Conodont stratigraphy of the Lower Ordovician Huk Formation at Slemmestad, southern Norway

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Conodonts are present throughout the Lower Ordovician Huk Formation (previously the 'Orthoceras Limestone') at Slemmestad, southern Norway. Forty-one samples from the 8.6 m thick Huk Formation and the overlying 1.2 m thick Helskjer Member of the Elnes Formation were processed and yielded 5136 conodont elements of which 4963 were identifiable. Eighteen genera and 34 species are present. *Drepanoistodus stougei* n.sp. is described and taxonomic notes are included. The Huk Formation comprises, in ascending order, four conodont zones: The *B. navis*, *P. originalis*, *M. parva* and *E.? variabilis* zones, although only the *E.? variabilis–M. parva* Subzone of the latter zone is present. It is suggested that the Arenig–Llanvirn boundary is situated within the lowest 1 m of the Svartodden Member, the uppermost member of the Huk Formation.

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This paper summarizes the biostratigraphy of the Lower Ordovician Huk Formation (formerly the 'Orthoceras Limestone') at Slemmestad, southern Norway. Brief palaeontological descriptions are included, and a more extensive taxonomic treatment of the conodont fauna will be given in a subsequent paper.

The Ordovician sequence of the Baltoscandian platform has been summarized in various fairly recent papers (e.g. Poulsen 1966; Jaanusson 1973, 1976; Bruton & Williams 1982; Bruton et al. 1985; Bruton et al. 1989). The Ordovician succession of the Oslo region is up to 1000 m thick (Bruton *et al.* 1985) and is exposed within the NNE–SSW oriented Oslo Rift. The rift is approximately 220 km long and 45 km wide on land and was formed during the late Carboniferous and Permian (Ramberg & Spjeldnæs 1978; Neumann 1988). The Cambro-Silurian sediments underlying the Permo-Carboniferous volcanics have been preserved from erosion in many parts of the Oslo region.

The Oslo region is bordered by the Caledonian nappe front northwardly near Hamar (Nystuen 1981) and by autochthonous basement rocks to the east and west (Fig. 1B). The intermediate position between the northern orogenic zone and the Baltic Shield led to the development of the foreland character typical for the Oslo region. The Ordovician sections in the Oslo region display rapid lateral changes in litho- and biofacies, particularly in Caradoc and Ashgill time (Størmer 1967; Bockelie 1978), and the facies distribution was controlled by a shallowing towards the west and northwest. This distribution was established as early as Arenig time (Skjeseth 1952; Bjørlykke 1974).

A tripartite division of the Huk Formation is typical for Slemmestad and the central districts of the Oslo region, whereas a reduction to two members is seen in the northern parts (e.g. Nes–Hamar). In the Ringsaker area near Moelv the 45 m thick 'Stein Limestone', which was recently included in the Huk Formation (Owen *et al.* 1990), can be divided into three limestone units (Rasmussen 1989). To the south, in the Skien–Langesund district, the formation is represented only by the dark limestone beds belonging to the Rognstrand Member (Owen *et al.* 1990).

The Huk Formation of the Oslo–Asker area is divided into the Hukodden Member ('Megistaspis Limestone, 3cα'), the Lysaker Member ('Asaphus Shale, 3cβ') and the Svartodden Member ('Endoceras Limestone, 3cγ'). The unit is highly fossiliferous and trilobites, brachiopods, ostracods, gastropods and cephalopods have been documented in various papers (Brögger 1882; Öpik 1939; Størmer 1953; Jaanusson 1960; Wandås 1983; Nielsen 1989). Graptolites are common in the surrounding shale intervals (Monsen 1937; Spjeldnaes 1953, 1986; Berry 1964; Erdtmann 1965).

Conodonts have previously been reported by Kohut (1972) from the Early Ordovician Huk Formation at eleven localities throughout the Oslo region. He also investigated nine samples from the Bjørkåsholmen peninsula, Slemmestad, and concluded that the bulk of the investigated sections comprised only two of Lindström's (1971) conodont zones, that is, the *P. originalis* and *E.? variabilis* zones. However, the present work has shown that the *B. navis* and *M. parva* zones are also to be found within the Huk Formation at both Slemmestad and Ringsaker, and that the uppermost part of the 'Stein Limestone' at Ringsaker belongs to the *E. suecicus* Zone.

Location

Conodont samples were collected from two sections through the Huk Formation at Djuptrekkodden near the

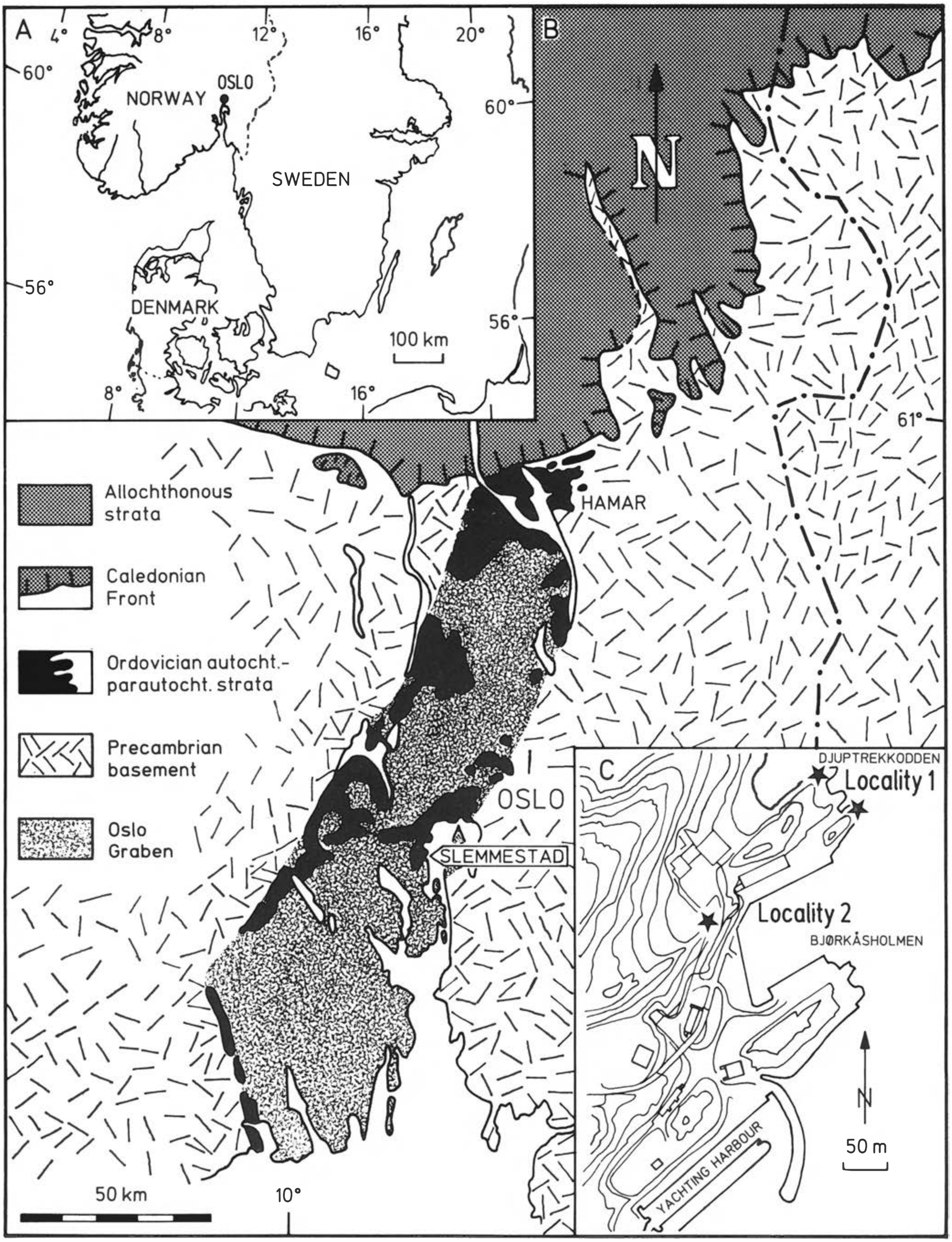

Fig. 1. Location map.

village of Slemmestad (UTM grid NM843296; Fig. 1C). A total of 41 samples (0.7 kg) have been studied. Thirteen of these were collected from the Hukodden Member at Djuptrekkodden (locality 1), and 21 were sampled from the Lysaker Member and the Svartodden Member at the roadcut 150 m SW of Djuptrekkodden (locality 2). Seven additional samples from the basal part of the Elnes Formation (Helskjer Member) at loc. 2 were also analysed.

Measured sections

Huk Formation. – The Huk Formation is 8.6 m thick at Djuptrekkodden and includes the compact Hukodden Member succeeded by the nodular and shaly Lysaker Member and the Svartodden Member.

Hukodden Member. – The Hukodden Member is 1.6 m thick and consists of 24 irregular beds of mainly dark grey mud- and wackestone. Several bedding planes are developed as discontinuity surfaces, commonly with pyrite impregnations. A prominent discontinuity surface separates beds 3 and 4 about 0.15 m above the base. The discontinuity surface represents a conspicuous hiatus which, at least partly, covers the time from the middle *B. navis* Zone to the basal *P. originalis* Zone. The $CaCO_3$ content varies from 25–54% in the two lower beds to about 70% in the interval from 0.1 m to 1 m (measured by use of atomic absorption spectrophotometry). A single bed at level 1.45 m above the base contained only 30% $CaCO_3$, but was rich in glauconite.

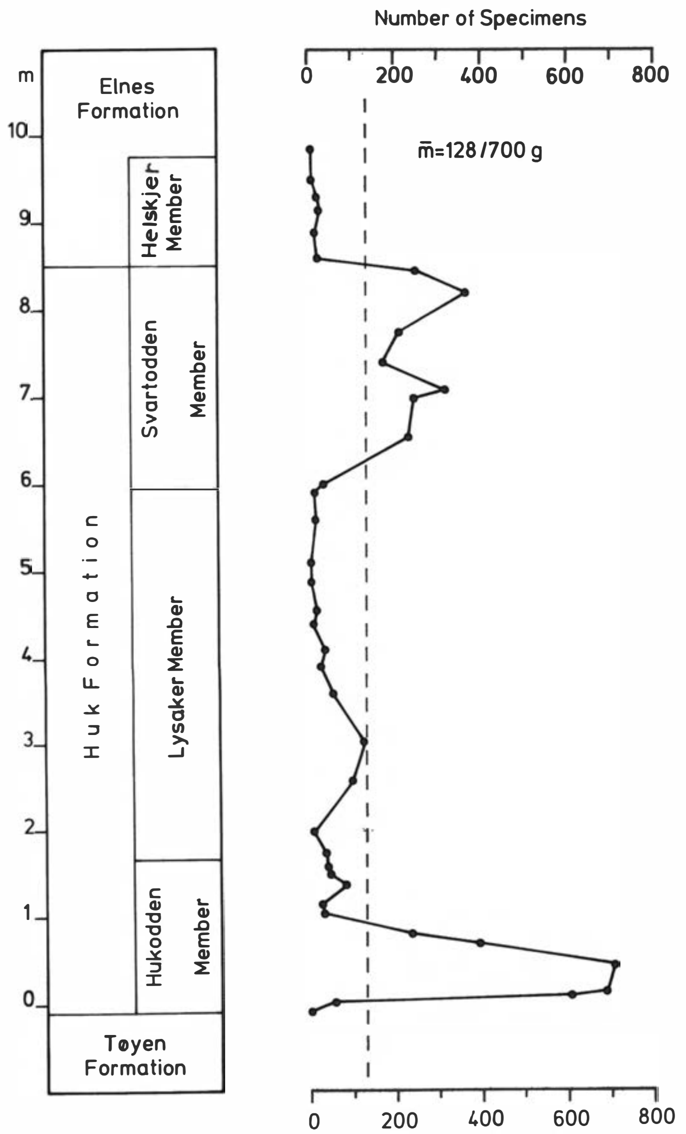

Fig. 2. Number of conodont elements per sample (0.7 kg).

Lysaker Member. – The overlying 4.4 m thick Lysaker Member is composed of about 57 nodular limestone layers surrounded by terrigenous mud and siltstone. The main constituent of the nodules is wackestone and mudstone, but a few layers are dominated by packstone. Coherent limestone beds occur in levels 1.9 m, 2.5 m and 4.1 m above the base of the formation. Phosphorite stainings are found at the last level. The ratio of limestone nodules to clastic matter varies in a cyclic manner, as nodules dominate the intervals 1.6–2.7 m, 4.0–4.2 m and 5.2–5.95 m and mainly clastic mud and silt dominates in between (see Fig. 3). The $CaCO_3$ content in the nodules varies from about 30% in the lowermost part to 47–70% in the rest of the Lysaker Member.

Svartodden Member. – The Svartodden Member is 2.6 m thick and generally consists of dark grey wackestone. Packstone is rare. The unit comprises five limestone beds separated by thin muddy laminae. Yellow, haematite impregnated bands are common in the middle part of the member whereas phosphoritic horizons occur both in the lower and middle parts. The unit is bioturbated and rich in cephalopods. The $CaCO_3$ content is about 75–80% for the entire member, except for the lowermost part which contains only about 37%.

Elnes Formation. – The Svartodden Member is succeeded by the Helskjer Member of the Elnes Formation. The 1.2 m thick Helskjer Member is composed of nine mudstone beds with a high content of terrigenous material.

Thermal maturation

Epstein *et al.* (1977) established the conodont colour alteration index (CAI) as a measure of organic alteration, and showed that the conodont colour is dependent on both temperature and the duration of heating. They distinguished between six indices (CAI 1, 1.5, 2, 3, 4, 5) which are related to the progressive and irreversible alteration of trace amounts of organic matter within the conodont elements. The conodont colour changes gradually from pale amber (CAI 1) in unaltered elements through light and dark brown to black (CAI 5) in elements heated to 300–400°C. Enlarging the scheme of Epstein *et al.* (1977), Rejebian *et al.* (1986) experi-

Fig. 3. Range chart. Bold line: vertical range of the conodont species. Stippled bold line: questionable occurrence.

mentally calibrated the temperature ranges of CAI 6–8 (colour changing from grey through white to clear).

The conodont elements from Slemmestad have values around CAI 5 and indicate heating to 300–480°C *sensu* Rejebian *et al.* (1986). Bergström (1980) and Aldridge (1984) documented similar values from other localities in the Oslo–Asker district. Aldridge (1984) studied the CAI values from several Silurian and Carboniferous conodont localities in the Oslo region, and pointed out that the exposures adjacent to the Permian igneous rocks show higher CAI values than localities situated more distant. It is suggested that the heating was caused mainly by the Permian magmatic activity related to the formation of the Oslo Rift, although burial, too, was believed to have influenced to some extent (Bergström 1980; Aldridge 1984). The Early Ordovician CAI data presented herein support the hypothesis, because the conodonts from Ringsaker and Hamar in the northern part of the Oslo region show CAI values of only 3–4 (110–300°C). These localities are, unlike Slemmestad, situated relatively far from Permian intrusive rocks, which means that the heating in this area is most likely produced by overburden.

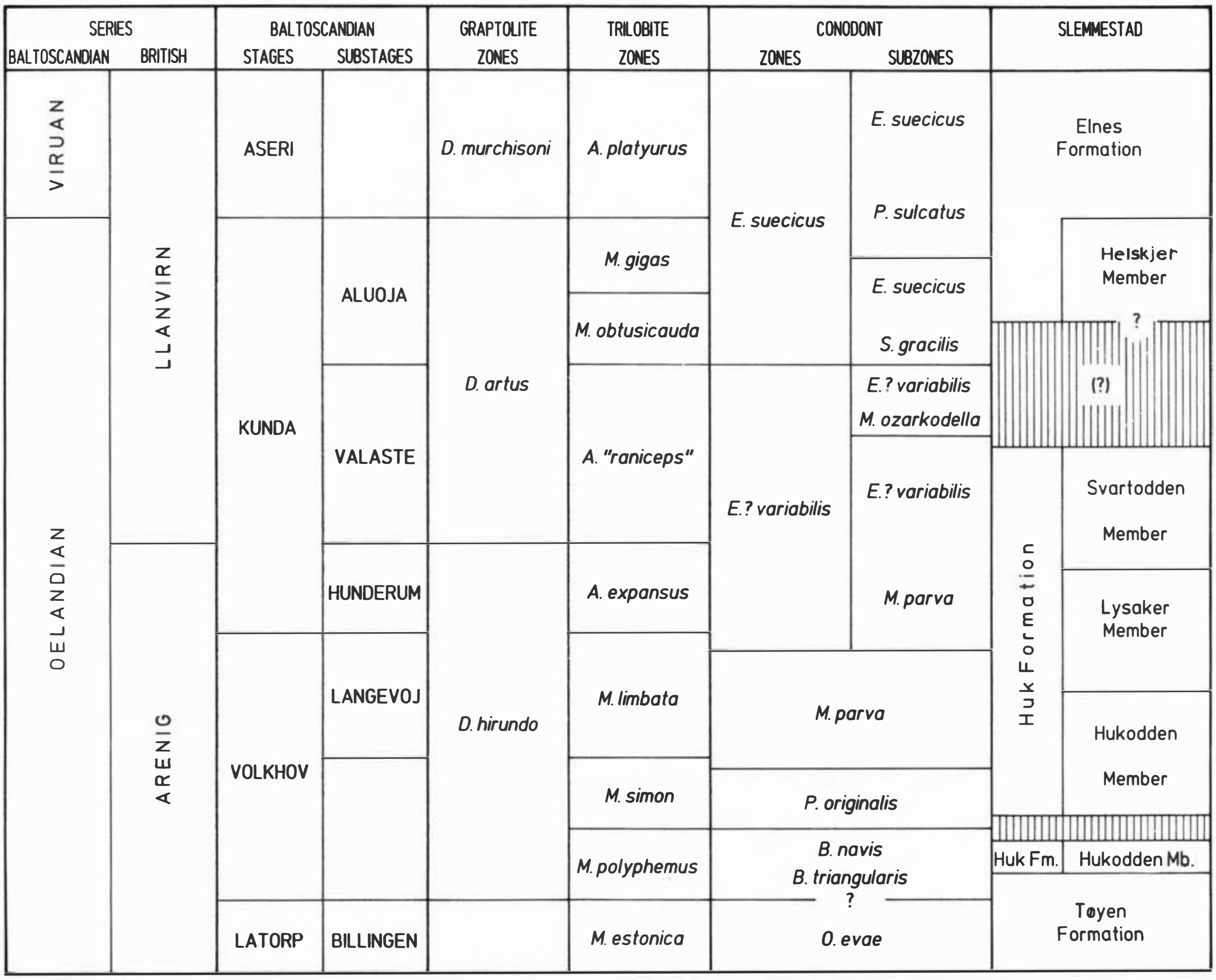

Fig. 4. Correlation table. Chronostratigraphy after Jaanusson (1982); Graptolite zones after Spjeldnæs (1953) and Berry (1964); Trilobite zones after Wandås (1983) (Llanvirn) and Nielsen (1989) (Arenig); Lithostratigraphy after Owen, Bruton, Bockelie & Bockelie (1990).

Conodont stratigraphy

A conodont zonation for the Lower Ordovician of Baltoscandia was introduced by Lindström (1971). The zonation, which was subsequently modified by Löfgren (1978, 1985) and Stouge (1989), has proved to be useful in most parts of the Baltoscandian platform, though certain problems arise when used in areas distant to where the zones were established (Kohut 1972; Stouge 1975).

The revised zonation of Lindström (1971) can be used with some modifications for the Norwegian sections (Figs. 3, 4). The base of the *M. parva* Zone was defined by the first appearance of both *Semiacontiodus cornuformis* (Sergeeva) and *Baltoniodus norrlandicus* (Löfgren) on the inner shelf (Löfgren 1978, 1985), while *S. cornuformis* appears markedly later than *B. norrlandicus* in the distal shelf areas, e.g. Ringsaker. Stouge (1989) connected the diachronous appearance of the two species with a westward migration of *S. cornuformis* caused by a major regression. The tendency is seen even more clearly in the outer shelf deposits of the allochthonous Ringsaker area, as *S. cornuformis* appears for the first time close to the base of the overlying *E.? variabilis* Zone. As a consequence, it is suggested that the base of the *M. parva* Zone should be defined by the first appearance of *B. norrlandicus*, as proposed by Stouge (1989), and not by the first appearance of *S. cornuformis*.

Kohut (1972) failed to recognize the *M. parva* Zone in the investigated Norwegian sections, probably due to large sampling intervals.

Baltoniodus navis Zone (–0.05–0.10 m)

Definition. – Interval from the first appearance of *B. navis* (Lindström) (Lindström 1971) to the level where *Drepanoistodus basiovalis* outnumbers *Drepanoistodus forceps* (for comments on the upper boundary, see below under *P. originalis* Zone).

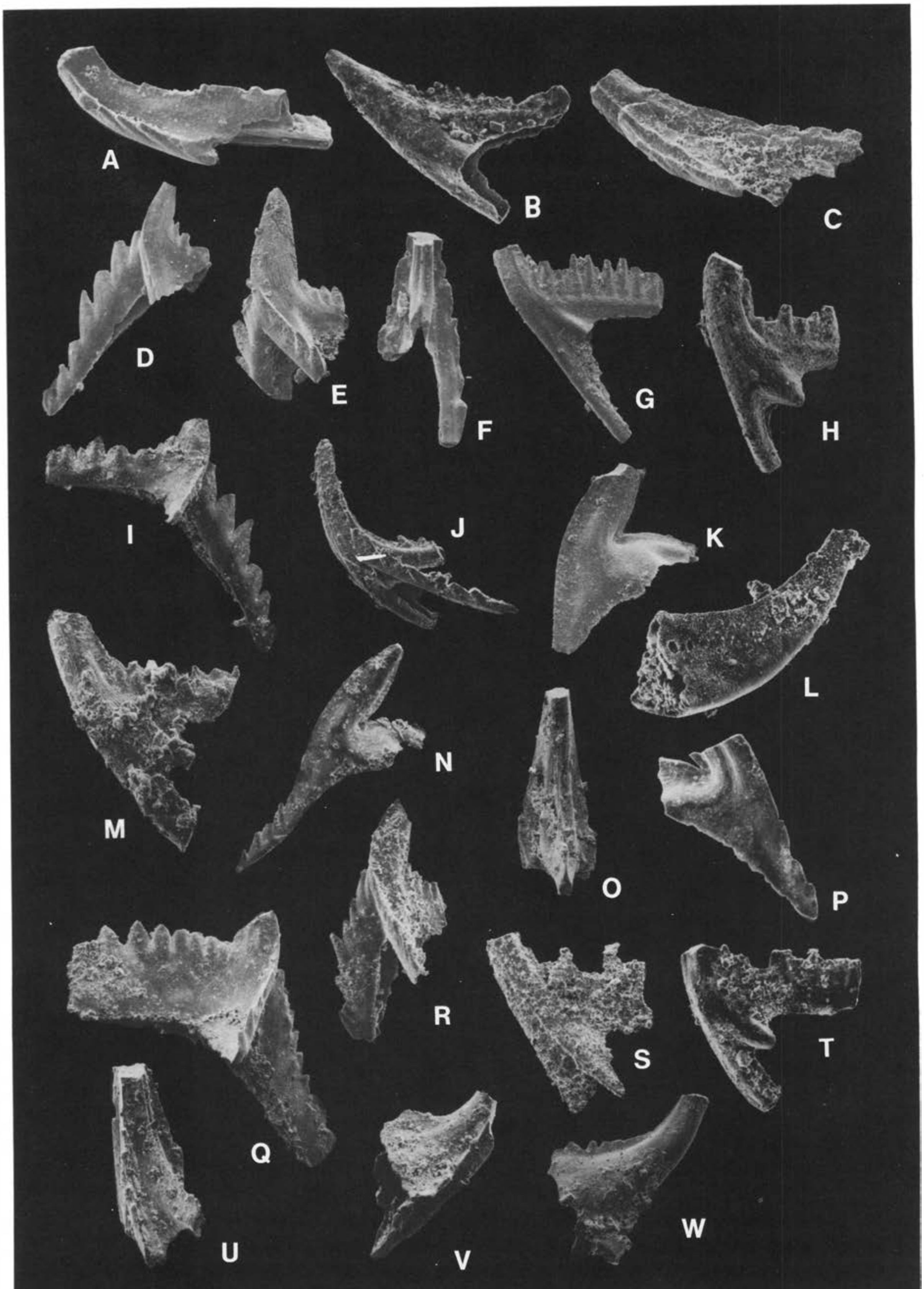

Fig. 5. □ A–C: *Amorphognathus?* sp. A. Alate S element, PMO 121.663. Sample 70032. 155×. B. Tertiopedate S element, PMO 121.664. Sample 70034. 145×. C. Quadriramate S element, PMO 121.665. Sample 70029. 125×. □ L: *Ansella jemtlandica* (Löfgren). L. Acostate undenticulated Pb element, PMO 121.666. Sample 70040. 160×. □ D–H, J, K: *Baltoniodus medius* (Dzik). D. Pastinate pectiniform Pa element, PMO 121.667. Sample 70035. 110×. E. Pastinate pectiniform Pb element, PMO 121.668. Sample 70035. 100×. F. Alate Sa element, PMO 121.669. Sample 70035. 170×. G. Tertiopedate Sb element, PMO 121.670. Sample 70035. 75×. H. Bipennate Sc element, PMO 121.671. Sample (7)-24. 110×. J. Quadriramate Sd element, PMO 121.672. Sample 70035. 90×. K. Geniculate coniform M element, PMO 121.673. Sample 70035. 90×. □ I, M, N: *Baltoniodus norrlandicus* (Löfgren). I. Pastinate pectiniform Pa element, PMO 121.674. Sample 70032. 80×. M. Bipennate Sc element, PMO 121.675. Sample 70021. 110×. N. Geniculate coniform M element, PMO 121.676. Sample 70032. 60×. □ O–U: *Baltoniodus navis*

Characteristics. – The *B. navis* Zone is 15 cm thick and spans the lowermost three beds of the Hukodden member. The lower 10 cm is strongly silicified and dolomitic, containing only 20–40% $CaCO_3$. Accordingly, only a few conodont elements have been obtained from the lower two beds. The upper bed contains almost 1000 elements/kg rock (Fig. 2). The fauna is characterized by the occurrence of *Baltoniodus triangularis* (Lindström), *B. navis, Microzarkodina flabellum* (Lindström) and *Drepanoistodus forceps*. A few elements of *Paroistodus parallelus* (Pander) have also been found. *P. originalis* constitutes about 1% of the fauna. The most common species are *Protopanderodus rectus* (Lindström) (44%) and *D. forceps* (23%). The absolute numbers of specimens in each sample are shown in Appendix 1.

The *B. navis* Pa element (Fig. 5Q) is distinguished by processes without the faint, median thickening typical of stratigraphically younger specimens of *B. navis*, and a very large basal sheath. These features indicate that the lower three beds of the Huk Formation are no younger than the middle or upper part of the *B. navis* Zone.

Paroistodus originalis Zone (0.10–0.65 m)

Definition. – Interval between the level where *Drepanoistodus basiovalis* outnumbers *D. forceps* and the first appearance of *Baltoniodus norrlandicus* (modified after Lindström 1971 and Stouge 1989).

Remarks. – Lindström (1971) originally placed the base at the first appearance of *Trigonodus brevibasis* (Sergeeva) and *Paroistodus originalis* (Sergeeva). In addition, he stated that *D. basiovalis* outnumbers *D. forceps* at approximately the same level (Lindström 1971, p. 31). However, the studies of Löfgren (1978, 1985) and Stouge (1989) have shown that *P. originalis* and *T. brevibasis* commonly appear considerably below the level where *D. basiovalis* becomes more abundant than *D. forceps*. Moreover, it has been demonstrated that *P. originalis* does increase abruptly in abundance even as early as the lower?–middle *B. navis* Zone on the distal part of the Baltoscandian shelf (Kohut 1972; Stouge 1975). It is therefore considered likely that the *D. basiovalis–D. forceps* ratio is less affected by palaeoenvironmental agents than the occurrence and abundance of *P. originalis* and *T. brevibasis.*

Characteristics. – The *P. originalis* Zone has been recognized in the lower part of the Hukodden Member. At Slemmestad, the base is characterized by the first appearance of *Trigonodus brevibasis*, accompanied by a considerable increase in abundance of *P. originalis*. The abrupt faunal change is a consequence of the hiatus spanning the time interval between the middle *B. navis* Zone to the lower *P. originalis* Zone or parts of it. The hiatus is accentuated by a prominent pyrite-impregnated discontinuity surface between bed 3 and bed 4.

Microzarkodina parva Zone (0.65–3.60 m)

Definition. – Interval between first appearance of *Baltoniodus norrlandicus* and first appearance of *Eoplacognathus? variabilis* (Sergeeva) *s.l.* (Stouge 1989; modified after Lindström 1971).

Remarks. – The base was defined by the first appearance of *Semiacontiodus cornuformis* by Löfgren (1978, 1985; modified after Lindström 1971). But, as stated above, *S. cornuformis* is a shallow water species and should not be used in regional correlations.

Characteristics. – The zone occurs in the interval between the middle part of the Hukodden Member and the middle part of the Lysaker Member. *Scalpellodus latus* (van Wamel) shows a drastic increase from 0.5% of the fauna in the upper part of the *P. originalis* Zone to 12% at base of the *M. parva* Zone. *Semiacontiodus cornuformis* enters for the first time at level 1.4 m but is very infrequent in both the Hukodden and Lysaker members. *P. originalis* is less common than in the previous zone, representing 1–17% of the fauna in the upper part of the Hukodden Member. With the exception of a few specimens from the lowermost nodular layer, the species has not been found in the Lysaker Member. The most common species are *Baltoniodus norrlandicus* (21%), *Protopanderodus rectus* (19%) and *Drepanoistodus basiovalis* (10%), this last species being especially common in the upper part. *Baltoniodus navis, Trigonodus brevibasis* and *Scalpellodus latus* are frequent close to the lower zonal boundary. A distinct pyrite-impregnated bed occurs at 1.0 m, close to the top of the Hukodden Member. The samples from below the bed contained 232–395 conodont elements/0.7 kg, whereas the samples above yielded only 30–60 elements/0.7 kg (Fig. 2). The sudden change is related to a marked decrease in the content of $CaCO_3$.

Eoplacognathus? variabilis Zone (3.60–8.60 m)

Definition. – Interval between the first appearance of *Eoplacognathus? variabilis* and first appearance of *Eoplacognathus suecicus* Bergström (Löfgren 1978; modified after Lindström 1971 and Bergström 1971).

(Lindström). O. Alate Sa element, PMO 121.677. Sample 70007. 80×. P. Geniculate coniform M element, PMO 121.678. Sample 70007. 75×. Q. Pastinate pectiniform Pa element, PMO 121.679. Sample 70004. 80×. R. Pastinate pectiniform Pb element, PMO 121.680. Sample 70005. 100×. S. Tertiopedate Sb element, PMO 121.681. Sample 70004. 120×. T. Bipennate Sc element, PMO 121.682. Sample 70007. 70×. U. Quadriramate Sd element. PMO 121.683. Sample 70007. 125×. □ V, W: *Baltoniodus triangularis* (Lindström). V. Pastinate pectiniform P element, PMO 121.684. Sample 70004. 105×. W. Asymmetrical bipennate S element, PMO 121.685. Sample 70004. 100×.

E.? variabilis–Microzarkodina parva Subzone (3.60–8.60 m)

Definition. – Interval between the first appearance of *E.? variabilis* and first appearance of *Microzarkodina ozarkodella* Lindström (Löfgren 1978).

Remarks. – Stouge (1989) introduced the informal '*Baltoniodus medius* zone' for the upper part of the *E.? variabilis – M. parva* Subzone *sensu* Löfgren (1978), defined by the first appearance of *B. medius* (Dzik). The level, which is about contemporary with the Arenig–Llanvirn boundary (see below), can be traced throughout the Baltoscandian platform, as *B. medius* is common throughout the area. The first entrance of *B. medius* coincides with the first appearance of *Histiodella holodentata* Ethington & Clark 1981 (senior objective synonym of *H. tableheadensis* Stouge 1984) in the Caledonian deposits of the Ringsaker area near Hamar. Since the latter species is also described from North America and China, it seems likely that a '*B. medius* zone' or a '*E.? variabilis–B. medius* subzone' would indeed be useful for both regional and intercontinental correlations. *B. medius* appears at level 6.50 m in the Slemmestad section, about 0.5 m above the base of the Svartodden Member.

Characteristics. – The zone is characterized by the co-occurrence of *E.? variabilis* and *Microzarkodina parva* Lindström (Löfgren 1978), covering the interval from the middle part of the Lysaker Member to the very top of the Svartodden Member. Only a few identifiable conodont elements have been recorded from the Lysaker Member (on average 17 elements per 0.7 kg sample), contrasting sharply with the Svartodden Member which contained an average of 243 elements/0.7 kg. Relatively common species in the Lysaker Member are *Baltoniodus norrlandicus* (about 30%), *Drepanoistodus stougei* (commonly 10–30%) and *Scalpellodus latus* which constitutes up to 20% of the fauna in the lower part of the member. The most frequent species in the Svartodden Member are *Baltoniodus medius* (25%), *Semiacontiodus cornuformis* (14%) and *Microzarkodina parva* (8%). *Drepanoistodus tablepointensis* Stouge is present in the lower half of the Svartodden Member and is recorded here for the first time from Baltoscandia. *Polonodus* cf. *tablepointensis* Stouge, *Polonodus? clivosus* Viira, *Dapsilodus mutatus* (Branson & Mehl), *Ansella jemtlandica* (Löfgren) and *Protopanderodus robustus* (Hadding) are scattered in the upper part of the Svartodden Member.

It is unknown whether the *E.? variabilis–M. ozarkodella* Subzone or the *Eoplacognathus suecicus* Zone is represented in the 1.20 m thick Helskjer Member of the succeeding Elnes Formation as no zonal species has been found from this part of the section. However, *Protopanderodus robustus, Scalpellodus gracilis* and *Baltoniodus medius* are relatively common. *P. robustus* appears for the first time near the basal *E.? variabilis–M. ozarkodella* Subzone in Ringsaker and close to the base of the *E. suecicus* Zone in Jämtland (Löfgren 1978), and a middle or upper Kundan age for the Helskjer Member may be indicated (cf. Jaanusson 1982, fig. 2). The dating is supported by recent trilobite studies of Wandås (1983) which indicated a *M. obtusicauda* or *M. gigas* Zone age for the Helskjer Member. Considering this, it seems possible that the Huk and Elnes formations are separated by a hiatus in the Oslo–Asker area (Fig. 4).

Correlation

Löfgren (1978, p. 34) correlated the Early Ordovician conodont successions from Jämtland, Sweden with coeval successions from both Baltoscandia and other areas and revised the conodont zonation of Lindström (1971). New data and suggestions were added by Ethington & Clark (1981), Cooper (1981), Stouge (1984) and Stouge & Bagnoli (1988) and only a few comments have to be supplemented herein.

It has been shown by Rasmussen & Stouge (1988) and Rasmussen (1989) that *Histiodella holodentata* Ethington & Clark occurs in the interval from the lower part of the *E.? variabilis–M. parva* Subzone to the base of the *E. suecicus* Zone in the Steinsodden section, Ringsaker. The successor species, *H. kristinae* Stouge appears at the base of the *E. suecicus* Zone.

At Steinsodden, *Baltoniodus medius* (Dzik) appears at the same level as *H. holodentata.* Thus, it seems likely that the upper 2 m of the Svartodden Member at Slemmestad (the interval comprising *B. medius*) can be correlated with parts of the *H. holodentata* bearing 'Hølonda Limestone' from the Trondheim region of central Norway (Bergström 1979) and the Table Point Formation (*sensu* Klappa *et al.* 1980) of Newfoundland (Stouge 1984). The correlation is favoured by the presence of *Drepanoistodus tablepointensis* in both the Table Point and Table Cove Formations of Newfoundland (Stouge 1984) and the Svartodden Member at Slemmestad. A similar interpretation was proposed by Stouge (1984), with the exception that he correlated the base of the *H. holodentata* Zone at Table Head with the base of the Baltoscandian *E.? variabilis–M. ozarkodella* Subzone.

In Midcontinent faunal terms (Sweet et al. 1971) the *B. medius* bearing part of the Svartodden Member correlates with Fauna 4, which corresponds to the *Paraprioniodus costatus–Chosonodina rigbyi–Histiodella holodentata* Interval of Ethington & Clark (1981) and the *H. holodentata* Zone of Sweet (1984).

The Arenig–Llanvirn boundary

The Arenig–Llanvirn boundary is placed at the base of the *Didymograptus artus* (formerly *D. 'bifidus'*) Zone in the British chronostratigraphic scheme (Fortey & Owens 1987). Graptolites have not been reported from the Huk Formation as yet, but they are common in the surrounding shales. Spjeldnæs (1953) described graptolites indicative of the *D. hirundo* Zone in the uppermost 3 m of the underlying Tøyen Formation and Berry (1964) reported a *Didymograptus murchisoni* Zone graptolite fauna from the dark shales of the Sjøstrand Member overlying the Helskjer Member of the succeeding Elnes Formation. Due to the lack of graptolites within the Huk Formation, there has been a lot of discussion concerning the placement of the Arenig–Llanvirn boundary. Størmer (1953) was of the opinion that the boundary should be placed close to the contact between the Helskjer and Sjøstrand members of the Elnes Formation (the contact between the 'Transition beds' and the Upper Didymograptus Shale of earlier workers), whereas Jaanusson (1960) and Skevington (1963) suggested that the boundary should be situated within the Huk Formation.

It was shown by Skevington (1967) that the *D. hirundo–D. artus* zonal boundary either coincides with or is situated a little below the *A. expansus–A. 'raniceps'* zonal boundary on northern Öland, Sweden. A similar conclusion was reached by Nielsen (1985), who correlated the trilobite-bearing Komstad Formation at Fågelsång, Scania, with the graptolitic shales of the Lovisefred drillcore, Scania (Nilsson 1984) using bentonite layers. Additional collecting and processing of conodont samples from the limestone sections of northern Öland in 1989 (Stouge & Bagnoli 1990; Rasmussen unpublished; Stouge unpublished) indicates that *Baltoniodus medius* (Dzik) appears for the first time at, or a little below, the base of the *A. 'raniceps'* Zone (trilobites determined by A. T. Nielsen, University of Copenhagen). This implies that the first appearance of *B. medius* may be an indicator for the Arenig–Llanvirn boundary. Considering this, the Arenig–Llanvirn boundary should be placed about 50 cm above the base of the Svartodden Member at Slemmestad.

Methods

The conodonts have been recovered by standard procedures (Lindström 1964; Stouge & Boyce 1983). The conodonts from the 41 processed limestone samples were isolated using 12% acetic acid. Each sample weighed 0.7 kg. The residue was washed through a 71 μm sieve and the material between 71 μm and 1 mm was separated in heavy liquid ($\rho = 2.8$ g/cm^3). All of the heavy residue was picked.

The samples contained 128 conodont elements on average (183 elements/kg) (Fig. 2). The figured specimens were photographed using a Scanning Electron Microscope. Figured specimens are deposited in the Paleontological Museum, Oslo (PMO).

Taxonomy

The taxonomy, except for minor modifications, conforms with that of Lindström (1971) and Löfgren (1978), and reference is made to these papers for further descriptions. The elemental notation introduced by Sweet (in Robison 1981, 1988) is used for pectiniform and ramiform apparatuses only, as it has been shown that at least some coniform apparatuses (*Panderodus*) have a different architecture (Smith et al. 1987). Only a few important synonyms are included. The genera and species have been arranged in alphabetical order. 'Occurrence' means the occurrence within the Slemmestad sections.

Genus *Amorphognathus* Branson & Mehl 1933

Type species. – Amorphognathus ordovicicus Branson & Mehl 1933

Amorphognathus? sp.
Fig. 5A–C

1983b *Amorphognathus falodiformis* (Sergeeva) – Dzik, p. 74 (*partim*), Fig. 7D (only), Sa element.

Description. – Sa: The Sa element (Fig. 5A) is an alate ramiform bearing one posterior and two lateral processes, all of which are denticulated. The element is characterized by a large basal sheath. Cusp is proclined.

Sb: The Sb element (Fig. 5B) is asymmetrically tertiopedate with denticulated anterior and posterior processes. The anterior process is twisted in and the denticles point upwards and inwards. Generally, the angle between the two processes is 30–45°. The lateral process-like extension is very short and undenticulated. Cusp is proclined.

Sd: The Sd element (Fig. 5D) is asymmetrically quadriramate with four denticulated processes. The element is characterized by a large, distally prolonged basal sheath. The angle between the individual processes is 20–30°. Cusp is proclined.

Remarks. – See *E.? variabilis* for discussion.

Occurrence. – Lysaker Member and Svartodden Member. *M. parva* Zone and *E.? variabilis–M. parva* Subzone.

Material. – 5 Sa, 4 Sb and 6 Sd elements.

Genus *Ansella* Fåhræus & Hunter 1985

Type species. – Belodella jemtlandica Löfgren 1978.

Ansella jemtlandica (Löfgren 1978)
Fig. 5L

1978 *Belodella jemtlandica* n.sp. – Löfgren, p. 46, pl. 15: 1–8; fig. 24A–D.
?1981 *Belodella jemtlandica* Löfgren–Cooper, pl. 26: 14.
1984 *Belodella jemtlandica* Löfgren–Stouge, p. 60 (*partim*), pl. 6: 13–23, *non* pl. 7: 1–4.

Remarks. – The *Ansella* apparatus was reconstructed and described by Löfgren (1978).

Occurrence. – Upper part of Svartodden limestone Member. *E.? variabilis–M. parva* Subzone.

Material. – One acostate non-denticulated element (Pb) (Fig. 5L), one acostate denticulated element (Sc) and one geniculate element (M).

Genus *Baltoniodus* Lindström 1971

Type species. – Prioniodus navis Lindström 1955.

Baltoniodus medius (Dzik 1976)

Fig. 5D–H, J, K

1976 *Prioniodus alatus medius* spp.n. – Dzik, p. 432, pl. 42: 1, fig. 23: a–h, *non* fig. 23: i–l.

1978 *Prioniodus (Baltoniodus) prevariabilis medius* Dzik – Löfgren, p. 86, pl. 12: 27–36, pl. 13: 1A, B, 3, 6A–D (*cum. syn.*).

Remarks. – The Sb and Sc elements (Fig. 5G, H) are characterized by an undenticulated anterior process and an angle between the anterior and posterior processes which is generally below 50°.

The Sd element (Fig. 5J) is either asymmetrical or symmetrical with one anterior, two lateral, and one posterior process. See Löfgren (1978) for description.

Occurrence. – Middle and upper part of Svartodden Member. *E.? variabilis–M. parva* Subzone. A few elements have been recorded from the basal part of the Elnes Formation.

Material. – 34 Pa, 109 Pb, 127 M, 25 Sa, 52 Sb, 73 Sc, 68 Sd.

Baltoniodus navis (Lindström 1955)

Fig. 5O–U

1955 *Prioniodus navis* n.sp. – Lindström p. 590, pl. 5: 33 (only).

1971 *Baltoniodus navis* (Lindström) – Lindström, p. 56, pl. 1: 13, 19–23 (only).

1978 *Prioniodus (Baltoniodus) navis* Lindström – Löfgren, p. 83, pl. 12: 8–16, pl. 14: 1A–B, 3A–D (*cum. syn.*).

Remarks. – The species was described by Löfgren (1978). The angle between the anterior and posterior processes of the Sb and Sc elements (Fig. 5S–T) is generally above 60° (Löfgren 1978).

Occurrence. – Hukodden Member. *B. navis* Zone to *M. parva* Zone.

Material. – 20 Pa, 49 Pb, 67 M, 24 Sa, 19 Sb, 18 Sc, 32 Sd.

Baltoniodus norrlandicus (Löfgren 1978)

Fig. 5I, M–N

1971 *Baltoniodus navis* (Lindström) – Lindström, p. 56 (*partim*), pl. 1:18 (only).

1978 *Prioniodus (Baltoniodus) prevariabilis norrlandicus* n.spp. – Löfgren, p. 84, pl. 10: 3A–E, pl. 12: 17–26, pl. 14: 2A–B (*cum. syn.*).

1983b *Baltoniodus navis* (Lindström) – Dzik, fig. 7F–M.

Remarks. – The species is characterized by a thickened posterior process on the Sb and Sc (Fig. 5M) elements. The Norwegian *B. norrlandicus* specimens typically have an angle of 50–60° between the anterior and posterior process on the Sb and Sc elements, which is a little less than that in the Swedish specimens described by Löfgren (1978) (Sb elements 55–60° and Sc elements 55–70°). *B. norrlandicus* was described fully by Löfgren (1978).

Occurrence. – The interval from the upper part of Hukodden Member to the lower part of Svartodden Member. *M. parva* Zone to *E.? variabilis–M. parva* Subzone.

Material. – 24 Pa, 58 Pb, 76 M, 26 Sa, 38 Sb, 52 Sc, 33 Sd.

Baltoniodus triangularis (Lindström 1955)

Fig. 5V–W

1955 *Prioniodus triangularis* n.sp. – Lindström, p. 591 (*partim*), pl. 5: 45 (only), Pb element.

1978 *Prioniodus (Baltoniodus) triangularis* (Lindström – Löfgren, p. 81, pl. 12: 1–7 (*cum. syn.*).

Occurrence. – Basal part of Hukodden Member. *B. navis* Zone.

Material. – 3 Pb, 1 M, 1 Sb.

Genus *Cornuodus* Fåhræus 1966

Type species. – Cornuodus erectus Fåhræus 1966.

Cornuodus longibasis (Lindström 1955)

Not figured

1955 *Drepanodus longibasis* n.sp. – Lindström, p. 564, pl. 3: 31.

1978 *Cornuodus longibasis* (Lindström) – Löfgren, p. 49, pl. 4: 36, 38–42; fig. 25a–c.

1978 *Cornuodus bergstroemi* Serpagli–Löfgren, p. 51, pl. 4: 37; fig. 25d.

1981 *Cornuodus longibasis* (Lindström) – Cooper, p. 161, pl. 26: 10–11.

1984 *Cornuodus longibasis* (Lindström) – Stouge, p. 62, pl. 8: 1–8 (*cum. syn.*).

1988 *Cornuodus longibasis* (Lindström) – Stouge & Bagnoli, p. 114, pl. 1: 20–21.

1988 *Cornuodus longibasis* (Lindström) – Bergström, pl. 1: 3.

Remarks. – The species was fully described by Löfgren (1978).

Occurrence. – Hukodden Member, Lysaker Member and Svartodden Member. *B. navis* Zone to *E.? variabilis–M. parva* Subzone.

Material. – 32 elements.

Genus *Dapsilodus* Cooper 1976
Type species. – *Distacodus obliquicostatus* Branson & Mehl 1933.

Dapsilodus mutatus (Branson & Mehl 1933)
Not figured

1933 *Belodus(?) mutatus* n.sp. – Branson & Mehl, p. 126, pl. 10: 17.
1978 *Acodus? mutatus* (Branson & Mehl) – Löfgren, p. 44, pl. 2: 9–21 (*cum. syn.*).

Occurrence. – Svartodden Member. *E.? variabilis–M. parva* Subzone.

Material. – 10 acodontiform and 16 acontiodontiform elements.

Genus *Drepanodus* Pander 1856
Type species. – *Drepanodus arcuatus* Pander 1856.

Drepanodus arcuatus Pander 1856
Fig. 6A–C

1856 *Drepanodus arcuatus* n.sp. – Pander, p. 20 (*partim*), pl. 1: 2, 4, 5, 17 (only).
?1856 *Drepanodus flexuosus* n.sp. – Pander, p. 20, pl. 1: 6–8, pl. 3: 4, 11, 12.
1974 *Drepanodus arcuatus* Pander – van Wamel, p. 61, pl. 1: 10–13.
1978 *Drepanodus arcuatus* Pander – Löfgren, p. 51, pl. 2: 1, 2, 4–8 (*non* fig. 3).
1987 *Drepanodus arcuatus* Pander – Olgun, p. 49. pl. 7: A; *non* B.
1988 *Drepanodus arcuatus* Pander – Stouge & Bagnoli, p. 115, pl. 2: 1–6 (*cum. syn.*).
1988 *Drepanodus arcuatus* Pander – Bergström, pl. 1: 4–5.
1989 *Protopanderodus* n.sp. A – McCracken, p. 23 (*partim*), pl. 1: 14, 15, 18, 21 (only).

Remarks. – *Drepanodus* Pander has been discussed in detail by Stouge & Bagnoli (1988). They distinguished between *Drepanodus arcuatus* and *Drepanodus planus* Pander, the latter species being characterized by the presence of costate elements. The elements agree with previous descriptions given by Lindström (1955), van Wamel (1974) and Stouge & Bagnoli (1988).

The interpretation of McCracken (1989) is not accepted. It seems likely that his *Protopanderodus* n.sp. A apparatus represents a mix of elements belonging to *Drepanodus arcuatus, D. planus* and *Protopanderodus reclinatus* (Lindström).

Occurrence. – Throughout the studied sequence.

Material. – 295 non-geniculate and 26 geniculate elements.

Drepanodus planus (Pander 1856)
Fig. 6D–E

1856 *Machairodus planus* n.sp. – Pander, p. 24, pl. 2: 39.
1988 *Drepanodus planus* (Pander) – Stouge & Bagnoli, p. 116, pl. 2: 7–10 (*cum. syn.*).
1989 *Protopanderodus* n.sp. A – McCracken, p. 23 (*partim*), pl. 1: 11, 12, ?13, 19, 20, 24 (only).

Remarks. – The species was revised by Stouge & Bagnoli (1988).

Occurrence. – The uppermost part of Svartodden Member and lower part of Helskjer Member of the Elnes Formation. *E.? variabilis–M. parva* Subzone.

Material. – 7 non-geniculate elements.

Genus *Drepanoistodus* Lindström 1971

Type species. – *Oistodus forceps* Lindström 1955.

Remarks. – The *Drepanoistodus* apparatus comprises non-geniculate and geniculate coniform elements (Lindström 1971) which form a curvature transition series. Löfgren (1978) separated the non-geniculate elements into suberectiforms and homocurvatiforms, and considered the *Drepanoistodus* apparatus as being basically trimembrate.

The material presented herein favours that the homocurvatiform element (*sensu* Löfgren 1978) includes three different morphotypes, thus the *Drepanoistodus* apparatus is pentamembrate (van Wamel 1974, Cooper 1981, Stouge & Bagnoli 1990). In short, the homocurvatiform element type comprises the following three morphotypes: *Drepanodontiform type 1* (Fig. 6G): Non-geniculate element with a strongly recurved cusp. The cusp is anteriorly and posteriorly keeled. The anterior keel, which continues to the basal margin, is twisted strongly inward. The basal continuation of the anterior

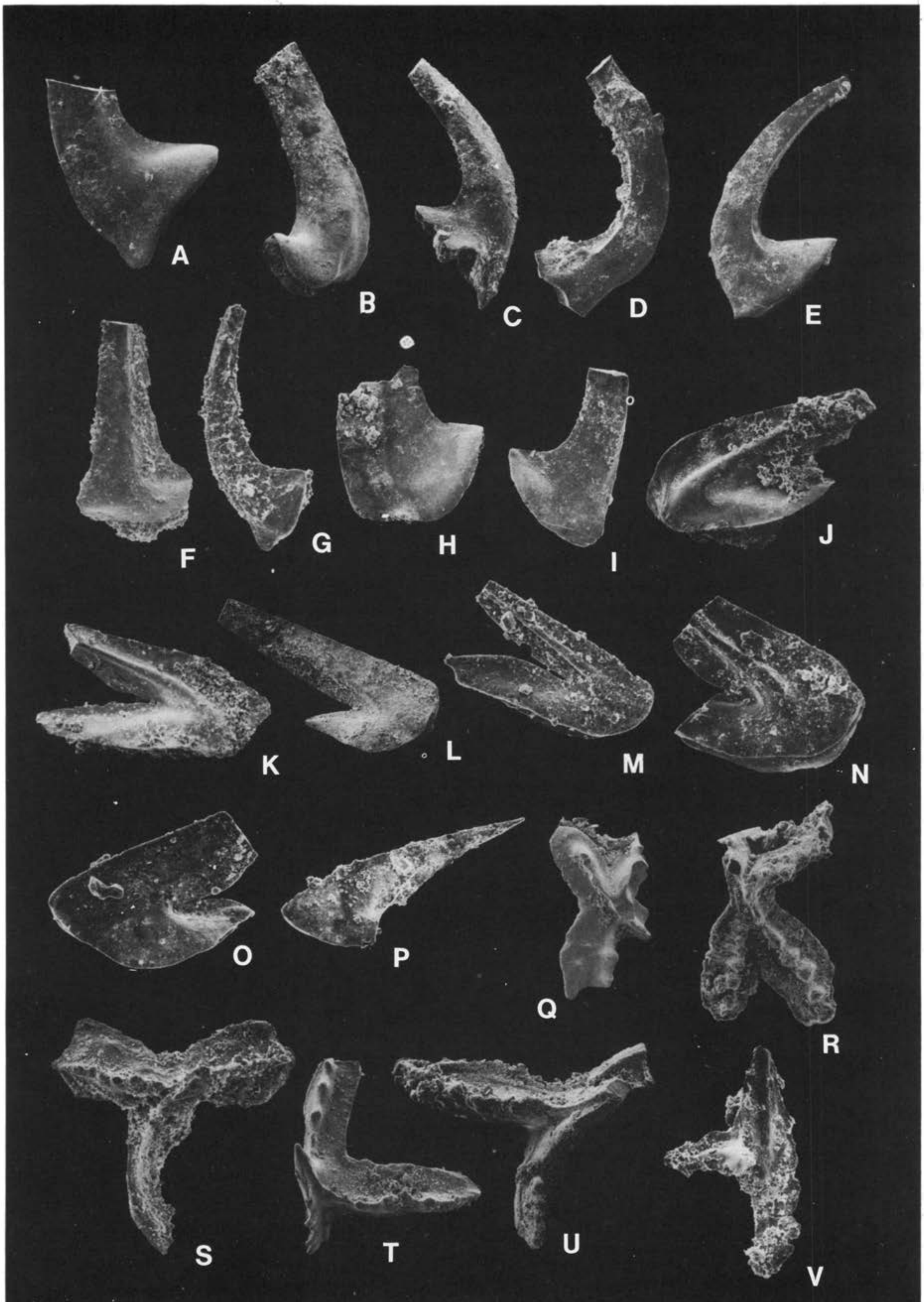

Fig. 6. □ A–C: ***Drepanodus arcuatus*** Pander. A. Non-geniculate sculponeiform element, PMO 121.686. Sample 70039. 45×. B. Geniculate pipaform element, PMO 121.687. Sample 70039. 40×. C. Non-geniculate arcuatiform element, PMO 121.688. Sample 70039. 80×. □ D, E: ***Drepanodus planus*** (Pander). D. Non-geniculate arcuatiform element, PMO 121.689. Sample 70040. 40×. E. Non-geniculate sculponeiform element, PMO 121.690. Sample 70040. 25×. □ F–J, N: ***Drepanoistodus stougei*** n.sp. F. Non-geniculate suberectiform element, PMO 121.691. Sample 70019. 90×. G. Non-geniculate drepanodontiform type 1 element, PMO 121.692. Sample 70019. 110×. H. Non-geniculate drepanodontiform type 3 element, PMO 121.693. Sample 70022. 70×. I. Non-geniculate drepanodontiform type 2 element, PMO 121.694. Sample 70019. 125×. J. Geniculate element, PMO 121.695. Sample 70022. 75×. Holotype. N. Geniculate element, PMO 121.696. Sample 70019. 130×. □ K: ***Drepanoistodus forceps*** (Lindström). K. Geniculate element, PMO 121.697. Sample 70004. 95×. □ L: ***Drepanoistodus basiovalis*** (Sergeeva). L. Geniculate

keel usually creates a thin, lateral costa on the base. A flare or extension, sometimes triangular in outline, may occur at the anterobasal corner. *Drepanodontiform type 2* (Fig. 6I): Non-geniculate element with recurved cusp. Cusp is keeled. The element is characterized by consistently having an anterobasal flare, commonly with a triangular outline. Unlike the 'drepanodontiform type 1' element, the anterior margin is straight or weakly twisted. *Drepanodontiform type 3* (Fig. 6H): Non-geniculate element with a slightly recurved cusp. Cusp is anteriorly and posteriorly keeled and not twisted. Unlike the other two drepanodontiforms, the element lacks the anterior triangular flare.

Drepanoistodus basiovalis (Sergeeva 1963)
Fig. 6L

1963 *Oistodus basiovalis* n.sp. – Sergeeva, p. 96, pl. 7: 6, 7?; fig. 3.
1971 *Drepanoistodus basiovalis* (Sergeeva) – Lindström, p. 43, figs. 6, 8.
1978 *Drepanoistodus basiovalis* (Sergeeva) – Löfgren, p. 55, pl. 1: 11–17; fig. 26B–C (*cum. syn.*).
1983a *Drepanoistodus forceps* (Lindström)? – Dzik, p. 337 (*partim*), fig. 8b (*partim*), *non* pl. 3: 1–4.
1987 *Drepanoistodus basiovalis* (Sergeeva) – Olgun, p. 49, pl. 6: W–EF, *non* GH.

Remarks. – Only the two lowermost elements in fig. 8b of Dzik (1983a) belong to *D. basiovalis*.

Occurrence. – *D. basiovalis* has been recognized throughout the Huk Formation, but is especially common in the lower and middle parts of the Hukodden Member and the middle part of the Svartodden Member. *B. navis* Zone (rare) to the *E.? variabilis–M. parva* Subzone.

Material. – 288 non-geniculate elements (35 suberectiform elements, 18 drepanodontiform type 1 elements, 52 drepanodontiform type 2 elements, 183 drepanodontiform type 3 elements) and 108 geniculate elements.

Drepanoistodus forceps (Lindström 1955)
Fig. 6K

1955 *Oistodus forceps* n.sp. – Lindström, p. 574, pl. 4: 9–13, fig. 3M.
1971 *Drepanoistodus forceps* (Lindström) – Lindström, p. 42, figs. 5, 8.
1978 *Drepanoistodus forceps* (Lindström) – Löfgren, p. 53, pl. 1: 1–6, fig. 26A (*cum. syn.*).
1983a *Drepanoistodus forceps* (Lindström) – Dzik, p. 337 (*partim*), text-fig. 8a, *non* pl. 3: 1–4, *non* text-fig. 8b.
1987 *Drepanoistodus forceps* (Lindström) – Olgun, pl. 6: Q–V.
1988 *Drepanoistodus forceps* (Lindström) – Bergström, pl. 1: 6, 7, 9, 10; *non* pl. 1: 8.

Occurrence. – Lowermost part of the Hukodden Member. *B. navis* Zone.

Material. – 71 non-geniculate elements (8 suberectiforms, 3 drepanodontiform type 1 elements, 2 drepanodontiform type 2 elements, 58 drepanodontiform type 3 elements) and 88 geniculate elements.

Drepanoistodus stougei n.sp.
Fig. 6F–J, N

1977 *Drepanoistodus forceps* (Lindström) – Gedik, p. 41, pl. 1: 7 (only).
1978 *Drepanoistodus?* cf. *venustus* (Stauffer) – Löfgren, p. 56 (*partim*), pl. 1: 8 (only).

Derivation of name. – After Dr Svend Stouge, Geological Survey of Denmark, who was the first to introduce the author to *Drepanoistodus*.

Type locality. – Djuptrekkodden, Slemmestad.

Type stratum. – 2 m above the base of Lysaker Member, sample 70022, *E.? variabilis–M. parva* Subzone, late Arenig.

Holotype. – PMO 121.695, a geniculate element, Fig. 6J.

Diagnose. – A *Drepanoistodus* species with a geniculate element that is characterized by a rounded anterior margin, a carinate cusp and a relatively long upper margin.

Description. – The non-geniculate elements seem to be indistinguishable from *D. basiovalis* (Sergeeva), and agree with previous descriptions of this species given by Lindström (1971) and Löfgren (1978). In samples where *D. basiovalis* and *D. stougei* occur together, the non-geniculate elements have been divided proportionally between the two species.

The geniculate coniform element is characterized by a rounded anterior margin. The upper margin, developing a distinct flare, is relatively long and constitutes commonly 50–80% of the cusp length. The inner side of the cusp has a carina which is more distinct than that of the

element, PMO 121.698. Sample 70007. 60×. □ M: *Drepanoistodus venustus* (Stauffer). M. Geniculate element, PMO 121.699. Sample 70034. 130×. □ O, P: *Drepanoistodus tablepointensis* Stouge. O. Geniculate element, PMO 121.700. Sample 70034. 110×. P. Geniculate element, PMO 121.701. Sample 70034. 80×. □ Q–U: *Eoplacognathus? variabilis* (Sergeeva). Q. Stelliplanate Pa element, PMO 121.702. Sample 70032. 50×. R. Stelliplanate Pa element, PMO 121.703. Sample 7–24. 75×. S. Pastiniplanate sinistral Pb element, PMO 121.704. Sample 70034. 70×. T. Pastiniplanate dextral Pb element, PMO 121.705. Sample 70032. 60×. U. Pastiniplanate sinistral PB element, PMO 121.706. Sample 7–24. 95×. □ V: *Lenodus* sp. A. V. modified tertiopedate element, PMO 121.707. Sample 70024. 125×.

outer side of the cusp. Some elements develop a weakly inverted basal cavity. Juvenile specimens may be very similar to *D. venustus* (Stauffer) but they typically have a more rounded upper part of the anterior margin.

Remarks. – Drepanoistodus stougei is more abundant than *D. basiovalis* in the lower part of the *E.? variabilis – M. parva* Subzone (early Kundan), whereas *D. basiovalis* is more frequent below and above this level. A similar pattern is seen even more clearly in the Ringsaker area. As sea level was markedly lower during the early Kunda, it is suggested that *D. stougei*, rather than *D. basiovalis*, preferred the shallow water environment.

Occurrence. – The interval from the middle part of Hukodden Member to the top of the Svartodden Member. *P. originalis* Zone to *E.? variabilis–M. parva* Subzone.

The species has been documented from Ringsaker, Norway (Rasmussen 1989, in prep.), Jämtland, Sweden (Löfgren 1978) and Turkey (Gedik 1977).

Material. – 56 non-geniculate elements (9 suberectiform elements, 9 drepanodontiform type 1 elements, 5 drepanodontiform type 2 elements, 33 drepanodontiform type 3 elements), and 44 geniculate elements.

Drepanoistodus tablepointensis Stouge 1984
Fig. 6O–P

1984 *Drepanoistodus tablepointensis* n.sp. – Stouge, p. 54, pl. 4: 9–17 (*cum. syn.*).

Remarks. – The species is previously reported only from the North America. See Stouge (1984) for description.

Occurrence. – The middle part of the Svartodden Member. Upper part of the *E.? variabilis–M. parva* Subzone.

Material. – 8 geniculate elements.

Drepanoistodus venustus (Stauffer 1935)
Fig. 6M

1935 *Oistodus venustus* n.sp. – Stauffer, p. 146, pl. 12: 12.
1976 *Drepanoistodus suberectus forceps* (Lindström) – Dzik, fig. 19e (only).
1978 *Drepanoistodus? venustus* (Stauffer) – Löfgren, p. 57, pl. 1: 9–10 (*cum. syn.*).
1984 *Drepanoistodus?* cf. *venustus* (Stauffer) – Stouge, p. 55, pl. 4: 18–25.

Remarks. – The species was first described by Stauffer (1935). The *D. venustus* group is much in need of revision

Occurrence. – Svartodden Member and probably also the upper part of the Lysaker Member. *E.? variabilis–M. parva* Subzone.

Material. – 30 non-geniculate elements (3 suberectiforms, 1 drepanodontiform type 1 element, 1 drepanodontiform type 2 elements, 25 drepanodontiform type 3 elements) and 43 geniculate elements.

Genus *Eoplacognathus* Hamar 1966
Type species. – *Ambalodus lindstroemi* Hamar 1964.

Eoplacognathus? variabilis (Sergeeva 1963)
Fig. 6Q–U

Pa element
1960 *Amorphognathus* n.sp. 1 – Lindström, fig. 4: 4.
1963 *Amorphognathus variabilis* n.sp. – Sergeeva, p. 105, pl. 8: 15–17; fig. 11.
1974 *Amorphognathus variabilis* Sergeeva – Viira, pl. 7: 3, 4.

Pb element
1960 *Ambalodus* n.sp. 2 – Lindström, fig. 4: 5.
1963 *Ambalodus planus* n.sp. – Sergeeva, p. 105, pl. 8: 11–15; fig. 10.
1972 *Ambalodus planus* Sergeeva – Viira, fig. 1.
1974 *Ambalodus planus* Sergeeva – Viira, p. 53, pl. 6: 22–24, 27, 30; figs, 40, 42.

Multielement taxonomy
1976 *Amorphognathus variabilis* Sergeeva – Dzik, p. 432 (*partim*), fig. 26: a, b (only).
?1976 *Eoplacognathus zgierzensis* n.sp. – Dzik, p. 424 (*partim*), fig. 30: b, c, f (only).
1978 *Eoplacognathus? variabilis* (Sergeeva) – Löfgren, p. 57, pl. 15: 15, 23–25, *non* pl. 15: 22.
1983 *Amorphognathus variabilis* Sergeeva – Bergström, p. 38 (*partim*), fig. 1.
?1983b *Amorphognathus falodiformis* (Sergeeva) – Dzik, p. 74 (*partim*), fig. 7: A, B (only).

Remarks. – It has been suggested that *Amorphognathus variabilis s.f.* is probably also a true *Amorphognathus* in the multielement sense (Dzik 1976, 1983b; Lindström in Ziegler 1977; Bergström 1983). However, the P elements are much more abundant than the ramiform and 'oistodontiform' elements (included respectively in *Amorphognathus?* sp. and *Lenodus* sp. A herein) in the Norwegian sections, and it seems more likely that separate species are represented by *A. variabilis s.f.*, a likely member of the *Eoplacognathus* lineage. A similar approach was proposed by Löfgren (1978), whereas Stouge & Bagnoli (1990) included parts of *E.? variabilis sensu* this paper in the revised multielement genus *Lenodus* Sergeeva.

The Slemmestad sections contained 108 P elements of *E.? variabilis*, compared to only 14 ramiform elements of *Amorphognathus?* sp. and 3 elements assigned to *Lenodus* sp. A.

Occurrence. – Upper part of the Lysaker Member and the Svartodden Member *E.? variabilis–M. parva* Subzone.

Material. – 23 Pa elements, 85 Pb elements.

Genus *Lenodus* Sergeeva 1963
Type species. – *Lenodus clarus* Sergeeva 1963.

Remarks. – It has been suggested that *Lenodus* occupied the M position in the multielement genus *Amorphognathus* (Bergström 1971; Lindström in Ziegler 1977), but convincing evidence is still lacking (see discussion above). Consequently, Bergström (in Robison 1981) tentatively regarded *Lenodus* as an unimembrate genus. Stouge & Bagnoli (1990) included species of *Lenodus* in the revised multielement genera *Trapezognathus* Lindström and *Lenodus* Sergeeva.

Lenodus sp. A
Fig. 6V

Description. – The element is a modified tertiopedate ramiform element bearing an anterior, denticulated process. The inner-lateral process or process-like extension is shorter or of the same size as the posterior and anterior processes, but may lack the denticulation. A large basal sheath is commonly developed between the inner-lateral process and the posterior processes. The angle between the anterior and posterior processes varies between 60 and 80° in a lateral view. Cusp is erect or recurved.

Occurrence. – The interval from the middle part of the Lysaker Member to the middle part of the Svartodden Member. *E.? variabilis–M. parva* Subzone.

Material. – 3 elements.

Genus *Microzarkodina* Lindström 1971

Type species. – *Prioniodina flabellum* Lindström 1955.

Microzarkodina flabellum (Lindström 1955)
Fig. 7A–D, F

1955 *Prioniodina flabellum* n.sp. – Lindström, p. 587, pl. 6: 23–25.
1971 *Microzarkodina flabellum* (Lindström) – Lindström, p. 58, pl. 1: 6–11; figs. 19, 20.
1974 *Microzarkodina flabellum* (Lindström) – van Wamel, p. 70, pl. 7: 18–23.
1978 *Microzarkodina flabellum* (Lindström) – Löfgren, p. 61, fig. 27A; pl. 11: 27–36, *non* fig. 27B.
1981 *Microzarkodina flabellum* (Lindström) – Ethington & Clark, p. 54, pl. 4: 2, pl. 5: 21, 22, 25, 26.
1985 *Microzarkodina flabellum* (Lindström) – Löfgren, fig. 4: H–N.

Remarks. – The species has been described by Lindström (1971) and Löfgren (1985). In the Slemmestad material *M. flabellum* is characterized by a relatively large angle between the anterior denticle and the cusp (commonly 38–57°). In comparison, this angle varies from 20 to 35° in *Microzarkodina parva*.

Occurrence. – Lower and middle part of the Hukodden Member. *B. navis* and *P. originalis* zones.

Material. – 57 P, 45 M, 7 Sa, 3Sb, 19 Sc, 9 Sd.

Microzarkodina parva Lindström 1971
Fig. 7E, G–K

1971 *Microzarkodina parva* n.sp. – Lindström, p. 59, pl. 1: 14.
1976 *Microzarkodina parva* Lindström – Dzik, fig. 35: a–h.
1977 *Microzarkodina flabellum* (Lindström) – Gedik, p. 42, pl. 2: 22–24.
1978 *Microzarkodina flabellum* (Lindström) – Löfgren, p. 61 (*partim*), fig. 27B (only).
?1981 *Microzarkodina flabellum* (Lindström) – Nowlan, p. 14, Pl. 2: 1–5.
1985 *Microzarkodina flabellum parva* Lindström – Löfgren, p. 127, fig. 4: A–G.

Remarks. – See Lindström (1971) for description. Stouge & Bagnoli (1990) revised *M. parva* and included younger (Kundan) specimens of *M. parva* in the new species *M. hagetiana* (Stouge & Bagnoli 1990).

Occurrence. – Interval from the middle part of Hukodden Member to the very top of Svartodden Member. *P. originalis* Zone to the *E.? variabilis–M. parva* Subzone.

Material. – 80 P, 71 M, 2 Sa, 8 Sb, 35 Sc, 11 Sd.

Genus *Paroistodus* Lindström 1971

Type species. – *Oistodus parallelus* Pander 1856.

Paroistodus originalis (Sergeeva 1963)
Fig. 7L–M

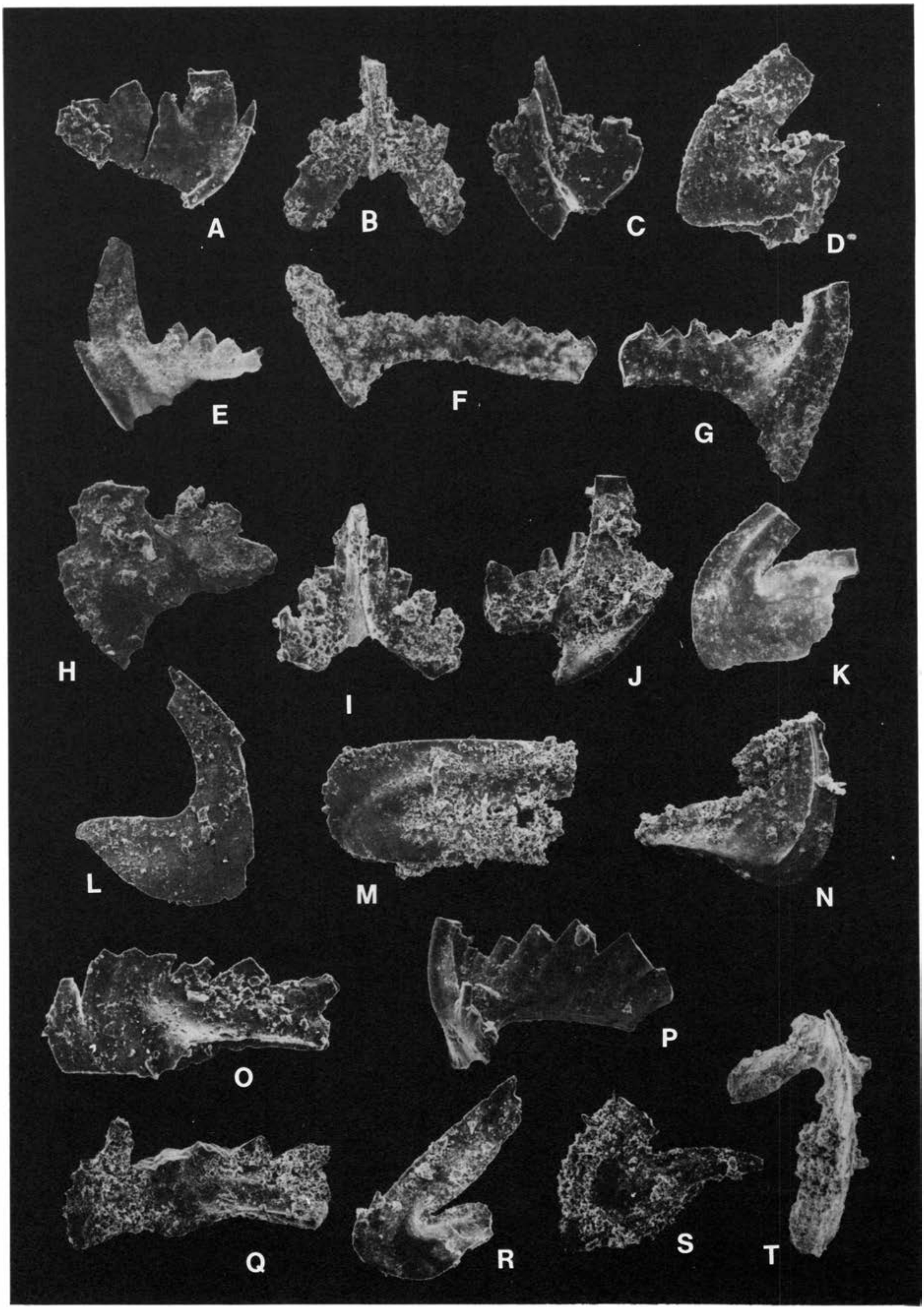

Fig. 7. □ A–D, F: *Microzarkodina flabellum* (Lindström). A. Carminate to angulate P element, PMO 121.708. Sample 70004. 80×. B. Alate Sa element, PMO 121.709. Sample 70004. 90×. C. Asymmetrical digyrate Sb element, PMO 121.710. Sample 70004. 200×. D. Geniculate M element, PMO 121.711. Sample 70004. 150×. F. Dolabrate Sc element, PMO 121.712. Sample 70004. 80×. □ E, G–K: *Microzarkodina parva* Lindström. E. Carminate to angulate P element, PMO 121.713. Stratigraphically early specimen, sample 70007. 90×. G. Dolabrate Sc element, PMO 121.714. Sample 70008. 100×. H. Carminate to angulate P element, PMO 121.715. Stratigraphically late specimen, sample 70040. 125×. I. Alate Sa element, PMO 121.716. Sample 70008. 170×. J Quadriramate Sd element, PMO 121.717. Sample 70021. 125×. K. Geniculate M element, PMO 121.718. Sample 70040. 120×. □ L, M: *Paroistodus originalis* (Sergeeva). L. Non-geniculate element, PMO 121.719. Sample 70005. 75×. M. Geniculate element, PMO 121.720. Sample 70005. 80×. □ N: *Paroistodus parallelus* (Pander). N. Non-geniculate element, PMO

1963 *Oistodus originalis* n.sp. – Sergeeva, p. 98, pl. 7: 8, 9; fig. 4.
1976 *Paroistodus originalis* (Sergeeva) – Lindström, p. 48; figs. 8, 12.
1978 *Paroistodus originalis* (Sergeeva) – Löfgren, p. 69, pl. 1: 22–25 (*cum. syn.*).

Occurrence. – Hukodden Member and basal part of Lysaker Member. Interval from *B. navis* Zone to *M. parva* Zone.

Material. – 215 non-geniculate elements, 240 geniculate elements.

Paroistodus parallelus (Pander 1856)
Fig. 7N

1856 *Oistodus parallelus* n.sp. – Pander, p. 27, pl. 2: 40.
1941 *Distacodus expansus* n.sp. – Graves & Ellison, p. 8, pl. 1: 6.
1971 *Paroistodus parallelus* (Pander) – Lindström, p. 47, figs. 8, 11.
1988 *Paroistodus parallelus* (Pander) – Stouge & Bagnoli, p. 128, pl. 8: 2, 6, 7 (*cum. syn.*).
1988 *Paroistodus parallelus* (Pander) – Bergström, pl. 2: 22–23.

Occurrence. – Basal part of Hukodden Member. *B. navis* Zone.

Material. – 2 non-geniculate elements, 3 geniculate elements.

Genus *Periodon* Hadding 1913

Type species. – *Periodon aculeatus* Hadding 1913.

Periodon flabellum (Lindström 1955)
Fig. 7O, P, S

1955 *Trichonodella flabellum* n.sp. – Lindström, p. 599, pl. 6: 28–30 (Sa element).
1971 *Periodon flabellum* (Lindström) – Lindström, p. 57, fig. 18.
1988 *Periodon flabellum* (Lindström) – Stouge & Bagnoli, p. 129, pl. 9: 12–18 (*cum. syn.*).

Remarks. – See Lindström (1955) and Stouge & Bagnoli (1988) for description.

Occurrence. – Hukodden Member. *B. navis* Zone to basal *M. parva* Zone.

Material. – 1 Pa, 5 Pb, 11 M, 5 Sb, 9 Sc, 2 Sd (*sensu* Stouge & Bagnoli 1988).

Periodon aculeatus spp. A
Fig. 7Q, R

1978 *Periodon flabellum* (Lindström) – Löfgren, p. 72 (*partim*), pl. 11: 6?, 7 (only).
1978 *Periodon flabellum* (Lindström) – Fåhræus & Nowlan, p. 462, pl. 3: 3–6, 2?; text-fig. 5: A–C, F; *non* D, E.
1978 *Periodon aculeatus* Hadding – Fåhræus & Nowlan, p. 462, pl. 3: 1, 7–11, 13, *non* 12; text-fig. 5: G–L.
1980 *Periodon flabellum* (Lindström) – Merrill, fig. 6: 36–39.
1987 *Periodon aculeatus* Hadding – Pohler et al., fig. 21.10: A–C (only).

Remarks. – *Periodon aculeatus* spp. A is distinguished from *P. flabellum* by having anteriorly denticulated M elements and a Pa element with a weakly thickened anterior process. In the Norwegian material (including unpublished material from Ringsaker) the Pa and M elements commonly have two or three denticles on the anterior process. *Periodon aculeatus* spp. A bears less denticles on both the Pa and M elements than the Middle Ordovician type species *Periodon aculeatus* Hadding *sensu stricto*.

Occurrence. – Interval from the upper part of the Hukodden Member to the upper part of the Svartodden Member. *P. originalis* Zone to *E.? variabilis–M. parva* Subzone.

Material. – 1 Pa, 3 M, 2 Sb, 3 Sc.

Genus *Polonodus* Dzik 1976

Type species. – *Ambalodus clivosus* Viira 1974.

Polonodus cf. *tablepointensis* Stouge 1984
Fig. 7T

cf. 1984 *Polonodus tablepointensis* n.sp. – Stouge, p. 72, pl. 12: 13, pl. 13: 1–5 (*cum. syn.*).
cf. 1987 *Polonodus tablepointensis* Stouge – Hünicken & Ortega, p. 140, pl. 7: 1–2.

121.721. Sample 70004. 95×. □ O, P, S: *Periodon flabellum* (Lindström). O. Angulate Pa element, PMO 121.722. Sample 70005. 140×. P. Modified tertiopedate Sd element, PMO 121.723. Sample 70005. 105×. S. Geniculate M element, PMO 121.724. Sample 70005. 90×. □ Q, R: *Periodon aculeatus* spp. A. Q. Bipennate Pa element, PMO 121.725. Sample 70006. 70×. R. Geniculate M element, PMO 121.726. Sample 70006. 95×. □ T: *Polonodus* cf. *tablepointensis* Stouge. T. Stelliplanate Pa element, PMO 121.727. Sample 70039. 50×.

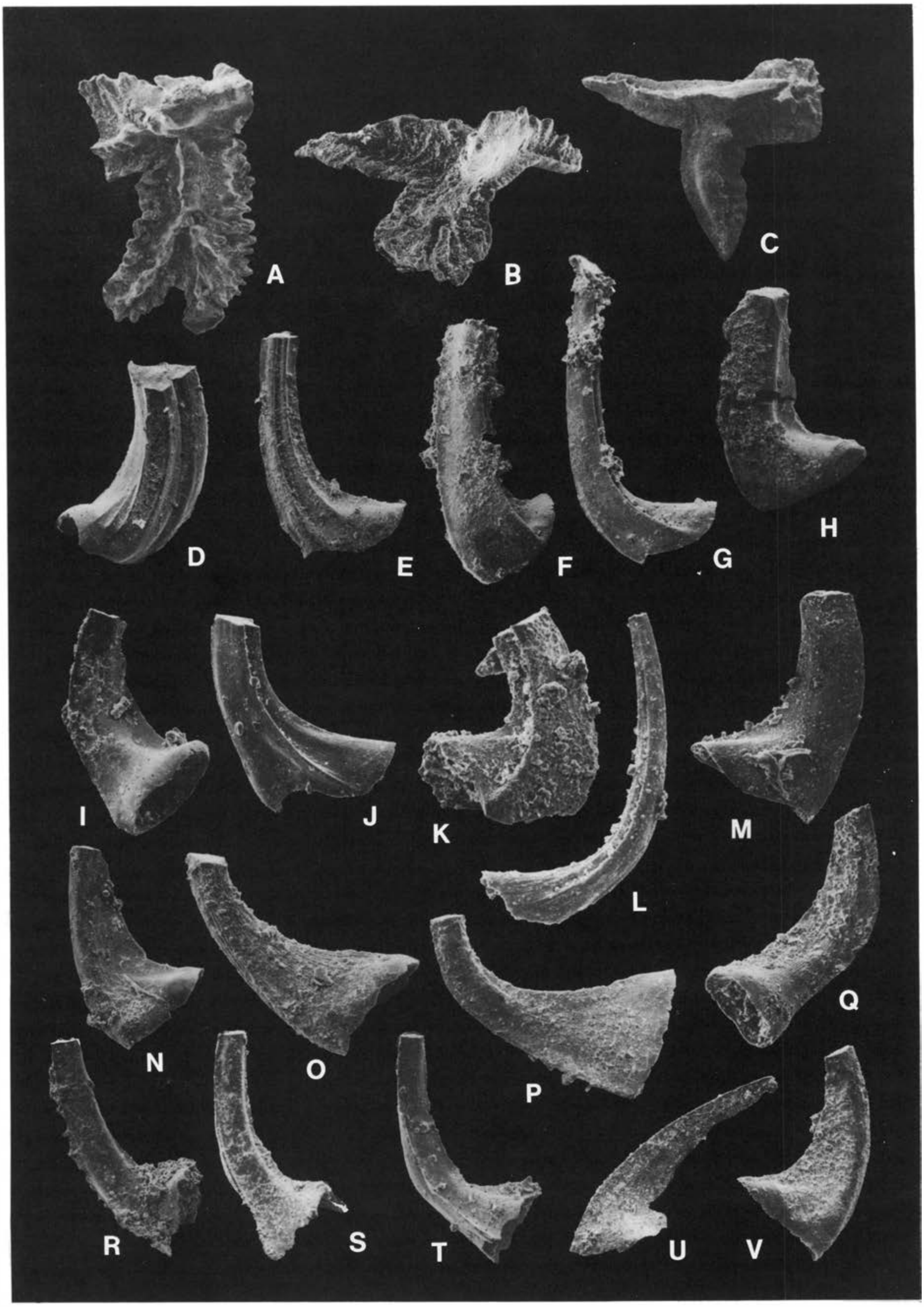

Fig. 8. □ A–C: *Polonodus? clivosus* (Viira). A. Stelliplanate Pa element, PMO 121.728. Sample 7–24. Upper view. 45×. B. Pastiniplanate Pb element, PMO 121.729. Sample 7–24. View from posterior end. 60×. C. Same specimen as 8B. Upper view. 55×. □ D, E: *Protopanderodus* cf. *varicostatus* (Sweet & Bergström). D. Non-geniculate scandodontiform element, PMO 121.730. Sample 70007. 75×. E. Non-geniculate acontiodontiform element, PMO 121.731. Sample 70007. 75×. □ F-H: *Protopanderodus rectus* (Lindström). F. Asymmetrical non-geniculate acontiodontiform element, PMO 121.732. Sample 70007. 75×. G. Symmetrical non-geniculate acontiodontiform element, PMO 121.733. Sample 70004. 90×. H. Non-geniculate scandodontiform element, PMO 121.734. Sample 70007. 50×. □ J-M: *Protopanderodus robustus* (Hadding). J. Symmetrical non-geniculate acontiodontiform element, PMO 121.735. Sample 70040. 95×. K. Asymmetrical non-geniculate acontiodontiform element, PMO 121.736. Sample 70040. 140×. L. Symmetrical non-geniculate acontiodontiform element, PMO 121.737. Sample 70040. 110×. M.

Remarks. – *Polonodus tablepointensis* was described by Stouge (1984). All the specimens at hand are badly preserved, which prevents safe species identification.

Occurrence. – Upper part of Svartodden Member. *E.? variabilis–M. parva.* Subzone.

Material. – 2 Pa, 3 Pb.

Polonodus? clivosus (Viira 1974)
Fig. 8A–C

1967 *Ambalodus* n.sp. – Viira, fig. 3: 24a, b.
1974 *Ambalodus clivosus* n.sp. – Viira, p. 51, figs. 37–38, pl. 8: 1.
non 1976 *Polonodus clivosus* (Viira) – Dzik, p. 432, fig. 7, fig. 29: c, d; pl. 43: 1.
?1978 *Polonodus clivosus* (Viira) – Löfgren, p. 76 (*partim*), pl. 16: 12a, b; pl. 16: 13 (only).
non 1984 *Polonodus? clivosus* (Viira) – Stouge, p. 73, pl. 16: 6–13.

Remarks. – *Polonodous clivosus* (Viira) *sensu* Dzik (1976) and Stouge (1984) is different from the type species *Ambalodus clivosus* Viira, as their figured specimens lack the distinct crests and ridges orientated perpendicular to the platform ledge. The stelliplanate pectiniform Pa element is associated with a pastiniplanate pectiniform Pb element in the Slemmestad section. The Pb element is three-branched and characterized by a wide, ornamented posterior process and a large reclined cusp.

Occurrence. – Middle part of Svartodden Member. *E.? variabilis–M. parva* Subzone.

Material. – 1 Pa and 3 Pb elements.

Genus *Protopanderodus* Lindström 1971

Type species. – *Acontiodus rectus* Lindström 1955

Protopanderodus rectus (Lindström 1955)
Fig. 8F–H

1955 *Acontiodus rectus* n.sp. – Lindström, p. 549, pl. 2: 7–11; fig. 3B.
1955 *Acontiodus rectus* n.sp. var. *Sulcatus* nov. – Lindström, p. 550, pl. 2: 12, 13; fig. 3D.
1955 *Scandodus rectus* n.sp. – Lindström, p. 593, pl. 4: 21–25; fig. 3K.
1971 *Protopanderodus rectus* (Lindström) – Lindström, p. 50.
1978 *Protopanderodus rectus* (Lindström) – Löfgren, p. 90, pl. 3: 1–7, pl. 3: 36A, B; fig. 31A–C (*cum. syn.*).
1987 *Protopanderodus rectus* (Lindström) – Olgun, p. 54, pl. 7: W–Z, AB, CD.

Remarks. – The species was fully described by Löfgren (1978).

Occurrence. – Throughout the Huk Formation.

Material. – 160 scandodontiforms, 390 symmetrical acontiodontiforms, and 486 asymmetrical acontiodontiform elements.

Protopanderodus robustus (Hadding 1913)
Fig. 8J–M

1913 *Drepanodus robustus* n.sp. – Hadding, p. 31, pl. 1: 5.
1978 *Protopanderodus robustus* (Hadding) – Löfgren, p. 94, pl. 3: 32–35, fig. 31G, J (*cum. syn.*).
1984 *Protopanderodus robustus* (Hadding) – Stouge, p. 49, pl. 2: 3?, 4?, 5–8.
1989 *Protopanderodus robustus* (Hadding) – McCracken, p. 20, pl. 1: 1–9, 10?; fig. 3E.

Remarks. – See Löfgren (1978) for description.

Occurrence. – Upper part of the Svartodden Member and basal part of the Elnes Formation (Helskjer Member). *E.? variabilis–M. parva* Subzone.

Material. – 18 scandodontiform elements, 31 symmetrical acontiodontiform elements and 34 asymmetrical acontiodontiform elements.

Protopanderodus cf. *varicostatus* (Sweet & Bergström 1962)
Fig. 8D, E

cf. 1962 *Scolopodus varicostatus* n.sp. – Sweet & Bergström, p. 1247, pl. 168: 4–9; fig. 1A, C, K.
cf. 1962 *Scandodus unistriatus* n.sp. – Sweet & Bergström, p. 1245, pl. 168: 12; fig. 1E.
1984 *Protopanderodus* cf. *varicostatus* (Sweet &

Non-geniculate scandodontiform element, PMO 121.738. Sample 70040. 95×. □ I, N. O: *Scalpellodus latus* (van Wamel). I. Non-geniculate scandodontiform element, PMO 121.739. Sample 70007. 130×. N. Non-geniculate short-based drepanodontiform element, PMO 121.740. Sample 70007. 100×. O. Non-geniculate long-based drepanodontiform element, PMO 121.741. Sample 70007. 175×. □ P, Q, V: *Scalpellodus gracilis* (Sergeeva). P. Non-geniculate long-based drepanodontiform element, PMO 121.742. Sample 70040. 130×. Q. Non-geniculate scandodontiform element PMO 121.743. Sample 70040. 170×. V. Non-geniculate short-based drepanodontiform element, PMO 121.744. Sample 70040. 95×. □ R-U: *Trigonodus brevibasis* (Sergeeva). R. Non-geniculate scandodontiform P element, PMO 121.745. Sample 70007. 110×. S. Non-geniculate alate Sa element, PMO 121.746. Sample 70007. 75×. T. Non-geniculate quadriramate Sd element, PMO 121.747. Sample 70007. 105×. U. Geniculate M element, PMO 121.748. Sample 70008. 50×.

Bergström) – Stouge, p. 51, pl. 3: 11–17 (*cum. syn.*).
1989 *Protopanderodus* cf. *varicostatus* (Sweet & Bergström) – McCracken, p. 22, pl. 3: 1–6, ?7, ?8.

Remarks. – The species was described by Löfgren (1978) and discussed by McCracken (1989).

Occurrence. – Hukodden Member and Svartodden Member. Interval from *B. navis* Zone to the *E.? variabilis–M. parva* Subzone.

Material. – 21 scandodontiform and 103 acontiodontiform elements.

Genus *Scalpellodus* Dzik 1976

Type species. – *Protopanderodus latus* van Wamel 1974.

Scalpellodus latus (van Wamel 1974)
Fig. 8I, N, O

1974 *Protopanderodus latus* n.sp. – van Wamel, p. 91, pl. 4: 1–3.
1978 Scalpellodus latus (van Wamel) – Löfgren, p. 99, pl. 5: 10, 14, pl. 6: 1–4, 7, 21 (*cum. syn.*).
1985 *Scalpellodus* cf. *latus* (van Wamel) – Löfgren, p. 127, fig. 4: AQ–AS, AZ, AAA.

Remarks. – See van Wamel (1974) and Löfgren (1978) for description.

Occurrence. – Interval from Hukodden member to lower part of the Svartodden Member. *P. originalis* Zone to *E.? variabilis–M. parva.* Subzone.

Material. – 37 scandodontiforms, 55 short-based drepanodontiforms, 68 long-based drepanodontiforms.

Scalpellodus gracilis (Sergeeva 1974)
Fig. 8P, Q, V

1974 *Scandodus gracilis* n.sp. – Sergeeva, p. 80 (*partim*), pl. 1: 6–9.
1978 *Scalpellodus gracilis* (Sergeeva) – Löfgren, p. 100, pl. 5: 3–6, pl. 5: 11–13, 15, pl. 6: 5–6, 8–20, 22–23 (*cum. syn.*).

Remarks. – The species was described by Löfgren (1978).

Occurrence. – Lysaker Member and Svartodden Member. *E.? variabilis–M. parva* Subzone.

Material. – 12 scandodontiforms, 25 short-based drepanodontiforms and 48 long-based drepanodontiforms.

Genus *Scolopodus* Pander 1856

Type species. – *Scolopodus sublaevis* Pander 1856

Scolopodus quadratus Pander 1856
Not figured

1856 *Scolopodus quadratus* n.sp. – Pander, p. 26, pl. 2: 6a–d, pl. A: 5d.
1856 *Scolopodus costatus* n.sp. – Pander, p. 26, pl. 2: 7a–d, pl. A: 5e.
1856 *Scolopodus striatus* n.sp. – Pander, p. 26, pl. 2: 8a–d, pl. A: 5f.
1955 *Scolopodus rex* n.sp. – Lindström, p. 595, pl. 3: 32.
1955 *Scolopodus rex* n.sp. var. *paltodiformis* nov. – Lindström, p. 596, pl. 3: 33–34.
1978 *Scolopodus rex* Lindström – Löfgren, p. 109, pl. 1: 38–39 (*cum. syn.*).
1982 *Scolopodus quadratus* Pander – Fåhræus, p. 21, pl. 2: 1–14, pl. 3: 1–8, 15.
1987 *Scolopodus quadratus* Pander – Olgun, pl. 7: EF–RS.
1988 *Scolopodus* spp. – Bergström, pl. 3: 43, 45, 44?

Remarks. – *S. quadratus* was revised and described by Fåhræus (1982).

Occurrence. – Basal part of Hukodden Member. *B. navis* Zone.

Material. – 37 non-geniculate coniform elements.

'Scolopodus' peselephantis Lindström 1955
Not figured.

1955 *Scolopodus? peselephantis* n.sp. – Lindström, p. 595, pl. 2: 19–20; fig. 3Q.
1978 *Scolopodus? peselephantis* Lindström – Löfgren, p. 108, pl. 4: 43–47 (*cum. syn.*).
1981 *'Scolopodus' peselephantis* Lindström – Ethington & Clark, p. 102, pl. 11: 26.
1988 *'Scolopodus' peselephantis* Lindström – Stouge & Bagnoli, p. 139, pl. 15: 18.

Occurrence. – Throughout the Huk Formation. Interval from the *P. originalis* Zone to the *E.? variabilis–M. parva* Subzone.

Material. – 9 non-geniculate coniform elements.

Genus *Semiacontiodus* Miller 1969

Type species. – *Acontiodus (Semiacontiodus) nogamii* Miller 1969.

Semiacontiodus cornuformis (Sergeeva 1963)
Not figured

1963 *Scolopodus cornuformis* n.sp. – Sergeeva, p. 93, pl. 7: 1–3; fig. 1.
1978 *Scolopodus cornuformis* Sergeeva – Löfgren, p. 105, pl. 7: 1–6, 9–12, pl. 8: 1–2, 4–6 (*cum. syn.*).

Occurrence. – From the upper part of the Hukodden Member to the Svartodden Member.
M. parva Zone and *E.? variabilis–M. parva* Subzone.

Material. – 164 drepanodontiforms and 63 cornuforms.

Genus *Trigonodus* Nieper 1969

Type species. – *Oistodus larapintinensis* Crespin 1943.

Trigonodus brevibasis (Sergeeva 1963)
Fig. 8R–U

1963 *Oistodus brevibasis* n.sp. – Sergeeva, p. 95, pl. 7: 4–5; fig. 2.
1971 *Scandodus brevibasis* (Sergeeva) – Lindström, p. 39, fig. 3; pl. 1: 24–27.
1974 *Triangulodus brevibasis* (Sergeeva) – van Wamel, p. 96, pl. 5: 1–7.
1978 *Scandodus brevibasis* (Sergeeva) – Löfgren, p. 104, pl. 1: 30–35 (*cum. syn.*).
cf. 1981 *Trigonodus larapintinensis* (Crespin) – Cooper, p. 180, pl. 27: 5–6, 11–12, 16–17.

Remarks. – The apparatus was reconstructed and described by van Wamel (1974). The apparatus is seximembrate and comprises one non-geniculate coniform (scandodontiform) P element, four non-geniculate, costate coniform S elements and one geniculate coniform M element. The S elements make a symmetry transition series from elements with one anterior and one posterior costae (Sc) through symmetrical tricostate (alate) Sa and asymmetrical tricostate (tertiopedate) Sb elements to tetracostate (quadriramate) Sd elements.

It was shown by Cooper (1981) that *Trigonodus* Nieper 1969 is the senior synonym of *Triangulodus* van Wamel 1974, but the generic classification of *T. brevibasis* is still under discussion by several workers. Bergström (in Robison 1981) considered *Triangulodus* and *Trigonodus* as junior synonyms of *Eoneoprioniodus* Mound 1965, but, as stated by Cooper (1981, p. 179), the latter genus is differentiated from *Trigonodus* by having adentate or weakly denticulated processes on the S elements. Lindström (in Ziegler 1977) and Sweet (1988) were of the opinion that *Triangulodus*, and the latter author also *Trigonodus* and *Eoneoprioniodus*, were junior synonyms of *Pteracontiodus* Harris & Harris 1965. However, unlike *Trigonodus*, which is characterized by having only two edges, the P element of *Pteracontiodus* has a third, lateral, process-like costa (Stouge, pers. comm. 1989).

Occurrence. – Lower and middle parts of the Hukodden Member. *P. originalis* Zone and basal part of *M. parva* Zone.

Material. – 11 P, 13 M, 7 Sa, 13 Sb, 4 Sc, 13 Sd.

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Appendix 1. Distribution of conodont elements. Sample 70003 corresponds to sample 3, 70004 to sample 4 etc. at Fig. 3.

	D. forceps	*P. parallelus*	*S. quadratus*	*P. flabellum*	*M. flabellum*	*P. rectus*	*D. arcuatus*	*D. basiovalis*	*B. triangularis*	*B. navis*	*P. originalis*	*P. cf. varicostatus*	*T. brevibasis*	*C. longibasis*	*S. latus*	*P. aculeatus spp. A*	*S. peselephantis*	*B. norrlandicus*	*M. parva*	*D. stougei n.sp.*	*S. cornuformis*	*Amorphognathus? sp.*	*E.? variabilis*	*Lenodus sp. A*	*S. gracilis*	*D. venustus*	*B. medius*	*P.? clivosus*	*D. tablepointensis*	*D. mutatus*	*A. jemtlandica*	*D. planus*	*P. cf. tablepointensis*	*P. robustus*	*Microzarkodina sp. indet.*	TOTAL
70003	23	3	2	1	2	18	5	1																												55
70004	136	2	24	4	64	259	35	1	5	50	3	5																								588
70005			7	28	15	224	42	73		51	201	2	27	1																						671
70006					14	284	18	104		41	220		4	1	2	4	1																			693
70007			4		28	207	38	84		48	3	14	13		44		1	2	5																	381
70008					26	37	22	29		39	2	5	17		36	1	2	1	3	2																222
70009						5	8	3			1							9	3																	29
70010					1	3	1				4				2			2	10																	23
70011						25	6	5			15			1	7			18			1															78
70012						13	3	8			4				9			7			1															45
70013						5	2	4							6			15	1		1															34
70014						7	1				2				2			6	2	10	2															32
70016															1			1																		2
70019						11	4	15						2	8			19	5	27	3															94
70021						8	2								24			57	18	8	2	1														120
70022							5								7		1	16	14	6	1		1													51
70023							2								6			6	2	2	2		1													21
70024						1	4							1	4			7		10	1			1												29
70025															1			2		1																4
70026							1							3	1			1	2				1		4											13
70027						1																				1?										1
70029							1							2				2		1	2	2	1													11
70030																				5	1															6
70031						3	2											1?		4	4			1	1											15
70032						1												136	4	8	20	1	44		1	1	5									221
7–24						5	4	26						8			1		13		29	4	22	1	8	5	97	4	2							229
70034						8	3	12						2					20		34	5	32		19	44	121		6	1						307
70035						2	14	7				8		2		3			25	7	28				7		54			4						161
70037						1	12	5				20		4					28	3	20		2		9		88			11			1?			203
70039						8	51	9				42		4					21		51	2	4		11	10	83				2	3	3	41		345
70040							35					27		1			2		31	6	22				21	9	28			6	1	3		40	1	235
70041								3				1														2	2			1		1	1?	1	1	12
70043						1?		1								1	1				2				3	1	6								2	17
7–28								6																	1		1			3			2	1		14
70044																											1									1
TOTAL	159	5	37	33	140	1036	321	396	5	229	455	124	61	32	160	9	9	307	207	100	227	15	108	3	85	73	488	4	8	26	3	7	5	83	3	4963