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Famennian conodonts from borehole Bolechowice 1 (in the Holy Cross Mts.)

ABSTRACT: The investigation of conodont remains has provided very full data concerning the thickness and division of the particular Famennian horizons and confirmed the occurrence of the Devonian-Carboniferous boundary at a depth suggested by H. Żakowa (1967). It has also suggested helpful amendments concerning the division of the Tournaisian, consequently also with regard to the sedimentation of the deposits. Correlations have been made of the stratigraphic value of this group of organisms and the importance in this respect of microflora, of ostracods and of macrofauna, particularly of some lamellibranchian species first described from Kazachstan and so far not reported in Poland outside the area of the Holy Cross Mts.

INTRODUCTION

In 1961 a borehole was drilled in the village of Bolechowice (SW part of the Holy Cross Mts.) which lies within the south-eastern part of the Gałęzice-Bolechowice-Borków syncline (fig. 1). After piercing the deposits of the Quaternary (down to a depth of 10.5 m.) and of the Middle and Lower Zechstein (to a depth of 104.5 m.) the borehole reached the deposits of the Lower Carboniferous (Tournaisian) and of the Upper Devonian — Famennian and Frasnian — the borehole ending at a depth of 212 m. A preliminary description of the Carboniferous and Devonian strata were given in 1963 and 1964 (Żakowa 1963, Ryka & Żakowa 1964) while a detailed description of their characteristics in what concerns the lithology, Carboniferous petrography, biofacies and lithofacies, macro- and microfauna as well as the stratigraphy, was published by H. Żakowa in 1967. A brief historical review was there given of the investigation work on the Lower Carboniferous of the south-eastern part of the Gałęzice-Bolechowice-Borków syncline and on the problem of the passage Devonian-Carboniferous strata. These investigations were based on the macro- and microfossils (the conodonts excepted) found in the above borehole. Their results were, moreover, discussed by H. Żakowa (1967) who was the first to correlate these data with the general development of the Strunian and the Tournaisian in the Holy Cross Mts.

Mention has already been made in all these papers of the discovery of conodonts in deposits of the *Gattendorfia* horizon (series consisting of darkgrey and black siliceous shales, siliceous-clay shales with intercalations of clay shales and claystones and, lower down, of greenish and grey marls and marly limestones, marls with limestone nodules and

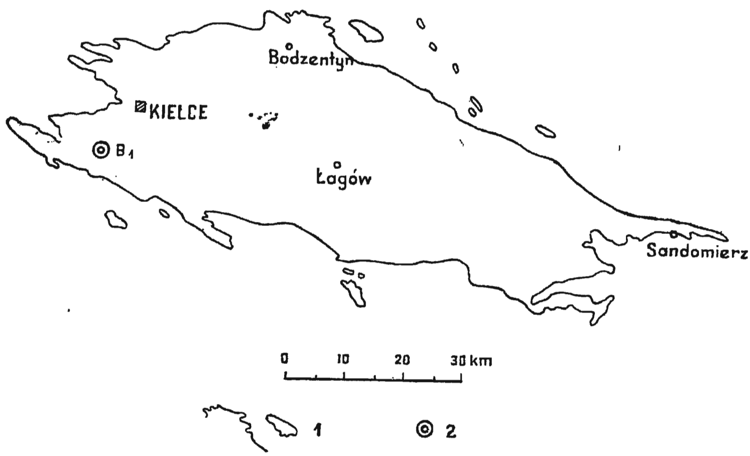

Fig. 1

Localisation of borehole Bolechowice 1 in the Palaeozoic of the Holy Cross Mts.

1 contour lines of the Palaeozoic deposits, *2* borehole

Lokalizacja wiercenia Bolechowice 1 w paleozoiku świętokrzyskim

1 zarys utworów paleozoicznych, *2* wiercenie

claystone intercalations) and of the Famennian from Bolechowice. The latter are lithologically analogous with the limestone series of the *Gattendorfia* horizon. It is interesting to note that the conodonts had been found here some decades ago by Z. Sujkowski (1933) while he was fragmentarily investigating the petrography of rocks from Kowala which is situated within the same syncline and about 3 km. to the east of Bolechowice. Z. Sujkowski found his conodonts within greenish clay shales which J Czarnocki (1933) without reliable evidence had referred to the *Gattendorfia* horizon.

In the research work on the conodonts the writers' main attention was turned to the separation of these microorganisms from the Famennian rocks. Only a few samples were collected from Lower Carboniferous deposits (mostly with negative results) also with the object of a revision of the Devonian-Carboniferous boundary which had been established by H. Żakowa (1967) in borehole Bolechowice 1 on other biostratigraphic principles. Hence, the elaboration of the conodonts was undertaken in order to reliably supplement previous conclusions concerning the stratigraphy of the sub-Zechstein series from this borehole. The greatest concern here was more accurately to divide the Famennian and determine the thickness of the Strunian.

At first 15 samples were taken for investigation between a depth of 141.3—141.75 m., also between 143.8 to 173.6 m. In view, however, of the above problems and under the belief that for the first time in the Famennian strata of the Holy Cross Mts. — a direct correlation might possibly be made of the conodont stratigraphy and the conclusions suggested by other organic groups, additional (13) samples were collected between the depth of 139.3 to 151 metres. Negative results were obtained for samples taken between 139.3—140.3 m., 140.9—141.3 m., 143.4 m., 142.5—143.8 m., 143.8—144.9 m., 144.9—146.0 m. and 146.0—147.1 metres. The remaining samples yielded the conodont remains described in the present paper.

The need for an undelayed elaboration of her materials, and the temporary exclusion of these themes from the program of the work of the Geological Institute of Poland (as well as from its Holy Cross Mts. Branch of the Geological Institute in Kielce) led the writer to seek co-operation with the VEB Geologische Erkundung Süd in Freiberg Germany). Her samples were then transferred to be worked out by Dr. G. Freyer. He is the author of all the chapters in the present paper, excepting the Introduction and the final conclusions. These have been prepared by H. Żakowa.

PREPARATION AND STATE OF PRESERVATION OF THE CONODONT REMAINS

To separate the conodont remains from the rock matrix H. Beckmann's (1952) monochloracetic acid procedure was used in the first place, occasionally replacing it by dissolution in acetic acid. It should be mentioned here that quite recently K. Diebel (1956) and G. Bischoff & W. Ziegler (1957) have suggested some most convenient methods for the preparation of these microfossils.

To begin with, the marls and limestones were thoroughly cleaned by means of a wire-brush, then broken up into small fragments, about the size of a plum, and steeped in 40% monochloracetic acid. These fragments were suspended by being placed on a finemesh perlon sieve in a glass beaker of abt. 2 liters capacity, filled with acid. Upon their separation from the rock matrix the micro-organisms dropped down while the rock residuum remained on the perlon sieve. After being dissolved from the rock the precipitate was carefully decanted and searched under binoculars. In order completely to dissolve the rock fresh acid was put into the beaker in amounts dependent on the contamination of the rock. The conodont remains were picked out by means an ordinary, wax-coated needle. They were kept in Francke's cells which are thought the most convenient ones.

It has been observed that some conodont remains, when steeped in strongly heated monochloracetic acid are subject to corrosion and display white weathered-like colouration. This phenomenon was observable after the specimens had been submitted to the action of the acid for a short period of some hours' duration. The fragments of the more clayey samples were again broken up into smaller bits before steeping them once more in fresh acid, because of the thick clayey film usually coating limestone fragments.

The photographs attached to the present paper were prepared with the Zeiss-Kurs microscope, Exacta Varex and the Carl Zeiss-Jena microfilm and microtar. Two Nitraphot lamps were used to obtain extra light. The specimens were exposed half a second with a medium diaphragm. To heighten the depth of focus a special diaphragm was used (centrally perforated), placed in a microtube.

Most of the conodont remains are in a satisfactory or even excellent state of preservation. Their most common colour is a pale or honey--yellow tint, occasionally they are dark. As has been mentioned above some of the conodont specimens on being for a short time submitted to the action of strongly heated monochloracetic acid display signs of corrosion. This is, however, very exceptional and probably occurs only in the case of previously somewhat corroded specimens. On the whole the methods of preparation did not deteriorate the condition of conodont assemblages separated from the material from borehole Bolechowice 1.

In specimens from the genus *Palmatolepis* the cavity filling is frequently preserved while in the genera *Ozarkodina, Spathognathodus* and *Polygnathus* this is rather rare. If present, it is very small, in correspondence to the circumference of the pulp cavity, or only partly preserved. No piritised conodonts have been found, but frequently some parts of the specimens (mostly denticles) had been altered by iron oxides. In the organic material under consideration there were no specimens completely altered by these oxides.

The number of the particular conodont forms is extremely variable and probably depends merely on the action of outside factors (deposits). The conodont „bone-beds", known from the descriptions of G. Bischoff and W. Ziegler (1957) from the Amönau quarry, have not been observed in the examined samples from borehole Bolechowice 1.

SPECIFICATION OF IDENTIFIED CONODONTS

The specifications listed below are based on results obtained by the examination of the particular samples (from the youngest to the oldest ones). The numbers of specimens are shown in chart 1.

Chart (Tabela) 1*

Quantitative chart of conodonts identified from borehole Bolechowice 1

Ilościowe zestawienie konodontów oznaczonych z wiercenia Bolechowice 1

Genus and species	Carboniferous		Devonian (Famennian)								
	Depth in metres										
	141.3–141.75	145.5	147.5	148.0	148.7	149.5	150.0	151.0	152.0	154.5	157.0
Acodina curvata Stauffer	—	—	—	—	—	—	—	—	—	—	—
Acodina sp.	—	—	—	—	—	—	—	—	—	—	—
Bryantodus nitidus Ulrich & Bassler	—	—	—	—	—	—	—	—	—	—	—
Ellisonia sp.	—	—	—	—	—	—	—	—	—	—	—
Falcodus variabilis Sannemann	—	—	—	—	—	—	—	1	—	—	3
Falcodus sp.	—	—	—	—	—	—	1	—	—	2	—
Hindeodella brevis Branson & Mehl	—	—	—	—	—	—	—	1	—	—	—
H. deflecta Hibbard	—	—	—	—	—	—	—	—	—	—	—
H. cf. deflecta Hibbard	—	—	—	—	—	—	2	1	—	—	—
H. germana Holmes	1	—	2	—	1	1	3	1	2	1	4
Hindeodella sp.	1	27	—	—	—	—	2	—	3	—	—
Ligonodina monodentata Bischoff & Ziegler	—	—	—	—	—	—	2	—	—	—	—
Ligonodina sp.	—	27	—	—	—	—	—	—	—	—	—
Lonchodina valida Sannemann	—	—	—	—	—	—	1	—	—	—	—
Lonchodina sp.	—	—	—	—	—	—	—	—	2	—	—
Nothognathella sublaevis Sannemann	—	—	—	—	—	—	—	—	—	—	—
N. typicalis Branson & Mehl	—	—	—	—	—	—	—	—	—	—	—
Ozarkodina delicatula (Stauffer & Plummer)	—	—	2	—	—	—	—	3	—	—	—
O. elegans (Stauffer)	—	—	—	—	—	—	—	—	—	—	—
O. homoarcuata Helms	—	—	—	—	—	—	1	—	—	—	—
O. lacera Helms	—	—	—	—	—	—	—	—	—	—	2
O. regularis Branson & Mehl	—	—	1	—	—	—	2	4	—	—	—
O. rhenana Bischoff & Ziegler	—	—	—	—	—	1	—	—	—	—	—
O. cf. rhenana Bischoff & Ziegler	—	—	—	—	1	—	—	—	—	—	—
Ozarkodina sp.	—	—	—	1	2	—	—	—	—	—	—
Palmatodella delicatula Ulrich & Bassler	—	—	—	—	—	—	3	—	2	—	—
Palmatolepis crepida crepida Sannemann	—	—	—	—	—	—	—	—	—	—	—
P. deflectens deflectens Müller	—	—	10	15	8	13	9	10	8	—	—
P. delicatula Branson & Mehl	—	—	—	—	—	—	—	—	—	—	—
P. distorta Branson & Mehl	—	—	—	—	—	—	—	—	—	—	5
P. glabra elongata Holmes	—	—	—	—	—	—	—	—	—	—	10
P. glabra pectinata Ziegler	—	—	—	—	—	—	—	—	—	—	15
P. glabra subsp. *a* Ziegler	—	—	—	—	—	—	—	—	—	—	3
P. gonioclymeniae Müller	—	—	7	—	—	9	9	—	—	—	—
P. minuta minuta Branson & Mehl	—	—	—	—	—	—	—	—	—	—	10
P. minuta loba Helms	—	—	—	—	—	—	—	—	—	—	—
P. minuta subsp. *a* Helms	—	—	—	—	—	—	—	—	—	—	—
P. quadrantinodosa inflexa Müller	—	—	—	—	—	—	—	—	—	—	—
P. quadrantinodosa marginifera Ziegler	—	—	—	—	—	—	—	—	—	—	6
P. quadrantinodosalobata Sannemann	—	—	—	—	—	—	—	—	—	—	—
P. perlobata subsp. *a* Helms	—	—	—	—	—	—	—	—	—	—	—
P. perlobata schindewolfi Müller	—	—	—	—	—	—	—	—	—	—	15
P. rhomboidea Sannemann	—	—	—	—	—	—	—	—	—	—	—
P. rugosa ampla Müller	—	—	—	—	—	—	—	—	—	—	4
P. rugosa grossi Ziegler	—	—	—	—	—	—	—	—	—	—	8
P. cf. regularis Cooper	—	—	—	—	—	—	—	—	—	—	—
P. schleizia Helms	—	—	—	—	—	—	—	—	—	7	—
P. subperlobata Branson & Mehl	—	—	—	—	—	—	—	—	—	—	—
P. triangularis Sannemann	—	—	—	—	—	—	—	—	—	—	—
Palmatolepis sp.	—	—	—	—	—	—	—	—	—	—	—
Polygnathus bicavata Ziegler	—	—	—	—	—	—	—	—	—	—	1
P. communis Branson & Mehl	—	—	—	—	—	—	4	2	4	—	—
P. diversa Helms	—	—	—	—	—	—	—	—	—	—	—
P. foliata Bryant	—	—	—	—	—	—	—	—	—	—	—
P. glabra glabra Ulrich & Bassler	—	—	—	—	—	—	—	—	—	—	8
P. procera Sannemann	—	—	—	—	—	—	—	—	—	—	—
Polygnathus sp.	—	2	—	—	—	—	3	—	—	—	—
Polylophodonta linguiformis Branson & Mehl	—	—	—	—	—	—	—	—	—	—	1
P. ? triphyllata Ziegler	—	—	—	—	—	—	—	—	—	—	—
Prioniodina prona (Huddle)	—	—	—	—	—	—	8	9	—	—	—
Pr. smithi (Stauffer)	—	—	4	—	—	—	1	3	2	—	—
Pseudopolygnathus marburgensis Bischoff & Ziegler	—	—	—	—	—	—	2	—	1	—	—
Ps. trigonica Ziegler	—	—	1	—	—	—	1	—	—	—	—
Roundya aurita Sannemann	—	—	—	—	—	—	—	—	—	—	—
Roundya sp.	—	—	—	—	—	—	—	—	2	—	—
Scaphignathus velifera Ziegler	—	—	—	—	—	—	—	—	2	4	1
Scutula venusta Sannemann	—	—	—	—	—	—	—	—	—	—	—
Scutula sp.	—	—	—	—	—	—	1	—	—	—	—
Siphonodella duplicata (Branson & Mehl)	—	1	—	—	—	—	—	—	—	—	—
S. isosticha (Cooper)	2	—	—	—	—	—	—	—	—	—	—
S. cf. obsoleta Hass	—	2	—	—	—	—	—	—	—	—	—
Spathognathodus aculeatus (Branson & Mehl)	—	—	4	3	—	2	4	5	—	—	—
Sp. cf. bohlenanus Helms	—	—	—	—	—	—	—	—	2	—	—
Sp. costatus costatus (E. R. Branson)	—	—	8	9	3	1	1	—	—	—	—
Sp. costatus spinulicostatus (E. R. Branson)	—	—	—	2	—	5	—	—	—	—	—
Sp. costatus ultimus Bischoff	—	—	3	—	—	—	—	—	—	—	—
Sp. inornatus (Branson & Mehl)	—	—	10	—	—	—	9	8	3	—	—
Sp. jugosus (Branson & Mehl)	—	—	—	—	—	—	4	—	—	—	—
Sp. stabilis (Branson & Mehl)	—	—	—	—	11	9	10	13	14	—	—
Sp. strigosus (Branson & Mehl)	—	—	—	—	—	—	9	—	—	—	—
Tripodellus robustus Bischoff	—	—	1	—	—	—	2	1	1	—	—
Tripodellus sp.	—	—	—	—	—	1	—	—	—	—	—

* 1–20 — number of specimens, — no specimens.
1 do 20 — ilość okazów, — brak okazów.

159.0	161.5	164.6	168.6	170.6—171.6	173.6
—	—	—	—	—	2
—	—	—	—	1	2
—	—	—	1	—	—
1	1	—	—	—	—
1	3	—	—	—	—
—	—	—	—	—	—
—	2	—	—	—	—
1	3	—	2	1	3
—	—	—	—	—	—
5	5	—	6	7	2
—	—	2	—	1	3
—	—	—	—	—	—
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—	—	—	—	—	—
—	3	—	—	—	—
—	—	—	2	—	—
—	2	—	—	—	—
2	—	—	—	—	—
4	—	—	—	—	—
3	—	—	—	—	—
4	—	—	—	—	—
2	3	—	1	2	3
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
3	1	—	4	2	4
—	—	—	—	—	4
—	—	—	—	—	—
—	—	—	2	—	—
—	—	—	—	—	—
15	—	—	—	—	—
21	—	—	—	—	—
—	4	—	10	—	12
—	—	—	—	—	—
8	13	—	—	—	1
—	—	—	—	1	2
—	—	—	2	5	—
5	—	—	—	—	—
—	—	—	—	—	—
—	5	—	—	—	6
—	—	—	—	—	2
12	—	—	—	—	—
15	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	7	1	—
—	—	—	—	—	—
—	4	—	5	—	2
—	—	—	16	—	20
—	—	3	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	3
—	—	—	—	—	2
10	4	—	5	—	3
—	5	—	4	—	3
—	—	2	—	—	1
—	—	—	—	—	—
1	—	—	—	—	—
15	12	—	4	—	9
1	5	—	2	—	1
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	3
—	—	—	—	—	—
—	—	—	—	—	—
—	2	—	—	—	—
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—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—

Depth 141.3—141.75 m.:

Hindeodella germana Holmes
Hindeodella sp. *(germana ?)*
Siphonodella isosticha (Cooper)
Age of sample: with reservation *cooperi-isosticha* zone (cu IIα)

Depth 145.5 m.:

Hindeodella sp. ?
Ligonodina sp. ?
Polygnathus sp. ?
Siphonodella duplicata (Branson & Mehl)
Siphonodella cf. *obsoleta* Hass
Age of sample: probably cu I, possibly the lowermost cu IIα

Depth 147.5 m.:

Hindeodella germana Holmes
Ozarkodina regularis Branson & Mehl — pl. I, fig. 14
Palmatolepis deflectens deflectens Müller
Palmatolepis gonioclymeniae Müller
Prioniodina smithi (Stauffer)
Pseudopolygnathus trigonica Ziegler
Spathognathodus aculeatus (Branson & Mehl)
Spathognathodus costatus costatus (E. R. Branson)
Spathognathodus costatus ultimus Bischoff — pl. I, fig. 10; pl. II, fig. 2
Spathognathodus inornatus (Branson & Mehl) — pl. I, fig. 7; pl. II, fig. 13
Tripodellus robustus Bischoff — pl. I, fig. 5
conodont-like fragment (*Acodina* ?). indeterminate foraminifers and badly preserved remains of Clymeniae or goniatites
Age of sample: middle — lowermost upper *costatus* zone (Wocklumeria, to VI)

Depth 148.0 m.:

Ozarkodina sp.
Palmatolepis defelectens deflectens Müller — pl. I, fig. 1; pl. II, figs. 3—4
Spathognathodus aculeatus (Branson & Mehl)
Spathognathodus costatus costatus (E. R. Branson)
Spathognathodus costatus spinulicostatus (E. R. Branson) — pl. I, fig. 9
Age of sample: middle *costatus* zone (to VIα)

Depth 148.7 m.:

Hindeodella germana Holmes
Ozarkodina cf. *rhenana* Bischoff & Ziegler
Ozarkodina sp.
Palmatolepis deflectens deflectens Müller
Spathognathodus costatus costatus (E. R. Branson)
Spathognathodus stabilis (Branson & Mehl)
Age of sample: *costatus* zone (to V/VI — to VI, in details not more accurately determinable)

Depth 149.5 m.:

Hindeodella germana Holmes
Ozarkodina rhenana Bischoff & Ziegler
Palmatolepis deflectens deflectens Müller
Palmatolepis gonioclymeniae Müller
Spathognathodus aculeatus (Branson & Mehl)
Spathognathodus costatus costatus (E. R. Branson)
Spathognathodus costatus spinulicostatus (E. R. Branson)

Spathognathodus stabilis (Branson & Mehl) — pl. I, fig. 11
Tripodellus sp.
Age of sample: middle *costatus* zone (perhaps the passage from the lower to the middle *costatus* zone, to VIα)

Depth 150.0 m.:
Falcodus sp.
Hindeodella cf. *deflecta* Hibbard
Hindeodella germana Holmes
Hindeodella sp.
Ligonodina monodentata Bischoff & Ziegler — pl. I, fig. 13
Lonchodina valida Sannemann
Ozarkodina homoarcuata Helms
Ozarkodina regularis Branson & Mehl
Palmatolepis delicatula Ulrich & Bassler — pl. I, fig. 3
Palmatolepis defelectens deflectens Müller
Palmatolepis gonioclymeniae Müller
Polygnathus communis Branson & Mehl
Polygnathus sp.
Prioniodina prona (Huddle)
Prioniodina smithi (Stauffer)
Pseudopolygnathus marburgensis Bischoff & Ziegler — pl. I, fig. 4
Pseudopolygnathus trigonica Ziegler
Scutula sp.
Spathognathodus aculeatus (Branson & Mehl)
Spathognathodus costatus costatus (E. R. Branson)
Spathognathodus inornatus (Branson & Mehl)
Spathognathodus jugosus (Branson & Mehl)
Spathognathodus stabilis (Branson & Mehl)
Spathognathodus strigosus (Branson & Mehl) — pl. I, fig. 8
Tripodellus robustus Bischoff
Age of sample: lower — lowermost *costatus* zone (passage to V/VI — lowermost to VI)

Depth 151.0 m.:
Falcodus variabilis Sannemann
Hindeodella brevis Branson & Mehl)
Hindeodella cf. *deflecta* Hibbard
Hindeodella germana Holmes
Ozarkodina delicatula (Stauffer & Plummer)
Ozarkodina regularis Branson & Mehl
Palmatolepis deflectens deflectens Müller
Polygnathus communis Branson & Mehl
Prioniodina prona (Huddle) — pl. I, fig. 2
Prioniodina smithi (Stauffer)
Spathognathodus aculeatus (Branson & Mehl) — pl. I, fig. 12
Spathognathodus inornatus (Branson & Mehl)
Spathognathodus stabilis (Branson & Mehl)
Tripodellus robustus Bischoff
Age of sample: probably on the boundary of the upper *styriaca* zone (lower *costatus* zone — sensu W. Ziegler or *styriaca* — *costatus* — *Interregnum* (to V) — sensu J. Helms)

Depth: 152.0 m.:
Hindeodella germana Holmes

Hindeodella sp.
Lonchodina sp.
Palmatodella delicatula Ulrich & Bassler
Palmatolepis deflectens deflectens Müller
Polygnathus communis Branson & Mehl
Prioniodina smithi (Stauffer)
Pseudopolygnathus marburgensis Bischoff & Ziegler
Roundya sp.
Scaphignathus velifera Ziegler
Spathognathodus cf. *bohleanus* Helms
Spathognathodus inornatus (Branson & Mehl)
Spathognathodus stabilis (Branson & Mehl) — pl. I, fig. 6; pl. II, fig. 11
Tripodellus robustus Bischoff
Age of sample: *styriaca* zone (upper to IV — to V) or upper *velifera* zone (upper to III — lower to IV)

Depth 154.5 m.:
Falcodus sp.
Hindeodella germana Holmes
Palmatolepis schleizia Helms
Scaphignathus velifera Ziegler — pl. II, fig. 9
Age of sample: according to J. Helms (1963) uppermost to III (= middle *velifera* zone sensu Ziegler); according to position in borehole probably the passage to III/to IV

Depth 157.0 m.:
Falcodus variabilis Sannemann
Hindeodella germana Holmes
Ozarkodina lacera Helms
Palmatolepis distorta Branson & Mehl — pl. II, fig. 6
Palmatolepis glabra elongata Holmes — pl. II, fig. 7
Palmatolepis glabra pectinata Ziegler — pl. II, fig. 8
Palmatolepis glabra subsp. *a* Ziegler
Palmatolepis minuta minuta Branson & Mehl
Palmatolepis perlobata schindewolfi Müller — pl. II, fig. 1
Palmatolepis rugosa ampla Müller
Pajamatolepis rugosa grossi Ziegler
Polygnathus bicavata Ziegler
Polygnathus glabra glabra Ulrich & Bassler
Polylophodonta linguiformis Branson & Mehl
Scaphignathus velifera Ziegler
Age of sample: upper *quadrantinodosa* zone — lower *velifera* zone (= to IIIα — lowermost to IIIβ)

Depth 159.0 m.:
Ellisonia sp.
Falcodus variabilis Sannemann
Hindeodella deflecta Hibbard
Hindeodella germana Holmes
Ozarkodina delicatula (Stauffer & Plummer)
Ozarkodina elegans (Stauffer)
Ozarkodina homoarcuata Helms — pl. I, fig. 15; pl. II, fig. 14
Ozarkodina lacera Helms — pl. II, fig. 12
Ozarkodina regularis Branson & Mehl

Palmatodella delicatula Ulrich & Bassler
Palmatolepis glabra elongata Holmes
Palmatolepis glabra pectinata Ziegler
Palmatolepis minuta minuta Branson & Mehl
Palmatolepis quadrantinodosa inflexa Müller — pl. II, fig. 5
Palmatolepis perlobata schindewolfi Müller
Palmatolepis rhomboidea Sannemann
Polygnathus glabra glabra Ulrich & Bassler
Polyphodonta ? triphyllata (Ziegler)
Prioniodina prona (Huddle)
Prioniodina smithi (Stauffer)
Age of sample: *rhomboidea* zone — lower *quadrantinodosa* zone (= to IIβ)

Depth 161.5 m.:
Ellisonia sp.
Falcodus variabilis Sannemann
Hindeodella brevis Branson & Mehl
Hindeodella deflecta Hibbard
Hindeodella germana Holmes
Lonchodina sp.
Nothognathella typicalis Branson & Mehl
Ozarkodina regularis Branson & Mehl
Palmatodella delicatula Ulrich & Bassler
Palmatolepis glabra subsp. *a* Ziegler
Palmatolepis minuta minuta Branson & Mehl
Palmatolepis quadrantinodosalobata Sannenmann
Palmatolepis subperlobata Branson & Mehl
Polygnathus glabra glabra Ulrich & Bassler
Polygnathus procera Sannemann
Prioniodina prona (Huddle)
Prioniodina smithi (Stauffer)
Scutula venusta Sannemann
Age of sample: *crepida-crepida* zone (to IIα)

Depth 164.6 m.:
specifically indeterminable conodont remains from the genera *Hindeodella*, *Palmatolepis* and *Polygnathus*
Age of sample: Upper Devonian, probably younger than to I (*Manticoceras* horizon)

Depth 168.6 m.:
Bryantodus nitidus Ulrich & Bassler
Hindeodella deflecta Hibbard
Hindeodella germana Holmes — pl. II, fig. 10
Nothognathella sublaevis Sannemann
Ozarkodina regularis Branson & Mehl
Palmatodella delicatula Branson & Mehl
Palmatolepis cf. *regularis* Cooper
Palmatolepis delicatula Branson & Mehl
Palmatolepis glabra subsp. *a* Ziegler
Palmatolepis minuta subsp. *a* Helms
Palmatolepis subperlobata Branson & Mehl
Palmatolepis triangularis Sannemann
Polygnathus glabra glabra Ulrich & Bassler

Polygnathus procera Sannemann
Prioniodina prona (Huddle)
Prioniodina smithi (Stauffer)
Age of sample: *crepida-crepida* zone (to IIα)

Depth 170.6 m.:
Acodina sp.
Hindeodella deflecta Hibbard
Hindeodella germana Holmes
Hindeodella sp.
Ozarkodina regularis Branson & Mehl
Palmatodella delicatula Ulrich & Bassler
Palmatolepis minuta loba Helms
Palmatolepis minuta subsp. *a.* Helms
Palmatolepis cf. *regularis* Cooper
Age of sample: *crepida-crepida* zone (to IIα)

Depth 173.6 m.:
Acodina curvata Stauffer
Acodina sp.
Hindeodella deflecta Hibbard
Hindeodella germana Holmes — pl. I, fig. 16
Hindeodella sp.
Ozarkodina regularis Branson & Mehl
Palmatodella delicatula Ulrich & Bassler
Palmatolepis crepida crepida Sannemann
Palmatolepis glabra subsp. *a* Ziegler
Palmatolepis minuta minuta Branson & Mehl
Palmatolepis minuta loba Helms
Palmatolepis perlobata subsp. *a* Helms
Palmatolepis quadrantinodosalobata Sannemann
Palmatolepis subperlobata Branson & Mehl
Palmatolepis triangularis Sannemann
Polygnathus diversa Helms
Polygnathus foliata Bryant
Polygnathus glabra glabra Ulrich & Bassler
Polygnathus procera Sannemann
Polygnathus sp.
Prioniodina prona (Huddle)
Prioniodina smithi (Stauffer)
Roundya aurita Sannemann
Age of sample: lower *crepida-crepida* zone (lowermost to IIα)

DESCRIPTION OF THE MORE IMPORTANT CONODONT SPECIES

The writers' micropalaeontological analysis shows that there are no new species of conodonts in the deposits of borehole Bolechowice 1, so far investigated. Although all the here identified species have been described at large, descriptions of some conodonts are given below because of the inadequate knowledge of these microorganisms from the Famennian strata of Poland (including those from the Holy Cross Mts.). They deal with the most important or the most numerous forms represented in the Famennian deposits of this borehole.

Genus *Hindeodella* Ulrich & Bassler, 1926
Hindeodella germana Holmes, 1928
(pl. I, fig. 16; pl. II, fig. 10)

1928. *Hindeodella germana* Holmes; Holmes H. B.: p. 25, pl. 9, fig. 9.
1955b. *Hindeodella germana* Holmes; Sannemann D.: p. 130, pl. 2, figs. 4—5.
1957. *Hindeodella germana* Holmes; Bischoff G.: p. 27, pl. 6, fig. 32—34.

Material.— 41 specimens.

Description.— Posterior bar long, in most specimens straight, occasionally slightly bent, with numerous narrow denticles, more or less posteriorly inclined. Between two larger denticles (of order I) there occur from 2 to 5 smaller (secondary) denticles. The posterior bar ends sharply, the overlapping of the younger denticles being often observable as previously mentioned by D. Sannemann. The main cusp is double the width and length of the larger denticles of the posterior bar. It is always inclined backward and inward. The anterior bar is bent inward and bears 6—8 narrow denticles of which two are often double the length of the remaining ones.

Life time.— Mostly Devonian — Carboniferous.

Genus *Palmatolepis* Ulrich & Bassler, 1926
Palmatolepis deflectens deflectens Müller, 1956
(pl. I, fig. 1; pl. II, figs. 3—4).

1934. *Palmatolepis gracilis* Branson & Mehl; Branson E. B., Mehl M. G.: p. 238, pl. 18, figs. 2, 5, 8.
1955a. *Palmatolepis gracilis* Branson & Mehl; Sannemann D.: p. 326, pl. 24, fig. 15.
1956. *Palmatolepis (Deflectolepis)* deflectens Müller; Müller K. J.: p. 32, pl. 11, figs. 28—39.
1962b. *Palmatolepis deflectens deflectens* Müller; Ziegler W.: p. 56, pl. 3, figs. 17—22.

Material. — 73 specimens.

Description. — This species has a long, generally narrow blade and a very small platform folding down and sideway from the blade at a considerable angle. End of platform pointed. On the sides the platform is delimited by swollen edges. Moreover, it bears a distinct azygous node from which a row of progressively smaller denticles stretches as far as the sharply pointed end. On the blade there is a row of distinct denticles outgrowing each other as far as the apex. In section the denticles are round and loosely arranged on the blade. On the aboral side

Palmatolepis glabra pectinata Ziegler, 1962
(pl. II, fig. 8)

1959. *Palmatolepis glabra* subsp. *c* Ziegler; Ziegler W.: pl. 1.
1962a. *Palmatolepis glabra pectinata* Ziegler; Ziegler W.: p. 398, pl. 2, figs. 3—5.
1965. *Palmatolepis glabra pectinata* Ziegler; Bouckaert J., Ziegler W.: pl. 3, figs. 4—6.

Material.— 36 specimens.

Description. — The subspecies has a very elongated and narrow platform and is slightly longer than the type form. The anterior edge is, as a rule, strongly bent. The blade is placed somewhat obliquely to the platform and bears numerous denticles which are fused nearly up to the apex. From among them distinctly protrudes the conelike azygous node situated at the lowermost point of the platform. The surface of the platform is finely granulated. The keel stretches on the aboral side. The outer anterior edge is bent at an angle in the form of a spinous apophysis.

Life time. — Upper *crepida-crepida* zone to upper *quadrantinodosa* zone (to IIα — to IIIα).

Palmatolepis gonioclymeniae Müller, 1956

1956. *Palmatolepis (Palmatolepis) gonioclymeniae* Müller; Müller K. J.: p. 26, pl. 7, figs. 12, 16, 19.
1962b. *Palmatolepis gonioclymeniae* Müller; Ziegler W.: p. 59, pl. 3, figs. 29—31.

Material. — 25 specimens.

Description. — The platform of this subspecies is relatively small and provided with a carina which is strongly incurved at a considerable distance from the azygous node. The carina stretches beyond the azygous node as far as the posterior slightly ascending end of the platform. The secondary carina and the secondary keel are lacking. The blade passes into the carina and they are both spotted with numerous, small, uniform denticles. The azygous node is distinctly developed. There is a keel on the aboral side of the platform but in some specimens it is not discernible throughout its length. The platform is divided by the carina into two approximately even parts.

Life time. — Middle *costatus* zone (boundary to V/VI — to VIα).

Palmatolepis minuta minuta Branson & Mehl, 1934

1934. *Palmatolepis minuta* Branson & Mehl; Branson E. B., Mehl M. G.: p. 236, pl. 18, figs. 1, 6, 7.

Palmatolepis glabra pectinata Ziegler, 1962 (pl. II, fig. 8)

1959. *Palmatolepis glabra* subsp. *c* Ziegler; Ziegler W.: pl. 1.
1962a. *Palmatolepis glabra pectinata* Ziegler; Ziegler W.: p. 398, pl. 2, figs. 3—5.
1965. *Palmatolepis glabra pectinata* Ziegler; Bouckaert J., Ziegler W.: pl. 3, figs. 4—6.

Material.— 36 specimens.

Description. — The subspecies has a very elongated and narrow platform and is slightly longer than the type form. The anterior edge is, as a rule, strongly bent. The blade is placed somewhat obliquely to the platform and bears numerous denticles which are fused nearly up to the apex. From among them distinctly protrudes the conelike azygous node situated at the lowermost point of the platform. The surface of the platform is finely granulated. The keel stretches on the aboral side. The outer anterior edge is bent at an angle in the form of a spinous apophysis.

Life time. — Upper *crepida-crepida* zone to upper *quadrantinodosa* zone (to IIα — to III*a*).

Palmatolepis gonioclymeniae Müller, 1956

1956. *Palmatolepis (Palmatolepis) gonioclymeniae* Müller; Müller K. J.: p. 26, pl. 7, figs. 12, 16, 19.
1962b. *Palmatolepis gonioclymeniae* Müller; Ziegler W.: p. 59, pl. 3, figs. 29—31.

Material. — 25 specimens.

Description. — The platform of this subspecies is relatively small and provided with a carina which is strongly incurved at a considerable distance from the azygous node. The carina stretches beyond the azygous node as far as the posterior slightly ascending end of the platform. The secondary carina and the secondary keel are lacking. The blade passes into the carina and they are both spotted with numerous, small, uniform denticles. The azygous node is distinctly developed. There is a keel on the aboral side of the platform but in some specimens it is not discernible throughout its length. The platform is divided by the carina into two approximately even parts.

Life time. — Middle *costatus* zone (boundary to V/VI — to VIα).

Palmatolepis minuta minuta Branson & Mehl, 1934

1934. *Palmatolepis minuta* Branson & Mehl; Branson E. B., Mehl M. G.: p. 236, pl. 18, figs. 1, 6, 7.

1955a. *Palmatolepis minuta* Branson & Mehl; Sannemann D.: p. 326, pl. 24, figs. 12, 16.
1956. *Palmatolepis (Deflectolepis) minuta* Branson & Mehl; Müller K. J.: p. 31, pl. 10, fig. 19; pl. 11, figs. 20—26.
1962b. *Palmatolepis minuta minuta* Branson & Mehl; Ziegler W.: p. 65, pl. 3, figs. 1—10.
1965. *Palmatolepis minuta minuta* Branson & Mehl; Bouckaert J., Ziegler W.: pl. 3, figs. 1—3.

Material.— 32 specimens.

Description. — This subspecies has a flat platform whose central part is somewhat concave while the edges are raised. The lobe is always indicated, occasionally even very distinctly. The blade bears a row of usually distinct denticles round in section. The platform of this subspecies is greatly reduced and during vertical growth it gradually grows smaller and more ovoid. The carina is very slightly bent, especially before the azygous node. Poor granulation is detectable on the oral side of the platform. The aboral side is smooth, with a distinct keel running across it. Secondary keel lacking.

Life time. — Middle *triangularis* zone to upper *velifera* zone to Iδ ? — to IV).

Palmatolepis perlobata schindewolfi Müller, 1965
(pl. II, fig. 1)

1956. *Palmatolepis (Palmatolepis) schindewolfi* Müller; Müller K. J.: p. 27, pl. 8, figs. 22—31.
1959. *Palmatolepis perlobata schindewolfi* (Müller); Helms J.: p. 649, pl. 2, fig. 9; pl. 5, fig. 13.
1962b. *Palmatolepis perlobata schindewolfi* Müller, Ziegler W.: p. 70, pl. 8, figs. 2—5.
1963. *Palmatolepis perlobata schindewolfi* Müller; Brouckaert J., Ziegler W.: pl. 3, fig. 5.

Material. — 27 specimens.

Description. — Platform strongly elongated. In young specimens the surface of the platform is smooth, in mature ones it is covered by coarse nodes. The inner lobe is mostly small, often posteriorly turned. The blade is sigmoidal and covered by a row of raised denticles. Anteriorly it is high and vertically placed on the platform. A keel occurs on the aboral side of the platform stretching in coincidence with the direction of the blade. The aboral side of the interior lobe is generally provided with a secondary keel. In some specimens the platform is slender, in others stumpy, while its end may be pointed or rounded. In *Palmatolepis perlobata schindewolfi* the interior lobe is often directed slightly backward.

Life time. — Upper *crepida-crepida* zone to lower *costatus* zone (to IIα — boundary to V/VI).

Palmatolepis quadrantinodosa inflexa Müller. 1956
(pl. II, fig. 5)

1956. *Palmatolepis (Palmatolepis) inflexa* Müller; Müller K. J.: p. 30, pl. 10, figs. 3—11.

1962b. *Palmatolepis quadrantinodosa inflexa* Müller; Ziegler W.: p. 73, pl. 7, figs. 1—5.

Material.— 5 specimens.

Description. — This subspecies is characterised by a large granulated platform. The blade is strongly bent and its maximum curve occurs before the azygous node. This is large and as a rule it stands isolated on the inner side of the platform. The secondary carinae are lacking. The carina is strongly curved before reaching the azygous node, beyond it as far as the posterior end it stretches in a somewhat changed direction. The aboral side of the platform displays distinct growth lines and a continuous keel. Secondary keels lacking.

Life time. — Lower *quadrantinodosa* zone (to II β).

Palmatolepis triangularis Sannemann, 1955

1955a. *Palmatolepis triangularis* Sannemann; Sannemann D.: p. 327, pl. 24, fig. 3.

1959. *Palmatolepis triangularis* Sannemann; Helms J.: p. 650, pl. 1, figs. 18—20; pl. 4, figs. 20—25.

1962b. *Palmatolepis triangularis* Sannemann; Ziegler W.: p. 83, pl. 1, figs, 1—16.

1965. *Palmatolepis triangularis* Sannemann; Bouckaert J., Ziegler W.: pl. 1, figs. 1—6.

Material. — 36 specimens.

Description. — Triangle-like platform is provided with a triangulate lobe. Surface of platform ornamented by finer or coarser granulation. The granulation does not represent any evolutionary stage since it occurs analogously in young as well as in mature individuals. Blade high, narrow, bearing numerous small, uniformly developed denticles. Azygous node very large, more or less circular in contour. Aboral side of platform smooth, with concentric growth lines. Keel distinct, thinning out in the direction of the posterior end and disappearing before reaching it. Secondary keel either absent or indicated only along a small distance from the azygous node to the inner lobe.

Life time. — *Triangularis* zone, occasionally to the middle *crepida-crepida* zone (to Iδ — to IIα).

Genus *Polygnathus* Hinde, 1879

Polygnathus glabra glabra Urlich & Bassler, 1926

1926. *Polygnathus glaber* Urlich & Bassler; Ulrich E. O, Bassler R. S.: p. 46, pl. 7, fig. 13.

1955b. *Polygnathus glaber* Ulrich & Bassler, Sannemann D.: p. 149, pl. 3, fig. 14.

1962b. *Polygnathus glabra glabra* Ulrich & Bassler; Ziegler W.: p. 89, pl. 10, figs. 18—20.

Material. — 30 specimens.

Description. — The platform in this form is lancet-shaped or heart--shaped, occasionally with a sagittal end. Surface of platform smooth. In its very centre there is a blade bearing nodelike denticles; to the rear their height is gradually reduced and their spacing increased. A keel is present on the aboral side of the platform, fused with the blade. The anterior part of the keel comprises a narrow pulp cavity. The blade is of the same length as the platform and laterally viewed its anterior part is the highest one. The anterior part of the platform is uniformly rimmed by a convexity.

Life time. — Lower *crepida-crepida* zone to upper *quadrantinodosa* zone (to IIα ? — to IIIα).

Genus *Scaphignathus* Ziegler, 1960

Scaphignathus velifera Ziegler, 1962

(pl. II, fig. 9)

1959. *Scaphignathus velifera* Ziegler; Helms J.: p. 655, pl. 2, fig. 19a, b; pl. 5, figs. 20, 28.

1962a. *Scaphignathus velifera* Ziegler; Ziegler W.: p. 403, pl. 3, figs. 1—6.

1962b. *Scaphignathus velifera* Ziegler; Ziegler W.: p. 102, pl. 11, figs. 19—24.

1965. *Scaphignathus velifera* Helms; Bouckaert J., Ziegler W.: pl. 5, figs. 5—7.

Material.— 7 specimens.

Description. — Blade high, bearing 5—7 denticles. The narrow and slender platform is on either side delimited by raised rims. On the edge it bears two rows of nodes or lateral ridges. In mature specimens there is another row of nodes in the middle of the platform. An elongated flat pulp cavity with swollen curving edges occurs on the aboral side of the platform. The blade is not rectilinearly placed on the platform but oriented slightly towards the outer side.

Life time. — *Velifera* zone to the lowermost *styriaca* zone (to III β — upper to IV).

Genus *Spathognathodus* Branson & Mehl, 1941
Spathognathodus aculeatus (Branson & Mehl), 1934
(pl. I, fig. 12)

1934. *Spathodus aculeatus* Branson & Mehl; Branson E. B., Mehl M. G.: p. 186, pl. 17, figs. 11, 14.
1934. *Spathodus tridentatus* Branson; Branson E. R.: p. 307, pl. 27, fig. 26.
1955a. *Spathognathodus tridentatus* (Branson); Sannemann D.: pl. 24, fig. 15.
1962b. *Spathognathodus aculeatus* (Branson & Mehl); Ziegler W.: p. 105, pl. 13, figs. 27—36.
1965. *Spathognathodus aculeatus* (Branson & Mehl); Bouckaert J., Ziegler W.: pl. 5, figs. 1—4.

Material.— 18 specimens.

Discription. — Individuals of this species in top view are straight or only just slightly side-curved. The upper edge bears closely spaced denticles, most of them are round in section, decreasing to the rear. The denticles are often intergrown one with the other as far as the apex. The anterior denticles are the highest ones. Towards the end of the anterior part the lower edge passes into a broad, flat and symmetric pulp cavity. Towards the rear this pulp cavity grows narrower so rapidly that at the posterior end of the conodont it passes into a narrow furrow. At the point of the maximum width of the pulp cavity three, fairly often four isolated denticles occur which may be twice as thick as the denticles on the blade. They are arranged parallel to the blade denticles and may be connected with them by a poorly indicated edge.

Life time. — Middle part of the lower *costatus* zone to the middle *costatus* zone (boundary to V/VI — to VI*a*).

Spathognathodus costatus spinulicostatus (E. R. Branson), 1934
(pl. I, fig. 9)

1934. *Spathodus spinulicostatus* E. R. Branson; Branson E. R.: p. 305, pl. 27, fig. 19.
1957. *Spathognathodus spinulicostatus spinulicostatus* (E. R. Branson); Bischoff G.: p. 57, pl. 4, fig. 27.
1962b. *Spathognathodus spinulicostatus spinulicostatus* (E. R. Branson) Ziegler W.: p. 108, pl. 14, figs. 11—18.

Material.— 7 specimens.

Description. — This subspecies is characterised by the presence of

7—9 distinct nodes on one side of the blade; at the base they may be connected. In top view the blade is straight or slightly concave. The pulp cavity is very large and flat. It is with two expanded areas, one is usually larger than the other and in mature individuals it is covered by isolated minute nodes. The denticles of the blade are slightly raised on the anterior edge.

Life time. — From the middle part of the lower *costatus* zone (boundary to V/VI — to VI).

Spathognathodus costatus ultimus Bischoff, 1957
(pl. I, fig. 10; pl. II, fig. 2)

1957. *Spathognathodus spinulicostatus ultimus* Bischoff; Bischoff G.: p. 57, pl. 4, figs. 24—26.
1959. *Spathognathodus spinulicostatus ultimus* Bischoff; Helms J.:, pl. 3, figs. 6, 9.
1962b. *Spathognathodus costatus ultimus* Bischoff; Ziegler W.: p. 109, pl. 14, figs. 19, 20.

Material.— 3 specimens.

Description. — On either side of the blade the subspecies has tranverse ridges and it derives from the form *Spathognathodus costatus spinulicostatus*. Because of the presence of these ridges a platform-like broad surface is formed. The ridges of the two sides meet at an angle that opens towards the back. They are from 12 to 16 in number. In top view the conodont is straight or slightly concave. The pulp cavity is very large, flat and distended on both sides. The distension on the outer side is most often the larger one. It may be smooth or covered by small nodules.

Life time. — From the middle *costatus* zone (to VIα).

Spathognathodus stabilis (Branson & Mehl), 1934
(pl. I, figs. 6, 11; pl. II, fig. 11)

1934. *Spathodus crassidentatus* Branson & Mehl; Branson E. B., Mehl M. G.: p. 276, pl. 22, figs. 17, 18.
1943. *Spathognathodus crassidentatus* (Branson & Mehl); Cooper Ch. L., Sloos L. L.: p. 175, pl. 28, fig. 1.
1956. *Spathognathodus crassidentatus* (Branson & Mehl); Bischoff G., Ziegler W.: p. 166, pl. 13, figs. 13—14.
1962b. *Spathognathodus stabilis* (Branson & Mehl); Ziegler W.: p. 112, pl. pl. 13, figs. 1—10.

Material.— 57 specimens.

Description. — The blade, partly granulated, is narrow and slightly expanded towards the base. Laterally it is somewhat curved and passes into a rounded end. On the aboral edge, about the middle of the blade, there is an elongated, usually broad pulp cavity gradually flattening towards the edges. The side edges of the cavity are somewhat raised. The blade bears 15 to 18 denticles, mutually intergrown as far as the apex. The uppermost part of the blade bears from 4 to 5 robust denticles which rise abruptly at the anterior end.

Life time. — Upper part of the middle *velifera* zone to the upper *costatus* zone (to III β — to VI).

STRATIGRAPHIC VALUE OF UPPER DEVONIAN CONODONT ASSEMBLAGES AND THEIR DISTRIBUTION IN THE LIMESTONES OF BOREHOLE BOLECHOWICE 1

Although no detailed information is so far available concerning the outside appearance and the life conditions of conodont-bearing animals, yet their hard, satisfactorily preserved elements — the conodonts themselves — have proved excellent index fossils, particularly for the Upper Devonian and the Lower Carboniferous. While up to abt. 1953 studies of conodonts were confined mainly to the area of the United States of America, from that time onwards they have been extended increasingly, particularly in the Palaeozoic of Germany. H. Beckmann's work (1949) on the Bergisches Land and the Lahn-Dill depression was the first valiant attempt in this field. Classic Palaeozoic profiles, systematically examined from the aspect of the occurrence of conodonts, have been described in numerous publications, chiefly those prepared by the college of Marburg. Hence, it was possible to work out the para-stratigraphy based on conodonts besides the orthostratigraphy based on cephalopods and trilobites.

It has been established that numerous conodont species are sufficiently short-lived to provide a basis for a chronological specification. This specification comprises, in the first place, the Upper Devonian and Lower Carboniferous platform conodonts which are exceptionally valuable as index fossils. Among the most important ones are the genera *Palmatolepis, Ancyrodella, Ancyrognathus, Polygnathus* and *Siphonodella*. Contrary to the above forms the compound barlike conodonts are of no great stratigraphic importance. Such genera as *Palmatodella, Ozarkodina, Prioniodina* and the like contain a considerable percent of passage forms typical of the Upper Devonian, indeed, their vertical range often extends far beyond the Upper Devonian.

The sequence of Upper Devonian conodont zones suggested and worked out in 1962 by W. Ziegler has now been currently accepted and proves most convenient for the stratigraphic zonation of the deposits.

Similar conclusions were also made by J. Helms on the basis of numerous investigations carried out in the Schiefergebirge of eastern Thuringia. W. Ziegler's description of the chronological evolution of conodonts has been confirmed in all the Germans sections. The same applies to the Upper Devonian of western Europe and of Bulgaria. The micropalaeontological investigations carried out in the section of borehole Bolechowice 1 also reliably indicates the occurrence of some of the 24 conodont zones.

The stratigraphy based on conodonts is more useful than that worked out on macrofossils. The conodont remains occur in greater abundance and are separated from the rock without any greater difficulty. The distinctly greater abundance of microfossils also provides better opportunities for observing faunal changes on the boundaries of the particular horizons. This makes it possible to establish transition zones with mixed assemblages. Obviously, the stratigraphic boundaries within lithologically analogous series, established on conodonts, do not always coincide with the boundaries determined on macro-organisms, since neither does the phylogeny of conodont-bearing animals correspond to the evolution of cephalopodonts, trilobites or brachiopods.

In borehole Bolechowice 1 conodonts have been found at the depth between 141.3 and 173.6 metres. The assemblages observed there reliably prove the occurrence of the Upper Devonian, namely from the lower part of the *Cheiloceras* horizon (= lower *crepida-crepida* zone) to the lower part of the *Wocklumeria* horizon (= from the middle to the lowermost part of the upper *costatus* zone). The conodonts suggest that the lower part of the Cheiloceras horizon comprises here a relatively large interval contained between the depths of 161.5 and 173.6 m. at the least. Specimens of *Palmatolepis crepida crepida* which mark an index zone have been found only at the depth of 173.6 metres. *Palmatolepis triangularis* is an important microform in this zone because it disappears in the middle part of the *crepida-crepida zone*. Its presence in the upper part of this zone has not, so far, been established. Hence the boundary of the middle and upper *crepida-crepida* zone should occur in borehole Bolechowice 1 in the interval between 168.6 and 161.5 metres.

It is noteworthy that *Palmatolepis quadrantinodosalobata, P.* cf. *regularis* and *P. subperlobata* are other important conodonts associated with the *crepida-crepida* zone differentiated in the above borehole (fig 2). The lowermost Upper Devonian zones corresponding to the *Manticoceras* horizon and containing very typical conodonts have not been found in the investigated samples. Thus there is a complete lack of the genera *Ancyrodella* and *Ancyrognathus* also *Icriodus*. Similarly but very few specimens have been found within the *crepida-crepida* zone of the species *Palmatolepis triangularis* whose numerous specimens have been

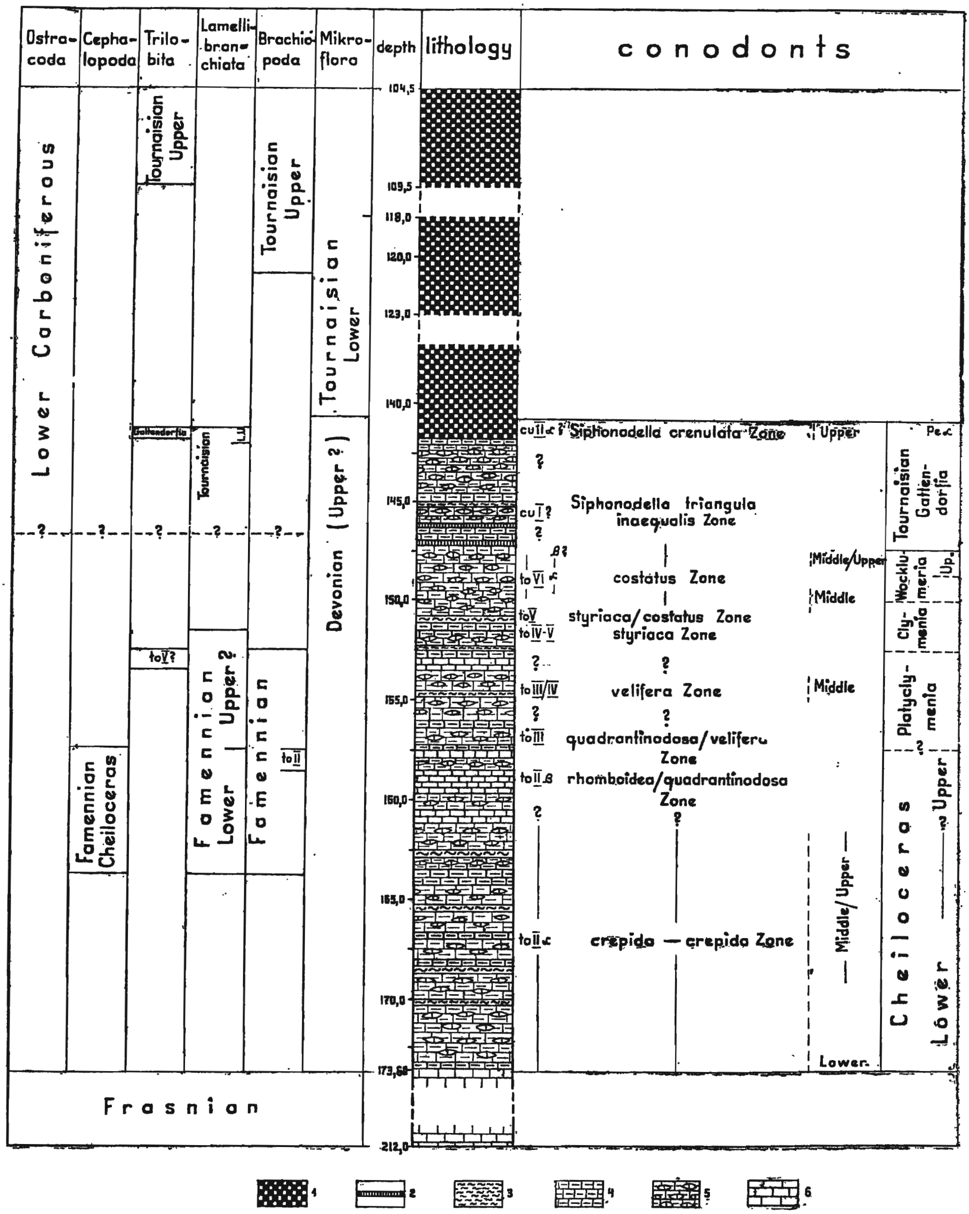

Fig. 2

Carboniferous and Devonian stratigraphy in borehole Bolechowice 1 based on the investigated groups of organic remains

1 siliceous-clay series with phosphate concretions and tuffogenic material, *2* bituminous marly claystones, *3* marly claystones, *4* marls, *5* marls with limestone nodules, *6* limestones

Stratygrafia karbonu i dewonu w wierceniu Bolechowice 1 według opracowanych grup szczątków organicznych

1 seria krzemionkowo-ilasta z konkrecjami fosforytowymi i materiałem tufogenicznym, *2* bitumiczne iłowce margliste, *3* iłowce margliste, *4* margle, *5* margle z gruzłami wapieni, *6* wapienie found in the *Manticoceras* horizon and which have given the name to the uppermost zone to I.

The appearance of the species *Palmatolepis rhomboidea* (at a depth of 159 m. in the borehole) has led to the establishment of the lower boundary of the *rhomboidea* zone that corresponds to the lowermost part of the *Cheiloceras* horizon (= to IIβ). The forms: *Palmatolepis quadrantinodosalobata, P. crepida crepida* and *P. subperlobata* disappear at the same time. Hence, the boundary of the *rhomboidea* zone (= to IIβ) and the *crepida-crepida* zone (= to IIα) occurs in the borehole under discussion between the depth of 159.0 and 161.5 metres. A sample collected from the depth of 159.0 m. belongs to the boundary beds *(rhomboidea* zone — lower part of the *quadrantinodosa* zone). This sample has yielded *Palmatolepis rhomboidea* side by side with *P. glabra elongata* which appears together with the lower *quadrantinodosa* zone. The above forms are not numerically abundant (a dozen or so specimens). In agreement with the cephalopod division the sample from 159.0 m. still belongs to the to IIβ zone (= upper *Cheiloceras* horizon).

The conodonts separated from a sample collected higher up (at a depth of 157 m.) indicate that we are dealing here with an interval from the upper part of the *quadrantinodosa* zone to the lower portion of the *velifera* zone. This corresponds to the lower *Platyclymenia* horizon (to IIIα — lower to IIIβ). At this depth we note the occurrence of *Scaphignathus velifera* (isolated specimens) together with rare specimens of *Palmatolepis rugosa ampla* and *P. rugosa grossi.* Other more important associated forms found here are *P. minuta minuta, P. distorta, P. glabra elongata* and *Polygnathus glabra glabra.*

A sample collected from the depth of 154.5 m. contains only one rather important form, i.e. *Palmatolepis schleizia.* J. Helms, the author of this species, states that the upper part of the *Prolobites* horizon (= upper to III) is the stratum typicum, the upper boundary of this horizon not being, however, reached by this form. According to W. Ziegler's division this stratigraphic interval corresponds to the middle *velifera* zone. The presence of *Palmatolepis schleizia* in borehole Bolechowice 1 reasonably suggests the occurrence here of deposits from the border area to III/to IV.

The sample collected from the depth of 152 m. contains conodonts whose occurrence range is not confined to only one zone. Hence it is hardly possible to determine its stratigraphic position without some reservations. *Spathognathodus bohleanus* found here makes its appearance in the middle *velifera* zone and extends as far as the upper *styriaca* zone. Also the remaining *Spathognathodus* forms have a relatively prolonged life time. *Polygnathus styriaca,* the index species for the *styriaca* zone, has not been observed here. This provokes various suggestions concerning the age of the marls and limestones at the depth of 152 m., namely that they are referable either to the *styriaca* zone or to the upper *velifera* zone. Such a position is tentatively proposed by the time interval from the upper part to III as far as to V. Moreover, the boundary between the upper *velifera* zone and the lower *styriaca* zone is not as yet clearly defined. The assignment of the sample from the depth under consideration to the *styriaca* zone (upper to IV/to V) is reasonably suggested by the fact that conodonts from the directly overlying marls (depth 151.0 m.) indicate the presence of an interval from about the boundary of the upper *styriaca* zone to the lower *costatus* zone as understood by W. Ziegler or to the *costatus-Interregnum* in J. Helms' meaning. This is, moreover, proved by the appearance for the first time of *Spathognathodus aculeatus,* a species whose occurrence ranges from the lower to the middle *costatus* zone. The remaining forms have a greater vertical extent. According to W. Ziegler the lower *costatus* zone begins in the upper part of the lower *Gonioclymenia* horizon (upper to V) stretching as far as the lower part of the upper *Gonioclymenia* horizon or possibly to the lower *Wocklumeria* horizon (to VIα).

The presence of *Palmatolepis gonioclymeniae* in a sample from the depth of 150 m. reasonably suggests its assignment to the middle *costatus* zone. This is likewise proved by conodonts from the genus *Spathognathodus* associated with the above form, whose stratigraphic value augments distinctly in the higher Upper Devonian. The middle *costatus* zone fits entirely into the *Wocklumeria* horizon (to VI).

Palmatolepis gonioclymeniae, present in the sample from 149.5 m., refers these marls and limestones to the middle *costatus* zone as well. A somewhat older age of these deposits is not excluded because of the presence in the above sample of two of the more important conodonts, associated with *Palmatolepis gonioclymeniae,* i.e. of *Spathognathodus costatus spinulicostatus,* and *Sp. costatus costatus* which make their appearance somewhat earlier, at least to the middle part of the lower *costatus* zone. They may still represent the passage from the lower to the middle *costatus* zone.

Our sample from 148.7 m. may only generally be assigned to the *costatus* zone. Its more accurate identification is hardly possible since *Spathognathodus costatus costatus,* the most important subspecies, occurs throughout the zone named after it. Neither do the remaining conodont species from this sample provide any closer information. The fact, however, that conodonts from the higher sample (depth of 148.0 m.) indicate the middle *costatus* zone reasonably suggests the same age for a sample connected slightly lower down (depth 148.7 m.). As is currently accepted *Spathognathus aculeatus* does not pass beyond the middle part of the *costatus* zone while the two other species of that genus may be encountered still higher up. A. Voges (1959) even reports that *Spatho-*

gnathodus costatus costatus occurs sporadically in the lowermost Lower Carboniferous.

Sample from the depth of 147.5 m. also corresponds to the interval that fits between the middle *costatus* zone and possibly the lower part of the upper *costatus* zone. In this zone, side by side with the afore mentioned forms, makes its first appearance *Spathognathodus costatus ultimus*. This subspecies appears in the middle *costatus* zone reaching as far as the upper boundary of the upper *costatus* zone. This also holds good for *Pseudopolygnathus trigonica,* a species typical of the middle and upper parts of the *costatus* zone. According to the cephalopod stratigraphy, marls and limestones from the depth of 147.5 m. are undoubtedly referable to the *Wocklumeria* horizon, perhaps to its upper portion (to VIβ).

While the Upper Devonian age of the samples under discussion is not questionable, the sample from the higher-lying beds (depth 145.5 m.), on the basis of the associated conodonts doubtless represents the Lower Carboniferous. Side by side with indeterminate remains, probably belonging to the genera *Hindeodella, Ligonodina* and *Polygnathus* the presence has been noted here of such forms as *Siphonodella duplicata* and *S.* cf. *obsoleta* that are characteristic of the Lower Carboniferous. The genera *Palmatolepis* and *Spathognathodus,* typical of the Upper Devonian, are lacking completely. It is hardly possible to determine the position of this sample on the basis of conodonts because of the relatively wide range of the species mentioned above. According to the investigations of A. Voges (1959) *Siphonodella duplicata* occurs from the middle part of cu I (= *Gattendorfia* horizon, possibly the *Siphonodella triangula inaequalis* zone) and reaches as far as the lowermost part of cu II*α* (lower *Pericyclus* horizon, possibly the *Siphonodella crenulata* zone). *Siphonodella obsoleta* makes its appearance about the same time but it stretches as far as the upper boundary of the *anchoralis* zone (= cu IIβ/γ). Hence the inference that the marls from 145.5 m. may be referred to the interval from cu I to the lowermost cu II*α*.

The sample from the depth 141.4—141.75 m. has yielded two specimens of *Siphonodella isosticha* in addition to a few stratigraphically valueless forms from the genus *Hindeodella. Siphonodella isosticha* is widely distributed in the first place within the *cooperi-isosticha* zone of North America. In Central Europe it corresponds approximately to the upper zone *Siphonodella crenulata* (= cu II*α*). This would indicate that, with the reservation here required because of the presence of only two specimens of *Siphonodella isosticha,* the above sample may belong to cu II*α* i.e. to the lower *Pericyclus* horizon according to the cephalopod classification (= the Upper Tournaisian).

FINAL CONCLUSIONS

To sum up the results of the conodont investigations in the sub-Zechstein series from borehole Bolechowice 1 we may reasonably infer that they have fulfilled the aims outlined in the introduction of this paper. The conclusions given below show the extent of the enlargement of our knowledge concerning the Devonian and the Carboniferous which have already been worked out by H. Żakowa (1967) and are also illustrated in fig. 2.

1. The conodont investigations do not contradict the assignment by H. Żakowa to the Frasnian of massive limestones between 173.6 and 212.0 m. (based on the presence there of corals and on general analogies to similar deposits of the Kielce syncline). Namely at the depth of 173.6 m. an assemblage has been differentiated characteristic of the lowermost part of to IIα (lower *crepida-crepida* zone) with which the Famennian (*Cheiloceras* horizon) begins. Since the main attention during the research work was focussed on the Famennian and the lowermost Carboniferous no samples were taken from the interval between 173.6 and 212.0 metres. In the case of positive results additional light might have been thrown on the contact of the Famennian and the Frasnian, as well as with respect to the more accurate dating of the Frasnian deposits. This is all the more interesting since H. Żakowa does not exclude the existence within the Frasnian of Bolechowice of some stratigraphic lacuna. Besides regional investigations conodonts might also prove useful in the checking up of this suggestion.

2. Certain Famennian deposits have been differentiated by H. Żakowa on the basis of brachiopods, lamellibranchs, cephalopods and trilobites only between 151.4 and 163.6 metres. The deposits underlying (down to 173.6 m.) or overlying the observed Famennian strata, to the boundary with the Carboniferous, did not yield any sound age marks. The conodonts have filled up these gaps and have made possible not only the differentiation of all the Famennian stages in the cephalopod division but that of the conodont zones, too.

3. The *Cheiloceras* horizon determined on cephalopods (*Cheiloceras* sp.) at a depth between 157.5 and 163.6 m. and on brachiopods (*Plectorhynchella krestovnikovi*) only between 157.5 and 158.5 m. actually comprises the 157.5—173.6 m. interval. Moreover, the conodonts allow the differentiation here of the lower (to IIα) and the upper (to IIβ) *Cheiloceras* horizon.

4. The index fossils among the Famennian macrofauna suggesting the *Clymenia* horizon were found only between 152.4 and 153.4 m. (*Cyrtosymbole (Waribole)* cf. *secunda*). The conodont remains from this interval have not been investigated. Neither does the age of the adjacent samples (from the depth of 152.0 and 154.5 m.) reliably clear up the range

of this horizon. The evidence provided by the conodonts would nevertheless suggest the assignment of the 152.4—153.5 m. interval rather to the *Platyclymenia* (to III — to IV) horizon than to the *Clymenia* horizon (to V). Thus, in borehole Bolechowice 1, the *Platyclymenia* horizon not distinguishable on macrofaunal basis (absence of index forms), comprises at least the 152.4—157.5 m. interval. It seems, however, reasonable to refer to the *Clymenia* horizon the deposits from a depth between about 150 and 152.4 metres.

5. Neither were reliable index fossils found among the macrofauna to mark the *Wocklumeria* horizon. The conodonts that determine the middle and upper (?) *costatus* zone, however, distinctly indicate the occurrence within the Famennian of borehole Bolechowice 1 of the above horizon. Investigations have shown that the lower part of the *Wocklumeria* horizon (to VI*a*) comprises at least a 2-metre interval, between the depth of 148 to about 150 metres. Higher up, at a depth of 147.5 m. the differentiated conodont assemblage reliably suggests the upper part of the *Wocklumeria* horizon (to II*β*), hence the occurrence at this depth of the Strunian.

6. In the light of conodont investigations, the problem of the Devonian-Carboniferous boundary seems to coincide with the suggestions of H. Żakowa (1967). That author postulates the existence of this boundary near to or within the 146.0—147.1 m. interval because of the first appearance there of mixed Devonian-Carboniferous elements (*Sansabella* sp., *Aurigerites* sp., *Posidonia (Karadjalia) venustiformis, P. (Karadjalia)* cf. *venustiformis* var. *globosa, P. (Karadjalia)* cf. *venusta,* also microflora showing Upper Devonian characters). Although the search for conodonts in samples from this interval gave negative results, yet most valuable index fossils were obtained from adjacent samples. Namely Lower Carboniferous conodonts were found at a depth of 145.5 m. and at a depth of 147.5 m., as has already been mentioned, the assemblage of the *Wocklumeria* horizon, (probably of its upper part). Hence the establishment of the Devonian-Carboniferous boundary between 145.5 and 147.5 m. or in the 146.0—147.1 m. interval, is quite doubtless.

7. According to the above the thickness of the Strunian is not closely determinable but most likely its maximum does not exceed 1.5 m. The total thickness of the *Wocklumeria* horizon in borehole Bolechowice 1, is likewise rather small (probably about 3.5 m.).

8. The complete Famennian section has been observed in this borehole, but the thickness of the particular horizons varies. On the whole, the thickness of the higher Famennian horizons is rather uniform (from 2.4 to 5.1 metres). The thickness of the *Cheiloceras* horizon, however, exceeds 16 metres, of which no less than 12 metres fall to the lower part of that horizon (to II*a*).

9. It is interesting to note the coincidence of suggestions concern-

ing the Devonian-Carboniferous boundary as provided by ostracods, conodonts and, to a certain extent, by lamellibranchs. This correlation very strikingly stresses the difference of the suggestions provided by microflora which place that boundary higher up among deposits, most likely already referable to the Lower Carboniferous. Hence it might be concluded that microfloral assemblages are less valuable stratigraphic indexes than other organic remains, particularly in problems concerning, the strata of adjacent systems.

10. According to H. Żakowa, deposits from a depth of 104.5 m. down to the 146.0—147.1 m. interval represent the Tournaisian, in confirmation of which she quotes lithostratigraphic, macrofaunal, microfaunal and microfloral evidence. The division of the Tournaisian into a lower and an upper part was laid down (with certain reservation) at about 121.0 metres. *Orbiculoidea* cf. *davreuxiana*, encountered in the 118.5—123.3 m. interval, and *Cyrtosymbole (Macrobole) brevispina* found in the 104.5—109.5 m. interval have been accepted as index forms of the Upper Tournaisian. In the stratigraphic discussion it has been stressed that the lamellibranchian form *Posidonia (Karadjalia) mariannae* var. *hemicyclia* is still obtained from the 141.3—141.75 m. interval, while in Kazachstan it is characteristic of the Upper Tournaisian. Within this interval the above form is accompanied by the trilobite *Cyrtosymbole (Macrobole)* cf. *laticampa*, which would suggest rather the Lower Tournaisian age (the *Gattendorfia* horizon) of these deposits. The Lower Tournaisian age is also indicated for the 141.75—141.95 m. interval by the lamellibranchs *Posidonia (Karadjalia) mariannae*, *P. (Karadjalia)* aff. *mariannae*, *P. (Karadjalia)* cf. *venustiformis*. Neither do the conodonts adequately clear up these small discordances and difficulties in zoning the Tournaisian, partly because only two out of several collected samples yielded positive results. An essential achievement, however, is the confirmation of the presence of Tournaisian deposits in the investigated samples taken from 145.5 m. and from 141.75 metres. According to the suggestions provided by conodonts the Lower Tournaisian — Upper Tournaisian boundary should not occur at the depth of about 121.0 m. but probably even below 141.75 metres. This suggestion would coincide with the stratigraphy based on lamellibranchs and differ somewhat in relation to the trilobite indices that are not very reliable.

11. Should the Lower Tournaisian — Upper Tournaisian boundary not occur before the depth of 141.75 m. the deposits of the *Gattendorfia* horizon in the borehole Bolechowice 1 would be wholly represented by the marl-limestone facies (analogous with the Famennian) with o thickness of about 4.5 m. The Upper Tournaisian, on the other hand, would be developed solely in the siliceous-clay facies with a thickness of abt. 35 meters. In this light the lithology of the particular Tournaisian horizons in borehole Bolechowice 1 would be analogous with that of the

Tournaisian section from the near-by Kowala (Żakowa 1967). As a consequence of these speculations it should be accepted that, within the Bolechowice area, changes in sedimentary environments do not occur within the *Gattendorfia* horizon but at the Lower Tournaisian — Upper Tournaisian boundary in the sectors so far investigated of the south--eastern part of the Gałęzice-Bolechowice-Borków syncline (Bolechowice, Kowala).

12. In order to supplement the statement of H. Żakowa as to the general coincidence of A. M. Sadykov's conception about the phylogeny and index-value of some interesting lamellibranchian species in common for Kazachstan and the Bolechowice area, it should be noted that this conclusion is also confirmed by conodonts: *Posidonia (Karadjalia) venustiformis* encountered in Kazachstan within the *Gattendorfia* horizon and in the Upper Famennian, within the Bolechowice area is characteristic of the same time interval (Lower Tournaisian, Strunian, upper part of the *Platyclymenia* horizon); *Posidonia (Karadjalia) bairensis* and *P. (Karadjalia) nalivkini* occur in the *Cheiloceras* horizon both in Kazachstan and in Bolechowice. *Posidonia (Karadjalia) simorini* which, in Kazachstan, is characteristic of the Upper Frasnian and the Lower Famennian (*Cheiloceras* horizon), is encountered in borehole Bolechowice 1 also in to II and, most likely, even in the *Platyclymenia* horizon (doubtful identification of specimens). The above conclusions will probably be also useful in the stratigraphic correlation of the lamellibranchian and cephalopod facies during the future investigation of the Famennian from the Holy Cross Mts.

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FAMEŃSKIE KONODONTY Z WIERCENIA BOLECHOWICE 1 (GÓRY ŚWIĘTOKRZYSKIE)

STRESZCZENIE: W wyniku badań konodontowych uzyskano szczegółowe dane odnoszące się do miąższości i wydzieleń poszczególnych poziomów famenu jak i potwierdzenie granicy dewon-karbon na głębokości sugerowanej przez H. Żakową (1967). Dzięki konodontom skorygowano podział turneju i w konsekwencji uwagi o sedymentacji osadów. Przeprowadzono korelacje w odniesieniu do znaczenia stratygraficznego tej grupy organizmów z mikroflorą, małżoraczkami i makrofauną, zwłaszcza gdy idzie o nie rozpoznane dotąd poza Górami Świętokrzyskimi gatunki małżów opisanych po raz pierwszy z Kazachstanu.

Artykuł oparty jest na badaniach konodontowych przeprowadzonych w laboratorium VEB Geologische Erkundung Süd we Freibergu. Wyniki zestawił dla niniejszej pracy G. Freyer z wyjątkiem wstępu i wniosków końcowych, które opracowała H. Żakowa. Badania zainicjowano w celu uzupełnienia dotychczasowych wiadomości o stratygrafii serii podcechsztyńskiej wiercenia Bolechowice 1 (fig. 1), nawierconej od głębokości 104,50 do 212,00 m (Żakowa 1963, 1967; Ryka & Żakowa 1964). Zasadniczą uwagę skoncentrowano na wyodrębnieniu konodontów ze skałek fameńskich w celu dokładniejszego jego rozpoziomowania i określenia miąższości strunu. Kilka próbek pobrano z dolnego karbonu także dla rewizji granicy dewon-karbon, ustalonej przez H. Żakową na innych podstawach biostratygraficznych.

Początkowo do badań pobrano 15 próbek z głębokości 141,30—141,75 m oraz 143,80—173,60 m. Następnie, ze względu na zarysowującą się po raz pierwszy dla famenu świętokrzyskiego możliwość bezpośredniej korelacji stratygrafii konodontowej z wnioskami uzyskanymi na podstawie małżów, małżoraczków, ramienionogów, trylobitów, głowonogów i mikroflory, dodatkowo opróbowano odcinek od 139,30 do 151,00 m (łącznie 13 próbek). Siedem próbek pobranych z dolnego karbonu dało wyniki negatywne. Listy oznaczonych konodontów z pozostałych próbek podane są dla poszczególnych głębokości w tekście angielskim, z określeniem wieku osadów, z których je wydobyto. Liczby okazów zostały uwzględnione w tabeli 1.

Stwierdzono, że w wierceniu Bolechowice 1 nie występują nowe gatunki konodontów. W części paleontologicznej zamieszczono opisy ważniejszych lub najliczniej występujących form w famenie Bolechowic. Zamieszczono też fotografie i rysunki niektórych okazów.

Dla wyodrębnienia konodontów zastosowano przede wszystkim procedurę z kwasem monochlorooctowym, a rzadziej rozpuszczano próbki w kwasie octowym

Stan zachowania większości konodontów jest bardzo dobry. U okazów rodzaju *Palmatolepis* często zachowało się wypełnienie podstawy. Nie znaleziono także konodontowych „bone-beds" oraz spirytyzowanych konodonów. Wielokrotnie jednak poszczególne ich części (przede wszystkim ząbki) były zastąpione przez tlenki żelaza.

Wyniki badań na konodonty spełniły zakreślone zadania. Odkrycie na głębokości 173,60 m zespołu charakterystycznego dla najniższej części to IIα (dolna zona *crepida-crepida*) potwierdza wniosek H. Żakowej o zaliczeniu niżej leżących wapieni masywnych do franu. Ponieważ autorka nie wyklucza istnienia pewnej luki stratygraficznej w obrębie franu Bolechowic, to w razie przebadania na konodonty odcinka od 173,60 do 212,00 m i pozytywnych wyników, można by prawdopodobnie bliżej określić wiek wapieni masywnych i kontakt famenu z franem.

Na podstawie brachiopodów, małżów, głowonogów i trylobitów H. Żakowa (1967) wyróżniła pewne utwory famenu tylko na głębokości 151,40—163,60 m. Konodonty natomiast stwierdziły, że w wierceniu osady famenu występują przynajmniej od głębokości 147,50 do 173,60 m. Na podstawie makrofauny tylko na pewnych odcinkach autorka ta mogła wytypować osady poziomu cheilocerasowego (np. na głęb. 157,50—163,60 m lub na podstawie ramienionogów tylko na głęb. 157,50—158,50 m), oraz zasugerować w interwale 152,40—153,40 m utwory poziomu klimeniowego (wnioski oparte na faunie trylobitowej). Konodonty natomiast pozwoliły na wyróżnienie zon konodontowych oraz na wyodrębnienie wszystkich poziomów famenu w podziale głowonogowym z podaniem ich miąższości (fig. 2). I tak poziom cheilocerasowy obejmuje interwał od 157,50 do 173,60 m (grubość ponad 16 m) z wydzieleniem to IIα (miąższość co najmniej 12 m) i to IIβ. W przeciwieństwie do tego grubość wyższych poszczególnych poziomów wynosi zaledwie kilka metrów. Poziom platyklimeniowy, nie wyróżniony przez makrofaunę, obejmuje co najmniej odcinek od 152,40 do 157,50 m (łącznie z odcinkiem, który H. Żakowa zaliczała raczej do wyższego poziomu). Do poziomu klimeniowego, jak się wydaje, należałoby odnieść utwory od głębokości około 150,00 do 152,40 m. Konodonty wskazują także na obecność poziomu wokliumeriowego, gdyż wyznaczają środkową i górną (?) zonę *costatus*. Wyraźnie zaznacza się tu dolna część tego poziomu (to VIα), która obejmuje przynajmniej 2-metrowy odcinek (od głęb. 148,00 do około 150,00 m). Już na głębokości 147,50 m znaleziono natomiast zespół, który wskazuje na górną część tego poziomu (to VIβ), a tym samym na występowanie strunu.

H. Żakowa (1967), na podstawie występowania mieszanych elementów dewońsko-karbońskich w interwale 146,00—147,10 m, dopatruje się granicy dewon-karbon w bliskości tego odcinka lub też w jego obrębie. Mimo że próbki na konodonty z tego interwału dały wyniki negatywne, to cenne wskaźniki uzyskano z próbek sąsiednich (na głęb. 145,50 m konodonty dolnokarbońskie oraz na głęb. 147,50 m jeszcze wskaźniki najprawdopodobniej to VIβ). Należy więc stwierdzić, że sugestie H. Żakowej w świetle badań konodontowych wydają się uzasadnione. W związku z tym miąższość strunu w najlepszym razie prawdopodobnie nie przekracza 1,5 m, przy czym ogólna grubość poziomu wokliumeriowego w wierceniu Bolechowice 1 wynosi najprawdopodobniej około 3,5 m.

Interesująca jest zgodność w sugerowaniu granicy dewon-karbon przez małżoraczki, konodonty i w pewnym stopniu przez małże. Przy tej korelacji jaskrawo zaznacza się fakt odmiennej wskaźnikowości mikroflory (fig. 2), na podstawie której granica ta powinna by przebiegać kilka metrów wyżej, w obrębie osadów, skąd mamy już dolnokarbońskie konodonty. Wynika z tego, że zespoły mikroflory ustępują miejsca innym szczątkom organicznym, gdy idzie o dobre wskaźniki stratygraficzne, zwłaszcza odnośnie do granic systemów.

Według H. Żakowej, osady z głębokości od 104,50 m do interwału 146,00—147,10 m reprezentują turnej, na co autorka przytacza zarówno dowody litostratygraficzne, jak również opiera się na makro- i mikrofaunie oraz na mikroflorze. Podział turneju na część dolną i górną został przeprowadzony z pewnym zastrzeżeniem na głębokości około 121,00 m. Za wskaźniki turneju górnego uznano *Orbiculoidea* cf. *davreuxiana* (głęb. 118,50—123,30 m) i *Cyrtosymbole (Macrobole) brevispina* (głęb. 104,50—109,50 m). W dyskusji stratygraficznej podkreślono, że jeszcze w interwale 141,30—141,75 m znaleziono małża *Posidonia (Karadjalia) mariannae* var. *hemicyclia*, który w Kazachstanie charakteryzuje górny turnej. Formie tej towarzyszy *Cyrtosymbole (Macrobole)* cf. *laticampa*, która sugerowałaby już dolnoturnejski wiek dla tych osadów. Natomiast małże — *Posidonia (Karadjalia) mariannae*, *P. (Karadjalia)* aff. *mariannae* i *P. (Karadjalia)* cf. *venustiformis*, występujące na odcinku 141,75—141,95 m, mówią o dolnoturnejskim wieku tych właśnie osadów. Konodonty również nie wyjaśniają dostatecznie tych drobnych niezgodności w rozpoziomowaniu turneju, jednakże sugerują przeprowadzenie granicy turnej dolny — górny nie na głębokości około 121,00 m, lecz prawdopodobnie nawet poniżej 141,75 m. Odpowiadałoby to stratygrafii opartej na podstawie małżów lecz różni się w korelacji ze wskaźnikami trylobitowymi, zresztą niepewnie oznaczonymi.

Należy dodać, że w przypadku występowania granicy turneju dolnego i górnego dopiero na głębokości około 141,75 m, osady poziomu gattendorfiowego w wierceniu Bolechowice 1 byłyby w całości reprezentowane przez utwory marglisto-wapienne (analogiczne do famenu) o miąższości około 4,50 m. Natomiast górny turnej byłby wykształcony wyłącznie jako seria krzemionkowo-ilasta o grubości około 35 m. W tym świetle litologia poszczególnych poziomów turneju w wierceniu Bolechowice 1 byłaby analogiczna do profilu turneju z pobliskiej Kowali. W konsekwencji tych uwag należałoby przyjąć, że zmiana środowisk sedymentacyjnych w obszarze Bolechowic nie nastąpiła w obrębie poziomu gattendorfiowego, lecz w zbadanych dotąd odcinkach synkliny gałęzicko-bolechowicko-borkowskiej (Bolechowice, Kowala) zachodzi na przełomie dolnego i górnego turneju.

W uzupełnieniu stwierdzenia H. Żakowej o ogólnej zgodności koncepcji A. M. Sadykova, odnoszącej się do filogenezy i wskaźnikowości ciekawych gatunków małżów wspólnych dla Kazachstanu i obszaru Bolechowic, należy dodać, że również konodonty potwierdzają ten wniosek. I tak *Posidonia (Karadjalia) venustiformis*, występująca w Kazachstanie w poziomie gattendorfiowym i w górnym famenie, cechuje w Bolechowicach ten sam odcinek czasowy (dolny turnej, strun, wyższa część poziomu platyklimeniowego). *Posidonia (Karadjalia) bairensis* i *P. (Karadjalia) nalivkini* w Kazachstanie i Bolechowicach występują w poziomie cheilocerasowym. *Posidonia (Karadjalia) simorini*, która w Kazachstanie cechuje wyższy fran i niższy famen, także w wierceniu Bolechowice pokazuje się w to III i prawdopodobnie jeszcze w poziomie platyklimeniowym (niepewne oznaczenia okazów).

Powyższe uwagi niewątpliwie będą pomocne także dla korelacji stratygraficznej facji małżowej i głowonogowej w dalszych badaniach świętokrzyskiego famenu.

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DESRIPTION OF PLATES I—II

OBJAŚNIENIA DO PLANSZ I—II

PL. I

1 — *Palmatolepis deflectens deflectens* Müller, depth (głębokość) 148.0 m. (sample — próbka — 182/64).

2 — *Prioniodina proma* (Huddle), depth (głębokość) 151.0 m. (sample — próbka — 186/64).

3 — *Palmatodella delicatula* Ulrich & Bassler, depth (głębokość) 150.0 m. (sample — próbka — 77/64).

4 — *Pseudopolygnathus marburgensis* Bischoff & Ziegler, depth (głębokość) 150.0 m. (sample — próbka — 185/64).

5 — *Tripodellus robustus* Bischoff, depth (głębokość) 147,5 m. (sample — próbka — 76/64).

6 — *Spathognathodus stabilis* (Branson & Mehl), depth (głębokość) 152.0 m. (sample — próbka — 78/64).

7 — *Spathognathodus inornatus* (Branson & Mehl), depth (głębokość) 147.5 m. (sample — próbka — 76/64).

8 — *Spathognathodus strigosus* (Branson & Mehl), depth (głębokość) 150.0 m. (sample — próbka — 185/64).

9 — *Spathognathodus costatus spinulicostatus* (E. R. Branson), depth (głębokość) 148.0 m. (sample — próbka — 182/64).

10 — *Spathognathodus costatus ultimus* Bischoff, depth (głębokość) 147.5 m. (sample — próbka — 76/64).

11 — *Spathognathodus stabilis* (Branson & Mehl), depth (głębokość) 149.5 m. (sample — próbka — 184/64).

12 — *Spathognathodus aculeatus* (Branson & Mehl), depth (głębokość) 151.0 m. (sample — próbka — 186/64).

13 — *Ligonodina monodentata* Bischoff & Ziegler, depth (głębokość) 150.0 m. (sample — próbka — 77/64).

14 — *Ozarkodina regularis* Branson & Mehl, depth (głębokość) 147.5 m. (sample — próbka — 76/64).

15 — *Ozarkodina homoarcuata* Helms, depth (głębokość) 159.0 m. (sample — próbka — 81/64).

16 — *Hindeodella germana* Holmes, depth (głębokość) 173,6 m. (sample — próbka — 87/64).

PL. II

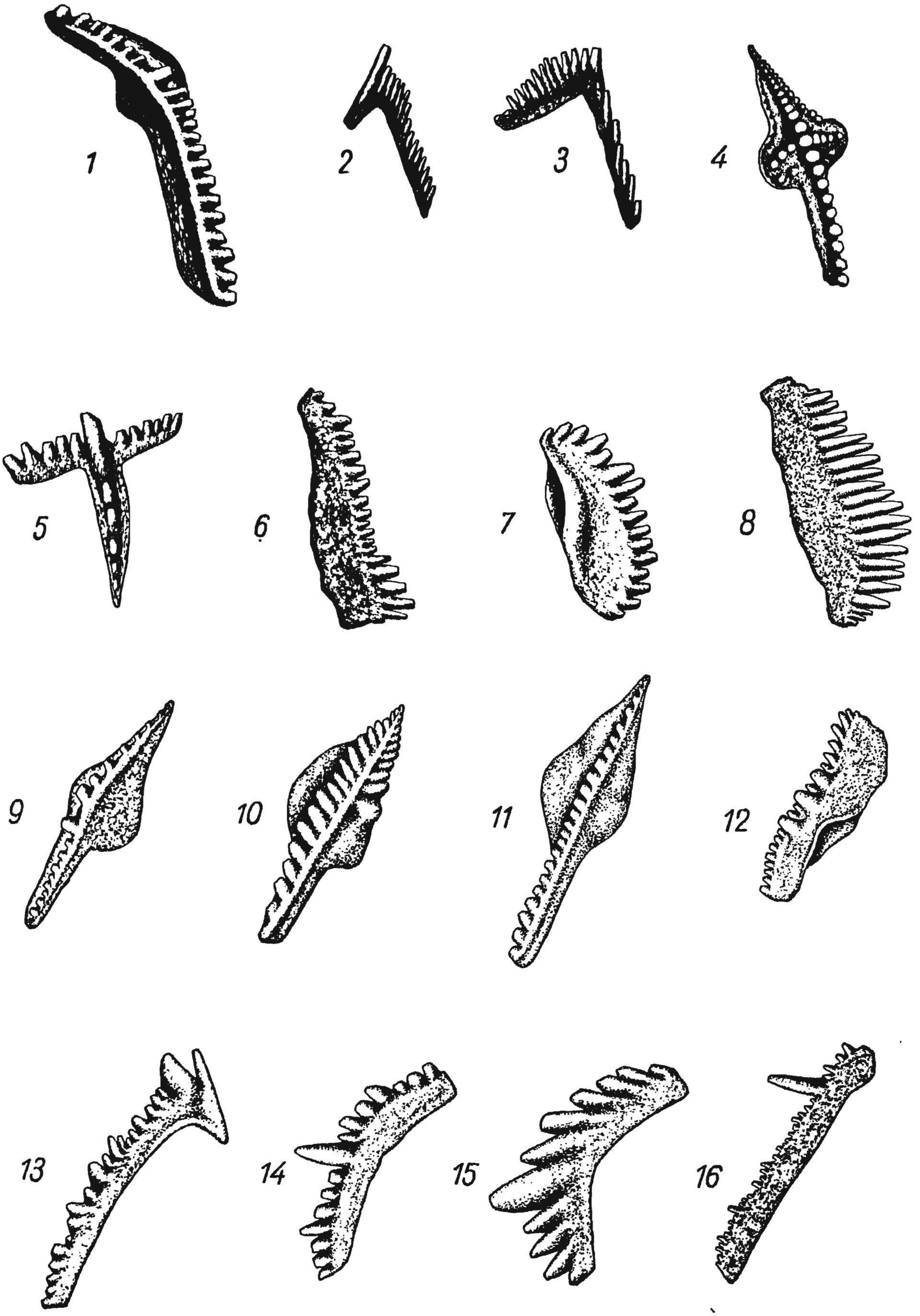
1 — *Palmatolepis perlobata schindewolfi* Müller, depth (głębokość) 157.0 m. (sample — próbka — 80/64).

2 — *Spathognathodus costatus ultimus* Bischoff, depth (głębokość) 147.5 m. (sample — próbka — 76/64).

3—3 — *Palmatolepis deflectens deflectens* Müller, depth (głębokość) 148.0 m. (sample — próbka — 182/64).

5 — *Palmatolepis quadrantinodosa inflexa* Müller, depth (głębokość) 159,0 m. (sample — próbka — 81/64).

6 — *Palmatolepis distorta* Branson & Mehl, depth (głębokość) 157.0 m. (sample — próbka — 80/64).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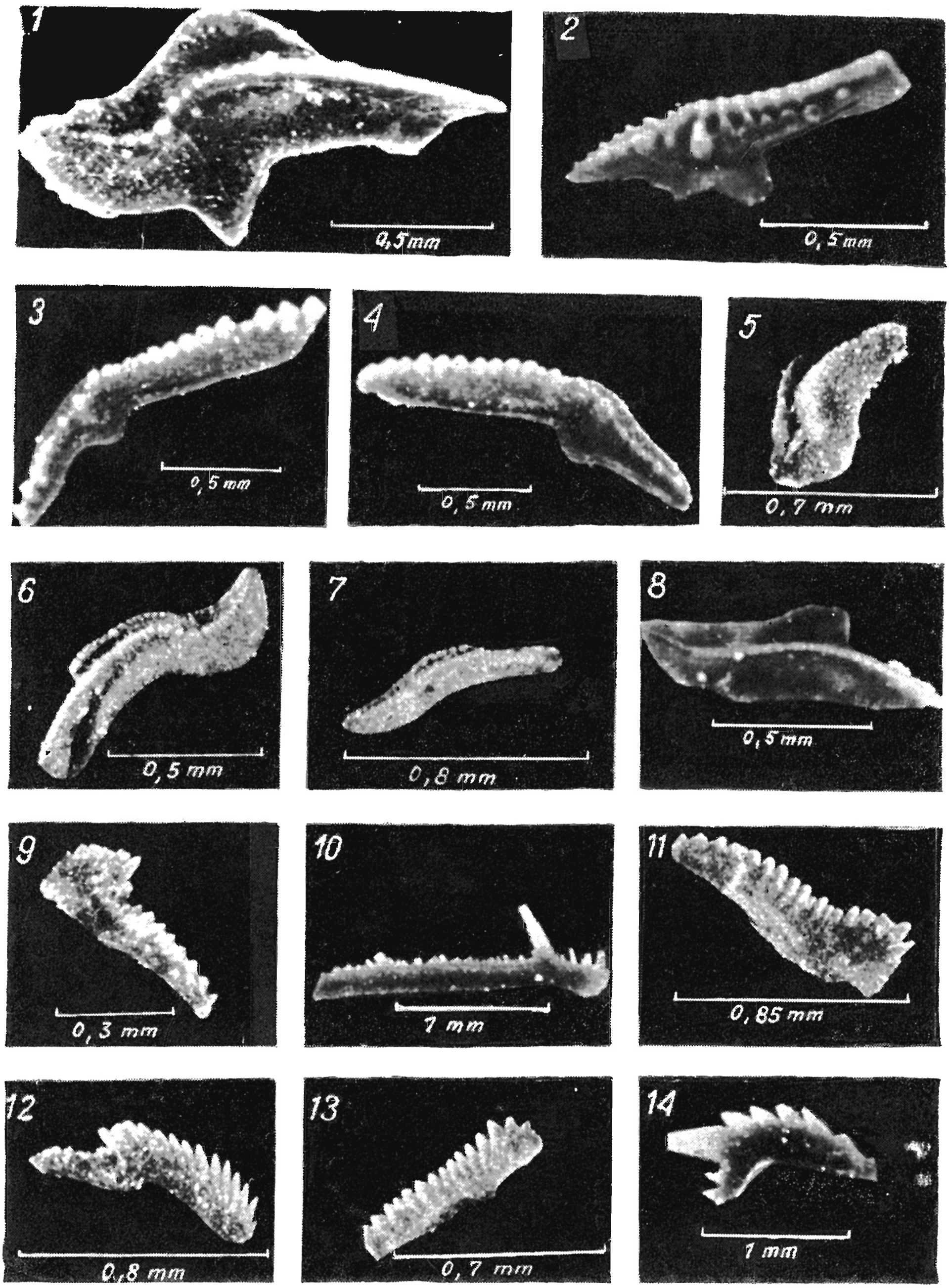
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7 — *Palmatolepis glabra elongata* Holmes, depth (głębokość) 157.0 m. (sample — próbka — 80/64).
8 — *Palmatolepis glabra pectinata* Ziegler, depth (głębokość) 157.0 m. (sample — próbka — 80/64).
9 — *Scaphignathus velifera* Ziegler, depth (głębokość) 154.5 m. (sample — próbka — 79/64).
10 — *Hindeodella germana* Holmes, depth (głębokość) 168.6 m. (sample — próbka — 85/64).
11 — *Spathognathodus stabilis* (Branson & Mehl), depth (głębokość) 152.0 m. (sample — próbka — 78/64).
12 — *Ozarkodina lacera* Helms, depth (głębokość) 159.0 m. (sample — próbka — 81/64).
13 — *Spathognathodus inornatus* (Branson & Mehl), depth (głębokość) 147.5 m. (sample — próbka — 76/64).
14 — *Ozarkodina homoarcuata* Helms, depth (głębokość) 159.0 m. (sample — próbka — 81/64).

All the specimens are from borehole Bolechowice 1. Figures by A. Ketzel (magn. abt. 15—18 ×). Photography by G. Freyer, VEB Geol. Erkundung Süd, Freiberg

Wszystkie okazy pochodzą z wiercenia Bolechowice 1. Rysunki wykonał A. Ketzel (pow. około 15 do 18 ×), a fotografie przygotował G. Freyer, VEB Geol. Erkundung Süd, Freiberg