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Upper Cambrian to Lower Ordovician conodonts of Łeba Elevation, NW Poland, and their stratigraphic significance

ABSTRACT: Stratigraphy of Upper Cambrian to Lower Ordovician deposits of Łeba Elevation, NW Poland, is improved basing upon the ranges of condont species. Lower Tremadocian claystones overlying concordantly Upper Cambrian claystones are recognized in the section Białogóra *1*. Glauconitites beginning the Ordovician carbonate sedimentary cycle are assigned mostly to the Arenigian *Prionidodus elegans (Didymograptus balticus)* Zone. Most Upper Cambrian to Lower Ordovician conodont species recorded in Łeba Elevation are described in the systematic part of the paper.

INTRODUCTION

The investigated area is situated in NW Poland and coincides with a tectonic unit called Łeba Elevation (Pożaryski 1969) making up the westerly prolongation of Peribaltic Syneclise (Fig. 1; Znosko 1966, Areń & Tomczyk 1976, Stolarczyk 1979).

The aim of this paper is to present, for the first time for that area, stratigraphic ranges of condonts recorded in some sections of the Upper Cambrian to Lower Ordovician deposits (Fig. 2). Detailed characteristics of the biostratigraphic zones and paleontological descriptions of most conodont species are also given. Much attention has been paid to correlating the conodont and graptolite zonal schemes to each other (Figs. 2—3). The biostratigraphic data are used for reconstruction of the sedimentary rhythm, especially for the Lower Ordovician. The present study supplements the knowledge of the Upper Cambrian (Lendzion 1970, 1975, 1976; Szaniawski 1971; Bednarczyk 1972, 1979; Bednarczyk & Turnau-Morawska 1975) and Lower Ordovician (Bednarczyk 1968; Modliński 1973, 1976; Podhalańska 1979) faunas of N Poland. Furthermore, the proper stratigraphic succession of various lithostratigraphic units of the Ordovician is recognized, at least for the investigated sections;

the nature of the Cambrian/Ordovician boundary is determined; and the chronostratigraphic position of the erosional surfaces, especially that one underlying the Arenigian to Ashgillian sedimentary cycle is recognized. The glauconitites beginning the latter cycle accumulated mostly in the *Prioniodus elegans* Zone in the investigated area as well as in the whole Peribaltic Syneclise.

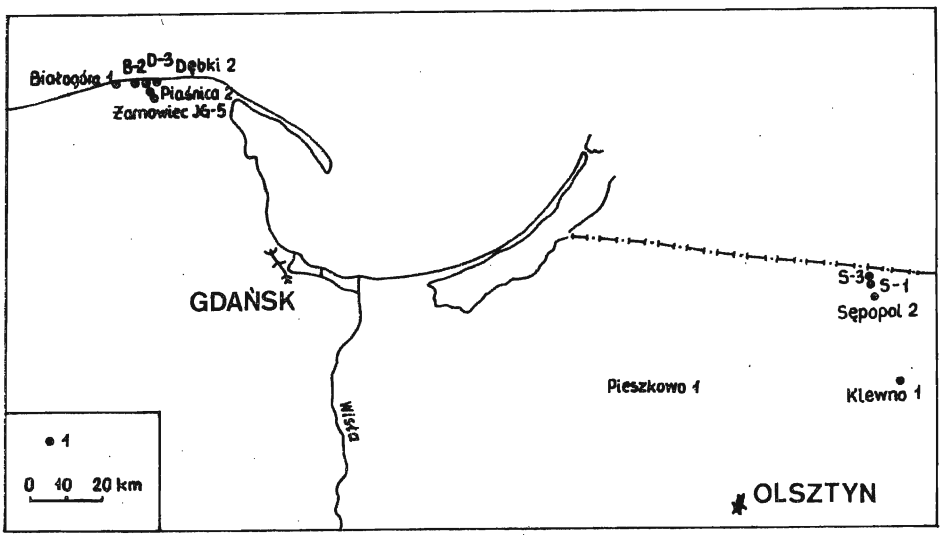

Fig. 1. Location of boreholes. *1* — boreholes

The investigated Upper Cambrian condonts are assigned to formal species and hence, the specific names are followed by the abbreviation s.f. = *sensu formae*, as suggested by Barnes & Poplawski (1973). The Ordovician conodonts are clustered into multielement species as defined by Lindström (1971, 1973, 1977), Van Wamel (1974), and Löfgren (1978). Not all identified multielement species are documented with all their component condont elements due to their repeated redeposition. In several cases, the preservation state is so poor that it would be unreasonable to take and present here a photograph.

The photographs have been taken by Mrs. M. Radzikowska, Institute of Paleobiology of the Polish Academy of Sciences, and Mr. L. Dwornik, Museum of the Earth of the Polish Academy of Sciences.

The present study was carried within the frame of a co-operation between the Institute of Geological Sciences of the Polish Academy of Sciences and the Oil Mining Survey Union "Geonafta" in Warsaw, which permitted the sampling of deep boreholes. The author is most grateful to the Director and staff geologists of the Oil Mining Survey Union and to the Oil Research Enterprise at Piła and Wołomin for their help in the sampling procedure.

The present paper contributes to the MR problem "*Geodynamics of Poland*". The documentary are kept in the Laboratory of Stratigraphy of the Institute here mentioned.

STRATIGRAPHY, FAUNA, AND CORRELATION OF THE SECTIONS

UPPER CAMBRIAN

Two local lithostratigraphic units are distinguished in the Upper Cambrian of Łeba Elevation (Bednarczyk & Turnau-Morawska 1975); these are: the Słowinskie and Piaśnica Formations. The former comprises two local biozones, namely the *Homagnostus obesus & Agnostus pisiformis*, and *Orusia lenticularis* Zones. The Piaśnica Formation does also include two biozones, namely the *Peltura minor* and *Peltura scarabeoides* Zones. However, the latter formation comprises also strata of the *Acerocare* Zone in the section Białogóra *1*. Conodonts have been found in limestones attributed to the first three of the above enumerated zones. They are associated with trilobites, ostracodes (Bednarczyk 1979), and inarticulate brachiopods.

HOMAGNOSTUS OBESUS & AGNOSTUS PISIFORMIS ZONE

This zone is represented by ferrugineous claystones intercalated with organogenic limestones at the depth of 2715.7 to 2706.1 m in the section Białogóra *1* (Fig. 2). The limestones comprise abundant cranidia and pygidia assigned to *Olenus truncatus* Brünnich. There are also a few conodonts (*Westergaardodina* sp.).

In the section Dębki *2*, this zone ranges from 2671.8 to 2661.8 m in depth and comprises ferrugineous claystones with a single bed of grey organogenic limestone. The limestone yielded cranidia and pygidia of the trilobites *Homagnostus obesus* (Belt), *Olenus truncatus* Brünnich, ostracodes *Cyclotron armatus* Grönwall, *C. lapworthi* (Groom), *C. nodomarginatum* Schrank, and conodonts *Furnishina furnishi* Müller s.f., *F. quadrata* Müller s.f., *Muellerina oelandica* (Müller) s.f., *Prooneotodus* cf. *gallatini* Müller s.f., *P. tenuis* (Müller) s.f., and *Westergaardodina bicuspidata* Müller s.f. The claystone comprises a few ostracodes, mostly *Cyclotron nodomarginatum* Schrank, and abundant valves of *Lingulella ferruginea* Salter.

The considered zone is represented by ferrugineous, black claystones interbedded with dark-grey limestones in the section Piaśnica *2* (depth 2690.0—2670.0 m). There are abundant cranidia of *Olenus truncatus* Brünnich, and conodonts *Furnishina alata* Szaniawski s.f., *F. asymmetrica* Müller s.f., *F. furnishi* Müller s.f., *F. quadrata* Müller s.f., *F. pomeranica* n.sp. s.f., *F. longibasis* n.sp. s.f., *Muellerina cambrica* (Müller) s.f., *Scandodus tortilis* Müller s.f., *Westergaardodina amplicava* (Müller) s.f., *W. bicuspidata* Müller s.f., *W. moessebergensis* Müller s.f., *W. muelleri* (Nogami) s.f., and *W. tricuspidata* Müller s.f. Szaniawski (1971) described the following conodont species from limestones recorded in the section Żarnowiec *IG-1* and attributed to the *Homagnostus obesus & Agnostus pisiformis* Zone: *Furnishina polonica* Szaniawski s.f., *Muellerina pomeranensis* Szaniawski s.f., *Westergaardodina obliqua* Szaniawski s.f., and *W. wimani* Szaniawski s.f.

ORUSIA LENTICULARIS ZONE

Grey recrystallized to coarse-crystalline or laminated with dark-grey claystone limestones recorded at the depth of 2706.1 to 2704.5 m in the section of Białogóra *1*, overlain by dark-grey, partly eroded claystones are assigned to this zone. The coarse-crystalline limestones contain abundant shells of *Orusia lenticularis* Wahlenberg associated with conodonts *Furnishina alata* Szaniawski s.f., *F. asymmetrica* Müller s.f., *F. furnishi* Müller s.f., *Hertzina elongata* Müller s.f., *Muellerina cambrica* (Müller) s.f., *M. oelandica* (Müller) s.f., *Prooneotodus gallatini* Müller s.f., *Proacodus obliquus* Müller s.f., *Westergaardodina bicupidata* Müller s.f., *W. moessebergensis* Müller s.f., *W. tricuspidata* Müller s.f., and *W. wimani* Szaniawski s.f.

The occurrence of the *Orusia lenticularis* Zone in the section Piaśnica *2* was recognized after the block of dark-grey organogenic limestone filled up with shells of *Orusia lenticularis* Wahlenberg,

scattered at the bottom of ferrugineous claystones making already part of the Piaśnica Formation. In addition to the brachiopods, the limestone comprises also abundant conodonts *Furnishina alata* Szaniawski s.f., *F. asymmetrica* Müller s.f., *F. furnishi* Müller s.f., *F. quadrata* Müller s.f., *Muellerina cambrica* (Müller) s.f., *Westergaardodina bicuspidata* Müller s.f., *W. bohlini* Müller s.f., *W. moessebergensis* Müller s.f., *W. tricuspidata* Müller s.f., and *W. wimani* Szaniawski s.f.

In the section Dębki *2*, limestone blocks with *Orusia lenticularis* Wahlenberg and conodont assemblage identical in taxonomic composition to that recorded in Piaśnica *2* section occur at the bottom of recrystallized limestones of the Piaśnica Formation.

PELTURA MINOR ZONE

In the section Piaśnica *2*, this zone is represented detached by blocks of light-grey organogenic limestone overcrowded with trilobites *Sphaerophthalmus alatus* (Boeck), *Peltura acutidens* Brögger, and *P. scarabeoidses* (Wahlenberg). There are also abundant conodonts including *Furnishina asymmetrica* Müller s.f., *Gapparodus? bisulcatus* Müller s.f., *Hertzina elongata* Müller s.f., *Prooneotodus gallatini* Müller s.f., *Oistodus* cf. *erectus* Druce & Jones s.f., *Proacodus obliquus* Müller s.f., *Prooneotodus tenuis* (Müller) s.f., *Coelocerodontus* sp. s.f., *Scandodus tortilis* Müller s.f., and *Westergaardodina* sp.n.? s.f. (Pl. 2, Fig. 6).

Blocks of organogenic limestone with trilobites *Peltura minor* Brögger and *Sphaerophthalmus alatus* (Boeck) are indicative of the *Peltura minor* Zone in the section Dębki *2*.

In the section Białogóra *1*, recrystallized limestones with cranidia of *Sphaerophthalmus alatus* (Boeck) overlain by black shaly claystones occur at the depth of 2704.5 to 2702.0 m, at an erosional surface of claystones attributed to the *Orusia lenticularis* Zone. They are regarded as equivalent to both the zones distinguished in the investigated area within the Piaśnica Formation (Bednarczyk & Turnau-Morawska 1975).

PELTURA SCARABEOIDES ZONE

Apart from the trilobites *Peltura scarabeoides scarabeoides* (Wahlenberg), *Parabolina lobata lobata* (Brögger), *Sphaerophthalmus humilis* (Phillips) and *Ctenopyge* cf. *pecten* (Salter), no fossils have been found in black shaly claystones and recrystallized limestones less than 2 m in total thickness which are attributed to this zone (Bednarczyk 1972, Lendzion 1976).

Except for the section Białogóra *1* where the Upper Cambrian strata pass concordantly into the Tremadocian, deposits of the uppermost Cambrian *Acerocare* Zone and those of the lowermost Ordovician (Tremadocian) have been eroded in the investigated area and hence, the Upper Cambrian rocks are overlain directly by the Arenigian glauconitites (Bednarczyk & Turnau-Morawska 1975).

The condont assemblages recorded in the lower three local zones of the Upper Cambrian of Łeba Elevation (Fig. 2) permit merely a rather vague stratigraphic correlation with the Upper Cambrian strata of Scandinavia, North America, N Iran, N China, and Australia.

Thus far, there is no condont-based universal zonal pattern for the Cambrian system similar to those proposed recently for the Ordovician (Bergström 1971, Lindström 1971), Silurian (Walliser 1971), or Devonian (Ziegler 1971). There are merely local stratigraphic schemes for the Upper Cambrian strata (Müller 1959, 1973; Nogami 1966, 1967; Miller 1969, 1978; Druce & Jones 1971).

Nonetheless, when the latter reports are taken into account along with several other papers (Miller & Melby 1971, Szaniawski 1971, Miller & Rushton 1973, Lee 1975, Fähraeus & Nowlan 1978, Abaimova 1978), some general features in common for the stratigraphic distribution of Upper Cambrian conodonts in various con-

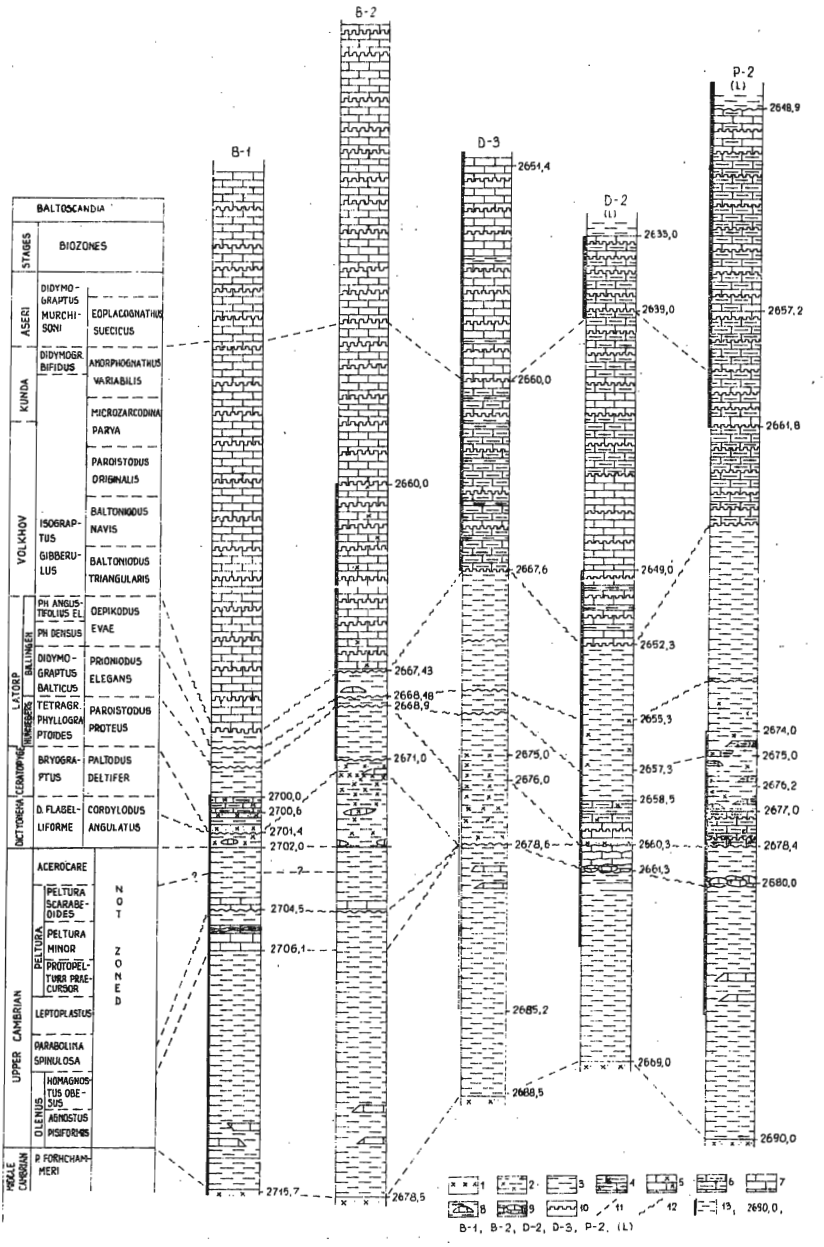

Fig. 2. Correlation of Upper Cambrian and Lower Ordovician sediments in the columns of the Łeba area

1 — glauconitites, *2* — claystones with glauconite, *3* — claystones, *4* — claystones with glauconite with interbeds of claystone, *5* — limestones with glauconite, *6* — marly limestones, *7* — limestones, *8* — claystones with interbeds of limestones, *9* — blocks of organogenic limestones, *10* — scouring surface, *11* — zone boundary, *12* — erosion surfaces, *13* — cored part of borehole; *B-1* — Białogóra *1*, *B-2* — Białogóra *2*, *D-2* — Dębki *2*, *D-3*— Dębki *3*, *P-2* — Piaśnica *2*; *L* — llandeilo, depth in meters

tinents appear more or less clearly. It is here meant that the lower Upper Cambrian conodont assemblages include mostly representatives of the genera *Furnishina* and *Westergaardodina*, whereas the genera *Proconodontus*, *Prooneotodus*, and *Oneotodus* prevail and the genera *Oistodus* and *Cordylodus* appear higher in the sections. Basing upon these observations, Miller (1969, 1978) proposed the *Proconodontus* Zone at the Cambrian/Ordovician boundary in Lava Dam section, House Range, Utah, North America, as an equivalent of the trilobite *Saukia* Zone (however, the uppermost portion of the latter zone is equivalent to the *Hirsutodontus hirsutus* Subzone, the lowermost subdivision of the Lower Ordovician *Cordylodus proavus* Zone). The *Proconodontus* Zone was subdivided by Miller (1978) into the *Proconodontus muelleri*, *P. notchpeakensis*, and *Oistodus minutus* Subzones.

Condont assemblage zones (numbered consecutively *1* to *4*) were established by Müller (1973) in the Upper Cambrian of N Iran. It is noteworthy that the zones *3* and *4* comprise conodonts indicative of the zones recognized by Miller (1978) in the House Range; these are: *Proconodontus muelleri*, *P. notchpeakensis*, *P. serratus*, *Cordylodus oklahomiensis*, and *C. proavus*. This consistency in composition of the Upper Cambrian conodont assemblages recorded in so distant areas as North America and N Iran point to the potential value of Cambrian conodonts for stratigraphic correlation.

It is, however, to be noted that conodont assemblages must make the basis for future zonal schemes of the Cambrian, while single species have to be always treated with much caution because of their morphological conservatism through time and hence, their large stratigraphic ranges.

LOWER ORDOVICIAN

Lower Ordovician conodonts of Łeba elevation derive entirely from the sections Białogóra *1*, Dębki *2*, Dębki *3*, and Piaśnica *2*. They occur in limestones and glauconitites interbedded with claystones rich in graptolites that allowed to recognize in Łeba Elevation graptolite zones consistent with those established in Scandinavia (Monsen 1937; Modliński 1973, 1976).

TREMADOCIAN

Dark-grey claystones with glauconite nests and up to 5 cm thick intercalations of dark-grey glauconitic limestone are assigned to the Lower Tremadocian in Białogóra *1* section. They overlie concordantly ferrugineous claystones of the Upper Cambrian Piaśnica Formation (Bednarczyk & Turnau-Morawska 1975). Their total thickness approximates 60 cm. Minute acrotretaceans *Eurytreta* sp., *Physotreta* sp., and *Orbithele* sp. are fairly abundant, associated with fragmented carapaces of *Caryocaris* sp. and *Ceratiocaris*? sp.

ARENIGIAN

Latorpian

TETRAGRAPTUS PHYLLOGRAPTOIDES ZONE

This zone overlies directly the Tremadocian claystones recorded at the depth of 2702.0 to 2701.4 m in the section Białogóra *1*. It is represented by clayey-marly glauconitites intercalated with dark-

-grey claystones containing minute brachiopods (*Lingulella*, *Eurytreta*) and fragmented crustacean *Caryocaris?* sp. These deposits range up to the depth of 2700.6 m and grade into grey limestones with sporadically scattered glauconite grains higher in the section. Fragmented drepanodontiform and oistodontiform conodonts occur in the glauconitites, while abundant inarticulate brachiopods and conodonts have been found in the limestones. Several new species are recognized in the brachiopod assemblage (Bednarczyk 1978) including *Rowellella parallela* sp.n., *Conotreta parva* sp.n., *Myotreta goryansky* sp. n., and *Torynelasma lebaensis* sp.n., among others[1]. Conodont elements attributed to the species *Cordylodus* cf. *angulatus* Pander, *Cornuodus longibasis* (Lindström), *Drepanodus arcuatus* Pander, *Drepanoistodus acuminatus* (Pander), *D.? inaequalis* (Pander), *D. numarcuatus* (Lindström), *D.? subaequalis* (Pander), *Paroistodus amoenus* (Lindström), *P. parallelus* (Pander), *P. proteus* (Lindström), and *Scolopodus? peselephantis* Lindström have been recorded in these strata.

In the section Dębki *3*, this zone is represented by grey-green marly claystones with glauconite laminae recorded at the depth of 2678.6 to 2676.0 m. They contain fragmented inarticulate brachiopods *Broeggeria salteri* (Holl).

Grey-greenish claystones rich in fragmented inarticulate brachiopods *Myotreta* sp. and *Broeggeria salteri* (Holl) and crustaceans *Caryocaris* sp. are assigned to the *Tetragraptus phyllograptoides* Zone in the section Białogóra *2*. They range in depth from 2671.0 to 2668.9 m. No core has been taken from the depth interval 2669.0 to 2701.0 m in that borehole, and the Cambrian/Ordovician boundary was traced at the depth of 2674.5 m after geophysic logging (Bednarczyk & Turnau-Morawska 1975).

DIDYMOGRAPTUS BALTICUS ZONE

Grey-brownish marly claystones with sporadically scattered glauconite grains recorded at the depth of 2676.0 to 2675.0 m (no core has been taken from the successive interval up to 2667.6 m in depth) in the section Dębki *3* are recognized for equivalent to the *Didymograptus balticus* Zone. These rocks contain merely fragmented rhabdosomes of *Acrograptus* sp. and *Expansograptus* sp. associated with conodont elements of *Drepanoistodus? subaequalis* (Pander) and *Paroistodus proteus* (Lindström).

There is no *Tetragraptus phyllograptoides* Zone in the section Dębki *2*. In turn, glauconitites underlying the clayey-marly set comprise conodont elements of *Drepanodus arcuatus* Pander, *Drepanoistodus? subaequalis* (Pander), *Paroistodus originalis* (Sergeeva), and *P. proteus* (Lindström). Higher in the section, at the depth of 2660.3 to 2658.5 m, marly limestones appear containing inarticulate brachiopods *Broeggeria salteri* (Holl) and *Conotreta* sp., and conodonts *Cornuodus longibasis* (Lindström), *Gothodus costulatus* Lindström, *Paroistodus proteus* (Lindström), and *Stolodus stola* (Lindström). The limestones are intercalated with glauconite-bearing, grey-green claystones rich in graptolites *Tetragraptus bigsbyi* (Hall), *Expansograptus extensus* (Hall), *E. urbanus* (Monsen), *Corymbograptus deflexus* (Elles & Wood), *Acrograptus* sp., and *Didymograptus minutus* Tornquist. The limestones are replaced upwards (up to the depth of 2657.3 m) with grey-green, 0.5 m thick claystones followed in turn by dark-grey claystones interbedded with almost black ones rich in inarticulate brachiopods *Lingulella lepis* Salter and *Broeggeria salteri* (Holl), and graptolites *Tetragraptus bigsbyi* (Hall), *Expansograptus extensus* (Hall), *Acrograptus vacillans* (Monsen), *Didymograptus minutus* Tornquist, *Loganograptus kjerulfi* (Herrmann), *Herrmannograptus milesi* (Hall), and *Clonograptus?* sp.

The *Tetragraptus phyllograptoides* Zone is lacking also in the section Piaśnica *2*. Glauconite-bearing, grey-green marly limestones recorded at the depth of 2678.4 to 2677.0 m are considered as the lowermost strata of the *Didymograptus balticus* Zone. They yielded *Lingulella* sp., *Conotreta* sp., *Broeggeria salteri* (Holl), and *Paterula*? sp. Higher in the section, there are 0.8 m thick, glauco-

[1] The new species will be described in a separate publication.

nite-brearing, grey-greenish claystones intercalated with marly limestones very similar to those recorded below. Fragmented graptolites *Didymograptus* sp., *Herrmannograptus?* sp., and *Clonograptus* sp. have been found in the claystones, whereas the limestones comprise conodonts *Acodus housensis* Miller, *Coelocerodontus* cf. *variabilis* Van Wamel, *Drepanodus arcuatus* Pander, *Drepanoistodus? subaequalis* (Pander), *Gothodus costulatus* Lindström, *Prioniodus deltatus deltatus* (Lindström), and *Scolopodus? peselephantis* Lindström. Grey-greenish claystones with sporadically scattered glauconite grains and glauconitic-limestone intercalations occur up to the depth of 2675.0 m. The claystones yielded *Lingulella lepis* Salter, *Broeggeria salteri* (Holl), *Conotreta* sp., *Expansograptus extensus* (Hall), *Corymbograptus deflexus* (Elles & Wood), *Acrograptus* sp., *Herrmannograptus?* sp., and *Clonograptus* sp. Conodont elements of *Drepanoistodus forceps* (Lindström), *D.? subaequalis* (Pander), *Gothodus* cf. *costulatus* Lindström, *Paraistodus parallelus* (Pander), *P. proteus* (Lindström), and *Prioniodus* (*Oepikodus*) cf. *intermedius* (Serpagli) have been found in the limestone intercalations.

PHYLLOGRAPTUS DENSUS ZONE

Dark-grey claystones with graptolites *Phyllograptus angustifolius* (Hall), *Ph. densus* Tornquist, *Expansograptus extensus* (Hall), and *Acrograptus?* cf. *nicholsoni* (Lapworth), and brachiopods *Lingulella* sp., recorded at the depth of 2668.9 to 2668.5 m in the section Białogóra *2* are assigned to this zone.

In the section Dębki *2*, the considered zone has been recognized at the depth of 2657.3 to 2655.3 m. It is represented by dark-grey to grey-green claystones intercalated with black claystones with pyritic concretions and glauconite grains. There are abundant inarticulate brachiopods *Lingulella lepis* Salter and *Broeggeria salteri* (Holl) and graptolites *Tetragraptus bigsbyi* (Hall), *Eotetragraptus quadribranchiatus* (Hall), *Phyllograptus anna* (Hall), *Ph. densus* Tornquist, *Ph. rotundatus* Monsen, *Expansograptus extensus* (Hall), *Corymbograptus deflexus* (Elles & Wood), *C. v-fractus* (Salter), *Acrograptus gracilis* (Tornquist), *A. nicholsoni* (Lapworth).

The *Phyllograptus densus* Zone has been recognized at the depth of 2675.0 to 2674.0 m in the section Piaśnica *2*; in fact, no core has been taken from the overlying depth interval, up to 2661.8 m in depth. As judged from the investigated core, the zone is represented by dark-grey to grey-greenish claystones with pyrite nests and glauconite grains, intercalated with glauconitic, marly limestones. The claystones comprise abundant inarticulate brachiopods *Lingulella lepis* Salter, *Conotreta* sp., and *Broeggeria salteri* (Holl), and graptolites *Tetragraptus bigsbyi* (Hall), *Schizograptus* sp., *Expansograptus extensus* (Hall), *E. nitidus* (Hall), *Corymbograptus deflexus* (Elles & Wood), *C. v-fractus* (Salter), and *Acrograptus nicholsoni* (Lapworth). In turn, the limestones contain conodont elements of *Drepanoistodus forceps* (Lindström) and *Gothodus* cf. *costulatus* Lindström.

PHYLLOGRAPTUS ANGUSTIFOLIUS ELONGATUS ZONE

Owing to the incompleteness of the investigated cores, this zone can be recognized merely in two sections of Łeba Elevation.

In the section Białogóra *2*, it is represented by dark-grey to grey-green claystones interbedded with grey limestones, recorded at the depth of 2668.48 to 2667.43 m. The only fossils found in those rocks are inarticulate brachiopods *Lingulella lepis* Salter, *Broeggeria salteri* (Holl), *Conotreta* cf. *mica* Gorjansky, *Myotreta* cf. *crassa* Gorjansky, and *Eoconulus* cf. *cryptonymus* Krause & Rowell.

In the section Dębki *2*, the Phyllograptus angustifolius elongatus Zone has been recognized at the depth of 2655.3 to 2652. 3 m. It is represented by dark-grey to grey-green claystones intercala-

ted with black claystones with graptolites *Tetragraptus bigsbyi* (Hall), *Phyllograptus angustifolius* Hall, and *Isograptus* cf. *gibberulus* (Nicholson), and fairly common inarticulate brachiopods *Lingulella lepis* Salter and *Broeggeria salteri* (Holl).

Volkhovian

Grey to beige limestones with sporadically scattered glauconite grains recorded at the depth of 2667.43 to 2660.0 m in the section Białogóra *2* are assigned to the Volkhovian (Upper Arenigian). These strata do not represent the entire Volkhovian, as no core has been taken higher in the section, up to 2639.2 m in depth. The latter interval covers the Upper Volkhovian to Llandeilo deposits. The investigated Volkhovian limestones comprise fragmented valves of *Lingulella* sp. and carapaces of *Asaphus* sp.

In the section Dębki *3*, the Volkhovian is represented by light-grey marly limestones intercalated here and there with black claystones. These deposits range from 2667.6 to 2660.0 m in depth. The limestones contain abundant conodont elements of *Cornuodus longibasis* (Lindström), *Drepanodus arcuatus* Pander, *Drepanoistodus forceps* (Lindström), and *Protopanderodus rectus* (Lindström), *?Scandodus brevibasis* (Sergeeva) (Pl. 6, Fig. 5).

Grey limestones interbedded with grey-green claystones recorded at the depth of 2652.3 to 2649.0 m (no core has been taken from the interval up to 2639.0 m in depth) in the section Dębki *2* are recognized for the Volkhovian. The limestones comprise abundant inarticulate brachiopods *Myotreta* sp. and *Scaphelasma* sp., whereas graptolites *Pandeograptus fructicosus* (Ruedemann) occur in the claystones.

Grey-beige to dark-grey at the bottom, marly limestones found at the depth of 2661.8 to 2657.21 m in the section Piaśnica *2* are attributed to the Volkhovian but this is merely a tentative attribution, as the limestones are non-fossiliferous.

LLANVIRNIAN

Marly limestones with thin intercalations of black claystones recorded at the depth of 2660.0 to 2651.4 m in the section Dębki *3* are assigned to the Llanvirnian. They comprise trilobites *Pterygometopus* cf. *sclerops* (Dalman), ostracodes, and conodonts *Cornuodus longibasis* (Lindström), *Drepanodus arcuatus* Pander, *Drepanoistodus forceps* (Lindström), *Protopanderodus rectus* (Lindström), and *Paraistodus parallelus* (Pander).

The Llanvirnian marly limestones have also been recognized in Dębki *2* section where they range from 2639.0 up to 2633.0 m in depth. They contain articulate brachiopods *Orthis* sp. and *Nicolella* sp., trilobites *Asaphus* (*Neoasaphus*) sp., *Illaenus* sp., and *Lonchodomas* sp., nautiloids *Orthoceras* sp., ostracodes, and conodonts *Drepanodus arcuatus* Pander, *Drepanoistodus forceps* (Lindström), *Paraistodus parallelus* (Pander), *P. proteus* (Lindström), and *Prioniodus* (*Oepikodus*) *evae* (Lindström).

In the section Piaśnica *2*, the Llanvirnian is represented by marly limestones ranging from 2657.21 up to 2648.9 m depth. Podhalańska (1979) recorded in those rocks conodonts indicative of the *Eoplacognathus suecicus* Zone. There are also several redeposited conodont elements pointing to erosional episode prior to the accumulation of the limestones. The conodont assemblage includes *Drepanodus arcuatus* Pander, *Drepanoistodus basiovalis* (Sergeeva), *D. forceps* (Lindström), *Eoplacognathus suecicus* Bergström, *Periodon aculeatus* Hadding, *Prioniodus* (*Baltoniodus*) *prevariabilis medius* Dzik, *Protopanderodus rectus* (Lindström), *P. robustus* (Hadding), and *Scalpellodus latus* Van Wamel.

FINAL REMARKS

In N Poland, the Tremadocian strata were previously reported exclusively from the Peribaltic Depression, namely the vicinity of Kętrzyn (Bednarczyk 1968), Lidzbark Warmiński (Modliński & Szymański 1972, Szymański 1974), and Gdańsk (Modliński 1976). These are sandy-conglomeratic deposits with *Obolus apollinis* Eichwald, attributed to the Lower Tremadocian. Accordingly to the authors cited above, the Upper Tremadocian is absent from the investigated sections; the stratigraphic gap is claimed to comprise the Upper Tremadocian and lowermost Arenigian (Szymański 1974). However, the conodont assemblages recorded in Kętrzyn area (Bednarczyk 1968) and west of that region as well, may point to a different geological situation.

The carbonate Ordovician deposits are underlain in the section Klewno *1* by conodont-bearing glauconitites and glauconitic sandstones (Bednarczyk 1968). The glauconitites comprise the following conodont species: *Drepanoistodus? inconstans* (Lindström), *Paroistodus amoenus* (Lindström), *P. parallelus* (Pander), and *Scolopodus rex* Lindström. The former two species appear restricted to the lowermost Arenigian *Paroistodus proteus* Zone, although *P. amoenus* appears already in the Upper Tremadocian *Paltodus deltifer* Zone (cf. Lindström 1971, 1973, 1977; Van Wamel 1974; Löfgren 1978). In turn, *P. parallelus* and *Scolopodus rex* appear but in the *Prioniodus elegans* Zone. This indicates that the glauconitite comprises some conodonts redeposited from eroded strata of the *Paroistodus proteus* Zone, but accumulated itself during the *Prioniodus elegans* Zone.

This conclusion is also supported by the condont assemblage of the overlying glauconitic sandstones, including *Drepanodus arcuatus* Pander, *Cornuodus longibasis* (Lindström), *Drepanoistodus forceps* (Lindström), *Paroistodus amoenus* (Lindström), *P. parallelus* (Pander), *Protopanderodus rectus* (Lindström), and *Scolopodus rex* Lindström. *D. arcuatus* ranges from the Upper Tremadocian up to the Llanvirnian. *C. longibasis* appears in the *Prioniodus elegans* Zone and persists up to the Llanvirnian. *D. forceps* and *P. rectus* range from the *Prioniodus elegans* Zone up to the *Prioniodus navis* Zone and Lower Llanvirnian, respectively. This indicates that the whole glauconitite-sandy set is to be attributed to the *Prioniodus elegans* Zone. The lowermost Arenigian strata were eroded earlier than the latter zone; the erosion reached down to the Middle Cambrian, removing the Lower (and possibly Upper) Tremadocian, as demonstrated by the occurrence of *Obolus appollinis* Eichwald in the glauconitites (Bednarczyk 1968). The shell of the latter brachiopod is filled up with glauconite grains which points to its burial in sedimentary environment of the glauconite.

The above argument is confirmed by the observations made in the sections Pieszkowo *1* and Sępopol *3* (Fig. 1), where glauconitites underlying the Ordovician carbonates cover the eroded surface of the Lower Tremadocian *Obolus*-bearing sandstones (Szymański 1974). The following conodont species have been found in the glauconitites: *Drepanodus arcuatus* Pander, *Drepanoistodus basiovalis* (Serge-

eva), *D. forceps* (Lindström), *Gothodus costulatus* Lindström, *Microzarkodina flabellum* (Lindström), *Oistodus lanceolatus* Lindström), *Scolopodus rex* Lindström, and *Stolodus stola* (Lindström). The youngest species of this assemblage are *D. basiovalis*, *M. flabellum*, and *P. originalis* which appear in the *Prioniodus navis* Zone. The others may contribute to the association typical of that zone, or they may have derived (along with the species *Oistodus lanceolatus*) from eroded deposits of the *Prioniodus evae*, or even *Prioniodus elegans* Zone. This indicates that one may deal with at least three erosional episodes in the Ordovician of Peribaltic Depression: prior to the *Prioniodus elegans* Zone (Klewno *1*), during that zone (Klewno *1*), and prior to glauconitite deposition of the *Prioniodus navis* Zone (Pieszkowo *1*, Sępopol *3*)[2].

As demonstrated by the conodont assemblages, several erosional episodes took place during the Early Ordovician also in the area of present-day Łeba Elevation.

In contrast to the Lower Ordovician (Latorpian) of Peribaltic Depression, the Lower Arenigian is represented in Łeba Elevation by a graptolite-bearing clayey-marly lithofacies. Conodonts occur mostly in carbonate intercalations. Accordingly to Modliński (1976), the Latorpian starts in the latter area with a variable in thickness glauconitite layer grading upwards into claystones of the *Tetragraptus phyllograptoides* Zone. The Arenigian overlies transgressively the Upper Cambrian claystones or sandy-carbonate-clayey deposits all over the investigated area, whereas the Tremadocian has become removed by an erosion that took place at the Tremadocian/Arenigian boundary (Modliński 1976). This image is, however, to be refined with use of the data on conodont distributional pattern.

As demonstrated above, dark-grey, 60 cm thick claystones intercalated with 5 cm thick beds of glauconite-bearing, grey limestones recorded in the section Białogóra *1* are to be assigned to the Tremadocian. These claystones overlie concordantly and without any traces of erosion black claystones of the Piaśnica Formation, Upper Cambrian (Bednarczyk & Turnau-Morawska 1975). The Tremadocian claystones differ from the Upper Cambrian ones in their grey color and occurrence of glauconite nests. The grey claystones are overlain by 80 cm thick, marly-clayey glauconitites with a 20 cm thick intercalation of glauconite-bearing claystones resembling very closely those below. Both the glauconitites and the latter claystones comprise aboundant fragments of valves assigned to *Lingulella* sp. and *Eurytreta* sp., carapaces of *Caryocaris* sp., and conodont elements of drepanodontiform and oistodontiform type. Identifiable inarticulate brachiopods and conodonts have been found but in the overlying grey limestones with glauconite grains. The conodont assemblage is mixed, with the Tremadocian elements represented by *Drepanoistodus? inaequalis* (Pander) and *D. acuminatus* (Pander). No doubt that both the species have been redeposited from the Upper Tremadocian *Paltodus deltifer* Zone. A lower part of the Tremadocian is represented by the glauconite-bearing claystones, as indicated by their sedimentary continuity with the Upper Cambrian. The species

[2] The successive younger conodont zones recorded in those sections will be discussed in a separate publication.

Cordylodus cf. *angulatus* Pander, *Drepanodus arcuatus* Pander, *Drepanoistodus numarcuatus* (Lindström), *Paroistodus amoenus* (Lindström), and *Scolopodus*? *peselephantis* Lindström may or may not have been redeposited from the Tremadocian, as they range up to the lowermost Arenigian *Paroistodus proteus* Zone. The latter zone is unequivocally indicated by the following conodonts recorded in the considered assemblage: *Drepanoistodus? subaequalis* (Pander), *Paroistodus parallelus* (Pander), and *P. proteus* (Lindström). The *Paroistodus proteus* Zone is equivalent to the *Tetragraptus phyllograptoides* Zone of the graptolitic zonal scheme of the Latorpian (Lindström 1971).

The glauconitites underlying in the section Dębki 2 carbonates of the *Didymograptus balticus* Zone contain *Drepanodus arcuatus* Pander, *Drepanoistodus*? *subaequalis* (Pander), *Paroistodus originalis* (Sergeeva), and *P. proteus* (Lindström). Most of these species have probably been redeposited from the *Paroistodus proteus* Zone, whereas the species *P. originalis* indicates clearly that the glauconites accumulated actually in the successive Arenigian zone, the *Prioniodus elegans* Zone. Then, the glauconitites of the *Prioniodus elegans* Zone overlie in the section Dębki *2* directly the erosional surface of bituminous limestones of the Piaśnica Formation, Upper Cambrian (Bednarczyk & Turnau-Morawska 1975). The Tremadocian to lowermost Arenigian (*Paroistodus proteus* Zone) deposits have been removed by erosion.

In fact, the assignment of the glauconitites recorded in Dębki 2 section to the *Prioniodus elegans* Zone is confirmed by the conodont assemblage found in the overlying limestones: *Cornuodus longibasis* (Lindström), *Paroistodus proteus* (Lindström), and *Stolodus stola* (Lindström); *P. proteus* ranges actually up to lowermost part of the *Prioniodus elegans* Zone (Lindström 1971, Löfgren 1978).

The Ordovician begins in the section Piaśnica 2 with grey-green marly limestones intercalated with glauconite layers and nests, overlying black ferrugineous claystones of the Piaśnica Formation, Upper Cambrian (Bednarczyk & Turnau-Morawska 1975). The conodont assemblage is indicative of the *Paroistodus proteus* Zone. Actually, the species *Acodus housensis* Miller, *Drepanoistodus*? *subaequalis* (Pander), and *Prioniodus deltatus deltatus* Lindström have probably been redeposited from deposits of that zone, as they are associated with a clearly younger species *Gothodus costulatus* Lindström. The occurrence of *Coelocerodontus* cf. *variabilis* Van Wamel, *Drepanodus arcuatus* Pander, and *Scolopodus*? *peselephantis* Lindström appears consistent with the above interpretation (cf. Lindström 1955, 1971). Higher in the section, there are graptolite-bearing claystones intercalated with glauconitic limestones, assigned to the *Didymograptus balticus* Zone equivalent to the *Prioniodus elegans* Zone of the conodont scheme. The conodont assemblage recorded in the glauconitic limestones appears clearly younger than that discussed above; it includes *Drepanoistodus forceps* (Lindström), *D.? subaequalis* (Pander), *Gothodus* cf. *costulatus* Lindström, *Paroistodus parallelus* (Pander), *P. proteus* (Lindström), and *Prioniodus* (*Oepikodus*) cf. *intermedius* (Serpagli). The conodont elements of *D.? subaequalis* may indeed be redeposited. One may thus claim that the conodont data support the attribution of this lithological set to the *Didymograptus balticus* Zone.

Due to the incompleteness of the cores taken from the above discussed boreholes, the successive conodont-bearing samples represent the Upper Arenigian (Volkhovian).

The limestones found in the section Dębki *3* contain the following conodont species: *Cornuodus longibasis* (Lindström), *Drepanodus arcuatus* Pander, *Drepanoistodus forceps* (Lindström), and *Protopanderodus rectus* (Lindström). The species *D. forceps* has insofar not been reported to range higher than to the *Prioniodus navis* Zone (the other species range into the Llanvirnian) and hence, the considered strata cannot be younger than of that age. It is to be noted that some conodonts may have been redeposited from eroded sediments of the *Prioniodus evae* Zone, or evan the *Prioniodus elegans* Zone. In fact, there are several erosional surfaces in the limestones. This is also the case of the limestones recorded in the section Piaśnica *2* (Fig. 2), containing *Drepanoistodus forceps* (Lindström) and *Gothodus costulatus* Lindström.

The Llanvirnian conodonts have been reported by Podhalańska (1979) from the grey limestones found in the section Piaśnica *2*, attributed to the *Eoplacognathus suecicus* Zone. These are: *Eoplacognathus suecicus* Bergström, *Periodon aculeatus* (Hadding), and *Prioniodus (Baltoniodus) prevariabilis medius* Dzik. In addition, the present author found in the same stratigraphic interval some conodonts redeposited from the Arenigian, e.g. *Drepanoistodus forceps* (Lindström) and *Scalpellodus latus* (Van Wawel). This is also the case in all the sections where the Llanvirnian has been recognized (Fig. 2). The marly limestones rich in brachiopods and trilobites of the Llanvirnian age recorded in the section Dębki *2* comprise also typically Arenigian conodont species *Drepanodus arcuatus* Pander and *Drepanoistodus forceps* (Lindström). In the section Dębki *3*, the Llanvirnian marly limestones contain mixed conodont elements attributed to *Drepanoistodus forceps* (Lindström), *Paroistodus parallelus* (Pander), *P. proteus* (Lindström), and *Prioniodus (Oepikodus) evae* (Lind ström).

One may thus conclude that the Lower Ordovician sedimentary environment of the investigated area was a shallow sea with labile bottom lifted commonly up above the wave base, which resulted in repeated erosional episodes affecting unconsolidated sediments. Fossil remains (conodonts including) were then redeposited. The most considerable erosion happened prior to the *Prioniodus elegans* (=*Didymograptus balticus*) Zone. It removed the deposits of the *Paroistodus proteus* and *Paltodus deltifer* Zones in the section Białogóra *1*. In places, the erosion reached down to the lowermost Arenigian and Tremadocian strata (Piaśnica *2*, Dębki *2*), and even to the uppermost Cambrian (Białogóra *2*). A considerable erosional episode took also place prior to the *Prioniodus navis* (=*Didymograptus bifidus*) Zone. Its effects appear most clearly in the Peribaltic Depression (Pieszkowo *1*, Sępopol *3*) where the glauconitites of that age overlie directly the *Obolus*-bearing Lower Tremadocian sandstones. In the investigated sections located in Łeba Elevation, the coeval rocks comprise commonly conodonts redeposited from the *Prioniodus triangularis* and *Prioniodus evae* Zones. This sea-bottom lability was probably related to the Sandomirian tectonic phase.

Table 1

Correlation between main stratigraphic units of Baltoscandia and the units discussed in this paper (Scandinavian units after Monsen 1937 and Lindström 1971)

British Series	Baltic Stages	Scandinavian Graptolite Zones	North Poland Graptolite Zones	Scandinavian Conodonts Zones	North Poland Conodonts Zones
Llanvirn	Kunda B_{III}	*D. "bifidus"* *Ph. typus*	?	*A. variabilis*	N o
Arenig	Volkhov B_{II}	*D. hirundo*	*D. hirundo*	*M. parva*	t Z
				P. originalis	o n
				B. navis	e d
		I. gibberullus		*B. triangularis*	*B. navis*
		Ph. ang. elongatus *Ph. densus*	*Ph. ang. elongatus* *Ph. densus*	*P. evae*	*P. evae*
	Latorp B_I	*D. balticus*	*D. balticus*	*P. elegans*	*P. elegans*
		T. phyllograptoides	*T. phyllograptoides*	*P. proteus*	*P. proteus*
Tremadoc	Ceratopyge A_{III}			*P. deltifer*	*P. deltifer*
	Pakerort A_{II}			*C. angulatus*	?

It is to be noted that owing to their close similarity in lithology, fauna, and commonness of sedimentary discontinuities, the Lower Ordovician of Łeba Elevation can be correlated precisely with time equivalent sections of Scania and Oland (Fig.2, Table 1; Hede 1951, Tjernvik 1956, Van Wamel 1974).

DESCRIPTION OF CONODONT TAXA

Genus *ACODUS* Pander, 1856

Acodus housensis Miller, 1969

(Pl. 4, Fig. 1)

1969. *Acodus housensis* n. sp.; Miller, p. 418, Pl. 63, Figs 11—20, Text-fig. 3A.
1973. *Acodus housensis* Miller; Lindström (in Ziegler), p. 3, *Clavohamulus*, Pl. 1, Fig. 1.

Material: A single acodontiform element.

Description. — Cusp recurved, with short base. Oral margin short, slightly rounded. Base elongate oval in cross section, pointed anteriorily. Basal cavity shallow, with apex displaced posteriorily. Anterior margin of the cusp sharp, posterior margin costate. Lateral costa along outer surface of the cusp, running towards the base. Longitudinal furrow marked at inner surface but not at the base.

Remarks. — Lindström (1973, p. 3) is of the opinion that the species *housensis* Miller is to be ascribed to either the genus *Oneotodus*, or *Semiacontiodus*. However, it differs from the former in that it displays a lateral costa; whereas from the latter it differs in the absence of keel from the oral margin.

Occurrence. — *Symphysurina* Zone in North America; *Paroistodus proteus* (?) to *Prioniodus elegans* Zone, Lower Ordovician in Europe, N Poland (Łeba Elevation) including.

Genus *COELOCERODONTUS* Ethington, 1959
Coelocerodontus cf. *variabilis* Van Wamel, 1974 s.f.
(Pl. 4, Fig. 16)

Material: 3 complete specimens.

Description. — Slender, slightly recurved, almost flat cusp with sharp posterior edge and rounded anterior one. Basal cavity subtriangular in cross section, filling up all the cusp. Inner surface of the cusp a little concave, outer surface a little convex. Indistinct keel at the anterior edge, and costa running close to anterior edge of the cusp appear at a single specimen.

Remarks. — The investigated specimens resemble in outline the species *Coelocerodontus variabilis* Van Wamel (1974, p. 57, Pl. 1, Figs 3a—b and 4a—b) as well as *C. burkei* Druce & Jones (1971, p. 61, Pl. 2, Figs 5a—12b, Text-fig. 22a—e). They differ from the former in their more slender and recurved shape, while from the latter they differ in the absence of keels.

Morphologically similar cusps were described by Löfgren (1978, p. 49) from the Lower to Middle Llanvirnian of N Sweden.

Occurrence. — *Prioniodus elegans* (?) Zone, Lower Ordovician in N Poland.

Coelocerodontus sp. s.f.
(Pl. 3, Fig. 12)

Material: A single specimen.

Description. — Low, slightly recurved cusp with wide base. Right lateral surface convex, left one flat. Both posterior and anterior edges provided with a sharp, fairly prominent keel. Basal cavity deep, reaching tip of the cusp. Cusp semielliptic in cross section.

Remarks. — The specimen resembles in its wide base the species *Coelocerodontus latus* Van Wamel (1974, p. 56, Pl. 1, Fig. 2a—b) but it differs from the latter in its less recurved tip of the cusp, semielliptic cross section of the base, and the absence of depressions from lateral surfaces of the base. Some morphological characteristics (e.g. the occurrence of sharp keels) make the investigated specimen similar to *C. burkei* Druce & Jones (1971, p. 61, Pl. 2, Figs 5a—12b, Text-fig. 22a—e).

Occurrence. — *Peltura minor* Zone, Upper Cambrian, in N Poland.

Genus *CORDYLODUS* Pander, 1856
Cordylodus cf. *angulatus* Pander, 1856

Material: A single incomplete specimen.

Remarks. — The specimen resembles closely the species *angulatus* Pander as presented by Lindström (1955, Pl. 5, Fig. 9).

Occurrence. — *Paltodus deltifer* Zone, Ordovician, in N Poland.

Genus *CORNUODUS* Fähraeus, 1966
Cornuodus longibasis (Lindström, 1955)
(Pl. 6, Fig. 2)

1955. *Drepanodus longibasis* n. sp.; Lindström, p. 564, Pl. 3, Fig. 31.
1966. *Cornuodus erectus* n. sp.; Fähraeus, p. 20, Pl. 2, Fig. 8a—b, Text-fig. 2B.
1974. *Protopanderodus longibasis* (Lindström); Van Wamel, p. 92, Pl. 4, Figs 4—6.
1976. *Cornuodus longibasis* (Lindström); Landing, p. 631, Pl. 1, Figs 12—13 and 15.
1978. *Cornuodus longibasis* (Lindström); Löfgren, p. 49, Pl. 4, Figs 36 and 38—42, Text-fig. 25A—C.

Material: Symmetrical elements of the species.

Description. — Considerably reclined cusp with long base. Basal cavity covering all the base, with tip displaced anteriorily. Keel extending along anterior edge, up to its contact with the base (as in symmetrical element in Van Wamel 1974, p. 50). No lateral costae. Posterior edge of the cusp sharp.

Remarks. — The investigated material includes also conodonts lacking any costae or keel, with erect, sharp-ridged cusp resembling very closely the holotype (see synonymy).

Occurrence. — Arenigian to Llanvirnian, Lower Ordovician. In Poland: Holy Cross Mts, Podlasie and Peribaltic Depressions (Bednarczyk 1968, 1969, 1971a, b), Łeba Elevation.

Genus *DREPANODUS* Pander, 1856
Drepanodus arcuatus Pander, 1856
(Pl. 5, Figs 14—16, Pl. 6, Figs 4, 10, 11, 13)

1856. *Drepanodus arcuatus* n. sp.; Pander, p. 20, Pl. 1, Figs 2, 4—5, and 17.
1955. *Drepanodus arcuatus* Pander; Lindström, p. 558, Pl. 2, Figs 30—33.
1971. *Drepanodus arcuatus* Pander; Lindström, p. 41, Figs 4 and 8.
1974. *Drepanodus arcuatus* Pander; Van Wamel, p. 61, Pl. 1, Figs 10—13.
1976. *Drepanodus arcuatus* Pander; Landing, p. 632, Pl. 1, Figs 16—19 and 21—23.
1978. *Drepanodus arcuatus* Pander; Löfgren, p. 51, Pl. 2, Figs 1—8.
1978. *Drepanodus arcuatus* Pander; Fähraeus & Nowlan, p. 458, Pl. 2, Figs 1—2 and 8.

Material: Drepanodontiform (of *sculponea, arcuatus,* and *gracilis* type) and oistodontiform elements of the species.

Remarks. — *Arcuatus*-type elements are considerably reclined cusps with smooth to costate lateral surfaces. *Sculponea*-type elements display a long base (as in *Drepanodus sculponea* Lindström, 1955, Pl. 2, Fig. 40). The commonnest in the collection are oistodontiform elements, all of them of *pipa* type (*Scandodus pipa* Lindström, 1955, p. 593, Pl. 2, Fig. 40). The least common are *gracilis*-type elements (*Drepanodus? gracilis* (Branson & Mehl); cf. Lindström 1955, Pl. 4, Fig. 44, ?Pl. 5, Figs 6—7).

Occurrence. — *Paltodus deltifer* to *Pygodus serra* Zone, Lower Ordovician. In Poland: Holy Cross Mts (Bednarczyk 1971, Dzik 1976), Podlasie Depression (Bednarczyk 1969, 1971), Peribaltic Depression (Bednarczyk 1968), Łeba Elevation.

Genus *DREPANOISTODUS* Lindström, 1971
Drepanoistodus acuminatus (Pander, 1856)
(Pl. 4, Fig. 10)

1955. *Oneotodus variabilis* n. sp.; Lindström, p. 582, Pl. 2, Figs 7 and 14—18, Pl. 5, Figs 4—5, Text-fig. 6.
1955. *Distacodus peracutus* n. sp.; Lindström, p. 555, Pl. 3, Figs 1—2.
1974. *Drepanoistodus acuminatus* (Pander); Van Wamel, p. 62, Pl. 2, Figs 1—6.

Material: Drepanodontiform (of *suberect* type) and distacodontiform elements of the species.

Description. — Distacodontiform element with proclined cusp. Keels at both anterior and posterior edge of the cusp, fairly prominent costae at lateral surfaces. Basal cavity shallow, pyramidal in shape.

Drepanodontiform elements represent two different morphological types. Some show low, reclined cusp with basal cavity wide oval in cross section. The others display erect, high, slender, oval in cross section cusp with long base, and conical basal cavity with its tip displaced anteriorily.

Occurrence. — *Paltodus deltifer* Zone, Lower Ordovician. In Poland: Holy Cross Mts (Bednarczyk & Biernat 1978), Łeba Elevation.

Drepanoistodus basiovalis (Sergeeva, 1963)
(Pl. 4, Figs 13—14)

1963. *Oistodus basiovalis* n. sp.; Sergeeva, p. 96, Pl. 7, Figs 6—7, Text-fig. 3.
1973. *Drepanoistodus basiovalis* (Sergeeva); Lindström, p. 73, Pl. 1, Figs 3—4.

1978. *Drepanoistodus basiovalis* (Sergeeva); Löfgren, p. 55, Pl. 1, Figs 11—17.

Material: Drepanodontiform and oistodontiform elements of the species.

Remarks. — The investigated drepanodontiform elements do not show any morphological difference from *Drepanodus planus* Lindström s.f. (1955, Pl. 2, Figs 35—36) except for that they are a little flattened and asymmetrical. Elements of the species *basiovalis* (Sergeeva) were assigned by Dzik (1976) and Van Wamel (1974) to *D. suberectus forceps* (Lindström) or *D. forceps* (Lindström), respectively. A single *homocurvatus*-type element may also be attributed to the species under discussion.

Occurrence. — Middle Arenigian to Middle Llanvirnian, Lower Ordovician. In Poland: Holy Cross Mts (Bednarczyk 1971b), Podlasie Depression (Bednarczyk 1969, 1971a), Peribaltic Depression (Bednarczyk 1968), Łeba Elevation.

Drepanoistodus forceps (Lindström, 1955)
(Pl. 4, Fig. 8, Pl. 5, Figs 7, 17 and Pl. 6, Fig. 12)

1955. *Oistodus forceps* n. sp.; Lindström, p. 574, Pl. 4, Figs 9—13, Fig. M.
1955. *Acodus gratus* n. sp.; Lindström, p. 545, Pl. 2, Figs 27—29.
1955. *Drepanodus homocurvatus* n. sp.; Lindström, p. 563, Pl. 2, Figs 23—24, Fig. 4d.
1955. *Drepanodus planus* n. sp.; Lindström, p. 565, Pl. 2, Figs 35—37, Fig. 4a.
1955. *Drepanodus suberectus* (Branson & Mehl); Lindström, p. 568, Pl. 2, Figs 21—22.
1973. *Drepanoistodus forceps* Lindström; Lindström in Ziegler, p. 75.
1974. *Drepanoistodus forceps* (Lindström); Van Wamel, p. 64, Pl. 2, Figs 14—22.
1976. *Drepanoistodus suberectus forceps* (Lindström); Dzik, Fig. 19g.
1978. *Drepanoistodus forceps* (Lindström); Löfgren, p. 53, Pl. 1, Figs 1—6.
1978. *Drepanoistodus forceps* (Lindström); Fåhraeus & Nowlan, p. 459, Pl. 1, Figs 22—25.

Material: Drepanodontiform (of *homocurvatus*, *planus*, and *suberectus* type) and oistodontiform elements of the species.

Remarks. — The most important reason for making a distinction between the species *basiovalis* (Sergeeva) and *forceps* (Lindström) is more acute antero-basal angle in the oistodontiform element of the latter species.

Occurrence. — *Paroistodus proteus* to *Paroistodus originalis* Zone, Lower Ordovician. In Poland: Holy Cross Mts (Bednarczyk 1971b, Dzik 1976), Podlasie Depression (Bednarczyk 1966, 1969, 1971a), Peribaltic Depression (Bednarczyk 1968), Łeba Elevation.

Drepanoistodus? inaequalis (Pander, 1856)
(Pl. 4, Figs 6, 11)

1955. *Oistodus inaequalis* Pander; Lindström, p. 576, Pl. 3, Figs 52 and 55—56.
1955. *Drepanodus deltifer* n. sp.; Lindström, p. 562, Pl. 2, Figs 42—43.
1955. *Acodus tetrahedron* n. sp.; Lindström, p. 546, Pl. 4, Figs 1—2.
1971. *Paltodus deltifer* (Lindström); Lindström, p. 441, Figs 7—8.
1974. *Drepanoistodus inaequalis* (Pander); Van Wamel, p. 65, Pl. 2, Figs 7—13.
1977. *Paltodus deltifer* (Lindström); Lindström in Ziegler, p. 421, *Paltodus*, Pl. 1, Figs 1—4.

Material: Oistodontiform, drepanodontiform, and acodontiform elements of the species.

Description. — Oistodontiform elements considerably reclined inwards, without any parapet--like extension of the inner surface of the base. Base short, with somewhat extended antero-basal part.

Drepanodontiform element reclined, sharp-edged, with lateral surfaces rounded. Base high, laterally flattened. Basal cavity deltoidal. Oral margin straight to slightly convex.

Acontodontiform element with fairly large-sized, blade-like cusp and small, tetrahedral base. Lateral surface with a costa close to the anterior edge. Oral margin short, a little convex.

Remarks. — Van Wamel (1974) assigned to this species some conodont elements described by Viira (1974, pp. 226, 230) from the Upper Tremadocian of Estonia under the names of *Scandodus varanguensis* Viira s.f., *Drepanodus pristinus* Viira s.f., and *D. bisimmetricus* Viira s.f. Lindström (1977, p. 421) suggests that these formal species may actually belong to another multielement species. The opinion of Van Wamel is, however, supported by the co-occurrence of all the three formal species with the drepanodontiform elements of *Drepanoistodus inaequalis* as conceived by Van Wamel (see Bednarczyk & Biernat 1978).

Occurrence. — *Paltodus deltifer* Zone, Lower Ordovician. In Poland: Holy Cross Mts (Bednarczyk & Biernat 1978), Łeba Elevation.

Drepanoistodus numarcuatus (Lindström, 1955)
(Pl. 4, Fig. 5)

1955. *Drepanodus numarcuatus* n. sp.; Lindström, p. 564, Pl. 2, Figs 48—49, Textfig. 31.
1955. *Acodus pulcher* n. sp.; Lindström, p. 546, Pl. 2, Fig. 38.
1974. *Drepanoistodus numarcuatus* (Lindström); Van Wamel, p. 67, Pl. 3, Figs 5—10.

Material: Drepanodontiform and acodontiform elements of the species.

Description. — Acodontiform element in form of reclined cusp with short oral margin ended with a keel. Basal cavity pyramidal in shape, with its tip displaced towards the anterior edge. Base a little convex at one side. Cusp edges with a keel; thin costa close to the anterior ridge.

Drepanodontiform element in form of reclined, sharp-edged cusp with rounded lateral surfaces and shallow basal cavity. Base elongate, with long and straight oral margin.

Occurrence. — *Paltodus deltifer* to *Paroistodus proteus* Zone, Lower Ordovician. In Poland: Łeba Elevation.

Drepanoistodus? subaequalis (Pander, 1856)
(Pl. 6, Figs 6, 9)

1856. *Paltodus subaequalis* n. sp.; Pander, p. 24, Pl. 1, Fig. 24, Text-fig. 4a.
1955. *Paltodus inconstans* n. sp.; Lindström, p. 583, Pl. 4, Figs 3—8.
1955. *Oistodus inaequalis* Pander; Lindström, p. 576 (partim), Pl. 3, Figs 53—54 and 57.
1974. *Drepanoistodus inconstans* (Lindström); Van Wamel, p. 67 (partim), Pl. 3, Figs 11, ?13, 14, and ?15.
1977. *Paltodus subaequalis* Pander; Lindström in Ziegler, p. 427, *Paltodus*, Pl. 1, Figs 7 and 9.
1978. *Paltodus inconstans* Lindström; Fåhraeus & Nowlan, p. 453, Pl. 2, Figs 3—6 and 9.

Material: Acodontiform, distacodontiform, drepanodontiform, and oistodontiform elements of the species.

Remarks. — The investigated drepanodontiform elements resemble in morphology *Paltodus inconstans* Lindström s.f.=*P. subaequalis* Pander s.f. As to the assignment of the distacodontiform elements to the discussed species, it was recently cast into doubt by Lindström (1977, p. 427) because the type specimen of *Distacodus peracutus* Lindström s.f. had been found in the Upper Tremadocian strata. The same author stated, however, that "the species is very rare in the strata below the Upper *Planilimbata* Limestones", which implies obviously its rarity in the Lower *Planilimbata* Limestones, too. This is indeed confirmed by the observations by Van Wamel (1974) in Öland and those by the present author in Łeba Elevation, NW Poland.

The oistodontiform elements differ from those attributed to *Drepanoistodus inaequalis* (Pander) in their more prominent costa at the inner surface of the cusp, and a parapet-like extension of the inner surface of the base. This difference supports the recognition of *D. subaequalis* (Pander) for a distinct species.

Occurrence. — *Paroistodus proteus* Zone, Lower Ordovician. In Poland: Peribaltic Depression and Łeba Elevation.

Genus *FURNISHINA* Müller, 1959
Furnishina asymmetrica Müller, 1959, s.f.
(Pl. 3, Figs 17—19, 22, 23)

1959. *Furnishina asymmetrica* n. sp.; Müller, p. 451, Pl. 11, Fig. 16.
1966. *Furnishina asymmetrica* Müller; Nogami, p. 354, Pl. 9, Figs 1—2.
1973. *Furnishina asymmetrica* Müller; Müller, p. 39, Pl. 1, Figs 6 and 8—9.
1978. *Furnishina asymmetrica* Müller; Abaimova, p. 78, Pl. 7, Fig. 1.

Material: 118 specimens.

Remarks. — This is asymmetrical *Furnishina* made distinct by its three carinae and the basal cavity widening at the base.

Occurrence. — Europe: Upper Cambrian up to the *Peltura scarabeoides* Zone: Sweden (Müller 1959), N Poland (Łeba Elevation); North America: Middle Cambrian Emigrant Springs Lms (Clark & Robison 1969), Upper Cambrian Gallatin Lms (Müller 1959); Asia: Upper Cambrian: Shirgesht Fm in N Iran (Müller 1973), Kazakhstan (Abaimova 1978).

Furnishina furnishi Müller, 1959, s.f.
(Pl. 1, Figs 2, 3, 5—9, 12, Pl. 3, Figs 14, 20, 21)

1959. *Furnishina furnishi* n. sp.; Müller, p. 452, Pl. 11, Figs 5—6, 8—9, and 11—15.
1966. *Furnishina furnishi* Müller; Nogami, p. 354, Pl. 9, Figs 5—7.
1969. *Furnishina furnishi* Müller; Clark & Robison, p. 1045, Text-fig. 1b.
1971. *Sagittodontus furnishi* (Müller); Druce & Jones, p. 87, Pl. 9, Figs 1—4, Text-fig, 28c—d?
1971. *Furnishina furnishi* Müller; Müller, Pl. 1, Figs 9, 12, and 14—15.
1973. *Furnishina furnishi* Müller; Müller, p. 39, Pl. 1, Figs 4—5, 7, and 10.
1978. *Furnishina furnishi* Müller; Abaimova, p. 78, Pl. 7, Fig. 2.

Material: 290 specimens.

Remarks. — *Furnishina* with basal cavity symmetrical in outline, three carinae, wide and a little convex anterior surface and slightly concave lateral surfaces of the cusp, proclined tip of the cusp.

Occurrence. — Europe: Middle Cambrian *Paradoxides paradoxissimus* Zone in Sweden (Müller 1971), Upper Cambrian in Łeba Elevation, N Poland; North America: Upper Cambrian Emigrant Springs Lms, Gallatin Lms, Dunderbergia Shales, Windfall Fm, Deadwood Fm (Müller 1959, Clark & Robison 1969); Asia: Upper Cambrian: Shirgesht Fm in N Iran (Müller 1973), Kushan Fm in N China (Nogami 1966), Kazakhstan (Abaimova 1978); Australia: Pre-Payntonian (Jones 1961).

Furnishina longibasis sp. n., s.f.
(Pl. 1, Figs 1, 4)

Material: 4 specimens.
Derivatio nominis: Latin *longa* — long, *basis* — base; after the elongate base.
Diagnosis: Asymmetrical *Furnishina* with long oral margin and slender cusp a little proclined at the tip.

Description. — *Furnishina* with long base and oral margin. Basal cavity deep, outlined as a human-foot trace in cross section. Anterior surface of the cusp flat, widening towards the base; posterior surface rounded. Oral surface arcuate. Cusp oval in cross section at the tip. Two lateral carinae starting at the aboral margin. Dark-brown color. Conodont height 2.8 mm, base length 2.4 mm, base width 1.1 mm.

Comparisons. — The newly erected species is distinctive in its long base resembling the species *Proacodus obliquus* Müller (1959, p. 458, Pl. 13, Figs 1—2 and 4). The other morphological characteristics (e.g. the occurrence of two carinae) are indicative of the genus *Furnishina* Müller.

Occurrence. — Upper Cambrian of Łeba Elevation, N Poland.

Furnishina sp. n.?, s.f.
(Pl. 1, Figs 10, 13)

Material: 1 specimen.
Diagnosis: Massive *Furnishina* with deep basal cavity and auriculately extended base margins.

Description. — Exceptionally massive *Furnishina* with auriculately extended base margins. Cusp recurved and thick. Its anterior surface flat, with a median narrow furrow. Posterior surface of the cusp with a distinct ridge, resulting in triangular outline of the cusp in cross section. Two lateral carinae starting at the aboral margin of the base, and reaching the cusp tip. Oral margin arcuate. "Aboral margin" tetralobate in outline.

Comparisons. — The morphological characteristics are entirely consistent with the genus *Furnishina* Müller. However, this specimen differs from its insofar known congeners in considerable thickness of the wall, and the base outline. The asymmetrical cross section of the base resembles the species *F. asymmetrica* Müller s.f., but the latter lacks any furrow at the anterior surface of the cusp.

Occurrence. — Upper Cambrian of Łeba Elevation, N Poland.

Furnishina pomeranica sp. n., s.f.
(Pl. 1, Fig. 17)

Material: 3 specimens.
Derivatio nominis: Latin *Pomerania* — Peribaltic region in N Poland.
Diagnosis: Furnishina with very small-sized cusp and wide and long base.

Description. — Cusp small-sized, sometimes poorly individualized, triangular in cross section. Base twice as high as the cusp. Two distinct lateral carinae starting at the aboral margin and reaching the cusp tip. Anterior surface slightly convex, broad, widening towards the base. Base concave triangular in cross section. Oral margin ogival in outline.

Comparisons. — The morphological characteristics are consistent with the genus *Furnishina* Müller but the small-sized or even poorly individualized cusp appears clearly different from all thus far known representatives of that genus.

Occurrence. — Upper Cambrian of Łeba Elevation, N Poland.

Furnishina quadrata Müller, 1959, s.f.
(Pl. 1, Figs 15—16)

1959. *Furnishina quadrata* n. sp.; Müller, p. 453, Pl. 12, Figs 2, 4, 9, Text-fig. 6c.
1966. *Furnishina quadrata* Müller; Nogami, p. 355, Pl. 9, Figs 3—4.
Material: 5 specimens.

Remarks. — *Furnishina* with relatively low cusp, wide base, and deep basal cavity. Anterior surface flat, delimited by two carinae extending from the base margin up to the cusp tip. Posterior surface rounded at the tip. Oral margin of the base arcuate. Base subsquare in cross section. The investigated specimens resemble most closely the form illustrated by Nogami (1966, Pl. 9, Figs 3—4)

Occurrence. — Europe: Upper Cambrian of Sweden (Müller 1959) and N Poland (Łeba Elevation); North America: Upper Cambrian Deadwood Fm, Orr Fm (Miller 1978); Asia: Kushan Fm in N China (Nogami 1966).

Genus *GAPPARODUS* Abaimova, 1978
Gapparodus cf. *bisulcatus* (Müller, 1959), s.f.
(Pl. 3, Fig. 2)

Material: 8 specimens.

Remarks. — The investigated specimens show a longitudinal furrow at the lateral surface and rounded anterior and posterior edges. Therefore, they are but tentatively assigned to the species *bisulcatus* Müller.

Occurrence. — Lower Cambrian of Siberia (fide Bengtson 1977); Middle Cambrian of Scania, Sweden (Müller 1971, Bengtson 1977), and the Emigrant Springs Lms, North America (Clark & Robison 1969); Upper Cambrian of Sweden, N Poland, North America, and Australia (Müller 1971, Jones 1961).

Genus *GOTHODUS* Lindström, 1955
Gothodus costulatus Lindström, 1955
(Pl. 5, Figs 4, 5, Pl. 6, Fig. 3)

1955. *Gothodus costulatus* n. sp.; Lindström, p. 569, Pl. 5, Figs 23—25.
1971. *Gothodus costulatus* Lindström; Lindström, p. 54, Pl. 1, Figs 1—5.
Material: Gothodiform and oistodontiform elements of the species.

Remarks. — Gothodiform element shows a denticulate posterior process, and smooth anterior process and lateral costa. Oistodontiform element displays a lingulate base.

Occurrence. — Latorpian, Lower Ordovician. In Poland: Holy Cross Mts, Peribaltic and Podlasie Depressions (Bednarczyk 1968, 1969, 1971a, b), Łeba Elevation.

Gothodus cf. *costulatus* Lindström, 1955
(Pl. 5, Fig. 2)

Material: 2 conodont fragments.

Description. — Tricostate conodont element with posterior costa denticulate, and the others smooth.

Occurrence. — Latorpian, Lower Ordovician of Łeba Elevation, N Poland.

Genus *HERTZINA* Müller, 1959
Hertzina elongata Müller, 1959, s.f.
(Pl. 3, Figs 1, 4, 8, 11, 13)

1959. *Hertzina elongata* n. sp.; Müller, p. 456, Pl. 13, Fig. 28.
1971. *Hertzina elongata* Müller; Müller, Pl. 1, Figs 2—3.
Material: 22 specimens.

Description. — Cusp slender and long, recurved, widening towards the base. Basal cavity deep, elongate oval in cross section. Posterior surface flat; anterior surface flat, delimited by two carinae.

Occurrence. — Upper Cambrian of Sweden, Poland, and the Dunderbergia Shales in North America (Müller 1959).

Genus *MUELLERINA* Szaniawski, 1971
Muellerina cambrica (Müller, 1959), s.f.
(Pl. 2, Fig. 8)

1959. *Distacodus? cambricus* n. sp.; Müller, p. 450, Pl. 14, Figs 1—2.
1971. *Oneotodus cambricus* (Müller); Müller, Pl. 2, Fig. 3.
Material: 2 specimens.

Remarks. — S-shaped cusp widening towards the base, oval in cross section. Basal cavity wide and deep. Lateral surface of the base most commonly convex, carinate. Inner surface of the base

with a depression, resulting in cordate outline of the base in cross section. The type material described by Müller (1959) displays two carinae at the base and hence, a different base-outline in cross section.

Occurrence. — Upper Cambrian of North America (Müller 1959) and N Poland.

Muellerina oelandica (Müller, 1959), s.f.
(Pl. 2, Fig. 7)

1959. *Scandodus oelandicus* n. sp.; Müller, p. 463, Pl. 12, Figs 14—15, Text-fig. 10.
1966. *Scandodus oelandicus* Müller; Nogami, p. 358, Pl. 9, Fig. 15.

Material: 11 specimens.

Remarks. — S-shaped cusp with wide base, oval in cross section. Basal cavity lunate in cross section. Two carinae run along the base, reaching the lower part of the cusp.

Occurrence. — Upper Cambrian of Sweden (Müller 1959) and Łeba Elevation, N Poland; Deadwood Fm and Windfall Fm in North America (Müller 1971); Kushan Fm in N China (Nogami 1966).

Genus *ONEOTODUS* Lindström, 1955
Oneotodus cf. *erectus* Druce & Jones, 1971, s.f.
(Pl. 3, Fig. 9)

1971. *Oneotodus* cf. *Oneotodus erectus* sp. n.; Druce & Jones, p. 81, Pl. 20, Fig. 8a—b, Text-fig. 26c.

Material: 2 specimens.

Description. — Erect, oval in cross section cusp with wide base. Antero-basal angle close to 75°. Oral margin short, arcuate. Aboral margin gently arcuate in its posterior part. Basal cavity wide and shallow, elliptic in cross section.

Remarks. — The morphological characteristics, and especially the base outline, point to the resemblance of the investigated conodonts to *Oneotodus* cf. *erectus* Druce & Jones from the Tremadocian Ninmaroo Fm, Australia.

Occurrence. — Upper Cambrian of N Poland.

Oneotodus sp. *a*, s.f.
(Pl. 2, Fig. 4)

Material: 1 specimen.

Description. — Cusp erect, oval in cross section. The widening base points to an affinity with *O. erectus* Druce & Jones (1971, Pl. 15, Figs 2—9).

Occurrence. — Upper Cambrian of N Poland.

Oneotodus sp. *b*, s.f.
(Pl. 2, Fig. 12)

Material: 2 specimens.

Description. — Cusp oval in cross section, filled entirely up with a deep basal cavity. Anterior and posterior edges rounded. Lateral surfaces flat. Base poorly individualized.

Occurrence. — Upper Cambrian of N Poland.

Genus *PAROISTODUS* Lindström, 1971

Paroistodus amoenus (Lindström, 1955)
(Pl. 4, Figs 7, 8, 12)

1955. *Drepanodus amoenus* n. sp.; Lindström, p. 588, Pl. 2, Figs 25—26, and Fig. 4B.
1955. *Oistodus parallelus* Pander; Lindström, p. 579, Pl. 4, Figs 27—29.
1974. *Paroistodus amoenus* (Lindström); Van Wamel, p. 78, Pl. 7, Figs 8—11.

Material: Drepanodontiform and oistodontiform elements of the species.

Description. — Oistodontiform elements very alike *Oistodus parallelus* Pander s.f., but with a different antero-basal outline and oral margin to posterior edge angle.

Drepanodontiform element with reclined cusp. Both anterior and posterior edges with a keel in the lower part. Basal cavity moderately deep, with its tip displaced anteriorily. Aboral margin arcuate. Antero-basal angle close to right. Cusp sharp-edged, with lateral surfaces convex.

Occurrence. — *Paltodus deltifer* to *Prioniodus elegans* Zone, Lower Ordovician. In Poland: Holy Cross Mts, Podlasie and Peribaltic Depressions, Łeba Elevation.

Paroistodus proteus (Lindström, 1955)
(Pl. 5, Fig. 12)

1955. *Drepanodus proteus* n. sp.; Lindström, p. 566, Pl. 3, Figs 18—21, Fig 2a—f, j.
1971. *Paroistodus proteus* (Lindström); Lindström, p. 46, Figs 8 and 10.
1978. *Paroistodus proteus* (Lindström); Fähraeus & Nowlan, p. 460, Pl. 2, Figs 17—18.
1978. *Paroistodus proteus* (Lindström); Löfgren, p. 68.

Material: Drepanodontiform elements of the species.

Remarks. — The investigated drepanodontiform conodont elements are non-costate, with straight oral margin and inverted base.

Van Wamel (1974) and Dzik (1976) attributed such elements to the species *Paroistodus parallelus* (Pander). The present author agrees, however, with Löfgren (1978) that these are distinct species with the difference consisting mostly in base morphology of the drepanodontiform elements.

Occurrence. — Latorpian Lower Ordovician. In Poland: Łeba Elevation.

Paroistodus parallelus (Pander, 1856)
(Pl. 5, Figs 3, 8—9, 11)

1856. *Oistodus parallelus* n. sp.; Pander, p. 27, Pl. 2, Fig. 40.
1955. *Oistodus parallelus* Pander; Lindström, p. 579, Pl. 4, Figs 26 and 30—31, Fig. 3(O).
1955. *Distacodus expansus* (Graves & Ellison); Lindström, p. 555, Pl. 3, Figs 13—17, Fig. 2g—i.
1971. *Paroistodus parallelus* (Pander); Linström, p. 47, Figs 8 and 11.
1973. *Paroistodus parallelus* (Pander); Lindström in Ziegler, p. 329, Paroistodus Plate 1, Figs 1—4.
1974. *Paroistodus parallelus* (Pander); Van Wamel, p. 79 (partim), Pl. 7, Figs 12—13.
1976. *Paroistodus parallelus* (Pander); Landing, p. 356, Pl. 3, Figs 1—2.
1978. *Paroistodus parallelus* (Pander); Fähraeus & Nowlan, p. 460, Pl. 2, Figs 12—13.
1978. *Paroistodus parallelus* (Pander); Löfgren, p. 68, Pl. 1, Figs 18—21.

Material: Oistodontiform and drepanodontiform elements of the species.

Remarks. — The investigated oistodontiform elements are entirely consistent with the species *Oistodus parallelus* Pander s.f. The drepanodontiform elements are consistent with *Distacodus exoansus* (Graves & Ellison) s.f. In contrast to Van Wamel (1974) and Dzik (1976), the present author follows Lindström (1971, 1973) and Löfgren (1978) in recognition of *Paroistodus proteus*, *P. parallelus*, and *P. originalis* (Sergeeva) for distinct species. In fact, Löfgren (1978) recorded *P. originalis* in the Llanvirnian which precludes its identity with *P. parallelus*.

Occurrence. — Latorpian, Lower Ordovician. In Poland: Holy Cross Mts, Podlasie and Peribaltic Depressions, Łeba Elevation.

Paroistodus originalis (Sergeeva, 1963)
(Pl. 6, Figs 1, 7—8)

1963. *Oistodus originalis* n. sp.; Sergeeva, p. 98, Pl. 7, Figs 8—9, Fig. 4.
1971. *Paroistodus originalis* (Sergeeva); Lindström, p. 48, Figs 8 and 12.
1974. *Paroistodus parallelus* (Pander); Van Wamel, p. 79 (partim), Pl. 7, Figs 14—17.
1976. *Paroistodus parallelus originalis* (Sergeeva); Dzik, Fig. 18g—h.
1978. *Paroistodus originalis* (Sergeeva); Löfgren, p. 69, Pl. 1, Figs 22...25 and 28.

Material: Oistodontiform and drepanodontiform elements of the species.

Remarks. — The oistodontiform elements are entirely consistent with *Oistodus originalis* Sergeeva s.f. The drepanodontiform elements display a wider cusp and shorter antero-basal part of the base than do their counterparts of the species *P. proteus* and *P. parallelus.*

Occurrence. — Upper Latorpian to Lower Llanvirnian, Lower Ordovician. In Poland: Peribaltic Depression, Łeba Elevation.

Genus *PRIONIODUS* Lindström, 1955
Prioniodus deltatus deltatus (Lindström, 1955)
(Pl. 4, Figs 2—4)

1955. *Acodus deltatus altior* n. sp.; Lindström, p. 544, Pl. 3, Figs 27—29.
1955. *Distacodus rhombicus* n. sp.; Lindström, p. 556, Pl. 3, Figs 35—36.
?1955. *Drepanodus latus* n. sp.; Lindström, p. 564, Pl. 3, Figs 22—23.
1955. *Oistodus linguatus* n. sp.; Lindström, p. 577 (partim; holotype = *Acodus erectus* Pander, 1856).
1974. *Prioniodus deltatus* (Lindström); Van Wamel, p. 85 (partim), Pl. 8, Figs 1—2, 4, 6, and 8—9.
1977. *Acodus deltatus deltatus* Lindström; Lindström (in Ziegler), p. 7, *Acodus*, Pl. 2, Figs 8—13.

Material: Acodontiform, prioniodontiform = oepikodontiform, distacodontiform, and oistodontiform elements of the species.

Description. — Distacodontiform element with relatively short cusp and high base. Lateral costa running along the posterior edge, with a prolongation at the base. Both anterior and posterior edges with a high keel. Area between the keel and costa slightly concave.

Oistodontiform element with arcuate base with linguately extended posterior part. Cusp reclined. Inner surface carinate.

Acodontiform element entirely consistent in morphology with *Acodus deltatus altior* Lindström s.f.

Prioniodontiform element with proclined cusp and poorly individualized processes. Posterior process provided with low, fused denticles. Anterior and lateral processes non-denticulate.

Remarks. — Accordingly to Van Wamel (1974, p. 86), the oldest known specimens of *Prioniodus navis* Lindström show sometimes a denticulate posterior process. They may represent an intermediate form to those younger, with more distinctly denticulate posterior process. The investigated prioniodontiform elements of *P. deltatus deltatus* (Lindström) may indeed support the opinion of Van Wamel, which in turn gives more justification to the present generic assignment of the species *deltatus* Lindström.

Occurrence. — *Paltodus deltifer* to *Paroistodus proteus* Zone, Lower Ordovician, of Europe, North America, and Australia. In Poland: Holy Cross Mts and Łeba Elevation.

Subgenus *PRIONIODUS (OEPIKODUS)* Lindström, 1955
Prioniodus (Oepikodus) evae Lindström, 1955
(Pl. 5, Figs 1, 6)

1955. *Oepikodus smithensis* n. sp.; Lindström, p. 571, Pl. 6, Figs 1—3.
1971. *Prioniodus evae* Lindström; Lindström, p. 52, Figs 13—14.
1976. *Prioniodus evae* Lindström; Landing, p. 638, Pl. 4, Figs 1—5.

1977. *Oepikodus evae* (Lindström); Lindström) (in Ziegler), *Oepikodus*, Pl. 1, Figs 6—11.
1978. *Prioniodus (Oepikodus) evae* Lindström; Löfgren, p. 79, Figs 7—11, Pl. 9, and Fig. 17A—B.

Material: Oepikodontiform and oistodontiform elements of the species.

Description. — Oepikodontiform element with two poorly individualized, costa-like, rounded lateral processes, non-denticulate anterior process, and denticulate posterior process. Lateral processes starting at the erect and fairly slender cusp, with a prolongation at the base. Denticles at the posterior process variable in height, fused at their base. Basal cavity situated beneath the posterior process, with a prolongation beneath the cusp.

Oistodontiform element with considerably extended posterior part of the base.

Occurrence. — *Prioniodus evae* Zone, Upper Latorpian, Lower Ordovician. In Poland: Holy Cross Mts (?) and Łeba Elevation.

Genus *PROACODUS* Müller, 1959
Proacodus obliquus Müller, 1959, s.f.
(Pl. 1, Figs 11, 14)

1959. *Proacodus obliquus* n. sp.; Müller, p. 458, Pl. 13, Figs 1—2 and 4.
1971. *Proacodus obliquus* Müller; Müller, Pl. 2, Fig. 2.

Material: 2 specimens.

Description. — Asymmetrical conodont ("left form") with short, massive cusp and elongate base. Cusp erect, with both anterior and posterior edges rounded, left lateral surface convex, right lateral surface flat, oval in cross section at the tip. Oral margin of the base long, arcuate. Antero-basal angle close to right. Anterior and posterior costae distinct, running along the base up to the lower part of the cusp. Basal cavity moderately high, semiovate in cross section.

Remarks. — The investigated conodonts differ from the type specimen in their more massive cusp, flat right lateral surface, wider base with more prominent costae, more clearly semiovate cross-section of the basal cavity.

Occurrence. — Upper Cambrian of Scandinavia (Müller 1959) and N Poland; Kushan Fm in N China (Nogami 1966); Upper Cambrian Elwinia Zone in North America (Müller 1971).

Genus *PROONEOTODUS* Müller & Nogami, 1971
Prooneotodus gallatini (Müller, 1959)
(Pl. 3, Figs 10, 15—16)

1959. *Oneotodus gallatini* n. sp.; Müller, p. 457, Pl. 13, Figs 5—6, ?7, 8—10, and ?12.
1971. *Oneotodus gallatini* Müller; Druce & Jones, p. 81, Pl. 9, Figs 9a—10c, Text-fig. 28f—g.

Material: 28 specimens.

Description. — Cusp recurved, oval in cross section. Base high, narrowing towards the tip, ova to elongate oval in cross section. Basal cavity deep.

Occurrence. — Upper Cambrian: Sweden and N Poland in Europe; Yencho Fm in N China; Chatsworth Lms in Australia; Gallatin Lms (Wyoming), Deadwood Fm (S. Dakota), Dunderbergia Shales and Windfall Fm (Nevada), Orr Fm and Lava Dam Fm (Utah) in North America (Müller 1959, 1971, 1973; Nogami 1967; Druce & Jones 1971; Miller 1978).

Prooneotodus tenuis (Müller, 1959)
(Pl. 3, Figs 3, 5—7)

1959. *Oneotodus tenuis* n. sp.; Müller, p. 457, Pl. 13, Figs 11, 13—14, and 20.
1966. *Oneotodus tenuis* Müller; Nogami, p. 356, Pl. 9, Figs 11—12.
1969. *Oneotodus tenuis* Müller; Clark & Robison, p. 1045, Text-fig. 1a.
1971. *Oneotodus tenuis* Müller; Druce & Jones, p. 83.

1972. *Oneotodus tenuis* Müller; Shergold & Druce, p. 18, Text-fig. 6.
1971. *Oneotodus tenuis* Müller; Müller, p. 8, Pl. 1, Figs 1 and 4—6.
1973. *Prooneotodus tenuis* (Müller); Müller, p. 45, Pl. 1, Figs 1 and 3a—b.
1976. *Prooneotodus tenuis* (Müller); Müller & Andres, p. 193, Pl. 2, Figs A—B.
1978. *Prooneotodus tenuis* (Müller); Abaimova, p. 33, Pl. 7, Figs 3, 5, and 7.
Material: 121 specimens.

Description. — Cusp slender, narrowing towards the tip, variable in recurvation. Base poorly individualized, elongate oval in cross section.

Occurrence. — Europe: Middle to Upper Cambrian of Sweden, Upper Cambrian of N Poland; North America: Middle Cambrian Emigrant Springs Lms, Upper Cambrian Dunderbergia Shales, Windfall Fm, Deadwood Fm, and Gallatin Lms; Asia: Kushan Fm and Yencho Fm in N China, Shirgesht Fm in N Iran; Australia: Chatsworth Lms (Müller 1959, 1971, 1973; Nogami 1966, 1967; Druce & Jones 1971).

Genus *PROTOPANDERODUS* Van Wamel, 1974
Protopanderodus rectus (Lindström, 1955)

1955. *Acontiodus rectus* n. sp.; Lindström, p. 549, Pl. 2, Figs 7—11, Fig. 3B.
1955. *Acontiodus rectus* n. sp.; var. *sulcatus* nov.; Lindström, p. 550, Pl. 2, Figs 12—13, Fig. 3D.
1955. *Scandodus rectus* n. sp.; Lindström, p. 593, Pl. 4, Figs 21—25, Fig. 3K.
1974. *Protopanderodus rectus* (Lindström); Van Wamel, p. 93, Pl. 4, Figs 7—10.
Material: Scandodiform and acontiodiform elements of the species.

Remarks. — The investigated scandodiform and acontiodiform elements are entirely consistent in morphology with the conodonts referred to in the synonymy.

Occurrence. — *Prioniodus elegans* to *Amorphognathus variabilis* Zone, Lower Ordovician. In Poland: Holy Cross Mts, Peribaltic and Podlasie Depressions, Łeba Elevation.

Genus *SCANDODUS* Lindström, 1954
Scandodus tortilis Müller, 1959, s.f.
(Pl. 4, Fig. 15)

1959. *Scandodus tortilis* n. sp.; Müller, p. 454, Pl. 12, Figs 7—8 and 10.
1971. *Scandodus tortilis* Müller; Müller, Pl. 2, Fig. 1.
Material: 12 specimens.

Description. — Asymmetrical, proclined, and turned leftwards conodont with both anterior and posterior edges sharp. Two distinct costae running along the anterior edge. Base long. Basal cavity deep, triangular in cross section (with one side convex, another concave, the angles rounded).

Remarks. — The investigated conodonts show a lower base and shorter oral margin than in the type material.

Occurrence. — Upper Cambrian of Sweden and N Poland; Upper Cambrian Windfall Fm in North America.

Genus *SCOLOPODUS* Pander, 1856
Scolopodus peselephantis Lindström, 1955
(Pl. 4, Fig. 9)

1955. *Scolopodus? peselephantis* n. sp.; Lindström, p. 595, Pl. 2, Figs 19—20, Fig. 3Q.
1974. *Scolopodus peselephantis* Lindström; Van Wamel, p. 94, Pl. 5, Figs 16—17.
1978. *Scolopodus? peselephantis* Lindström; Löfgren, p. 108, Pl. 4, Figs 16—17.
Material: 5 specimens.

Description. — Cusp proclined, with short, oval in cross section base and shallow basal cavity. Both anterior and posterior edges rounded. Lateral surfaces with two furrows running along the cusp, separated with a sharp costa.

Remarks. — Some specimens show fine longitudinal ribs, pyramidal basal cavity, and considerably erect cusp.

Occurrence. — *Paltodus deltifer* to *Paroistodus originalis* Zone, Lower Ordovician. In Poland: Holy Cross Mts. Podlasie Depression, Łeba Elevation (Bednarczyk 1969, 1971a, b).

Genus *STOLODUS* Lindström, 1971
Stolodus stola (Lindström, 1955)
(Pl. 5, Fig. 10)

1955. *Distacodus stola n.* sp.; Lindström, p. 556, Pl. 3, Figs 43—49.
1964. *Coelocerodontus stola* (Lindström); Lindström, Fig. 29.
1971. *Stolodus stola* (Lindström); Lindström, p. 51.
1974. *Stolodus stola* (Lindström); Van Wamel, p. 95 (partim), Pl. 8, Figs 20—23.
1976. *Stolodus* sp., *Stolodus stola* (Lindström); Landing, p. 640, Pl. 4, Fig. 21.
1978. *Stolodus stola* (Lindström); Fähraeus & Nowlan, p. 461, Pl. 1, Fig. 21.
1978. *Stolodus stola* (Lindström); Löfgren, p. 111, Pl. 9, Figs 18—19.

Material: 2 specimens.

Description. — Cusp proclined, shorter than the base, with prominent lateral costae extending from the point of maximum recurvation and all over the base. Both anterior and posterior edges provided with a keel with prolongation at the base.

Occurrence. — *Prioniodus elegans* to *Prioniodus navis* Zone, Lower Ordovician. In Poland: Podlasie Depression (Bednarczyk 1969) and Łeba Elevation.

Genus *WESTERGAARDODINA* Müller, 1959
Westergaardodina bicuspidata Müller, 1959, s.f.
(Pl. 2, Figs 2, 13)

1959. *Westergaardodina bicuspidata* n. sp.; Müller, p. 468, Pl. 15, Figs 1, 4, 7, 9—10, and 14.
1966. *Westergaardodina bicuspidata* (Müller) sp. indet.; Nogami, p. 359, Pl. 10, Fig. 4.
1966. *Westergaardodina bicuspidata* Müller; Hamar, p. 80, Pl. 6, Fig. 1, Text-fig. 2.
1971. *Westergaardodina bicuspidata* Müller; Müller, p. 11, Pl. 2, Fig. 8.
1971. *Westergaardodina bicuspidata* Müller; Druce & Jones, p. 100, Pl. 7, Figs 1a—4d, Text-fig. 32.
1973. *Westergaardodina bicuspidata* Müller; Müller, p. 47, Pl. 2, Fig. 3.

Material: 76 specimens.

Description. — U-shaped conodont with tiny median denticle, well developed lateral basal cavities at the tips of lateral denticles. Tips of the lateral denticles turned outwards, the median parts more close to each other.

Remarks. — The specimens are associated with phosphatic spherules recorded also by Müller (1959).

Occurrence. — Middle(?) to Upper Cambrian of Sweden; Upper Cambrian of N Poland; Upper Cambrian Deadwood Fm and Orr Fm in North America, Shirgesht Fm in N Iran, Kushan Fm and Yencho Fm in N China, Chatsworth Lms in Australia (Müller 1959, 1971, 1973; Nogami 1966, 1967; Druce & Jones 1971; Miller 1978).

Westergaardodina bohlini Müller, 1959, s.f.
(Pl. 2, Fig. 1)

1959. *Westergaardodina bohlini* n. sp.; Müller, p. 469, Pl. 15, Fig. 8.

Material: 2 specimens.

Description. — U-shaped conodont with small and narrow median denticle provided with a low keel. Basal cavities covering some two third of the lateral denticles in length, disappearing below their tips.

Occurrence. — Upper Cambrian of Sweden (Müller 1959, 1971) and Łeba Elevation, Poland.

Westergaardodina kleva Müller, 1959, s.f.
(Pl. 4, Fig. 18)

1959. *Westergaardodina kleva* n. sp.; Müller, p. 469, Pl. 15, Fig. 2.

Material: 1 specimen.

Description. — W-shaped *Westergaardodina* with lateral denticles twice as wide as the median one. Median denticle a little shorter than the others, provided with a rounded carina resulting in its triangular outline in cross section. Basal cavity extending at the base and lateral denticles. Anterior surface of the conodont flat, posterior surface flat.

Occurrence. — Upper Cambrian of Sweden (Müller 1959) and N Poland.

Westergaardodina moessebergensis Müller, 1959, s.f.
(Pl. 2, Fig. 9)

1959. *Westergaardodina moessebergensis* n. sp.; Müller, p. 470, Pl. 14, Figs 11—12 and 15.
1966. *Westergaardodina moessebergensis* Müller; Nogami, p. 360, Pl. 10, Figs 1—2.
1971. *Westergaardodina moessebergensis* Müller; Druce & Jones, p. 101, Pl. 8, Fig. 4a, c.
1971. *Westergaardodina* cf. *moessebergensis* Müller; Müller, p. 11, Pl. 2, Fig. 6.
1973. *Westergaardodina moessebergensis* Müller; Müller, p. 48, Pl. 2, Figs 7—8.
1978. *Westergaardodina moessebergensis* Müller; Abaimova, p. 86, Pl. 8, Figs 8 and 10—11.

Material: 8 specimens.

Description. — U-shaped conodont with wide and flat lateral denticles very close to each other Basal cavity shallow, extending at the base and lateral denticles.

Occurrence. — Upper Cambrian: Sweden and N Poland, Orr Fm in North America, Kazakhstan, Mila Fm in N Iran, Chatsworth Lms in Australia (Müller 1959, 1971, 1973; Druce & Jones 1971; Abaimova 1978; Miller 1978).

Westergaardodina muelleri Nogami, 1966, s.f.
(Pl. 2, Figs 3, 11)

1959. *Westergaardodina* n. sp.; Müller, p. 471, Pl. 15, Fig. 13.
1966. *Westergaardodina muelleri* n. sp.; Nogami, p. 361, Pl. 10, Fig. 3.
1969. *Westergaardodina muelleri* Nogami; Clark & Robison, p. 1045, Text-fig. 1c.
1973. *Westergaardodina muelleri* Nogami; Müller, p. 48, Pl. 2, Fig. 9.

Material: 5 specimens.

Description. — W-shaped conodont with high keel at the median denticle, extending from the base margin up to the denticle tip. Basal cavity wide and deep, with a prolongation at the outer surface of lateral denticles.

Occurrence. — Middle Cambrian Emigrant Springs Lms in North America; Upper Cambrian of Sweden and N Poland; Shirgesht Fm in N Iran, Kushan Fm and Yencho Fm in N China (Müller 1959, 1973; Nogami 1966, 1967; Clark & Robison 1969).

Westergaardodina tricuspidata Müller, 1959, s.f.
(Pl. 2, Fig. 5)

1959. *Westergaardodina tricuspidata* n. sp.; Müller, p. 470, Pl. 15, Figs 3 and 5—6.
1966. *Westergaardodina tricuspidata* Müller; Nogami, p. 362, Pl. 10, Fig. 5.
1971. *Westergaardodina tricuspidata* Müller; Müller, p. 11, Pl. 2, Fig. 12.

Material: 5 specimens.

Description. — W-shaped conodont with indistinct basal cavity and denticles equal in size. Fairly low keel at the median denticle.

Occurrence. — Upper Cambrian: Sweden and N Poland, Orr Fm in North America, Kushan Fm in N China (Müller 1959, 1971; Nogami 1966; Miller 1978).

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W. BEDNARCZYK

KONODONTY I ICH ZNACZENIE DLA STRATYGRAFII OSADÓW GÓRNEGO KAMBRU I DOLNEGO ORDOWIKU OBSZARU WYNIESIENIA ŁEBY (NW POLSKA)

(Streszczenie)

Obszar, na którym przeprowadzono badania, znajduje się w północno-zachodniej Polsce i obejmuje swoim zasięgiem jednostkę tektoniczną nazwaną wyniesieniem Łeby. Stanowi ono zachodnie przedłużenie obniżenia nadbałtyckiego.

W pracy przedstawiono, po raz pierwszy dla tego obszaru Polski, rozprzestrzenienie konodontów w kilku profilach kambru górnego i dolnego ordowiku (fig. 1—2) oraz podano szczegółową charakterystykę biozon wraz z opisami paleontologicznymi prawie wszystkich znalezionych w tych profilach konodontów. Szczególną uwagę zwrócono na możliwości korelacyjne zon graptolitowych i konodontowych (tab. 1). Sugestie wypływające z przeprowadzonej analizy zebranego materiału konodontowego posłużyły dla odtworzenia rytmu sedymentacji, w szczególności w basenie dolnoordowickim.

W wyniku badań uzupełniono dotychczasową znajomość fauny górnego kambru i dolnego ordowiku Polski oraz wyjaśniono, przynajmniej dla omawianych w pracy profilów, następstwo stratygraficzne poszczególnych ogniw stratygraficznych górnego kambru i dolnego ordowiku. W profilu Białogóra *1* wydzielono iłowce dolnego tremadoku leżące zgodnie na iłowcach kambru górnego. Stwierdzono, że glaukonity rozpoczynające węglanowy cykl sedymentacyjny ordowiku utworzyły się głównie w Zonie *Prioniodus elegans* (*Didymograptus balticus*) arenigu, zarówno na obszarze Łeby jak i całego obniżenia nadbałtyckiego.

Wydzielone ze skał górnokambryjskich konodonty zostały opisane jako gatunki formalne, w związku z czym, zgodnie z propozycją Barnesa & Poplawskiego (1973), nazwy gatunkowe opatrzono skrótem s.f.=sensu formae. Konodonty ordowickie zgrupowano jako gatunki wieloelementowe posługując się definicjami opracowanymi głównie przez Lindströma (1971, 1973, 1977), Van Wamela (1974) i Löfgren (1978).

Z uwagi na wielokrotną redepozycję elementów konodontowych, opisane gatunki nie mogły być ilustrowane wszystkimi wchodzącymi w ich skład elementami. W wielu przypadkach uniemożliwił to ich niekompletny stan zachowania.

PLATE 1

1, 4 *Furnishina longibasis* sp.n.s.f.; *1* — basal cavity wiew; *2* — lateral view of same specimen of holotype; borehole Piaśnica *2*, depth 2684.0 m, *H. obesus* & *A. pisiformis* Zone.
2, 3, 5—9, 12 *Furnishina furnishi* Müller s.f.; *2*, *5* — lateral views of same specimen, Piaśnica *2*, 2684.0 m; *3* — lateral view; *9* — posterior wiew of same specimen; Białogóra *1*, 2706.1—2704.5m, *Orusia lenticularis* Zone; *6*, *8* — lateral views of same specimen, Dębki *2*, 2671.0—2661.8 m, *H. obesus* & *A. pisiformis* Zone; *7* — basal cavity view; *12* — lateral view of same specimen, Dębki *2*, 2671.0—2661.8 m, *H. obesus* & *A. pisiformis*.
10, 13 *Furnishina* sp.n. s.f.; *10* — posterior view; *13* — anterior view of same specimen, holotype, Piaśnica *2*, 2684.0 m, *H. obesus* & *A. pisiformis* Zone,
11, 14 *Proacodus obliquus* Müller s.f.; *11* — lateral view; *14* — basal cavity view of same specimen, Białogóra *1*, 2706.1—2704.5 m, *O. lenticularis* Zone.
15, 16 *Furnishina quadrata* Müller s.f.; *15* — basal cavity view; *16* — posterior view of some specimen, Piaśnica *2*, 2684.0 m, *H. obesus* & *A. pisiformis* Zone.
17 *Furnishina pomeranica* sp.n.s.f.; lateral view, Piaśnica *2*, 2684.0 m, *H. obesus* & *A. pisiformis* Zone

All specimens ×75

PLATE 2

1 *Westergaardodina bohlini* Müller s.f.; borehole Piaśnica *2*, depth 2679.0—2680.0 m, *O. lenticularis* Zone
2, 13 *Westergaardodina bicuspidata* Müller s.f.; *2* — Białogóra *1*, 2706.1—2704.5 m, *O. lenticularis* Zone
4 *Oneotodus* sp.n.s.f.; Piaśnica *2*, 2679.0—2780.0 m, *P. minor* Zone
5 *Westergaardodina tricuspidata* Müller s.f.; Dębki *2*, 2671.8—2661.8 m, *H. obesus* & *A. pisiformis* Zone
3, 11 *Westergaardodina muelleri* Nogami s.f.; *3* — Piaśnica *2*, 2684.0 m; *11* — another specimen, Piaśnica *2*, 2679.0—2680.0 m, *O. lenticularis* Zone
6 *Westergaardodina* sp.n.s.f.; Piaśnica *2*, 2680.0 m, *P. minor* Zone
7 *Muellerina oelandica* (Müller) s.f.; Dębki *2*, 2671.8—2661.8 m, posterior view, *H. obesus* & *A. pisiformis* Zone
8 *Muellerina cambrica* (Müller) s.f.; Piaśnica *2*, 2684.2 m, lateral view, *H. obesus* & *A. pisiformis* Zone
9 *Westergaardodina moessebergensis* Müller s.f.; Białogóra *1*, 2706.1—2704.5 m, *O. lenticularis* Zone
10 *Westergaardodina wimani* Szaniawski s.f.; Białogóra *1*, 2706.1—2704.5 m, *O. lenticularis* Zone
12 *Oneotodus* sp. *b* s.f.; Piaśnica *2*, 2684.0 m, lateral view, *H. obesus* & *A. pisiformis*

All specimens ×75

PLATE 3

1, 4, 8, 11, 13 *Hertzina elongata* Müller s.f.; *1*, *8* — lateral views of same specimen; *4*, 11 — lateral views of different specimens; borehole Piaśnica *2*, depth 2680.0 m, *P. minor* Zone; *13* — lateral view of another specimen; Białogóra *1*, 2705.1—2704.5 m, *O. lenticularis* Zone

2 *Gapparodus*(?) *bisulcatus* (Müller) s.f.; Piaśnica *2*, 2680.0 m, *P. minor* Zone
3 ,5, 6, 7 *Prooneotodus tenuis* (Müller) s.f.; *3*, 6, 7 — lateral views, *P. minor*, 2680.0 m, 5 — Dębki *2*, 2661.8 m, *H. obesus* & *A. pisiformis* Zone
9 *Oneotodus* cf. *erectus* Druce & Jones s.f.; Piaśnica *2*, 2680.0 m, *P. minor* Zone
10, 15, 16 *Prooneotodus gallatini* (Müller) s.f.; *10* — Piaśnica *2*, 2680.0 m, *O. lenticularis* Zone; *15* — Białogóra *1*, 2705.1—2704.5 m, *O. lenticularis* Zone; *16* — Piaśnica *2*, 2680.0 m., *P. minor* Zone
12 *Coelocerodontus* sp.s.f.; Piaśnica *2*, 2680.0 m, *P. minor* Zone
14 20, 21 *Furnishina furnishi* Müller s.f.; lateral views; *14*, *20* — Piaśnica *2*, 2680.0 m, *P. minor* Zone; *21* — Dębki *2*, 2661.8 m, *H. obesus* & *A. pisiformis* Zone
17—19, 22, 23 *Furnishina asymmetrica* Müller s.f.; *17* — lateral view, Białogóra *1*, 2706.1—2704.5 m; *18* — basal cavity view; *19* — antero-lateral view of same specimen, Białogóra *1*, 2706.1—2704,5 m, *O. lenticularis* Zone; *22* — basal cavity view; *23* — antero-lateral view of same specimen, Białogóra *1*, 2706.1—2704.5 m, *O. lenticularis* Zone

All specimens ×75

PLATE 4

1 *Acodus housensis* Miller; lateral view, borehole Piaśnica *2*, depth 2677.0—2677.8 m, *P. elegans* (*D. balticus*) Zone
2—4 *Prioniodus deltatus* Lindström; *2* — Prioniodontiform; *3* — oistodontiform; *4* — distacodontiform; Piaśnica *2*, *P. elegans* (D. balticus) Zone
5 *Drepanoistodus numarcuatus* (Lindström); Drepanodontiform, Białogóra *1*, 2700.6—2700.0 m, *P. proteus* (*T. phyllograptoides*) Zone
6, 11 *Drepanoistodus*? *inaequalis* (Pander); *6* — oistodontiform; *11* — drepanodontiform; Białogóra *1*, *P. proteus* Zone (redeposited)
7—8, 12 *Paroistodus amoenus* (Lindström); *7* — oistodontiform; *12* — drepanodontiform, Białogóra *1*, *P. proteus* zone (redeposited)
9 *Scolopodus*? *peselephantis* Lindström; symmetrical element, Białogóra *1*, *P. proteus* Zone (redeposited)
10 *Drepanoistodus acuminatus* (Pander); Distacodontiform, Białogóra *1*, *P. proteus* Zone (redeposited)
13—14 *Drepanoistodus basiovalis* (Sergeeva); *13* — drepanodontiform; *14* — oistodontiform, Piaśnica *2*, 2657.2—2647.9 m, Llanvirnian
15 *Scandodus tortilis* Müller s.f.; Piaśnica *2*, 2680.0 m, *P. minor* Zone
16 *Coelocerodontus* cf. *variabilis* Van Wamel sf.; Piaśnica *2*, 2677.0—2676.2 m, *P. elegans* (D. balticus) Zone (redeposited?)
17 *Protopanderodus rectus* (Lindström); Acontiodontiform, Dębki *3*, 2667.6—2660.0 m, Volkhovian
18 *Westergaardodina kleva* Müller s.f.; Piaśnica *2*, 2684.0 m, *O. lenticularis* Zone

All specimens ×50

PLATE 5

1, 6 *Prioniodus (Oepikodus) evae* (Lindström); *1* — oistodontiform, *6* — oepikodontiform, borehole, Dębki *2*, depth 2639.0—2633.0 m, Llanvirnian
2 *Gothodus* cf. *costulatus* Lindström; prioniodontiform, Piaśnica *2*, 2677.0—2676.2 m, *P. elegans (D. balticus)* Zone
3, 8—9, 11 *Paroistodus parallelus* (Pander); *3* — oistodontiform; *8* — drepanodontiform; *9* — oistodontiform; *11* — drepanodontiform; Piaśnica *2*, *P. elegans (D. balticus)* Zone
4—5 *Gothodus costulatus* Lindström; *4* — gothodontiform, *5* — oistodontiform; Piaśnica *2*, *P. elegants (D. balticus)* Zone
7, 17 *Drepanoistodus forceps* (Lindström); *7* — drepanodontiform=suberectiform, *17* — drepanodontiform; Piaśnica *2*, 2775.0—2674.0 m, *P. evae (Ph. densus)* Zone
10 *Stolodus stola* (Lindström); Dębki *2*, 2660.3—2658.5 m, *P. elegans (D. balticus)* Zone
12 *Paroistodus proteus* (Lindström); drepanodontiform, Piaśnica *2*, 2677.0—2676.2 m. *P. elegans (D. balticus)* Zone
14—16 *Drepanodus arcuatus* Pander; *14* — drepanodontiform=gracilisform; *15* — drepanodontiform=pipaform; *16* — drepanodontiform=arcuatiform; Piaśnica *2*, *P. elegans (D. balticus)* Zone
31 Oistodontiform of (?) *Periodon flabellum* (Lindström); Piaśnica *2*, 2775.0—2774.0 m, *P. evae (Ph. densus)* Zone

All specimens ×50

PLATE 6

1, 7—8 *Paroistodus originalis* (Sergeeva); *1* — oistodontiform; *7* — oistodontiform; *8* — drepanodontiform; borehole Dębki *2*, 2660.3 m, *P. elegans (D. balticus)* Zone (*1*×100, *7*×50, *8*×75)

2 *Cornuodus longibasis* (Lindström); drepanodontiform; Dębki *3*, 2667.0—2660.0 m, Volkhovian (×50)

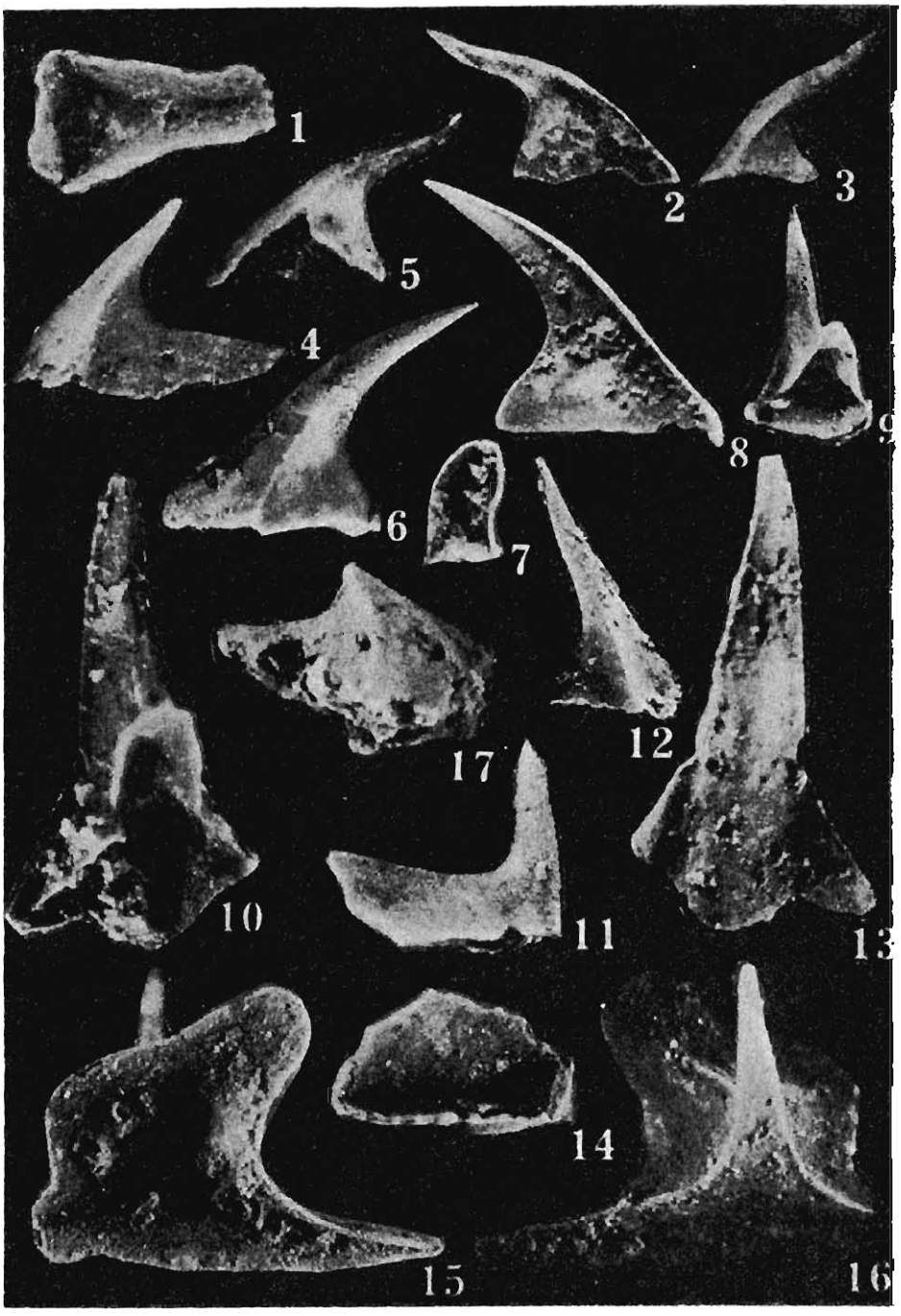
3 *Gothodus costulatus* Lindström; oistodontiform; Dębki *2*, 2660.3—2658.5 m, *P. elegans (D. balticus)* Zone (×100)

4, 10—11, 13 *Drepanodus arcuatus* Pander; *4* — drepanodontiform=sculponeaform; *10* — drepanodontiform=arcuatiform; *11* — oistodontiform=pigaform; *13* — drepanodontiform; Dębki *2*, 2660.3—2658.5 m, *P. elegans (D. balticus)* Zone (*4*×50, *10*×100, *11*×60, *13*×60)

5 Oistodontiform of (?) *Scandodus brevibasis* (Sergeeva); Dębki *3*, 2667.6—2660.0 m, Volkhovian (×60)

6, 9 *Drepanoistodus* (?) *subaequalis* (Pander); *6* — oistodontiform; *9* — drepanodontiform; Dębki *2*, 2660.3 m, *P. elegans (D. balticus)* Zone, redeposited? elements (*6*×100, *9*×100)

12 Drepanodontiform of (?) *Drepanoistodus forceps* (Lindström); Dębki *2*, 2660.3—2658.5 m, *P. elegans (D. balticus)* Zone (×75)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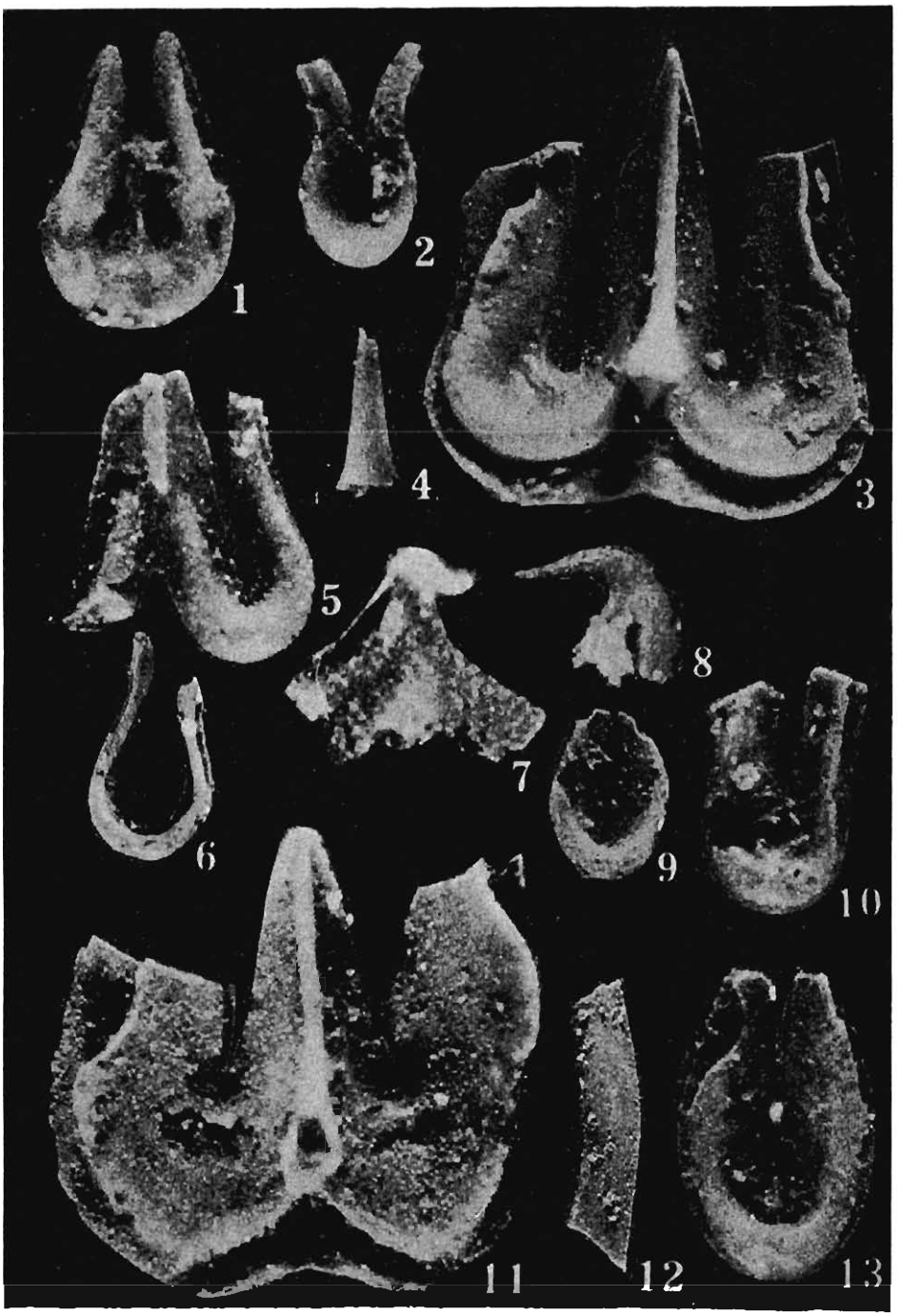
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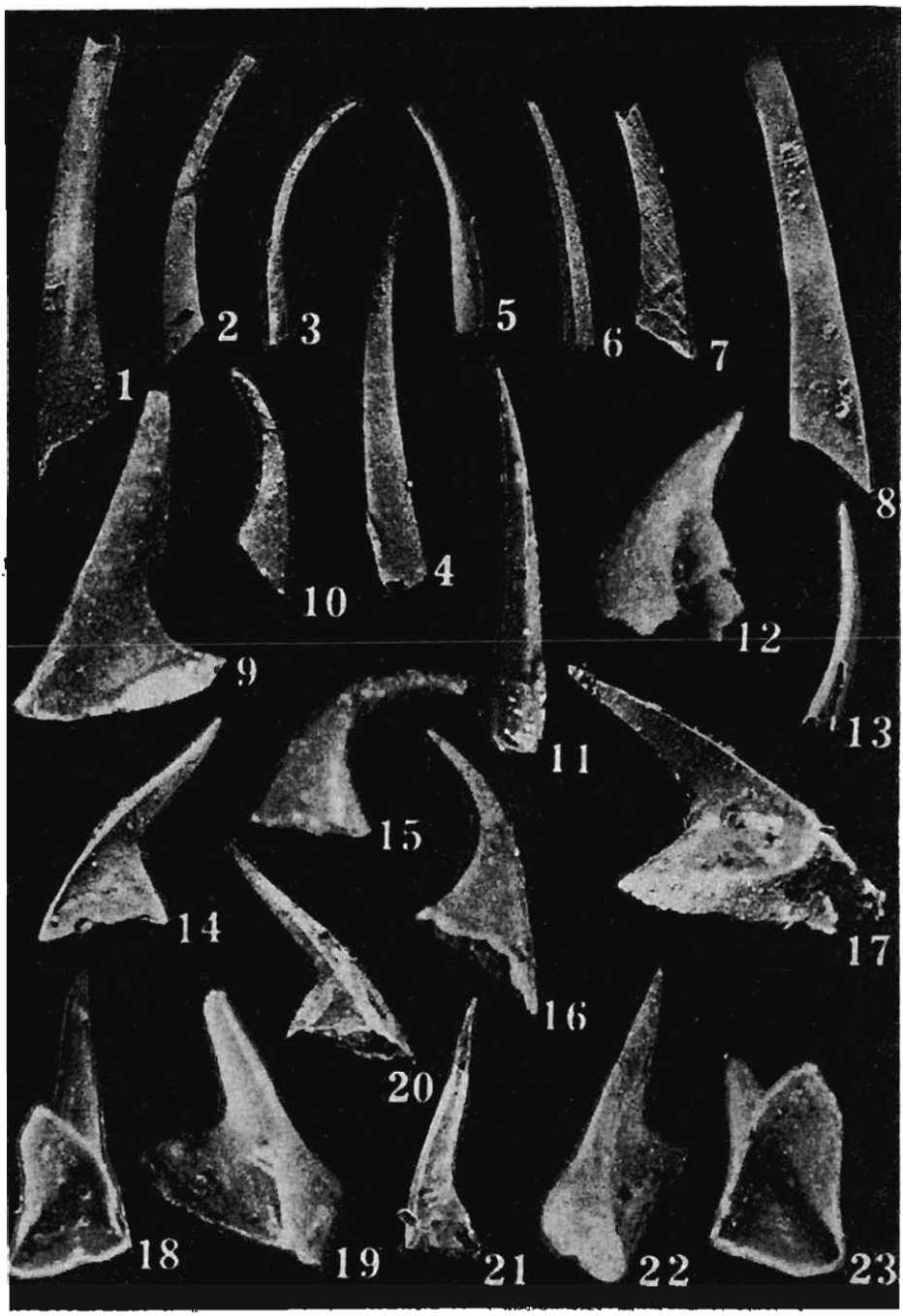
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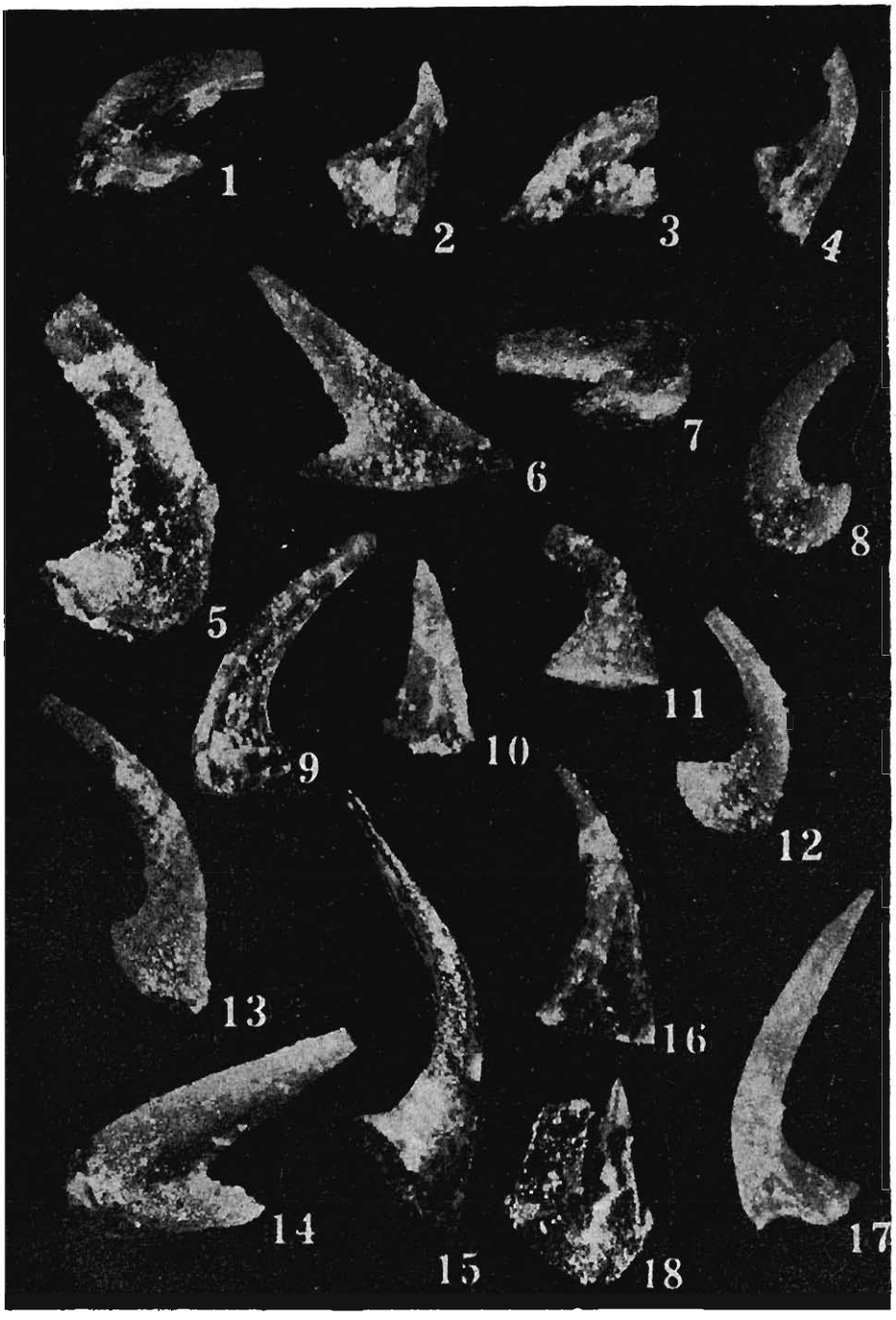
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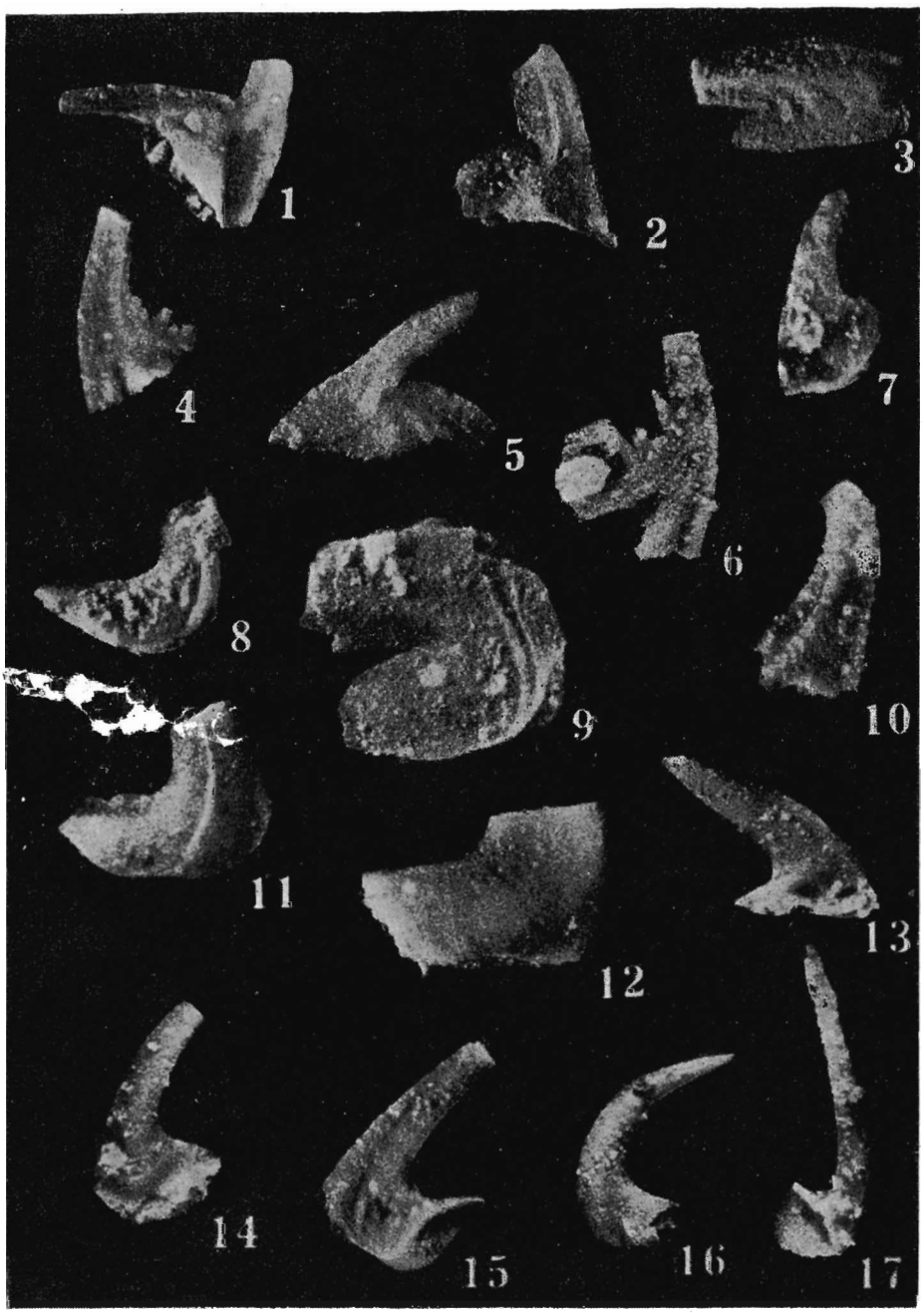
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