of the Quasiendothyra kobeitusana Zone in the Russian Platform (Yuferev 1974). Likewise, the bottom of the Gattendorfia Stage can be traced on the basis of cephalopods only in some regions (i.e. the Urals and in Kazakhstan; Yuferev 1974). Conodonts of the genus *Siphonodella* so characteristic of the Lower Carboniferous are known from the southern parts of the Urals (Kononova 1975) and from the Donetz Basin (Kozickaya & al. 1975).

The problem of the Devonian/Carboniferous boundary has been discussed at the Eighth Carboniferous Congress at Moscow in 1975. Miscellaneous variants of the location of this boundary have been considered but no definite conclusions have been reached owing to differences on the question of criteria advanced by the particular authors — as expressed in the numerous reports. These differences are responsible for the confusion now arisen in the nomenclature applied to the sub-divisions of the passage beds. At the present time controversial opinions prevail concerning the range of the Famennian, the position of the "Strunian" and the identification of the Tournaisian bottom with that of the Carboniferous.

As yet it is hardly possible undoubtedly to determine the position of the Devonian/Carboniferous boundary on the basis of materials from some profiles from Western Pomerania. In the first place this is due to the lack of knowledge of the complete flora and fauna of the uppermost Devonian and lowermost Carboniferous. Incomplete coring is another impediment in the tracing of vertical ranges of the fauna under consideration. Maybe, the biostratigraphic analysis of other borehole profiles from Western Pomerania (such as Grzybowo *1*, Karlino *1*, Wierzchowo *4)* will at least to some extent contribute to our knowledge of sediments from the Devonian/Carboniferous passage beds of this region.

However, taking into account the faunistic and palynological descriptions from the Chojnice region, so far available, it seems reasonable to place the Devonian/Carboniferous boundary at the base of Tn1a.

DEVONIAN-CARBONIFEROUS PASSAGE BEDS IN THE WESTERN POMERANIA

LITHOLOGICAL CHARACTERISTICS OF THE DEVONIAN AND CARBONIFEROUS DEPOSITS

The uppermost Devonian and Lower Carboniferous sediments under consideration have been observed in boreholes directly below the Zechstein of the southern part of the Koszalin-Chojnice region between Miastko and Chojnice (Western Pomerania, NW Poland) (Fig. 1, 2.) They consist of carbonate muddy and terrigenous sediments, occurring in variable proportions. The lack of the predominance of any one of the rocks above mentioned impedes a detailed lithological correlation of the particular

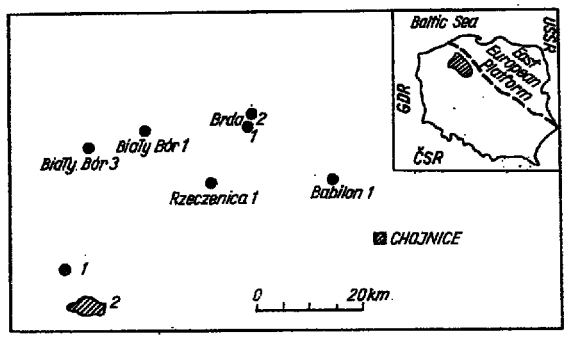


Fig. 1. Sketch map showing the localization of the selected boreholes in the Chojnice region

1 — boreholes, 2 — investigated area

profiles. Some resemblance of deposits has been observed in the profiles Babilon *1*, Brda *1* and Brda *2* though they differ chronologically. Carbonate deposits are dominant here. In the profiles Rzeczenica *1*, Biały Bór *1* and Biały Bór *3*, lying farther south-west from the boreholes mentioned above, the sediments have a more important admixture of muddy material. The constant presence of quartz in the aleuritic fraction is observed in all these profiles.

The description here given is based on the traditional methods of investigation and on the macroscopic examination of rocks and thin sections from the cored parts of the various profiles.

BABILON *1* PROFILE

Below the Zechstein, at a depth from 2618.7 to 3313.7 m, the development of the deposits displays monotony. They are represented by marly and organodetrital limestones alternating with marls or marly mudstones.

In the lower parts of the Babilon *1* profile — the 3313.7—2870.8 m interval — there occur compact, grey organodetrital limestones interbedded with marly limestones, sporadically intercalated by very fine marly mudstones. Micrite, less often sparite, are the main constituents of the organodetrital limestones. Terrigenous

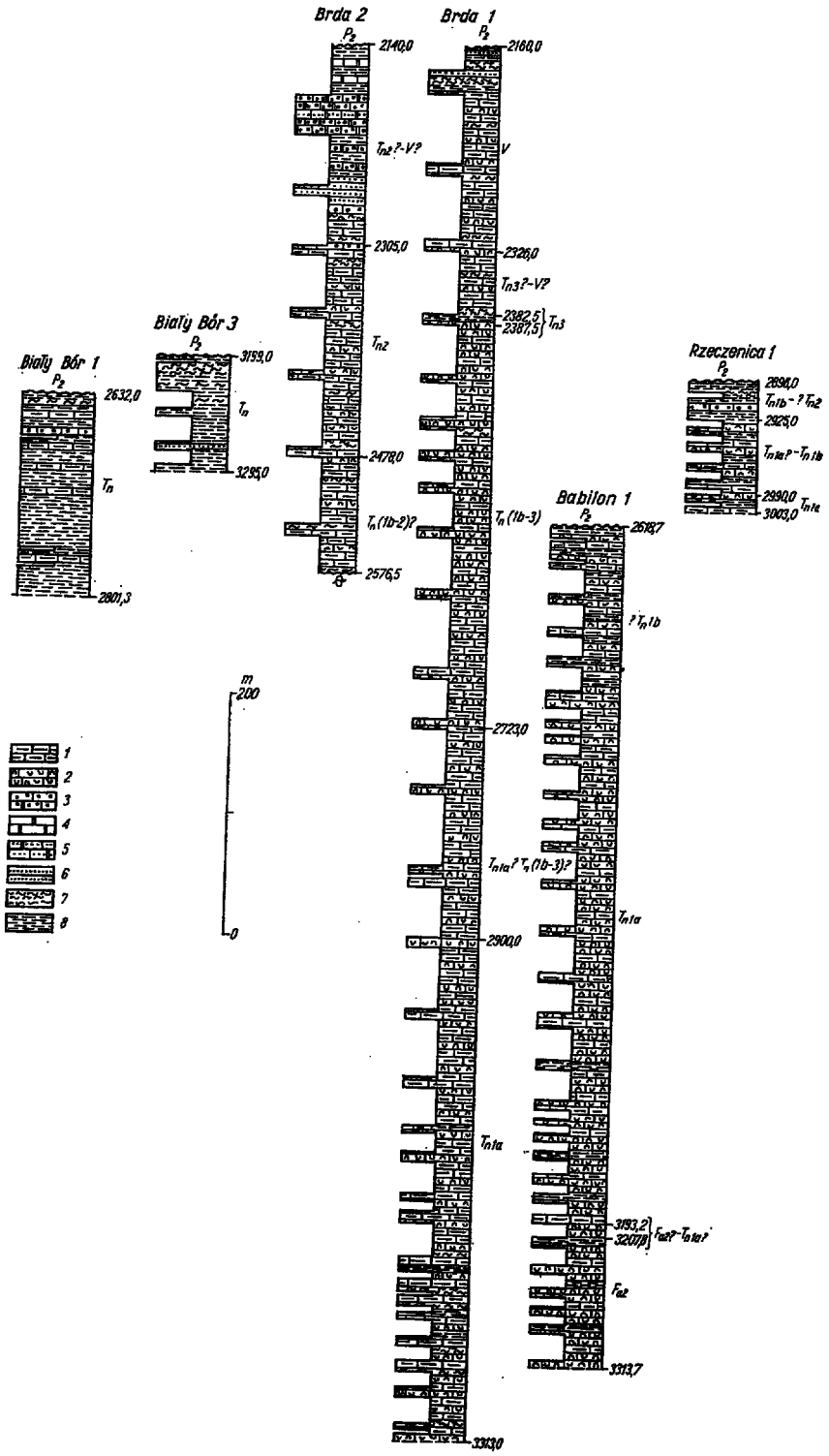


Fig. 2. Uppermost Devonian and Lower Carboniferous lithostratigraphic profiles from boreholes in the Chojnice region

1 — marly limestones, 2 — organodetrital limestones, 3 — oolitic limestones, 4 — dolomitized oolitic limestones, 5 — dolomitized sandy limestones, 6 — sandstones, 7 — siltstones, 8 — marly mudstones and marls

quartz in the aleuritic fraction and a muddy substance occur in subordinate amounts. Dolomite rhombohedrons and anhydrite, occurring either as minute nest-like accumulations or impregnating the faunal remains, are rarely encountered in the matrix. The grain components of the organodetrital limestones are represented chiefly by organic remains, varying in size, often conformably oriented. Echinoderms (trochites, less often echinoid spines), brachiopods, bryozoans, rarer lamellibranchs, gastropods and corals are in predominance. An examination of thin sections has also shown the presence of calcisfers, eucaryotic algae (from such genera as *Nonopora, Kamaenella, Girvanella)* also of thin micrite envelopes coating some minute organic remains.

In the marly limestones alternately interbedded with organodetrital limestones the percentage share of grain components, also of bioclasts is considerably lower, while holothurian sclerites, scolecodonts and plant remains are also encountered in the marly limestones.

In the higher part of the profile — beginning at the depth of c. 2870 m up to the top parts — a depth of 2618.7 m — there is a predominance of marly limestones, marls and mudstones, while the organodetrital limestones occur only as thin intercalations, some 10—15 cm in thickness. The faunal composition in this part of the profile resembles that mentioned above, but trilobites and more numerous lamellibranchs and gastropods may be encountered, too.

BRDA *1* PROFILE

The differentiation of sediments in this profile is somewhat stronger but it comprises a much longer time period than that of the Babilon *1* profile considered above. In the bottom parts of the Brda *1* profile (3313.0—3120.0 m) the presence is noted of grey marly limestones, locally organodetrital, regularly interbedded with grey siltstone. In the marly limestones terrigenous quartz occur in the aleuritic fraction. The fauna is represented by brachiopods, echinoderms, bryozoans, also lamellibranchs and gastropods, while thin sections show the presence of ostracods and algae from the genus *Girvanella*. In the silty intercalations the quartz grains (most of them 0.05 mm in size) are in micritic matrix, less often in muddy substance. Feldspars, mica and, occasionally automorphous dolomite occur, too. The fauna resembles that observed in the marly limestones, but is badly preserved. Fragments of crinoids, brachiopods, bryozoans, also of ostracods and numerous algae from the genus *Girvanella* are observable.

Between the depth of 3120.0 and 2650.0 m there is a predominance of marly grey limestones, partly organodetrital. Similarly as in the lower part of the profile, quartz in the aleuritic fraction is present, automorphous dolomite being very rare. There are no silty intercalations. The fauna is similar, too, but thin sections additionally show the presence of calcisfers.

In the 2650—2388.0 m interval, the predominant components are compact organodetrital limestones, exceptionally rich in organic remains and with rare thin intercalations of marly limestones, marls or marly mudstones. Sparite is as a rule the chief component of the organodetrital limestones. A marly substance and quartz grains in the aleuritic fraction are also encountered. The organic remains are represented by trochites, echinoid spines, bryozoans, brachiopods, lamellibranchs, gastropods and trilobites, also by ostracods and numerous foraminifers (from the genera *Cornuspira, Tournayella, Endothyra),* calcisfers and unusually abundant algae (*Girvanella* sp. and *Kamaenella* sp.).

Higher up between 2388.0 and 2375.0 m the occurrence is noted of extremely sandy organodetrital limestones, gradually passing from quartzy-calcareous siltstones with sporadical feldspars into quartzy-micaceous-feldspar siltstones, laminated by

dark grey mudstone. The limestones contain only brachiopods, crinoids, fragments of plants and algae from the genus *Girvanella*, while in the siltstones only badly preserved plant fragments may be found. This assemblage is much poorer as compared with that observed in the underlying organodetrital limestones.

Beginning at a depth of 2375.0 up to 2195.0 m there appear dark grey marly limestones, partly organodetrital, interbedded with marls or marly mudstones, with extremely fine intercalations of quartz-calcareous siltstones. The limestones contain a marly substance and quartz in the aleuritic fraction. Chalcedony accumulations are sporadically encountered — sometimes filling in the organic remains — also dolomite and trace anhydrite. The fauna is represented by brachiopods, lamellibranchs, crinoids, bryozoans, single corals, gastropods, calcisfers, ostracods and foraminifers. Moreover, algae (*Girvanella sp.*, *Kamaenella* sp.) occur in abundance.

In the top parts of the profile (between 2195.0 and 2179.0 m) the presence has been observed of variegated siltstones, streaked by mudstones, and sandstones. The siltstones contain quartz grains, a muddy substance, iron hydroxides and trace anhydrite accumulations. Crinoids, brachiopods, foraminifers and algae are detectable among very badly preserved organic remains. The sandstones are composed of quartz grains cemented by a muddy-dolomitic substance. Some crinoids and brachiopods have been detected among the sparse and poorly preserved organic remains.

BRDA 2 PROFILE

Carbonate deposits have been encountered overlying the Ordovician and underlying the Zechstein in the 2544.0—2181.0 m interval. In the lower part of the profile, at a depth between 2544.0 and 2350.0 m there occur light grey marly limestones, partly organodetrital, intercalated by grey-greenish quartz-calcareous siltstones with plant remains. Thin mudstone intercalations are also sporadically present.

The marly limestones generally have an admixture of terrigenous quartz grains in the aleuritic fraction, while automorphous dolomite grains occur rarely, those of anhydrite being but trace elements. In the more strongly organodetrital parts there occur crinoids accompanied by brachiopods, bryozoans, minute single corals and sporadically by lamellibranchs. Ostracods, foraminifers (from the genera *Earlandia, Septabrunsiina* and *Endothyra*), also algae (*Girvanella* and *Kamaenella*) are noted. Most of the fossil remains show signs of redeposition, as is suggested by their state of preservation and frequent conformable orientation.

In the siltstones the organic remains are considerably less abundant and not so well preserved, but the faunal assemblage there is much the same.

At a depth between 2350.0 and 2280.0 m there occur grey oolitic limestones with interbedding of marly limestones containing ooids and sporadical thin intercalations of marly limestones with terrigenous quartz in the aleuritic fraction, and of grey-greenish quartz-calcareous flora-bearing siltstones. The parts of the profile intercalated as mentioned above, are characterised by a repeated sequence: oolitic limestone interbedding with marly limestone, partly organodetrital containing ooids — marly limestone with quartz — quartzy calcareous flora-bearing siltstone. The oolitic limestones are characterised by the presence of thickly crowded ooids, 0.08—0.6 mm in size and of abundant organic remains represented by crinoid fragments, echinoid spines, ostracods and algae (from the genus *Kamaenella*). They are inserted in a sparite poorly dolomitized matrix. The matrix also locally contains terrigenous quartz, single, rather big potassium feldspar grains and trace anhydrite. The ooids show a typically radially-concentric construction while their nuclei consist most often of minute fragments of organic remains, less often of detrital quartz. Squeezing is often detectable among the ooids.

Overlying the oolitic limestones, in the 2280.0—2215.0 m interval, the presence has been noted of brick-coloured, poorly calcareous sandstones laminated by dark-grey mudstones, also intercalations of dolomitized limestones. Higher up, to the depth of 2181 m there occur dolomite-iron oolitic limestones intercalated by sandy dolomitized limestones, sporadically with interbeddings of dark-grey dolomitic siltstones streaked by grey sandstone.

The oolitic limestones are pinkish-grey in colour, usually porous and poorly fossiliferous. Their matrix consists of calcium carbonate and xenomorphous dolomite, seldom of anhydrite. Inserted in the matrix are few fragments of crinoids and sparsely dispersed ooids, while the allochtonous components are represented by quartz, potassium feldspars and fragments of volcanic rocks. Both, the ooids and the fragments of echinoderms have been subjected to dolomitisation. In rocks with the predominance of dolomitic cement there is no sharp boundary between the ooids and the matrix.

The dolomitized sandy limestones also have a pinkish colour, they are coarse-grained and porous. Here and there they are enriched in allochtonous components, such as grains of quartz, of potassium feldspars and fragments of volcanic rocks, or organic remains.

RZECZENICA 1 PROFILE

The lithology of the sediments here reached between 3003.0 and 2896.0 m is rather monotonous, consisting of marls and marly shales intercalated by marly limestones partly organodetrital, sporadically oolitic.

In the bottom part (between 3003.0 and 2916.7 m) the presence has been noted of marls, marly shales and thin intercalations of marly limestones, locally organodetrital. The fauna here is almost exclusively associated with the last named sediments. In this part of the profile there is a dominance of ostracods, echinoderms, bryozoans, brachiopods, subordinate lamellibranchs, gastropods and foraminifers from the family Ammodiscidae. The conodonts are rather few in the lower parts of the above interval, appearing in greater numbers above the depth of 2925.0 m The fauna displays certain features of redeposition, as is suggested by the state of preservation and space orientation. The matrix of the organodetrital limestones is marly, moreover, the presence is noted of terrigenous quartz in the aleuritic fraction.

Higher up, in the 2916.7—2911.7 m interval, besides marls and marly limestones, the presence is noted of limestones with ooids, even, of a thin lamina of oolitic limestone some 10—15 cm in thickness. The faunal assemblage occurring in these limestones is enriched in numerous calcisfers, algae from the family Dasycladaceae, also in foraminifers from the genera *Earlandia* and *Endothyra*. The oosparite intercalation noted at a depth of 2916.0 m is completely unfossiliferous. Sparite is the main component and in it are inserted loosely dispersed, variously sized ooids. They are, as a rule, single, roundish, with numerous concentric films. Ellipsoidal ooids are rather rare and have considerably fewer envelopes, double ooids occur, too.

The uppermost parts of the profile, at a depth between 2911.7 and 2896.0 m, are characterised by the presence of marls and quartz-calcareous plant bearing siltstones. The organic remains are chiefly associated with all the marls. Brachiopods, lamellibranchs, echinoderms and ostracods occur in small numbers. The main component consists, besides a marly substance, of automorphous dolomite grains and single ooids.

BIAŁY BÓR 1 PROFILE

In this profile, at a depth between 2801.3 and 2734.5 m the occurrence has been observed of marls and marly mudstones intercalated by marly limestones, partly organodetrital, and with thin interbeddings of grey siltstones. In the top part

of this interval there occur laminae of muddy siderite, a few centimetres thick. The fauna is represented by few brachiopods and crinoids. Higher up, at a depth between 2734.5 and 2690.0 m there occur dark-grey marls intercalated by marly limestones bearing fossil remains only of brachiopods, scolecodonts and ostracods. The interval between 2690.0 and 2644.8 m consists, besides marls, also of marly limestones enriched in grain components. Among them the presence has been noted of ooids, crinoidal detritus, intraclasts and terrigenous quartz in the aleuritic fraction. The textural arrangement of these components, also the state of their preservation, reasonably suggest redeposition. Moreover, cracks, a few centimetres deep, filled with marly limestone containing ooids, are encountered in the marly limestones.

In the top parts of the profile here considered (at a depth from 2644.8 to 2633.0 m) there occur dark-grey marly mudstones. The fauna here is represented only by inarticulate brachiopods, scolecodonts and holothurian sclerites. Variegated siltstones overlie these beds.

BIAŁY BÓR 3 PROFILE

In the lower part of the profile, at a depth from 3295.0 to 3210.0 m there occur black mudstones, partly slightly marly, with thin intercalations (from 10 to some 15 cm) of grey muddy siderites. There are also sporadical interbeddings of dark-grey poorly calcareous quartz sandstones with feldspars, also of quartz-carbonate-iron siltstones. The fauna is present only in the mudstones where the occurrence has been noted only of single trochites, brachiopods and ostracods. Pyrite occurs, too. In the higher parts of the profile (between 3210.0 and 3197.0 m) the presence has been noted of grey siltstones streaked by marly mudstones, locally variegated. Quartz grains, mica, plant detritus, also badly preserved faunal remains (single trochites and brachiopods) have been observed in the siltstones.

BIOSTRATIGRAPHY

The biostratigraphic subdivision followed in the present description of the upermost Devonian and Lower Carboniferous deposits in Western Pomerania (NW Poland) is that accepted in the Franco-Belgium area. The choice of this classification was made on the presence in the deposits here considered of a well defined fossil assemblage. Brachiopods are here the predominant macrofaunal remains, in some parts of the profile accompanied by lamellibranchs, sporadically by trilobites and corals, while foraminifers, conodonts, ostracods, calcisfers, algae and spores represent the microfauna. The brachiopods and conodonts have been worked out by the writer, the remaining macrofauna by Korejwo (1975, 1976), the spores by Turnau (1975a, b). The foraminifers and algae are reported upon merely as additional characteristics of the sediments under consideration.

Hence, this assemblage resembles that observed in the classic areas of the occurrence of the Carboniferous Limestone in the Franco-Belgium Basin (vide Paproth 1969). The stratigraphic subdivision of the Lower Carboniferous sediments in this facies, based on corals and brachiopods, has been worked out at a relatively early date (Dorlodot 1909, Delepine

1911, fide Paproth 1969). This subdivision does not provide data for reliable correlation of the various facies of Dinantian deposits, more stress has been laid during the latest years on the study of such microorganisms as spores, conodonts and foraminifers. The two first groups are particularly useful in stratigraphy and correlation owing to their occurrence both in the Carboniferous Limestones and the Culm facies.

The differentiation of cephalopod zones and the more closely determined conodont zones has proved impossible owing to the predominance in the profiles under consideration of brachiopods, the sporadical presence of conodonts (only in some intervals), and the lack of cephalopods. It has, therefore, been decided to use the same letter-symbols as in the Franco-Belgium Basin. Namely: Fa2 (a-d) for the Upper Famennian sediments, Tn1a for sediments possibly the equivalents of the Etroeungt beds, and Tn1b, Tn2 (a-c) and Tn3 (a-c) for the Tournaisian sediments.

The first complete description of the Famennian biostratigraphy from the typical profiles of the Dinant synclinorium in Belgium has been presented in 1968 by Bouckaert, Streel & Thorez. In their classification the uppermost Famennian (Fa2d) was characterised by the lower pusillites-lepidophytus (PL1) spore assemblage, its bottom being determined by the appearance of the form *Spelaeotriletes lepidophytus*. According to the latest investigations the Fa2d botom fits into the conodont Bispathodus costatus Zone, probably underlying the boundary somewhere between its lower and middle part. Consequently it runs slightly below the Wocklumeria Stage (doV/doVI) (Streel & al. 1975).

On the other hand, the Tournaisian bottom (Tn1a) is currently assigned in this region to the base of the foraminiferal zone Quasiendothyra kobeitusana, hence between the lower and middle spore assemblage pusillites-lepidophytus (PLi/PLm). This boundary fits into the middle or upper Bispathodus costatus zone (doVI) (Streel & al. 1975). The middle and lower parts of the higher pusillites-lepidophytus (PLm and PL_{21}) spore assemblage fit into the Tn1a, while the upper part ($PLs^{\varepsilon}{}_{3}s$_ already belongs to the lower parts of Tn1b (i. a. Neves 1972). The PLs(_$^{\varepsilon}$ spore assemblage has been observed in the Hangenberg shales (The Rhine Schiefergebirge — Paproth & Streel 1970) together with the "Protognatodus-Fauna" sensu Ziegler 1969, therefore, in accordance with the lower boundary of the Carboniferous system, suggested by the Second Heerlen Carboniferous Congress to the base of the Gattendorfia subinvoluta Zone which still fits into the top Devonian.

The worked out Upper Devonian conodont zonation is of universal importance throughout the globe. The definitions of these zones as well as their sequence are currently recognized according to Ziegler's (1962, 1971) standard classification.

The subdivision of the Lower Carboniferous of Europe, based on conodonts, is not so doubtless as that of the Devonian. There exist several

parallel classifications for the various regions. A unified division (Austin 1974) has recently been proposed, based on works of many German, Belgian and English Authors (Table 1).

The subdivision pattern of the Gattendorfia Stage, as based on conodonts, is most adequately documented in Rhine Schiefergebirge (Voges 1959, 1960), while the position of the conodont fauna above that stage and below the first Viséan zone with *Gnathodus bilineatus* is not so clear there (Matthews 1970, Austin 1974). In Austin's opinion (1974) it is better defined in Belgium. This author has presented a correlation of the conodont zones distinguished in Belgium and Germany with those of Great Britain and North America. Earlier correlations of these regions have been presented i.a. by Rhodes & Austin (1971), also by Collinson, Rexroad & Thompson (1971).

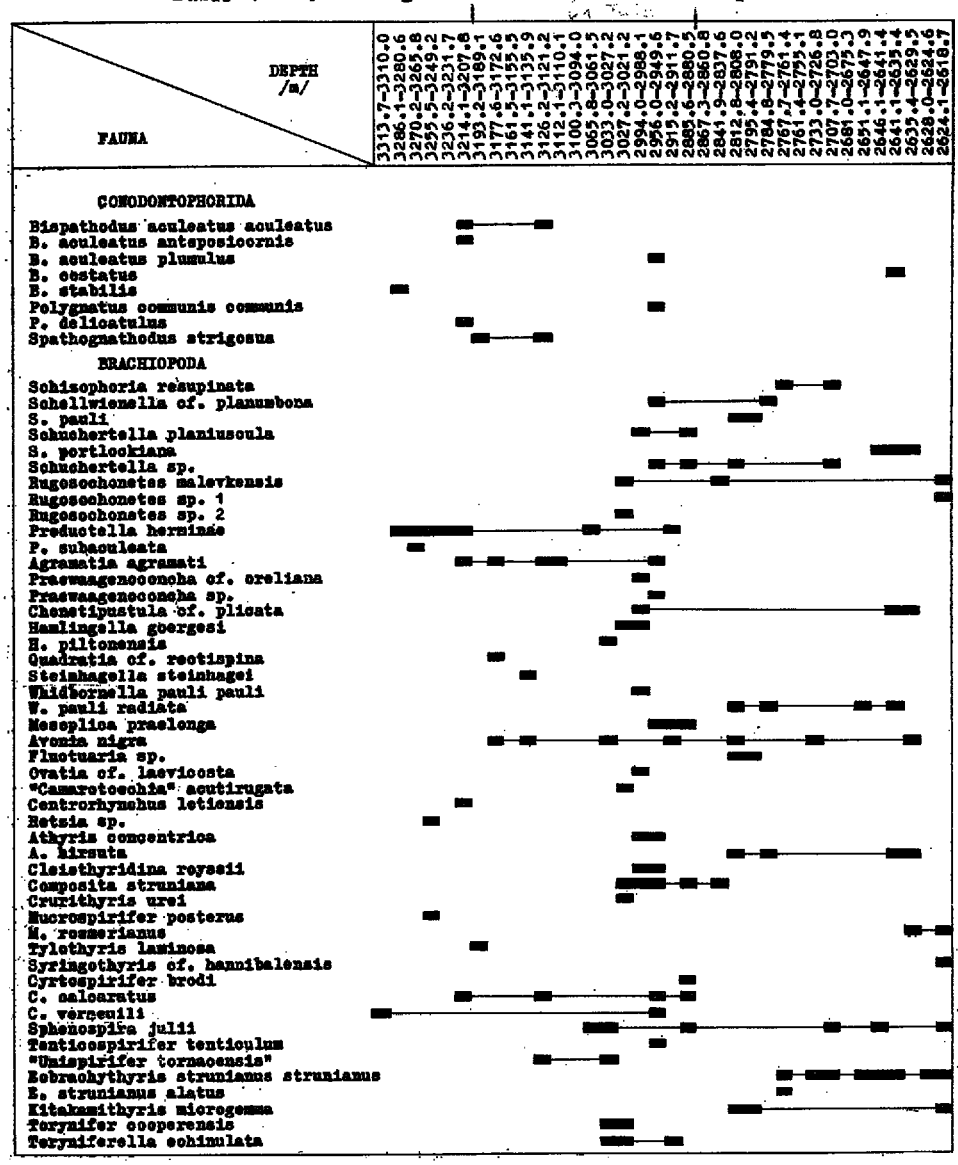
UPPER FAMENNIAN (Fa2)

The oldest sediments among those here considered belong to the Upper Devonian. They have been reached only in the 3313.7—3207.8 m interval of the Babilon *1* profile. Its paleontology is well characterised by the brachiopod assemblage and the spores, while conodonts have been found only sporadically and, therefore, are not so helpful.

The brachiopods occurring here (Table 2) are i.a. represented by such species as *Productella herminae* Frech, *P. subaculeata* (Murch.), *Mucrospirifer posterus* (Hall & Clarke), *Cyrtospirifer calcaratus* (Sow.) and *C. verneuili* (Murch.). Most of these forms have a long vertical range — Frasnian, Famennian — some have even been reported from slightly younger sediments (Table 2). The above species have previously been observed in the Famennian of other profiles in the Chojnice region of Western Pomerania (Matyja 1972, 1975a, b). Besides forms mentioned above in the Upper Devonian of the Babilon *1* profile, species characteristic only of the Upper Famennian have also been found, finally determining the age of the sediments under consideration. They are: *Agramatia agramati* (Nal.) and *Centrorhynchus letiensis* (Goss.). The first of these forms has so far been reported from the higher parts of the Yeletzke beds and from the Dankov-Lebedianske beds of the Russian Platform (Sokolskaja 1948, Sarycheva & Sokolskaja 1952) while the latter one is known from Belgian sediments not older than Fa2a (Sartenaer 1968, Bouckaert, Streel & Thorez 1968), it not being excluded that it may also pass into somewhat younger deposits (Tn1a) (Dehée 1929).

Conodonts have been encountered mostly in the top part of the interval here considered at a depth from 3214.1 do 3207.8 m. They are represented chiefly by the three following species: *Bispathodus aculeatus aculeatus* (Branson & Mehl), *B. aculeatus anteposicornis* (Scott) and *Polygnathus delicatulus* (Ulrich & Bassler). The first two forms are not reported from below the upper parts of the lower Bispathodus costatus Zone (Ziegler, Sandberg & Austin 1974) while the third one does not occur above the lower B. costatus Zone (Klapper *in* Ziegler 1975). Thus, these species determine the position of sediments from this interval as the upper parts of the lower B. costatus Zone (?Fa2c or even Fa2d) (Streel & al. 1975). The stratigraphic position of the underlying sediments from a depth between 3313.7 and 3214.1 m cannot however, be reliably determined on conodonts. *Bispathodus stabilis* (Branson & Mehl), has been encountered at a depth between 3286.1 and 3280.6 m. Taking into account the range of this species and the suggestions mentioned above, these sediments may still represent the lower B. costatus Zone as well as any other

Table 2. Vertical ranges of fauna in the Babilon *1* profile



of the lower conodont zones beginning with the upper P. marginifera Zone (Ziegler, Sandberg & Austin 1974). In the Belgian classification this would correspond to the time interval Fa2a to Fa2c and even Fa2d (Bouckaert, Streel & Thorez 1968, Streel & al. 1975).

By means of a spore analysis, Turnau (1975a) succeeded to distinguish at a depth from 3313.7 to 3249.3 m "spore assemblage 5" corresponding to Streel's assemblage VU (Fa2c), and — in the interval between 3236.3 and 3135.9 m — "spore assemblage 4" supposed to correspond to Streel's assemblage PLi (Fa2d). E. Turnau does not, however, exclude that sediments above 3193.2 m may, according to the Belgian classification, already represent TnIa.

On the basis of the above paleontological data, sediments from between 3313.7 and 3207.8 m have been referred to the Upper Famennian.

Tn1a

Sediments of this age have been encountered in the Brda *1*, Rzeczenica *1* and Babilon *1* profiles. An exceptionally interesting and rich brachiopod essemblage (Table 2) occurs in the cored parts of Babilon *1* profile, from 3193.2 m to the top of the profile i.e. 2618.7 m. The first species known from the Etroeungt beds and their age equivalents (Tn1a in the Belgian classification) make their appearance already at the base of the profile. Namely i.a. *Tylothyris laminosa* (McCoy), *Avonia nigra* (Goss.), *Steinhagella steinhagei* (Paul) and *"Unispirifer tornacensis"* (Kon) (Dehée 1929, Goldring 1957, Demanet 1958, Bouckaert, Streel & Thorez 1968, Conil & Pirlet 1970). Above the depth of c. 3065.8 m the brachiopod assemblage grows strongly more diversified the greatest specific abundance being noted in the 3065.8—2880.5 m interval. Among the most interesting forms are i.a. *Schellwienella* cf. *planumbona* Well., *Schuchertella planiuscula* (Sem.), *Rugosochonetes malevkensis* Sok., *Praewaagenoconcha* cf. *oreliana* (Moell.), *Chonetipustula* cf. *plicata* (Sarr. em. Kayser), *Hamlingella goergesi* (Paeck.), *H. piltonensis* (Reed), *Whidbornella pauli pauli* (Goldr.), *Mesoplica praelonga* (Sow.), *?Fluctuaria* sp., *Ovatia* cf. *laevicosta* (White), *"Camarotoechia" acutirugata* (Kon), *Cleiothyridina royssii* (Eveillé), *Composita struniana* (Dehée), *Crurithyris urei* (Flem.), *Cyrtospirifer brodi* (Venj.), *Sphenospira julii* (Dehée), *"Torynifer cooperensis"* (Swall.) and *Toryniferella echinulata* Brice. Alongside with species mentioned from the above interval some few other forms occurring in the lower parts of the profile are also encountered.

The assemblage just mentioned presents considerable interest in that it comprises brachiopods characteristic of the Upper Devonian as well as those associated with the Etroeungt (Tn1a) beds, but also genera typical of the proper Carboniferous (sensu Heerlen 1935). Among the Upper Devonian forms are, in the first place, species from the genera *Productella* Hall, *Agramatia* Sok., *Praewaagenoconcha* Sok., *Cyrtospirifer Nal.* and *Tenticospirifer* Tien (i.a. Nalivkin 1937, Sarycheva & Sokolskaja 1952, Liashenko 1959, Vandercammen 1959).

The forms characteristic of the Etroeungt beds and their age equivalents are apparently i.a. *Schuchertella* cf. *planiuscula* (Sem.), *Rugosochonetes malevkensis* Sok., *Hamlingella goergesi* (Paeck.) *H. piltonensis* (Reed), *Composita struniana* (Dehée), and *Sphenospira julii* (Dehée), (vide i.a. Dehée 1929, Paeckelmann 1931, Paul 1939, Krestovnikov & Karpyshev 1948, Goldring 1957, 1970, Demanet 1958, Conil & Pirlet 1970, Semikhatova & al. 1975). The genera undoubtedly Carboniferous are represented by *Chonetipustula* Paeck, *Fluctuaria* Muir-Wood & Cooper and *Ovatia* Muir-Wood & Cooper (Muir-Wood & Cooper 1960, Muir-Wood 1965).

Above the depth of 2880.5 m no Devonian species have been encountered, *Sphenospira julii* (Dehée) excepted, reaching to the top of the Babilon *1* profile, and *Whidbornella pauli radiata* (Goldr.) which appears beginning with the depth of 2812.8 m. Moreover, in the top parts of the profile (beginning with 2867.3 m) there occur several forms so far known from the age equivalents of the Etroeungt beds. They are: *Rugosochonetes malevkensis* Sok., encountered also in the lower parts of the profile and *Schellwienella pauli* (Gaillw.) and *Kitakamithyris microgemma* (Phill.) (Gallwitz 1932, Paul 1939, Weyer 1967, Semikhatova & al. 1975).

In the 2867.3—2618.7 m interval of the Babilon *1* profile there have been observed species known both from the Etroeungt beds (Tn1a) and those from the proper Tournaisian (sensu Heerlen 1935). Among them occur forms encountered also in the lower parts of the profile: *Schellwienella* cf. *planumbona* Weller, *Avonia nigra* (Goss.) and *Composita struniana* (Dehée), as well as those only just making

their appearance such as *Athyris hirsuta* (Hall), *Mucrospirifer roemerianus* (Kon.), *Syringothyris* cf. *hannibalensis* (Swall.) and *Eobrachythyris strunianus strunianus* (Goss.), (vide Dehée 1929, Sarycheva & Sokolskaya 1952, Demanet 1958, Balashova 1969, Brice 1970, Conil & Pirlet 1970, Bublichenko 1971 & al.) The presence should also be noted of *Chonetipustula* cf. *plicata* (Sarr. em. Kayser) a form referred to the Lower Carboniferous (Paeckelmann 1931, Muir-Wood & Cooper 1960), occurring in the Babilon *1* profile below the depth of 2867.3 m.

In the interval here considered other macrofossils have been encountered besides the brachiopods, namely corals, lamellibranchs, trilobites. With a few exceptions, these contain forms regarded as typical of the Carboniferous (Korejwo 1975). *Phacops* (*Phacops*) *accipitrinus* (Phill.) so far regarded as an index species for the Etroeungt beds (Chlupač 1966, Alberti 1972 — fide Korejwo 1975) is, in the first place, such an exception.

Should it be accepted that the occurrence ranges of the majority of the brachiopods here mentioned are undoubtedly true, the sediments between 3193.2 and 2618.7 m would have all to be regarded as corresponding to Tn1a. The few conodonts (Table 2) do not, unfortunately, provide any help for the more exact age determination of sediments in this part of the profile. Namely: *Spathognathodus strigosus* (Branson & Mehl) observed between 3193.2 and 3189.1 m, also between 3126.2 and 3121.2 m is reported from the lower Palmatolepis marginifera Zone (Fa2a) to the age equivalents of the so called "Protognathodus-Fauna" (sensu Ziegler 1969) including (Ziegler & Leuteritz *in* Koch & al. 1970; Ziegler 1971) the upper part of Tn1a, possibly also the lowermost Tn1b (Austin 1974). *Bispathodus aculeatus plumulus* (Rhodes, Austin & Druce) from the 2956.0—2949.6 m interval, makes its appearance in the higher parts of the lower Bispathodus costatus Zone and persists including the Siphonodella sulcata Zone (Ziegler, Sandberg & Austin 1974). *Polygnathus communis communis* Branson & Mehl, observed at a depth from 2956.0 to 2949.6 m has a long vertical range and is known from the Upper Famennian and Lower Carboniferous (Bischoff 1957, Voges 1959, Boogaert 1967, Ziegler 1971), while *Bispathodus costatus* (Branson) found between 2641.1 and 2635.4 is reported from the lower B. costatus Zone to the lower parts of the Siphonodella sulcata Zone (Ziegler, Sandberg & Austin 1974).

On the basis of spores encountered in Babilon *1* profile within the 3193.2—2618.7 m interval, Turnau (1975a) has been able to distinguish three assemblages. "Assemblage *4*" (from 3236.3 to 3135.9 m) is regarded by that authors as an equivalent of Streel's PL_1 (Fa2d) assemblage, subject, however, to the reservation, that Tn1a may be present already beginning with 3193.2 m. "Assemblage *3*" between 3033.0 and 3021.2 m is by E. Turnau correlated with Streel's PLm and PLs_1 (Tn1a), and "assemblage *2*" (between 2994.0 and 2618.7 m) with Streel's assemblage PLs_2, possibly also with his PLs_3 all of which in that author's opinion belong to Tn1b *.

It is hardly possible to determine whether the sediments here considered contain any age equivalents of Tn1b. The presence of the proper Tournaisian (sensu Heerlen 1935) could reasonably be supported by the spore "assemblage *2*" (Turnau 1975a), by the occurrence of numerous Carboniferous lamellibranchs species (Korejwo 1975), as well as by that of some brachiopods, already previously mentioned. On the other hand, it might be disavowed by the occurrence (between 2885.6 and 2618.7 m) of *Phacops (Ph.) accipitrinus* (Phill.) (vide Korejwo 1975) and of such brachiopod species as *Whidbornella pauli radiata* (Goldr.), *Sphenospira julii* (Dehée) and *Kitakamithyris microgemma* (Phill.). So far these have been held as the index

* According to recent opinion of E. Turnau (personal communication) the spore "assemblage *2*" (Turnau 1975a) is entirely of the Tn1a age.

forms for Tn1a. It should, however, be taken into account that *Sphenospira julii* has been found in Belgium in the Modava profile of the Hastière Limestones above the Etroeungt Limestones with *Phacops* sp., but below the first occurrence site of the genus *Siphonodella* (Austin, Conil, Rhodes & Street 1970).

Sediments of the Brda *1* profile, reached between 3313.0 and 2900.0 m, are probably the equivalents of the higher parts of the Babilon *1* profile. This is indicated by the presence in common of such brachiopod species as: *Schellwienella pauli* (Gallw.), *Rugosochonetes malevkensis* Sok., *Whidbornella pauli radiata* (Goldr.), *"Camarotoechia" acutirugata* (Kon.), *Athyris concentrica* (Buch), *Cleiothyridina royssii* (Eveillé), *Composita struniana* (Dehée), *Cyrtospirifer calcaratus* (Sow.), *Sphenospira julii* (Dehée), *Eobrachythyris strunianus strunianus* (Goss.), *Kitakamithyris microgemma* (Phill.) and *"Torynifer cooperensis"* (Swall.) (Table 3).

Moreover, the Brda *1* profile has also yielded such Famennian species as *?Steinhagella membranacea* (Phill.), *Trifidorostellum posturalicum* (Rozm.) and *Torynifer praematura* (Hall) (Sokolskaya 1948, Sarycheva & Sokolskaya 1952, Goldring 1957, Rozman 1962, Bublichenko 1971; Kicuła & Żakowa 1972). It is also interesting to note the occurrence within that part of Brda *1* profile of species encountered in the uppermost Devonian and Lower Carboniferous. Among them are: *Leptagonia analoga* (Phill.) and *Rugosochonetes hardrensis* (Phill.) (Davidson 1864—65, Whidborne 1896, Demanet 1934, Nalivkin 1937, Paul 1939, Sarycheva & Sokolskaya 1952, Martynova 1961, Gaetani 1965, Brunton 1968, Kaliś 1969), also *Schuchertella semenovi* (Semikh. & al. 1975) mentioned i.a. from the Upinsky horizon and *Schellwienella burlingtonensis* Well. (Sarycheva & Sokolskaya 1952) from the Cherepetsky horizon of the Russian Platform.

In the Brda *1* as well as in the Babilon *1* profile, we are dealing with a mixed Devonian-Carboniferous brachiopod assemblage some forms in which suggest the assignment of these sediments to Tn1a.

The last interval supposedly still belonging to Tn1a is that part of the profile between 2906.0 and 2900.0 m where *Phacops* sp. has been encountered (Korejwo 1976). It is namely regarded that this genus does not pass the Devonian/Carboniferous boundary (sensu Heerlen 1935).

The single conodont specimens of *Polygnathus communis communis* Branson & Mehl and *Spathognathodus strigosus* (Branson & Mehl) observed in the lower part of the Brda *1* profile, between 3201.0 and 3187.5 m do not contribute any additional data in what age determination is concerned.

Sediments at the base of the Rzeczenica *1* profile, between 3003.0 and 2990.0 m (Table 4), have likewise been referred to Tn1a. The brachiopods here observed do not, however, represent such a strongly differentiated asssemblage as that encountered in sediments from the other two profiles here considered. Deposits of the Rzeczenica *1* profile probably represent but their minor fragments.

Of forms in common the presence should be noted of: *Leptagonia analoga* (Phill.), *Mucrospirifer* cf. *roemerianus* (Kon.), *Eobrachythyris strunianus alatus* (Goss.) and *Kitakamithyris* cf. *microgemma* (Phillips). Besides there occur: *Aulacella interlineata* (Sow.), *Athyris* cf. *sulcifera* Nal., *Crurithyris unionensis* (Well.) and *Cyrtospirifer* cf. *postarchiaci* Nal. so far not reported from any one of the profiles here under consideration. From among the forms just mentioned, *Athyris sulcifera* and *Cyrtospirifer postarchiaci* belong to Upper Famennian forms (Nalivkin 1937, 1947, Sarycheva & Sokolskaya 1952, Martynova 1961). *Aulacella interlineata* is known both from the Upper Devonian deposits and from the age-equivalents of Tn1a (Davidson 1864—65, Whidborne 1896, Dehée 1929, Gallwitz 1932, Abramian 1957, Sarycheva, Sokolskaya, Beznosova & Maksimova 1963), while *Crurithyris unionensis* has been reported from sediments coresponding to or younger than Tn1a (Weller 1914, Nalivkin 1937, Balashova 1960, Bublichenko 1971, Kalasnikov 1974).

In addition to the brachiopods other macrofossils have been observed in this profile. The most noteworthy one is a trilobite from the genus *Phacops* at a depth between 3003.0—2999.0 m, also some more closely indeterminate Clymeniida (Korejwo 1976) from a depth between 2993.6 and 2990.0 m.

The conodonts occurring in the Rzeczenica *1* profile between 3003.0 and 2990.0 m are represented by only a few species: *Bispathodus aculeatus aculeatus* (Branson & Mehl), *Bispathodus costatus* (Branson), *Polygnathus communis communis* Branson & Mehl and *Spathognathodus* aff. *inornatus* (Branson & Mehl). The first two forms make their appearance in the lower Bispathodus costatus Zone (Ziegler, Sandberg & Austin 1974), while the third one beginning with the Palmatolepis marginifera Zone (Boogaert 1967). Both, *Bispathodus aculeatus aculeatus* and *Polygnathus communis communis* have a rather long vertical range, but that of *Bispathodus costatus* is shorter and has not been reported higher up than the bottom parts of the Siphonodella sulcata Zone (Ziegler, Sandberg & Austin 1974).

TOURNAISIAN

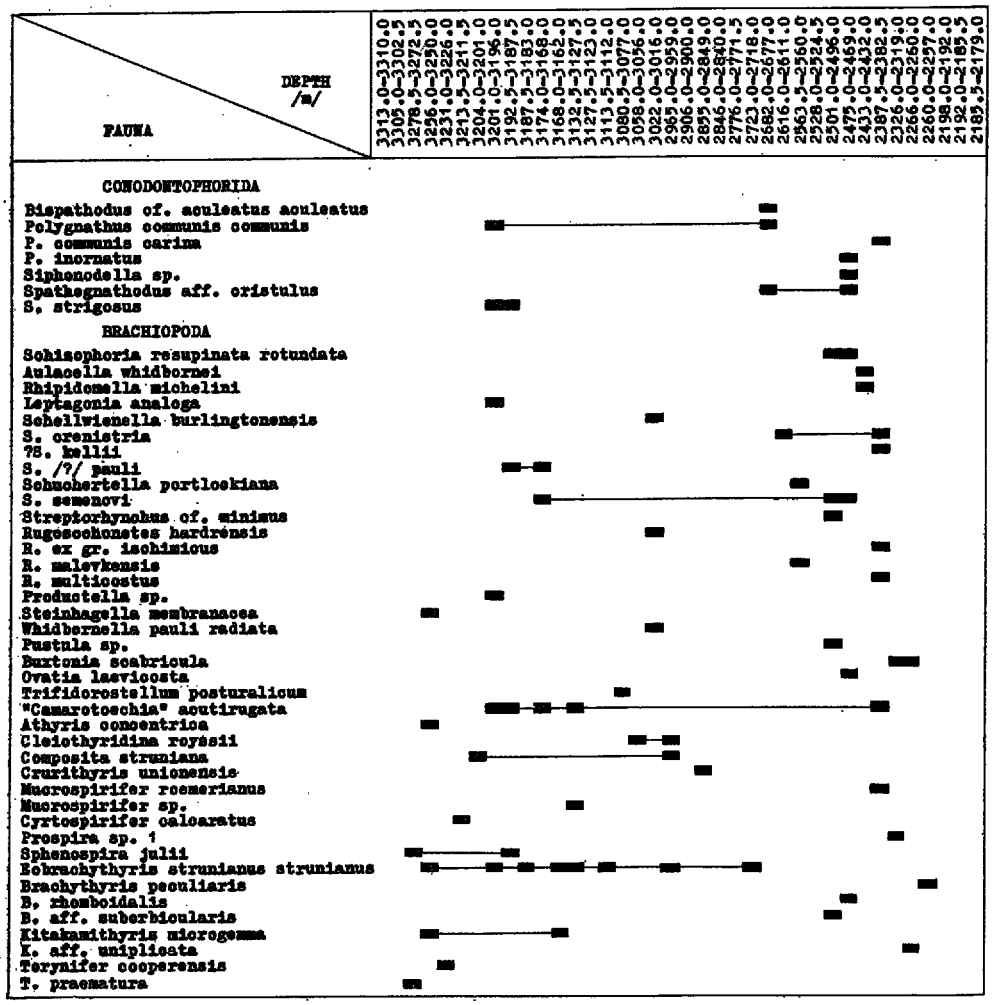
Sediments of the proper Tournaisian sensu Heerlen 1935 (without Tn1a) have been observed in the profiles of five boreholes, namely Brda *1*, and Brda *2*, Rzeczenica *1*, Biały Bór *1* and Biały Bór *3*.

The most complete Tournaisian profile is that of Brda *1* (Table 3). It has been differentiated here among sediments regarded as Tn1a and the Viséan, at a depth from 2723.0 and 2382.5 m. It has not, however, been possible more closely to determine the boundary between Tn1a and the younger sediments, nor to divide the Tournaisian into smaller stratigraphic subunits. It has been accepted that, in the Brda *1* profile, the interval between 2906.0 and 2900.0 still belongs to Tn1a. The first undoubtedly Carboniferous species appear beginning at a depth of 2723.0 m. The age of sediments from between 2900.0 and 2723.0 m cannot be accurately determined because of the incomplete coring and the scarcity of fauna. *Crurithyris unionensis* (Well.), the only form obtained there from a depth between 2855.0 and 2849.0 m has been reported both from deposits regarded as the equivalent of the Etroeungt beds (Tn1a) and from Tournaisian strata, probably not higher up than the Middle Tournaisian (Weller 1914, Nalivkin 1937, Balashova 1960, Bublichenko 1971, Kalashnikov 1974). Hence the sediments just mentioned may represent either Tn1a only, or Tn1a together with younger deposits, or even only the proper Tournaisian. This last stage without any doubt occurs between 2723.0 and 2382.5 m, as is reasonably suggested by the presence — beginning from the depth of 2723.0 m — of several Lower Carboniferous trilobites, i.a. of the Tournaisian genera *Moschoglossis* (between 2723.0 and 2677.0 m) and *Phillibole* (between 2723.0 and 2718,0 m) (Korejwo 1976).

Within the interval accepted as the proper Tournaisian, the brachiopods are represented by the following forms: *Schizophoria resupinata rotundata* Dem., *Aulacella whidbornei* (Gallw.), *Rhipidomella michelini* (Eveillé), *Schellwienella crenistria* (Phill.), *?Sch. kellii* McCoy, *Schuchertella portlockiana* (Sem.), *Sch. semenovi* Sok. (passing from the lower parts of the profile), *Streptorhynchus* cf. *minimus* Gallw., *Rugosochonetes* ex gr. *ischimicus* Nal., *R. malevkensis* Sok., *R. multicostus* (Winch.), *Pustula* sp., *Ovatia laevicosta* (White), *"Camarotoechia" acutirugata* (Kon.), *Mucrospirifer roemarianus* (Kon.), *Eobrachythyris strunianus strunianus* (Goss.), *Brachythyris rhomboidalis* (McCoy) and *B.* aff. *suborbicularis* (Hall) (Table 3).

From among these mentioned above, *Schellwienella crenistria* and *Schuchertella portlockiana* belong to forms having a long vertical range, from Tn1a through the Tournaisian as far as the Viséan (Paeckelmann 1930, Gallwitz 1932, Paul 1939, Sarycheva & Sokolskaya 1952, Sokolskaya 1954, Abramian 1957, Demanet 1958, Kaliś

Table 3. Vertical ranges of fauna in the Brda *1* profile



1969). The remaining species are, however, essentially Tournaisian forms though some of them also occur in slightly older sediments. This applies to profiles from the Western Pomerania as well as those from other regions. Such is *Schuchertella semenovi*, a form occurring in the Tn1a sediments of the Brda *1* profile and in the Tournaisian, though as yet it has been mentioned exclusively from the Upinsky horizon to the Russian Platform (Sokolskaya 1954), moreover *Streptorhynchus* cf. *minimus*, *Aulacella whidbornei* both noted from the Etroeungt beds and the Tournaisian of the Rhine Schiefergebirge (Gallwitz 1932), also *Rugosochonetes malevkensis*, encountered in Tn1a of the Babilon *1* profile, in the Brda *1* profile in the Tournaisian, so far reported from the Malevsky horizon of the Russian Platform (Sokolskaya 1950, Semikhatova & al. 1975). Another noteworthy form is *Mucrospirifer roemerianus* (Kon.) observed in the Babilon *1* profile and in deposits probably corresponding to Tn1a, while in the Brda *1* profile it occurs in the Tournaisian, also *Eobrachythyris strunianus strunianus* (Goss.), a form typically characteristic of the

uppermost Famennian and Tn1a (Dehée 1929, Brice 1970), though it has also been reported from younger deposits, most likely including Tn3a (Demanet 1958, Conil & Pirlet 1970).

In the last cored interval (2387.5—2382.5 m) of the Brda *1* profile, there occur sediments belonging to the Upper Tournaisian. This is reasonably suggested by the presence of such brachiopods as *Rugosochonetes* ex gr. *ischimicus* Nal. and *R. multicostus* (Winch) (Weller 1914, Nalivkin 1937, Ballashova 1953, 1960).

Deposits recognised as Tournaisian, i.e. in the 2723.0—2382.5 m interval, contain alongside with brachiopods rather numerous gastropods, lamellibranchs, trilobites (Korejwo 1976), as well as conodonts. The latter are represented only by a few species, between 2682.0—2677.0 m, namely: *Bispathodus* cf. *aculeatus aculeatus* (Branson & Mehl), *Polygnathus communis communis* (Branson & Mehl) and *Spathognathodus* aff. *cristulus* Youngquist & Miller — the last named one occurring also between 2475.0 and 2469.0 m — *Polygnathus inornatus* Branson, *Siphonodella* sp. (2475.0—2469.0 m) and *Polygnathus communis carina* Hass (2387.5—2382.5 m) (Table 3). All these forms, the last one excepted, have rather long vertical ranges. Namely *Bispathodus aculeatus aculeatus* and *Polygnathus communis communis* appear in the Famennian, the former being reported still from the Middle Tournaisian in the lower Siphonodella crenulata Zone of the Rocky Mts. and in the lower part of the coral-brachiopod "Z" zone in NW England (Ziegler, Sandberg & Austin 1974). The lower S. crenulata Zone probably corresponds to the Tn2b of the Belgian division, while the lower parts of the English "Z" zone may be an equivalent of the Middle Tournaisian of Belgium (vide Austin 1974).

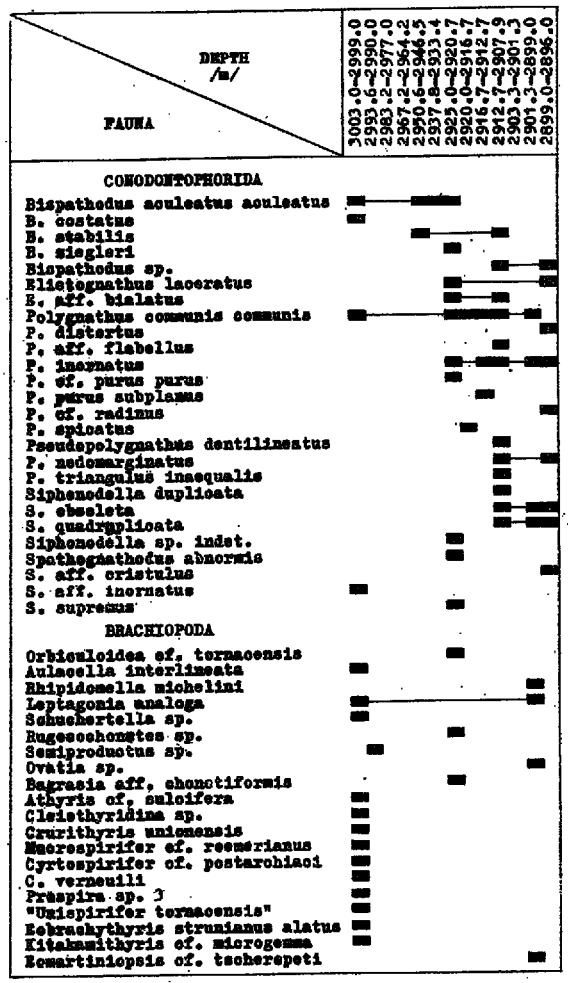
Polygnathus communis communis persists to the end of the Tournaisian and is still reported from the Scaliognathus anchoralis Zone of Germany (Voges 1959). This corresponds to Tn3c of the Belgian division (Austin 1974), but it may also occur higher up (Bischoff 1957). Out of the remaining ones, *Polygnathus inornatus* Branson and the genus *Siphonodella* have not as yet been reported from outside the Tournaisian (Voges 1959, Klapper *in* Ziegler 1975), while in Belgium the last named genus does not even pass Tn3a (Groessens 1971). Thus, all the conodonts encountered in this part of the profile fully confirm the Tournaisian age of the sediments here under consideration.

The Upper Tournaisian age of sediments from the interval between 2387.5 and 2382.5 m is reliably indicated by *Polygnathus communis carina* Hass. The range of this form seems to be connected solely with the Upper Tournaisian. The first appearance of this subspecies in Belgium has been observed in Tn3a (Austin 1974). In the Rhine Schiefergebirge, however, in Sauerland, it occurs in the Scaliognathus anchoralis Zone (Voges 1959) which corresponds to Tn3c of the Belgian division (Austin 1974). Rexroad & Scott (1964) also Thompson (1967) mention this subspecies from the Gnathodus semiglaber-Pseudopolygnathus multistriatus Zone of North America which is held as the equivalent of the lower part of the European Scaliognathus anchoralis Zone.

Thus, the minimum Tournaisian thickness in the Brda *1* profile seems to be c. 340 m.

Paleontologically documented Lower Tournaisian sediments have been observed beginning from the depth of 2925.0 m to the top parts of the Rzeczenica *1* profile i.e. 2896.0 m (Table 4). No brachiopods have been encountered in the 2990.0—2925.0 m interval, while the conodonts are here represented only by two species: *Bispathodus aculeatus aculeatus* (Branson & Mehl) and *B. stabilis* (Branson & Mehl) with fairly long vertical ranges. They are connected with the sediments of both, the Upper Famennian and the Tournaisian (Ziegler, Sandberg & Austin 1974). Furthermore, this interval has also yielded single specimens of lamellibranchs and gastropods (Korejwo 1976). The fauna mentioned above does not allow doubtless to determine

Table 4. Vertical ranges of fauna in the Rzeczenica *1* profile



whether both Tn1a and Tn1b or only Tn1b are present in sediments from a depth between 2990.0 and 2925.0 m.

A rather rich conodont assemblage has been found in the 2925.0—2920.7 m interval, made up of *Bispathodus ziegleri* (Rhodes, Austin & Druce), *Elictognathus laceratus* (Branson & Mehl), *E.* aff. *bialatus* (Branson & Mehl), *Polygnathus inornatus* Branson, *P.* cf. *purus purus* Voges, *Siphonodella* sp. indet., *Spathognathodus abnormis* (Branson & Mehl) and *S. supremus* Ziegler. This assemblage, *Bispathodus ziegleri* and *Spathognathodus supremus* excepted, is undoubtedly Carboniferous in age. *Elictognathus laceratus* makes its appearance beginning with the conodont Siphonodella — Pseudopolygnathus triangulus inaequalis Zone and persists to the Siphonodella crenulata Zone (Voges 1959, Klapper 1966, Thompson & Fellows 1970), *Polygnathus inornatus* has not so far been observed outside the Tournaisian (Voges 1959, Klapper *in* Ziegler 1975); *P. purus purus* is mentioned from the higher parts of the Siphonodella sulcata — Protognathodus kockeli Zone to the Siphonodella crenulata Zone (Voges 1959, Schönlaub 1969) while *Spathognathus abnormis* is known from the Kinderhook series of North America (Klapper 1966). From among the forms

here mentioned, *Elicognathus laceratus* indicates that, between 2925.0 and 2920.7 m we are dealing with a zone not lower than the second Carboniferous conodont zone Siphonodella — Pseudopolygnathus triangulus inaequalis. Hence, it is not excluded that the first Carboniferous zone Siphonodella sulcata — Protognathodus kockeli fits into the 2990.0—2925.0 m interval. The conodont zones here mentioned, as well as the next one Siphonodella — Pseudopolygnathus triangulus Zone are correlated in the Belgian division with Tn1b (vide Austin 1974).

The position of *Bispathodus ziegleri* (Rhodes, Austin & Druce) and of *Spathognathodus supremus* Ziegler is not clearly defined in the Carboniferous conodont assemblage, neither does it coincide with their vertical ranges so far currently held. *Bispathodus ziegleri* is noted beginning from the higher parts of the lower Bispathodus costatus Zone, *Spathognathodus supremus* from the middle B. costatus Zone. Neither of them has so far been found above the upper B. costatus Zone (Ziegler 1962, 1971; Sandberg & Austin 1974).

In the light of the available data it is hardly possible undoubtedly to determine whether these forms have been redeposited from older Upper Famennian sediments or if their vertical range in this regions is exceptionally long as compared with other areas, finally we may perhaps be dealing with stratigraphic condensation. This last hypothesis seems, however, to be the least probable one.

Brachiopods observed at a depth from 2925.0 to 2920.7 m are unusualy few. Three forms only have been encountered: *Orbiculoidea* cf. *tornacensis* Dem., *Rugosochonetes* sp. and *Bagrasia* aff. *chonetiformis* (Krest. & Karp.). The first one has so far been reported from Upper Tournaisian sediments (Demanet 1934, Żakowa 1971 b) while *B. chonetiformis* is mentioned from the Etroeungt beds of the south Urals (Krestovnikov & Karpyshev 1948).

The higher parts of the Rzeczenica *1* profile (2920.7 to 2896.0 m) contain an extremely abundant conodont assemblage alongside with some few brachiopods, lamellibranchs and gastropods.

Among the brachiopods the presence has been noted of: *Rhipidomella michelini* (Eveillé) — a form passing from the lower parts of the profile recognised as Tn1a — *Leptagonia analoga* (Phill.), *Ovatia* sp. and *Eomartiniopsis* cf. *tscherepeti* Sok. The two first species have a rather long vertical range (Gallwitz 1932, Demanet 1934, 1958, Nalivkin 1937, Sarycheva & Sokolskaya 1952, Brunton 1968), while *Eomartiniopsis tscherepeti* is a typically Tournaisian species and so far it has been reported from the Chernyshinsky horizon of the Russian Platform (Sokolskaya 1941, Sarycheva & Sokolskaya 1952).

In spite of the great specific variety of the conodont forms occurring in the 2920.7—2896.0 m interval it is hardly possible reliably to determine whether these sediments represent the complete Siphonodella — Pseudopolygnathus triangulus inaequalis Zone or if two younger zones are present here. With the just mentioned zone we are dealing to at least the depth of 2907.9 m. This would seem reliably indicated by the presence there of the index species of the zone, i.e. of *Ps. triangulus inaequalis* Voges (2912.7—2907.9 m) (Voges 1959, Meischner 1970), even though it has also been reported from a younger zone i.e. Siphonodella — Pseudopolygnathus triangulus triangulus in the Carnic Alps, (Schönlaub 1969), also by the occurrence of *Polygnathus purus subplanus* Voges (2916.7—2912.7 m) not known from above the Siphonodella — Pseudopolygnathus triangulus inaequalis Zone (Voges 1959, Schönlaub 1969).

Together with the above forms there occur: *Siphonodella duplicata* (Branson & Mehl), *S. obsoleta* Hass and *S. quadruplicata* (Branson & Mehl).

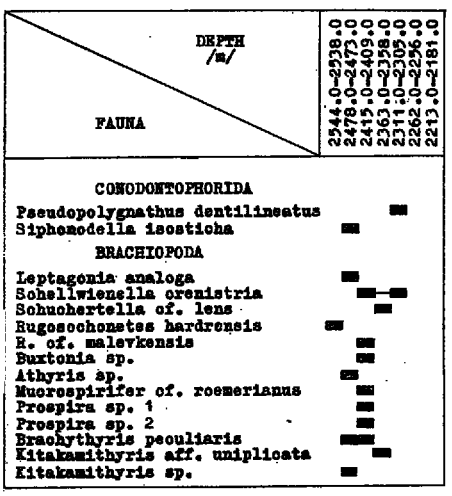
The conodonts encountered above the depth of 2907.9 m might only reliably suggest that sediments from the 2907.9—2896.0 m interval cannot belong to a zone

younger than the Siphonodella crenulata Zone, but that they may perhaps be older. This is indicated by the presence of *Elictognathus laceratus* (Branson & Mehl), *Polygnathus distortus* Branson & Mehl, *P.* cf. *radinus* Cooper, *Pseudopolygnathus nodomarginatus* (Branson) and *Siphonodella quadruplicata* (Branson & Mehl) (Bischoff 1957, Voges 1959, Klapper 1966, Klapper *in* Ziegler 1975, Rhodes, Austin & Druce 1969, Schönlaub 1969, Thompson & Fellows 1970).

In the Brda *2* profile sediments observed between 2544.0 and 2181.1 m. represent the complete Lower Carboniferous, with Tournaisian deposits undoubtedly present in the 2544.0—2305.0 m interval (Table 5).

The Lower Carboniferous age would, on the one hand, be suggested by the presence of a trilobite from the *Cumingella* genus (Korejwo 1976) on the other hand of that of several brachiopods and conodonts. Of material importance for the stratigraphy of these sediments is the presence of the conodonts *Siphonodella isosticha* (Cooper) between 2478.0 and 2409.0 m and that of *Pseudopolygnathus dentilineatus* Branson between 2311.0 and 2305.0 m. The range of the first of these species, so far reported, i.a. from Great Britain and the Mississippi Valley of North America, indicates that it is associated with the middle members of the Tournaisian. In Great Britain this species occurs in the higher parts of coral zone "K" in the conodont zone Siphonodella-Polygnathus inornatus (Rhodes, Austin & Druce 1969). In North America this is correlated either with the Siphonodella quadruplicata or the next S. isosticha — S. cooperi Zone (Rhodes & Austin 1971). In America the species *S. isosticha* makes its appearance in the upper parts of the Siphonodella quadruplicata Zone and persists throughout the Siphonodella isosticha — Siph. cooperi Zone (upper parts of the Hannibal Formation and the Choteau Formation; Collinson, Rexroad & Thompson 1971). The second of the above forms — *Pseudopolygnathus dentilineatus* (2315.0—2305.0 m) though with a long vertical range has never been reported from higher up than the Middle Tournaisian. In England it has not been observed above the Spathognathodus costatus costatus — Gnathodus delicatus Zone (Rhodes, Austin & Druce 1969) which, in North America, is correlated with the S. isosticha — S. cooperi Zone and in Germany with the upper S. crenulata Zone (Rhodes & Austin 1971). These two conodont species reliably permit to determine the age of this part of the Brda *2* profile as Middle Tournaisian.

Table 5. Vertical ranges of fauna in the Brda *2* profile



Brachiopods occurring in the Brda *2* profile, within the interval referred to the Middle Tournaisian (2478.0–2305.0 m) are represented by: *Leptagonia analoga* (Phill.), *Schellwienella crenistria* (Phill.), *Schuchertella* cf. *lens* (White), *Rugosochonetes* cf. *malevkensis* Sok., *Mucrospirifer* cf. *roemerianus* (de Kon.), *Prospira* sp. *1*, *Prospira* sp. *2*, *Brachythyris peculiaris* (Shum.), *Kitakamithyris* aff. *uniplicata* (Campbell) and *Kitakamithyris* sp. (Table 5). From among these forms *Brachythyris peculiaris* (Shum.) seems to be of the greatest significance. It is particularly characteristic of the Choteau Limestones of N. America which have been assigned to the Siphonodella isosticha — S. cooperi Zone. Moreover, it occurs in the Tournaisian strata of Kazakhstan (the Kassinsky horizon — Nalivkin 1937) and in the Urals (limestones of the Lytva horizon — Kalashnikov 1974).

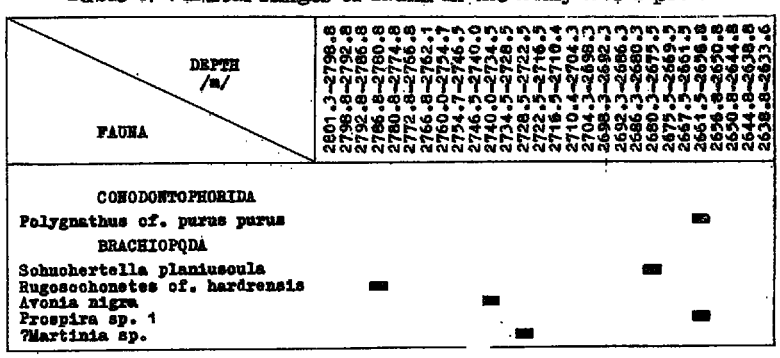
The top parts of sediments in the Brda *2* profile (between 2305.0 and 2140.0 m) lack faunistic documentation. It can only be supposed that they represent the Upper Tournaisian, possibly also the lowermost Viséan.

The accurate age determination of the sediments reached in the 2801.3–2632.0 m interval of the Biały Bór *1* profile is hardly possible owing to the extremely meagre fauna (Table 6). They cannot, however, be younger than the Middle Tournaisian. This is indicated by the presence of *Polygnathus cf. purus purus* Voges in the top parts of the profile (between 2661.5 and 2656.8 m), also of *Avonia nigra* (Goss.) between 2740.0 and 2734.5 m. The first form has not been reported higher up than the Siphonodella crenulata Zone (Schönlaub 1969), which, in the Belgian division would correspond to the Middle Tournaisian (Tn2b and Tn2c — Austin 1974d). Neither has *Avonia nigra* been observed above Tn2b (Demanet 1958, Conil & Pirlet 1970).

Besides *Avonia nigra* (Goss.), some brachiopods without much stratigraphic significance have also been found here. Namely: *Schuchertella planiuscula* (Sem. & Moell), *Rugosochonetes* cf. *hardrensis* (Phill.), *Prospira* sp. *1* and *?Martinia* sp. (Table 6).

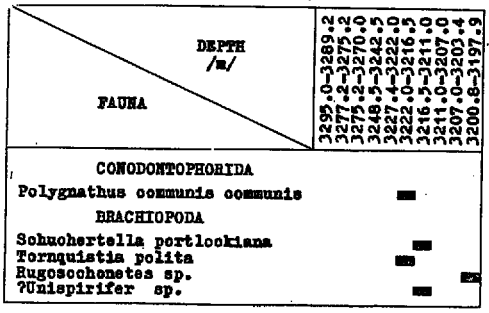
The sediments reached in the 3295.0–3194.0 m interval of the Biały Bór *3* profile, below the Zechstein, likewise bear a very poor fauna (Table 7). The only brachiopods yielded by the cored parts are: *Schuchertella portlockiana* (Sem.), *Tornquistia polita* (McCoy), *Rugosochonetes* sp. and *?Unispirifer* sp. These are very com-

Table 6. Vertical ranges of fauna in the Biały Bór *1* profile



mon forms, with the exception of *T. polita*, found at a depth between 3222.5 and 3216.5 m. It has not, so far, been reported from below the Middle Tournaisian (Tn2b) though it sometimes even reaches the Viséan (Paeckelmann 1930, Sokolskaya 1950, Demanet 1958). *Polygnathus communis communis* (Branson & Mehl) is the only conodont here encountered — a form with an exceptionally long vertical range.

Table 7. Vertical ranges of fauna in the Biały Bór *3* profile



Hence it seems that the Carboniferous sediments from the Biały Bór *3* profile are not older than Middle Tournaisian and that it is not excluded that the higher parts of the Biały Bór *1* profile may be their equivalents.

VISÉAN

Younger sediments have been also encountered above the Tournaisian in the Brda *1*, probably also Brda *2* profiles within the region under consideration (Table 3, 5). Korejwo (1976) has referred them to the Lower Viséan chiefly on the basis of brachiopods identified by the present writer.

Though a description of these sediments does not fit into the scope of the present paper, yet it should be mentioned that the elaboration of the conodonts has been helpful for the closer age determination of sediments from some intervals of the Brda *2* profile (see p. 513). Therefore, if the Viséan sediments do occur in the Brda *2* profile, they should be searched for in its top parts though no faunistic documentation is as yet available.

On the other hand, the Viséan sediments occur in the Brda *1* profile probably already at a depth of 2326.0 m. *Buxtonia scabricula* (Sow.) is its only age index. It is a form very characteristic of the Viséan of Germany and the USSR (Paeckelmann 1931, Sarycheva & Sokolskaya 1952, Litvinovich 1962, Kalashnikov 1974). Other brachiopod forms here encountered, such as: *Prospira* sp. *1*, *Brachythyris* cf. *peculiaris* (Shum.) and *Kitakamithyris* aff. *uniplicata* (Campb.) have also been noted in the Middle Tournaisian of the Brda *2* profile.

However, the occurrence in the lower cored interval (2387.5—2382.5 m) of the Upper Tournaisian sediments, as well as the presence of *Buxtonia scabricula* (Sow.) just mentioned, reasonably suggest the assignment to the Viséan of sediments from above 2326.0 m, the Tournaisian/Viséan boundary being most probably situated within the uncored interval between 2382.5 and 2326.0 m.

DEVONIAN-CARBONIFEROUS PASSAGE BEDS IN OTHER POLISH AREAS

Besides Western Pomerania, the Devonian/Carboniferous passage beds are also known from outcrops and borehole profiles in other Polish areas. Their detailed stratigraphy and Devonian or Carbonifetous age still remain an open question.

A short description of their characteristics is as follows:

LUBLIN REGION

The age of sediments occurring in the top parts of the Devonian here is variously interpreted.

In the central and western part of the Lublin Basin they are developed in the muddy-marly facies bearing a marine fauna (Niedrzwica beds). Their equivalents in the eastern part of the basin are dolomitic or variegated clastic deposits, occasionally conglomeratic, representing the littoral logoon-continental facies (Hulcza beds).

The Niedrzwica beds have been first differentiated by Miłaczewski & Niemczycka (1967) in the Niedrzwica *IG-1* borehole profile. They are c. 370 m thick and contain a very rich and diversified macrofauna as well as numerous plant remains.

In the Niedrzwica *IG-1* profile the brachiopods are represented by an assemblage, specifically and generically poor, but of great numerical abundance. It contains such forms as *Bagrasia chonetiformis* (Krest. & Karp.), *Productella* cf. *subaculeata* (Murch.), *Athyris* cf. *concentrica* (Buch), *Schuchertella* cf. *matyrica* (Nal.), *Plicochonetes nanus* (Vern.), *Hamlingella goergesi* (Paeck.). Because of the mixed Devonian/Carboniferous character of this fauna the "Upper Famennian — Strunian" age was initially assigned to the Niedrzwica beds (Miłaczewski & Niemczycka 1967), later on (Miłaczewski & Żelichowski 1968) it was accepted as "Strunian" (equivalent of the Wocklumeria Stage). Alongside with brachiopods and lamellibranchs, Kaliś (1969) found the following cephalopods in the Niedrzwica beds: *Glatziella* sp. and *Kallocymenia* sp. in Niedrzwica *2* profile and *Kosmoclymenia sedgwicki* (Münst.) in the Opole Lub. *5* profile. These are forms characteristic of the Wocklumeria Stage of Western Europe and seem of conclusive significance in the age determination of the Niedrzwica beds.

In the profiles worked out by Kaliś (1969) the brachiopods are represented by a rich assemblage. In the Niedrzwica *2* profile that author has observed the presence i. a. of: *Plicochonetes waldschmidti* Paeck., *Aulacella interlineata* (Sow.), *Schellwienella crenistria* (Phill.), *Productella herminae* Frech, *Mesoplica praelonga* (Sow.) and *Pugnax pugnus* (Mart.). The "Strunian" sediments in this profile are c. 200 m thick. The brachiopod assemblage reported from the "Strunian" sediments, c. 380 m thick in the Niedrzwica *3* profile, is markedly richer. Besides the forms just mentioned there also occur: *Athyris concentrica* (Buch), *Tylothyris laminosa* (McCoy), *Sphenospira julii* (Dehée), *Spinocyrtia struniana* (Goss.), *Kitakamithyris microgemma* (Phill.), *Spirifer tornacensis* Kon., *Bagrasia chonetiformis* (Kres. & Karp.), *Schellwienella umbraculum* (Schl.), *Praewaagenoconcha retiformis* (Krest. & Karp.). The presence is also noted in this profile of *Phacops (Phacops) accipitrinus* (Phill.).

Miłaczewski & Żelichowski (1970) have finally assigned the Upper Famennian age (including the Wocklumeria Stage) to the Niedrzwica beds.

The Hulcza beds, initially referred by Żelichowski (1966) to the Lower Tournaisian, have subsequently been recognised as the facial age equivalents of the Niedrzwica beds (Miłaczewski & Żelichowski 1968, 1970). Their thickness ranges from a dozen or so to c. 470 m.

The Niedrzwica and Hulcza beds are unconformably and with a sedimentary lacuna overlaid by Viséan sediments often underlaid by a tuffoidal series (vide Korejwo 1969, Żelichowski 1972).

HOLY CROSS MTS.

Our knowledge of the Devonian/Carboniferous passage beds in the Holy Cross Mts. is still incomplete owing to the inadequate data on the Famennian, particularly of its uppermost part, as well as owing to tectonic disturbances which often prohibit an undoubtful interpretation of the profiles.

The "Strunian" sediments are differentiated in this area on a mixed Devonian/Carboniferous fauna and on its correlation with microorganism as well as on the sedimentary continuity in some profiles.

Increased attention has been focused during the recent years by H. Żakowa on the study of the uppermost Devonian and Lower Carboniferous sediments. On the basis of materials from re-examined profiles this author has amended some earlier determinations. H. Żakowa also had at her disposal new valuable borehole data.

In the Gałęzice region sediments of the Wocklumeria Stage have been observed on the Besówka and Ostrówka hills. The presence of this stage in Gałęzice had already been suggested by Czarnocki (1928) and confirmed by the study of conodonts (Wolska 1967). The latter author has noted in the Besówka and Ostrówka hills the presence of the Bispathodus costatus Zone.

Wolska's stratigraphic classification of the Gałęzice Famennian has been revised and more precisely determined according to the standard subdivision of Szulczewski and Żakowa in 1976. These authors have ascertained that the youngest conodont assemblage from the Famennian of Gałęzice belongs to the middle Bispathodus costatus (do V?/VI) Zone. The uppermost part of the Wocklumeria stage (the upper B. costatus Zone), possibly also a part with the "Protognathodus-Fauna" has, not, however, been documented in Gałęzice.

In the Bolechowice region, the most representative borehole profile for the Devonian/Carboniferous passage beds is that of Bolechowice *1* where Famennian and Lower Tournaisian sediments have been found in the calcareous-marly facies. The presence of the Wocklumeria Stage is suggested by conodonts which indicate the middle, probably also the upper part of the B. costatus Zone (Freyer & Żakowa 1967). The thickness of this stage is c. 3.5 m. Overlying these sediments and underlying the Tournaisian with the Carboniferous genus *Siphonodella*, the occurrence has been noted of the "Strunian", c. 1 m thick, bearing a flora Devonian in character, but without the important pusillites-lepidophytus spore assemblage yielding Carboniferous ostracods (from the genera *Sansabella* and *Aurigerites*) and lamellibranchs characteristic of the Devonian/Carboniferous passage beds (subgenus *Posidonia/ /Karadjalia;* Żakowa 1967, 1970). The Tournaisian sediments belonging to the Gattendorfia Stage are also represented by marly-calcareous deposits, higher up passing into siliceous-muddy ones.

The continuous passage of the Devonian into the Carboniferous at Kowala has been suggested already by Czarnocki (1933, 1939) only on lithological grounds. A study of the trilobites (Osmólska 1962) has confirmed the presence of the Wocklumeria and Gattendorfia stages, while conodonts indicate the middle part of the Bispathodus costatus Zone (Wolska 1967). The sedimentary continuity of the Devonian and Carboniferous deposits in the calcareous-marly facies is stressed by Żakowa (1967, 1970).

Most probably there also occurs a continuous passage from the Devonian into the Carboniferous in the marly shales near Kielce (Karczówka). The trilobites found in a dumphill by Osmólska (1962) are represented by Upper Famennian forms (*Phacops wedekindi wedekindi* R. & E. Richter) and *Cyrtosymbole (Waribole) conifera* (R. & E. Richter), moreover by species with features typical already of the Carboniferous Proetidae.

In the Neptunian dykes occurring in the Dalnia hill near Kielce, the presence has been observed of an extremely abundant and unique fauna (i.a. with conodonts), characteristic of some Famennian and Tournaisian members. The conodonts represent a mixed assemblage varying in age (Szulczewski 1973). They supply evidence i.a. for the presence of the middle part of the B. costatus Zone. This assemblage also con-

tains forms from the genus *Protognathodus*. It is not clear, however, whether they indicate the uppermost Devonian — a part with the "Protognathodus Fauna" sensu Ziegler (1969) — or the lowermost Tournaisian. The assemblage here considered also contains numerous species i.a. from the genera *Siphonodella* and *Pseudopolygnathus*, indicating the presence of two first conodont zones of the Carboniferous (but also younger ones).

The "Strunian" sediments in the mudstone facies, c. 20 m thick, have been differentiated also on lithological grounds in the Miedzianogóra (Bęczków) syncline (Żakowa & Pawłowska 1966, Żakowa 1967, 1970).

In the Borków region (Jabłonna), similarly as in Kowala, the presence of the Wocklumeria and Gattendorfia stages has been observed on the basis of trilobites (Osmólska 1962). The trilobites from the first stage are accompanied by an abundant macrofauna. The conodonts worked out by Wolska (1967) suggest the B. costatus Zone.

In the Jabłonna *IG-1* profile (Żakowa 1974) the contact of the Devonian with the Carboniferous is tectonic. Between the B. costatus (probably its middle part) Zone and the Tournaisian sediments with *Siphonodella* (as observed by M. Sulczewski) there occurs a series of unfossiliferous deposits, such as tuffs, siltstones and radiolarites.

The sediments of the uppermost Devonian and Lower Carboniferous have also been found in the Łagów syncline, i.a. in the Zaręby *1, 2* and *3* borehole profiles (Żakowa 1971a). Two lithological complexes showing angular unconformity have been distinguished in these sediments: the lower marly-calcareous (Famennian) complex and the higher siliceous-mudstone (Tournaisian). Although the presence of the Wocklumeria Stage sediments within the area here considered has not been undoubtedly proved, but neither has it been excluded (Żakowa 1971a). In what microflora is concerned, as in the case of Bolechowice, no pusillites-lepidophytus spore assemblage has so far been observed.

From the above we may see that the "Strunian" deposits in the Holy Cross Mts. are developed chiefly in the calcareous and calcareous-marly facies and are connected with the neritic zone of the basin. Their thickness has been determined only at Bolechowice where it is c. 1 m, and at Bęczków, c. 20 metres.

CRACOW REGION

Devonian and Lower Carboniferous deposits are known only from outcrops in the Dębnik anticline. However, the presence of the Famennian in the area under consideration is still an open question.

The "Stromatopora outcrops" N of Dębnik, have been recognized by Jarosz (1926) as Upper Famennian. Overlying them he has observed Lower Carboniferous sediments with *Spirifer tornacensis* Kon. and *Productus burlingtonensis* (Weller).

A more complete Upper Famennian profile has been observed by that author S of Dębnik near the village Żbik. He has differentiated there the Upper Famennian, an age equivalent of the "Stromatopora outcrops" overlaid by the uppermost Famennian with brachiopods, i.a. *Orthothetes (Schellwienella) crenistria* Phill., *Productus fallax* Pander, *Productus (Productella) praelongus* Sow., *Athyris concentrica* Buch, *A. royssii* Eveille.

Paul (1939) and Żakowa (1965) supposed that the "Żbik outcrops" and the "Stromatopora outcrops" are equivalents of the Angertal beds from the Rhine Schiefergebirge.

However, the age determination of the "outcrops" seems rather doubtful in the light of the most recent investigations. The last results of the study on the Devonian of the Cracow anticline indirectly question the assignments postulated by Jarosz (Ślósarz & Żakowa 1975).

On the basis of a mixed Devonian/Carboniferous brachiopod assemblage (i.a. *Plicatifera fallax* (Pander), *Cyrtospirifer postarchiaci* Nal., *Athyris hirsuta* (Hall), Żakowa (1965) postulated the presence in the Karniowice *3* borehole profile of the Devonian/Carboniferous passage beds. The results of investigations of the conodont fauna (Chorowska 1975) from this and the adjacent profiles indicate that the Famennian is represented here only by its lower part. Żakowa's (Ślósarz & Żakowa 1975) revision of the macrofauna stresses the Lower Famennian age of sediments from the Karniowice *3* profile.

The results of investigations on the Devonian of the Cracow anticline supply important data for the Famennian stratigraphy of the Dębnik ridge and for the views on the age of the "Stromatopora" and "Żbik" outcrops. Żakowa (1965, 1975) sees a strong resemblance between the brachiopod fauna from the Karniowice *3* profile and the assemblage from the "Żbik outcrops", hence the Upper Famennian age of the latter sediments appears very doubtful.

MIECHÓW SYNCLINE

Towards the close of the Famennian, owing to movements of the Bretonian phase, the sea retreated from extensive areas of the Miechów syncline. However, there are zones where the complete Famennian sequence is suggested by sedimentary continuity of the Carboniferous. These are the Kobylniki-Radzanów region, and the Węgrzynów and Kazimierza Wielka-Dobiesławice area (Jurkiewicz & Żakowa 1972, Kicuła & Żakowa 1972).

CARPATHIAN FORELAND

Lower Carboniferous sediments have been observed in many boreholes of the Carpathian Foreland. They are represented here both by the Tournaisian and the Viséan. A continuous transition of the Devonian into the Carboniferous has been noted in the Załucze *1* profile (Żakowa 1963, 1968; Żakowa, Głowacki & Jurkiewicz 1963; Kicuła & Żakowa 1972). These sediments are developed as limestones and marls yielding a fairly abundant fauna. In the opinion of Żakowa & al. 1963) the sedimentary continuity in this profile is reliably suggested by petrographic investigations as well as by macrofauna: the occurrence of *Seminula struniensis* Dehée and *Prionoceras (Imitoceras) cf. intermedium* Schind. alongside with the Upper Devonian clymeniids from the genus *Postglatziella*. The overlying deposits have been recognized as Tournaisian on the presence of *Athyris puschiana* (Vern.).

In this profile the thickness of the Upper Devonian probably exceeds 100 m (the deposits with a mixed fauna being only a few metres) while the Carboniferous ones are c. 370 m thick (Żakowa & al. 1963).

SUDETES

In the Western Sudetes, Upper Devonian sediments have been observed in the Kłodzko and Świebodzice area (fide Oberc 1968).

In the Kłodzko area its occurrence is confined to Góra Wapnica at Dzikowiec, Łęczna, Ścinawa, Gołogłowy and Owcza Góra.

The most representative and most thoroughly investigated occurrence site is that at Dzikowiec. It has proved possible to differentiate in its lower parts the so called "Basic beds" some metres thick. They are overlaid by the "Main limestones" (30—40 m thick). In the top parts of the limestones the presence has been noted of foraminifers from the genus *Quasiendothyra* with great number of the species *Q.*

communis communis (Rauzer-Chernousova) (Górecka & Mamet 1970). The "Main limestones" at Dzikowiec is overlaid by red limestones (the so called "Clymenia limestones") yielding an abundant clymeniids fauna. Laterally they interlock with grey nodular limestones. The age of these limestones has been referred on the basis of conodonts to the middle part of the B. costatus zone (Chorowska 1974). *Quasiendothyra kobeitusana* (Rauzer-Chernousova) has i.a. been observed by Górecka & Mamet (1970) in the "Clymenia limestones". These are overlaid by "Gattendorfia limestones" and represent the lower part of the G. crassa Zone (fide Żakowa 1968). The presence of the second and third Carboniferous conodont zones: Siphonodella-Pseudopolygnathus triangulus inaequalis and Siphonodella-Pseudopolygnathus triangulus triangulus has been noted by Chorowska (1974). The absence of deposits younger than those from the middle part of the B. costatus Zone but older than the Siphonodella-Pseudopolygnathus triangulus inaequalis is referred by that authoress to an erosional lacuna and to tectonic disturbances.

In the Świebodzice depression the uppermost Devonian is fairly well paleontologically documented and it is represented chiefly by clastic sediments (Gunia 1968). The youngest Upper Devonian has been proved in the northern part of the Świebodzice depression in the neighbourhood of Cieszów and Pełcznica mostly on the basis of clymeniids trilobites. On these forms the Clymenia limestones and the marly shales with limestone lenses of Pełcznica have been referred (Gunia 1968) to the uppermost Famennian (doV and doVI). In Gunia's opinion shales with limestone lenses from the neighbourhood of Cieszów are of the same age.

DEVONIAN/CARBONIFEROUS FACIES AND PALEOGEOGRAPHY OF THE CHOJNICE REGION

Devonian and Carboniferous deposits were laid down in a sedimentary basin which stretched along the marginal zone of the East European Precambrian Platform. They lie on the folded Caledonian substratum (Bednarczyk 1974, Teller 1974, Znosko 1962, 1965, 1974) and are covered by Zechstein sediments (Dadlez 1974).

In spite of an inadequate knowledge of the Famennian and Dinantian deposits of this area it may be reasonably supposed that they have been formed under slightly different conditions in 2 zones in the shallow part of the basin.

In the first — shallower — zone, where deposits encountered in the Babilon *1*, Brda *1* and Brda *2* profiles have been observed (Fig. 1, 2), a calcareous-marly sedimentation dominated throughout the uppermost Famennian and the greater part of the Tournaisian. The Upper Famennian (Fa2), c. 106 m thick (but not pierced) has been found only in the Babilon *1* profile and it is represented mainly by organodetrital limestones, interbedded by marly limestones with thin intercalations of marly mudstones. The organodetrital limestones are made up of organic remains variously preserved, most of them damaged but not rounded. These fossil remains are often directionally ordered but not sorted according to size or weight. Echinoderms, brachiopods, ostracods, foraminifers, calcisfers and

eucaryotic algae predominate. Holothurian sclerites, scolecodonts and plant fragments occur in the marly interbeddings.

A similar type of sedimentation also prevails in the Tournaisian (beginning from Tn1a). Sediments of this age have been observed in the Babilon *1* and Brda *1* profiles. In the former they are a continuation of the Upper Famennian. Lithologically organodetrital limestones dominate over the marly limestones, particularly in the lower parts. The appearance in great abundance of terrigenous quartz in the aleuritic fraction — a constant admixture of Tn1a deposits — is, however, the most characteristic feature of sediments of this age. The increased affluence of quartz did not, however, affected the development of the benthonic fauna which is represented by the same assemblages as in the Tn1a sediments.

A change in the sedimentary conditions does not occur before the upper parts of the lowermost Tournaisian (top part of Tn1a, perhaps also Tn1b). A predominance sets in of marly sediments (marly limestones, marls and marly mudstones), while the organodetrital limestones grow subordinate. The faunistic assemblage resembles that in the organodetrital limestones, while the somewhat different conditions led to the appearance of trilobites and a great abundance of lamellibranchs and gastropods.

In the Brda *1* profile, the unpierced Tn1a beds resemble the top parts of Tn1a, perhaps also the Tn1b in the Babilon *1* profile. These are also marly limestones, locally organodetrital, bearing an analogous fauna. They only differ in the greater percentage of siltstones with feldspars, mica and flora. This may suggest an intermittently increased supply of terrigenous material into this part of the basin.

Tournaisian deposits, younger than Tn1a, are present in the Brda *1* and Brda *2* profiles. In the former there is a dominance of organodetrital limestones with thin intercalations of marly limestones, marls or marly mudstones with an extremely rich fauna. Quartz is here present, too. The uppermost Tournaisian part of this profile is very strongly sandy in character. The transition is observed of very sandy organodetrital limestones through quartz-calcareous siltstones with rare feldspars into quartz-mica-feldspar siltstones. This supply of terrigenous material, resulting from stronger erosion of the alimentary areas, has deteriorated organic life. The only forms here present are single brachiopods, crinoids, plant fragments and eucaryotic algae. At the turn of the Tournaisian and the Viséan, marly, often organodetrital limestones, marls and marly mudstones, also thin siltstones laminae are again deposited. This may suggest an intermittent decreased denudation. The rich fauna is represented by echinoderms, bryozoans, lamellibranchs, single corals, gastropods, calcisfers, ostracods and foraminifers.

During the Lower Viséan the supply of terrigenous material increases again changing the type of sedimentation into a clastic one. This re-

sults in the formation of siltstones and sandstones, chiefly variegated and bearing only crinoids, brachiopods, single foraminifers and algae.

In the Brda *2* profile the Tournaisian differs slightly in character. In the lower parts of the profile the sediments, probably representing the Lower Tournaisian (but without Tn1a) and a part of the Middle Tournaisian, resemble those of analogous age in the Brda *1* profile. They are marly limestones, partly organodetrital with flora-bearing siltstones. Beginning with the Middle Tournaisian, however, a decidedly shallower facies sets in. The characteristic sequence may be here observed from oolitic limestones through marly limestones with quartz to quartz-calcareous siltstones containing flora and feldspars. In the Upper Tournaisian variegated sandstones with limestone intercalations are sedimented, while at the turn into the Lower Viséan there formed dolomitic-iron limestones, oolitic and intercalated by sandy limestones, occasionally by siltstones and sandstones containing potassium feldspars and fragments of volcanic rocks. The fauna is represented by fragments of crinoids.

The here presented analysis of the character of sedimentation in the Babilon *1*, Brda *1* and Brda *2* profiles reasonably suggest that:

a) The unequal intensity in the supply of terrigenous material into the uppermost Famennian and Lower Carboniferous basin of the zone here considered indicates that the character of sedimentation is constantly affected by a more closely indeterminate alimentary area. This is most readily detectable in the Upper Tournaisian and Lower Viséan deposits.

b) The sedimentation of the Famennian and Lower Carboniferous deposits occurred in a shallow part of the basin. This is, in the first place, manifested by the considerable percentage of organodetrital limestones. The abundance of organic remains and their frequent directional order may suggest high water energy in this environment. The organic remains, however, are neither rounded nor sorted according to size and weight, but merely damaged suggesting their transport over short distances. The high periodical water energy of the environment also seems to be indicated by the local presence of ooids in the Middle (and ? Upper) Tournaisian observed in the Brda *2* profile.

The shallow-water environment might also be confirmed by the rather constant abundance of eucaryotic algae in the organic assemblage. Their presence would indicate that the euphotic zone reached to the bottom of the basin.

In a somewhat different part of the basin (probably deeper), were laid down Tournaisian sediments observed in the Rzeczenica *1*, Biały Bór *1* and Biały Bór *3* profiles (see Fig. 1, 2). Here the sediments are represented by marls and marly mudstones, also by subordinate marly limestones. There are sporadical very thin laminae of siltstones, sandstones and muddy siderites (Biały Bór *1* and Biały Bór *3* profiles), also of marls or oolitic limestones (Rzeczenica *1* and Biały Bór *1* profiles). No organodetrital lime-

stones have been observed in this zone outside the Rzeczenica *1* profile where they occur only as sporadical intercalations. Moreover, the percent content of terrigenous material in the deposits of this zone is considerably lower and not so constant as in the shallower zone considered above.

The Tournaisian sediments from the Rzeczenica *1*, Biały Bór *1* and Biały Bór *3* profiles are, moreover, characterised by their meagre faunal assemblage of organisms belonging to the sessile benthos. The presence is noted of ostracods, few brachiopods (often inarticulate) distinctly smaller in size than those observed in the Brda *1* and Brda *2* profiles. Scolecodonts and holothurian sclerites are more abundant while conodonts occur only in the Rzeczenica *1* profile.

The markedly poor benthonic assemblage of the Tournaisian in this part of the basin suggests unfavourable conditions for organic life in the near-to-the-bottom parts.

Some parts at the bottom of the basin were probably insufficiently oxidized, as is suggested by the bituminous character of the deposits and the presence of pyrite (Biały Bór *3* profile).

In the Lower Tournaisian (Rzeczenica *1* profile) shallow areas were formed locally and oolitic sediments occurred there.

In the marly limestones of the upper parts of Biały Bór *1* profile here representing the Tournaisian (?Middle), thin laminae have in fact been observed enriched in ooids, feldspars, quartz and containing intraclasts of marly limestones. However, their presence may reasonably suggest intermittent supply into this zone of sediments from more shallow areas.

An analysis of sediments from the Biały Bór *1*, Biały Bór *3* and Rzeczenica *1* profiles indicates:

a) a distinctly smaller and variable percent content of the terrigenous material and a considerably higher one of muddy substance;

b) a poor assemblage of the benthonic fauna and almost complete absence of organodetrital limestones in the rock assemblage; occurring as laminae of no more than a few centimetres thick (Rzeczenica 1);

c) this part of the basin was probably somewhat deeper, some areas of the bottom being badly aerated as is suggested by the bituminous character of the sediments and the presence of pyrite (Biały Bór *3*).

During the Upper Devonian and Lower Carboniferous the basin of NW Poland must have communicated to the west, across the present area of Rugia and Mecklenburg (German Lowland) with the Franco-Belgium basin while to the SE it was connected with the Lublin and Lvov-Volhynian Basins. These interconnections are suggested by strong faunistic similarities, particularly with the Franco-Belgium Basin. It is supposed that the basin of NW Poland stretched far NE and probably encroached the East-European Precambrian Platform (Korejwo 1969, 1975).

The littoral facies are absent from the Koszalin-Chojnice zone near to the present Devonian/Carboniferous boundaries. Hence it is supposed that these boundaries are erosional-tectonic in character (Dadlez 1974).

The Lower Carboniferous sediments of NW Poland resemble those of the NE part of the German Lowland and most probably they had been laid down within the same sedimentary basin. It seems, however, that the sediments of the Pomeranian profiles represent a shallower facies than that in the Rugia region, and that in Pomerania they have a higher percent content of terrigenous material and oolitic limestones (Korejwo 1969, Żelichowski 1972, Dadlez 1974). Żelichowski (1972) supposes that the denuded areas were situated within the zone of the Bretonian Pomerania--Holy Cross Mts swell with upraised areas overflooded during the Tournaisian.

Most unfortunately, the literature available to the writer lacks more detailed data on the Devonian sediments and the Etroeungt beds in Rugia. The Etroeungt beds, here referred to the Devonian, are represented by dolomitic-sandy-marly sediments, from 5 to 60 m thick (Hoffmann & al. 1975). In the Chojnice region, however, their thickness is several times that in Rugia. In the Babilon *1* profile they overlie the Famennian (Fa2) probably underlying the Tn1b. They are over 300 m thick, possibly greatly exceeding this figure. The exact delimitation of the Tn1a deposits from the lowermost parts of Tn1b — if these are present (see chapter on stratigraphy) — on the basis of the examined fauna has proved impossible. On the other hand, the Tn1a sediments have not been pierced in the Brda *1* profile and they are overlaid by deposits assigned to Tn1b and to higher members. The minimum thickness of Tn1a in this profile is c. 400 meters.

The distinctly greater depths of the Tn1a sediments in the Chojnice region, as compared with those in Rugia, indicate that, at the Devonian/ /Carboniferous turn, the sea bottom of the Chojnice basin was subjected to much stronger subsidence, compensated, however, by rapid sedimentation.

The Tournaisian thickness (sensu Heerlen 1935 i.e. Tn1b — Tn3c) seems to be much the same in the two areas mentioned above. In Rugia it ranges between 200 and 500 metres (Hoffmann & al. 1975).

In the Chojnice region, probably complete Tournaisian sediments have been observed in the Brda *1* profile. They are c. 400 m thick. In other profiles of the Chojnice region the Tournaisian sediments are represented only by some members of this stage.

High figures of the thickness of "Strunian" sediments, included into the Famennian, are likewise reported from the Lublin Basin (Miłaczewski & Niemczycka 1967, Miłaczewski & Żelichowski 1968, Kaliś 1969, Miłaczewski & Żelichowski 1970, Żelichowski 1972). These are calcareous, marly, fossiliferous sediments referred to as the Niedrzwica beds, c. 370 m thick, as for example in the Niedrzwica *IG-1* borehole.

In the classical regions of the occurrence of the Devonian/Carboniferous passage beds of Europe their thickness is markedly differentiated, but sometimes several times smaller than that observed in Western Pomerania.

In the Franco-Belgium Basin, the thickness of the Etroeungt beds s.l. ranges from over a dozen to over twenty metres (in the Etroeungt profile it is c. 18 m., in the Avesnelles profile c. 26 m., in the Hastière profile c. 22 m.), the beds with *Cymaclymenia euryomphala* not being much over 10 m (Paproth & Streel 1970, Fig. 1).

In the Rhine Schiefergebirge these figures are still smaller. In the type Hönnetal profile, the Wocklumeria Stage sediments (doVI) are a few metres thick, and those bearing *Cymaclymenia euryomphala* do not reach 1 m in thickness (Paproth & Streel 1970, Fig. 1).

In northern Devonshire the lower part of the Pilton Beds A is c. 370 m thick (Goldring 1970, Fig. 1).

In the central part of the Russian Platform (Moscow syneclise) the Zavolzsky horizon is from 30—40 m thick, the Malevsky horizon 5—20 m (Semikhatova & al. 1975). In the Donets Basin, however, the thickness of the Novotroicky horizon ($C_1^t a$) ranges from 5 to 220 metres (Rotay 1975).

Along the marginal zone of the Precambrian Platform, from the Lublin area to Rugia, diabase intrusions are noted, also tuffite sandstones and tuffites. In the Lublin Basin these intrusions are encountered at the bottom of the Middle or Upper Viséan regardless of the age of the underlying sediments; diabase dykes are likewise encountered in Rugia within Devonian and Dinantian deposits (vide Korejwo 1969).

In some Western Pomeranian profiles the presence of diabases has also been observed in Upper Dinantian (perhaps Namurian) sediments, also of sandstones tuffogenous in character, and of conglomerates containing fragments of volcanic rocks and tuffites (Korejwo 1975). Volcanic activity in regions mentioned above is connected with phenomena of the Variscan diastrophism, particularly of the Bretonnian phase. The present complicated block tectonics of the Sub-Zechstein substratum in the Koszalin-Chojnice zone are due to the Asturian or perhaps a younger phase (Dadlez 1974, Znosko 1974).

A survey of all the phenomena observable at the Devonian/Carboniferous boundary in the Chojnice region indicates that this area has an all-European significance for the clearing up of the problems connected with Devonian/Carboniferous passage beds and the boundary between these systems.

The whole of the Koszalin-Chojnice zone is likewise an important region connecting the classical occurrence sites of the Devonian and Carboniferous sediments of Western Europe with those of Eastern Europe.

It is hoped that the elaboration of additional material from borehole

profiles in Western Pomerania will perhaps compliment the data on the Devonian/Carboniferous passage beds and their correlation with simultaneous sediments in other European areas.

PALEONTOLOGICAL DESCRIPTIONS

Eighty four brachiopod species and subspecies belonging to 48 genera, and 32 conodont species and subspecies representing 6 genera, have been identified among the fauna found in several profiles from the Chojnice region.

The greatest difficulties encountered by the writer in the identification of brachiopods are due chiefly to the lack of new descriptions of this group. The few available more recent descriptions of brachiopods from the Upper Devonian and Lower Carboniferous in Europe concern selected species or genera. It seems, however, that many species, not seldom even genera, are conceived too broadly and their diagnostic features are not accurately determined. In the first place this applies to the family Spiriferidae some of whose species are approached with excessive generalisation deteriorating their stratigraphic usefulness.

Difficulties in the identification of brachiopods were also occasionally caused by the unsatisfactory state of their preservation (incomplete shells, and, foremost, damaged outer parts of valves impeding the examination of microornamentation, a feature of great generic significance). Brachiopods from the Babilon *1* and Brda *1* profiles are those relatively best preserved, the most numerous and strongly differentiated. They are characterised by generic and specific abundance but numerical meagreness.

Conodonts (honey-coloured) are on the whole well preserved but only rare and mostly single specimens occur in the profiles here considered. Conodonts from the Rzeczenica *1* profile are numerically and specifically most abundant, though represented by few individuals. The dominance of platform conodonts over the ramiform ones is well marked.

Fairly numerous eucaryotic algae and foraminifers have also been encountered in the sediments under consideration. However, merely their presence is reported in the present paper, a more detailed analysis of these group will be published separately.

Not all of the forms figured here have been described, but only those whose specific or generic assignments are controversial.

BRACHIOPODA

Genus *Rugosochonetes* Sokolskaya 1950

Rugosochonetes sp. *1*

(Pl. 4, Fig. 8)

Material. — One ventral valve.

Description. — Ventral valve rather big (c. 13 mm broad), much broader than long. Length of hinge line slightly less than the maximum valve width occurring at

its mid-length. Ears small, poorly distinguishable. Mid-part of valve broadly flattened. Capillae rather numerous (60) dividing near the beak and the anterior margin of valve.

Remarks. — In outline this form resembles *Rugosochonetes laguessiamus* (Kon.) (comp. Sokolskaya 1950, pp. 37—42, Pl. 4, Figs 1—33). From this species our form differs in a markedly latter ventral valve and the presence on it of a broad central flattening, also in fewer capillae.

Occurrence. — Western Pomerania, Babilon *1* profile, depth 2618.7—2624.1 m.

Rugosochonetes sp. *2*
(Pl. 4, Fig. 4)

Material. — One ventral valve.

Description. — Ventral valve minute, rounded-triangle shaped, strongly convex, with maximum width corresponding to length of hinge line. Beak small but strongly swollen. Ears small, rectangular. Rather narrow but relatively high elevation of central part of valve (mid-length). Valve covered by c. 30 capillae divided near to the beak and to the anterior margin.

Remarks. — In small dimensions, triangular outline and strong convexity of ventral valve medially elevated, this form closely resembles the species *Plicochonetes tricornis* (Sem.) (comp. Sokolskaya 1950, pp. 75—77, Pl. 10, Figs 18—20) from which it differs mostly in the presence on the radial costae of regularly arranged concentric rugae (feature characteristic of the genus *Rugosochonetes*), also in more minute and delicate capillae.

Occurrence. — Western Pomerania, Babilon *1* profile, depth 3021.2—3027.2 m.

Genus *Bagrasia* Nalivkin, 1960
Bagrasia aff. chonetiformis (Krest. & Karp., 1948)
(Pl. 8, Fig. 2)

Material. — One shell, almost complete.

Description. — Shell rather big, ventral valve convex, maximum width along the hinge line. Ears gently concave, beak sharply pointed and curved, just protruding above the hinge line. Dorsal valve slightly concave, the ventral one ornamented with very numerous, flatly lying, strongly elongated spines. Broad, flat concentric bands consisting of numerous minute spines predominate in anterior part of valve.

Remarks. — In outline and type of ornamentation the above form resembles the species *Bagrasia chonetiformis* (Krest. & Karp.) (comp. with Krestovnikov & Karpyshev, 1948, pp. 49—49, Pl. 3, Figs 19—21). It differs in bigger dimensions, considerably stronger convexity of ventral valve, more readily detectable and bigger ears, but foremost in the presence on the anterior part of valve of concentric bands made up of numerous minute spines. The latter feature brings our specimens close to the genus *Buxtonia* Thomas.

Occurrence. — Western Pomerania, Rzeczenica *1* profile, depth 2920.7—2925.0 m.

"Unispirifer tornacensis" (Koninck, 1887)
(Pl. 14, Figs 3, 7—8)

Material. — Several dorsal valves.

Description. — Valve rather small (up to 20 mm in width) semioval in outline, poorly convex, much broader than long, maximum width corresponding to length

of hinge line. Hinge line sharply pointed. Alae small. Costae ornamenting sides of valve — well over ten on either side of fold — rather broad, rounded. Fold only slightly protruding but distinctly indicated, delimited by two furrows deeper than those separating costae on the sides of valve. Fold with 5 costae, the two most outer ones running from the beak, the remaining three appearing lower down. Microornamentation poorly visible (effaced) as closely arranged imbricate growth lines.

Remarks. — The forms figured and described here are identical with those presented by Sokolskaya (1941, pp. 12—19, Pl. 1, Figs 1—14) as *Spirifer tornacensis* Kon. It seems, however, that both, the specimens from the Russian Platform as well as many others identified with the species *S. tornacensis* should be again worked out. Their generic and specific assignments also call for a revision, i.e. to be separated from the species created by Koninck and established as an independent genus. Some authors (Thomas 1971) have already postulated this suggestion. Today, the species *S. tornacensis* is too broadly conceived and made to include typical forms (of large size and with the characteristical sulcus pattern) as well as considerably smaller forms having fewer costae on the sides and on the sulcus. The species *S. tornacensis* s.l., has already been referred by some authors to other genera i.a. to *Spirifer*, *Unispirifer* (type forms), *Fusella* (small forms, especially from the USSR) (Campbell 1957, Maxwell 1961, Bublichenko 1971, Thomas 1971, Carter 1974).

Occurrence. — Western Pomerania, Babilon *1* profile, depth 3027.2—3033.0 and 3121.2—3126.2 m; Rzeczenica *1* profile, depth 2999.0—3003.0 m.

Genus *Prospira* Maxwell, 1954

Prospira sp. *1*

(Pl. 12, Figs 2, 7; Pl. 13, Figs 5, 7)

Material. — Several ventral valves.

Description. — Ventral valve rather small, slightly convex, beak small, narrow, hardly protruding above the hinge line. Ornamentation consisting of straight, low, rather broad costae (well over ten on either side of sulcus), separated by narrow furrows. Costae delimiting the sulcus broader than the remaining ones, occasionally bifurcating. Sulcus very narrow and deep. Microornamentation poorly preserved, showing only concentric, crowded, imbricate growth lines. Inside the ventral valve short, slightly divergent dental plates, basally thickened.

Remarks. — This form is referable to the genus *Prospira* Maxwell on its small dimensions, character of ornamentation (degenerated ornamentation of the median segment consisting of a narrow, fairly deep sulcus, one pair of delimiting costae and single, thick, rounded costae on the side segments), also on the inner structure (short thickened dental plates of ventral valve). Our form comes very near to the species *Prospira platynota* (Weller) (comp. Weller 1914, pp. 317—319, Pl. 39, Figs 1—10) and it also resembles some forms from the species *Imbrexia praeulbanensis* (Bubl.) (comp. Bublichenko 1971, pp. 88—89, Pl. 16, Figs 7—10; Pl. 17, Figs 1—8) but it differs from them in a very simple pattern of sulcus.

Occurrence. — Western Pomerania, Biały Bór *1* profile, depth 2656.8—2661.5 m; Brda *2* profile, depth 2409.0—2415.0 m; Brda *1* profile, depth 2310.0—2326.0 m.

Prospira sp.*2*

(Pl. 12, Fig. 13)

Material. — One ventral valve.

Description. — Ventral valve rather small, fairly convex, considerably broader than long, triangular in outline. Alae long, well indicated. Beak small, narrow.

slightly protruding above the hinge line. Costae ornamenting the valve straight, low, rounded and broad (c. 20 on either side of sulcus), separated by very shallow and narrow furrows. Sulcus very narrow but not too deep. Microornamentation consisting of crowded imbricate growth lines.

Remarks. — From *Prospira* sp. *1* our form differs in a distinctly triangular outline, greater number of costae on the sides of the ventral valve, much more narrow and shallow furrows and sulcus and in the normal width of costae delimiting the sulcus. *Prospira* sp. *2* comes very near to the Tournaisian species *Prospira typa* Maxw. (comp. Maxwell 1961, p. 92, Pl. 20, Figs 10—14) from Australia, but differs from it by a distinctly narrow sulcus.

Occurrence. — Western Pomerania, Brda *2* profile, depth 2409.0—2415.0 m.

Prospira sp. *3*
(Pl. 12, Fig. 8)

Material. — 2 ventral valves.

Description. — Ventral valve small (c. 15 mm) distinctly broader than long. Beak fairly robust, strongly curved but only slightly protruding above the hinge line. Costae ornamenting the valve few (c. 12 on either side of the sulcus), fairly broad, low. Besides costae delimiting the sulcus (only slightly broader than the remaining ones) and the medial costa, there is but one pair of secondary costae in the sulcus. Microornamentation consisting of thin, closely arranged imbricate growth lines.

Remarks. — *Prospira* sp. *3* comes very near to *Fusella osipovensis*, a species established by Beznosova (1959, pp. 69—71, Pl. 3; Figs 7—9). It differs therefrom in considerably smaller dimensions, and a strongly curved beak. Our form also resembles *Fusella taidonensis* (Tolm.) (comp. Tolmachev 1924, p. 177, Pl. 11, Figs 1—3; Sokolskaya 1941 pp. 19—21, Pl. 2, Figs 1—2), differing from the latter form in a narrower sulcus, fewer side costae and in the presence of but one pair of secondary costae in the sulcus.

Occurrence. — Western Pomerania, Rzeczenica *1* profile, depth 2999.0—3003.0 m.

Genus *Brachythyris* McCoy, 1844
Brachythyris aff. *suborbicularis* (Hall, 1958)
(Pl. 11, Fig. 9)

Material. — One ventral valve.

Description. — Valve fairly big (over 20 mm) slightly convex, semicircular in outline. Costae straight, rather broad, flat, few. Two costae delimiting the sulcus somewhat broader than the remaining ones. Sulcus narrow, rather shallow, distinctly indicated, steep-walled.

Remarks. — Our form in outline, character of ornamentation, and shape comes very near to the species *Brachythyris suborbicularis* (Hall) (comp. Nalivkin & Fotiyeva 1973, p. 70, Pl. 23, Figs 1—3). It differs, however from the latter form in having a considerably less convex ventral valve and a narrower sulcus with steeper walls.

Occurrence. — Western Pomerania, Brda 2 profile, depth 2496.0—2501.0 m.

Genus *Kitakamithyris* Minato, 1951
Kitakamithyris aff. *uniplicata* (Campbell 1955)
(Pl. 16, Fig. 8)

Material. — 2 dorsal valves.

Description. — Dorsal valve convex, broader than long, with rounded ends of hinge line. Maximum width of valve below the hinge line. Fold indistinctly indicated. Valve ornamented by well distinguishable imbricate growth lines showing bipartite radially arranged bases of spines.

Remarks. — The dimensions, outline and ornamentation of our form show close resemblance with the Australian species *Kitakamithyris uniplicata* (Campbell) (comp. Maxwell 1961, pp. 100—101, Pl. 20, Figs 23, 24). The difference lies in the fold of our form being much less distinctly indicated.

Occurrence. — Western Pomerania, Brda *2* profile, depth 2358.0—2363.0 m; Brda *1* profile depth 2260.0—2266.0 m.

CONODONTOPHORIDA

Genus *Elictognathus* Cooper, 1939
Elictognathus aff. *bialatus* (Branson & Mehl, 1934)
(Pl. 21, Figs 1, 2)

Material. — 2 incomplete specimens.

Description. — Form with arched blade, consisting of high, narrow denticles. On either side of blade its lateral ridges developed as fairly broad shelves (the inner one somewhat broader than the outer) whose margins are slightly upraised forming a sort of denticled parapets (the inner one somewhat higher than the outer). They are parallel to the main blade but not as high. The posterior end of the main blade directed slightly inwards. Basal cavity narrow and elongated as the blade. Keel anteriorly straight, posteriorly somewhat incurved behind the basal cavity.

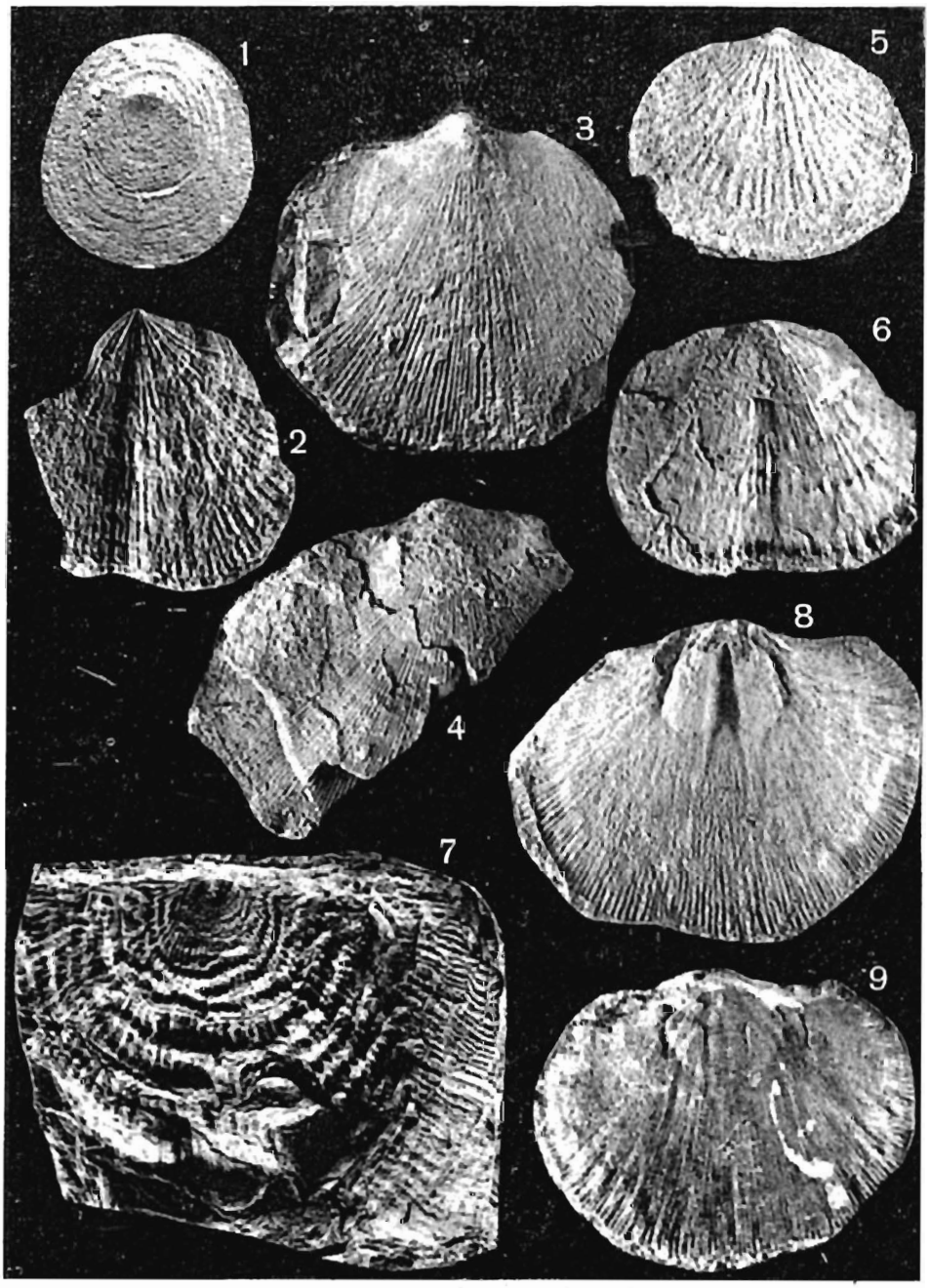
Remarks. — Our form closely resembles the species *Elictognathus bialatus* (Branson & Mehl) (comp. Branson & Mehl 1934, p. 273, Pl. 22, Fig. 11; Thompson & Fellows 1970, p. 81, Pl. 4, Figs 8, 9). From the latter form it differs in the presence of a well developed outer shelf-like ridge.

Occurrence. — Western Pomerania, Rzeczenica *1* profile, depth 2920.7—2925.0 m.; 2907.9—2912.7 m.

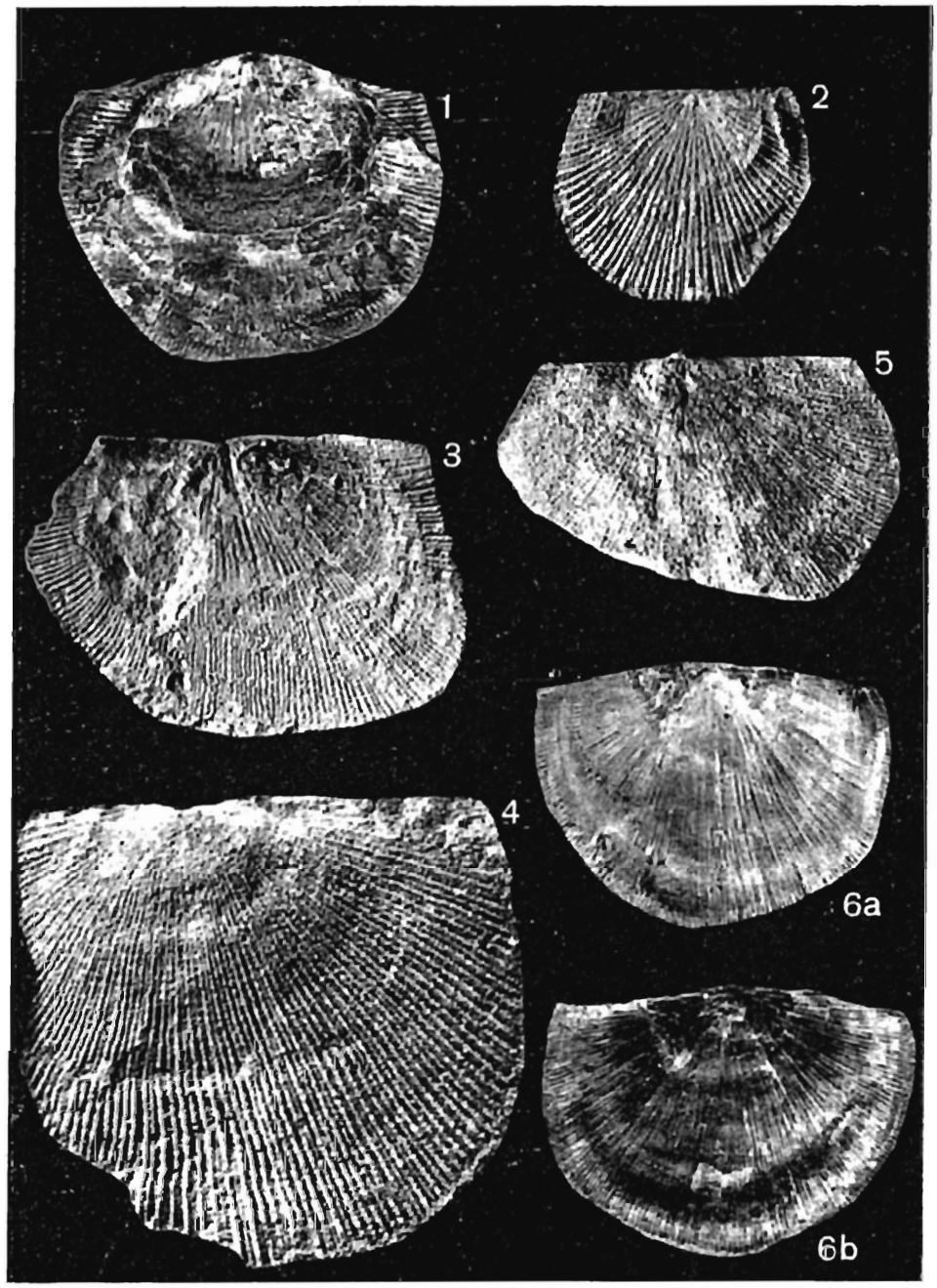
Genus *Polygnathus* Hinde, 1879
Polygnathus aff. *flabellus* Branson & Mehl, 1938)
(Pl. 21, Fig. 12)

Material. — One specimen.

Description. — Form somewhat asymmetric, fairly broad, with slightly arched platform bearing a free blade. Anteriorly the platform convex on either side, its inner side lobe-like. Carina in the anterior part of platform straight being the elongation of the free blade, above the basal cavity curved and running arcuately to the posterior end of platform. Top surface of platform ornamented with ridges not reaching to the carina. On the inner surface of platform near to the margin,



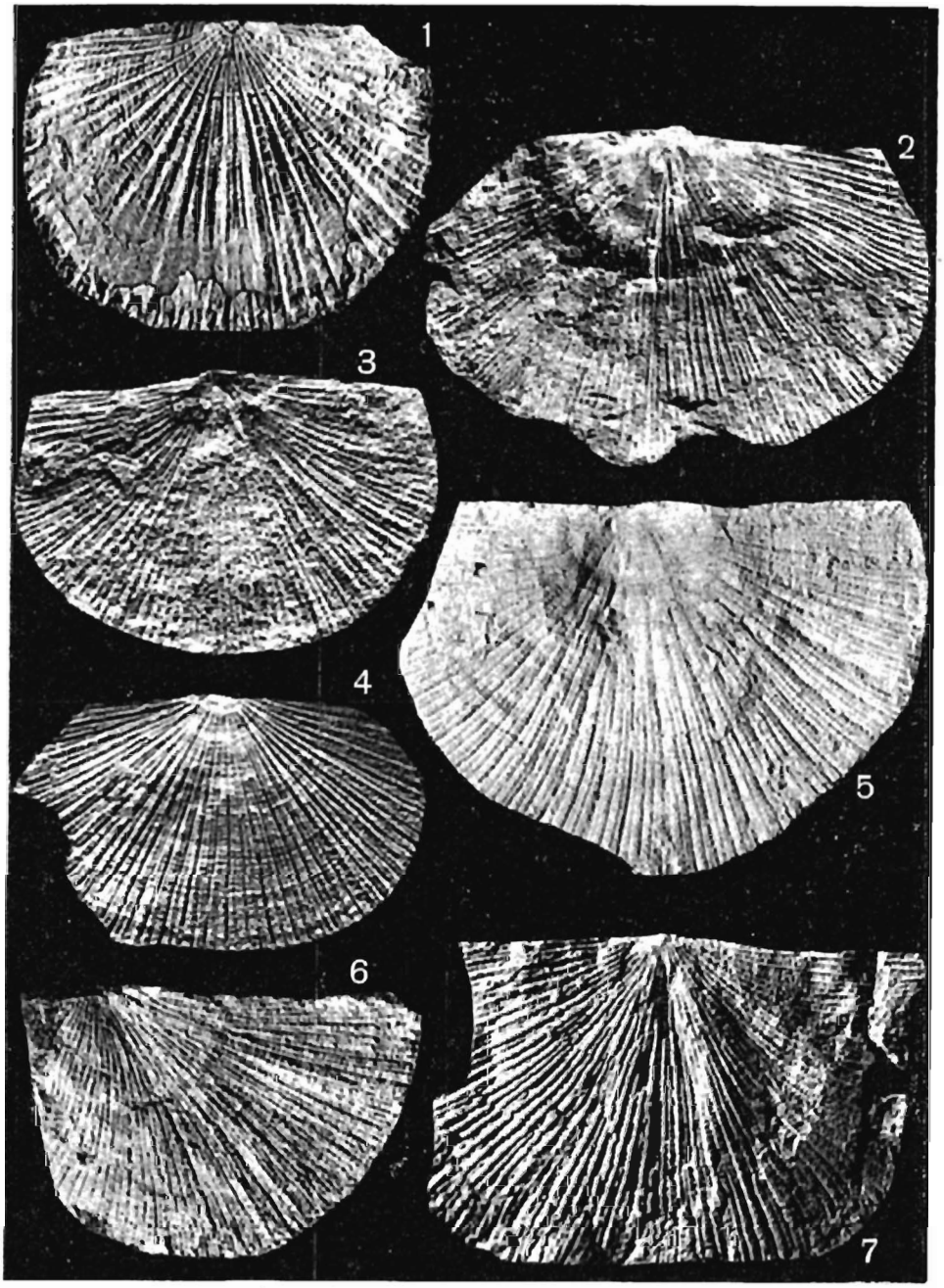
1 — *Orbiculoidea* cf. *tornacensis* Dem.; borehole Rzeczenica *1*, depth 2920.7—2925.0 m, ×8.
2, 6 — *Aulacella interlineata* (Sow.); Rzeczenica *1*, 2999.0—3003.0 m; 2 ×3, 6 ×4.
3-4 — *Rhipidomella michelini* (Eveillé); 3 Rzeczenica *1*, 2899.0—2901.3 m, ×3; 4 Brda *1*, 2432.0—2433.0 m, ×2.
5 — *Aulacella whidborneí* (Gallw.); Brda *1*, 2432.0—2433.0 m, ×7.
7 — *Leptagonia analoga* (Phill.); Rzeczenica *1*, 2999.0—3003.0 m, ×3.
8-9 — *Schizophoria resupinata rotundata* Dem.; Brda *1*, ×3; 8 2469.0—2475.0; 9 2496.0—2501.0.



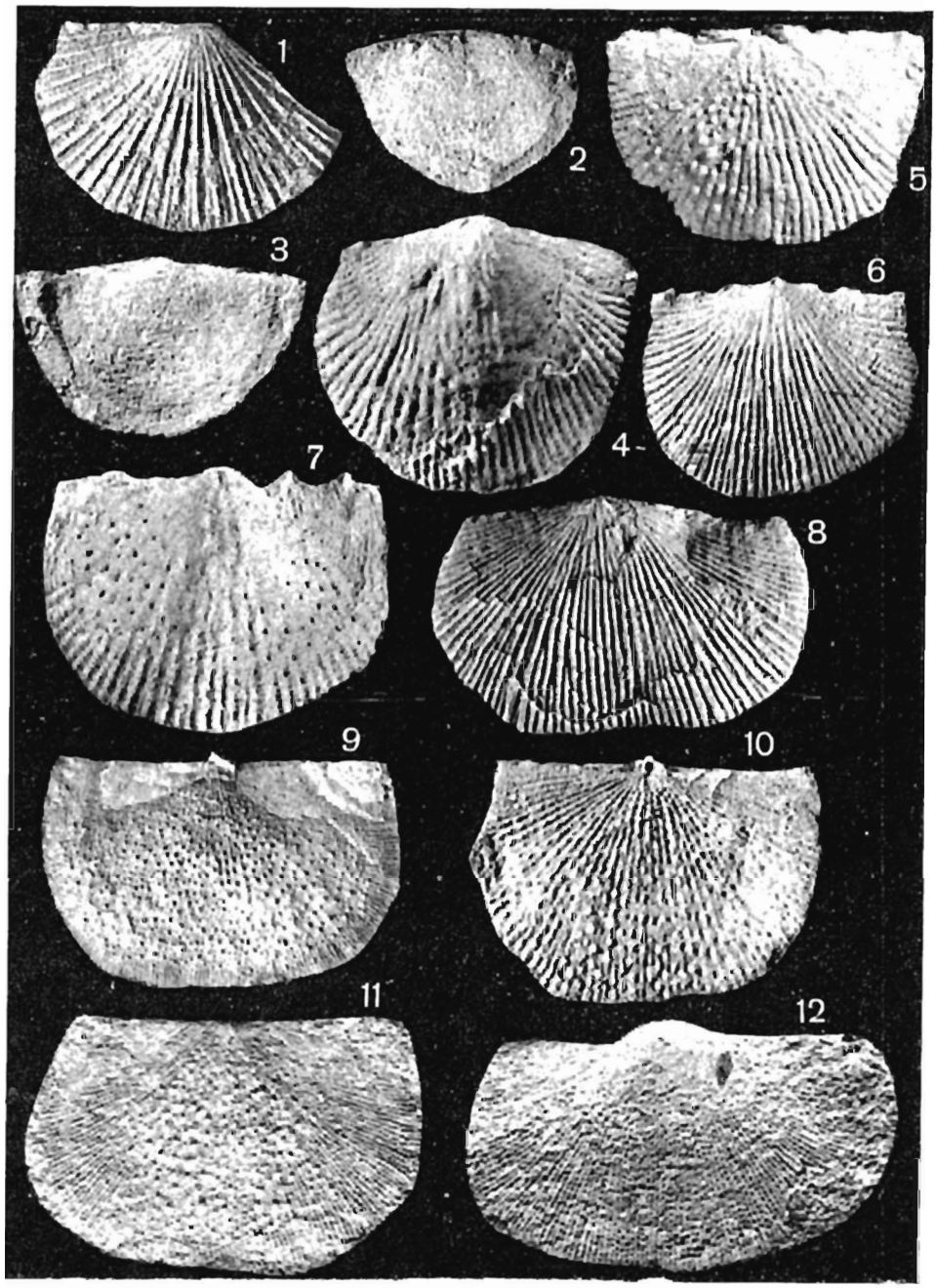
1-2, 6 — *Schellwienella ?pauli* (Gallw.); 1 Babilon *1*, 2791.2—2795.4 m, ×1.5; 2 Brda *1*, 3168.0—3174.0 m, ×3; 6 Babilon *1*, 2808.0—2812.8 m, ×1.

3-4 — *Schellwienella crenistria* (Phill.); 3 Brda *2*, 2305.0—2311.0 m, ×1.5; 4 Brda *1*, 2382.5—2387.5 m, ×3.

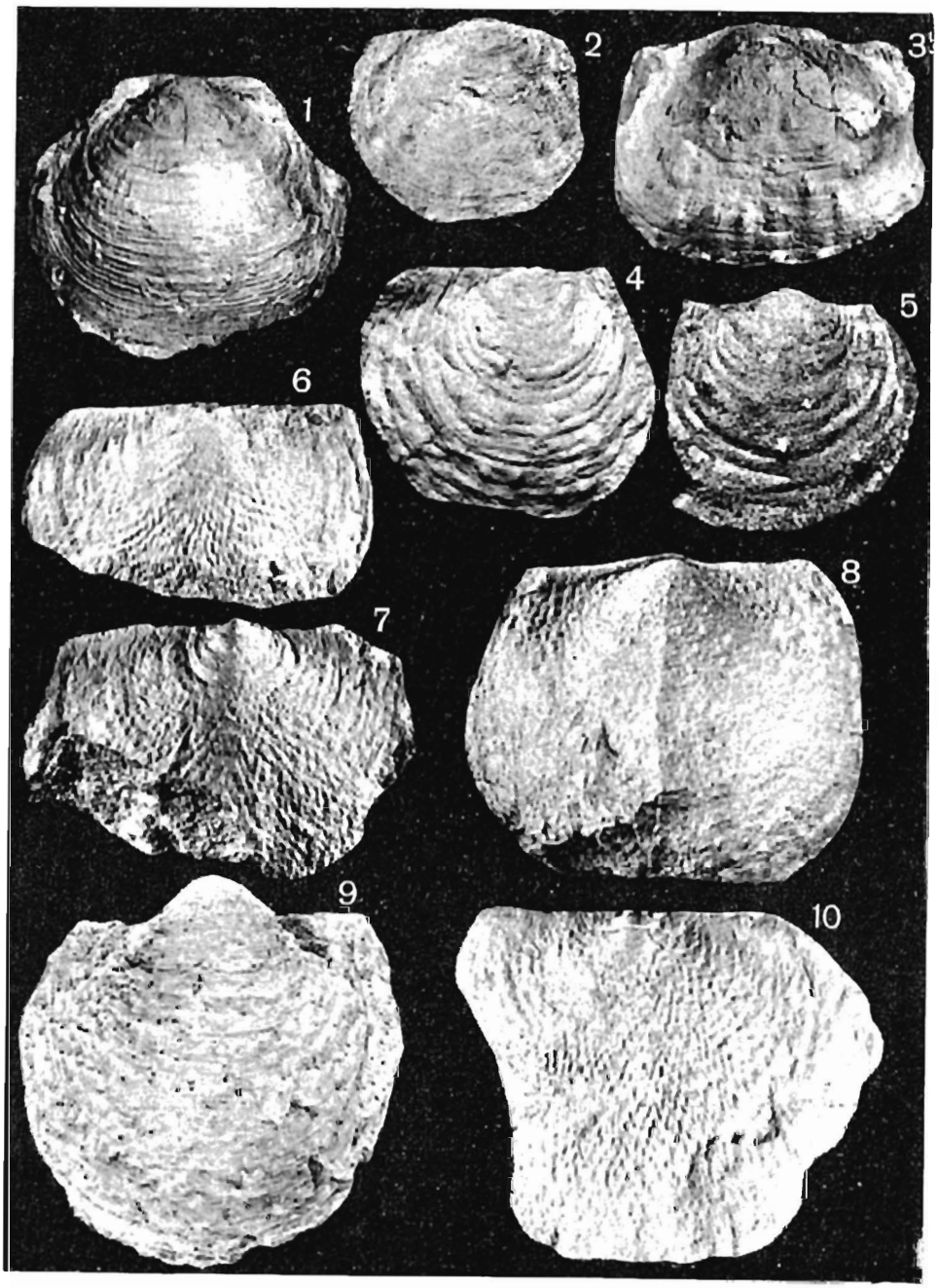
5 — *?Schellwienella kelli* McCoy; Brda *1*, 2382.5—2387.5 m, ×1.5.



1 — *Schuchertella planiuscula* (Sem. et Moell.); Babilon 1, 2988.1—2994.0 m, ×6.
2, 5-6 — *Schuchertella portlockiana* (Sem.); 2 Biały Bór 3, 3211.0—3216.5 m., ×2.5; 5 Babilon 1, 2641.4—2646.1 m., ×2; 6 Brda 1, 2560.0—2563.5 m., ×3.
3-4 — *Schuchertella semenovi* Sok.; Brda 1, ×4; 3 2496.0—2501.0 m, 4 2469.0—2475.0 m.
7 — *Schuchertella lens* (White); Brda 1, 2358.0—2363.0 m, ×3.



1 — *Streptorhynchus* cf. *minimus* Gallw.; Brda *1*, 2496.0—2501.0 m, ×7.
2-3 — *Tornquistia polita* (McCoy); Biały Bór 3, 3216.5—3222.0 m, ×6.
4 — *Rugosochonetes* sp. 2; Babilon *1*, 3021.2—3027.2 m, ×8.
5, 7 — *Rugosochonetes malevkensis* Sok., Babilon *1*, 3021.2—3027.2 m, ×7.
6 — *Rugosochonetes* cf. *hardrensis* (Phill.); Brda *2*, 2538.0—2544.0 m, ×6.
8 — *Rugosochonetes* sp. *1*; Babilon *1*, 2618.7—2624.1 m, ×4.
9 — *Rugosochonetes multicostus* (Winch.); Brda *1*, 2382.5—2387.5 m, ×3.
10 — *Rugosochonetes hardrensis* (Phill.); Brda *1*, 3016.0—3022.0 m, ×6.
11-12 — *Rugosochonetes* ex gr. *ischimicus* Nal.; Brda *1*, 2382.5—2387.5 m, ×4.



1 — *Productella subaculeata* (Murch.); Babilon 1, 3265.8—3270.2 m, ×4.

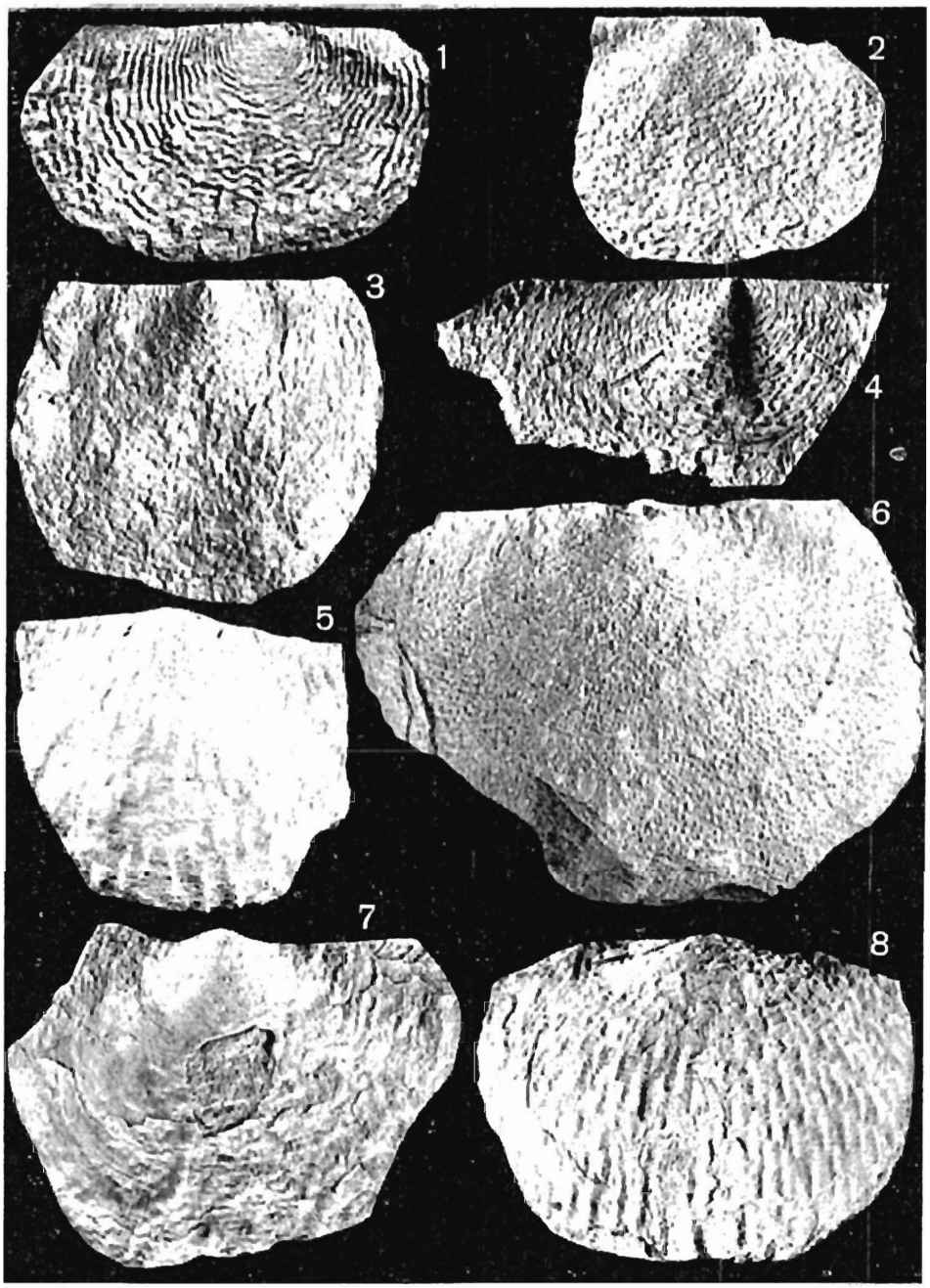
2–4 — *Productella herminae* Frech; Babilon 1; 2 3207.8—3214.1 m, ×4; 3 3280.6—3286.1 m, ×4; 4 3094.0—3100.9 m, ×5.

5 — *Chonetipustula* cf. *plicata* (Sarr. em. Kays.); Babilon 1, 2629.5—2635.4 m, ×6.

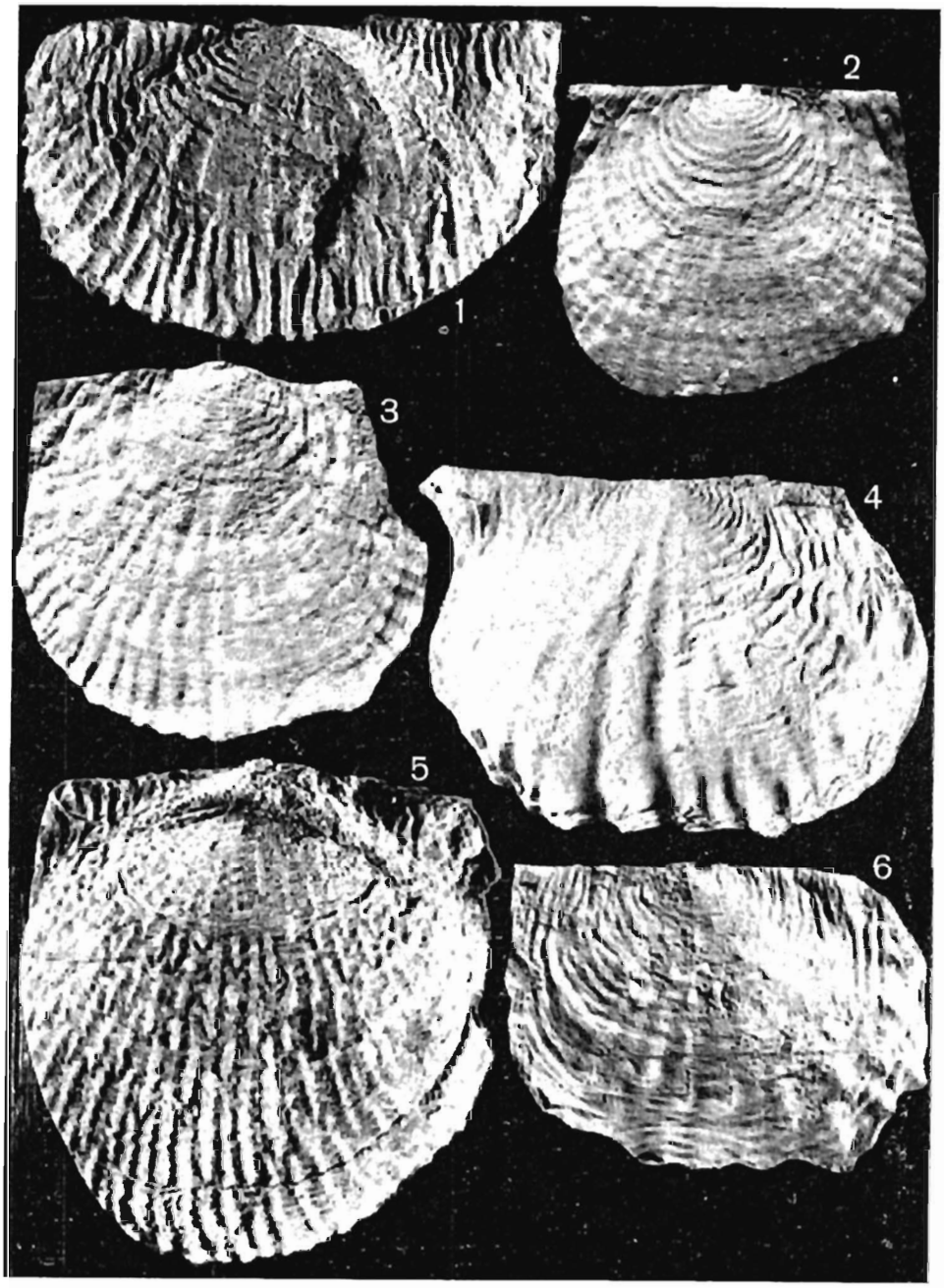
6–7, 10 — *Agramatia agramati* (Nal.); Babilon 1, ×2; 6 2949.6—2956.0 m; 7 3207.8—3214.1 m; 10 3121.2—3126.2 m.

8 — *Praewaagenoconcha* cf. *oreliana* (Moell.); Babilon 1, 2988.1—2994.0 m, ×4.

9 — *Praewaagenoconcha* sp.; Babilon 1, 2949.6—2956.0 m, ×4.



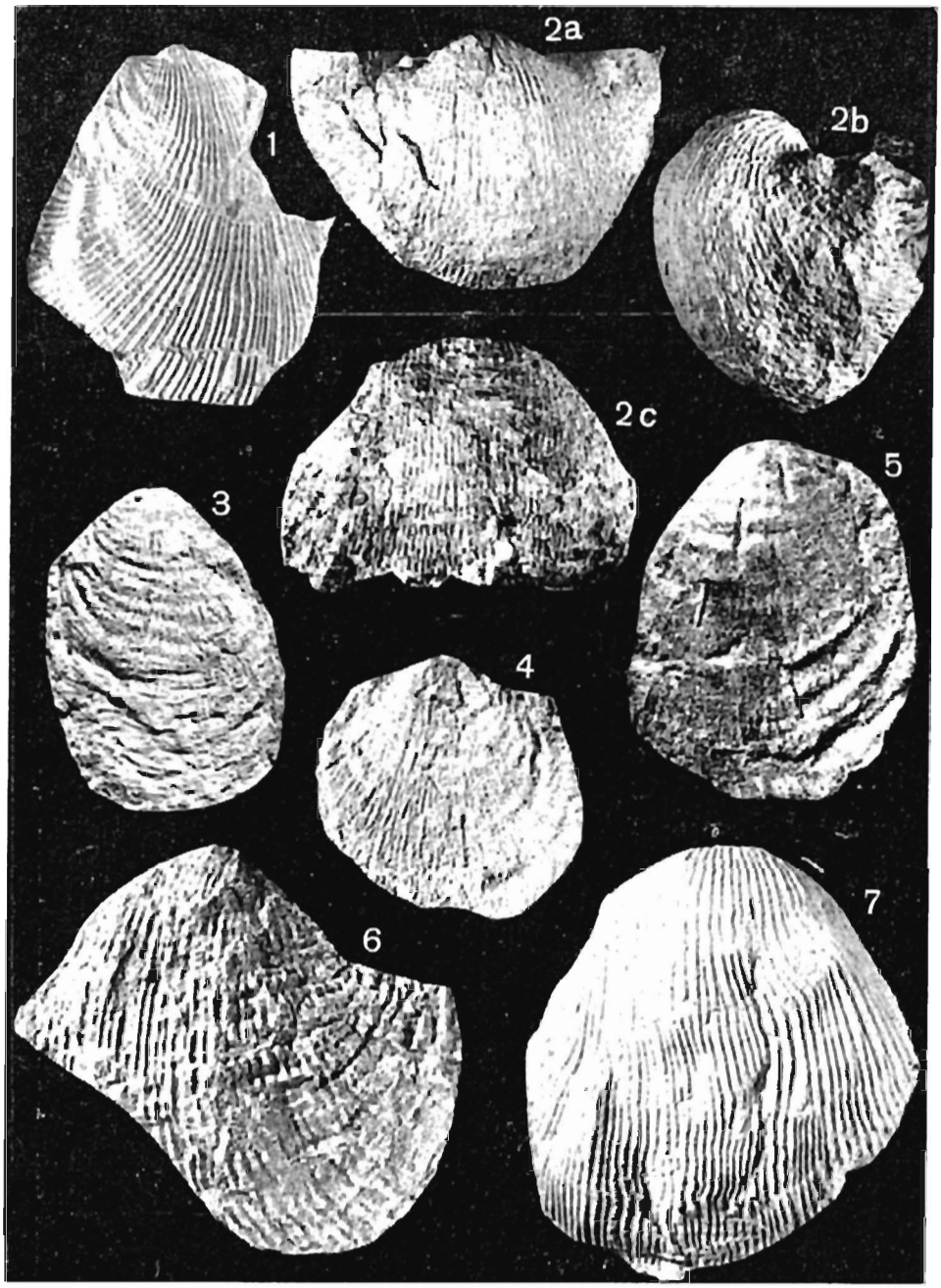
1 — ?*Steinhagella membranacea* (Phill.); Brda 1, 3250.0—3256.0 m, ×3.
2-3 — *Hamlingella piltonensis* (Reed); Babilon 1, 3027.2—3033.0 m, ×2.
4 — *Steinhagella steinhagei* (Paul); Babilon 1, 3135.9—3141.4 m, ×3.
5, 8 — *Whidbornella pauli pauli* Goldr.; Babilon 1, 2988.1—2994.0 m, ×3.
6 — *Hamlingella goergesi* (Paeck.); Babilon 1, 3221.2—3027.2 m, ×3.
7 — *Quadratia* cf. *rectispina* (Hall); Babilon 1, 3172.6—3177.6 m, ×4.



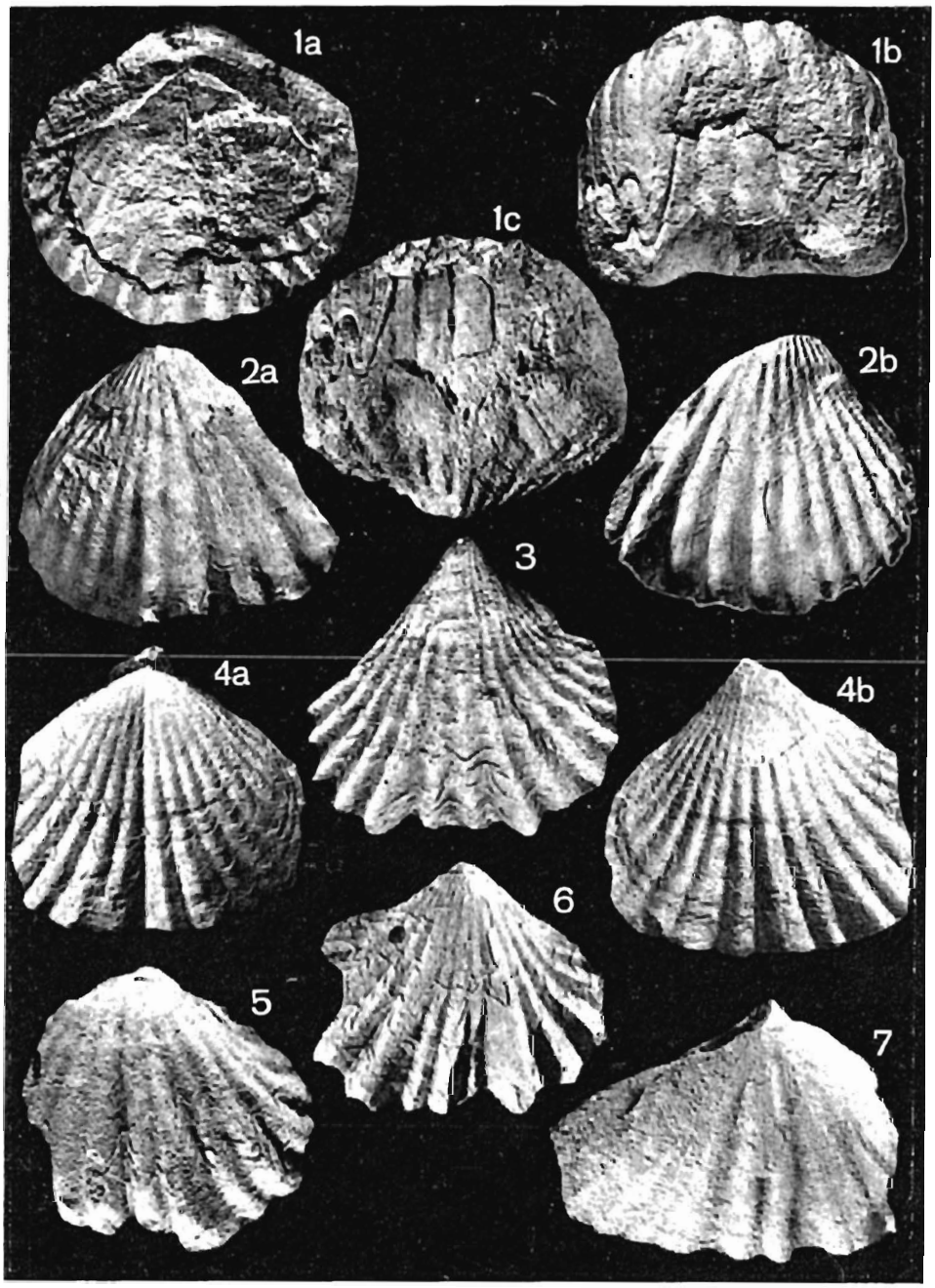
1, 5 — *Whidbornella pauli radiata* Goldr.; 1 Brda *1*, ×3; 3016.0—3022.0 m; 5 Babilon *1*, 2779.5—2784.8 m.

2-3 — *Avonia nigra* (Gross.); Babilon *1*, 3135.9—3141.1 m, ×6.

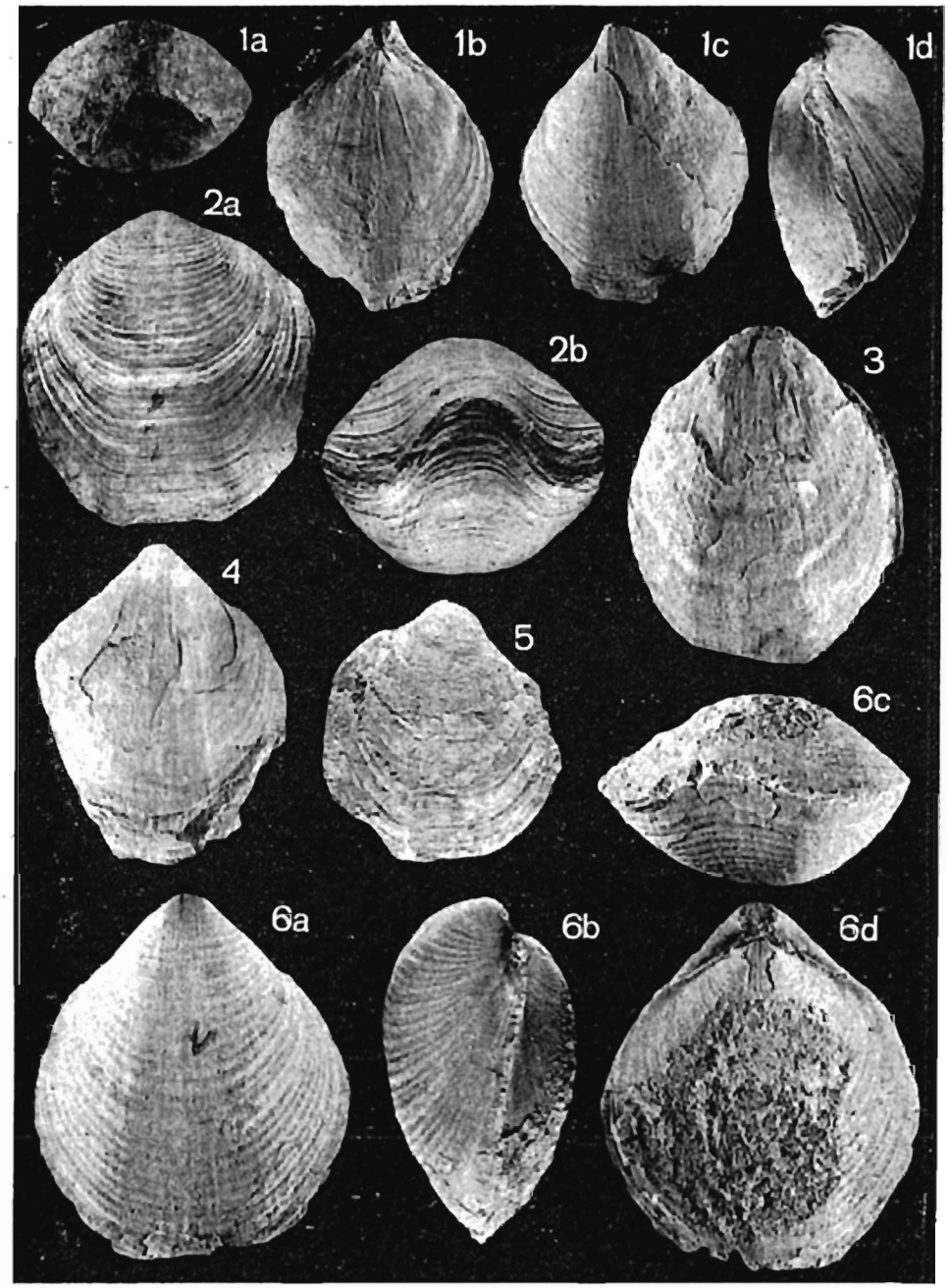
4, 6 — *Mesoplica praelonga* (Sow.); Babilon 1; 4 2911.7—2915.2 m, ×3; 6 2880.5—2885.6 m, ×4.



1 — *Ovatia laevicosta* (White); Brda 1, 2469.0—2475.0 m, ×4.
2 — *Bagrasia* aff. *chonetiformis* (Krest. et Karp.); Rzeczenica 1, 2920.7—2925.0 m, ×1.5.
3-5 — ?*Fluctuaria* sp.; Babilon 1; 3—4 2791.2—2795.4 m, ×4; 5 2808.0—2812.0 m, ×8.
6 — *Buxtonia scabricula* (Sow.); Brda 1, 2260.0—2266.0 m, ×1.5.
7 — *Ovatia* cf. *laevicosta* (White); Babilon 1, 2988.1—2994.0 m, ×3.



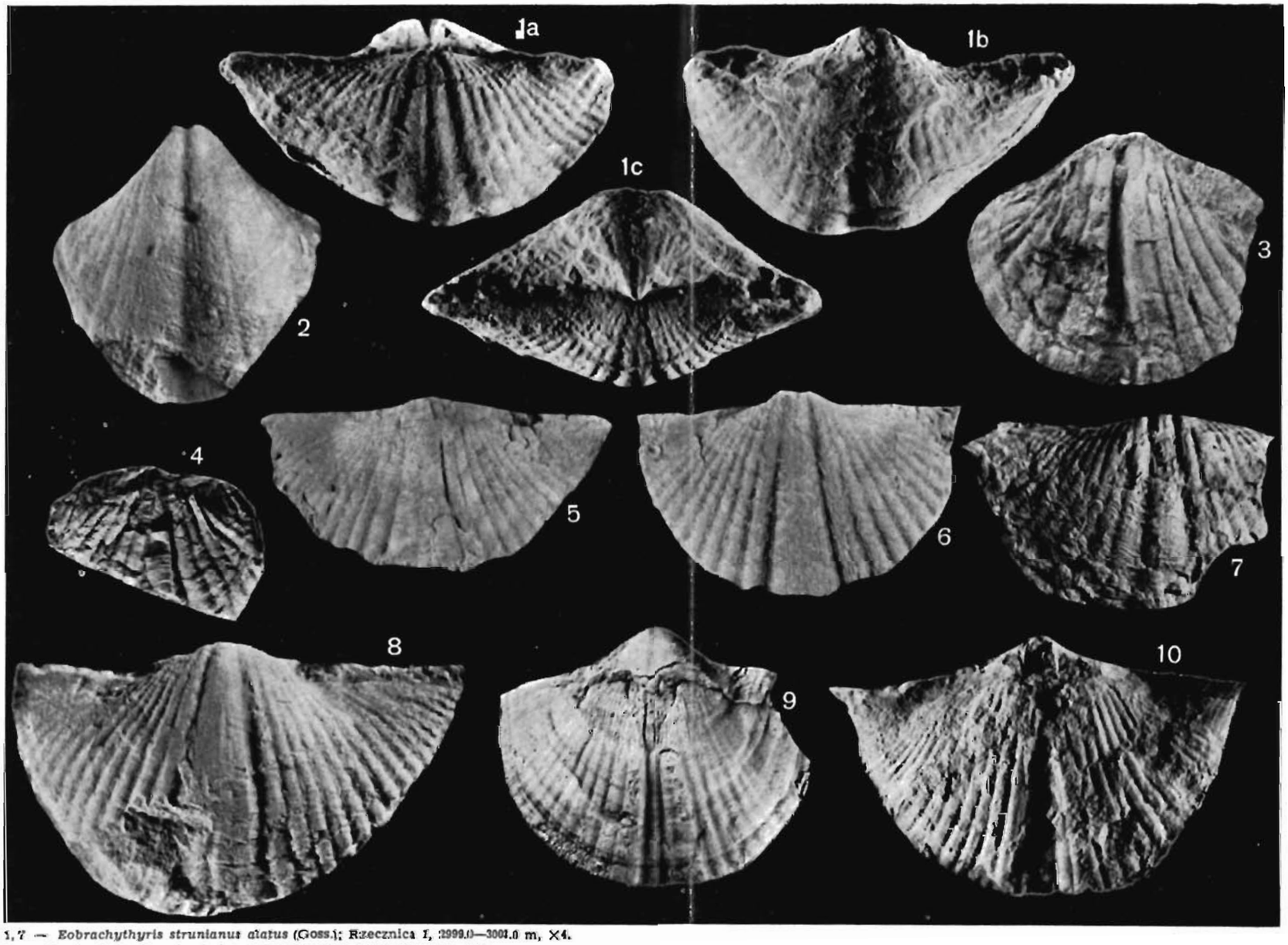
1-2 — *Centrorhynchus letiensis* (Goss.); Babilon 1, 3207.8—3214.0 m, ×3.
3, 5-6 — *"Camarotoechia" acutirugata* (Kon.); Brda 1; 3 2382.5—2387.5 m, ×3; 5 3168.0—3174.0 m, ×5; 6 3187.5—3192.5 m, ×6.
4 — *Retzia* sp.; Babilon 1, 3249.3—3255.5 m, ×6.
7 — *Trifidorostellum posturalicum* (Rozm.); Brda 1, 3077.0—3080.5 m, ×3.



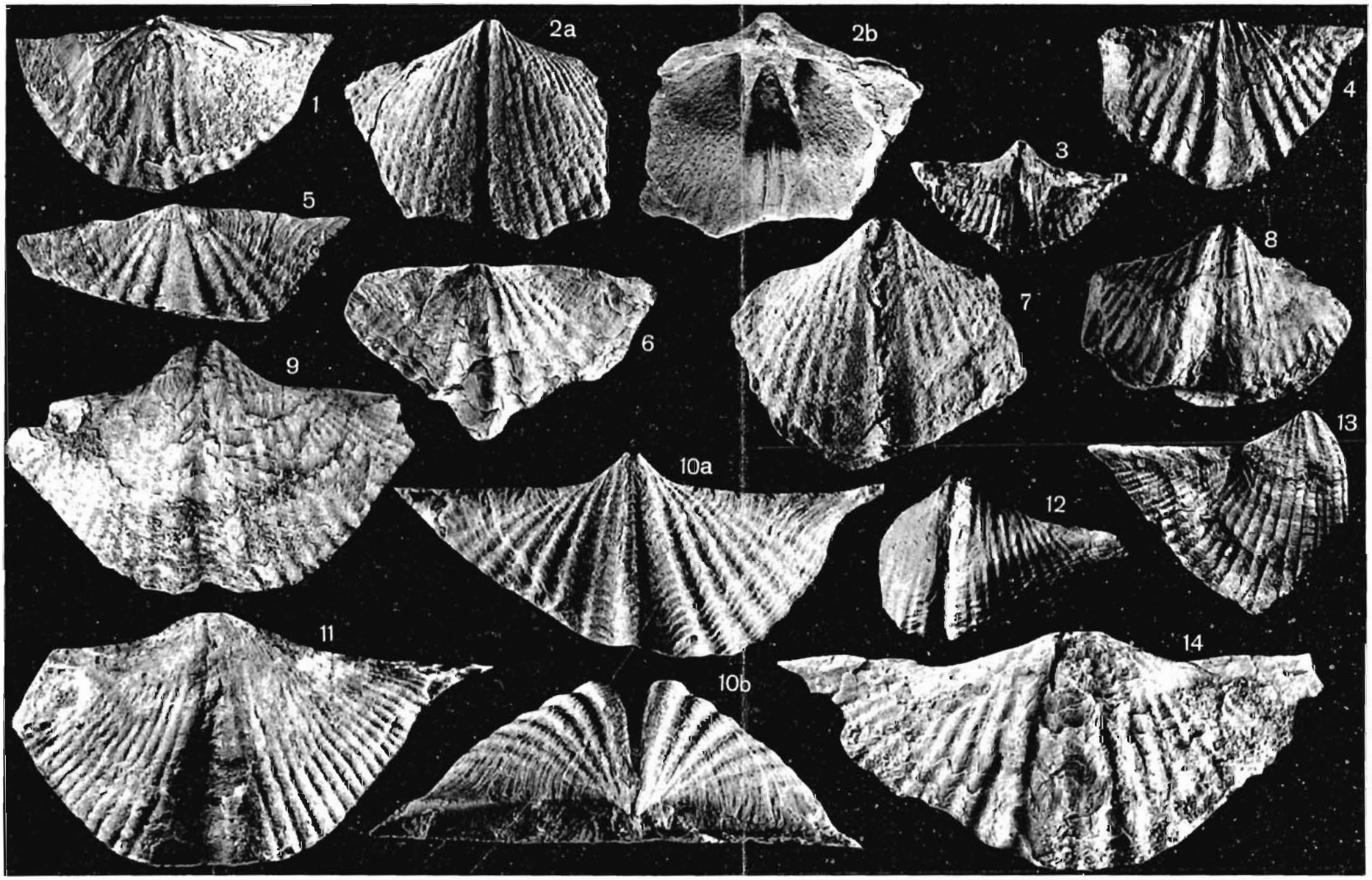
1, 3, 5 — *Composita struniana* (Dehée); 1, 3 Brda *1*; 1 2959.0—2965.0 m, ×3; 5 3201.0—3204.0 m, ×5; 3 Babilon *1*, 2837.6—2841.9 m, ×3.

2, 6 — *Athyris concentrica* (Buch); Babilon *1* 2988.1—2994.0 m, 2 ×3; 6 ×4.

4 — *Athyris hirsuta* (Hall); Babilon *1*, 2779.5—2784.9 m, ×3.

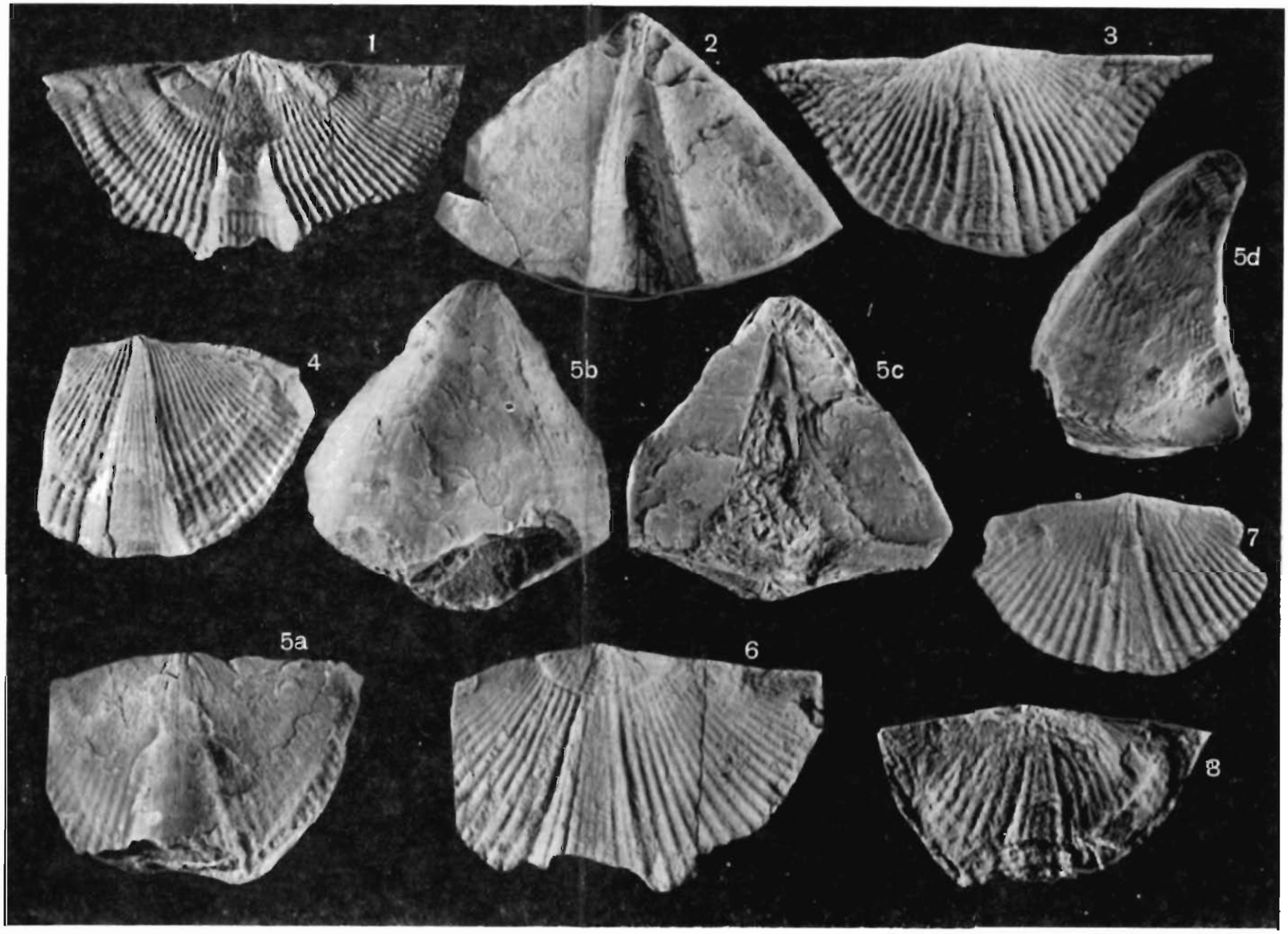


1, 7 — *Eobrachythyris strunianus alatus* (Goss.); Rzecznica 1, 2999.0—3001.0 m, ×4.
2 — *Brachythyris rhomboidalis* (McCoy); Brda 1, 2469.0—2475.0 m, ×4.
3-4 — *Brachythyris peculiaris* (Shum.); ×3; 3 Brda 1, 2257.0—2260.6 m; 4 Brda 2, 2409—2415.0 m.
5-6, 8, 10 — *Eobrachythyris strunianus strunianus* (Goss.); 5, 10 Babilon 1; 5 2703.0—2707.7 m, ×4; 10 2624.6—2628.0 m, ×3; 6, 8 Brda 1, ×5; 6 3162.0—3168.0 m; 8 2718.0—2723.0 m.
9 — *Brachythyris* aff. *suborbicularis* (Hall); Brda 1, 2496.0—2501.0 m, ×3.

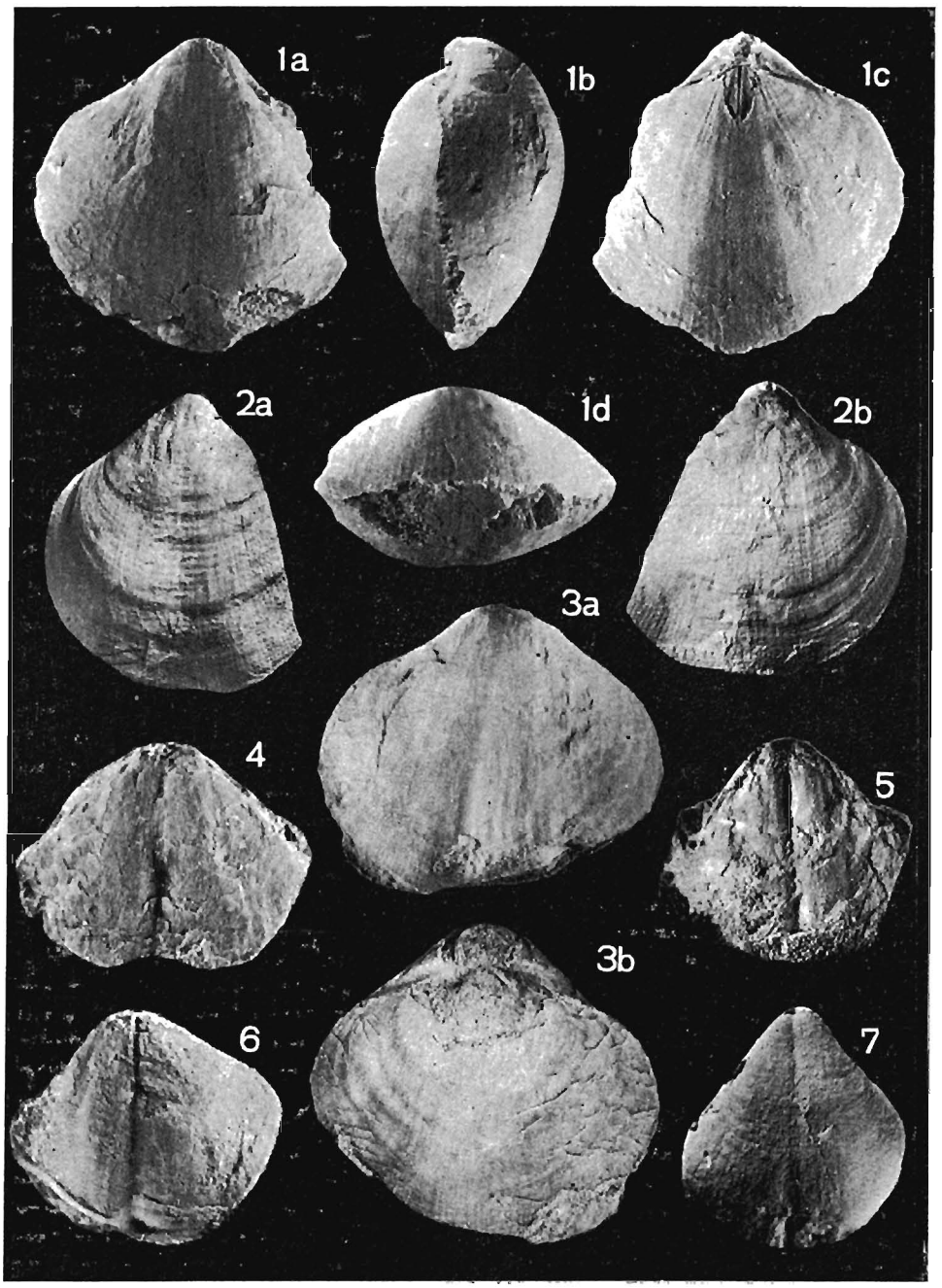


1, 9, 11, 14 — *Mucrospirifer roemerianus* (Kon.); 1, 9, 14 Brda 1, 2382.5—2387.5 m; 1, 9 ×3; 14 ×4; 11 Babilon 1, 2618.7—2624.1 m, ×2.
2, 7 — *Prospira* sp. 1; 2 Brda 2, 2409.0—2415.0 m, ×3; 7 Brda 1, 2319.0—2326.0 m, × 5.
3, 12 — ?*Prospira* sp.; Rzeczenica 1, ×4; 3 2990.0—2993.6 m; 12 2999.0—3003.0 m.
4 — *Mucrospirifer posterus* (Hall & Clarke); Babilon 1, 3249.3—3255.5 m, ×3.
5-6, 10 — *Tylothyris laminosa* (McCoy); Babilon 1, 3189.1—3193.2 m; 5, 10 ×4; 6 ×3.
8 — *Prospira* sp. 3; Rzeczenica 1, 2999.0—3003.0 m, ×4.
13 — *Prospira* sp. 2; Brda 2, 2409.0—2415.0 m, ×3.

1 — *Cyrtospirifer* cf. *postarchiaci* (Nal.); Rzeczenica *1*, 2999.0—3003.0 m, ×4.
2, 4, 10 — *Cyrtospirifer verneuili* (Murch.); 2 Rzeczenica *1*, 2999.0—3003.0 m, ×3; 4, 10 Babilon *1*; 4 3310.0—3313.7 m, ×1.5; 10 2949.6—2956.0 m. ×3.
3 — *Cyrtospirifer brodi* (Venj.); Babilon *1*, 2880.0—2885.6 m, ×3.
5, 7 — *Prospira* sp. *1*; Brda *1*, 2319.0—2326.0 m, ×4.
6, 8 — *Cyrtospirifer calcaratus* (Sow.); ×3; 6 Babilon *1*, 3121.2—3126.2 m; 8 Brda *1*, 3211.5—3213.5 m
9 — *Syringothyris* cf. *hannibalensis* (Swall.); Babilon *1*, 2618.7—2624.1 m, ×4.



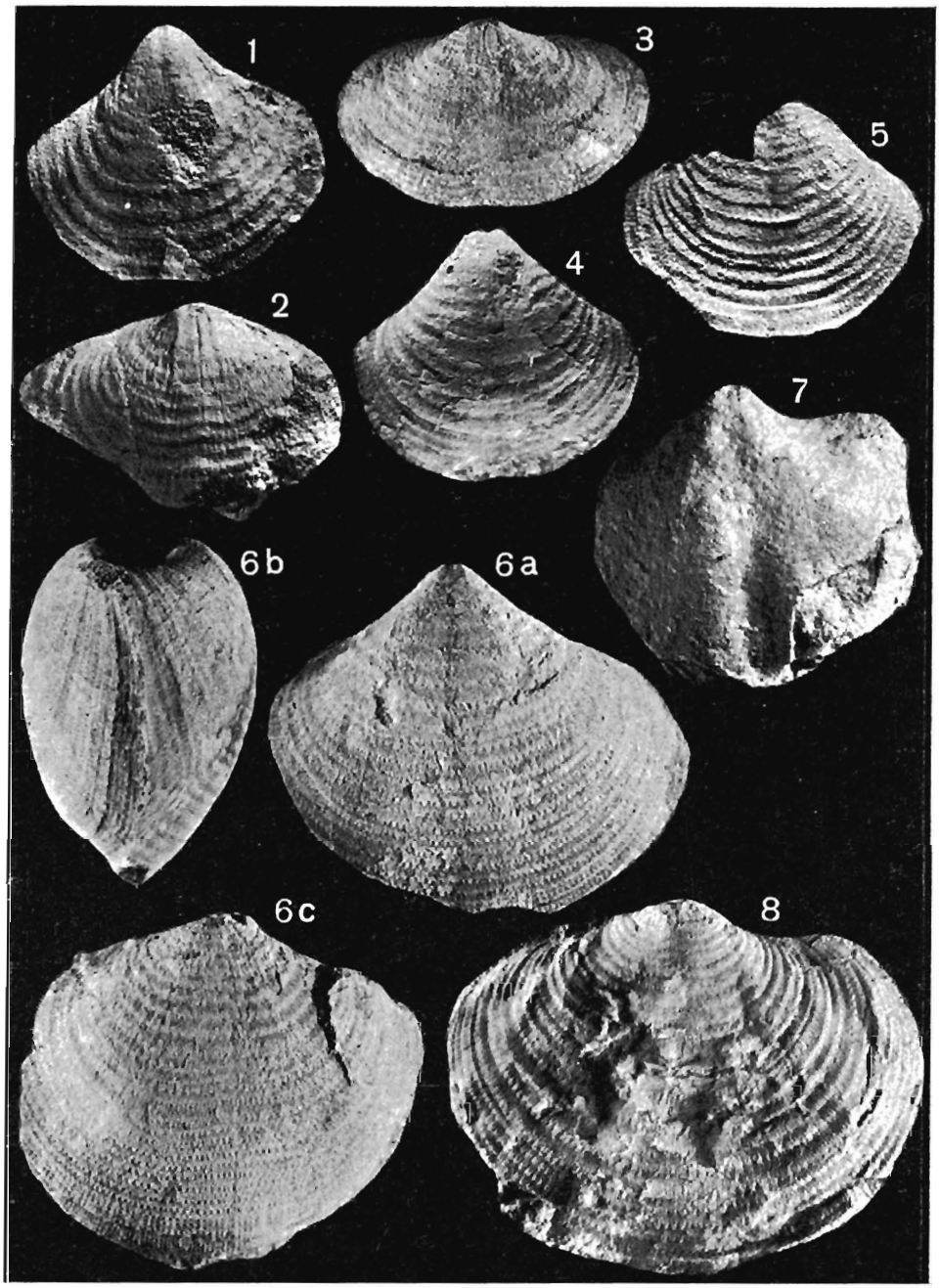
1-2, 4-5 — *Sphenospira julii* (Dehée); ×2; 1 Brda *1*, 3272.5—3278.5 m; *2*, 4-5 Babilon *1*; 2 2880.5—2885.6 m; 4 2618.7—2624.6 m; 5 3061.5—3065.8 m.
3, 7-8 — *"Unispirifer tornacensis"* (Kon.); ×4; 3, 7 Babilon *1*; 3 3027.2—3033.0 m; 7 3121.2—3126.2 m; 8 Rzeczenica *1*, 2999.0—3003.0 m.
6 — *Tenticospirifer tenticulus* (Murch., Vern. & Keys.); Babilon *1*, 2949.6—2956.0 m, ×3.



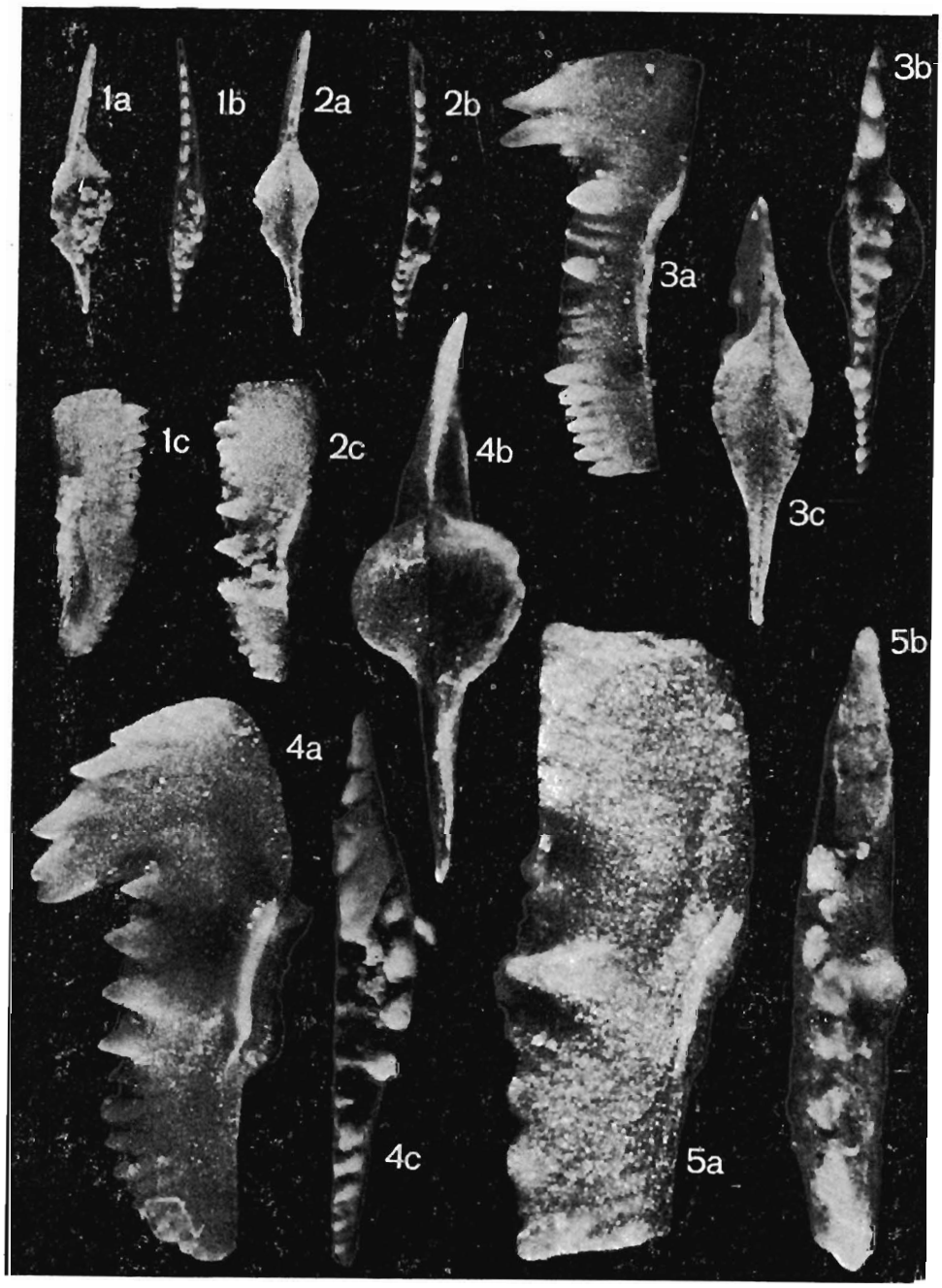
1-3 — *Cleiothyridina royssii* (Eveillé); 1 Brda *1*, 3056.0—3058.0 m, ×3; 2—3 Babilon *1*, 2949.6—2956.0 m, ×2.5.

4-6 — *Crurithyris unionensis* (Well.); 4, 6 Brda *1*, 2849.0—2855.0 ×5; 5; Rzeczenica *1*, 2999.0—3003.0 m, ×4.

7 — *Crurithyris urei* (Flem.); Babilon *1*, 3021.2—3027.2 m, ×7.



1-2 — *„Torynifer cooperensis"* (Swall.); Babilon *1*, 3027.2—3033.0 m, ×4.
3 — *Torynifer praematura* (Hall); Brda *1*, 3272.5—3278.5 m, ×3.
4-5 — *Kitakamithyris microgemma* (Phill.); Brda *1*; 4 3162.0—3168.0 m, ×5; 5 3250.0—3256.0 m, ×3.
6 — *Toryniferella echinulata* (Brice); Babilon *1*, 2911.7—2915.2 m, ×3.
7 — *Eomartiniopsis* cf. *tscherepeti* (Sok.); Rzeczenica *1*, 2899.0—2901.3 m, ×3.
8 — *Kitakamithyris* aff. *uniplicata* (Campb.); Brda *1*, 2260.0—2266.0 m, ×3.

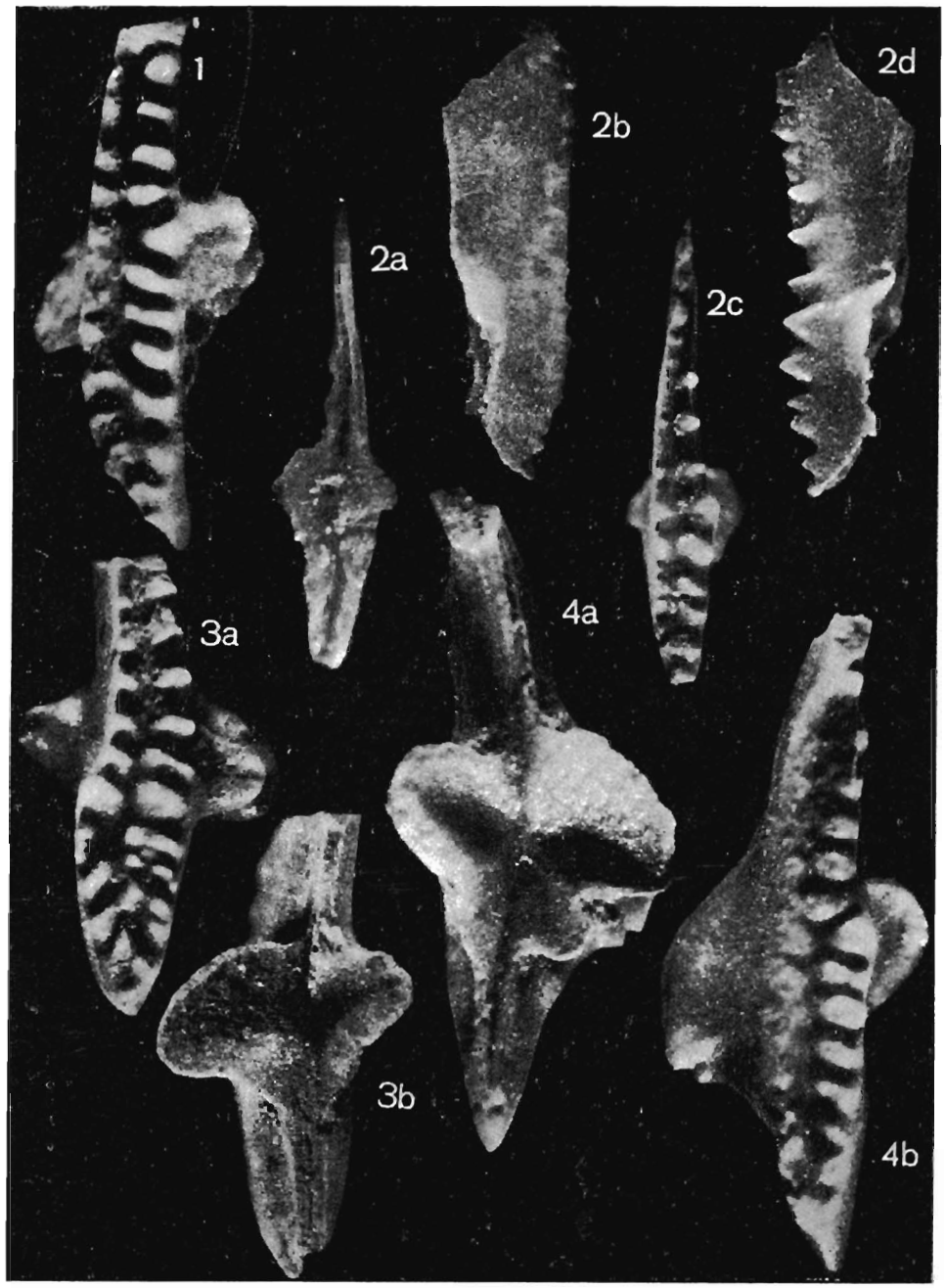


1-3 — *Bispathodus aculeatus aculeatus* (Branson & Mehl); 1—2 Rzeczenica *1*, 1 2920.7—2925.0 m; 2 2999.0—3003.0 m; 3 Babilon *1*, 3207.8—3214.1 m.

4 — *Bispathodus aculeatus plumulus* (Rhodes, Austin & Druce); Babilon *1*, 2949.6—2956.0 m.

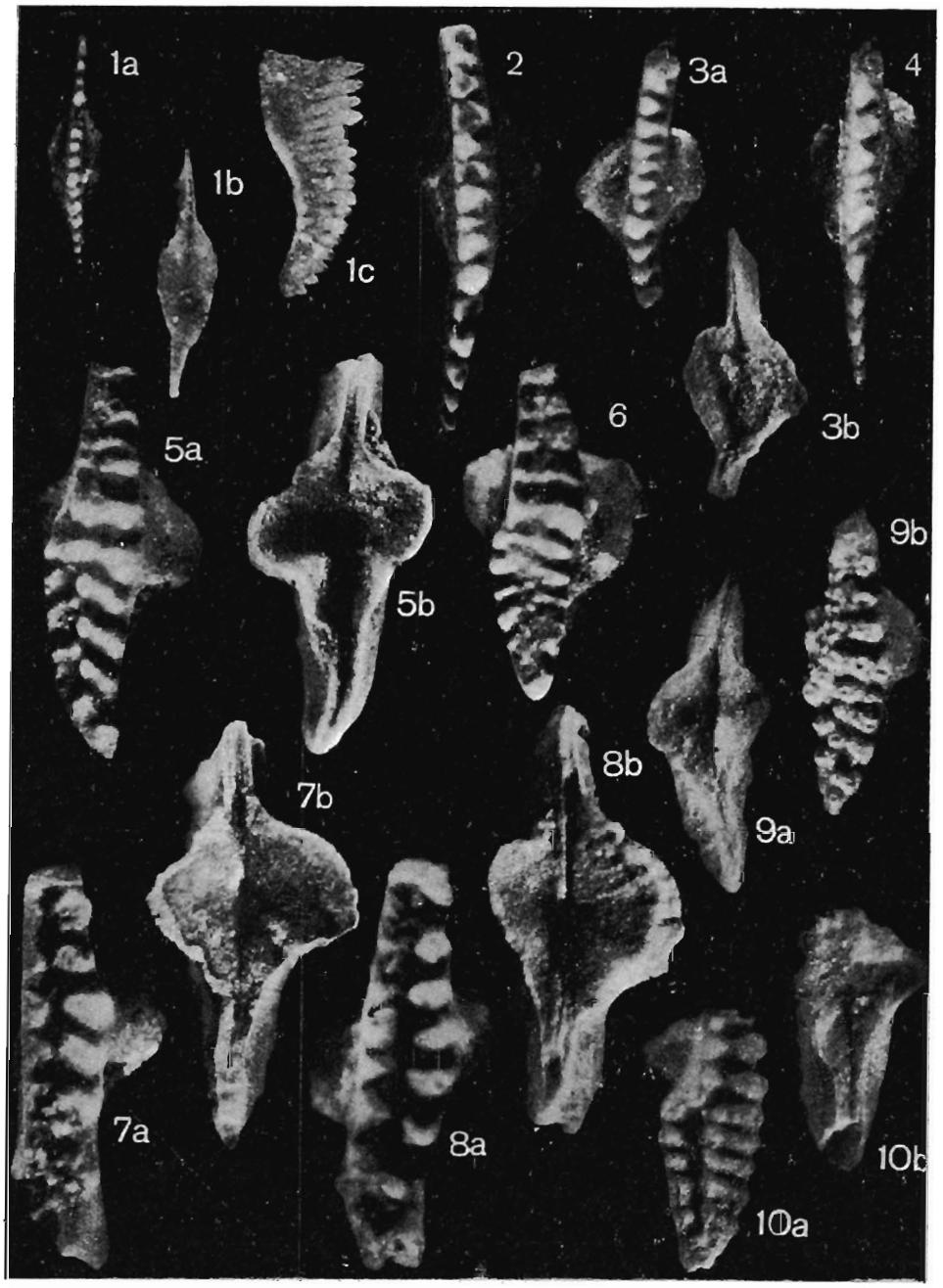
5 — *Bispathodus aculeatus anteposicornis* (Scott); Babilon *1*, 3207.8—3214.1 m.

All photos ×50



Bispathodus costatus (Branson)

1, 3-4 — Rzeczenica *1*, 2999.0—3003.0 m, ×50.
2 — Babilon *1*, 2635.4—2641.4 m, ×50.



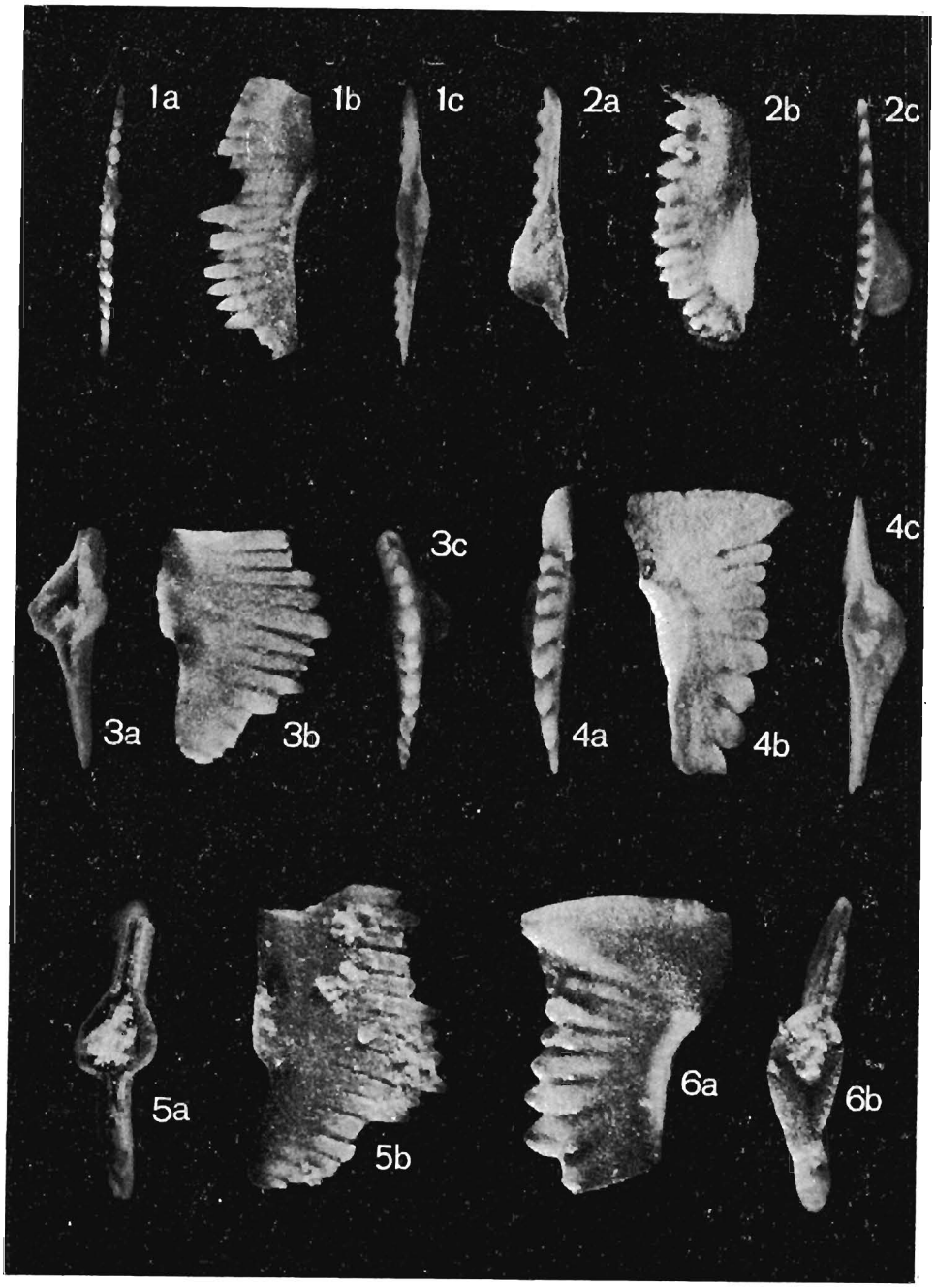
1-4 — *Bispathodus stabilis* (Branson & Mehl); 1 Babilon *1*, 3280.6—3286.1 m; 2-4 Rzeczenica *1*, 2920.7—2925.0 m.

5-6, 9-10 — *Bispathodus ziegleri* (Rhodes, Austin & Druce); Rzeczenica *1*, 2925.0—2927.0 m.

7 — *Bispathodus costatus* (Branson) — *Bispathodus spinulicostatus* (Branson); Rzeczenica *1* 2999.0—3003.0 m.

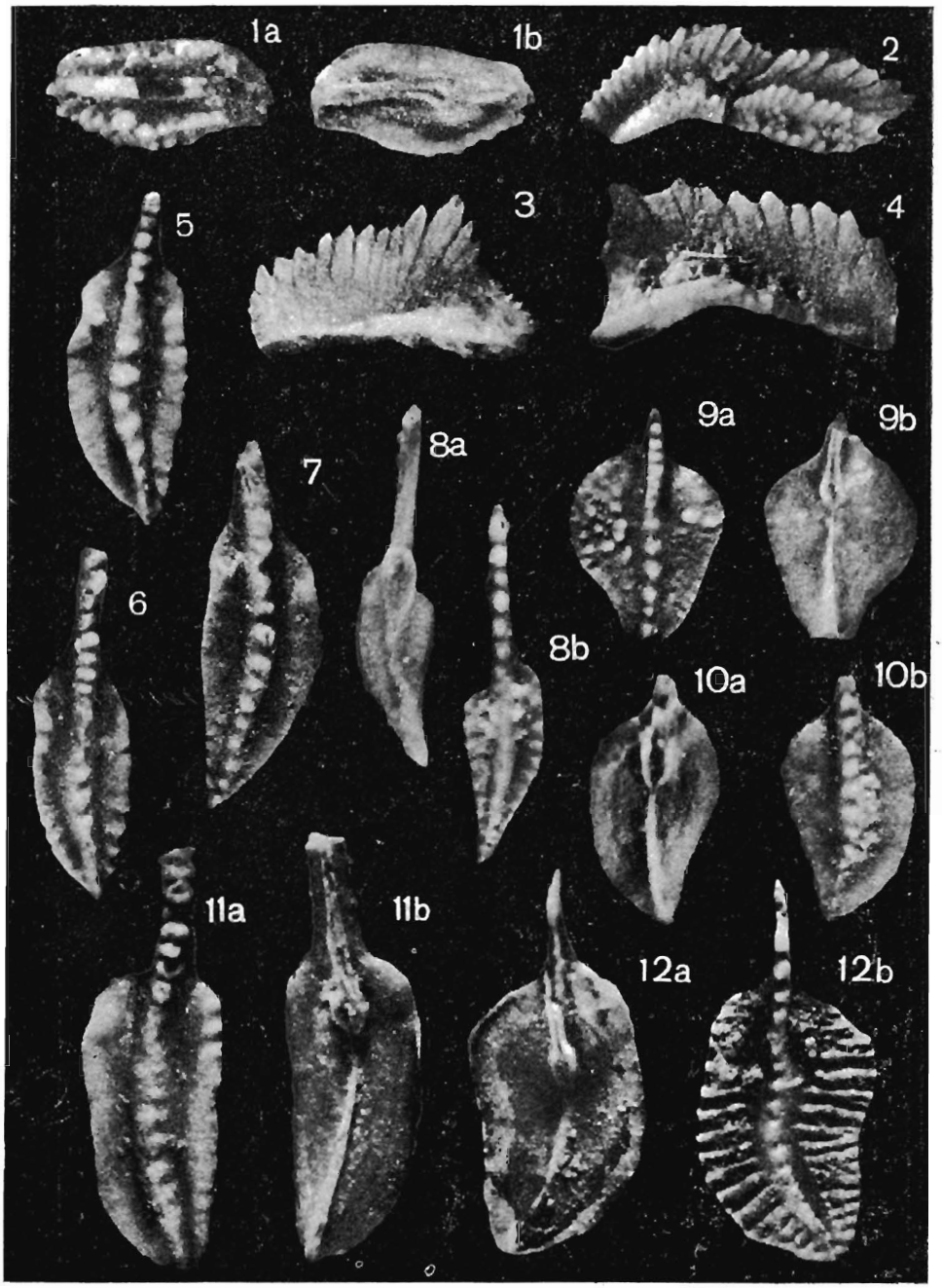
8 — *Bispathodus costatus* (Branson); Rzeczenica *1*, 2999.0—3003.0 m.

All photos ×50



1 — *Spathognathodus strigosus* (Branson & Mehl); Brda *1*, 3196.0—3201.0 m.
2 — *Spathognathodus supremus* Ziegler; Rzeczenica *1*, 2920.7—2925.0 m.
3, 5 — *Spathognathodus* aff. *inornatus* (Branson & Mehl); Rzeczenica *1*, 2999.0—3003.0 m.
4, 6 — *Spathognathodus* aff. *cristulus* Youngquist & Miller; Brda *1*, 2469.0—2475.0 m; 6 Rzeczenica *1*, 2896.0—2899.0 m.

All photos ×50



1-2 — *Elictognathus* aff. *bialatus* (Branson & Mehl); Rzeczenica *1*; 1 2920.7—2925.0 m; 2 2907.9—2912.7 m.

3-4 — *Elictognathus laceratus* (Branson & Mehl); Rzeczenica *1*; 3 2920.7—2925.0 m, 4 2896.0—2899.0 m.

5-7, 11 — *Polygnathus communis communis* Branson & Mehl; Rzeczenica *1*; 5, 7, 11 2907.9—2912.7 m; 6 2899.0—2901.3 m.

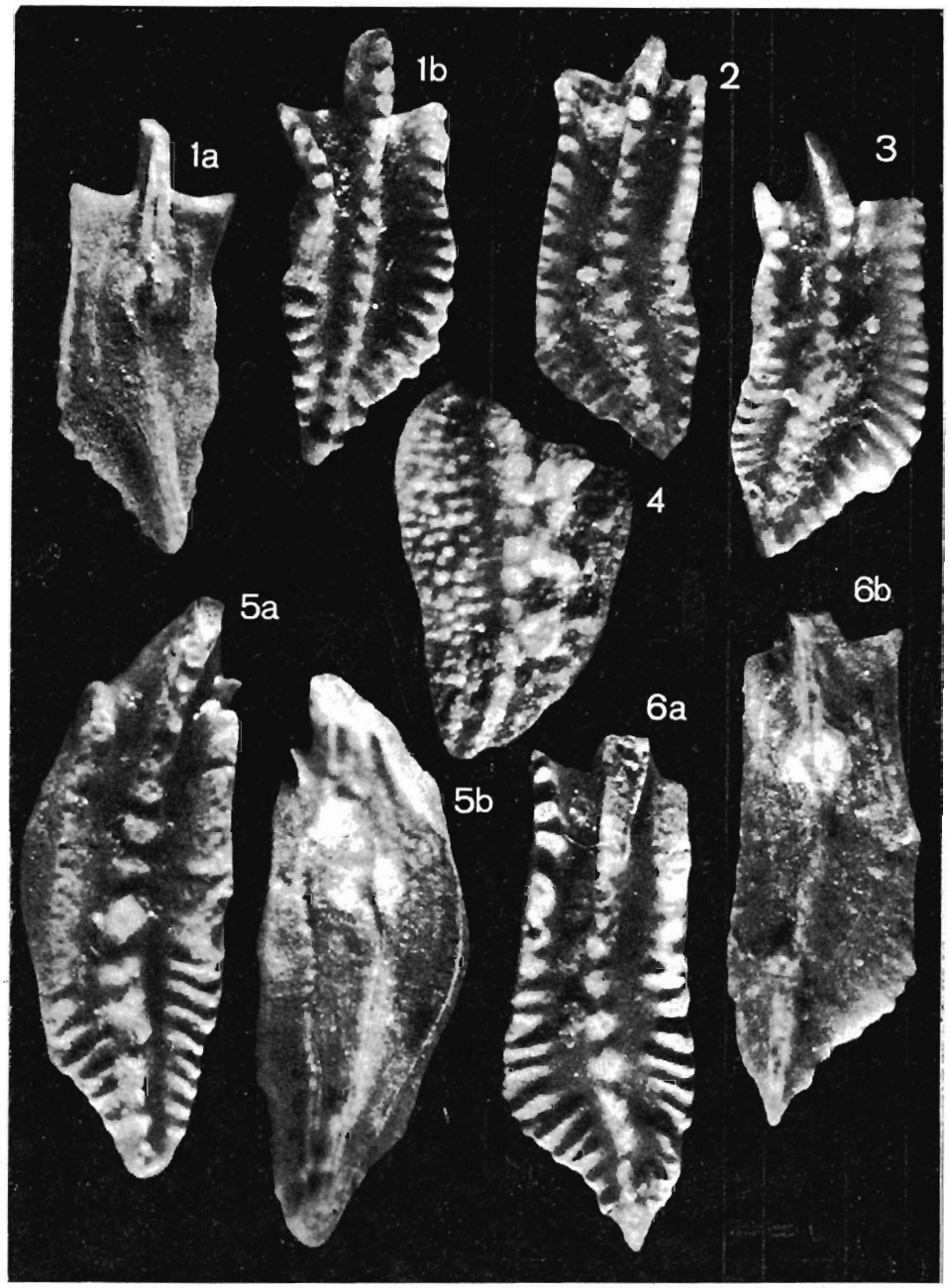
8 — *Polygnathus delicatulus* Ulrich & Bassler; Babilon *1*, 3207.8—3214.1 m.

9 — *Polygnathus communis carina* Hass; Brda *1*, 2382.5—2387.5 m.

10 — *Polygnathus purus subplanus* Voges; Rzeczenica *1*, 2912.7—2916.7 m.

12 — *Polygnathus* aff. *flabellus* Branson & Mehl; Rzeczenica *1*, 2907.9—2912.7 m.

All photos ×50

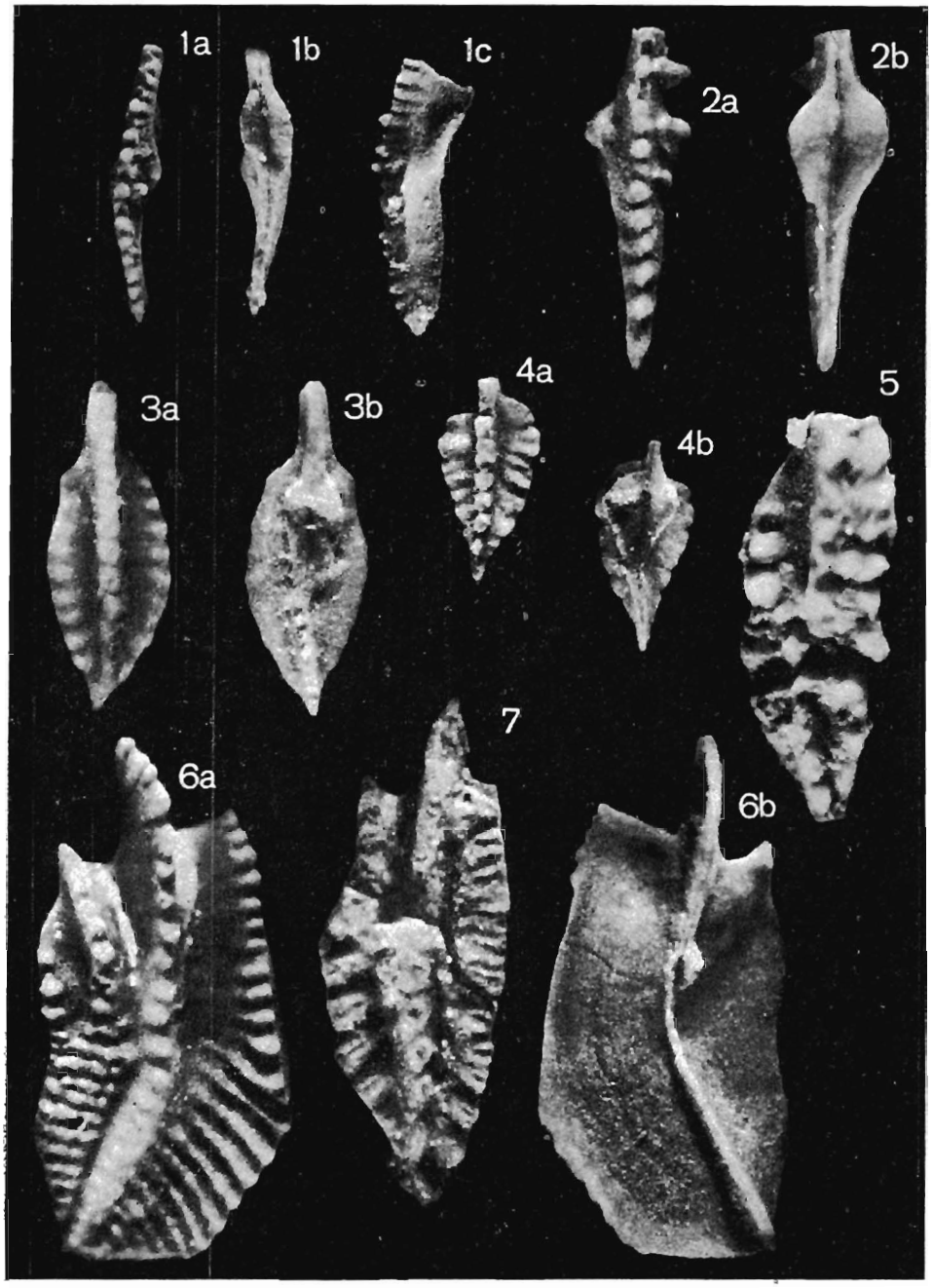


1-3, 6 — *Polygnathus inornatus* Branson; Rzeczenica *1*; 1 2907.9—2912.7 m; 2 2896.0—2899.0 m; 3 2899.0—2901.3 m; 2912.7—2916.7 m.

4 — *Polygnathus* cf. *radinus* Cooper; Rzeczenica *1*, 2896.0—2899.0 m.

5 — *Polygnathus spicatus* Branson; Rzeczenica *1*, 2916.7—2920.0 m.

All photos ×50



1 — ?*Spathognathodus* sp.; Rzeczenica *1*, 2907.9—2912.7 m.

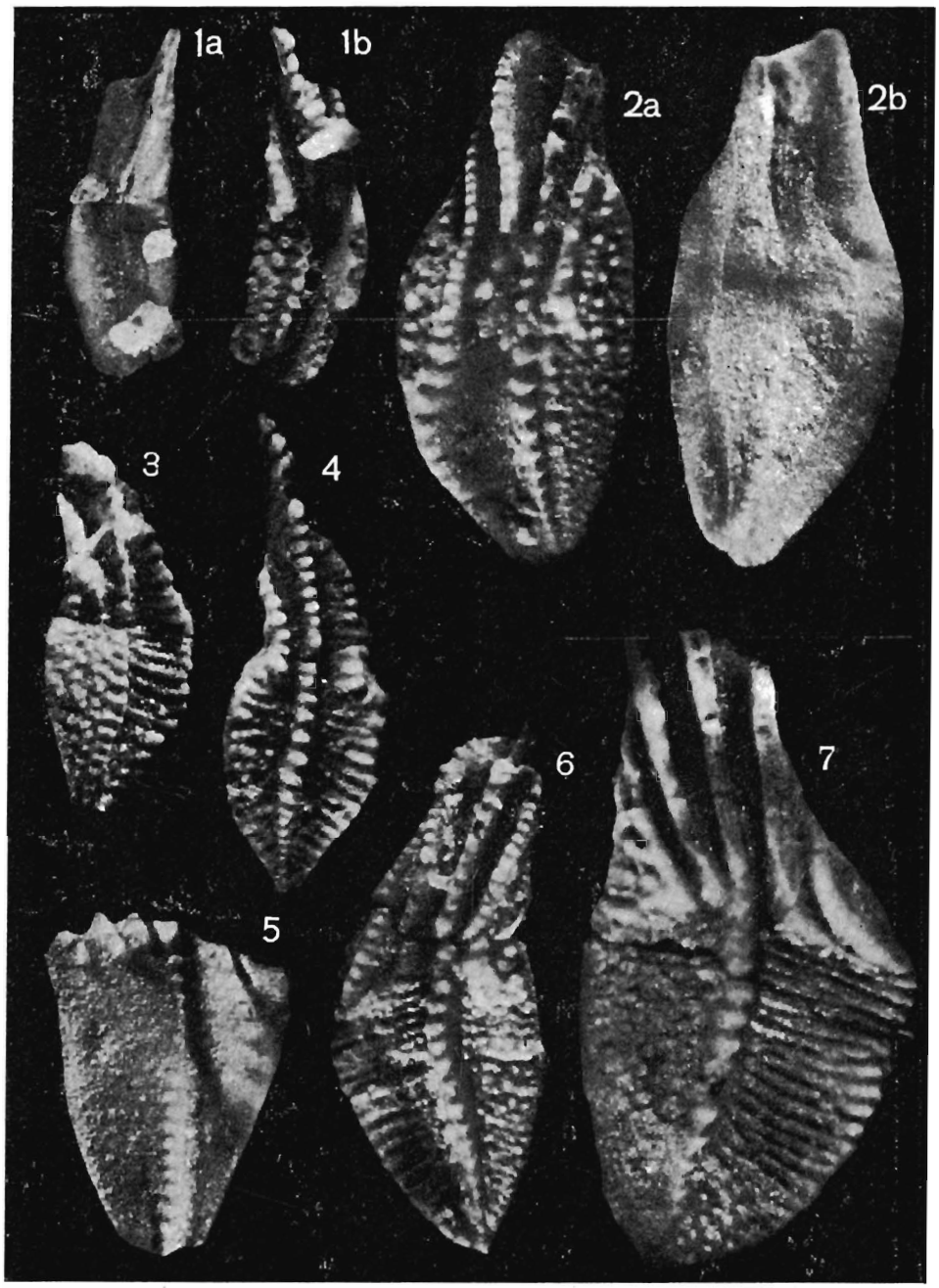
2, 5 — *Pseudopolygnathus dentilineatus* Branson; 2 Brda *2*, 2305.0—2311.8 m; 5 Rzeczenica *1*, 2907.9—2912.7 m.

3, 7 — *Pseudopolygnathus nodomarginatus* (Branson); Rzeczenica *1*; 3 2896.0—2899.0 m; 7 2907.9—2912.7 m.

4 — *Pseudopolygnathus triangulus inaequalis* Voges; Rzeczenica *1*, 2907.9—2912.7 m.

6 — *Polygnathus distortus* Branson & Mehl; Rzeczenica *1*, 2896.0—2899.0 m.

All photos ×50



1 — *Siphonodella isosticha* (Cooper); Brda *2*, 2473.0—2478.0 m.
2 — *Siphonodella obsoleta* Hass; Rzeczenica *1*, 2896.0—2899.0 m.
3, 6-7 — *Siphonodella quadruplicata* (Branson & Mehl); Rzeczenica *1*, 2907.9—2912.7 m.
4 — *Siphonodella duplicata* (Branson & Mehl); Rzeczenica *1*, 2907.9—2912.7 m.
5 — *Siphonodella* sp. ind.; Rzeczenica *1*, 2920.7—2925.0 m.

the ridges occasionally bifurcating. Small basal cavity situated in the anterior part of platform.

Remarks. — Our form comes near to *Polygnathus* cf. *flabellus* Branson & Mehl (comp. Voges 1959, p. 290, Pl. 34, Figs 8—11). It differs therefrom in the characteristic curve of carina, the presence of an inner lobe in the anterior part of the platform, also in the more delicate ridges on its upper surface.

Occurrence. — Western Pomerania, Rzeczenica *1* profile, depth 2907.9—2912.7 m.

Genus *Siphonodella* Branson & Mehl, 1944
Siphonodella sp. indet.
(Pl. 24, Fig. 5)

Material. — 3 incomplete platforms.

Description. — Fragments only of the platform have been preserved without its most anterior part. Platform fairly long and relatively narrow. Carina low, consisting of minute denticles. Upper surface of platform smooth, excepting the rostral ridges on either side of carina. Two rostral ridges detectable on outer side of platform, the longer inner one reaching to the margin of the platform nearer its posterior end. Three ridges present on the inner side of platform.

Remarks. — Our form resembles the species *Siphonodella obsoleta* Hass (comp. Klapper *in* Ziegler 1975, p. 463, Pl. 1, Fig. 7). It differs, however, foremost, in the lack of nodes on the inner side of platform.

Occurrence. — Western Pomerania, Rzeczenica *1* profile, depth 2920.7—2925.0 m.

Genus *Spathognathodus* Branson & Mehl, 1941
Spathognathodus aff. *cristulus* Youngquist & Miller, 1949
(Pl. 20, Figs 4, 6)

Material. — 3 specimens, one of them complete.

Description. — Form with 9 denticles along the oral margin, of which the anterior one blade-shaped, robust, high and considerably broader than the remaining ones. The next denticles (1—3) small, rather low, narrow and with rounded tips, the remaining ones directed to posterior end of blade being distinctly broader, more robust, with tips somewhat pointed. Basal cavity slightly asymmetric, starting behind the anterior denticle and not reaching to the posterior end of blade. Its outer part is somewhat longer and broader than the inner one.

Remarks. — In general outline this form resembles *Spathognathodus cristulus* Youngquist & Miller (comp. Rhodes, Austin & Druce 1969, pp. 227—228, Pl. 8, Figs 14—18). It differs from the latter species foremost in the asymmetric basal cavity not reaching to the posterior end of blade, also in much bigger posterior denticles.

Occurrence. — Western Pomerania, Rzeczenica *1* profile, depth 2896.0—2899.0 m.; Brda *1* profile, depth 2469.0—2475.0 m and 2676.0—2682.0 m.

Spathognathodus aff. *inornatus* (Branson & Mehl, 1934)
(Pl. 20, Figs 3, 5)

Material. — 3 incomplete specimens.

Description. — Form somewhat arcuately curved inwards with the posterior end of blade a little dipping down. The line formed by denticles, as seen in side view, culminates above the basal cavity. These denticles are laterally flattened,

pointed in the near-to-the tip parts and gradually decrease to the posterior blade. Basal cavity rather small, situated below the culmination of denticles, almost symmetrical (the outer one somewhat broader than the inner), characteristically drop-like shaped, broadest and rounded at posterior end of blade.

Remarks. — Our form comes near to *Spathognathodus inornatus* (Branson & Mehl) (comp. Branson & Mehl 1934, p. 185, Pl. 17, Fig. 23; Ziegler 1962, p. 111, Pl. 12, Fig. 24). It differs from that species in different outline of the basal cavity and in the posterior end of blade being incurved inwards and down.

Occurrence. — Western Pomerania, Rzeczenica *1* profile, depth 2999.0—3003.0 m.

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BIOSTRATYGRAFIA WARSTW PRZEJŚCIOWYCH DEWON—KARBON Z WYBRANYCH PROFILÓW NW POLSKI

(Streszczenie)

Intensywne badania geologiczne w poszukiwaniu bituminów prowadzone w ostatnim dziesięcioleciu przez Polską Służbę Geologiczną na Pomorzu Zachodnim (NW Polska) dostarczyły nowych i cennych materiałów z wierceń, które wzbogaciły naszą znajomość wgłębnej budowy geologicznej tego jeszcze mało znanego rejonu.

W pracy przedstawiono wyniki badań biostratygraficznych i litologicznych osadów najwyższego dewonu i dolnego karbonu z rejonu Chojnic z następujących profilów wiertniczych: Babilon *1*, Brda *1*, Brda *2*, Rzeczenica *1*, Biały Bór *1* i Biały Bór *3* (fig. 1 i 2). Opracowanie oparto głównie na szczegółowej analizie zespołu brachiopodów i konodontów, uwzględniając również wyniki badań nad inną fauną oraz mikroflorą. Wśród brachiopodów stwierdzono obecność 84 gatunków, wraz z podgatunkami, należących do 48 rodzajów oraz 32 gatunki i podgatunki konodontów, reprezentujących 6 rodzajów. Zasięgi pionowe poszczególnych form w omawianych profilach przedstawiono w 6 tabelach (por. tab. 2—7). Zilustrowano opracowaną faunę (por. pl. 1—24), a opisy podano jedynie tych form, których przynależność gatunkowa bądź rodzajowa jest dyskusyjna.

W badanych profilach wyróżniono górny famen (Fa2), osady będące odpowiednikiem warstw Etroeungt Francji i Belgii (Tn1a), a także turnej właściwy (sensu Heerlen 1935). Przedyskutowano pozycję stratygraficzną warstw przejściowych dewon-karbon w Europie w świetle badań paleontologicznych oraz omówiono osady tego wieku w Polsce.

Przedstawiono rozwój facjalno-paleogeograficzny basenu sedymentacyjnego w rejonie Chojnic na przełomie dewonu i karbonu, wyróżniając dwie strefy sedymentacyjne.

Całokształt obserwowanych zjawisk na pograniczu dewonu i karbonu, a także wyjątkowo duża miąższość osadów, będących odpowiednikiem wiekowym warstw Etroeungt (Tn1a) w rejonie Chojnic, wskazuje, że obszar ten w skali europejskiej wydaje się mieć istotne znaczenie dla wyjaśnienia problemu warstw przejściowych dewon-karbon i granicy między tymi systemami.