ACTA PALAEONTOLOGICA POLONICA
Vol. XVI 1971 No. 4

HUBERT SZANIAWSKI

NEW SPECIES OF UPPER CAMBRIAN CONODONTS FROM POLAND

Abstract. — From the *Agnostus pisiformis* Zone the Upper Cambrian, from borehole Żarnowiec (northern Poland), five new species of conodonts are described and one genus is established: *Furnishina polonica* n.sp., *F. alata n.sp., Muellerina pomeranensis*, n.gen., n.sp. *Westergaardodina obliqua* n.sp. and *W. wimani* n.sp. It was noted that chemical composition of Cambrian conodonts depends on their diagenesis. Differences in the development of basal opening in the genus *Furnishina* Müller and of all later genera were observed. Occurrence of conodonts of the genus *Westergaardodina* Müller in pairs, similarly as in the case of proper conodonts, was recorded.

INTRODUCTION

Lower Ordovician conodonts were described over a century ago (Pander 1856) and are relatively well-known at present. Strong diversity of the Ordovician assemblage suggested the occurrence of conodonts already in the Cambrian, but it was only in 1956 that Müller first reported on their finding and in 1959 described the Cambrian forms found in numerous localities in Sweden, Germany and the United States. In the next years they were described in a few papers (Poulsen, 1966; Nogami, 1966, 1967; Miller, 1969) and their evolution was discussed (Clark & Miller, 1969); moreover some further notes on their occurrence and stratigraphical value were given (Goodwin, 1962; Drouce & Jones, 1968; Clark & Robison, 1969; Meshkova, 1969). Non the less our present knowledge of Cambrian conodonts is still very poor. They are known from a few parts of Cambrian section from various continents.

The conodont assemblage of the author was found in Upper Cambrian deposits pierced by borehole Żarnowiec in the northern Poland.

Here, the Upper Cambrian is characterized by a condensed sedimentation and is well-documented with trilobite fauna (Lendzion, 1970). The Upper Cambrian profile, except for its uppermost part, is 9 m thick and consits of clayey shales with intercalations of black and gray limestones.

Conodonts were recorded in almost all of the limestone and in some shale layers. Continuity of section enabled detailed studies of phylogenetic evolution of conodonts. Conodont material is still being collected, hence its elaboration will take a longer period of time. The present paper presents preliminary results of the studies and a description of a few of the most common and new species. All the specimens were obtained from one sample of black limestone assigned to the *Agnostus pisiformis* Zone, the lowermost part of Upper Cambrian. This sample, 10 dkg in weight, yielded over 3,000 well-preserved conodonts belonging to some twenty species. Among the associated fauna, inarticulate brachiopods, ostracods and problematic organisms were found.

The material described is haused at the Institute of Palaeozoology, Polish Academy of Sciences, Warsaw (abbreviated as Z. Pal.).

The drawings were made by Mrs D. Sławik, by using binocular microscope Leitz, and on the basis of the author's sketches. The micrographs were made by J. Kuczyński with Stereoscan Mark II at the Institute of Electronic Technology, Polish Academy of Sciences.

The author would like to thank Dr. K. Lendzion from the Geological Institute of Poland, Warsaw, for make available to the author the core samples.

CHARACTERISTICS OF CAMBRIAN CONODONTS

All of the hitherto recorded Cambrian conodonts, except for the genus *Westergaardodina* Müller, belong to a group of simple conodonts. They are characterized by a very wide and deep basal opening with a thin sheath, and by lack of basal filling. Specimens found in Baltic region are commonly black-coloured and insoluble in hydrochloric acid; however, X-ray analysis performed by Müller (1959) revealed that similarly to all the other conodonts, they consist of apatite. On the other hand, electron-probe analyses of the oldest Cambrian conodonts from the North America, performed by Clark & Miller (1969), revealed significant admixtures of organic matter. These authors suppose that European conodonts have similar admixtures responsible for this insolubility. Moreover, they suggest that a change in chemical composition leading to a gradual decrease of carbon and a simultaneous increase in calcium phosphate contents was one of the evolutionary trends of Cambrian conodonts.

Specimens from the author's collection vary in preservation. Some are black and insoluble in hydrochloric acid, whereas others are lighter and partly soluble. Sometimes the former ones are somewhat lighter in colour and translucent close to the aboral margin. Hence, their chemical composition partly depends on diagenesis. The studies of conodont ultrastructure (Pietzner *et al.*, 1968; Barnes *et al.*, 1970) revealed that

intralamellar spaces, initially free, are often refilled posthumously with petroleum and pyrite. As regards the conodonts from the collection examined, such penetration seems to be more probable as they are found in heavy bitumen deposits with large pyrite admixtures. Refilling with allochtonous material certainly depended both on sedimentary conditions in which conodonts were deposited and on the structure of conodonts. Intervals between the edges of lamellae observed on the inner surface of basal cavity are relatively large (Pl. I, Fig. 4b). These conodonts were built of few lamellae most probably widely spaced, which enabled penetration with foreign material. Therefore the difference between Cambrian and the later conodonts presumably does not consist in the chemical composition but in the internal structure. This problem may be univocally solved by detailed ultrastructural and chemical analyses.

Lindström (1970), holding the view that a part of Cambrian conodonts differs in chemical composition from normal conodonts, has established the order Westergaardodinida for the former, separating them from all the "proper" ones comprised in the order Conodontophoridia Eichenberg. The order Westergaardodinida Lindström includes the genera *Furnishina* Müller, *Hertzina* Müller, *Proacodus* Müller and *Westergaardodina* Müller. However, it seems that it may be valid only in the case of the genus *Westergaardodina* Müller, characterized by peculiar structural pattern. If one accepts the inclusion of the genus *Furnishina* Müller in the above order, one should also include other Cambrian conodonts similar in structure and mode of preservation. However, some of the latter are closer to Ordovician ones, e.g. *Scandodus rarus* Müller is close both to *Furnishina furnishi* Müller from the Cambrian and to Ordovician species *Scandodus rectus* Lindström and *S. pipa* Lindström. Some species of the genus *Evencodus* Moskalenko from the Middle Ordovician of the Siberian Platform (Moscalenko, 1970) are very similar to some specimen of *Furnishina furnishi* Müller, but this may result from homeomorphism. ?Conodonts of the genus *Hertzina* Müller form an isolated group characterized by completely empty interior. *Oneotodus tenuis* Müller may also belong to this group. Most probably this group is also distant from the genus *Westergaardodina* Müller.

The large number of specimens of the species *Furnishina alata* n.sp. and *F. polonica* n.sp. makes possible a detailed study of their ontogenetic development. The evolution of the basal opening is of special interest here. Clark & Müller (1968) have distinguished two types of basal opening: the first type (basal cavity) is relatively large and increases with age, the basal opening/specimen size ratio being constant; basal opening of the second type (pit) is small and its development is arrested at an early growth stage of conodont, thus being constant for given species. Development of the basal opening in the genus *Furnishina* Müller and in some other Cambrian conodonts differs from both types distinguished

by Clarke & Müller, being closer to the first type but not proportional to the conodont size. A complete lack of the basal opening in very young specimens is the most important here. Such specimens have a form of arrow with the base very weakly differentiated (Pl. I, Fig. 3, Pl. V, Figs. 1,3). The basal opening appears when cusp is already well-developed, and begins to increase rapidly when the growth of the latter becomes much smaller (Text-fig. 1). The species of the genus *Furnishina* Müller are represented by juvenile and adult specimens in more or less equal amounts in the collection; thus it may be assumed that conodonts of different development stage have occured in the same animal. Young forms of these species are very similar to each other. The lack of basal openings in juvenile forms of Cambrian conodonts explains the complete lack of basal filling in these conodonts, noted by Müller (1959).

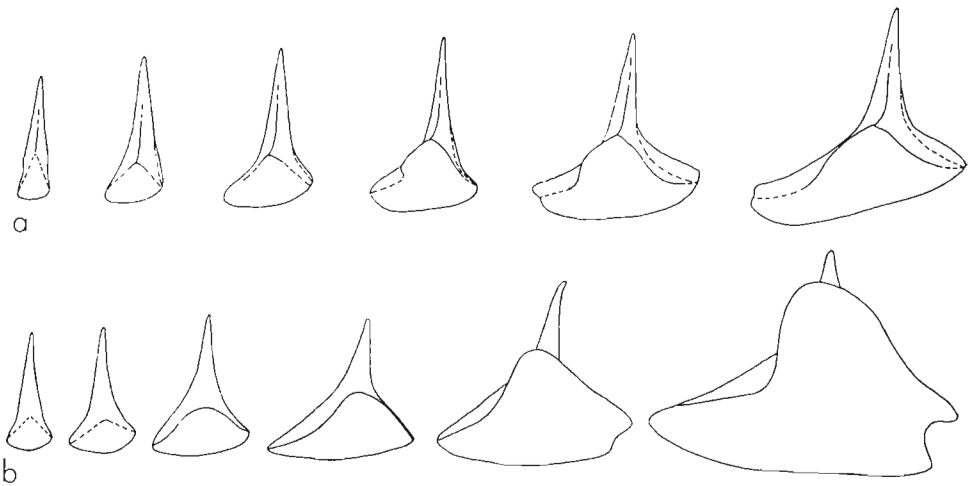


Fig. 1. — Series of ontogenetic development stages: *a Furnishina alata* n. sp., *b Furnishina polonica* n. sp.

All the specimens described in the paper are strongly asymmetric, and all, except for *Westergaardodina obliqua* n.sp., have left and right forms symmetrical to each other. This is of interest in reference to conodonts of the genus *Westergaardodina* Müller, which are characterized by varying symmetry. All the species of that genus hitherto known, except for *W. matsushitai* Nogami, are symmetrical and thus belong to the first class of symmetry in conodonts of Lane (1968), represented by a few species only. Conodonts of the species *W. wimani* n.sp. are in themselves asymmetric but they have left and right forms, thus they represent the second class of symmetry, after Lane (*op.cit.*), to which the majority of conodonts belongs. Conodonts of the species *W. matsushitai* Nogami and *W. obliqua* n.sp. are asymetric and unpaired. However, only seven specimens of the latter species have been hitherto known, so their "mirror

images" may be still unknown. These conodonts belong to the fourth class of symmetry of Lane, which is similarly rare. The occurrence of right and left forms in the species *Westergaardodina wimani* n.sp. is of certain interest, because it points out to the fact that conodonts of the genus *Westergaardodina* Müller presumably occurred in pairs in one animal, as proper conodonts.

Significant differentiation of conodonts in the section of the Upper Cambrian and their worldwide distribution suggest their usefulness to stratigraphical subdivision.

DESCRIPTIONS

Genus *Furnishina* Müller, 1959

Furnishina polonica n.sp.

(Pl. I, Fig. 1; Pl. II, Figs. 1—2; Pl. III, Figs. 1—2; Pl. V. Fig. 3; Text-fig. 1b)

Holotype: Pl. II, Fig. 1 (Z.Pal.No.C IV/1).

Type horizon and locality: Upper Cambrian, the *Agnostus pisiformis* Zone, borehole Żarnowiec, depth 2727.5 m.

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

Material. — Approximately 650 specimens.

Diagnosis. — Cusp short, slightly reclined or erect and circular in cross-section; base very large, strongly asymmetric, with narrow ridge along one of its lateral surface.

Description. — Cusp erect or slightly reclined, relatively short; its cross-section circular, except for the basal part where it is subtriangular in result of flattening of the anterior part and sharpening of the posterior one. Narrow costae appear in the basal part of anterolateral sides of the cusp, continuing up to aboral margin; they are weakly marked on the cusp, increasing in size towards the base, where they form high and acute edges. Anterior side of the cusp widens downward gradually passing into flat anterior side of the base, with which it forms one deltoid surface.

The base is extremely large, strongly asymmetrical and subtriangular, with one side concave in cross-section; it is widest in the anterior part, narrowing toward the posterior. One of its anterolateral corners is strongly elongated. Oral margin rounded, and almost equal in length to the cusp. Lateral surfaces join one another forming a convex vault over the basal opening; one of them is slightly concave, the other almost flat; long and narrow ridge, most prominent on both ends, continues obliquely across the flat surface; on some specimens this ridge disappears completely in the middle part and its upper part arcuately bent forms the oral margin;

between the lower part of this ridge and costa, wide furrow occurs; sinus from the aboral margin corresponds to this furrow.

Basal opening extremely large, obtuse, occuppying the whole base.

Remarks. — The above description concerns adult specimen. Young forms are characterized by a weaker development of the base, oral margin proportionally shorter, ridge on the base undifferentiated, aboral margin more regular and cusp proclined (Text-fig. 1*b*; Pl. III, Fig. 2; Pl. V, Fig. 3); on the other hand, some very large specimens exhibit furrows on the anterior side of the base.

Intraspecific variability includes differences in the ratios between height, width and length of specimens, degree of elongation of the anterolateral corner of the base and in the development of the basal ridge.

Margins of laminae are well-marked on inner surfaces of basal openings of numerous specimens (Pl. III, Fig. 1*b*).

Comparisons. — *Furnishina polonica* n.sp. is the most similar to *F. furnishi* Müller, differing in strong asymmetry, circular cross section of cusp, larger basal opening and occurrence of ridge on the surface of the base.

Furnishina polonica n.sp. is also similar to conodonts from China, identified as *Furnishina asymmetrica* Müller by Nogami (1966, p. 354, Pl. 9, Figs. 1,2). Only some differences in length/width ratio of the base may be assumed on the basis of the illustrations. However, from Nogami's description it follows that the latter species is characterized by prominent posterior margin (keel) and triangular section of cusp.

Comparison with *Furnishina alata* n.sp. is given below (p. 407).

Furnishina alata n.sp.

(Pl. I, Figs. 3—4; Pl. III, Figs. 3—5, Pl. V, Figs. 1—2; Text-Fig. 1*a*)

Holotype: Pl. III, Fig. 4 (Z.Pal.No. C.IV/652).

Type horizon and locality: Upper Cambrian, the *Agnostus pisiformis* Zone, borehole Żarnowiec, depth 2727.5 m.

Derivation of the name: Lat. *alatus*, meaning winged — referring to wing-like projections of the base.

Material. — Approximately 600 specimens.

Diagnosis. — Cusp slightly reclined, slender, subtriangular in cross section; posterior and oral margins sharp; costae strongly projected and anterior corners of the base strongly laterally elongated in a form of wings.

Description. — Cusp slightly reclined, relatively slender and short, and except for distal part, subtriangular in cross section; its anterior side rounded, whereas, posterior, sharp. Distal part subcircular in cross section and commonly slightly recurved. Anterolateral costae appear close to the tip, and continue up to aboral margin gradually becoming more and more

PLATES

I — V

Plate I

Fig. 1. *Furnishina polonica* n. sp.: top view, × 60 (Z.Pal.No.C.IV/6). See also Plates II, III, V.

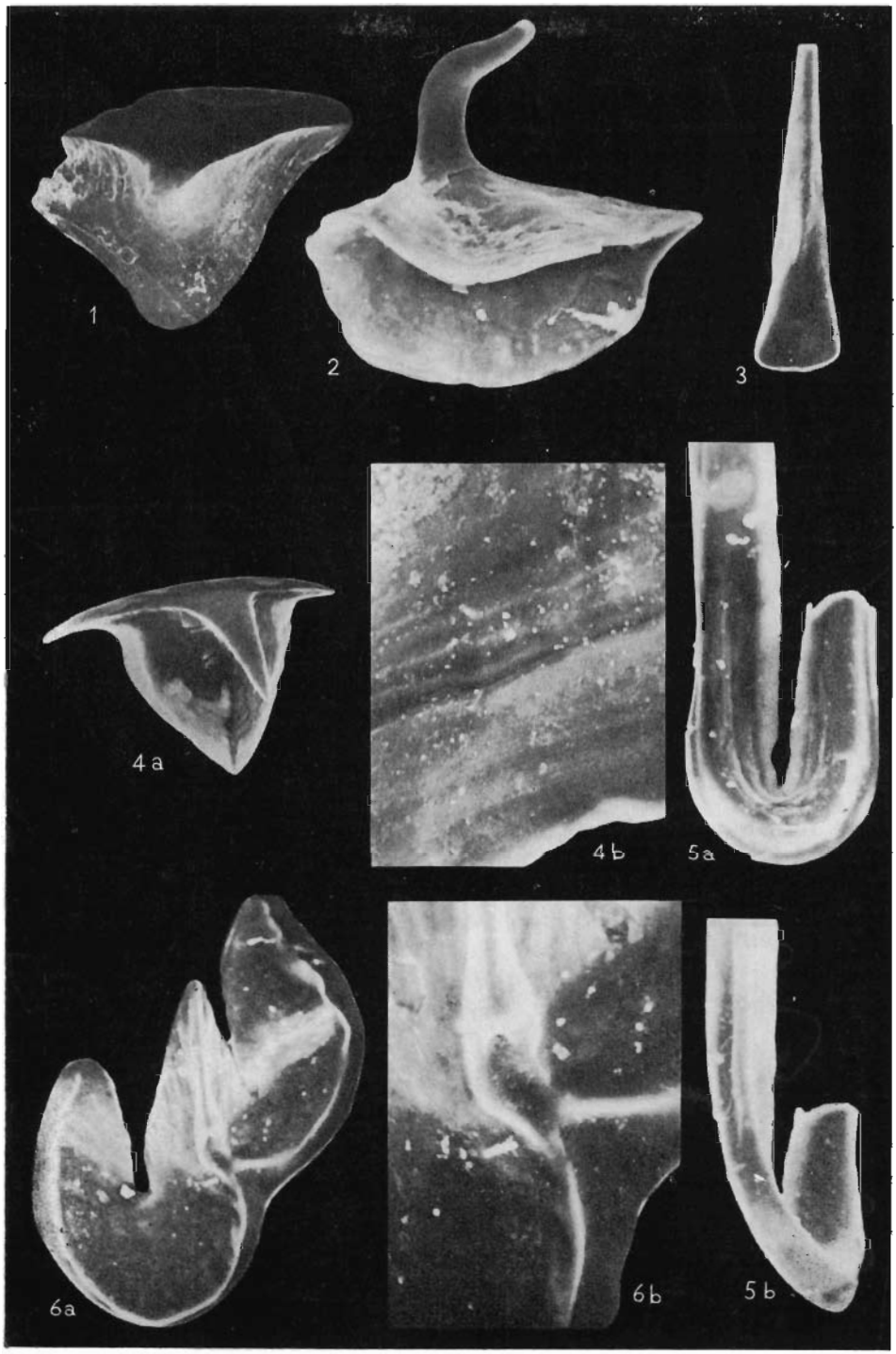
Fig. 2. *Muellerina pomeranensis* n. sp.: postero-basal view, × 120 (Z.Pal.No.C. IV/1256). See also Plates II, IV.

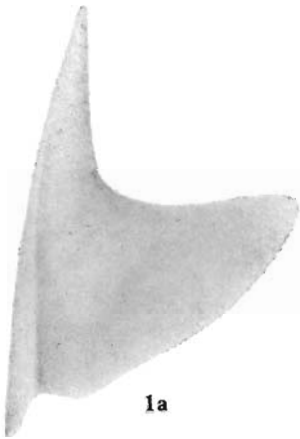
Figs. 3—4. *Furnishina alata* n. sp.: *3* posterior view of the young specimen, × 120 (Z.Pal.No.C.IV/656), *4a* top view of the adult specimen, × 90 (Z.Pal.No.C. IV/657), *4b* part of the inner surface of basal opening of the same specimen. × 300. See also Plates III, V.

Fig. 5. *Westergaardodina wimani* n. sp.: specimen with distal parts of teeth broken off, posterior and left lateral views, × 120 (Z.Pal.No.C.IV/1504). See also Plate V.

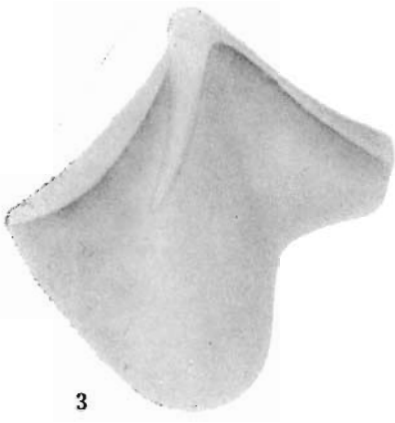
Fig. 6. *Westergaardodina obliqua* n. sp.: *a* posterior view, × 120 (Z.Pal.No.C. IV/1557), *b* part of the same specimen showing basal opening, × 300.

All specimens from the *Agnostus pisiformis* Zone
of the Upper Cambrian from borehole Żarnowiec

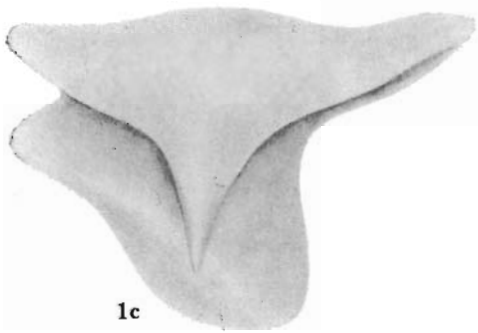

1
2
3
4a
4b
5a
6a
6b
5b



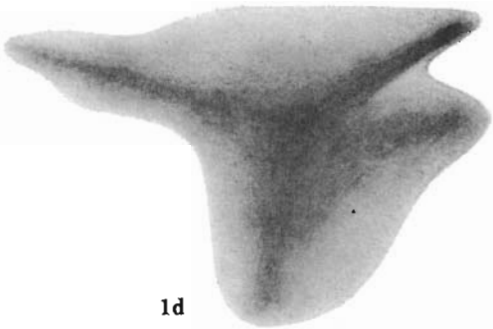
1a



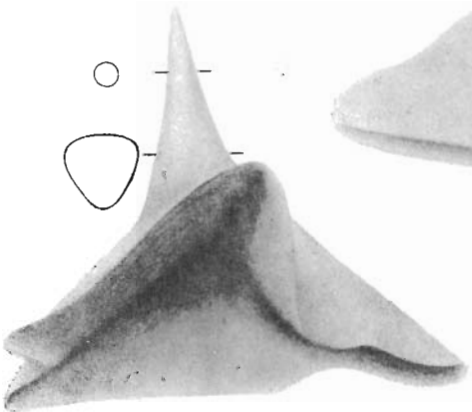
3



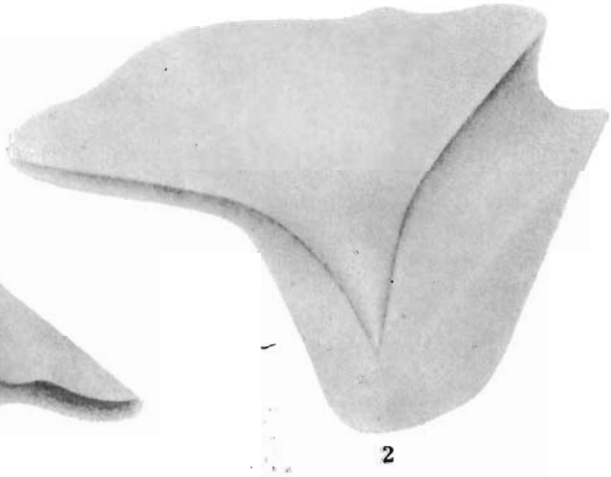
1c



1d



1b



2

Plate II

Figs. 1—2. *Furnishina polonica* n. sp.: *1 a—d* left lateral, posterior, top and basal views, and cross sections of holotype (Z.Pal.No.C.IV/1), *2* top view (Z.Pal.No. C.IV/2).

Fig. 3. *Muellerina pomeranensis* n. sp.: posterior view (Z.Pal.No.C.IV/1251).

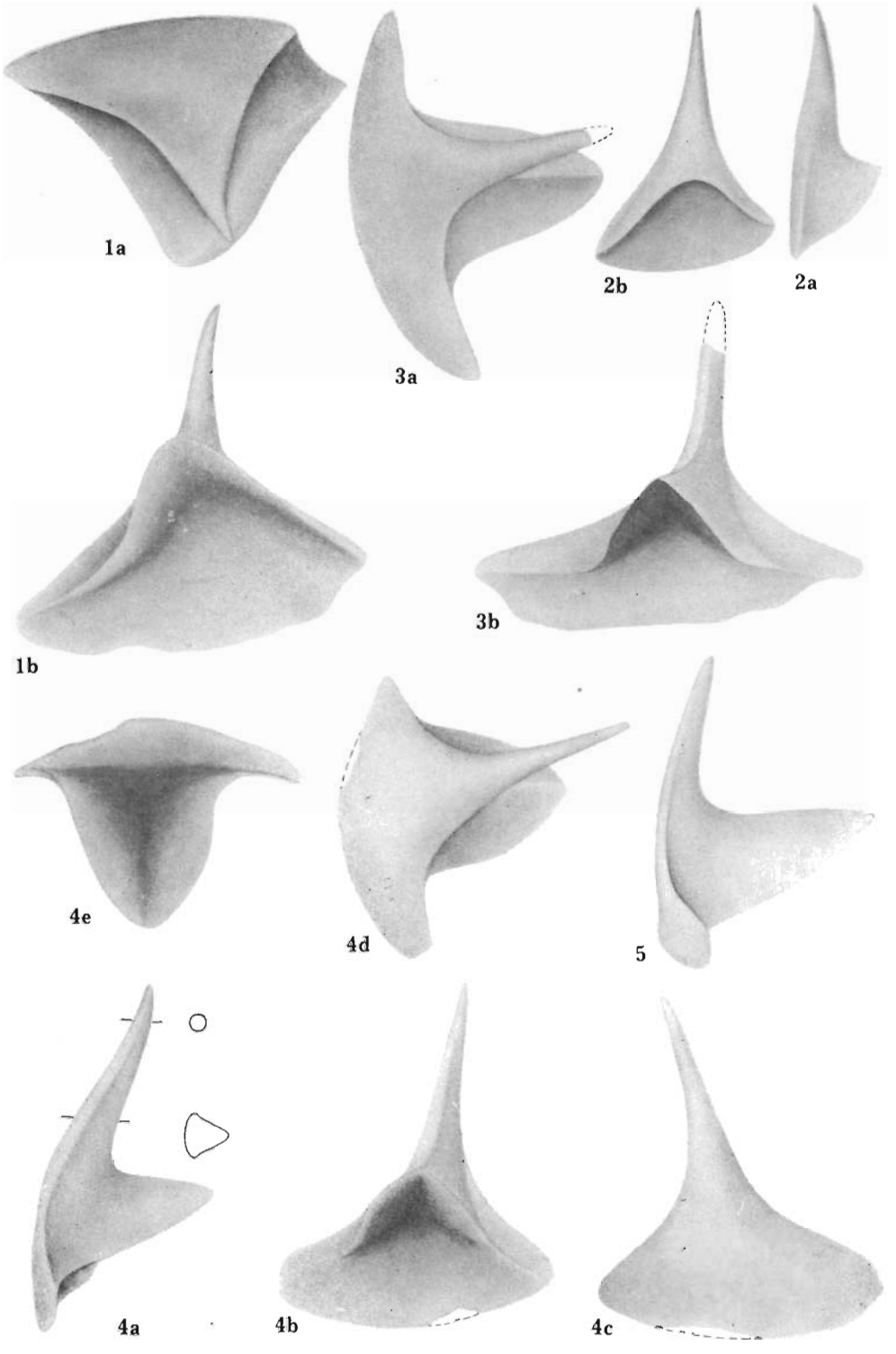
All from the *Agnostus pisiformis* Zone of the
Upper Cambrian from borehole Żarnowiec; ca. × 90

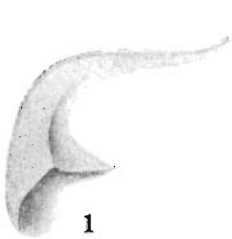
Plate III

Figs. 1—2. *Furnishina polonica* n. sp.: *1 a—b* top and posterior views (Z.Pal.No.C. IV/3), *2 a—b* left lateral and posterior views (Z.Pal.No.C.IV/4).

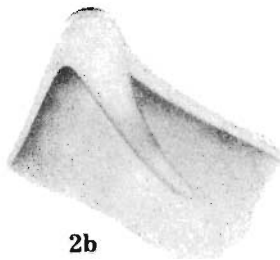
Figs. 3—5. *Furnishina alata* n. sp.: *3* posterior view (Z.Pal.No.C.IV/651), *4 a—e* left lateral, posterior, anterior, top and basal views, and cross sections of holotype (Z.Pal.No.C.IV/652), *5* left lateral view (Z.Pal.No.C.IV/653).

All specimens from the *Agnostus pisiformis* Zone of the Upper Cambrian from borehole Żarnowiec; ca. × 90

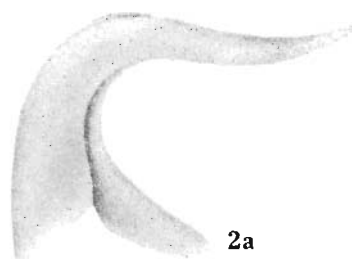

1a
3a
2b
2a
1b
3b
4e
4d
5
4a
4b
4c



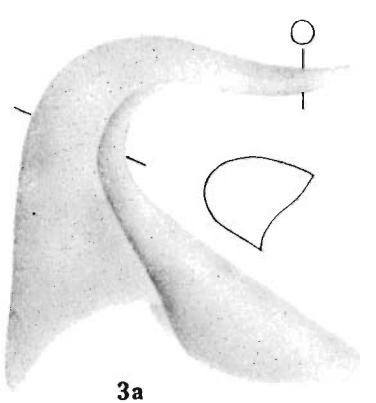
1



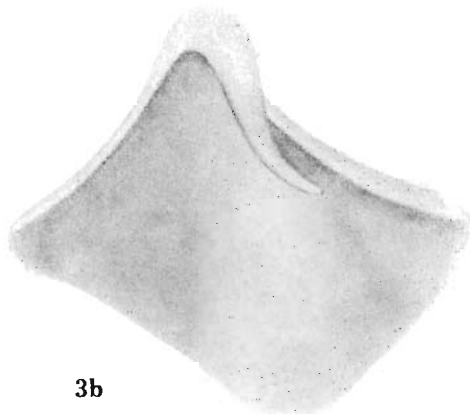
2b



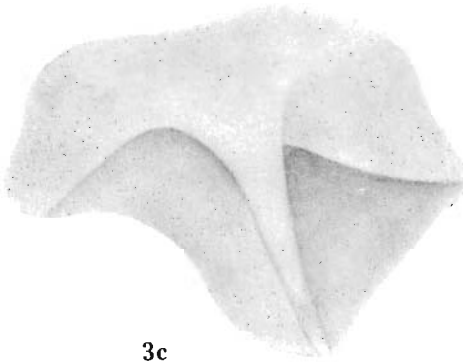
2a



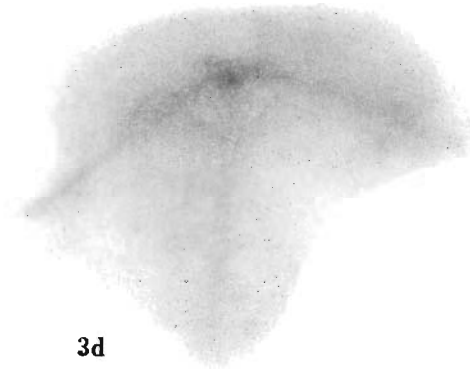
3a



3b

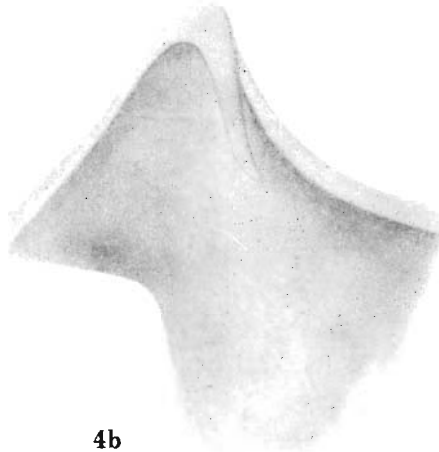


3c



3d

4a



4b

Plate IV

Figs. 1—4. *Muellerina pomeranensis* n. sp.: *1* left lateral view of young specimen (Z.Pal.No.C.IV/1252), *2 a—b* left lateral and posterior views (Z.Pal.No.C. IV/1253), *3 a—d* left lateral, posterior, top and basal views, and cross sections of holotype (Z.Pal.No.C.IV/1254), *4 a—b* left lateral and posterior views (Z.Pal.No.C.IV/1255).

All specimens from the *Agnostus pisiformis* Zone
of the Upper Cambrian from borehole Żarnowiec; ca. × 90

Plate V

Figs. 1—2. *Furnishina alata* n. sp.: *1 a—b* left lateral and posterior views of young specimen (Z.Pal.No.C.IV/654), *2 a—b* left lateral and posterior views (Z.Pal. No.C.IV/655).

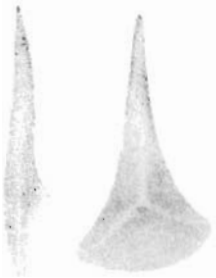
Fig. 3. *Furnishina polonica* n. sp.: *a—b* left lateral and posterior views of young specimens (Z.Pal.No.C.IV/5).

Figs. 4—6. *Westergaardodina obliqua* n. sp.: *4* posterior view (Z. Pal. No. C. IV/1554), *5* posterior view of specimen with distal part of the left lateral tooth broken off (Z.Pal.No.C.IV/1555), *6 a—c* posterior, anterior and left lateral views, and cross sections of holotype (Z.Pal.No.C.IV/1556).

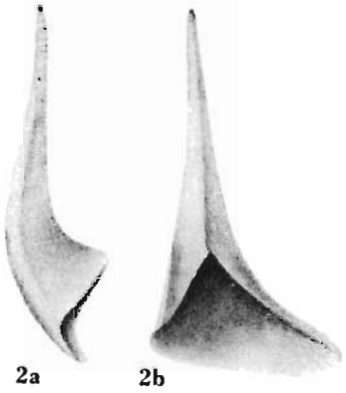
Figs. 7—9. *Westergaardodina wimani* n. sp.: *7* posterior view (Z.Pal.No.C.IV/1501), *8 a—c* posterior, anterior and right lateral views, and cross sections of holotype (Z.Pal.No.C.IV/1502), *9 posterior view* (Z.Pal.No.C.IV/1503).

All specimens from the *Agnostus pisiformis* Zone
of the Upper Cambrian from borehole Żarnowiec ca. × 90

1a 1b

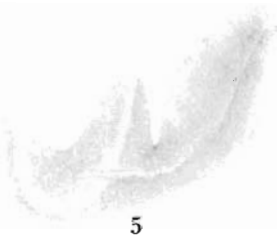


3a 3b



2a 2b

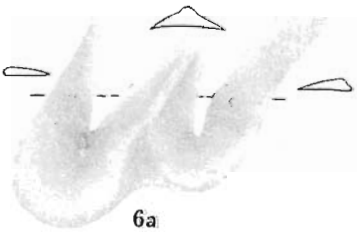
4



5

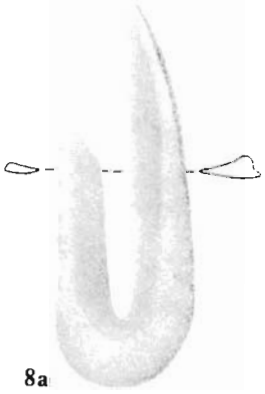
6c

7



6a

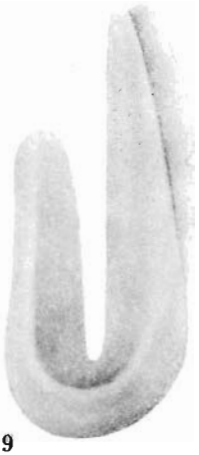
6b



8a

8b

8c



9

projected. Cusp slightly twisted in relation to base, which is confirmed best by the course of posterior margin.

Base large, subtriangular in cross section, formed of two triangular steep lateral surfaces, joined with straight sharp oral edge and wide, slightly convex anterior side, almost normal to them. Oral margin of large specimens almost equal in length to cusp. Anterior side is more basally and laterally extended than the rest of the base; its lateral corners are strongly elongated and form wing-like projections, one of which is longer than the other. Aboral margin of lateral side is commonly incised by small sinus.

Basal opening large, triangular in cross section and almost bilaterally symmetrical.

Remarks. — *Furnishina alata* n.sp. is characterized by relatively small variability, concerning mainly interrelations among height, length and width, and in the development and length of lateral wings of the base. However, there are significant differences between adult and immature forms. The latter are characterized by remarkably smaller base with very short oral margin; cusp is erect and lateral wings poorly developed.

Margins of laminae are visible in basal opening of the majority of specimens and occasionally reflected also on the oral surface (Pl. I, Fig. 4).

Comparisons. — *Furnishina alata* n.sp. is the closest to *F. asymmetrica* Müller, differing in remarkably smaller expression of asymmetry, more slender cusp and appearance of wing-like projections.

The species differs from *F. polonica* n.sp. in subtriangular cross section of cusp, sharp posterior and oral margins, in outline of the base, appearance of wing-like projections and lack of ridge on the base surface.

Genus *Muellerina* nov.

Type species: *Distacodus*(?) *cambricus* Müller, 1959, p. 450, Pl. 14, Figs. 1,2.

Derivation of the name: Named in honour of Prof. Dr Klaus J. Müller from the University of Bonn.

Diagnosis. — Simple symmetric or asymmetric conodonts with two lateral costae, which continue along cusp up to aboral margin, and without sharp anterior and posterior margins. Basal opening large, deep, occupying the whole base. Cusp commonly strongly recurved.

Species assigned. — *Distacodus(?) cambricus* Müller, *Muellerina pomeranensis* n.sp., *Scandodus oelandicus* Müller.

Occurrence. — Europe and Asia: Upper Cambrian.

Discussion. — Muellerina gen. nov. differs from the genus *Distacodus Hinde*, 1879, sensu Müller, 1959, by the lack of sharp anterior and posterior margins and occurrence of asymmetric species. On the other hand, it

differs from the genus *Scandodus* Linström, 1954 by weaker twist of cusp in relation to the base and by occurrence of symmetric species, and from the genus *Furnishina* in nonflattened anterior side of the base and in general outline of the whole base. Moreover, it differs from the genera *Distacodus* Hinde and *Scandodus* Lindström in far larger basal opening. All its species hitherto known differ from the three above genera in strongly recurved cusp.

Remarks. — *Distacodus (?) cambricus* Müller is excluded from the genus *Distacodus* Hinde because of the lack of sharp anterior and posterior margins, that was previously pointed out by Müller (1959). *Scandodus oelandicus* Müller is included in *Muellerina* gen. nov., because its cusp is barely insignificantly twisted in relation to the base and thus its sharp margins should be interpreted as lateral costae, and not as anterior and posterior margins.

Muellerina pomeranensis n.sp.
(Pl. I, Fig. 2; Pl. II, Fig. 3; Pl. IV)

Holotype: Pl. IV, Fig. 3 (Z. Pal. No.C.IV/1254).

Type horizon and locality: Upper Cambrian, the *Agnostus pisiformis* Zone, borehole Żarnowiec, depth 2727.5 m.

Derivation of the name: after Pomerania, region of Poland.

Material. — Approximately 250 specimens.

Diagnosis. — Asymmetric *Muellerina* with cusp strongly recurved and bent laterally, slender, subcircular in cross section; base extremely large, anteriorly convex and posterioly concave-convex; costae prominent beginning close to the base of cusp; base is more strongly elongated in one lateral direction than in the other.

Description. — Cusp slender, strongly reclined and bent towards longer side of the base, becoming gently recurved near tip, subcircular in cross section, except for its basal part. Costae appear on both posterolateral sides of cusp, in one-third of cusp length from the base, becoming progressively prominent towards the base.

Base very wide, more elongated in one lateral direction than in the other; anterior side uniformly convex, whereas posterior convex on the elongated side and concave on the shorter one; convex part strongly extended downward. Lateral costae, particularly shorter one, very prominent on the base. Maximal width of the base attained along the line joining the points of junction of costae and aboral margin; usually it exceeds the height of complete specimens. Deep and wide sinus formed by aboral margin seen in side view.

Basal opening very wide and deep.

Remarks. — Intraspecific variability small and mainly concerning differences in proportions of dimensions, and particularly in length of convex posterior side of the base.

Young individuals are relatively rare in the collection and have base markedly smaller in relation to the total length of cusp, than the older specimens.

Comparisons. — *Muellerina pomeranensis* n.sp. is closest to *Scandodus oelandicus* Müller, differing in longer and more slender cusp, circular in cross section, lateral costae appearing far closer to the base, and somewhat different outline of the base. Young specimens of the former species are similar to *Distacodus (?) cambricus* Müller, however they differ in strong asymmetry.

Genus *Westergaardodina* Müller, 1959

Diagnosis of this genus, given by Müller (1959, p, 465) should be supplemented on the basis of the species established both by the author and Nogami (Nogami, 1966, p. 360, Pl. 10, Figs. 6—8). Besides the species bilaterally symmetrical, also asymmetrical with right and left forms and asymmetrical, unpaired ones belong here. Moreover, basal opening of the representatives of that genus may be replaced not only by two, but also by single lateral opening.

Westergaardodina wimani n.sp.

(Pl. I, Fig. 5; Pl. V, Figs. 7—9)

Holotype: Specimen figured on Pl. V, Fig. 8 (Z.Pal.No.C.IV/1502).

Type horizon and locality: Upper Cambrian, the *Agnostus pisiformis* Zone, borehole Żarnowiec, depth 2727,5 m.

Derivation of the name: Named in honour of Carl Wiman, who for the first time (1893) mentioned the fossils presently included to the genus *Westergaardodina* Müller.

Material. — Fifty four specimens.

Diagnosis. — Asymmetrical *Westergaardodina* with left and right forms, built of two teeth, parallel to each other. One of the teeth is significantly longer and with long, shallow lateral opening.

Description. — Median tooth does not occur. From two lateral teeth, one is about one-third longer than the other. These teeth are parallel to each other and the interspace between them is narrower than tooth width. Teeth are anteriorly flat, posteriorly convex and sharpening towards the inner margin. Teeth tips are flat and blunty. In side view the whole conodont is gently arched, anteriorly convex and posteriorly concave.

Length/width ratio for the specimens approximately equals 3.0.

Basal opening developed as a single lateral opening located on the longer tooth; it is shallow and continues from tip up to two-thirds of tooth length. Downward it is gradually shallowing and on some specimens it continues as a narrow furrow along the external margin up to the base or even around it.

Remarks. — Intraspecific variability concerns rather large differences in ratios of specimen length to width, length of particular teeth, and length and depth of lateral opening. Lateral opening of smaller specimens is poorly developed, and in some specimens it is developed in a form of shallow furrow.

Comparisons. — *Westergaardodina wimani* n.sp. is somewhat similar to bidenticulate forms of the species *W. bicuspidata* Müller, differing in essentially uneven teeth length and occurrence of single lateral opening.

Westergaardodina obliqua n.sp.
(Pl. I, Figs. 6; Pl. V, Figs. 4—6)

Holotype: Specimen figured on Pl. V Fig. 6 (Z.Pal.No.C.IV/1556).

Type horizon and locality: Upper Cambrian, the *Agnostus pisiformis* Zone, borehole Żarnowiec, depth 2727.5 m.

Derivation of the name: Lat. *obliquus*, referring to inclination of teeth in relation to the base.

Material. — Seven specimens.

Diagnosis. — Asymmetrical *Westergaardodina* with short teeth strongly inclined sideward. Middle tooth ornamented with narrow longitudinal ridge ending with small basal opening; opening continues as furrow along the external margin of the lateral teeth.

Description. — Specimens wider than long. All the three teeth almost equal in length and strongly inclined sideward. Axis of middle tooth forms an angle 40—60° with the base line. Middle tooth is triangular in outline, wide at base and anteriorly concave or flat and posteriorly convex in cross section. Narrow but prominent ridge begins close to apex and continues up to the base.

Lateral teeth are commonly close to the middle tooth in length, Teeth are thin, anteriorly flat and posteriorly slightly convex in cross section, becoming sharpened towards inner margins. Their thickness increases towards the base. Inner margins of lateral teeth are slightly convex.

Specimens are anteriorly strongly concave and posteriorly convex in side view.

Basal opening begins with narrow "tunnel" on the end of ridge of the middle tooth and thereafter pass into a furrow dividing into two and continuing along external margins of lateral teeth up to their tips. Those furrows are occasionally deep on lateral teeth and of the form of lateral openings.

Remarks. — *Westergaardodina obliqua* n.sp. is very rare. Intraspecific variability large and mainly concerning differences in length of particular teeth, and their inclination, outline of lateral teeth, length of ridge from the middle tooth and development of lateral openings. Narrow furrows parallel to medial ridge are traceable both on anterior and posterior side on the middle tooth of some specimens. Basal opening on the end of medial ridge is visible only on well-preserved specimens in high magnification.

All specimens collected are characterized by the same type of asymmetry; their "mirror images" have not been found, however, it cannot be excluded that they will be found in the future.

Comparisons. — *Westergaardodina obliqua* n.sp. is closest to *W. tricuspidata* Müller, differing essentially in strong sideward inclination of all teeth.

Palaeozoological Institute
of the Polish Academy of Sciences
Warszawa, Żwirki i Wigury 93
April, 1971

REFERENCES

BARNES, C. R. SASS D. B. & MONROE, E. A. 1970. Preliminary studies of the ultrastructure of selected Ordovician conodonts. — *Life Sci. Contr. Roy. Ont. Mus.*, **76**, 1—24, Toronto.

CLARK, D. L. & MILLER, J. F. 1969. Early evolution of conodonts. — *Bull. Geol. Soc. Amer.*, **80**, 125—134, Boulder, Colorado.

CLARK, D. L. & MÜLLER, K. J. 1968. The basal opening of conodonts. — *J. Paleont.*, **42**, 2, 561—570, Menasha.

CLARK, D. L. & ROBINSON, R. A. 1969. Oldest conodonts in North America.- *J. Poleont.* 43, 4, 1044—1046.

DROUCE, E. C. & JONES, P. J. 1968. Stratigraphical significance of conodonts in the Upper Cambrian and Lower Ordovician sequence of the Boulia Region, Western, Queensland. — *Austral. J. Sci.*, **31**, 88, Sydney.

GOODWIN, P. W. 1962. Late Cambrian and early Ordovician conodonts from the Bighorn Mountains, Wyoming. — *Geol. Soc. Amer. Spec. Papers*, **68**, 183, Baltimore.

LANE, R. H. 1968. Symmetry in conodont element-pairs. — *J. Paleont.*, **42**, 5, 1258—1263, Menasha.

LENDZION, K. 1970. Biostratigraphic table of the Cambrian in Poland, North and Eastern Poland. — *In*: Geology of Poland, vol. I: Stratigraphy, part 1, Pre-Cambrian and Paleozoic, table 5, Warsaw.

LINDSTRÖM, M. 1954. Conodonts of the lowermost Ordovician strata of South-Central Sweden. — *Geol. För. Förh.*, **76**, 479, 517—603, Stockholm.

— 1970. A suprageneric taxonomy of the conodonts. — *Lethaia, 3*, 4, 427—445, Oslo.

MESHKOVA, N. P. 1969. Biostratigrafija i paleontologija nižnego kembrija Sibiri i Dalnego Vostoka. — *Akad. Nauk SSSR, Sibir, Otd. Inst. Geol. Geofiz.*, Moskva.

MILLER, J. F. 1969. Conodont fauna of the Notch Peak Limestone (Cambro-Ordovician), House Range, Utah. — *J. Paleont., 43*, 413—439, Menasha.

MOSKALENKO, T. A. 1970. Konodonty krivoluckogo jarusa (srednij Ordovik) Sibirskoj Platformy. — *Trudy Inst. Geol. Geofiz.*, **61**, 5—166, Moskva.

MÜLLER, K. J. 1956. Taxonomy, nomenclature, orientation, and stratigraphic evaluation of conodonts. — *J. Paleont.*, **30**, 1324—1340, Menasha.

— 1959. Kambrische conodonten. — *Ztschr. Deutch. Geol. Ges.*, **111**, 2, 685—708, Hannover.

NOGAMI, Y. 1966. Kambrische Conodonten von China, Teil I. — *Mém. Coll. Sci., Univ. Kyoto*, B, **32**, 4, 351—367, Kyoto.

— 1967. Kambrische Conodonten von China, Teil 2. — *Ibidem*, **33**, 4, 211—219.

PANDER, C. H. 1856. Monographie der fossilen Fische des silurischen Systems der Russisch-Baltischen Gouvernements. 1—91, St. Petersbourg.

PIETZNER, H., VAHL, J., WERNER, H. & ZIEGLER, W. 1968. Zur chemischen Zusammensetzung und Mikromorphologie der Conodonten. — *Palaeontographica*, A, **128**, 4—6, 115—152, Stuttgart.

POULSEN, V. 1966. Early Cambrian distacodontid conodonts from Bornholm. — *Biol. Medd. Danske Vidensk. Selsk.*, **23**, 15, 1—11, Copenhagen.

WESTERGÅRD, A. H. 1953. Two problematic fossils from the Cambrian in Sweden. — *Geol. Fören. Förh.*, **75**, 4, 465—468, Stockholm.

WIMAN, C. 1893. Über das Silurgebiet des Bottnischen Meeres. — *Bull. Geol. Inst.*, **1**, 70, Uppsala.

HUBERT SZANIAWSKI

NOWE GATUNKI KONODONTÓW Z KAMBRU GÓRNEGO POLSKI

Streszczenie

W otworach górnego kambru wiercenia Żarnowiec w północnej Polsce stwierdzono występowanie bogatego zespołu konodontów. Opracowano część materiału z poziomu *Agnostus pisiformis* (Lendzion, 1970) opisując 5 nowych gatunków i wyróżniając nowy rodzaj. Nowymi jednostkami taksonomicznymi są: *Furnishina alata* n. sp., *F. polonica* n. sp., *Muellirina pomeranensis* n. gen., n. sp., *Westergaardodina obliqua* n. sp., i *W. wimani* n. sp. Różny stan zachowania badanych konodontów i ich reagowania z kwasem solnym świadczy, że ich skład chemiczny zależny jest do pewnego stopnia od diagenezy. Nasuwa to przypuszczenie, że europejskie konodonty kambryjskie z wyjątkiem być może rodzaju *Hertzina* Müller, nie różnią się od konodontów późniejszym składem chemicznym, jak sądzą Clark i Miller (1969), lecz strukturą wewnętrzną, ułatwiającą ich postmortalną penetrację obcym materiałem. Zdaniem autora *Furnishina* Müller i *Hertzina* Müller nie powinny być łączone z rodzajem *Westergaardodina* Müller w osobny rząd jak proponuje to Lindström (1970).

Otwór bazalny u rodzaju *Furnishina* Müller i niektórych innych kono-

dontów kambryjskich, inaczej niż u wszystkich konodontów późniejszych, u osobników młodych jest stosunkowo bardzo mały a rozwija się dopiero później, kiedy ząb główny jest już dobrze wykształcony. Gatunki posiadające ten typ otworu reprezentowane są w kolekcji równie licznie przez formy młode jak i dojrzałe.

Występowanie symetrycznych względem siebie form prawych i lewych w gatunku *Westergaardodina wimani* n. sp. wskazuje, że konodonty tego rodzaju prawdopodobnie tak jak konodonty właściwe występowały parami.

Znaczne zróżnicowanie konodontów w profilu górnego kambru wskazuje, że będą one miały dużą wartość stratygraficzną.

ХУБЕРТ ШАНЯВСКИ

НОВЫЕ ВИДЫ КОНОДОНТОВ ИЗ ВЕРХНЕГО КЕМБРИЯ ПОЛЬШИ

Резюме

В породах верхнего кембрия, вскрытых скважиной Жарновец в Северной Польше (Лендзён, 1970), было выявлено богатое сообщество конодонтов. Исследовался материал горизонта *Agnostus pisiformis*, в котором описано 5 новых видов и определен новый род. Новым таксономическим элементам присвоены названия: *Furnishina alata* n. sp., *F. polonica* n. sp., *Muellerina pomeranensis* n. gen., n. sp., *Westergaardodina obliqua* n. sp., *W. wimani* n. sp. Разное состояние сохранности исследованных конодонтов и неодинаковая реакция при действии соляной кислотой свидетельствуют о том, что их химический состав в определенной степени зависит от диагенеза. Это заставляет предполагать, что европейские конодонты кембрийского возраста, возможно за исключением рода *Hertzina* Müller, не отличаются химическим составом от более поздних конодонтов, как предполагают Кларк и Миллер (1969), а отличие состоит в разной внутренней структуре, влияющей на проникание внешнего материала после гибели организмов. По мнению автора, *Furnishina* Müller и *Hertzina* Müller не должны объединяться с родом *Westergaardodina* Müller в отдельный отряд, как предлагает Линдштрём (1970).

У юных особей рода *Furnishina* Müller и некоторых других кембрийских конодонтов, в отличие от всех более молодых конодонтов, полностью отсутствует базальное отверстие, которое развивается позже, когда главный зуб уже развит в значительной степени. Виды с отверстием такого типа представлены в коллекции многочисленными как юными, так и зрелыми формами.

Наличие симметрических по отношению друг к другу правых и левых форм вида *Westergaardodina wimani* n. sp. свидетельствует о том, что конодонты этого рода, как вероятно и истинные конодонты, располагались по-парно.

Большая дифференцированность конодонтов в разрезе верхнего кембрия позволяет предполагать, что они будут иметь важное стратиграфическое значение.