SVERIGES GEOLOGISKA UNDERSÖKNING

SER C NR 610 AVHANDLINGAR OCH UPPSATSER ÅRSBOK 60 NR 5

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LOWER VIRUAN (MIDDLE ORDOVICIAN) CONODONTS

FROM THE GULLHÖGEN QUARRY, SOUTHERN CENTRAL SWEDEN

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Redaktör: Per H. Lundegårdh

DAVIDSONS BOKTRYCKERI AB, VÄXJÖ 1966

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ABSTRACT

Lower Viruan (Middle Ordovician) conodont-elements from the Skövde and Vikarby Limestones of the Gullhögen quarry in the town of Skövde in South-central Sweden are described. 32 species are identified, 15 of these species being considered as new. The species are assigned to 14 previously described genera and one new genus, viz. *Cornuodus* n. gen. The boundary between the Skövde and the Vikarby Limestones of the Gullhögen quarry is defined by means of conodonts.

INTRODUCTION

For a couple of years I have been engaged in the study of conodont faunas extracted from Swedish Oealandian (Lower Ordovician) and Lower Viruan (Middle Ordovician) limestone deposits, the main purpose being the establishment of a range chart for Swedish Oelandian conodonts. During the preliminary investigation of the conodont faunas a condensed sequence (only 14 cm thick) of limestone in the Gullhögen quarry in Västergötland, central Sweden, was found to be exceedingly rich in conodonts. I thought it worth while to make this sequence the subject of a special purely faunistic study. When this special investigation was started, the particular limestone sequence in the Gullhögen quarry was supposed to belong to the *Platyurus* Limestone (Aseri Stage; Jaanusson in Thorslund & Jaanusson, 1960, p. 17). However, it soon became evident that the composition of the conodont fauna in the upper part of the sequence differed rather considerably from the type of fauna met with in the lower part of the sequence. Dr. Jaanusson *(in litt.* dated Aug. 16., 1963) kindly informed me that his subsequent studies of the Viruan of Kinnekulle and northern Billingen had shown that the upper part of the sequence should belong to the Lasnamägi Stage. Consequently, the scope of my studies was altered to include a comparison between the Aserian and Lasnamägian conodont faunas of the Gullhögen quarry.

This paper has been elaborated at the Department of Palaeontology, University of Lund. I am greatly indebted to its Director, Professor Gerhard Regnéll, who in every possible way has facilitated and stimulated my work. Dr. Maurits Lindström and Dr. Stig Bergström at the same Department have always shown great interest in my work and always been ready to give me helpful advice and criticism. I am also indebted to Dr. Valdar Jaanusson at the Institute of Palaeontology, Uppsala University, who has furnished me with unpublished informations about the Viruan in Västergötland. Without the generous help of these gentlemen it would have been impossible for me to complete this report. I also wish to acknowledge my gratitude to mr. K. A. Lindbergson, Director General of the Geological Survey of Sweden, and Dr. F. Brotzen and Dr. P. H. Lundegårdh, also at the Geological Survey, who have made the publication of this paper possible. Professor Otto Zdansky, Uppsala, has revised the English manuscript.

STRATIGRAPHY AND LITHOLOGY

General Remarks

In the present paper I have followed Jaanusson *(i. a.* 1960a, 1960b, 1960c, 1964) in using the Estonian chrono-stratigraphical terms for Swedish Middle Ordovician deposits. I have also adopted Jaanusson's (1964) topo-stratigraphical classification of the strata dealt with in this paper. The stratigraphical terms applied and their correlation with graptolite zones are summarized in Table 1.

TABLE 1. CORRELATION OF THE STRATIGRAPHIC UNITS REFERRED TO IN THE PRESENT PAPER. MAINLY AFTER JAANUSSON (1964, TABLE 1)

Gullnögen quarry	Graptolite zones	Baltoscandia		Great Britain
		stages	series	stages
Gullnögen Formation	Glyptograptus teretiusculus	Uhaku	Viru series	Llandeilo
	?	Lasnamägi		Llanvirn
Skövde Limestone	Didymograptus murchisoni			
Vikarby Limestone		Aseri		
Not yet subdivided	Didymograptus bifidus	Kunda	Oeland series	

The Vikarby Limestone (Jaanusson, 1963, p. 2) is the upper member of the Segerstad Formation (Jaanusson, 1960a) the lower member of which is called Kårgärde Limestone (Jaanusson, 1963, p. 2). These members were established [by Jaanusson (op. cit.)] in the Siljan district, Dalarna, North central Sweden. The Vikarby

Limestone corresponds to the zone of *Illaenus planifrons*, while the Kårgärde Limestone corresponds to the zone of *Angelinoceras latum*. Finds of fossils indicating the zone of *Illaenus planifrons* have been made in the Aserian deposits of the Gullhögen quarry (Jaanusson, 1964).

The Skövde Limestone (Jaanusson, 1964) corresponds to the upper part of the "Schroeteri" Limestone.

Gullhögen Quarry

The quarry of the Gullhögen cement factory (see Pl. 1) is situated in the town of Skövde in Västergötland, central Sweden. The quarry is very large and extensively worked. It provides a section through Upper Cambrian shales and Oelandian and Viruan limestones and mudstones. The topmost beds belong to the middle of the Ryd Formation (Jaanusson, 1964). The quarrying in Lower Viruan strata started in the beginning of the 1950'ies. At present this quarry provides the most extensive outcrop in Västergötland of Viruan strata.

The first description of a Viruan sequence from this quarry was published by Jaanusson (*in* Thorslund & Jaanusson, 1960, p. 17). It dealt in a preliminary way with the entire sequence of strata exposed in the quarry. The reddish-brown limestone between the discontinuity surface at the top of the Vikarby Limestone and the discontinuity surface *c.* 7 cm higher in the sequence (cf. text-fig. 1) was included in the *Platyurus* Limestone (Aseri Stage). However, subsequent finds of *Illaenus chiron* Holm (Jaanusson, 1964) in loose boulders with a lithology almost identical with that of the sequence in question prove that this part belongs to the Lasnamägi Stage.

Jaanusson (1964) records the following species from the Vikarby Limestone in the Gullhögen quarry:

Asaphus (Neoasaphus) platyurus Angelin

Conchoprimitia n. sp.

"Orthoceros" nilssoni (Boll) sp. coll.

Lituites (Lituites) cf. *törnquisti* Holm

Froms the Skövde Limestone in the Gullhögen quarry Jaanusson (1964) records the following species:

Illaenus chiron Holm

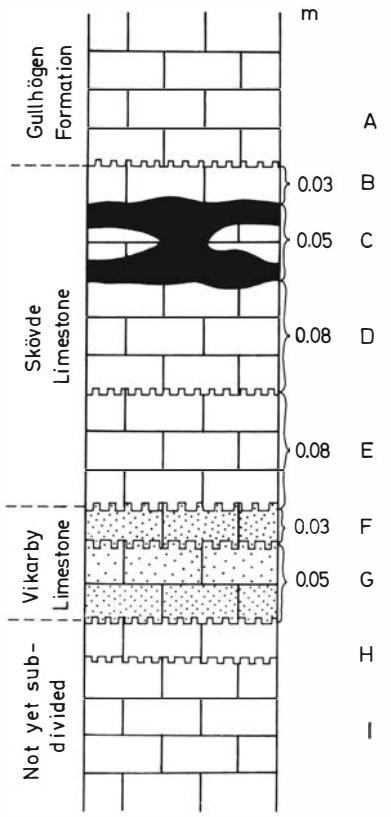
Nileus sp.

Conchoprimitia n. sp.

During the summer of 1962 the following section was measured in the northern wall of the quarry (see Pl. 1, figs. 1, 2).

Dr. Roy Stanfors has kindly evamined the ooids from a mineralogical point of view. The ooids consist of an outer layer of haematite and inner concentric layers of typically developed charmosite. Quite often the ooids have a quartz-grain for a nucleus.

Description of the section:



Gullhögen Formation

A. 0.10 + m. Grey limestone with intercalations of greyisch-green mudstone.
Smooth discontinuity surface.

Skövde Limestone

B. 0.03 m. Reddish-brown limestone.

C. 0.05 m. Grey mudstone, partly replaced by limestone.

D. 0.08 m. Limestone. Grey in the upper part and reddish-brown in the lower part.
Smooth discontinuity surface.

E. 0.08 m. Reddish-brown limestone.
Discontinuity surface.

Vikarby Limestone

F. 0.03 m. Oolitic reddish-brown limestone.
Deeply pitted discontinuity surface with a haematitic crust.

G. 0.05 m. Reddish-brown limestone, exceedingly rich in oids especially in the lower 3 centimetres.
Perfectly smooth discontinuity surface.

Kunda Stage

H. 0.02 m. Reddish-brown limestone.
Discontinuity surface.

I. 0.10 + m. Reddish-brown limestone.

Fig. 1. Section through the Lower Viruan and the topmost Oelandian beds at the Gullhögen quarry.

NOTES ON VIRUAN CONODONTS

Samples

Three samples were taken from the levels marked E, F, and G, respectively, in text-fig. 1. The sample from E weighed 227 g, that from F 219 g, and that from G 231 g. In addition two samples were taken from the levels marked A and H, respectively, in order to check the vertical distribution of the identified species. However, the conodonts extracted from these samples have not been included in the systematic description.

Historical Survey

The first description of Swedish Viruan conodonts was given by Hadding (1913) who described one new genus and 10 species from the Lower Dicellograptus Shale of Skåne. Nilsson (1952, p. 684) reports the occurrence of some of Hadding's

species in south-eastern Skåne. In 1955 Hadding's conodonts were revised by Lindström (1955b). Lamont & Lindström (1957) used Swedish material of Llandeilian age for their description of a new genus, viz. *Pygodus*. Bergström (1961) has described a conodont fauna from Tvären in south-eastern Södermanland. He recorded one new genus, 24 species, three subspecies, and one variety from erratic boulders of *Ludibundus* Limestone corresponding to the zone of *Nemagraptus gracilis* and part of the zone of *Diplograptus multidens*. The following authors have mentioned the presence of conodonts, but have not identified any genera or species: Thorslund (1940, pp. 114, 115) from Tvären; Hede (1951, Table 6, p. 75) from the Fågelsång district in Skåne; Lindström (1953, p. 131) from the Sularp Shale (according to Nilsson, 1960, p. 224, part of the zone of *Diplograptus multidens)* in the Fågelsång district; Nilsson (1953, p. 44) from the Middle Dicellograptus Shale in Skåne; Strachan (1959, p. 49) mentions conodonts from the *Ludibundus* Limestone in Jämtland and Tvären.

Affinities of the Conodonts

The identified conodont species are tabulated in Table 2.

All species identified by me as belonging to previously known genera have a stratigraphic range that is too wide to be useful for correlation. Z. Wolska (1961) has described Polish Lower Viruan conodonts encountered in erratic boulders. The following of Wolska's species appear also in the Vikarby and Skövde Limestones of the Gullhögen quarry: *Acontiodus rectus* (= *A. robustus), Drepanodus homocurvatus, Drepanodus suberectus, Oistodus forceps, Oistodus inclinatus, Panderodus gracilis,* and *Prioniodus* cf. *variabilis (?= Prioniodus prevariabilis* n. sp). According to Wolska (op. cit. p. 364), the age of the boulders from which these species were obtained could be anything from *Schroeteri* Limestone (= Lasnamägi Stage) to *Ludibundus* Limestone (= Kukruse Stage). However, since the transition from *Prioniodus prevariabilis* n. sp. to *Prioniodus variabilis* takes place somewhere in the middle of the Uhaku Stage (according to verbal communication by Dr. Bergström), Wolska's Viruan conodonts are probably not younger than topmost Uhaku. Wolska (op. cit.) also states (in Table 1) that *Oistodus inclinatus* occurs in Caradocian strata in Great Britain but to the best of my knowledge this species is not known from Great Britain.

S. P. Sergeeva (1962, 1963) has reported from the Leningrad district in the USSR the occurrence of some Oelandian and Lower Viruan conodont species which were previously known from Sweden, Great Britain, and North America. Unfortunately, Sergeeva has not supplied any figures of the species identified by her. Accordingly I have not found it feasible to include her unfigured species.

The only conodonts of a comparable age known so far from North America are those from the Joins Formation in Oklahoma described by Harris (1962) in

TABLE 2. NUMBER OF CONODONTS EXTRACTED FROM THE SKÖVDE AND VIKARBY LIMESTONES

GENERA ET SPECIES	VIKARBY Ls.	SKÖVDE Ls.	TOTAL
Acodus triangulatus n. sp.	8	6	14
A. viruensis n. sp.	5	—	5
Acontiodus arcuatus LINDSTRÖM	12	7	19
A. coniformis n. sp.	92	14	106
A. reclinatus LINDSTRÖM	1	—	1
A. robustus (HADDING)	547	63	610
A. sulcatus n. sp.	20	23	3
A. unciformis n. sp.	41	—	41
Ambalodus n. sp.	12	2	14
A. foliaceus n. sp.	3	—	3
A. reclinatus n. sp.	—	4	4
Cornuodus erectus n. gen. et sp.	7	13	20
Drepanodus arcuatus PANDER	17	2	19
D. homocurvatus LINDSTRÖM	48	12	60
D. sculponea LINDSTRÖM	5	—	5
D. suberectus BRANSON & MEHL	2	—	2
Oistodus forceps LINDSTRÖM	22	3	25
O. inclinatus BRANSON & MEHL	—	7	7
O. robustus BERGSTRÖM	28	8	36
Paltodus sulcatus n. sp.	—	3	3
Panderodus ethingtoni n. sp.	9	38	47
P. gracilis (BRANSON & MEHL)	3	5	8
Paracordylodus speciosus n. sp.	52	4	56
P. lindstroemi BERGSTRÖM	39	1	40
Phragmodus n. sp	1	—	1
Prioniodus alatus HADDING	10	20	30
P. prevariabilis n. sp.	37	13	50
Roundya inclinata (RHODES)	4	2	6
Scandodus formosus n. sp.	12	88	100
S. pipa LINDSTRÖM	9	2	11
Scolopodus? peselephanti LINDSTRÖM	1	6	7
Tetraprioniodus asymmetricus BERGSTRÖM	37	7	44
"Fibrous" conodonts	26	—	26
Total number of specimens	1072	391	1463

his preliminary paper. According to Ruedemann (1947) the Joins Formation belongs to the zone of *Didymograptus bifidus*. Out of a more extensive material Harris (1962) describes four genera and seven species. None of Harris's conodonts is identical with any form identified by me. Furthermore, Harris's conodonts seem to belong to a type of fauna which is rather different from the Skövde and Vikarby faunas. For instance Harris's new genera *Histiodella* and *Ptiloncodus* have no representatives among my material. Harris's new species *Oistodus multicorrugatus* which probably is no *Oistodus* but a new genus is a type of conodont not met with in the Skövde and Vikarby Limestones.

Stratigraphic significance of the condonts

The two faunas are noticeable dominated by distacodontid forms, especially the drepanodontids among which *Acontiodus* is the outstanding genus. Species of the genus *Acontiodus* make up *c.* 65 % of the total Vikarby fauna, but only *c.* 30 % of the Skövde fauna. The dominating *Acontiodus* species is *A. robustus* which makes up *c.* 50 % of the Vikarby fauna and *c.* 15 % of the Skövde fauna.

With regard to the conodonts the Vikarby and Skövde Limestones of the Gullhögen quarry can be separated faunistically from each other by the following criteria, viz. for the Vikarby Limestone:

(1) The strong predominance of the genus *Acontiodus* and especially *A. robustus.*
(2) The presence of *Acodus viruensis* n. sp., *Acontiodus unciformis* n. sp., and "fibrous" conodonts.
(3) The absence of features mentioned below as characteristic of the Skövde Limestone.

For the Skövde Limestone:

(1) The presence of *Ambalodus arcuatus* n. sp. and *Oistodus inclinatus.*
(2) The absence of genera such as *Pygodus* and *Haddingodus* which in Sweden characterize the Uhaku Stage.
(3) The absence of those features indicated to be characteristic of the Vikarby Limestone.

DESCRIPTION OF FOSSILS

Genus *Acodus* PANDER, 1956

LECTOGENEROTYPE. — *Acodus erectus* PANDER, 1856 (ULRICH & BASSLER, 1926)

Acodus triangulatus n. sp.

Pl. II, fig. 1. Text-fig. 2 C.

DERIVATION OF NAME. — From Latin *triangulum* = triangle. Referring to the triangular outline of the cross-section of the cusp.

HOLOTYPE. — LO 4097 T, pl. II, fig. 1.

DIAGNOSIS. — A smoothly curved *Acodus* with a moderately deep conical basal cavity and a strongly marked, almost median costa.

DESCRIPTION. — The base is indistinctly set off from the cusp.

The oral margin is sharp and faintly convex or straight.

The antero-basal angle is *c.* 90°, and so is the postero-basal angle. The basal cavity is moderately deep, conical, its apex being directed toward the anterior edge. The anterior margin of the cavity is typically concave.

The cusp is provided with sharp edges. The basal part of the anterior keel is slightly flexed laterally toward the non-costate face of the cusp. The lateral costa

of the cusp emerges imperceptibly at the aboral margin, but then becomes rapidly well defined and protruding. The costa runs almost medially along the lateral face of the cusp to the apex of the latter. As a result of the expended basal cavity the area between the costa and the posterior edge is convex at the base. Otherwise it is concave.

The area between the costa and the anterior edge is almost flat.

The non-costate lateral face of the cusp is evenly convex in outline.

REMARKS. — This species is closely related to *Scandodus formosus* n. sp. The only morphological difference between the two species is the existence of a lateral costa on *Acodus triangulatus* n. sp.

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 14 specimens.

Acodus viruensis n. sp.

Pl. II, figs. 2a, 2b. Text-fig. 2A.

DERIVATION OF NAME. — From the Viru Series in which the species occurs.

HOLOTYPE. — LO 4098 T, pl. II, figs. 2a, 2b.

DIAGNOSIS. — An *Acodus* with laterally compressed base and a strong, sharply keeled, erect, and sword-like cusp.

DESCRIPTION. — The base is rather distinctly set off from the cusp, and laterally compressed. The oral margin is straight and provided with a keel. The aboral margin is somewhat sinuous in outline. The antero-basal angle is *c.* 80°. The postero-basal angle is *c.* 60°, but varies rather considerably.

The basal cavity is fairly deep and triangular in outline. The margins of the cavity are straight or slightly concave. The apex of the cavity ends medially in the cusp. Since the exact variation of the depth of the basal cavity is not known, I have tentatively assigned one specimen with a shallow cavity to this species.

The cusp is erect or somewhat reclined, laterally flattened, keeled, and sword-like in appearance.

The lateral costa originates distinctly from the point, where the aboral margin flares; it then runs close to the posterior margin of the cusp, and continues to the apex of the cusp.

OCCURRENCE. — In the Vikarby Member of the sequence investigated.

MATERIAL. — 5 specimens.

Genus *Acontiodus* PANDER, 1856

LECTOGENEROTYPE. — *Acontiodus latus* PANDER, 1856 (ULRICH & BASSLER, 1926).

REMARKS. — Lindström (1955a, p. 547) redefined the genus *Acontiodus* as follows: "To the genus *Acontiodus* belong simple, more or less symmetrical conodonts with smooth lateral faces and a posterior keel to each side of which is a lateral costa".

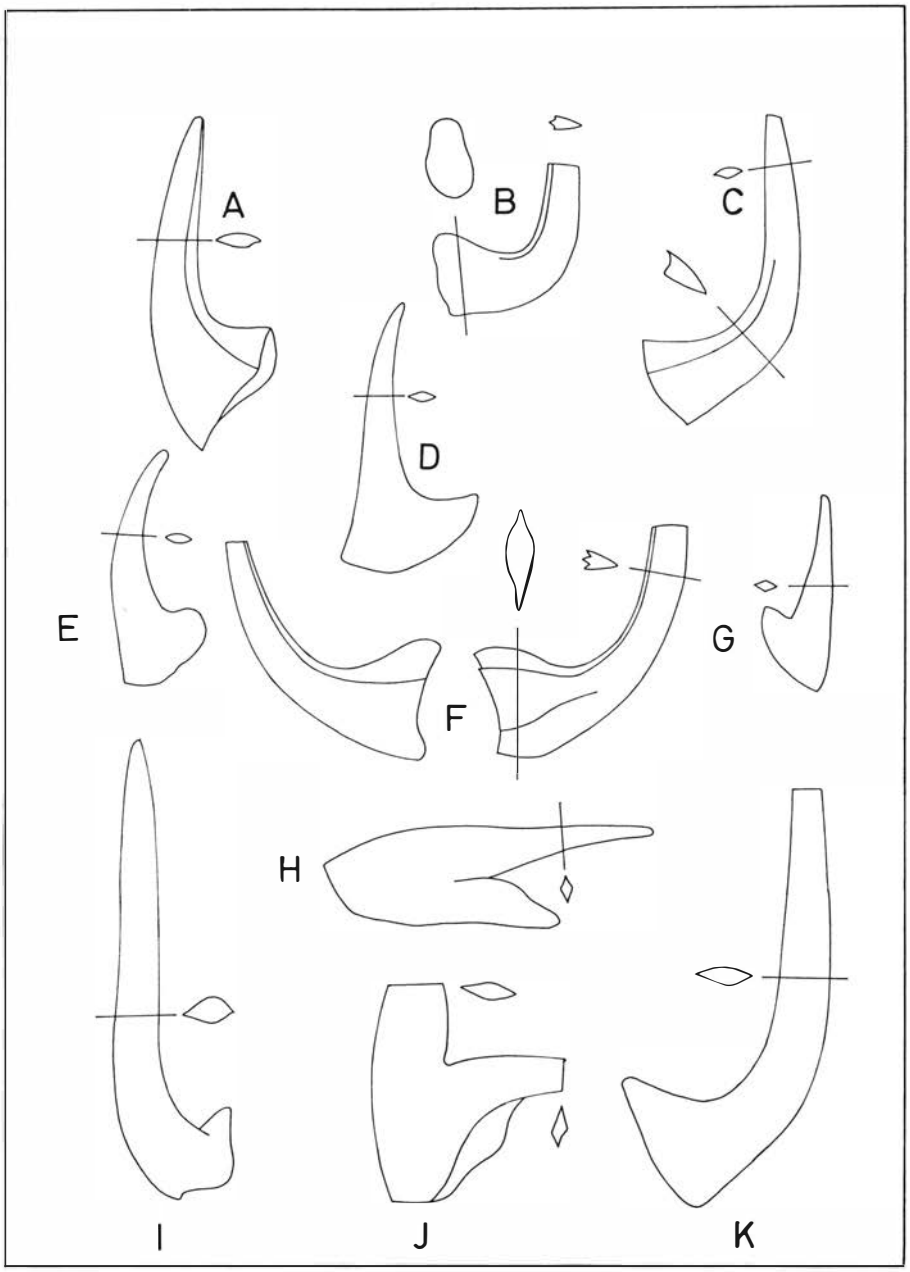


Fig. 2. Outlines and cross-sections of simple conodonts from the Vikarby and Skövde Limestone. A. *Acodus viruensis* n. sp.; B. *Cornuodus erectus* n. gen. et sp.; C. *Acodus triangulatus* n. sp.; D. *Drepanodus suberectus* (BRANSON & MEHL); E. *Drepanodus homocurvatus* LINDSTRÖM; F. *Acontiodus sulcatus* n. sp.; G. *Oistodus inclinatus* BRANSON & MEHL; H. *Oistodus forceps* LINDSTRÖM; I. *Scandodus pipa* LINDSTRÖM; J. *Oistodus robustus* BERGSTRÖM; K. *Scandodus formosus* n. sp.
Litt. I×30, other specimens ×75.

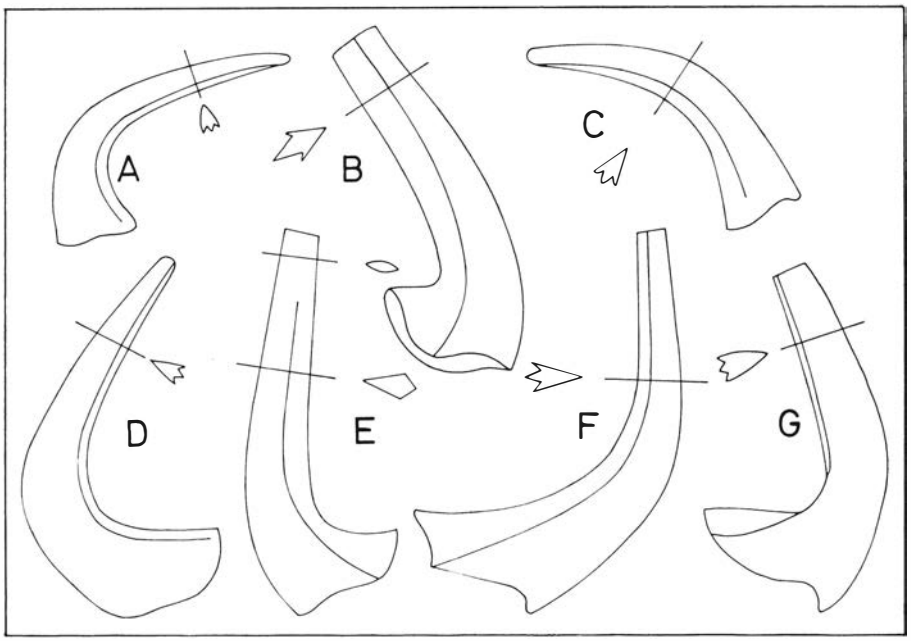


Fig. 3. Outlines and cross-sections of some *Acontiodus* species from the Vikarby and Skövde Limestone. A. *A. arcuatus* LINDSTRÖM: B. *A. unciformis* n. sp.; C. *A. coniformis* n. sp.; D. *A. reclinatus* LINDSTRÖM; E, F, G. *A. robustus* (HADDING).
All specimens ×75.

Ethington (1959, p. 268) proposed another definition for the genus *Acontiodus* stating that only antero-posteriorly compressed conodonts of the *Acontiodus*-type should remain within the genus. Laterally compressed conodonts of the *Acontiodus*-type should according to Ethington be referred to *Distacodus*. This suggestion has recently been discussed by Sweet & Bergström (1962, p. 1220) who conclude that the redefinition proposed by Lindström should be upheld. I fully agree with their discussion and conclusion. I, therefore, consider it unfortunate that Hass (1962) has sustained the redefinition proposed by Ethington.

Acontiodus arcuatus LINDSTRÖM, 1955

Pl. II, fig. 13. Text-fig. 3A.

1955 *Acontiodus arcuatus* — LINDSTRÖM, p. 547; Pl. 2, figs. 1—4.

The specimens referred by me to this species agree in almost every respect with the description given by Lindström (1955a, p. 547).

REMARKS. — The base of the specimens available to me is not as compressed as of those described and figured by Lindström. But I do not think that variation in compression of the base would justify the erection of a new species.

I have followed Lindström in assigning to *A. arcuatus* forms with a rather short base. It is, however, possible that they belong to a separate species, since no transitional forms between this and the normal type have been found. This question has to be settled on the basis of a more extensive fossil material. A few specimens with very faint costae have been noticed, probably representing transitional forms between *A. arcuatus* and *Drepanodus arcuatus*. These transitional forms have been referred to *A. arcuatus*.

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 19 specimens.

Acontiodus coniformis n. sp.

Pl. II, fig. 3. Text-fig. 3B.

? 1955 *Acontiodus* aff. *rectus* LINDSTRÖM — SANNEMANN, p. 23; Pl. 2, fig. 3.

DERIVATION OF NAME. — From Latin *conus* = cone, and *-formis* = "having the form of". Thus alluding to the conical shape of the base.

HOLOTYPE. — LO 4100 T, pl. II, fig. 3.

DIAGNOSIS. — An *Acontiodus* with a more or less compressed long and conical base provided with a deep conical basal cavity.

DESCRIPTION. — The base is rather long and conically shaped. Usually the base is more or less compressed laterally, but a few specimens with an almost circular cross-section of the base have been referred to this species. The base continues into the cusp by a very smooth curvature. The angle between the base and the cusp varies between 100° and 130°, the variation thus being rather considerable. The oral margin is rounded and provided with an edge. The aboral margin is almost straight.

The basal cavity is deep and conical with its apex almost reaching the anterior edge of the cusp.

The cusp is proclined or almost erect, comparatively long, and provided with faint edges.

The postero-lateral costae are more or less pronounced but always distinct. They run from the apex of the cusp to the aboral margin of the base. There are a number of specimens in which the costae barely reach the aboral margin. This feature has not been regarded as a specific criterium. The area between the costa and the anterior margin is usually flat, but may occasionally be concave.

REMARKS. — Morphologically this species is closely related to *Acontiodus rectus*, but clearly separated by its long base and deep conical basal cavity.

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 106 specimens.

Acontiodus reclinatus LINDSTRÖM, 1955

Pl. II, fig. 4. Text-fig. 3D.

1955 *Acontiodus reclinatus* — LINDSTRÖM, p. 548; Pl. 2, figs. 5, 6.

The single specimen encountered agrees in all respects with the description given by Lindström (1955a, p. 548).

OCCURRENCE. — In the Vikarby Member of the section investigated.

MATERIAL. — 1 specimen.

Acontiodus robustus (HADDING, 1913)

Pl. II, figs. 5a, 5b. Text-figs. 3E, F, G.

1913 *Drepanodus robustus* — HADDING, p. 31; Pl. 1, fig. 5.
1955 *Acontiodus rectus* — LINDSTRÖM 1955a, p. 549; Pl. 2, figs. 7—11.
1955 *Acontiodus robustus* (HADDING) — LINDSTRÖM 1955b, p. 108; Pl. 22, figs. 1, 2, 4, 6.
1960 *Acontiodus rectus* LINDSTRÖM — LINDSTRÖM, Figs. 2:8, 3:7, 6:10, 8:8.
1961 *Acontiodus rectus* LINDSTRÖM — Z. WOLSKA, p. 345; Pl. 1, figs. 1, 2.
?1962 *Acontiodus cooperi* — SWEET & BERGSTRÖM, p. 1221; Pl. 168, figs. 2, 3.
1962 *Acontiodus robustus* (HADDING) — SWEET & BERGSTRÖM, p. 1222; Pl. 169, fig. 11.

All the specimens referred to this species agree in every respect with the redescription of the species given by Lindström (1955b, p. 108).

REMARKS. — On examining the holotype of *A. robustus* (HADDING), that of *A. rectus* LINDSTRÖM, and an extensive material of this type collected by myself, I have arrived at the conclusion that *A. rectus* is a junior subjective synonym of *A. robustus*. *A. robustus* is a very variable species, but the form represented by the holotype is a numerically predominating form. *A. robustus* falls clearly within Lindström's description of *A. rectus*.

I am not quite convinced that *Acontiodus cooperi* SWEET & BERGSTRÖM represents a species. It may rather be a junior subjective synonym of *A. robustus*. The variation of the aboral margin of *A. robustus* is rather great. It is possible to arrange the material into a gradational series leading from specimens with an almost straight aboral margin over specimens with a pronounced undulation of the aboral margin to specimens with a more or less conspicuous antero-basal "hook". The "hook" is typical of *A. cooperi*. By courtesy of Dr. Stig Bergström I have had an opportunity to compare topotypes of *A. cooperi* with my "hooked" specimens of *A. robustus*. The two forms seem to be conspecific. In the Pratt Ferry Fm., Alabama, *A. cooperi* and *A. robustus* occur together (Sweet & Bergström, 1962), but according to Sweet & Bergström no transitional forms are to be found. However, I refrain from declaring *A. cooperi* a junior subjective synonym of *A. robustus*, since in deposits younger than those investigated by me (i. a. in the Pratt Ferry Fm.) forms belonging to the complex now under discussion may be referable to distinct species.

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 610 specimens. (C. 250 specimens are provided with the "hook" typical of *A. cooperi*.)

Acontiodus sulcatus n. sp.

Pl. II, figs. 6a, 6b. Text-fig. 2F.

DERIVATION OF NAME. — From Latin *sulcus* = groove. The species is provided with a groove on the inner face of the base.

HOLOTYPE. — LO 4104 T, Pl. II, figs. 6a, 6b.

DIAGNOSIS. — An *Acontiodus* with laterally flattened base, a fairly shallow triangular basal cavity, and a long, erect, and edged cusp.

DESCRIPTION. — The base is flattened laterally and provided with strong anterior and posterior keels. The oral margin is convex. The aboral margin is concave.

The basal cavity is moderately deep and triangular in outline with straight, equally long anterior and posterior margins.

The cusp is long and erect and provided with anterior and posterior edges. The postero-lateral costae start on the aboral margin about one quarter of the length of the aboral margin from the postero-basal corner. On the inner face of the base the costa is developed as a rounded ridge. On the same face there is a broad groove. This groove takes its origin just above the aboral margin at a point about one third of the distance between the two basal corners from the anterior edge, and runs upwards to the point of the strongest curvature of the cusp, where it disappears.

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 43 specimens.

Acontiodus unciformis n. sp.

Pl. II, figs. 7a, 7b. Text-fig. 3B.

DERIVATION OF NAME. — From Latin *uncus* = hook and *-formis* = "having the form of". Thus alluding to the hook-like outline of the species.

HOLOTYPE. — LO 4105 T, Pl. II, figs, 7a, 7b.

DIAGNOSIS. — An *Acontiodus* with a strongly reclined and twisted cusp and a rather shallow basal cavity.

DESCRIPTION. — The basal cavity is rather shallow, triangular in outline, its apex being bent toward the anterior margin of the cusp. In some specimens the basal cavity is inverted.

The oral margin is evenly rounded.

The cusp is long, strongly reclined, fairly stout, and twisted in relation to its base.

The postero-lateral costa in the face of the cusp twisted toward the opening of the basal cavity is initially well defined, but on ascending along the cusp it migrates toward the middle of the lateral face. At the same time it becomes less prominent, and at two thirds of the height of the cusp it almost has the appearance of a carina. The other postero-lateral costa is very prominent. It runs rather close to the posterior edge of the cusp from the aboral margin of the base to the apex of the cusp.

OCCURRENCE. — Only in the Vikarby Member of the section investigated.

MATERIAL. — 41 specimens.

Genus *Ambalodus* Branson & Mehl, 1933

Generotype. — *Ambalodus triangularis* Branson & Mehl, 1933.

Ambalodus n. sp.

Pl. IV, figs. 1a, 1b.

Description. — The basal cavity is shallow and continues as slits or grooves along the aboral faces of the processes.

The platforms are conspicuous but narrow. In some specimens the platforms are very narrow in the distal part of the anterior process, where the inner platform may be developed as a ledge and outer platform entirely missing.

The cusp is suberect and short usually only a little longer than the longest denticles, and laterally compressed.

The anterior process is much longer than the other processes. It is concave close to the cusp but otherwise convex. The orally placed denticles are fused, laterally compressed, and have pointed apices. Three or four denticles next to the cusp are small and indistinct. Close to the cusp the row of denticles bends sharply inward.

The anterior process meets the posterior process at an angle or a smooth curve. The angle between the two processes varies around 120°.

The length of the posterior process is a little more than half the length of the anterior process. The oral face of the posterior process is as a rule smoothly concave except for the pointed end of the process which is bent downward. The inner platform is broader than the outer platform, and has a convex margin. Five or six denticles next to the cusp are small and indistinct. The development of the other denticles resembles that on the anterior process.

The lateral process is bent strongly downward and provided with six or seven distinct, fused and laterally slightly compressed denticles.

Occurrence. — Throughout the sequence investigated.

Material. — 14 specimens.

See addendum, p. 32.

Ambalodus foliaceus n. sp.

Pl. IV, fig. 2.

Derivation of Name. — From Latin *folium* = leaf. This species has the appearance of a leaf.

holotype. — LO 4107 T, Pl. IV, fig. 2.

Diagnosis. — An *Ambalodus* having a suberect cusp, a slender anterior process which is smoothly curved inward, a posterior process that is short and strongly curved downward, and a rather short lateral process that is directed forward.

Description. — The basal cavity is very shallow and continues as slits or grooves to the ends of the processes.

The cusp is suberect with rounded lateral faces, and is provided with triangle-shaped anterior and posterior keels.

The anterior process is long and slender, and smoothly curved inwards. Its end is pointed, and in side-view the oral face is concave. The process as a whole is bent slightly downwards and somewhat twisted outwards. The platforms of the anterior process are narrow with their margins bent upward. The inner platform is much wider than the outer. Orally the anterior process carries a row of denticles. Two or three denticles next to the cusp are fused and indistinct. The other denticles, usually six in number, are widely separated, of uniform size and outline, have rounded lateral faces, and are faintly edged. Some very small, but distinct and discrete denticles may occur between the ordinary denticles. The length of the posterior process is only one third of the length of the anterior process. It is laterally compressed, and the platforms are represented by ledges. Close to the cusp the process is bent strongly downward and forward, further away it is bent strongly backwards. Ultimately it becomes straight or slightly concave in side-view. In place of denticles it carries a ridge. The outer lateral process is roughly half as long as the anterior process, and is directed forward. Its platforms are well developed and of equal size and shape. The lateral process carries a row of discrete denticles with rounded lateral faces and very faint edges. The number of denticles is usually four or five.

OCCURRENCE. — Only found in the Vikarby Member of the section investigated.

MATERIAL. — 3 specimens.

Ambalodus reclinatus n. sp.

Pl. IV, figs. 3a, 3b.

DERIVATION OF NAME. — The cusp is strongly reclined.

HOLOTYPE. — LO 4108 T, Pl. IV, figs. 3a, 3b.

DIAGNOSIS. — An *Ambalodus* with typical platforms, with a stout and strongly reclined cusp, and with the anterior process longest and most prominent among the three processes.

DESCRIPTION. — The basal cavity is shallow and continues as slits or grooves along the aboral faces of the processes.

The platforms are typical and well developed. They taper in a distal direction, thus giving the processes a more or less pointed end. The cusp is strongly reclined, stout with convex lateral faces, and faintly edged.

The anterior process is long and prominent. It is smoothly curved inwards. The inner platform of the process is slightly broader than the outer. Orally the process carries a row of denticles. The denticles are biggest next to the cusp, whereupon they gradually diminish in size with the exception of the last but one denticle which is again comparatively big. The denticles are fused, have pointed apices, are slightly compressed laterally, and inclined towards the cusp. The convex margin of the inner and the outer platform produces a leaf-like appearance of the posterior

process which is smaller than the anterior one. There are usually six denticles on the oral face of the posterior process. The denticles are biggest next to the cusp, then slightly smaller but for the last denticle which is again prominent. The latter is almost discrete in contrast to the others which are fused. The denticles are only slightly compressed laterally. The lateral process is of about the same length as the posterior process. Next to the cusp it carries three or four distinct but fused denticles. Further distally the denticles rapidly become smaller and indistinct; most distally the denticles are represented by a small ridge. The ridge and the row of denticles are gently bent outward.

All processes are bent downward, thus giving the conodont a pointed appearance.
OCCURRENCE. — In the Skövde Limestone of the section investigated.
MATERIAL. — 4 specimens.

Genus *Cornuodus* n.gen.

DERIVATION OF NAME. — From Latin *cornu* = horn. The name alludes to the general resemblance to a cow-horn, of conodonts referred to this genus.
GENEROTYPE. — *Cornuodus erectus* n. sp.
DEFINITION. — To this genus belong simple symmetrical or asymmetrical conodonts lacking edges or costae on a comparatively long base.
REMARKS. — This genus morphologically is close to *Paltodus* PANDER, 1856 and *Panderodus* ETHINGTON, 1959, but, in my opinion, the absence of costae and edges on the base justifies the erection of a new genus.

Cornuodus erectus n. sp.
Pl. II, figs. 8a, 8b. Text-fig. 2B.

DERIVATION OF NAME. — The cusp of this species is erect.
HOLOTYPE. — LO 4109 T, Pl. II, fig. 8a.
DIAGNOSIS. — A *Cornuodus* with a deep basal cavity and an erect cusp which is provided with faint edges and faintly developed posterior costae.
DESCRIPTION. — The base is conical in outline with convex lateral faces and rounded margins. The oral margin is straight or somewhat concave in side-view. The aboral margin is convex.

The basal cavity is deep and conical with its apex in the mid-line of the cusp.

The cusp is strong, erect, and provided with faint anterior and posterior edges. On the lateral faces of the cusp there is a costa close to the posterior edge. In some specimens the costae are very faint or may even by wanting.

The lateral faces of the cusp are rounded.
OCCURRENCE. — Throughout the sequence investigated.
MATERIAL. — 20 specimens.

Genus *Drepanodus* PANDER, 1856

LECTOGENEROTYPE. — *Drepanadus arcuatus* PANDER, 1856 (S. A. MILLER, 1889)
REMARKS. — Several of Hass's (1962) recent definitions of Pander's genera are incomplete and sometimes even misleading. Hass (op. cit.) defines the genus *Drepanodus* as follows: "Almost bilaterally symmetrical; outline biconvex to subcircular in horizontal section; anterior and posterior sides rounded or sharp-edged". Since in his definition Hass says nothing about the angle or the degree of curvature of the junction between the cusp and the base, the genus *Oistodus* is included in *Drepanodus* as understood by him. Thus Hass actually reintroduced the confusion that had existed in regard to the definitions of the two genera before they were redefined by Lindström (1955a). Lindström's redefinitions have been followed by most subsequent writers (i. a. A. T. Glenister, 1957, W. C. Sweet et al., 1959, R. H. Ethington, 1959, S. M. Bergström, 1961). It would be fortunate if they be generally accepted. Lindström's (1955a, p. 558) interpretation of the genus *Drepanodus* is as follows: To *Drepanodus* belong simple "symmetrical or sub-symmetrical species with smooth lateral faces, sharp anterior and posterior edges, and the posterior edge of the cusp meeting the oral margin in a curve". I have quoted Lindström's (1955a, p. 573) redefinition of *Oistodus* below that genus.

Drepanodus arcuatus PANDER, 1856
Pl. III, fig. 15.

1856 *Drepanodus arcuatus* — PANDER, p. 20; Pl. 1, figs. 4, 5, 17, (not figs. 2, 30, 31).
1955 *Prepanodus arcuatus* PANDER — LINDSTRÖM, p. 558; Pl. 2, figs. 30—33.
1955 *Drepanodus* cf. *arcuatus* PANDER — LINDSTRÖM, p. 560; Pl. 2, figs. 45, 46.
non 1955 *Drepanodus arcuatus* PANDER — RHODES, p. 126; Pl. 10, fig. 24.

For further synonyms, see Lindström (1955a) and Rhodes (1955).

My specimens agree in every respect with the redescription of the species given by Lindström (1955a, p. 558).

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 19 specimens.

Drepanodus homocurvatus LINDSTRÖM, 1955
Pl. II, figs. 11a, 11b. Text-fig. 2E.

1933 *Oistodus curvatus* — BRANSON & MEHL, p. 110; Pl. 9, figs. 4, 10, 12.
1935 *Oistodus curvatus* BRANSON & MEHL — STAUFFER 1935a, p. 146; Pl. 12, figs. 20, 23, 24, 27, 29, 30, 36.
1935 *Oistodus curvatus* BRANSON & MEHL — STAUFFER 1935b, p. 609; Pl. 74, figs. 5, 10, 12, 17, 20—23, 25—29, 31, 33—40, 47—49.
1941 *Oistodus curvatus* BRANSON & MEHL — GRAVES & ELLISON, Pl. 3, fig. 17.
1951 *Oistodus curvatus* BRANSON & MEHL — BRANSON, MEHL & BRANSON, p. 9; Pl. 2, figs. 7—10.

1953 *Oistodus curvatus* BRANSON & MEHL — RHODES, p. 295, Pl. 21, figs. 82, 83, 89, 90; non Pl. 22, figs. 157—161.
1955 *Oistodus curvatus* BRANSON & MEHL — SWEET, p. 251; Pl. 28, fig. 7.
1955 *Drepanodus homocurvatus* — LINDSTRÖM, p. 563; Pl. 2, figs. 23, 24, 39.
1955 *Drepanodus amoenus* — LINDSTRÖM, p. 558; Pl. 2, figs. 25, 26.
1955 *Drepanodus planus* — LINDSTRÖM, p. 565; Pl. 2, figs. 35—37.
?1955 *Drepanodus homocurvatus* LINDSTRÖM — SANNEMANN, p. 26; Pl. 1, fig. 14; Pl. 2, fig. 4.
1957 *Drepanodus homocurvatus* LINDSTRÖM — GLENISTER, p. 725, pl. 86, fig. 13; Pl. 87, figs. 1—6, 8.
1959 *Drepanodus homocurvatus* LINDSTRÖM — STONE & FURNISH, p. 222; Pl. 31, fig. 8.
1959 *Drepanodus homocurvatus* LINDSTRÖM — ETHINGTON, p. 276; Pl. 39, fig. 16.
1959 *Drepanodus homocurvatus* LINDSTRÖM — SWEET, TURCO, WARNER & WILKIE, p. 1049; Pl. 130, fig. 7.
1960 *Drepanodus homocurvatus* LINDSTRÖM — PULSE & SWEET, p. 252; Pl. 35, figs. 4, 13.
1961 *Drepanodus homocurvatus* LINDSTRÖM — BERGSTRÖM, p. 39; Pl. 2, figs. 13, 14; Pl. 5, fig. 19.
1961 *Drepanodus homocurvatus* LINDSTRÖM — Z. WOLSKA, p. 348; Pl. 2, figs. 7a, 7b.
1962 *Drepanodus homocurvatus* LINDSTRÖM — SWEET & BERGSTRÖM, p. 1226; Pl. 169, fig. 9.

The specimens referred to this species agree with Branson & Mehl's original description and Lindström's subsequent description.

REMARKS. — I have had the opportunity to examine the type species of the drepanoid conodont species distinguished and described by Lindström (1955a) together with a rather extensive collection of my own of drepanoids of Oelandian and Lower Viruan age.

In addition, a collection of excellently preserved *D. homocurvatus* from the Cynthiana Limestone, Kentucky, has been available by courtesy of Dr. Stig Bergström. The specimens thus assembled have been examined with special regard to the outline and depth of the basal cavity and the curvature of the cusp. These features turned out to be much more variable than anticipated by Lindström. Consequently it is impossible to maintain *D. amoenus*, *D. homocurvatus*, and *D. planus* as three separate species, since the main distinguishing criteria are the features just mentioned. Consequently the names mentioned are subjective synonyms. I have preferred to sustain the name *D. homocurvatus*, since it is in common use.

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — More than 60 specimens.

Drepanodus sculponea LINDSTRÖM, 1955

Pl. II, fig. 9.

1955 *Drepanodus sculponea* — LINDSTRÖM, p. 567; Pl. 2, fig. 40.

My specimens agree in all respects with Lindström's description.

OCCURRENCE. — In the Vikarby Member of the section investigated.

MATERIAL. — 5 specimens.

Drepanodus suberectus (BRANSON & MEHL, 1933)

Pl. II, fig. 10. Text-fig. 2D.

1933 *Oistodus suberectus* — BRANSON & MEHL, p. 111; Pl. 9, fig. 7.
1955 *Dredanodus suberectus* (BRANSON & MEHL) — LINDSTRÖM, p. 568; Pl. 2, figs. 21, 22.
1960 *Drepanodus suberectus* (BRANSON & MEHL) — PULSE & SWEET, p. 253; Pl. 35, figs. 2, 7.
1962 *Drepanodus suberectus* (BRANSON & MEHL) — SWEET & BERGSTRÖM, p. 1226; Pl. 169, fig. 8.

For further synonyms, see Sweet & Bergström (1962).

The two specimens found agree in every respect with Branson & Mehl's description.

OCCURRENCE. — In the Vikarby Member of the sequence investigated.

MATERIAL. — 2 specimens.

Genus *Oistodus* PANDER, 1856

LECTOGENEROTYPE. — *Oistodus lanceolatus* PANDER, 1856 (ULRICH & BASSLER, 1926)

REMARKS. — Hass (1962, p. W 44) defines *Oistodus* as follows: "Like *Distacodus* but with base greatly expanded posteriorly". Unfortunately this definition is just as incomplete as it is misleading, if compared with the current interpretation of the genus *Oistodus* (cf. i. a. Glenister, 1957, p. 725; Sweet et al. 1959, p. 1052; Ethington, 1959, p. 281; Bergström, 1961, p. 44; Sweet & Bergström, 1962, p. 1231). The definition accepted by these authors was originally proposed by Lindström (1955a, p. 573): "To *Oistodus* belong simple conodonts with a more or less wide basal cavity. The posterior edge makes a sharp angle with the oral edge. As a rule, either or both of the lateral faces are carinate". In the foregoing I have (p. 14 and p. 21) discussed Hass's (1962) rejection of Lindström's definitions of the two genera *Acontiodus* and *Drepanodus*, and almost the same arguments could be aduced in this case as well.

Oistodus forceps LINDSTRÖM, 1955

Pl. III, figs. 1a, 1b, 1c. Text-fig. 2H.

1955 *Oistodus forceps* — LINDSTRÖM, p. 574; Pl. 4, figs. 32, 33.
1961 *Oistodus forceps* LINDSTRÖM, — Z. WOLSKA, p. 351; Pl. 3, figs. 5, 6.

My specimens agree in every respect with Lindström's description of the species.

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 17 specimens.

Oistodus inclinatus BRANSON & MEHL, 1933

Pl. III, fig. 3. Text-fig. 2G.

1933 *Oistodus inclinatus* — BRANSON & MEHL, p. 110; Pl. 9, fig. 8.
1951 *Oistodus inclinatus* BRANSON & MEHL — BRANSON, MEHL & BRANSON, p. 3; Pl. 2, figs. 5, 6.
1957 *Oistodus inclinatus* BRANSON & MEHL — GLENISTER, p. 726; Pl. 86, fig. 11.
1959 *Oistodus inclinatus* BRANSON & MEHL — STONE & FURNISH, p. 224; Pl. 31, fig. 6.
1959 *Oistodus inclinatus* BRANSON & MEHL— SWEET, TURCO, WARNER & WILKIE, p. 1053; Pl. 131, fig. 6.
1960 *Oistodus inclinatus* BRANSON & MEHL — PULSE & SWEET, p. 255; Pl. 35, figs. 10, 12.
1961 *Oistodus inclinatus* BRANSON & MEHL — Z. WOLSKA, p. 351; Pl. 3, figs. 2a, 2b.

For further synonyms, see Fay (1952, art. 3, p. 135).

The specimens encountered by me agree in every respect with Branson & Mehl's description.

OCCURRENCE. — In the Skövde Limestone of the section investigated.

MATERIAL. — 7 specimens.

Oistodus robustus BERGSTRÖM, 1961

Pl. III, figs. 3a, 3b, 3c, 3d. Text-fig. 2J.

1961 *Oistodus robustus* — BERGSTRÖM, p. 45; Pl. 3, figs. 7—10.

Most of the specimens assigned by me to this species conform in all respects to Bergström's description.

REMARKS. — This species is obviously more variable than anticipated by Bergström. In his description Bergström stresses the following features as being typical for the species: — the cusp being short and lacking carinae or costae, and the flare of the inner basal margin. However, all of these features are liable to variation. There are specimens with a rather long cusp, specimens with carinate base, and specimens with a more or less pronounced downwardly directed anterior extension of the cusp. Especially the flare on the basal margin is very variable, ranging from a flare represented by a smooth curve with slight convexity, through a prominent bulge to an almost process-like lateral extension. It is possible that the last-mentioned form should be referred to *Gothodus* LINDSTRÖM, 1955.

After examining the holotype and the figured typoid of *O. robustus* (cf. Bergström, 1961, Pl. 3, figs. 7—10) together with some specimens of my own I was inclined to place *O. robustus* in *Falodus* LINDSTRÖM, 1955, since traces of denticles and true denticles could be observed on the anterior extension of the cusp. But a careful re-examination of the specimens from the Gullhögen quarry together with a collection of Viruan *O. robustus* from Dalarna in north-central Sweden revealed that the denticulation on the anterior extension is an aberrant feature. As such it is unstable and should not be used for the distinction of genera.

S. P. Sergeeva (1963) has recently described two new species of the genus *Falodus* from the Oelandian of the Leningrad district in the USSR, viz. *Falodus parvidentatus* from the Kunda Stage and *F. simplex* from the Kunda and Volkhov Stages. The Volkhov Stage corresponds to the British zone of *Didymograptus extensus* and parts of the zones of *Dichograptus* and *Didymograptus hirundo* (Jaanusson, 1960, p. 346). To judge from Sergeeva's figures of these two species they probably belong to the same group as *O. robustus*. However, since I have not been able to examine any material from the Upper Oelandian of the Leningrad district, I have no knowledge of their variation and have therefore preferred not to discuss Sergeeva's species in this connexion.

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 36 specimens.

Genus *Paltodus* PANDER, 1856

LECTOGENEROTYPE. — *Paltodus subaequalis* PANDER, 1856 (ULRICH & BASSLER, 1926)

Paltodus sulcatus n. sp.

Pl. III, figs. 9a, 9b.

?1944 *Paltodus arcuatus* STAUFFER — MEHL & STROTHMANN in E. B. Branson, Pl. 12, figs. 27, 28.

DERIVATION OF NAME. — From Latin *sulcus* = groove. The species is provided with a lateral groove.

HOLOTYPE. — LO 4121 T, Pl. III, figs. 9a, 9b.

DIAGNOSIS. — A laterally flattened *Paltodus* with a moderately deep basal cavity, a proclined and stout cusp provided with edges, and a groove running on the inner face.

DESCRIPTION. — The conodont as a whole is laterally flattened.

The basal cavity is triangular in outline, and has its apex in the mid-line of the cusp. The cavity is moderately deep. The base lacks edges. The oral margin is straight in side-view. The aboral margin is thickened and has the appearance of a rim.

The cusp is stout and proclined. It is thickened anteriorly which gives it a wedge-shaped cross-section.

Along the inner face of the conodont there runs a groove close to the posterior margin.

REMARKS. — In an unpublished M. Sc. thesis Strothmann has identified *Paltodus arcuatus* STAUFFER among his material. To judge from the figured specimens in E. B. Branson (1944, Pl. 12, figs. 27, 28) Strothmann's specimens are not conspecific with *P. arcuatus* but ought possibly to be referred to *P. sulcatus* n. sp.

OCCURRENCE. — In the Skövde Limestone of the section investigated.

MATERIAL. — 3 specimens.

Genus *Panderodus* ETHINGTON, 1959

GENEROTYPE. — *Paltodus unicostatus* BRANSON & MEHL, 1933.

Panderodus ethingtoni n. sp.

Pl. III, figs. 5a, 5b.

DERIVATION OF NAME. — In honour of Professor R. L. Ethington who erected the genus.

HOLOTYPE. — LO 4122 T, Pl. III, figs. 5a, 5b.

DIAGNOSIS. — A *Panderodus* with five costae basally; an erect or slightly reclined cusp and a deep triangular basal cavity. The anterior margin is rounded, while the posterior margin is sharp.

DESCRIPTION. — The base is anteriorly fairly flattened from the sides. The base meets the cusp in a smooth curve. The oral margin is straight and sharp. The aboral margin is somewhat sinuous in outline. The antero-basal angle is *c.* 90°.

The basal cavity is triangular in outline with its apex posterior to the mid-line of the cusp. It ends at a height, where the cusp starts curving. The cusp is erect or slightly proclined.

The anterior margin of the base and the cusp is rounded, while the posterior margin is sharp.

The conodont carries three costae. One lateral face carries two costae up to about mid-height of the conodont, where the anterior of the two costae curves toward the anterior margin in which it ends. The other more or less median costa continues up to the apex of the cusp. The other lateral face carries three costae. The posterior-most of the three ends, where the cusp starts to curve. The median costa continues to the apex of the cusp. The posterior curves at mid-height toward the anterior margin, where it meets the corresponding costa on the other face of the conodont.

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 47 specimens.

Panderodus gracilis (BRANSON & MEHL, 1933)

Pl. III, figs. 14a, 14b.

1933 *Paltodus gracilis* — BRANSON & MEHL, p. 108; Pl. 8, figs. 20, 21.
1959 *Panderodus gracilis* (BRANSON & MEHL) — ETHINGTON, p. 285; Pl. 39, fig. 1.
1962 *Panderodus gracilis* (BRANSON & MEHL) — SWEET & BERGSTRÖM, p. 1233; text-fig. 1H.

For further synonyms, see Sweet & Bergström (1962, p. 1233).

All the specimens encountered agree in every respect with Branson & Mehl's description, although the variation of the species seems to be rather great.

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 8 specimens.

Genus *Paracordylodus* LINDSTRÖM, 1955

GENEROTYPE. — *Paracordylodus gracilis* LINDSTRÖM, 1955

Paracordylodus lindstroemi BERGSTRÖM, 1961

Pl. III, fig. 8.

1960 *Paracordylodus* n. sp. 2 — LINDSTRÖM, Figs. 6:6, 7:15, 8:6.
1961 *Paracordylodus lindstroemi* — BERGSTRÖM, p. 50; Pl. 2.

My specimens agree in every respect with Bergström's description.

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 40 specimens.

Paracordylodus speciosus n. sp.

Pl. III, figs. 6a, 6b.

DERIVATION OF NAME. — From Latin *speciosus* = magnificent.

HOLOTYPE. — LO 4125 T, Pl. III, figs. 6a, 6b.

DIAGNOSIS. — *A Paracordylodus* with a gently tapering and proclined cusp, an inwardly deflected, rather long and multidenticulated posterior process, and a straight and rod-like anterior process.

DESCRIPTION. — The basal cavity is fairly shallow and continues as grooves on the aboral faces of the processes.

The anterior process constitutes the postero-aborally directed continuation of the base of the cusp. It meets the cusp in a very smooth curve. It is of about the same length as the posterior process, slightly compressed laterally, and has a distinct carina on its inner face.

In relation to the cusp and the anterior process the posterior process is strongly deflected inwards. The posterior process is straight in side-view. It makes an angle of *c.* 40° with the anterior process. The posterior process is carinate. Orally it carries a row of erect and fused denticles. The denticles are usually rather big and robust, and are laterally compressed but have convex lateral faces. Intercalated between these denticles of uniform size there are irregulary distributed denticles which are much smaller than the ordinary denticles. As a rule only one of these small denticles occurs between two ordinary denticles.

On the outer face of the basal sheeth there is a more or less distinct carina. Occasionally this carina is developed almost as a true process.

REMARKS. — Specimens which have a carina developed almost as a true process should probably be referred to *Gothodus* LINDSTRÖM, 1955. A carina is also found on *Paracordylodus lindstroemi,* and seems to have the same variation in that species, too. *Paracordylodus speciosus* n. sp. and *P. lindstroemi* differ only by the arrangement in a hindeodellid series of the denticles on the posterior process of the latter species.

OCCURRENCE. — Throughout the section investigated.

MATERIAL. — 56 specimens.

Genus *Phragmodus* BRANSON & MEHL, 1933

GENEROTYPE. — *Phragmodus primus* BRANSON & MEHL, 1933

Phragmodus? n. sp.

Pl. III, figs. 12a, 12b.

DESCRIPTION. — This is a complex unit consisting of two large and prominent denticles (as I do not know the extension of the basal cavity, they are henceforth designated anterior cusp and posterior cusp), interspersed with denticles, and a lateral process. The posterior cusp is long, reclined, and very prominent. The oral margin is slightly concave and provided with three almost discrete and laterally compressed denticles with blunt apices and dull edges.

Anterior to the posterior cusp there are three (?) fused (?) denticles. Further anteriorly is the anterior cusp which is smaller than the posterior cusp. It is erect, has rounded lateral faces, and is faintly edged. The lateral process starts on the lower third of the anterior margin of the anterior cusp. It curves aborally and posteriorly. The distal part of the lateral process is flexed outwards and carries at least two basally fused denticles. The outer half of the process is folded longitudinally inward and upward. The inward folded aboral margin is possibly minutely denticulated.

The lateral process of my specimen is not complete.

The basal cavity is fairly deep, but since the cavity is filled with matrix I do not know the extension of its apex. The basal cavity continues as an inverted basal cavity along the lateral process.

REMARKS. — I have found only one specimen of the above described type. My reason for not placing this specimen unreservedly in *Phragmodus* is the presence of a lateral process — as in *Ligonodina* — and the possible existence of minute denticles on the aboral margin of this process. But the conodont as a whole has the appearance of a *Phragmodus*, and this I judge to be of greater inportance than the existence of a lateral process. My specimen may also represent a new genus closely related to genera like *Ligonodina*, *Loxognathus*, *Phragmodus*, and *Periodon*.

OCCURRENCE. — In the Vikarby Member of the section investigated.

MATERIAL. — 1 specimen.

Genus *Prioniodus* PANDER, 1856

LECTOGENEROTYPE. — *Prioniodus elegans* PANDER, 1856 (MILLER, 1889)

Prionidus alatus HADDING, 1913

Pl. IV, figs. 4a, 4b, 4c.

1913 *Prioniodus alatus* — HADDING, p. 32; Pl. 1, figs. 9, 10.
1955 *Prioniodus alatus* HADDING — LINDSTRÖM, p. 111; Pl. 22, figs. 26, 28—34.
1960 *Prioniodus alatus* HADDING — LINDSTRÖM, fig. 4:2.
1961 *Prioniodus alatus* HADDING — Z. WOLSKA, p. 355; Pl. 4, figs. 5a, 5b.

My specimens agree in every respect with Hadding's original description and with Lindström's (1955b) redescription of the species.

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 30 specimens.

Prioniodus prevariabilis n. sp.

Pl. IV, figs, 5a, 5b.

?1960 *Prioniodus* n. sp. 1 — LINDSTRÖM, fig. 4:1.

?1961 *Prioniodus* cf. variabilis BERGSTRÖM — Z. WOLSKA, p. 356; Pl. 5, figs. 2a, 2b.

DERIVATION OF NAME. — This species is probably phylogenetically older than *Prioniodus variabilis* BERGSTRÖM, 1961.

HOLOTYPE. LO 4129 T, Pl. IV, figs. 5a, 5b.

DIAGNOSIS. — A *Prioniodus* with a strong and suberect cusp; a long and straight lateral process; a laterally deflected anterior process, and a straight posterior process.

DESCRIPTION. — The basal cavity is comparatively deep, its apex almost reaching the base of the cusp. The cavity continues along the processes as rather deep furrows. There may be a basal funnel.

Specimens with at whitish basal filling have been observed.

The cusp is strong and suberect. Its lateral faces are rounded. The posterior edge of the cusp continues on the posterior process. The continuation of the lateral and anterior processes can be followed as distinct costae on the cusp.

The anterior process is shorter than the lateral process but longer than the posterior process. It is strongly deflected laterally, and slightly twisted inwards. The denticulation of this process seems to be rather variable. The denticles vary in size, are irregulary spaced, and have rounded lateral faces.

The posterior process is laterally compressed, straight in side-view, and carries a row of uniformly sized and basally fused denticles which are inclined toward the cusp. The denticles are only slightly compressed laterally.

The lateral process is straight and directed more or less anteriorly. It is laterally compressed. The denticles are of uniform size and shape. They are inclined towards the cusp. The denticles are basally fused, have rounded lateral faces, and are pointed.

REMARKS. — The only observable difference between this species and *Prioniodus variabilis* BERGSTRÖM is the presence of a ledge on the latter species. This ledge runs "near the aboral margin".

A basal funnel that probably belongs to this species has been found (Pl. IV, fig. 5c).

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 50 specimens.

Genus *Roundya* HASS, 1953

GENEROTYPE. — *Roundya barnettana* HASS, 1953

Roundya inclinata (RHODES, 1953)

Pl. III, fig. 4.

1953 *Trichonodella inclinata* — RHODES, p. 315; Pl. 22, figs. 176, 177, 186.
1955 *Roundya inclinata* (RHODES) — RHODES, p. 137.
1957 *Roundya inclinata* (RHODES) — GLENISTER, p. 733; Pl. 88, fig. 19.
1959 *Trichonodella inclinata* RHODES — ETHINGTON, p. 290; Pl. 41, fig. 6.
1961 *Roundya inclinata* (RHODES) — BERGSTRÖM, p. 53; Pl. 5, figs. 10—13.

The specimens referred by me to this species agree rather well with Rhodes' description.

REMARKS. — Rhodes states that the usual number of smaller denticles in the hindeodellid series of denticles is "usually two, but rarely one or three". In my specimens the number of smaller denticles is almost constantly three.

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 6 specimens.

Genus *Scandodus* LINDSTRÖM, 1955

GENEROTYPE. — *Scandodus furnishi* LINDSTRÖM, 1955

Scandodus pipa LINDSTRÖM, 1955

Pl. III, fig. 13. Text-fig. 2 I

1955 *Scandodus pipa* — LINDSTRÖM, p. 593; Pl. 4, figs. 38—42.

My specimens agree in every respect with Lindström's description.

OCCURRENCE. — Throughout the sequence investigated.

MATERIAL. — 11 specimens.

Scandodus formosus n. sp.

Pl. III, fig. 11. Text-fig. 2K.

DERIVATION OF NAME. — From Latin *formosus* = beautiful.

HOLOTYPE. — LO 4132 T, pl. III, fig. 11.

DIAGNOSIS. — A slender, evenly curved *Scandodus* with a moderately deep basal cavity and sharp edges.

DESCRIPTION. — The base is only slightly expanded posteriorly, and meets the cusp in a curve.

The basal cavity is moderately deep, conical in outline, and with its apex pointing forward.

The cusp is long, slender, and gently tapering, and is provided with sharp edges.

The edges continue on the anterior margin of the base and on the straight oral margin. The lateral faces of the cusp are even and somewhat convex.
OCCURRENCE. — Throughout the sequence investigated.
MATERIAL. — 100 specimens.

Genus *Scolopodus* PANDER, 1956

LECTOGENEROTYPE. — *Scolopodus sublaevis* PANDER, 1856
(ULRICH & BASSLER, 1926)

Scolopodus? peselephanti LINDSTRÖM, 1955

Pl. IV, fig. 10.

1955 *Scolopodus? peselephanti* — LINDSTRÖM, p. 595; Pl. 2, figs. 19, 20.

My specimens agree in every respect with Lindström's description and figures.
OCCURRENCE. — Throughout the sequence investigated.
MATERIAL. — 7 specimens.

Genus *Tetraprioniodus* LINDSTRÖM, 1955

(= *Trapezognathus* LINDSTRÖM, 1955)
GENEROTYPE. — *Tetraprioniodus robustus* LINDSTRÖM, 1955

Tetraprioniodus asymmetricus BERGSTRÖM, 1961

Pl. III, figs. 7a, 7b.

1961 *Tetraprioniodus asymmetricus* — BERGSTRÖM, p. 55; Pl. 2, figs. 15—17.
1963 *Tetraprioniodus minax* — S. P. SERGEEVA, p. 102; Pl. 8, figs. 1—3.

The specimens referred to this species agree reasonably well with Bergström's description.
REMARKS. — The asymmetry characteristic of this species varies a good deal. Thus I have found some symmetrical specimens which evidently belong to this species.
OCCURRENCE. — Throughout the sequence investigated.
MATERIAL. — 44 specimens.

"Fibrous" conodonts

Pl. IV, figs. 7, 8, 9a, 9b.

A number of "fibrous" conodonts have been found in the Vikarby Limestone of the Gullhögen quarry. From the morphological point of view several of these "fibrous" conodonts could readily be referred to different species within the genera *Cyrtoniodus* and *Cordylodus*. A few species ought probably to be referred to the genus *Chirognathus*.

Since the systematics of "fibrous" conodonts are in a rather disordered condition and in bad need of a thorough revision, I have preferred not to classify my specimens. However, some of the most common forms have been figured.

For a recent account on "fibrous" conodonts, see Sweet & Bergström (1962, p. 1249).

OCCURRENCE. — In the Vikarby Limestone of the section investigated.

MATERIAL. — 26 specimens.

Department of Palaeontology, University of Lund, June 3rd, 1964

ADDENDUM

Recent publications

Ethington & Clark (1964) have recently published a paper on "Conodonts from the El Paso Formation (Ordovician) of Texas and Arizona". The following of their species appear also in the Vikarby and Skövde Limestones of the Gullhögen quarry: *Drepanodus amoenus (= D. homocurvatus), D. homocurvatus, Drepanodus suberectus*, and *Scandodus pipa*.

G. Hamar (1964) has recently published a paper on conodonts from the Ampyx Limestones at Ringerike, Norway. The Ampyx Limestone corresponds to the zone of *Nemagraptus gracilis* of the Caradocian. Hamar reports occurrence of, *i.a.*, the following species which also occur in the Skövde and/or Vikarby Limestones of the Gullhögen quarry: *Acodus* n. sp. (= *Acodus triangulatus* n. sp), *Acontiodus kullerudensis* n. sp. = *Acontiodus robustus* (HADDING), *Acontiodus rectus (= A robustus), Ambalodus lindstroemi* n. sp. (= *Ambalodus* n. sp.), *Ambalodus* aff. *lindstroemi* n. sp. (= *Ambalodus reclinatus* n. sp.), *Distacodus* n. sp. (= *Acontiodus unciformis* n. sp.), *Drepanodus arcuatus, Drepanodus homocurvatus, Oistodus robustus, Paltodus* n. sp. (= *Panderodus ethingtoni* n. sp), *Paracordylodus lindstroemi, Prioniodus alatus, Scolopodus? peselephanti*, and *Tetraprioniodus asymmetricus*. While this paper was in press another paper by Hamar (1966) was published. In this Hamar erects the species *Acontiodus semisymmetricus* n.sp. which probably is a senior synonym of *Acontiodus sulcatus* n. sp.

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Fig. 1. Aerial photograph of the Gullhögen quarry at Skövde. X indicates the location of the sampled section. Scale c. 1:6000.
Godkänd för spridning den 25 februari 1963 i Rikets allmänna kartverk.

Fig. 2. Photograph of the sampled section. The hammer-head (length 22 cm) rests on the top of the Kunda Stage.

Plate I Photograph by Dr. S. M. Bergström.

EXPLANATION OF PLATE II

Unretouched photographs of coated conodonts from the Vikarby and Skövde Limestones of the Gullhögen quarry.

Photographs by the author.

Fig. 1. *Acodus triangulatus* n. sp. Lateral view of holotype. x52. LO 4097 T.
Figs. 2a, 2b. *Acodus viruensis* n. sp. Lateral views of holotype. x52. LO 4098 T.
Fig. 3. *Acontiodus coniformis* n. sp. Lateral view of holotype. x52. LO 4100 T.
Fig. 4. *Acontiodus reclinatus* LINDSTRÖM. Lateral view. x52. LO 4101 t.
Figs. 5a, 5b. *Acontiodus robustus* (HADDING). Lateral views. x46. Fig. 5a: LO 4102 t, Fig. 5b: LO 4103 T.
Figs. 6a, 6b. *Acontiodus sulcatus* n. sp. Lateral views of holotype. x52. LO 4104 T.
Figs. 7a, 7b. *Acontiodus unciformis* n. sp Lateral views of holotype. x 52. LO 4105 T.
Figs. 8a, 8b. *Cornuodus erectus* n.gen. et sp. Lateral views. x52. Fig. 8a: LO 4109 T. Fig. 8b: LO 4110 t.
Fig. 9. *Drepanodus sculponea* LINDSTRÖM. Lateral view. x52. LO 4114 t.
Fig. 10. *Drepanodus suberectus* (BRANSON & MEHL). Lateral view. x52. LO 4115 t.
Figs. 11a, 11b. *Drepanodus homocurvatus* LINDSTRÖM. Lateral views. x52. LO 4112 t and LO 5113 T.
Fig. 12. *Acontiodus arcuatus* LINDSTRÖM. Lateral view. x52. LO 4099 t.

EXPLANATION OF PLATE III

Unretouched photographs of coated conodonts from the Vikarby and Skövde Limestones of the Gullhögen quarry.

Photographs by the author.

Figs. 1a, 1b, 1c. *Oistodus forceps* LINDSTRÖM. Lateral views. x52. Figs. 1a, 1b: LO 4116 t, Fig. 1c: LO 4117 t.
Fig. 2. *Oistodus inclinatus* BRANSON & MEHL. Lateral view. x52. LO 4118 t.
Figs. 3a, 3b, 3c, 3d. *Oistodus robustus* BERGSTRÖM. Lateral views. x52. Figs. 3a, 3b: LO 4119 t, Figs. 3c, 3d: LO 4120 t. x46.
Fig. 4. *Roundya inclinata* (RHODES). Lateral view. x46. LO 4131 t.
Figs. 5a, 5b. *Panderodus ethingtoni* n. sp. Lateral views of holotype. x52. LO 4122 T.
Figs. 6a, 6b. *Paracordylodus speciosus* n. sp. Lateral views of holotype. x52. LO 4125 T.
Figs. 7a, 7b. *Tetraprioniodus asymmetricus* BERGSTRÖM. Lateral views. x46. LO 4135 t.
Fig. 8. *Paracordylodus lindstroemi* BERGSTRÖM. Outer lateral view. x52. LO 4124 t.
Figs. 9a, 9b. *Paltodus sulcatus* n. sp. Lateral views of holotype. x52. LO 4121 T.
Fig. 10. *Scolopodus? peselephanti* LINDSTRÖM. Lateral view. x52. LO 4134 t.
Fig. 11. *Scandodus formosus* n.sp. Lateral view of holotype. x52. LO 4132 T.
Figs. 12a, 12b. *Phragmodus?* n. sp. Lateral views. x46. LO 4126 t.
Fig. 13. *Scandodus pipa* LINDSTRÖM. Lateral view. x46. LO 4133 t.
Figs. 14a, 14b. *Panderodus gracilis* (BRANSON & MEHL). Lateral views. x52. LO 4123 t.
Fig. 15. *Drepanodus arcuatus* PANDER. Lateral view. x52. LO 4111 t.

EXPLANATION OF PLATE IV

Unretouched photographs of coated conodonts from the Vikarby and Skövde Limestones of the Gullhögen quarry.

Photographs by the author.

Figs. 1a, 1b. *Ambalodus* n. sp. Oral and aboral views of the holotype. x52. LO 4106 T.
Fig. 2. *Ambalodus foliaceus* n. sp. Oral view of holotype. x52. LO 4107 T.
Figs. 3a, 3b. *Ambalodus reclinatus* n. sp. Oral and aboral views of holotype. x52. LO 4108 T.
Figs. 4a, 4b, 4c. *Prioniodus alatus* HADDING. Outer and inner lateral views. x46. Figs. 4a, 4b: LO 4127 t, Fig. 4c: LO 4128 t.
Figs. 5a, 5b. *Prioniodus prevariabilis* n. sp. Anterior and oblique lateral views of holotype. x46. LO 4129 T.
Fig. 5c. Basal funnel of *Prioniodus prevariabilis* n. sp. Lateral view. x52. LO 4130 t.
Fig. 6 "Fibrous" conodont. Lateral view. x52. LO 4136 t.
Fig. 7. "Fibrous" conodont. Oblique lateral view. x52. LO 4137 t.
Figs. 8a, 8b. "Fibrous" conodont. Lateral views. x52. LO 4138 t.

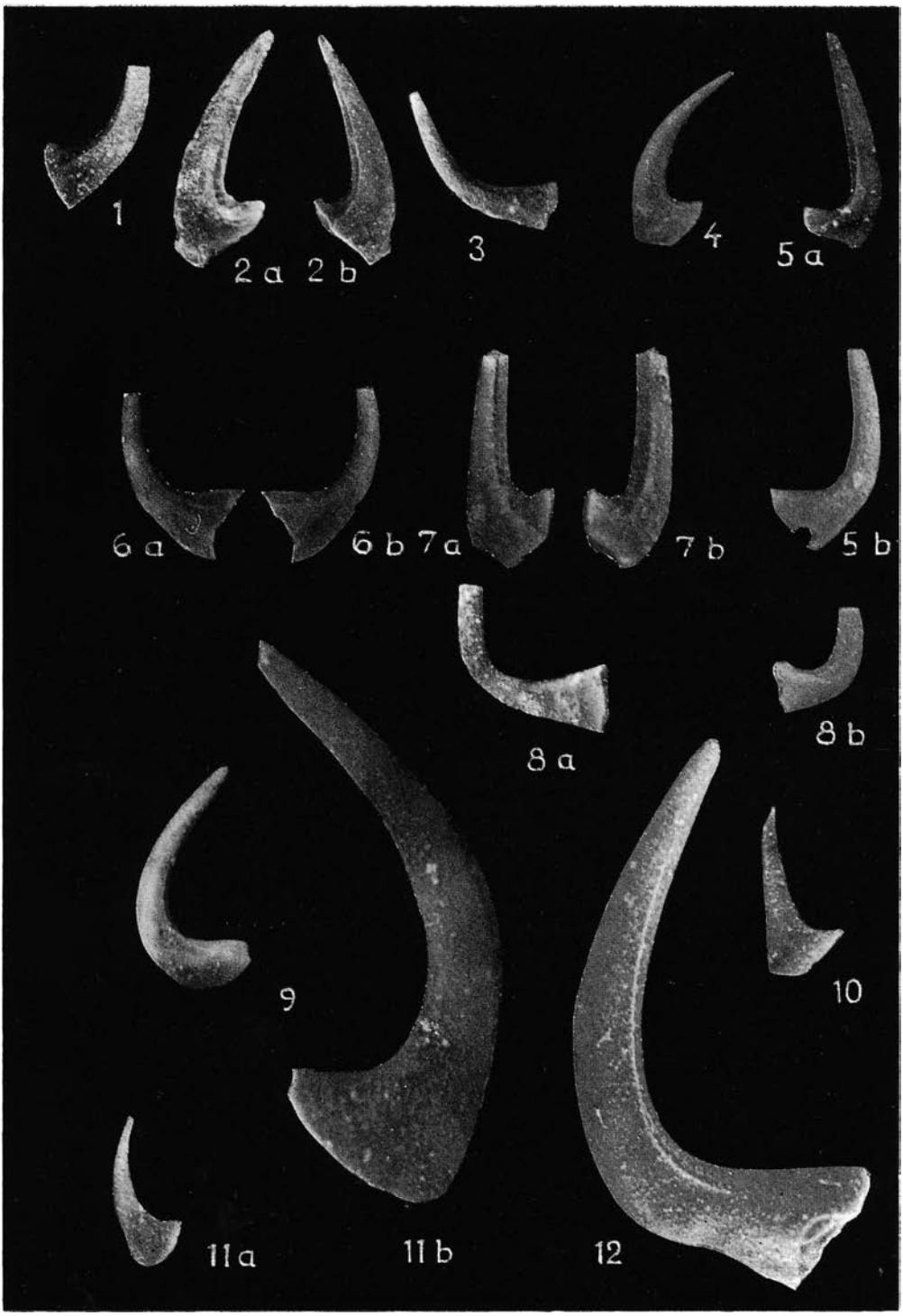

Plate II

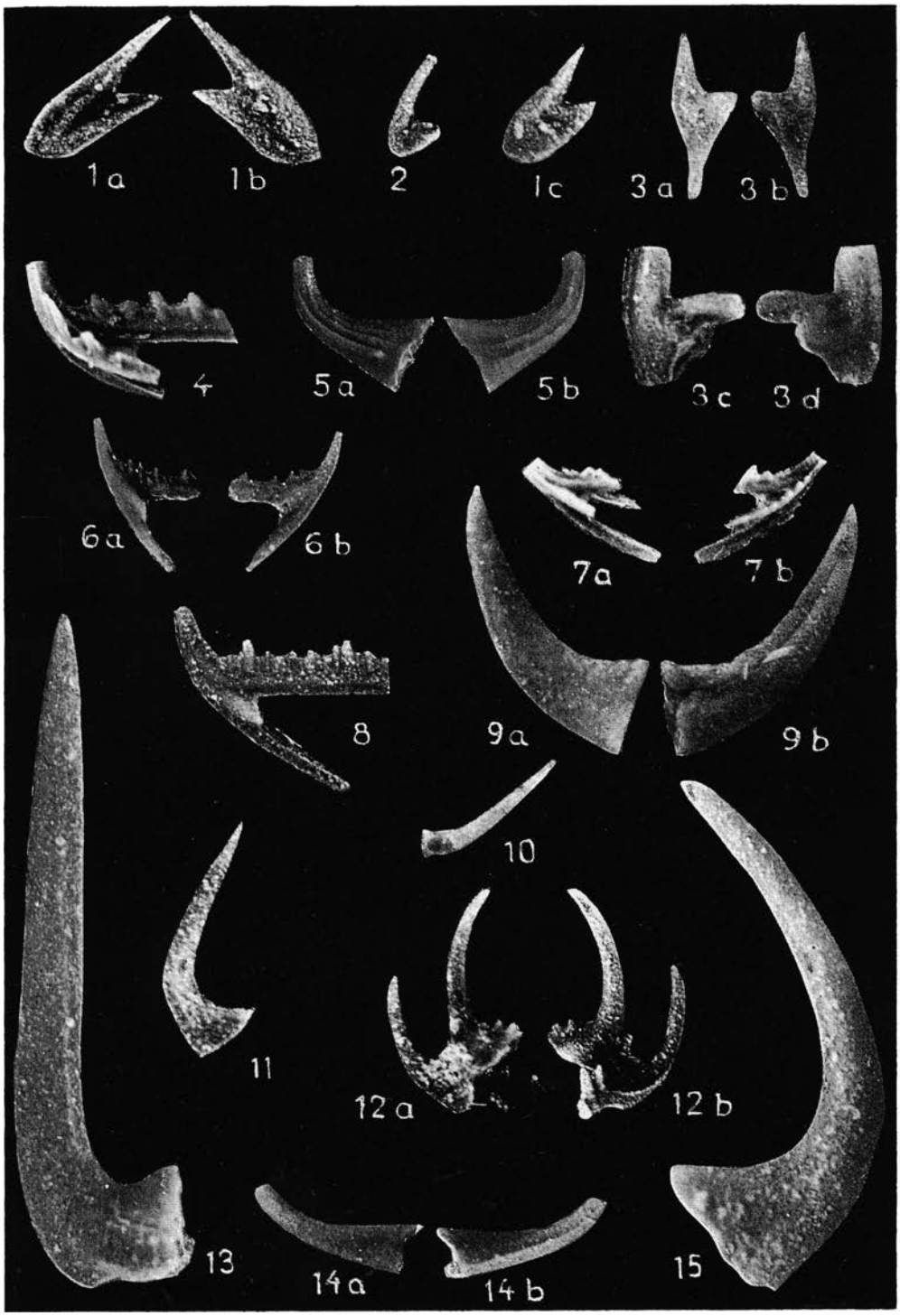
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Plate III

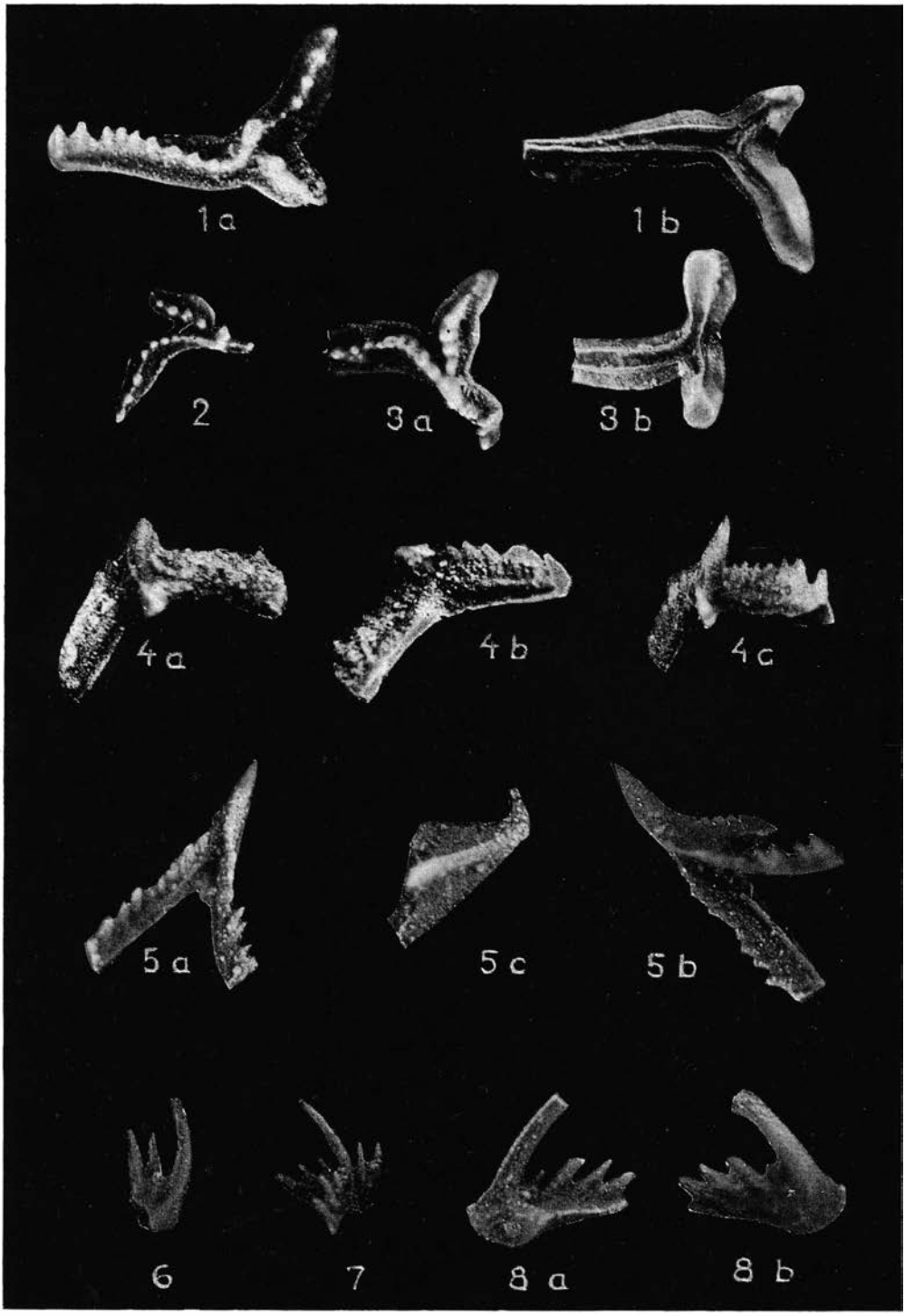

Plate IV

PRIS 6 KRONOR

Distribution
SVENSKA REPRODUKTIONS AB
Fack Vällingby 1

Växjö 1966 C. Davidsons Boktr.
Printed in Sweden