6. On the Early Ordovician of Sweden Stratigraphy and Fauna

By

Torsten E. Tjernvik

Contents

ABSTRACT.—The paper deals with the stratigraphy and faunas of the upper Tremadocian and the lower Arenigian rocks of Sweden. Sections through these rocks from most of the Palaeozoic districts of the country are described and figured. The limestones examined are subdivided into trilobite zones, and an attempt is made to correlate some of these zones with the graptolite zones of the Arenigian Lower Didymograptus shale. Correlations are also proposed with the early Ordovician beds of Great Britain, Norway, and the East Baltic.

A number of new trilobite genera and species are described, and several old species, imperfectly known, are revised.

ABBREVIATIONS.—The following abbreviations denote the collections in which the specimens dealt with in the paper are housed:

LP Palaeontological Institution of Lund.
OPM Palaeontological Museum of Oslo.
PU Palaeontological Institution of Uppsala.
RM Riksmuseum (State Museum of Nat. History), Stockholm.
SGU Sveriges Geologiska Undersöknings Museum (Geol. Survey Museum), Stockholm.

Acknowledgments

In 1949 the late Dr. E. WARBURG, at that time in charge of the Palaeontological Institution of Uppsala, made it possible for me to start an examination of the Ordovician Planilimbata limestone and its fauna. Until her retirement in 1950 she facilitated my work in many ways, for which assistance I shall always keep her in grateful memory.

During the following years I have had the advantage to continue my investigations under the guidance of Professor P. THORSLUND, who has given unsparingly of his time and energy in support of the continuation and completion of the present work. To him I wish to tender my most grateful thanks for his inspiring teaching, his advice and criticism, and for his great personal kindness.

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Palaeontological Institution of the University of Uppsala, January 1956.

T. Tjernvik

I. STRATIGRAPHY

Introduction

This paper contains the results of the author's investigations on some of the early Ordovician rocks of Sweden. The field work has been carried out mainly during the last six years when the author has had the opportunity of studying a fairly large number of sections in different parts of Sweden.

Schematically the stratigraphical classification and correlation of the Ordovician beds discussed is the following:

Limbata limestone	Lower	Arenigian
Planilimbata limestone	Didymograptus shale	
	Ceratopyge limestone	
	Ceratopyge shale	Tremadocian
	Dictyonema shale	
	Cambrian	

The Tremadocian rocks are well known, and are subdivided into trilobite or graptolite zones. The stratigraphy of the Lower Didymograptus shale is on the whole made clear. The aim of the investigation has been a wider knowledge of the hitherto rather neglected early Arenigian limestones of Sweden. The main part of the paper is therefore devoted to the Planilimbata limestone, to its stratigraphy, fauna, and its relation to the Tremadocian beds. The investigated limestones have been subdivided into trilobite zones, and an attempt is made to correlate these zones with the graptolite zones of the Lower Didymograptus shale.

To start with the early Ordovician rocks of Närke were studied. In this province of South Central Sweden the beds are undisturbed by tectonic movements, and are made up of fossiliferous limestones in which the succession of faunas can be followed rather easily. These limestones are of Arenigian age. They usually begin with Planilimbata limestone, and rest upon Upper Cambrian alum shale belonging to the zone of *Peltura*.

Ordovician beds older than the Planilimbata limestone have so far not been known from Närke. But while examining a section at Latorp the author found in the glauconitic basal layers of the Ordovician rocks a bed of white limestone, frequently thinning out to nothing. It contains the brachiopod *Lycophoria laevis* STOLLEY. In the surrounding glauconitic limestone a couple of trilobites foreign to the fauna of the Planilimbata limestone, as well as to that of the Ceratopyge limestone, were encountered. One of these trilobites is *Plesiomegalaspis armata* n. sp. It is related to *P. heroides* (BRÖGGER).

Similar limestones with *Lycophoria laevis* are reported from Dalarna and Jämtland where they are underlying the Planilimbata limestone. They were included by WIMAN (1906) into the Tremadocian Ceratopyge limestone. Yet they do not contain *Ceratopyge forficula* (SARS), and the relation of their fauna to the typical Ceratopyge fauna has hitherto not been determined with certainty. Nor has the relation of the Ceratopyge fauna to that of the Planilimbata limestone been fully settled either there or in other places.

In the hope of obtaining a more intimate knowledge of these faunas the investigations were extended to Västergötland, where sections through the lowermost Ordovician beds were studied at several localities. The situation of these localities is shown on the sketch-map, text-fig. 1.

In the north-eastern part of the Palaeozoic district of this province the author found stratigraphical conditions similar to those in Närke. At Stora Stolan on the northern slopes of Billingen mountain the glauconitic limestone below the beds with *Plesiomegalaspis planilimbata* (ANGELIN) contains one or two thin layers of white limestone with *Lycophoria laevis* and *Plesiomegalaspis armata*. No trace of the typical Ceratopyge fauna is to be seen; shells of *Lycophoria laevis* are lying directly upon the corroded surface of Cambrian anthraconite (stinkstone) with *Peltura scarabaeoides* (WAHLENBERG).

At Skultorp on the south-eastern slopes of Billingen a similarly incomplete

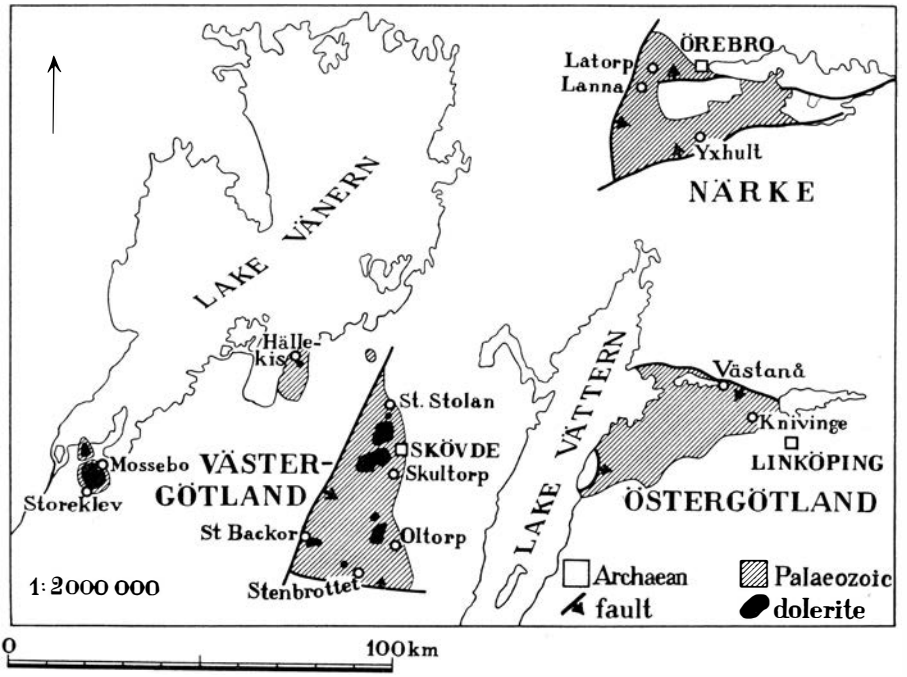


Fig. 1. Sketch-map showing the distribution of the localities in Västergötland, Närke, and Östergötland dealt with in the paper.

succession has been observed. Still less is to be learned at the nearby Varvsberget mountain where, as stated by THORSLUND (1937a), Ordovician layers older than the Planilimbata limestone are entirely lacking.

However, farther to the south and to the west of the district the beds with *Lycophoria laevis* are found in contact with typical Ceratopyge limestone. Good sections through rocks of that kind are exposed at Stenbrottet, SE of Ålleberg mountain, and at some localities at Hunneberg mountain.

In the following some representative sections through the early Ordovician beds of Västergötland and Närke are described. We begin with an exposure at Storeklev, Hunneberg, which is the locality situated farthest to the south-west.

The Sections in Västergötland (Vestergötland, Vestrogothia)

STOREKLEV

Storeklev is the name of a precipice at the southern end of Hunneberg mountain. There a good section is available in an old quarry half-way up the slope. Ordovician layers with a thickness of about five metres are exposed, consisting of dark shales with scattered beds of limestone. The shales are covered

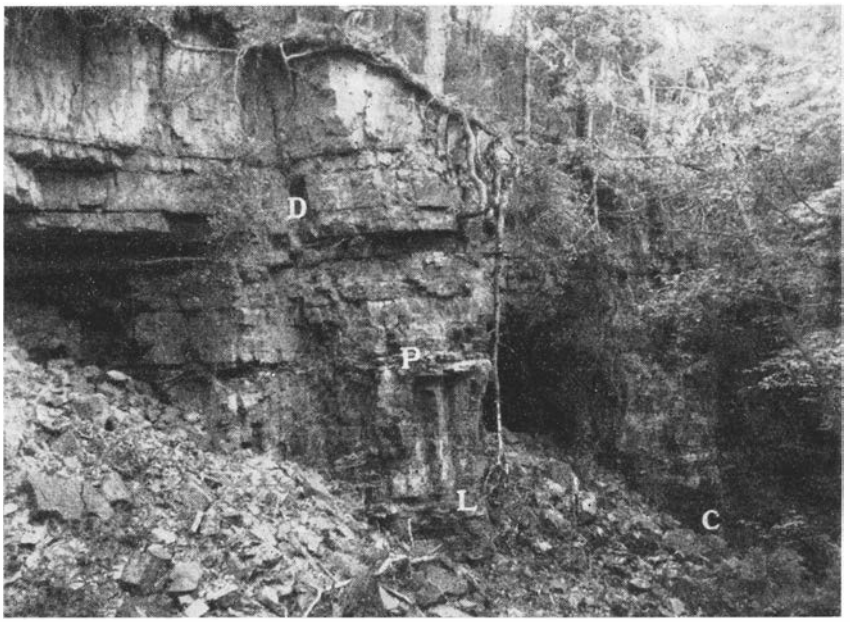


Fig. 2. The old quarry at Storeklev, Hunneberg mountain. C = Ceratopyge limestone. L = limestone bed with *Lycophoria laevis*. P = limestone bed with *Plesiomegalaspis planilimbata*. D = dolerite.

by dolerite. A description of the section is given below, followed by a discussion on the stratigraphical classification of the rocks.

Description of the section in text-fig. 3 (fossils recorded: PU nos. Vg 90–139):

UPPER CAMBRIAN:

Subzone of *Peltura minor*:

A. Bed of anthraconite with *Peltura minor* (BRÖGGER), *Sphaerophthalmus major* LAKE, and *Ctenopyge tumida* WESTERGÅRD.

TREMADOCIAN:

Ceratopyge beds:

Zone of *Apatokephalus serratus*:

B. Dark-grey shales with beds and nodules of dark-grey limestone, total thickness about 1.5 m. The two lowermost limestone beds are richly fossiliferous, and have yielded the following species: *Ceratopyge forficula*, *Euloma ornatum* ANGELIN, *Orometopus elatifrons* (ANGELIN), *Apatokephalus serratus* (BOECK), *Triarthrus angelini* LINNARSSON, *Peltura*? *norvegica* (MOBERG & MÖLLER), *Niobe insignis* LINNARSSON, *Niobella obsoleta* (LINNARSSON), *Varvia longicauda* n.gen. & n.sp., *Symphysurus angustatus* (SARS & BOECK), *Nileus limbatus* BRÖGGER, *Harpides rugosus* (SARS & BOECK), and "*Protopliomerops*" *primigenius* (ANGELIN).

Fossils collected at this locality and certainly from the same limestone beds are kept in the collections of the State Museum of Nat. History and of the

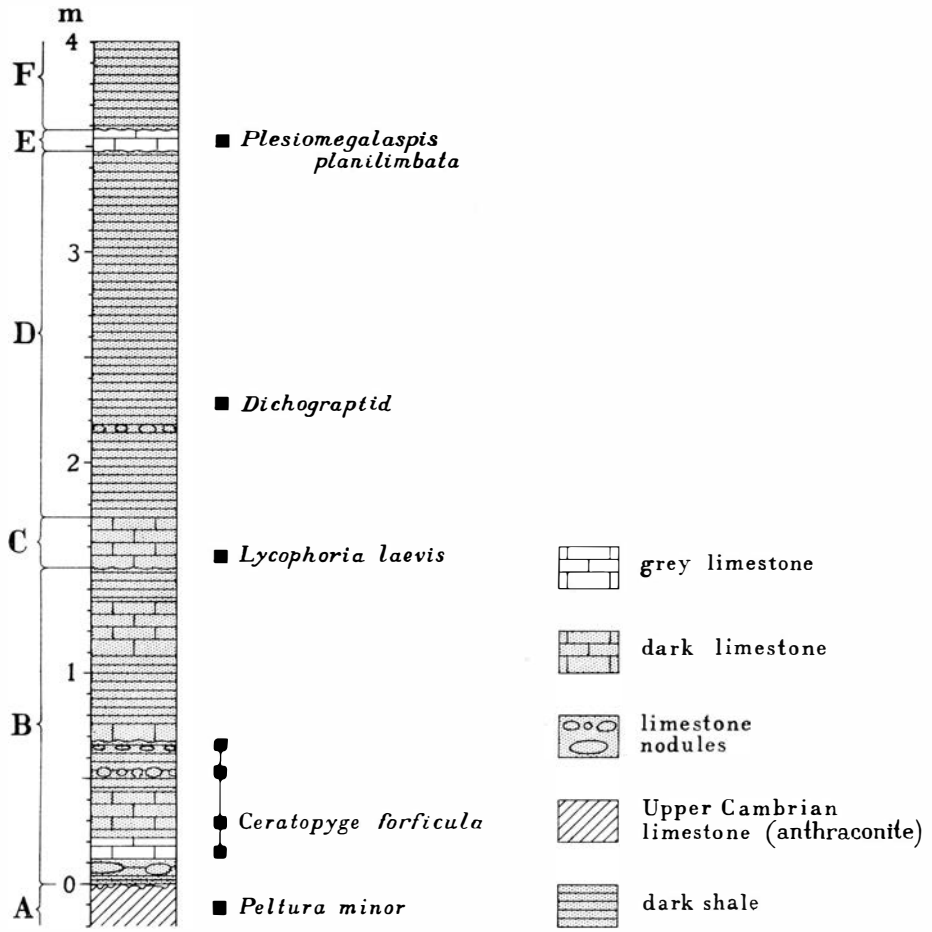


Fig. 3. Section through the Ordovician beds at Storeklev, Hunneberg mountain.

Geological Survey Museum in Stockholm. On slabs containing some of the above fossils specimens of *Promegalaspides intactus* (MOBERG & SEGERBERG) and *Parabolinella* sp. are preserved.

The shales are in part very hard and pyritiferous. They contain *Broeggeria* cf. *salteri* (HOLL).

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

C. Bed of dark-grey limestone, 0.25 m thick, with sparse grains of glauconite at the base. Fossils are fairly abundant and the following species were encountered: *Lycophoria laevis*, *Apheoorthis? suecica* n. sp., *Hunnebergia retusa* n. gen. & n. sp., *Niobe incerta* n.sp., *Symphysurus angustatus*, *Varvia falensis* n. sp., *Nileus limbatus*, *Falanaspis aliena* n. gen. & n. sp., *Euloma* sp. no. 1, and *Geragnostus crassus* n. sp.

D. Dark-grey shale, 1.75 m thick, chiefly devoid of fossils. In the lower part of the bed occurs a thin layer of pyritiferous shale with small nodules of limestone. 10–15 cm above this layer the shale is fairly rich in specimens of an undescribed large dichograptid commented on below.

Zone of *Plesiomegalaspis planilimbata* (Lower Planilimbata limestone):

E. Bed of grey limestone, 0.10 m thick, with *Plesiomegalaspis planilimbata*, *P. heroides*, *Megalaspides nericiensis* WIMAN, *Promegalaspides stenorhachis* (ANGELIN), *Niobe emarginula* ANGELIN, *Niobella bohlini* n.sp., *Lapidaria rugosa* n.gen. & n.sp., *Symphysurus angustatus*, *Euloma* sp. no. 2, and *Ampyx* sp.

Zone of *Tetragraptus phyllograptoides*:

F. Grey shale referred by TÖRNQUIST (1901, p. 2) to this zone.

COMMENTS ON THE STRATIGRAPHY.—All species listed above from the subdivision B belong to the Ceratopyge fauna. Characteristic members of this fauna are: *Ceratopyge forficula*, *Euloma ornatum*, *Triarthrus angelini*, *Apatokephalus serratus*, *Orometopus elatifrons*, *Niobe insignis*, *Niobella obsoleta*, *Varvia longicauda*, *Symphysurina? oriens* (MOBERG & SEGERBERG), "*Protopliomerops*" *primigenius*, and *Eostrophomena elegantula* WALCOTT. Limestones containing this fauna (but no other limestones) are referred in this paper to the Ceratopyge limestone which is equivalent to the zone of *Apatokephalus serratus*. This zone is looked upon as the uppermost stratigraphical subdivision of the Tremadocian of Sweden.

The overlying strata of shales and limestones are referred to a new unit, the Hunneberg group. They are regarded as the lowermost Arenigian of Sweden. The limestones of this group have a far wider regional distribution than the Ceratopyge limestone. Their trilobite faunas show many Tremadocian features, the hitherto known graptolite faunas of the corresponding shales are, however, of Arenigian age.

The Hunneberg group begins with the limestone bed marked as division C. It contains a trilobite and brachiopod fauna distinctly different from that of the Ceratopyge limestone. The main part of the fauna is as yet undescribed. Some of its index fossils are present in the bed: *Lycophoria laevis*, *Apheoorthis? suecica*, *Hunnebergia retusa*, *Niobe incerta*, *Varvia falensis*, and *Falanaspis aliena*. Layers with this fauna have been referred to the new trilobite zone of *Plesiomegalaspis armata*. *Lycophoria laevis* occurs in the basal beds of the zone.

The shale bed D contains a small undescribed graptolite fauna. The commonest species is a large dichograptid with a funicle about 3 cm long and with four distal branches. It might be a peculiar *Tetragraptus*, but the specimens might possibly be broken and the branches divide again distally. Professor O. M. B. BULMAN has kindly examined some of the specimens collected. He has pointed out that they show some likeness to *Dichograptus sedecimus* HARRIS & THOMAS and a couple of *Clonograptus* species described by the same authors from the basal Bendigonian (lower Arenigian) of Australia.

The above incompletely known dichograptid is new to Sweden, and seems to be a good index fossil for the basal strata of the Lower Didymograptus shale. In all probability these strata are contemporaneous with the limestone with *Plesiomegalaspis armata*.

A third trilobite fauna is met with in the uppermost limestone bed (E). It contains, *inter alia*, *Plesiomegalaspis planilimbata*, *P. heroides*, *Megalaspides nericiensis*, *Promegalaspides stenorhachis*, and *Niobe emarginula*. These species are index fossils for those basal beds of the Planilimbata limestone which had been distinguished by TJERNVIK (1952) as the Lower Planilimbata limestone. In the present paper this subdivision is called the zone of *Plesiomegalaspis planilimbata*. It is not equivalent to the *Megalaspis planilimbata* zone or *Planilimbata* zone of WESTERGÅRD (1931, 1940), THORSLUND (1937 a, 1940), REGNÉLL (1942), and TJERNVIK (1952) which subdivision included the whole of the Planilimbata limestone. As will be shown in the following the zone of *Plesiomegalaspis planilimbata* can be correlated with the graptolite zone of *Tetragraptus phyllograptoides* (division F of the section).

MOSSEBO

At Mossebo on the north-eastern slopes of Hunneberg the Ordovician beds are at present well exposed (text-fig. 4). The debris of dolerite boulders, which formerly covered a great part of the precipice, is by now removed to be used as road metal.

The locality has been visited and its sections described by several authors: LINNARSSON (1869), SIDENBLADH (1870), A. LINDSTRÖM (1887), TÖRNQUIST (1901, 1904), MOBERG (1906), and WESTERGÅRD (1922).

LINNARSSON collected from the limestone beds the type specimens of *Geragnostus sidenbladhi*, *Triarthrus angelini*, *Niobe insignis*, and *Niobella obsoleta*. TÖRNQUIST described numerous new species of graptolites from the shales. MOBERG used a section at Mossebo for the classification of the lowermost Ordovician rocks of Västergötland. He referred the limestone beds of the locality and the shale with *Tetragraptus phyllograptoides* to his Ceratopyge Region.

Description of a new section at Mossebo, text-fig. 5 (fossils recorded: PU nos. Vg 140–231):

UPPER CAMBRIAN:

Subzone of *Peltura minor*:

A. Bed of anthraconite, 0.45 m thick. Its lower part contains *Peltura minor*, *P. scarabaeoides acutidens* BRÖGGER, and *Sphaerophthalmus major*. The upper part is rich in pyrite and devoid of fossils.

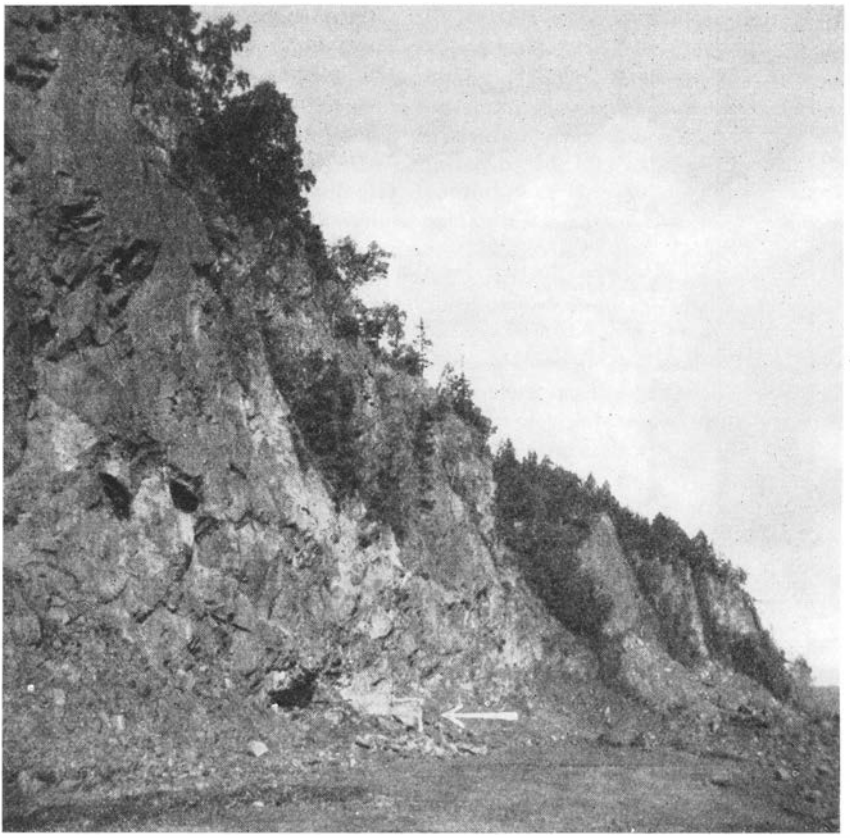


Fig. 4. Precipice of dolerite at Mossebo, Hunneberg mountain. The arrow points at the underlying Cambrian and Ordovician beds.

TREMADOCIAN:

Ceratopyge beds:

Zone of *Apatokephalus serratus*:

B. Beds of usually very dark limestone, total thickness about 0.4 m. The lowermost bed is highly fossiliferous. At the base it is light-grey and rich in shells of *Triarthrus angelini* and *Peltura? norvegica*. The upper, dark-coloured part of the bed contains *Ceratopyge forficula*, *Euloma ornatum*, *Orometopus elatifrons*, *Apatokephalus serratus*, *Niobe insignis*, *Niobella obsoleta*, *Varvia longicauda*, *Symphysurus angustatus*, *Dikelokephalina dicraeura* (ANGELIN), *Shumardia* cf. *pusilla* (SARS), *Geragnostus sidenbladhi* (LINNARSSON), *G. crassus*, *Trinodus mobergi* n. sp., and *Broeggeria* cf. *salteri*.

The upper beds are stained with pyrite and commonly poor in fossils. Yet in a thin layer of light-grey limestone near the top *Ceratopyge forficula* occurs abundantly.

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

C. Beds of very dark limestone rich in pyrite, total thickness 0.4 m. Scattered spots of light-grey limestone occur in the lowermost part of the zone. In

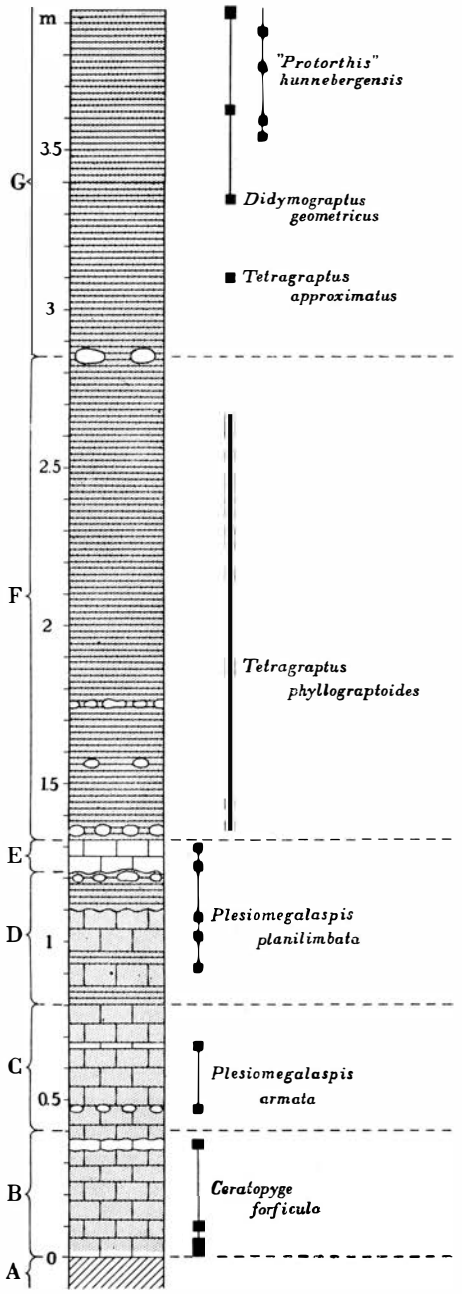


Fig. 5. Section through the Ordovician beds at Mossebo, Hunneberg mountain.

these light-coloured portions *Plesiomegalaspis armata* was encountered. A thin layer of similar limestone appears at a higher level. It contains *Plesiomegalaspis armata*, *Niobe* cf. *incerta*, *Niobella* cf. *bohlini*, *Lapidaria tenella* n.sp., *Falanaspis aliena* (common), *Orometopus grypos* n.sp., *Saltaspis viator* n.sp., *Triarthrus* sp., *Geragnostus crassus*, and *Broeggeria* sp.

The upper surface of the uppermost limestone bed is very uneven exhibiting deep and wide pits. Such surfaces appear at the boundaries between the zones of the early Ordovician limestones. Probably they are due to chemical corrosion.

Zone of *Plesiomegalaspis planilimbata*:

D. Beds of dark limestone intercalated with thin layers of hard, dark mudstone and shale. The total thickness is 0.4 m. The limestone contains *Plesiomegalaspis planilimbata*, *Megalaspides nericiensis* (common), and *Promegalaspides stenorhachis*; the shales *Broeggeria* sp. and *Ceratiocaris*? sp.

Some pygidia of *Plesiomegalaspis heroides* found beyond doubt in this limestone are kept in the Geol. Survey collections.

E. Bed of grey limestone, 0.10 m, with *Plesiomegalaspis planilimbata*, *Megalaspides nericiensis*, *Niobella bohlini*, and *Symphysurus angustatus*.

Zone of *Tetragraptus phyllograptoides*:

F. Dark shale with small nodules of limestone, total thickness about 1.5 m. From the nodules poor specimens of *Symphysurus angustatus* were obtained. The shale is rich in well preserved graptolites. Determined species are *Tetragraptus phyllograptoides* and *Didymograptus undulatus* TÖRNQUIST which are also the most common ones.

A slab of shale from this zone containing both the above graptolites and a pygidium of *Plesiomegalaspis planilimbata* was collected long ago at Mossebo (RM no. Ar. 14402).

Zone of *Didymograptus balticus*:

G. Dark shale of varying thickness covered by dolerite. The lower boundary of the zone is drawn at a level with nodules of pyritic limestone. These nodules often fuse into a bed of limestone containing glauconite grains. From a nodule at the same level, but in another exposure at Mossebo a complete specimen of *Megalaspides nericiensis* was collected by Mr. R. TILSTAM, Lilleskog, and presented to the Palaeontological Institution of Uppsala.

Only the shale of the lowermost part of the zone was examined. It contains, *inter alia*, *Tetragraptus approximatus* NICHOLSON and *Didymograptus geometricus* TÖRNQUIST. No specimens of *D. balticus* TULLBERG were found. This species, collected by TÖRNQUIST (1901, p. 19) from the shales at Mossebo, probably occurs at a higher level.

Brachiopods are common in the shale, above all "*Protorthis*" *hunnebergensis* WALCOTT. Other species encountered belong to the genera *Broeggeria* and *Acrotreta*. Flattened and corroded shells of trilobites occur sparsely. One pygidium probably belongs to *Megalaspides nericiensis*.

COMMENTS ON THE STRATIGRAPHY.—The above section makes clear that the shales with *Tetragraptus phyllograptoides* contain *Plesiomegalaspis planilimbata* and *Megalaspides nericiensis*. Thus the graptolite zone of *T. phyllograptoides* is to be correlated, wholly or in part, with the trilobite zone of *P. planilimbata*.

The shales overlying the zone of *T. phyllograptoides* were referred by TÖRNQUIST (1901, p. 2) and MOBERG (1906, p. 45) to the zone of *Didymograptus balticus*. The author's examination of these shales has been very superficial. The trilobites encountered do not permit a safe correlation of the shales with any part of the Planilimbata limestone. However, the presence of "*Protorthis*" *hunnebergensis* is of interest. At Gymninge in Närke this brachiopod occurs in abundance in the uppermost limestone bed of the zone of *Plesiomegalaspis planilimbata* (compare p. 138). The bed contains several trilobite species foreign to the lower part of the same zone. They seem to indicate that the zone of *D. balticus* corresponds to the upper part of the zone of *P. planilimbata*.

STENBROTTET

At Stenbrottet (Orreholmen), 5 km SE of Ålleberg mountain limestone and alum shale are quarried for use in lime-kilns. Lower Ordovician layers are well exposed, and display instructive sections through highly fossiliferous beds of Tremadocian and early Arenigian age.

The rocks and their stratigraphy have been dealt with by several authors. LINNARSSON (1880) made the first find of Dictyonema shale in Västergötland at this locality. L. v. POST (1906) proved the existence of Ceratopyge limestone, and supplied a detailed section through the Ordovician beds. The stratigraphy has been discussed later by WESTERGÅRD (1909, 1922) and by THORSLUND (1937a). The latter pointed out that the Ceratopyge limestone is overlain by beds of Planilimbata limestone rich in glauconite.

After their deposition the early Ordovician layers have been intermittently denudated, and later some beds have probably been squeezed out owing to sliding. The result is that the thickness and sequence of the beds are changing so rapidly that no stratigraphically complete section is obtainable. Two sections are therefore described. They are reproduced in text-fig. 6.

Description of section I, text-fig. 6, at the north-eastern end of the quarry (fossils recorded PU nos. Vg 232–467):

UPPER CAMBRIAN:

Subzone of *Peltura scarabaeoides*:

A. Bed of anthraconite, about 0.5 m thick, with *Peltura scarabaeoides*.

TREMADOCIAN:

Zone of *Dictyonema flabelliforme flabelliforme*:

B. Alum shale, about 0.4 m thick, with lenses of anthraconite in its upper part, both rocks containing *Dictyonema flabelliforme flabelliforme* (EICHWALD).

Probably owing to denudation, connected with changes of sea level after the deposition of the beds, some lenses were detached from the alum shale, and are found embedded in the superposed glauconitic shale belonging to the zone of *Apatokephalus serratus*.

Zone of *Apatokephalus serratus*:

C. Shaly rock, 0.02–0.12 m thick, consisting mainly of glauconite grains. No fossils were encountered here. Occasionally small lenses of light-brown limestone are embedded in the shale. They contain *Triarthrus angelini*.

D. In a basal layer of light-grey limestone, 0.06 m thick, fossils occur in abundance. They are: *Ceratopyge forficula*, *Euloma ornatum*, *Orometopus elatifrons*, *Apatokephalus serratus*, *Niobe insignis*, *Niobella* aff. *obsoleta*, *Varvia longicauda*, *Symphysurina*? *oriens*, *Symphysurus angustatus*, *Nileus limbatus*, *Parapilekia speciosa* (DALMAN), "*Protopliomerops*" *primigenius*, *Agerina praematura* n. gen. & n. sp., *Harpides rugosus*, *Geragnostus sidenbladhi*, *G. crassus*, *Trinodus mobergi*, *Eostrophomena elegantula*, *Nanorthis*? *christianiae* (KJERULF), and *Broeggeria* sp.

The upper surface of the limestone bed is uneven, containing deep pits filled by the superposed dark-green glauconitic limestone. The latter encloses a few scattered remnants of a thin layer of white limestone containing *Ceratopyge forficula* and *Symphysurina*? *oriens*.

Occasionally the basal limestone bed is rich in *Triarthrus angelini* associated with sparse specimens of *Saltaspis* sp.

The total thickness of the division D is only about 0.1 m.

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

E. Dark-green glauconitic limestone, 0.12 m thick, with two or three thin layers of white limestone. In the glauconitic rock bleached shells of *Plesiomegalaspis*

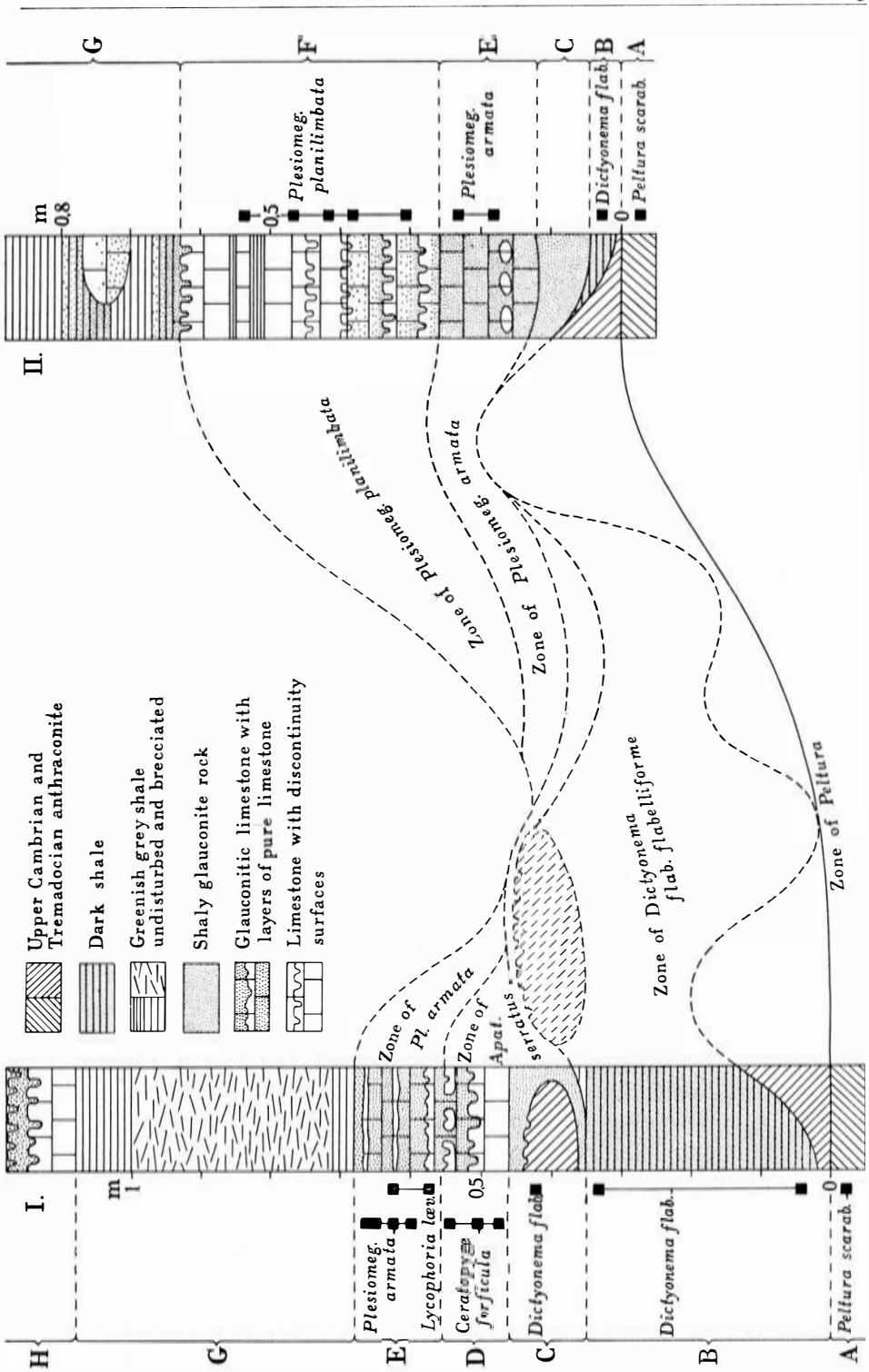


Fig. 6. Sections I and II through the lowermost Ordovician beds at Stenbrottet, Västergötland.

armata and *Nanorthis? billingensis* are common. The white limestone is exceedingly rich in fossils, and has rendered a rather large number of species. They are: *Plesiomegalaspis armata, Plesiomegalaspis?* sp. no. 1, *Hunnebergia retusa, Promegalaspides* sp., *Niobe incerta, Niobella* cf. *bohlini, Lapidaria tenella, Varvia falensis, Symphysurus angustatus, Saltaspis viator, Triarthrus* sp., *Parabolinella?* sp. no. 1, *Shumardia* sp., *Apatokephalus* sp., *Illaenus?* sp., *Falanaspis aliena, Orometopus grypos*, one odontopleurid trilobite, *Geragnostus lepidus* n. sp., *G. crassus, Lycophoria laevis* (in the lower layers only), *Apheorthis? suecica, Nanorthis? billingensis*, and *Broeggeria* sp. The white limestone contains glauconite and is rich in pyrite.

The zone of *Plesiomegalaspis planilimbata* is entirely lacking in this section.

Lower Didymograptus shale (Billingen group. Compare the comments below):

Zone of *Phyllograptus densus*:

G. Greenish grey shale, about 0.4 m thick, partly disturbed by sliding. No fossils were obtained from this section (compare, however, section II, division G).

Limbata limestone:

H. The shale is overlain by limestone in which *Megistaspis* sp. aff. *limbata* (BOECK) is found a few centimetres above a glauconitic bed with several surfaces of discontinuity.

Description of section II, text-fig. 6, situated 120 m S of section I (fossils recorded: PU nos. Vg 468–490; 594–609):

UPPER CAMBRIAN:

Subzone of *Peltura scarabaeoides*:

A. Bed of anthraconite, about 0.3 m thick, with *Peltura scarabaeoides*.

TREMADOCIAN:

Zone of *Dictyonema flabelliforme flabelliforme*:

B. Denudated bed of alum shale and anthraconite, 0.01–0.30 m thick. Almost all of the shale and the upper lenses of anthraconite encountered in section I are absent in this section. Some anthraconite is left at the base of the zone only. It forms dome-shaped knobs, usually attached to the bed with *Peltura*. They are 0.2–0.3 m high. In the depressions between the knobs a thin layer of alum shale is preserved. It contains *Dictyonema flabelliforme flabelliforme*. Further informations on the bed will be given in a future paper.

Zone of *Apatokephalus serratus?*:

C. Glauconitic shale, 0.05–0.12 m thick, without fossils, probably corresponding to the subdivision C of section I.

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

E. Dark-green glauconitic limestone, 0.14 m thick, with *Plesiomegalaspis armata* and *Nanorthis? billingensis*.

Zone of *Plesiomegalaspis planilimbata*:

F. Brown, grey or greenish limestone, 0.37 m. The lower beds are rich in glauconite grains, in the upper part there are two thin layers of greenish shale.

Five surfaces of discontinuity occur in the limestone. They are uneven, with narrow pits, and are coloured by glauconite. The topmost surface corresponds to the boundary towards the next zone. In the limestone the following species were found: *Plesiomegalaspis planilimbata*, *P. heroides* (in the lowermost bed only), *Megalaspides nericiensis*, *Promegalaspides stenorhachis*, *Niobe emarginula*, *Niobella bohlini*, *Lapidaria rugosa*, *Varvia breviceps* (ANGELIN), *Symphysurus angustatus*, *Pliomerops actinurus* (DALMAN), *Apatokephalus pecten* WIMAN, and *Leiagnostus peltatus* n. sp.

In the greenish shale belonging to the zone, Dr. B. WÆRN has collected beautiful specimens of most of the above species and in addition *Shumardia nericiensis* WIMAN and *Geragnostus wimani* n. sp.

Lower Didymograptus shale (Billingen group. Compare the comments below):

Zone of *Phyllograptus densus*:

G. Undisturbed greenish grey shale, about 0.8 m thick. The basal part contains glauconite grains and nodules of glauconitic limestone, the upper part a bed of grey, pyritic limestone. A few specimens of *Phyllograptus angustifolius* J. HALL and *P. densus* TÖRNQUIST were found in a thin seam of brownish shale about 10 cm below the limestone bed.

The shale is superposed by Limbata limestone identical with that of subdivision H in section I.

COMMENTS.—The quarry at Stenbrottet offers the best opportunities for studying the fauna of the zone of *Plesiomegalaspis armata*. The thin limestone beds of this zone have supplied some easily recognized brachiopod species and nearly twenty species of trilobites. Good index fossils are: *Lycophoria laevis*, *Apheoorthis? suecica*, *Plesiomegalaspis armata*, *Hunnebergia retusa*, *Varvia falensis*, *Lapidaria tenella*, *Saltaspis viator*, *Falanaspis aliena*, and *Orometopus grypos*. They demonstrate the marked difference of the fauna from that of the underlying Ceratopyge limestone, to which the beds with *Lycophoria laevis* had previously been referred.

The Lower Didymograptus shale belonging to the early zones of *Tetragraptus phyllograptoides* and *Didymograptus balticus*, both included in the Hunneberg group, are not developed at Stenbrottet. The bed of greenish grey shale present in the quarry contains *Phyllograptus densus*. As will be shown later this shale is equivalent in age to the Upper Planilimbata limestone. It is well developed at Billingen mountain. In the description of the next section it is referred to a new stratigraphical subdivision, the Billingen group.

STORA STOLAN

Going northwards from Stenbrottet one finds that the Tremadocian rocks are thinning out to nothing. At Billingen mountain they are lacking. Beds belonging to the zone of *Plesiomegalaspis armata* are still present, and maintain the same thickness as at Stenbrottet. Their trilobite fauna is, however, impoverished. These conditions are exemplified at the locality described below.

At Stora Stolan on the northern slopes of Billingen limestones and shales similar to those at Stenbrottet are quarried. Their stratigraphy and faunas have been discussed by WESTERGÅRD (1922, 1931) who also communicated a section through the strata.

A new section has been measured and investigated in the quarry. Fossils have also been collected from the numerous large pieces of glauconitic limestone lying in and outside the quarry.

Description of the section in text-fig. 7 (fossils recorded: PU nos. Vg 491–532):

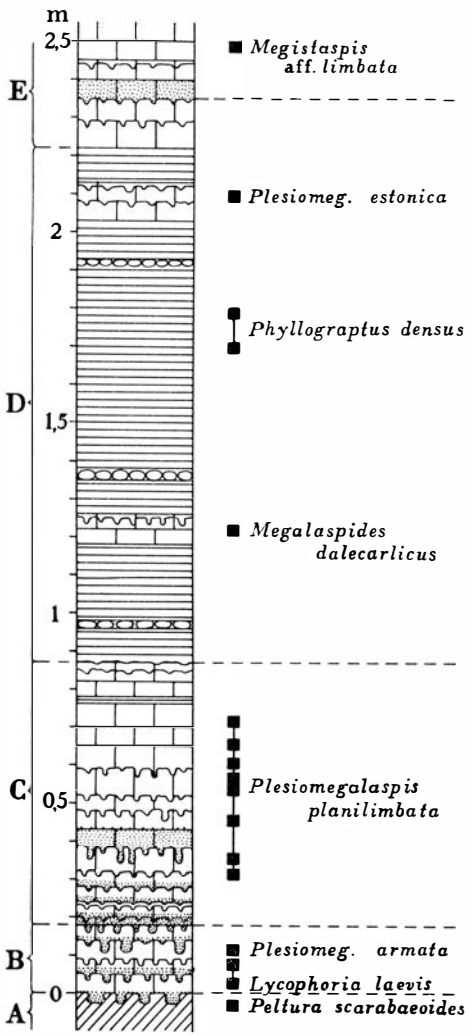


Fig. 7. Section through the early Ordovician limestones and shales at Stora Stolan, Billingen mountain.

UPPER CAMBRIAN:

Subzone of *Peltura scarabaeoides*:

A. Bed of anthraconite with *Peltura scarabaeoides*.

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

B. Glauconitic limestone, 0.18 m thick with thin layers of light-grey or (in the topmost layer) brown limestone. Fossils are rather sparse in the glauconitic rock, in the grey limestone they sometimes occur in abundance. They are: *Plesiomegalaspis armata*, *Niobe* cf. *incerta*, *Varvia falensis*, *Saltaspis viator*, *Lycophoria laevis*, *Apheoorthis? suecica*, *Nanorthis? billingensis*, and *Broeggeria* sp.

Zone of *Plesiomegalaspis planilimbata*:

C. Grey, brown, or greenish limestone, about 0.7 m thick, with glauconitic basal beds and with thin layers of greenish shale. In the limestone about ten surfaces of discontinuity are discernible. The beds, as usual in this zone, are rather rich in fossils. The following species were obtained: *Plesiomegalaspis planilimbata*, *Megalaspides nericiensis*, *Promegalaspides stenorhachis*, *Niobe emarginula*, *Niobella bohlini*, *Varvia breviceps*, *Symphysurus angustatus*, *Pliomerops actinurus*, *Remopleuridiella* sp. no. 1, and *Shumardia* sp.

Billingen group (Lower Didymograptus shale):

Zone of *Phyllograptus densus* (*sensu* TÖRNQUIST):

D. Greenish grey shale with nodules and two beds of grey limestone, total thickness 1.35 m. The strata are very poor in fossils. A few poorly preserved graptolites were found in the shale between the two limestone beds. The determinable species, *Phyllograptus densus* and *P. angustifolius*, place it into the zone of *Phyllograptus densus*.

In the lower limestone bed a pygidium of *Megalaspides dalecarlicus* (HOLM) was encountered. This trilobite is known to occur with *Phyllograptus densus*. The limestone of the upper bed is hard, and its fossils are difficult of extraction. Some specimens of *Plesiomegalaspis estonica* n.sp. were nevertheless secured.

The upper bed is overlain by a thin layer of shale devoid of fossils.

Limbata limestone:

E. Grey or reddish limestone, about 4 m thick and poor in fossils. At the base are seen some surfaces of discontinuity and a thin glauconitiferous layer. The beds contain *Megistaspis* aff. *limbata*.

COMMENTS ON THE STRATIGRAPHY.—As pointed out above the Tremadocian beds of Västergötland thin out towards the North. In the section at Stora Stolan they are entirely lacking, and limestones of Arenigian age are resting directly upon Upper Cambrian alum shales with anthraconite.

The Arenigian limestones are initiated by thin beds belonging to the zone of *Plesiomegalaspis armata*. These are overlain by Planilimbata limestone, followed by Lower Didymograptus shale. A few, yet important points of information about these strata are obtained from the section.

In the author's preliminary account of 1952 the Planilimbata limestone of Närke was divided into two stratigraphical divisions, viz. the Lower Planilimbata limestone, characterized by a fauna with several species allied to those of the Tremadocian beds, and the Upper Planilimbata limestone. At its base the latter contains *Megalaspides dalecarlicus*. This species is not found in the upper beds of the subdivision, where *Plesiomegalaspis estonica* (synonymous with *Megalaspis planilimbata*, later form, in the above paper) is the index fossil.

The Lower Planilimbata limestone is identical with the zone of *Plesiomegalaspis planilimbata*, which is included by the present writer into the Hunneberg group. At Stora Stolan it shows a typical development, i.e. it is built up of grey limestone beds rich in *Plesiomegalaspis planilimbata*.

The superposed Lower Didymograptus shale contains two beds of limestone, the lower with *Megalaspides dalecarlicus* and the upper with *Plesiomegalaspis estonica*. In the shale itself *Phyllograptus densus* has been found, indicating that the Upper Planilimbata limestone of Närke is to be correlated, at least in part, with the graptolite zone of *Phyllograptus densus*. Shales belonging to this zone and corresponding limestones are referred to the Billingen group.

The beds of the group are overlain by Limbata limestone.

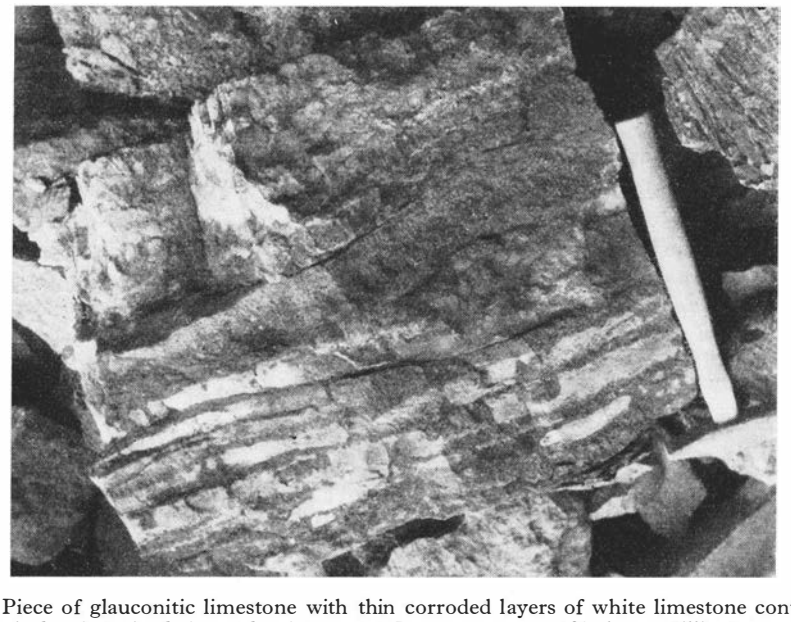


Fig. 8. Piece of glauconitic limestone with thin corroded layers of white limestone containing *Lycophoria laevis* and *Plesiomegalaspis armata*. From a quarry at Skultorp, Billingen mountain.

SKULTORP

In the old quarries at Skultorp, situated on the south-eastern slopes of Billingen, 5 km SSW of the town of Skövde, the sequence of strata is similar to that at Stora Stolan. The Ordovician beds are initiated by dark-green glauconitic limestone with several deeply corroded layers of light-grey limestone containing *Lycophoria laevis*, *Apheoorthis*? *suecica*, *Nanorthis*? *billingensis*, and *Plesiomegalaspis armata* (text-fig. 8). It is followed by beds of grey limestone belonging to the zone of *Plesiomegalaspis planilimbata*. In these were found, *inter alia*, *Plesiomegalaspis planilimbata*, *P. heroides*, and *Lapidaria rugosa*. The limestones are overlain by greenish grey shale, about 0.8 m thick, with beds and nodules of grey limestone. One of the lower beds contains *Megalaspides dalecarlicus*.

OLTORP

At some localities along the eastern boundary of the Palaeozoic district of Västergötland the thinning out of the early Ordovician zones is still more pronounced (compare THORSLUND 1937 a). Such is the case at Oltorp, and a section through the Ordovician beds at this place is given below. This is done partly for the reason of Oltorp being the type locality of some of ANGELIN's trilobite species from the zone of *Plesiomegalaspis planilimbata*.

Oltorp is a farm situated at the eastern side of Varvsberget mountain, 6 km W of the town of Tidaholm. In the last century alum shale was quarried in the slope W of the farm for the manufacturing of potash alum. The quarries have

been abandoned long ago and are covered by debris and vegetation. A few years ago, however, a new quarry was opened 1 km W of the farm, exposing the uppermost part of the Cambrian alum shale, and all of the thin Ordovician beds preserved at this locality.

Description of a section at Oltorp, text-fig. 9 (fossils recorded: PU nos. Vg 548–583):

UPPER CAMBRIAN:

Subzone of *Peltura scarabaeoides*:

A. Bed of anthraconite with *Peltura scarabaeoides*. The upper surface of the bed is sometimes very uneven with narrow grooves, occasionally 20 cm deep, filled with Ordovician glauconitic limestone and small pebbles of anthraconite, some of which are phosphatized.

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis planilimbata*:

B. Dark-grey or brown limestone, about 0.1 m thick. Its basal part is rich in glauconite grains and nodules of phosphatized anthraconite. In the pure limestone fossils occur in abundance. They are often covered by pyrite, more or less replaced by haematite(?). The following species were found: *Plesiomegalaspis planilimbata*, *P. heroides*, *Megalaspides nericiensis*, *Promegalaspides stenorhachis*, *Niobe emarginula*, *Niobella bohlini*, *Varvia breviceps*, *Symphysurina*? *perseverans* n.sp., *Pliomerops actinurus*, and *Geragnostus wimani*.

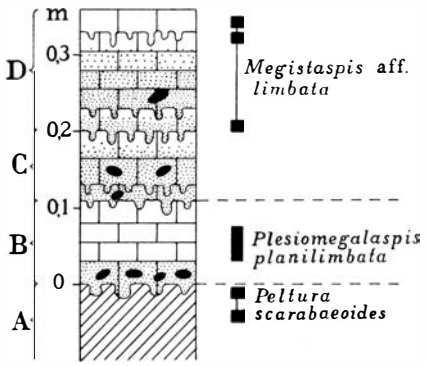


Fig. 9. Section through the limestone beds at Oltorp, Västergötland. Black spots = lumps of phosphatized anthraconite.

Limbata limestone:

C. Glauconitic non-fossiliferous limestone, about 0.1 m thick, very likely constituting the base of the Limbata limestone.

D. Brown limestone, about 0.15 m thick, with glauconite grains, nodules of phosphatized anthraconite, and pyrite. Specimens of *Megistaspis* aff. *limbata* are common.

COMMENTS.—From a stratigraphical point of view the above section demonstrates the incompleteness of the early Ordovician rocks exposed in the quarry. The Tremadocian beds, as well as the limestone belonging to the zone of *Plesiomegalaspis armata*, are lacking. The zone of *Plesiomegalaspis planilimbata* is represented by a bed of only 10–12 cm thickness. It is followed immediately by Limbata limestone. The Lower Didymograptus shale, found at Stenbrottet and Stora Stolan, is entirely lacking in the section.

At Oltorp ANGELIN collected his type specimens of *Plesiomegalaspis plani-*

limbata, *Niobe emarginula*, *Varvia breviceps*, and *Diaphanometopus lineatus*. They come with all certainty from the dark limestone of the subdivision B of the section, i.e. from the zone of *Plesiomegalaspis planilimbata*. Of ANGELIN's collection only some fragmentary specimens of *Niobe emarginula* and *Varvia breviceps* are preserved in the State Museum. They are partly covered by pyrite and haematite(?) in the same way as the fossils found in the subdivision B. No trilobites, similar to those described by ANGELIN, are found in the superposed Limbata limestone.

The above descriptions have dealt chiefly with the late Tremadocian beds, and with the lowermost Arenigian limestones and shales included in the Hunneberg group. Only the section at Stora Stolan has permitted a closer study of the overlying beds referred to the Billingen group proving that the Lower Didymograptus shale of Billingen corresponds in age to the Upper Planilimbata limestone of Närke. Before giving a more detailed account of the graptolite shales of Västergötland which belong to the Billingen group a couple of sections through the Planilimbata limestone of Närke will be described.

The Sections in Närke (Nerike)

In Närke the Tremadocian beds are lacking, and of the Hunneberg group only the zone of *Plesiomegalaspis planilimbata* (the Lower Planilimbata limestone) is well developed. It is followed by the Upper Planilimbata limestone which contains a fairly rich trilobite fauna, distinctly different from that of the underlying beds.

In the Ordovician limestones of Närke a rhytmic sedimentation is conspicuous. The sequence of strata is built up of a large number of cycles, separated by surfaces of discontinuity. A complete cycle of sedimentation consists of a basal layer of grey limestone, often rich in fossils, an intermediate seam of grey shale or marly limestone, and a top layer of grey or reddish limestone, in which fossils are less common. As a rule the total thickness of each cycle is very small, usually less than 10 cm. This cyclic sedimentation will be discussed in a future paper.

In the sections described below fossils were searched for in everyone of the cycles. In this way a rather large number of specimens was collected, for which the accurate level is known. The vertical distribution of the stratigraphically most important species is plotted in the text-figs. of the sections.

LATORP

At first an account of a section through the early Ordovician beds of Stora brottet ("the large quarry") at Latorp will be given. There the existence of the zone of *Plesiomegalaspis armata* is proved with certainty, and the basal Ordovician layers are similar to those at Billingen mountain in Västergötland.

The quarry is situated on the edge of a limestone terrace, about 13 km W of the town of Örebro. It was abandoned long ago, but almost all of the Upper Cambrian alum shale and some metres of the Ordovician limestones are still accessible. Accounts of the stratigraphy and the faunas of these beds have been published previously by LINNARSSON (1875a, b) and WESTERGÅRD (1922).

Description of a section at Latorp, text-fig. 10, at the southern end of the quarry (fossils recorded: PU nos. N 15–228):

UPPER CAMBRIAN:

Subzone of *Peltura scarabaeoides*:

A. Alum shale with lenses of anthraconite containing *Peltura scarabaeoides* and *Sphaerophthalmus alatus* (BOECK).

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

B. The zone is initiated by a dark-green glauconitic limestone, 0.1–0.2 m thick, with lumps of phosphatized anthraconite and very sparse grains of quartz. It encloses a thin layer of light-grey limestone, generally 2 or 3 cm, but sometimes 10 cm thick, with sparse glauconite grains and occasional lumps of chalcedony. The layer frequently thins out to nothing. Below it, in the glauconitic limestone immediately overlying the Cambrian alum shale, a cranidium of *Triarthrus* sp. and a few specimens of *Lycophoria laevis* were found. In the thin layer of grey limestone the latter species occurs abundantly, associated with *Apheoorthis? suecica*, *Nanorthis? billingensis*, and *Niobe* sp. The superposed glauconitic limestone contains *Plesiomegalaspis armata*, and *Nanorthis? billingensis*.

The zone terminates with a layer of brown limestone about 5 cm thick. It is very poor in fossils, the only species encountered being *Lamanskya splendens* MOBERG & SEGERBERG. The upper surface of the bed is pitted by narrow depressions filled with glauconitic limestone belonging to the next zone.

Zone of *Plesiomegalaspis planilimbata* (Lower Planilimbata limestone):

C. Grey or brown limestone, 1.0 m thick, with glauconitic basal beds, two thin layers of greenish grey shale and several surfaces of discontinuity. The beds belonging to the lower and middle part of the zone are fairly fossiliferous, while the uppermost dark-brown limestone is almost barren. The following species were obtained: *Plesiomegalaspis planilimbata*, *Megalaspides nericiensis*, *Promegalaspides stenorhachis*, *Niobe emarginula*, *Niobella bohlini*, *Varvia breviceps* (abundant in the lower part of the zone, absent in the upper part), *Lapidaria rugosa*, *Symphysurus angustatus*, *Nileus limbatus*, *Cyclopyge gallica* n. sp., *Glaphurina? insolita* n. sp., and *Nanorthis?* sp. The shale contains furthermore: *Apatokephalus pecten*, *Shumardia nericiensis*, *Geragnostus crassus*, and *Trinodus elliptifrons* n. sp.

Billingen group (Upper Planilimbata limestone):

Zone of *Megalaspides dalecarlicus*:

D. The zone begins with a layer of greenish grey shale with nodules of brownish limestone. It is followed by beds of grey, slightly brownish or reddish lime-

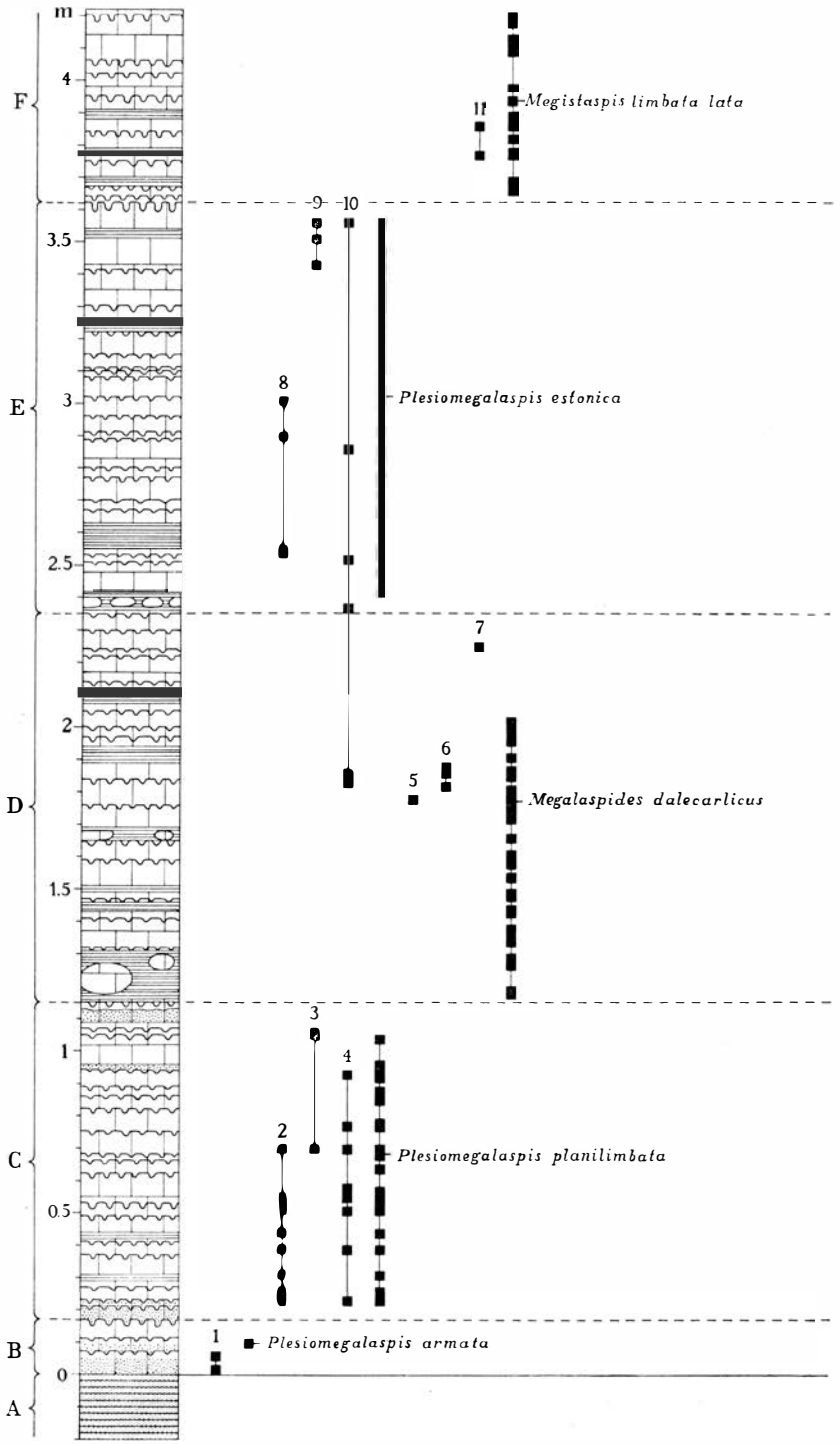


Fig. 10. Section through the early Ordovician limestones at Latorp, Närke. Vertical distribution of *Lycophoria laevis* (1), *Varvia breviceps* (2), *Cyclopyge gallica* (3), *Megalaspides nericiensis* (4), *Plesiomegalaspis scutata* (5), *Megalaspides paliformis* (6), *Plesiomegalaspis norvegica* (7), "*Endoceras*" sp. (8), *Agerina erratica* (9), *Euloma laeve* (10), and *Ptychopyge* sp. (11).

stone, alternating with thin layers of grey shale. The total thickness is 1.15 m. In the lower and middle part of the zone the limestone beds are rich in fossils, whereas in the upper part few specimens only are found. The fauna distinctly differs from that of the preceding zone. Index fossils are *Megalaspides dalecarlicus*, *M. paliformis* n. sp., *Plesiomegalaspis norvegica* n. sp., and *P. scutata* n. sp. Besides the following species occur: *Niobella* aff. *imparilimbata* (BOHLIN), *Nileus exarmatus* n. sp., *Euloma laeve* ANGELIN, *Ampyx pater* HOLM, and *A. obtusus* MOBERG & SEGERBERG.

Zone of *Plesiomegalaspis estonica*:

E. Beds of grey or (in the uppermost part) reddish limestone, intercalated with thin layers of greenish grey shale, total thickness about 1.3 m. Shales and clayey limestones dominate the lower part of the zone. The beds contain: *Plesiomegalaspis estonica*, *Niobella* aff. *imparilimbata*, *Asaphus* sp., *Nileus exarmatus*, *Agerina erratica* n. sp., *Euloma laeve*, *Ampyx pater*, *A. obtusus*, *Remopleuridiella* sp. no. 2, and "*Endoceras*" sp.

The upper boundary of the zone is marked by a pronounced surface of discontinuity situated above a bed of reddish limestone.

Limbata limestone:

F. Beds of grey limestone intercalated with layers of grey shale, higher up reddish limestone. Index fossil is *Megistaspis limbata lata* (TÖRNQUIST). It is associated with *Asaphus* sp. and *Ptychopyge* sp. The limestone and its fauna will not be treated in this paper.

LANNA

Before discussing the above succession of trilobite faunas another section through limestones, corresponding to those at Latorp, but richer in fossils will be described. It is found at Lanna, a locality 6 km SW of Latorp and at the brink of the same limestone terrace. Several quarries have been opened in the slope, and two of them are at present worked for stone-cutting and manufacture of cement. An abandoned large quarry, Stora brottet, was visited by LINNARSSON who described its strata (1875 b). There in a layer of grey shale Professor J. G. ANDERSSON found the peculiar trilobite fauna described by WIMAN (1905). In this old quarry the beds are still accessible, as shown in text-fig. 11 picturing the north-western wall. At the base some metres of Upper Cambrian alum shale are exposed. They are followed by 3 metres of Ordovician Planilimbata limestone and 7 metres of Limbata limestone. In the former the lithological units corresponding to the zones are discernible (as seen in the photograph). The units consist to the greatest extent of thin limestone beds with intercalated layers of shale, but are terminated by thicker beds of purer limestone. This varying composition is reflected in the strong effect of the weathering on the Planilimbata limestone as compared with that on the much more homogeneous and solid Limbata limestone.

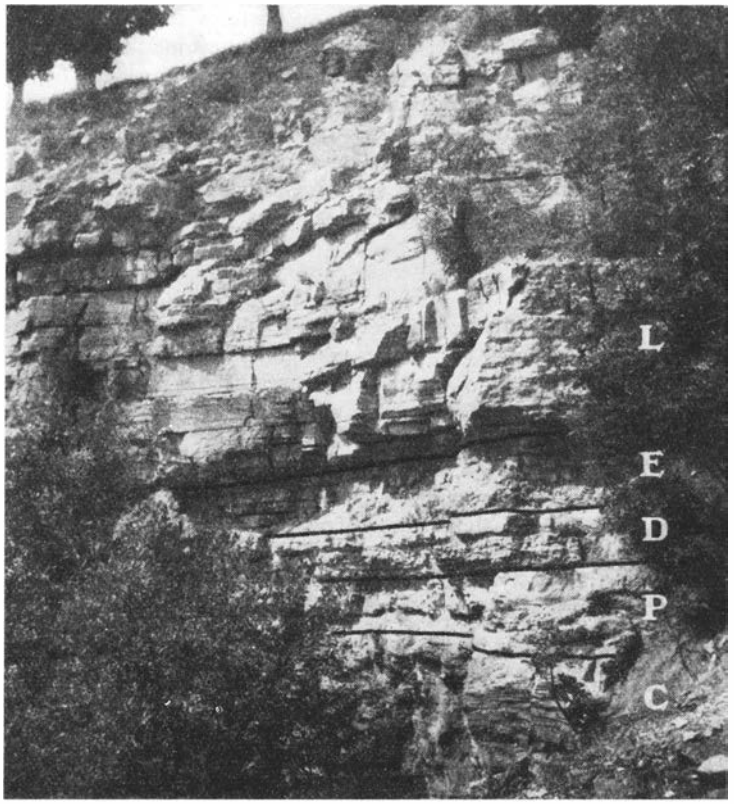


Fig. 11. The north-western wall in Stora brottet ("the large quarry") at Lanna, Närke. C = Upper Cambrian alum shale. P = Zone of *Plesiomegalaspis planilimbata*. D = Zone of *Megalaspides dalecarlicus*. E = Zone of *Plesiomegalaspis estonica*. L = Limbata limestone.

Description of a section at Lanna, text-fig. 12 (fossils recorded: PU nos. N 2–12; 229–611):

UPPER CAMBRIAN:

Subzone of *Peltura scarabaeoides*:

A. Alum shale and lenses of anthraconite with *Peltura scarabaeoides*, *Sphaerophthalmus alatus*, and *Nericiaspis robusta* (TJERNVIK).

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*?:

B. The basal part of the glauconitic limestone initiating the Ordovician rocks often contains fossils which show that the zone of *Plesiomegalaspis planilimbata* immediately overlies the Cambrian alum shale. But the zone of *Plesiomegalaspis armata* seems just as frequently to be preserved as a bed of dark-green glauconitic limestone, terminated by a thin layer of brown limestone. The total thickness may amount to 0.2 m. No fossils have, however, been found

which would definitely establish the existence of the zone. The species obtained are: *Plesiomegalaspis* sp., *Niobella* cf. *bohlini*, and *Nanorthis*? cf. *billingensis*.

Zone of *Plesiomegalaspis planilimbata* (Lower Planilimbata limestone):

C. Grey or brown limestone, 0.85 m thick. The basal beds are rich in glauconite grains and lumps of phosphatized anthraconite. Three thin layers of greenish grey shale are found, containing the "Shumardia fauna" described by WIMAN (1905). The limestone is in part rich in fossils and has rendered: *Plesiomegalaspis planilimbata*, *Megalaspides nericiensis*, *Promegalaspides stenorhachis*, *Niobe emarginula*, *Niobella bohlini*, *Varvia breviceps* (abundant in the lower part of the zone), *Symphysurus angustatus*, *Nileus limbatus*, *Cyclopyge gallica* (in one of the upper beds only), *Ampyx* cf. *pater* HOLM, *Pliomerops actinurus*, *Diaphanometopus lineatus*, and *Geragnostus explanatus* n. sp. The shale contains most of these species and in addition: *Remopleuridiella* sp. no. 1, *Apatokephalus pecten*, *Shumardia nericiensis*, *Orometopus* sp., *Geragnostus crassus*, *G. wimani*, *Trinodus elliptifrons*, and *Leiagnostus peltatus*.

The topmost limestone bed is dark-brown and almost devoid of fossils.

Billingen group (Upper Planilimbata limestone):

Zone of *Megalaspides dalecarlicus*:

D. Beds of grey, slightly brownish or reddish limestone, intercalated with layers of greenish grey shale, total thickness about 0.7 m. A basal bed of shale or marly limestone is extremely rich in fossils, *inter alia*, fragments of *Cheirocrinus* sp. In the lower and major part of the zone *Megalaspides dalecarlicus* is the commonest trilobite species. The upper beds contain *Megalaspides paliformis*, *Plesiomegalaspis norvegica*, and *P. scutata*. Other species found in this zone are: *Plesiomegalaspis* aff. *estonica* (very rare), *Niobella* aff. *imparilimbata*, Genus et species indet., *Nileus exarmatus*, *Triarthrus*? sp., *Remopleuridiella* sp., *Ampyx pater*, *A. obtusus*, "*Protopliomerops*" sp., *Geragnostus*? sp. no. 2, *G.*? *toernquisti* (HOLM), and one straight cephalopod.

In an adjoining quarry, Boströms brott, *Selenoharpes excavatus* (LINNARSSON) has been found in this zone.

Zone of *Plesiomegalaspis estonica*:

E. Grey or reddish limestone, intercalated with rather thick layers of greenish grey shale, total thickness 1.30 m. In the basal beds of grey limestone fossils are abundant. They are fairly frequent also in the middle and upper part of the zone, with the exception of the uppermost beds of reddish limestone, which are almost barren. The shale is usually very poor in fossils. The following species were found in the beds of the zone: *Plesiomegalaspis estonica*, *Megalaspides* sp. (in the basal beds), *Niobella* aff. *imparilimbata*, *Symphysurus* sp., *Nileus exarmatus*, *Nileus*? sp., *Menoparia*? *nericiensis* n. sp., *Remopleuridiella* sp., *Raymondaspis* spp. nos. 1 and 2, *Ampyx pater*, *A. obtusus*, *Lonchodomas* sp., *Cyrtometopus priscus* n. sp., *Euloma laeve*, *Agerina erratica*, *Geragnostus* aff. *crassus*, *Geragnostus*? sp. no. 2, *Leiagnostus* sp., "*Endoceras*" sp., and *Protocycloceras*? sp.

Limbata limestone:

E. Grey limestone with thin layers of greenish grey shale, higher up reddish limestone. Fossils: *Megistaspis limbata lata*, *Ptychopyge* sp., *Asaphus* sp., *Niobella imparilimbata*, *Cyrtometopus* aff. *clavifrons*, *Geragnostus* sp., "*Endoceras*" sp., etc.

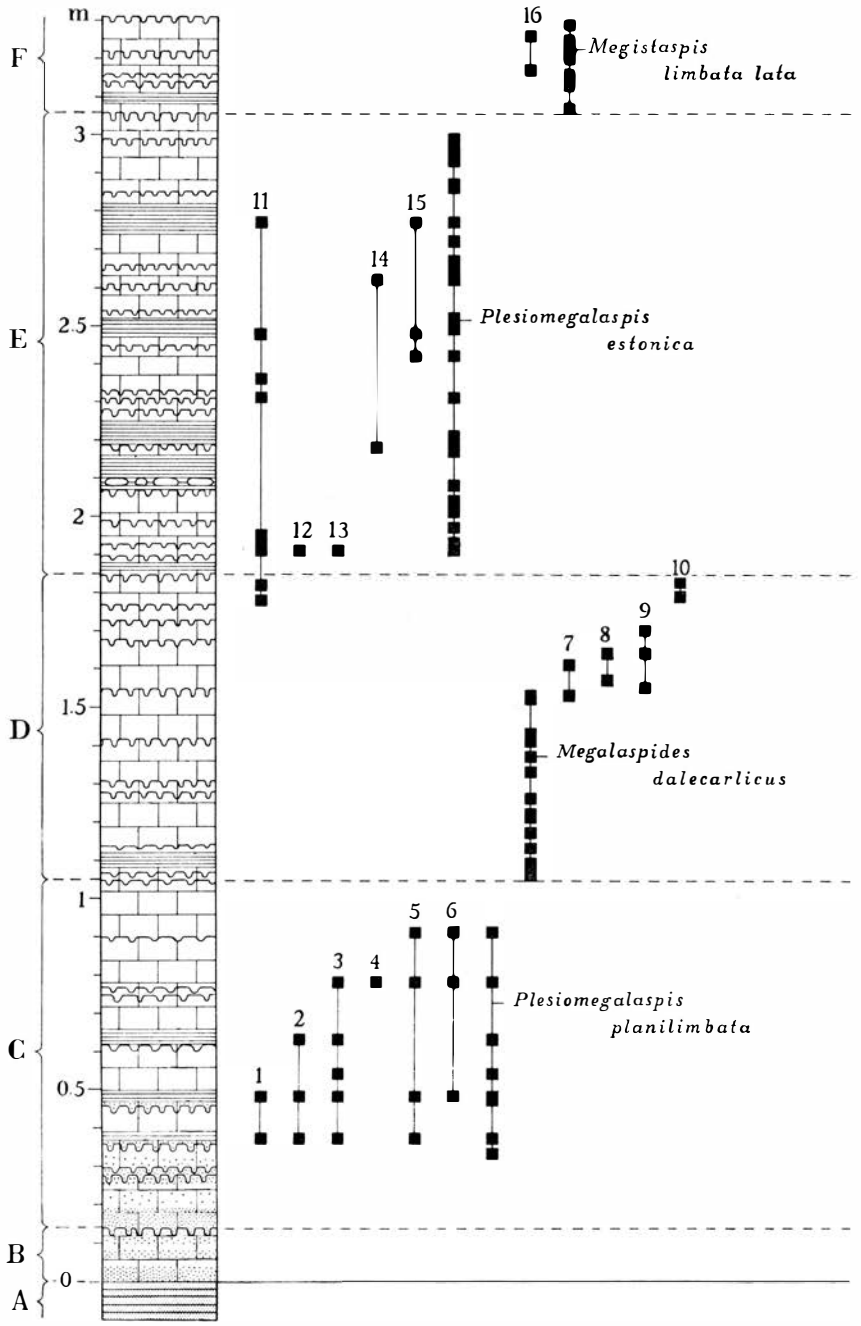


Fig. 12. Section through the early Ordovician limestones at Lanna, Närke. Vertical distribution of *Apatokephalus pecten* (1), *Shumardia nericiensis* (2), *Varvia breviceps* (3), *Cyclopyge gallica* (4), *Megalaspides nericiensis* (5), *Promegalaspides stenorhachis* (6), *Megalaspides paliformis* (7), Trilobite genus et species indet. (8), *Plesiomegalaspis norvegica* (9), *Plesiomegalaspis scutata* (10), *Euloma laeve* (11), *Menoparia*? *nericiensis* (12), *Lonchodomas* sp. (13), "*Endoceras*" sp. (14), *Agerina erratica* (15), and *Ptychopyge* sp. (16).

COMMENTS.—The two last illustrated sections display the rhytmic nature of the sedimentation during the early Ordovician of Närke. Periods of sedimentation have changed with periods of non-sedimentation, the latter represented by surfaces of discontinuity. The rock might be divided into a large number of small units, separated by gaps of unknown extent. The periodic changes of the fauna are probably connected with this successive deposition. Not only is the association of species changing successively, the species themselves may undergo distinct alterations during the time necessary for the deposition of a zone. These conditions sometimes complicate the delimitation of the species as well as of the zones.

A conspicuous gap in the faunistic succession is, however, discernible between the zone of *Plesiomegalaspis planilimbata* and the zone of *Megalaspides dalecarlicus*. This obvious gap, occurring in the middle of the Planilimbata limestone, has made it difficult to maintain this subdivision as a stratigraphical unit. Consequently, the zone of *Plesiomegalaspis planilimbata* (the Lower Planilimbata limestone) is referred to the Hunneberg group which initiates the Arenigian of Sweden. The two following zones of *Megalaspides dalecarlicus* and *Plesiomegalaspis estonica* (the Upper Planilimbata limestone) are attributed to the next subdivision, the Billingen group.

The fauna of the limestones, belonging to the Hunneberg group displays several Tremadocian features. The trilobites of the genera *Shumardia*, *Apatokephalus*, *Orometopus*, *Promegalaspides*, *Niobe*, *Varvia*, and *Symphysurina*? derive from ancestors in the Tremadocian or the Upper Cambrian rocks.

These old genera are absent in the beds of the Billingen group. The lower part of this group is characterized by the abundant occurrence of *Megalaspides dalecarlicus* which in somewhat higher beds is associated with, and at last replaced by large species of *Plesiomegalaspis*. The limestone containing these trilobites has been referred to the zone of *Megalaspides dalecarlicus*.

In the upper part of the Billingen group, i.e. in the zone of *Plesiomegalaspis estonica*, the ultimate species of the genus *Plesiomegalaspis* is the index fossil. The two Tremadocian genera *Euloma* and *Harpides* are still represented. The genera *Lonchodomas*, *Asaphus*, and *Cyrtometopus* make their first appearance, as well as the endoceratids.

In the Limbata limestone one meets the first representatives of the large *Megistaspis limbata* group, appearing suddenly and abundantly. Species of *Asaphus* and *Ptychopyge* are important members of the fauna. So are also the endoceratids.

YXHULT

In a quarry at Yxhult, about 18 km S of Örebro, a section through the early Ordovician limestones has been examined (compare TJERNVIK, 1952). The succession of faunas is the same as at Lanna, and only a few observations will be recorded.

In the lowermost bed, belonging to the zone of *Plesiomegalaspis planilimbata*, a cranidium of an illaenid, *Dysplanus*? sp. no. 1, was encountered.

The lower part of the zone of *Plesiomegalaspis estonica* contains some fairly thick layers of greenish grey shale. They are unusually rich in fossils, and have yielded the following species: *Plesiomegalaspis estonica*, *Niobella* aff. *imparilimbata*, *Menoparia*? *nericiensis*, *Ampyx pater*, *A. obtusus*, *Selenoharpes* sp., *Harpides* aff. *rugosus*, *Cyrtometopus priscus*, *Sphaerexochus*? sp., *Productorthis*? sp., and *Cheirocrinus* sp.

ÖRSTA

Two other sections have furnished some information on the Hunneberg group of Närke. At Örsta, 2 km NNE of Latorp, the zone of *Plesiomegalaspis armata* has been established with certainty. There, below the beds with *Plesiomegalaspis planilimbata*, one finds a dark-green glauconitic limestone, enclosing a thin layer of white limestone with *Lycophoria laevis* and *Apheoorthis*? *suecica*. The glauconitiferous limestone contains rather large lumps of chalcedony. The total thickness of the zone is only 0.1–0.15 m.

GYMNINGE

In a quarry at Gymninge, 600 m SE of Örsta, only the zone of *Plesiomegalaspis planilimbata* is represented. Its limestone beds are very rich in fossils. As illustrated below the fauna displays alterations from the basal beds upwards, indicating a distinct change within the limits of the zone.

The lower beds contain some species related to forms from the underlying zone of *Plesiomegalaspis armata*. They are: *Plesiomegalaspis heroides*, *Lapidaria rugosa*, *Varvia breviceps*, and *Lycophoria* sp. *Varvia breviceps* occurs in abundance, whereas the other fossils are rare. All these species are associated with *Plesiomegalaspis planilimbata*.

A limestone bed in the uppermost part of the zone has supplied a large amount of fossils, but none of the above mentioned species have been found. Most conspicuous is the absence of *Varvia breviceps* and *Plesiomegalaspis planilimbata*. The latter is replaced by a closely related species which differs by having a pygidium with a narrower rhachis and a greater number of segments. In these respects it agrees with the much later species *Plesiomegalaspis estonica*. *Cyclopyge gallica*, occurring very sparsely in the underlying beds, is one of the commonest members of the fauna. Some other species are related to or identical with forms from the overlying zone of *Megalaspides dalecarlicus*. These are: *Megalaspides* aff. *dalecarlicus*, *Nileus exarmatus*, *Ampyx* cf. *obtusus*, and *Geragnostus*? sp. no. 1. Further species characteristic of this part of the zone are: *Niobella* aff. *obsoleta* no. 2, *Nileus orbiculatus* n.sp., *Raymondaspis brevicauda* n.sp., and "*Protorthis*" *hunnebergensis*. The latter is known from the shale with *Didymograptus balticus* at Mossebo, Hunneberg.

The general aspect of the fauna, however, is uniform throughout the zone. *Megalaspides nericiensis*, *Promegalaspides stenorhachis*, *Niobe emarginula*, *Niobella bohlini*, *Symphysurus angustatus*, and *Pliomerops actinurus* are never lacking in any part of the section.

The Graptolite Shales of the Billingen Group in Västergötland

As apparent from the section at Mossebo at Hunneberg mountain the zone of *Plesiomegalaspis planilimbata* (the Lower Planilimbata limestone) corresponds to the graptolite zone of *Tetragraptus phyllograptoides*, and probably also to the zone of *Didymograptus balticus*.

At Stora Stolan on Billingen mountain the Upper Planilimbata limestone is represented by shales containing *Phyllograptus densus*. HOLM (1882 a) has proved that this graptolite is contemporaneous with *Megalaspides dalecarlicus*. In limestone nodules occurring in a marly shale with *Phyllograptus densus* at Skattungbyn in Dalarna he encountered several trilobites, *inter alia*, *Megalaspides dalecarlicus* and *Ampyx pater*.

Fossils found by WESTERGÅRD (1940) in a drilling core from Borghamn in Östergötland, confirm the observation made by HOLM. At this locality the middle part of the Planilimbata limestone is made up of grey shales and limestones, containing at the same level both *Megalaspides dalecarlicus* and *Phyllograptus densus*.

In Västergötland the shale with *Phyllograptus densus* is found in the mountains of Kinnekulle, Mösseberg, and Billingen. It is thinning out towards the east. In Billingen it is poorly developed. In the western mountains, especially in Kinnekulle, the thickness is much greater, and the graptolite fauna is considerably richer than that of Billingen. The stratigraphy and the fauna of the shale have been treated by LINNARSSON (1869), TÖRNQUIST (1901, 1904), v. POST (1906), WESTERGÅRD (1928, 1931, 1943), and THORSLUND (1937a). In the following two sections through the shale and its adjoining beds are given.

STORA BACKOR

At Stora Backor, on the north-western slopes of Mösseberg mountain a quarry provides a good section through the Upper Cambrian and the Lower Ordovician rocks. It was figured and described by THORSLUND (1937a) who established the existence at this locality of Dictyonema shale (represented by a bed of anthraconite), Ceratopyge limestone, Planilimbata limestone, Lower Didymograptus shale, and Limbata limestone.

Description of a section at Stora Backor, text-fig. 13 (fossils recorded: PU nos. Vg 610–662, and in the collections of SGU):

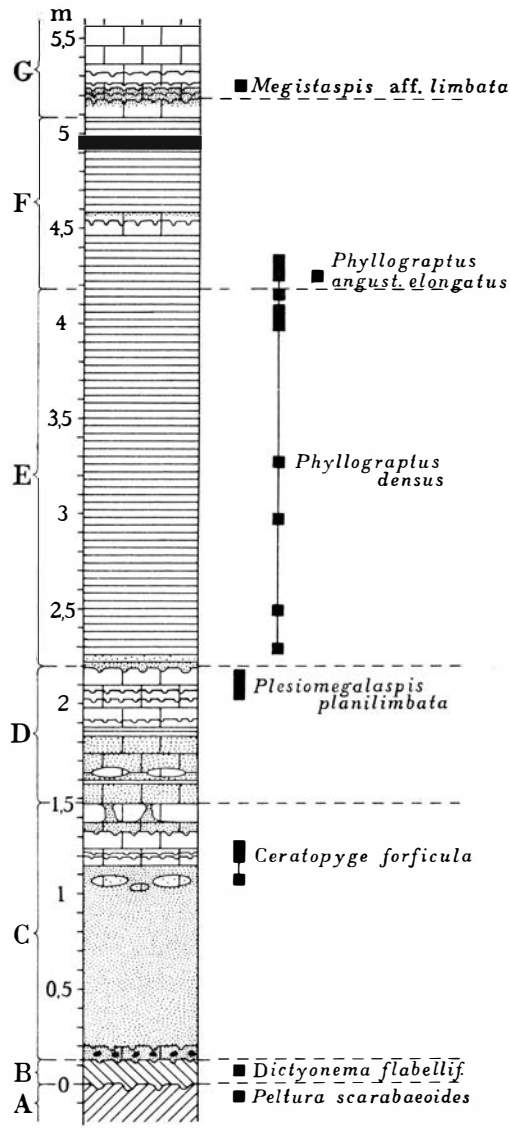


Fig. 13. Section through the early Ordovician limestones and shales at Stora Backor, Västergötland.

UPPER CAMBRIAN:

Subzone of *Peltura scarabaeoides*:

A. Bed of anthraconite with *Peltura scarabaeoides* and *Sphaerophthalmus alatus*.

TREMADOCIAN:

Zone of *Dictyonema flabelliforme flabelliforme*?:

B. Bed of anthraconite, about 0.1 m thick, with *Dictyonema flabelliforme* s. l. The specimens are too fragmentary to permit a closer determination.

Zone of *Apatokephalus serratus*:

C. Shaly rock, composed mainly of glauconite grains, with nodules and beds of hard light-grey limestone, total thickness 1.35 m. In the nodules THORSLUND encountered *Ceratopyge forficula* and *Shumardia pusilla*. The beds contain *Ceratopyge forficula*, *Euloma ornatum*, *Niobe insignis*, *Niobella obsoleta*, *Symphysurina? oriens*, *Symphysurus angustatus*, *Parapilekia speciosa*, and *Apatokephalus serratus*.

ARENIGIAN:

Hunneberg group:

No fossils have been found which would prove decisively the existence of the zone of *Plesiomegalaspis armata*.

Zone of *Plesiomegalaspis planilimbata*:

D. Glauconitic limestone with thin layers of green marly limestone or shale, superposed by beds of grey limestone, total thickness about 0.7 m. In the glauconitic beds no determinable species were encountered. The grey limestone contains *Plesiomegalaspis planilimbata*, *Megalaspides nericiensis*, *Niobe emarginula*, *Niobella bohlini*, *Cyclopyge gallica*, *Ampyx* cf. *pater*, and *Pliomerops actinurus*.

The upper surface of the topmost bed is uneven, and just below it the limestone is discoloured to a brownish tint.

Billingen group (Lower Didymograptus shale). Using the Norwegian classification the author has divided the shale into two zones:

Zone of *Phyllograptus densus*:

E. Greenish or dark-grey shale, glauconitiferous at the base, thickness about 2.0 m. Graptolites are common, but as a rule poorly preserved. Specimens of *Phyllograptus densus* appear 10 cm above the lower limit and are found throughout the shale belonging to the zone. They are associated with *Phyllograptus angustifolius*, *Didymograptus* cf. *suecicus* TULLBERG, *Tetragraptus* cf. *bigsbyi* (J. HALL), and *Ceratiocaris*? sp.

Zone of *Phyllograptus angustifolius elongatus*:

F. Greenish grey shale, enclosing a bed of limestone, total thickness about 0.9 m. The lower boundary of the zone is drawn at a level where lumps of pyrite are common. Close above this level the shale is dark-coloured and rather rich in specimens of *Phyllograptus densus*, *P. angustifolius elongatus* BULMAN, *Didymograptus* cf. *kreklingensis* MONSEN, and *D.* cf. *ensjöensis* MONSEN.

In the limestone bed no determinable fossils were encountered. The limestone is hard, grey or reddish, in part glauconitiferous, and contains a surface of discontinuity. The superposed shale is as barren as the limestone.

Limbata limestone:

G. Limestone, about 6 m thick. The basal bed, which is reddish and devoid of fossils, has been included into the preceding zone. It is overlain by a glauconitic limestone with several surfaces of discontinuity and containing poor specimens of *Megistaspis* aff. *limbata*.

COMMENTS.—As mentioned in the description of the above section the Norwegian classification has been used for the shale with *Phyllograptus densus*. This was divided by MONSEN (1937) into two zones: a lower one with *Phyllograptus densus*, and an upper one with *Phyllograptus angustifolius elongatus*. This subdivision has been used later by SKJESETH (1952), STØRMER (1953), and SPJELDNÆS (1953).

In Sweden the zone of *Phyllograptus densus* corresponds approximately to the trilobite zone of *Megalaspides dalecarlicus*. At Stora Backor the former is followed by shale with *Phyllograptus angustifolius elongatus*. No trilobites have been found in this part of the shale. It underlies, however, the Limbata limestone, and thus the zone of *Phyllograptus angustifolius elongatus* can be correlated, at least in part, with the uppermost portion of the Planilimbata limestone, i.e. with the zone of *Plesiomegalaspis estonica*. This interpretation is confirmed to some extent by the fossils found in the section described below.

HÄLLEKIS

At Hällekis on the north-western slopes of Kinnekulle mountain a large quarry is opened in Ordovician limestones overlying the Lower Didymograptus shale. The shale is exposed in some parts of the quarry, and through its uppermost layers tunnels for drainage have been driven. At the mouth of such a tunnel, 500 m SSE of the manor of Hällekis, the following section was examined.

Description of the section, text-fig. 14 (fossils recorded: PU nos. Vg 663–680):

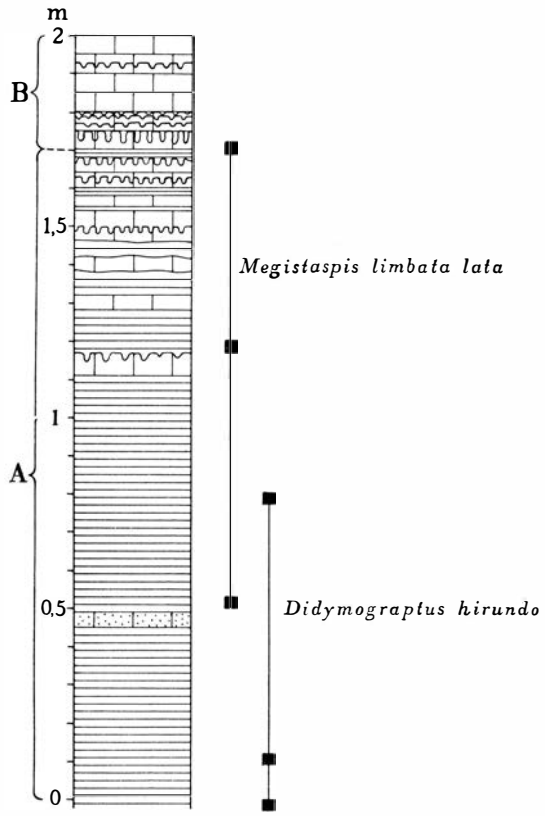


Fig. 14. Section through the uppermost part of the Lower Didymograptus shale at Hällekis, Kinnekulle.

ARENIGIAN:

Lower Didymograptus shale (corresponding to the lowermost part of the Limbata limestone):

A. Greenish grey shale with beds of limestone, total thickness of exposed layers about 1.7 m. Below the level of 1.5 m the limestone beds are grey. Above it they are reddish with intercalated thin layers of red shale. Several of the limestone beds are terminated upwards by surfaces of discontinuity.

About 50 specimens of graptolites were collected from the shale. Most common is *Didymograptus hirundo* SALTER (20 specimens, several excellently preserved). It is associated with *Phyllograptus* cf. *nobilis* HARRIS & KEBLE, and *Azygograptus* cf. *suecicus* MOBERG.

In the shale immediately above the lowermost limestone bed a cranidium and a free cheek of *Megistaspis limbata lata* were encountered.

Limbata limestone:

B. Red limestone with surfaces of discontinuity, stained yellow. The lowermost bed contains *Megistaspis limbata lata*, *Ptychopyge* sp., and *Niobella* cf. *imparilimbata*.

COMMENTS.—The upper layers of the section contain *Megistaspis limbata lata* which is an index fossil for the lowermost part of the Limbata limestone. Some graptolites, contemporaneous with this trilobite, are furnished by the shale. The dominating species is, according to the kind determination by Dr. I. STRACHAN, *Didymograptus hirundo*. It is an early form with narrow branches. Another common species is *Phyllograptus* cf. *nobilis*. It resembles a form found by SPJELDNÆS (1953, pp. 172 and 182, pl. 1, fig. 10) at Slemmestad in Norway, and associated there with an early form of *D. hirundo* and *Isograptus lunata* HARRIS. At a somewhat higher level typical specimens of *I. gibberulus* NICHOLSON have been encountered. These Norwegian species were collected from shales overlying the zone of *Phyllograptus angustifolius elongatus*.

From the beds at Hällekis no specimens of *P. angustifolius elongatus* were obtained. This corroborates the supposition that the shale with this graptolite

is older than the Limbata limestone. It can probably be correlated approximately with the uppermost part of the Planilimbata limestone, i.e. with the zone of *Plesiomegalaspis estonica*. This agrees with the observations made by SKJESETH (1952, p. 143) at Heramb in Norway. In mudstone with lenses of limestone underlying the Norwegian Orthoceras limestone this author encountered *P. angustifolius elongatus* and a trilobite fauna similar to that of the uppermost Planilimbata limestone of Sweden.

The shales representing the lowermost Limbata limestone at Hällekis the writer regards as belonging to the lowermost part of the zone of *Isograptus gibberulus*.

The Early Ordovician Rocks in Other Palaeozoic Districts of Sweden

SKÅNE

In Skåne (Scania), the southernmost province of Sweden, the author has not carried out any investigations of his own, and the following is only a summary of previously known facts.

The rocks resemble those of Hunneberg mountain and of the Oslo District in being developed as thick graptolite bearing shales, in which intercalations of limestone are thin or lacking. The succession is almost complete stratigraphically; the lower part of the Hunneberg group, however, seems to be weakly represented. In the beds overlying the Dictyonema shale the following subdivisions are met with:

TREMADOCIAN.—The Tremadocian beds of the classical locality of Fågelsång were uncovered, described, and discussed by MOBERG and SEGERBERG (1906). In shales superposing the Dictyonema shale two beds of limestone are enclosed. The lower limestone bed and the surrounding dark shales were designated by MOBERG as Ceratopyge shale or *Shumardia* zone. They contain, *inter alia*, *Shumardia dicksoni* MOBERG, *Ceratopyge forficula*, *Euloma ornatum*, *Orometopus elatifrons*, *Nanorthis? christianiae*, and *Broeggeria salteri*.

The upper limestone bed was referred by MOBERG to his zone of *Apatokephalus serratus*. It contains, *inter alia*, *Ceratopyge forficula*, *Euloma ornatum*, *Apatokephalus serratus*, *Niobe insignis*, *Niobella obsoleta*, *Promegalaspides intactus*, *Orometopus elatifrons*, *Harpides rugosus*, and "*Protopliomerops*" *primigenius*.

ARENIGIAN.—Trilobite facies: The lowermost part of the Hunneberg group, the zone of *Plesiomegalaspis armata*, seems to be lacking or weakly developed. The zone of *Plesiomegalaspis planilimbata* is as a rule represented by shales. However, TULLBERG (1880, p. 40) encountered at Kiviks Äsperöd, on the eastern shore of Skåne, a bed of dark-grey limestone. It rests upon the Dic-

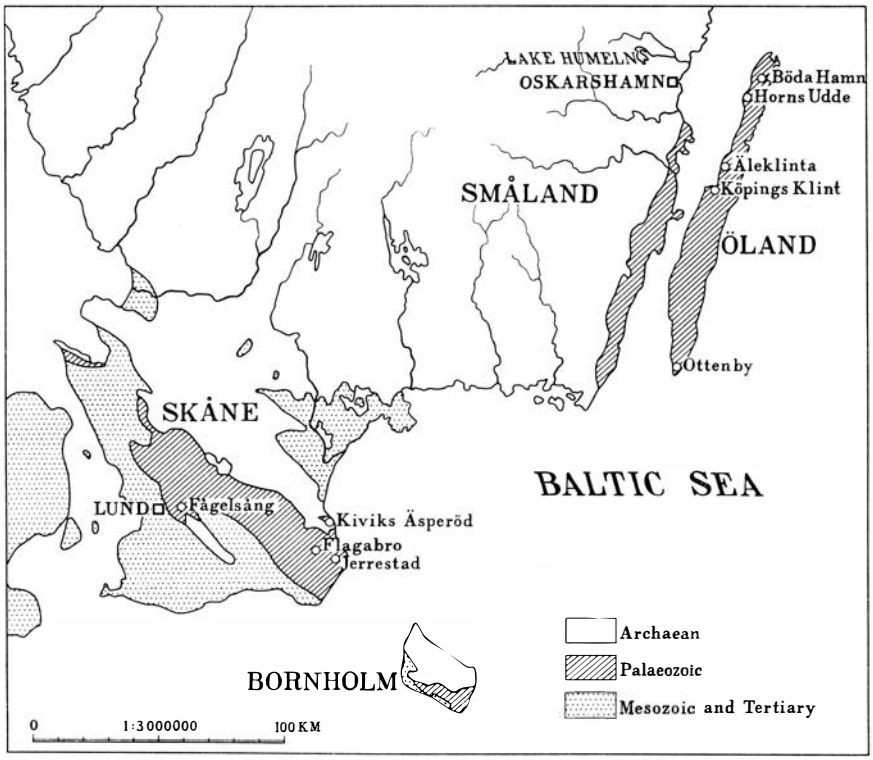


Fig. 15. Sketch-map showing the distribution of the localities in Skåne, Öland, and Småland dealt with in the paper.

tyonema shale, and is in its turn superposed by shales with *Didymograptus balticus*. According to MOBERG (1906, p. 17, footnote 1) the limestone contains *Plesiomegalaspis planilimbata*.

From the Billingen group no limestones are known.

Graptolite facies: Greenish shales belonging to the zone of *Tetragraptus phyllograptoides* have been reported by TÖRNQUIST (1901, p. 3) from Flagabro. They contain *T. phyllograptoides* and *Didymograptus undulatus*.

The zone of *Didymograptus balticus* is well developed in Skåne. The type locality of *D. balticus* is Kiviks Äsperöd where the species was collected by TULLBERG (1880) in slabs of dark shale accumulated on the shore. At Flagabro the greenish shales, mentioned above, are overlain by dark shales containing a rich graptolite fauna. According to TÖRNQUIST (1901, p. 3) the species are for the most part identical with those found in the zone of *D. balticus* at Hunneberg mountain. Grey shales containing members of the same fauna were encountered by WESTERGÅRD (1909, p. 27) at Jerrestad. In a drilling core from Fågelsång described by HEDE (1951) the Ceratopyge beds are followed by shales belonging to the zone of *D. balticus*.

Shales referable to the zone of *Phyllograptus densus* have been observed in several localities. According to TÖRNQUIST (1901, p. 3) the Lower Didymograptus shale at Flagabro is terminated by dark shales crowded with specimens of *P. densus*. This species was also collected by WESTERGÅRD (1909, p. 24) from greenish grey shales at Jerrestad. HEDE (1951) reports that at Fågelsång the zone of *Didymograptus balticus* is succeeded by dark shales containing, *inter alia*, *Phyllograptus densus*, *P. angustifolius*, and *Didymograptus extensus* (J. HALL).

The drilling core from Fågelsång has furnished an instructive section through the Ordovician beds of Skåne. According to HEDE (1951, p. 71) the sequence and thickness of the Tremadocian and Arenigian subdivisions are as follows:

—— ? ——	"Asaphus limestone" or/and Limbata limestone	0.26 m
	Gap in the succession, due to faulting	
Arenigian	Zone of *Phyllograptus densus*	2.71 m
	Hiatus	
	Zone of *Didymograptus balticus*	1.20 m
	Hiatus (?)	
	Zone of *Apatokephalus serratus* and part of "*Shumardia* zone"	1.06 m
	Hiatus	
	Ceratiocaris? *scanica* beds	0.49 m
	Zone of *Dictyonema norvegicum* and *Bryograptus kjerulfi*	0.15 m
Tremadocian	Brachiopod beds	1.60 m
	Zone of *Adelograptus hunnebergensis*	2.95 m
	Zone of *Dictyonema flabelliforme*	0.40 m
	Zone of *Dictyonema sociale*	0.20 m
	Upper Cambrian zone of *Acerocare* and *Parabolina heres* s. l.(?)	

According to HEDE (1951, p. 37) the boundary between the Tremadocian and the Arenigian beds is very sharp. Since the lowermost Arenigian beds with *Plesiomegalaspis armata* and with *Tetragraptus phyllograptoides* seem to be lacking in the core the existence of a hiatus at the boundary is highly probable.

ÖLAND

The island of Öland off the eastern coast of Southern Sweden is built up of Cambrian and Ordovician rocks, the latter represented mainly by limestones. The early Ordovician beds are well exposed in the cliff of the western shore. In the southernmost part of the island these beds attain their greatest thickness and stratigraphical completeness.

OTTENBY

At Ottenby, near the southern point of Öland, the Ordovician beds have been studied by several authors. TULLBERG (1882, p. 7) reported from the locality the occurrence of Dictyonema shale, Ceratopyge limestone, and Planilimbata

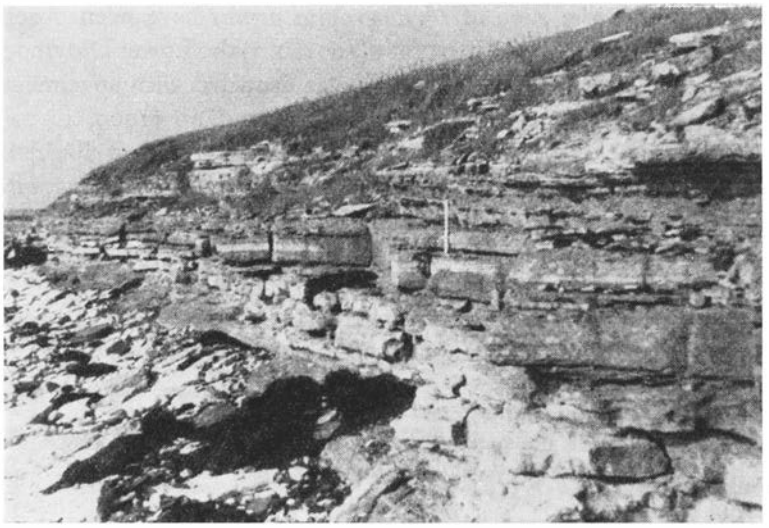


Fig. 16. The cliff of the western shore at Ottenby, Öland. The hammer stands on the limestone bed with *Lycophoria laevis*.

limestone. In the Ceratopyge limestone a rich trilobite fauna was encountered by HOLM (1882 b, p. 67). Accounts of all the beds exposed in southern Öland were given by MUNTHE (1902, p. 24) and by MOBERG (1906, p. 44). MOBERG distinguished the following subdivisions:

Ordovician:

Asaphus limestone
Limbata limestone
Planilimbata limestone
Ceratopyge limestone
Ceratopyge shale
Dictyonema shale

Cambrian:

Zone of Peltura

As the result of the investigations carried out by WESTERGÅRD (1909, 1944, and 1947) the Dictyonema shale of Öland is well known. At Ottenby it comprises the three zones of *Dictyonema flabelliforme flabelliforme*, *Clonograptus tenellus*, and *D. flabelliforme norvegicum*. The total thickness is 7.8 m.

The Dictyonema shale is superposed by Ceratopyge shale developed as alum shale. According to WESTERGÅRD (1944, p. 5) its thickness is 2.3 m. At Ottenby it contains *Ceratopyge forficula* and *Shumardia pusilla*, at Ventlinge, 5 km to the north, *Triarthrus angelini*, *Shumardia oelandica* MOBERG, and *Geragnostus sidenbladhi urceolatus* (MOBERG & SEGERBERG). It is followed by

glauconitic shales and Ceratopyge limestone. A detailed account of the lithology of the latter beds was given by HADDING (1932, p. 14).

In the summer of 1953 the author measured and examined the Ordovician limestone beds exposed on the shore W of the manor of Ottenby.

Description of the section, text-fig. 17 (fossils recorded: PU nos. Öl 132–202):

TREMADOCIAN:

Ceratopyge shale:

A. Alum shale, free from glauconite grains, in the uppermost part pyritiferous. The only fossil encountered is *Broeggeria salteri*.

Zone of *Apatokephalus serratus* (glauconitic shale and Ceratopyge limestone):

B. Glauconitic clayey shale, about 0.3 m thick, with *Broeggeria* sp. The shale is darkish grey-green and contains, according to HADDING (1932, p. 21), 85 per cent glauconite.

C. Beds of grey limestone intercalated with layers of greenish grey clayey shale or dark-green glauconitic shale, total thickness 0.6 m. The basal and the uppermost limestone beds are glauconitiferous. Five surfaces of discontinuity are discernible, the uppermost one terminating the zone. The limestone is rather rich in fossils, particularly at the level of 0.6 m. The following species have been collected: *Ceratopyge forficula*, *Euloma ornatum*, *Orometopus elatifrons*, *Niobe insignis*, *Niobella obsoleta*, *Varvia longicauda*, *Symphysurina*? *oriens*, *Symphysurus angustatus*, *Nileus limbatus*, *Cyclopyge latifrons* n.sp., *Agerina praematura*, "*Protopliomerops*" *primigenius*, *Triarthrus angelini*, *Acerocare*? sp., *Geragnostus crassus*, and *Broeggeria* sp.

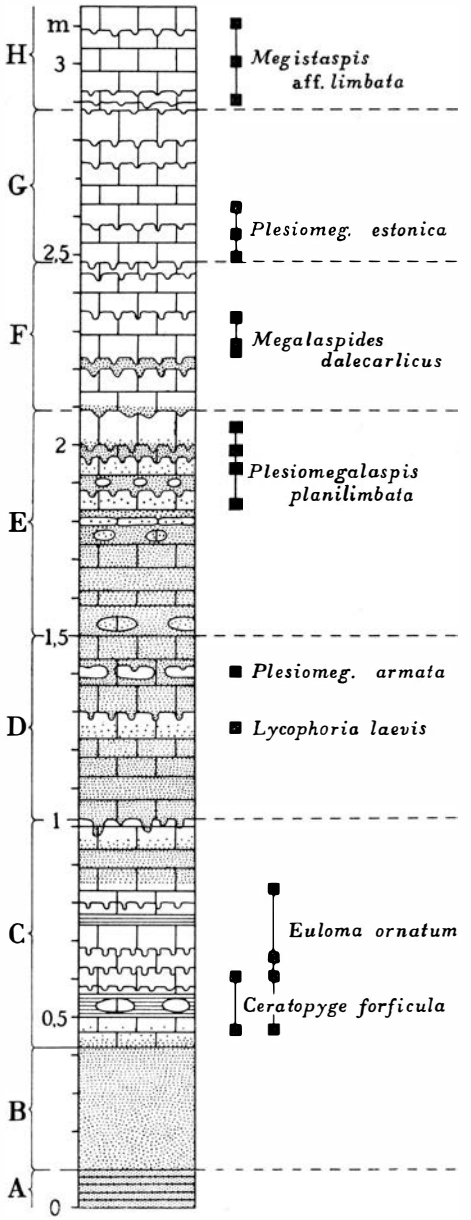


Fig. 17. Section through the early Ordovician limestone beds at Ottenby, Öland.

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

D. Dark-green glauconitic limestone, about 0.5 m thick, with a layer of glauconitic shale and two beds of rather pure limestone. The lower bed is brownish or yellowish grey, and contains *Lycophoria laevis* and *Apheoorthis? suecica*. The upper bed resembles the thin layers of white limestone occurring in the zone of *Plesiomegalaspis armata* at Stenbrottet in Västergötland. It has yielded: *Plesiomegalaspis armata*, *Niobella* cf. *bohlini*, *Falanaspis aliena*, *Apatokephalus* sp., and *Nanorthis? billingensis*.

Zone of *Plesiomegalaspis planilimbata* (Lower Planilimbata limestone):

E. The lower and main part of the zone consists of glauconitic limestone and shales, very poor in fossils. These layers are followed by a few beds of grey fossiliferous limestone. The total thickness is about 0.6 m. In the limestone the following species were obtained: *Plesiomegalaspis planilimbata*, *Niobe emarginula*, *Varvia breviceps*, *Symphysurus angustatus*, and *Geragnostus wimani*.

Upwards the zone is terminated by a bed of brown limestone. This is separated from the next zone by a well defined surface of discontinuity.

Billingen group (Upper Planilimbata limestone):

Zone of *Megalaspides dalecarlicus*:

F. Grey or greenish grey, at the top reddish limestone, thickness about 0.4 m. The basal beds are in part glauconitiferous. Fossils occur sparsely. They are: *Megalaspides dalecarlicus*, *Plesiomegalaspis* cf. *norvegica*, *Niobella* aff. *imparilimbata*, and *Nileus exarmatus*.

Zone of *Plesiomegalaspis estonica*:

G. Grey limestone, 0.4 m thick, with *Plesiomegalaspis estonica*, *Niobella* aff. *imparilimbata*, *Symphysurus* sp., *Nileus exarmatus*, *Ampyx pater*, *Raymondaspis* sp., and *Geragnostus*? sp. no. 2.

Limbata limestone:

H. Grey limestone, about 0.25 m exposed. It contains *Megistaspis* aff. *limbata*, *Asaphus* sp., *Niobella imparilimbata*, *Nileus exarmatus*, and *Raymondaspis* cf. *limbata* (ANGELIN).

COMMENTS.—The examination of the Ordovician beds at Ottenby has been rather superficial. Little time has been available for the collecting of fossils, and from the beds overlying the Ceratopyge limestone only a few specimens were obtained. Their number and distribution permit, however, a comparison of the Arenigian limestone beds with those of the Swedish mainland. The underlying Cambrian and Tremadocian alum shales are well known from a drilling core described by WESTERGÅRD (1944). This core and the above section form the basis of the following statements:

The stratal sequence of the Upper Cambrian and early Ordovician beds is fairly complete. In the Upper Cambrian alum shale all the zones, encountered in Sweden, are represented. In the Dictyonema shale the index fossils of three

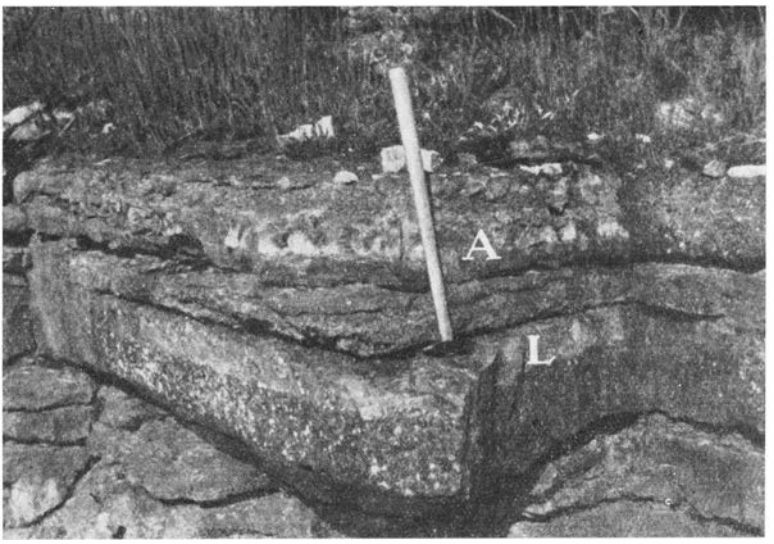


Fig. 18. Beds of glauconitic limestone with two layers of fairly pure limestone. The lower layer (L) contains *Lycophoria laevis*. From the upper one (A), which is deeply corroded, *Plesiomegalaspis armata* has been collected. Ottenby, Öland.

zones have been found. The Ceratopyge beds are well developed. The early Arenigian limestones belonging to the Hunneberg and the Billingen groups correspond well to those of Västergötland and Närke.

KÖPINGS KLINT

As pointed out by WESTERGÅRD (1947) the Upper Cambrian beds of Öland are thinning out northwards, the Dictyonema shale towards the west or northwest. About the thickness and the stratigraphical continuity of the upper Tremadocian and the lower Arenigian limestones in different parts of the island rather little is known. They seem, however, to undergo interesting variations.

At Köpings Klint, 75 km N of Ottenby, several sections have been examined by WESTERGÅRD (1922), HADDING (1927 and 1932), and REGNÉLL (1939, 1940, and 1942). They report, *inter alia*, the following (compare the section in text-fig. 19):

The Upper Cambrian strata are made up of anthraconite and conglomerates with a total thickness of only one metre. According to WESTERGÅRD (1922, p. 36) the beds contain *Agnostus pisiformis* (LINNÆUS), *Olenus gibbosus* (WAHLENBERG), and *Orusia lenticularis* (WAHLENBERG). No fossils from the uppermost zones have been encountered.

The Dictyonema shale is only a few centimetres thick. It contains *Dictyonema flabelliforme norvegicum*.

The Ceratopyge shale exhibits a glauconitic development with laminae of glauconite-free bituminous shale. The total thickness is about 1.6 m. According

to WESTERGÅRD (1922, p. 36), HADDING (1927, p. 83, and 1932, p. 33), and REGNÉLL (1939, p. 1) the shales contain, *inter alia*, *Broeggeria salteri*, *Nanorthis*? *christianiae*, *Clonograptus heres* WESTERGÅRD, *Bryograptus* sp., and *Ceratopyge forficula*.

In the cliff 800 m W of the church of Köping the author has examined the overlying Ordovician limestones.

Description of the section in text-fig. 19 (fossils recorded: PU nos. Öl. 203–237):

TREMADOCIAN:

Ceratopyge shale:

Only the uppermost part of the glauconitic shale is exposed. It is terminated by a thin layer of glauconite sand.

Zone of *Apatokephalus serratus*:

Grey and reddish, in part glauconitic limestone beds alternating with thin layers of glauconitic and greenish grey clayey shale. The total thickness is 0.45 m. The limestone contains *Ceratopyge forficula*, *Euloma ornatum*, *Varvia longicauda*, *Symphysurina*? *oriens*, *Symphysurus angustatus*, *Harpides rugosus*, *Agerina praematura*, *Broeggeria* sp., and *Eostrophomena elegantula*.

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

At the base of the Hunneberg group a new accumulation of glauconite grains has taken place. The zone is built up of dark-green glauconitic shales with two beds of glauconitic limestone. The total thickness is about 0.3 m. The lower limestone bed is reddish and devoid of fossils. The upper bed is yellow-grey and deeply corroded. It contains *Lycophoria laevis* and *Nanorthis*? *billingensis*.

Zone of *Plesiomegalaspis planilimbata*:

Limestone beds, 0.35 m thick, grey and glauconitic at the base, otherwise variegated, chiefly red, in part green and yellow. From the lower part of the zone *Plesiomegalaspis planilimbata*, *Niobe emarginula*, and *Nileus limbatus* were collected. The upper beds contain a few species of the rich fauna encountered in the uppermost part of the zone at Gymninge in Närke. These are: *Plesiomegalaspis* aff. *estonica*, *Nileus exarmatus*, and "*Protorthis*" *hunnebergensis*.

Billingen group:

Zone of *Megalaspides dalecarlicus*:

Red limestone, about 0.3 m thick, with yellow-coloured surfaces of discontinuity. It contains *Plesiomegalaspis norvegica*, *Niobella* aff. *imparilimbata*, *Nileus exarmatus*, *Dysplanus*? sp. no. 2, *Raymondaspis* sp. no. 1, and a small, straight cephalopod.

Zone of *Plesiomegalaspis estonica*:

Red limestone, about 0.4 m, with *Plesiomegalaspis estonica* and *Nileus exarmatus*. Upwards the zone is terminated by a conspicuous, brightly green and yellow surface of discontinuity.

Limbata limestone:

Red limestone with *Megistaspis* aff. *limbata*.

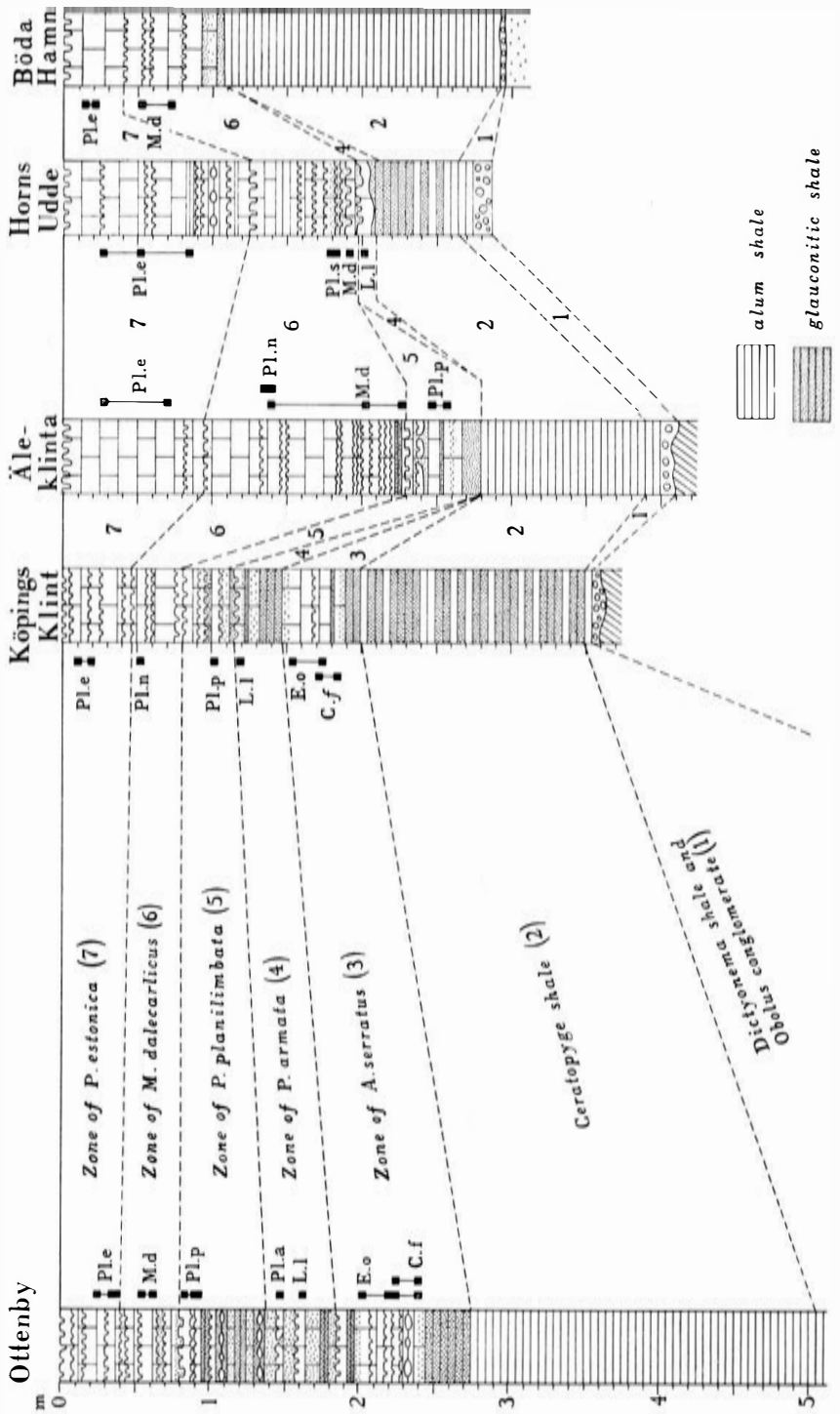


Fig. 19. Sections through the early Ordovician beds at five localities in Öland. Vertical distribution of *Ceratopyge forficula* (C.f), *Euloma ornatum* (E.o), *Lycophoria laevis* (L.l), *Plesiomegalaspis armata* (Pl.a), *Plesiomegalaspis planilimbata* (Pl.p), *Megalaspides dalecarlicus* (M.d), *Plesiomegalaspis norvegica* (Pl.n), *Plesiomegalaspis scutata* (Pl.s), and *Plesiomegalaspis estonica* (Pl.e).

COMMENTS.—The Tremadocian rocks of Sweden are grey, greenish grey, brownish, or almost black. Very seldom they are reddish. In the Arenigian Planilimbata limestone the first strongly red-colcured strata of the Ordovician are encountered. They have a limited regional distribution, being confined to Northern Öland, the South Bothnian District, and Dalarna. At Köpings Klint they show a typical development. The upper and main part of the Planilimbata limestone is brightly red; immediately below the surfaces of discontinuity the rock is, however, just as brightly yellow-coloured.

No satisfactory explanation of the sudden appearance of these red-coloured strata is known.

ÄLEKLINTA

At Äleklinta, about 11 km NNE of Köpings Klint, the Cambrian and Ordovician beds have been studied by HOLM (1882 b), MUNTHE (1904), HADDING (1927), REGNÉLL (1942), and WESTERGÅRD (1947).

According to HADDING (1927, p. 79) the Cambrian system ends with a bed of anthraconite belonging to the zone of *Agnostus pisiformis*. It is followed by a thin conglomerate of Tremadocian age, the Obolus conglomerate, containing fragments of Upper Cambrian rocks with *Orusia lenticularis*. At Djupvik, 6 km farther to the north the pebbles of the conglomerate were found to contain several species of late Upper Cambrian age. WESTERGÅRD (1922, p. 37) reports, *inter alia*, *Peltura scarabaeoides* and *Sphaerophthalmus alatus*.

The Ordovician system begins with the Obolus conglomerate. Its matrix has yielded *Obolus* sp. and fragments of *Dictyonema* sp.

The conglomerate is followed by alum shale, about 1.2 m thick. At the base it contains, according to WESTERGÅRD (1947, p. 9), *Dictyonema flabelliforme norvegicum*. The upper and main part has been referred to the Ceratopyge shale.

In the shore-cliff, 300 m N of the small harbour of Äleklinta, a section through the early Ordovician limestones has been examined by the present author. It differs in several respects from that at Köpings Klint.

Description of the section in text-fig. 19 (fossils recorded: PU nos. Öl 238–265):

TREMADOCIAN:

Ceratopyge beds:

The Ceratopyge shale is an alum shale, about one metre thick. It has not been examined. The Ceratopyge limestone is lacking.

ARENIGIAN:

Hunneberg group:

The zone of *Plesiomegalaspis armata* has thinned out to nothing.

Zone of *Plesiomegalaspis planilimbata*:

A basal bed, 0.13 m thick, composed almost entirely of glauconite grains is followed by grey, in part glauconitic limestone terminated above by a con-

spicuous surface of discontinuity with deep and wide pits. The total thickness of the zone is about 0.5 m. The following fossils were encountered: *Plesiomegalaspis planilimbata*, *Megalaspides* cf. *nericiensis*, *Promegalaspides stenorhachis*, *Niobella bohlini*, *Varvia breviceps*, and *Nileus exarmatus*. Some other species have been collected by Dr. B. BOHLIN and kindly placed at the disposal of the author. They are: *Plesiomegalaspis*? sp. (a pygidium with a very narrow concave border), *Niobe emarginula*, and *Geragnostus wimani*.

Billingen group:

Zone of *Megalaspides dalecarlicus*:

The zone begins with a layer of glauconitic limestone and marl which is followed by beds of brown, grey, or reddish limestone, the first-named with brown-coloured surfaces of discontinuity. The beds are intercalated with thin layers of greenish grey marl. The total thickness of the zone seems to be 1.35 m. The limestone contains *Megalaspides dalecarlicus*, *Plesiomegalaspis* cf. *norvegica*, *Plesiomegalaspis* sp., *Niobella* aff. *imparilimbata*, and *Nileus exarmatus*.

Zone of *Plesiomegalaspis estonica*:

Limestone, about one metre thick, grey, reddish, or brownish with red spots. It is poor in fossils and has yielded only a few specimens of *Plesiomegalaspis estonica*, *Niobella* aff. *imparilimbata*, *Euloma laeve*, and "*Endoceras*" sp. A pygidium of *Geragnostus* aff. *crassus*, collected by REGNÉLL (1942, p. 13) at Äleklinta, probably comes from these beds. The zone is delimited from the overlying Limbata limestone by a distinct, yellow surface of discontinuity. Just below it the rock is coloured a deep red.

Limbata limestone:

Grey limestone, changing upwards into red limestone, with *Megistaspis* aff. *limbata*.

COMMENTS.—Äleklinta is not far from Köpings Klint, yet the sections at the two localities show considerable dissimilarities. At Äleklinta the two zones of *Apatokephalus serratus* and *Plesiomegalaspis armata* have thinned out to nothing, indicating a great hiatus between the Tremadocian and the Arenigian beds. The limestones of the Billingen group on the other hand have considerably increased in thickness, being nearly three times as thick as at Köpings Klint. They are furthermore but faintly red-coloured with the exception of that portion of the uppermost limestone bed which lies immediately below the boundary towards the Limbata limestone.

HORNS UDDE

At Horns Udde in Northern Öland a part of the lower Ordovician rocks is accessible in the high and steep cliff of the western shore.

Description of a section at this locality, text-fig. 19 (fossils recorded: PU nos. Öl 266–284):

TREMADOCIAN:

At the time for the author's visit nearly all of the Tremadocian beds were covered by beach gravel. According to WESTERGÅRD (1947, p. 9) the Tremadocian begins with a conglomerate from which *Obolus apollinis* EICHWALD and fossils from several of the Upper Cambrian zones have been collected. Above follows alum shale containing *Dictyonema* sp. The main part of this shale as well as an overlying glauconitic shale are, however, regarded as Ceratopyge shale. Upwards it changes into glauconitic limestone. At the top the latter contains small lumps of phosphatized anthraconite(?). These are often red-coloured throughout, probably due to subaerial weathering. *Broeggeria salteri* is the only fossil obtained from the glauconitic beds.

ARENIGIAN:

Hunneberg group:

This group is represented by a bed of light-grey limestone, 5–10 cm thick, with a deeply corroded upper surface. It contains *Lycophoria laevis*, and thus belongs to the zone of *Plesiomegalaspis armata*. The zone of *P. planilimbata* has thinned out to nothing.

Billingen group:

This group is made up of limestone beds intercalated with thin layers of clayey shale or marly limestone. At the base the limestone is grey and glauconitic, the rest being variegated, mostly red.

In a bed close to the lower boundary of the group a pygidium of *Plesiomegalaspis scutata* was found. This is an index fossil for the upper part of the zone of *Megalaspides dalecarlicus*, and indicates that the lower half of this zone is very poorly represented. Other fossils encountered are: *M. dalecarlicus*, *Plesiomegalaspis* sp., *Niobella* aff. *imparilimbata*, *Nileus exarmatus*, and *Geragnostus* sp.

The beds belonging to the zone of *Plesiomegalaspis estonica* contain *P. estonica*, *Niobella* aff. *imparilimbata*, *Nileus exarmatus*, and "*Endoceras*" sp.

The upper boundary of each zone is distinguished by a conspicuous, bright-coloured surface of discontinuity. The thickness of the zones is 0.7 m and 1.25 m, respectively.

Limbata limestone:

The Billingen group is overlain by red limestone with *Megistaspis* aff. *limbata*.

BÖDA HAMN

The stratigraphy of the Cambrian and Lower Ordovician beds of northernmost Öland has been studied in a drilling core obtained at Böda Hamn. The faunas of the Cambrian and Ordovician rocks have been examined by WÆRN (1953) and BOHLIN (1955). The following statements are based upon their reports (compare text-fig. 19):

UPPER CAMBRIAN:

This series seems to be altogether lacking.

TREMADOCIAN:

Obolus conglomerate:

The Ordovician system begins with a conglomerate in which *Obolus* sp. and conodonts have been found. The thickness is only 2 cm.

Ceratopyge beds:

The Ceratopyge shale is developed as alum shale with *Broeggeria salteri*. At the top it passes into glauconitic shale. The total thickness is 1.73 m.

The Ceratopyge limestone is lacking.

ARENIGIAN:

Hunneberg group:

No fossils suggesting the presence of the two zones of *Plesiomegalaspis armata* and *P. planilimbata* have been found.

Billingen group:

The Ceratopyge shale appears to be followed directly by Upper Planilimbata limestone. It is a grey limestone, in part glauconitiferous, and about 1.1 m thick. *Megalaspides dalecarlicus* was encountered 35 cm and 55 cm above the lower boundary, and from the top of the limestone *Plesiomegalaspis* cf. *estonica* and *Euloma* sp. were collected. These fossils indicate the presence at this locality of both zones of the group.

The group is overlain by Limbata limestone with *Megistaspis limbata lata* and *Niobella imparilimbata*.

COMMENTS.—The sections in text-fig. 19 show the varying thickness of the lowermost Ordovician beds at the five localities described above.

The Ceratopyge shale is present in all sections. In Northern Öland it seems to thin out towards the west. The Ceratopyge limestone attains its greatest thickness in Southern Öland. Half-way towards the north it is still well developed, and then thins out rapidly to nothing. The limestones belonging to the Hunneberg group have a greater extension towards the north. In the northernmost part of the island they are, however, lacking or very poorly developed. The limestones of the Billingen group cover all the island, being thickest at Äleklinta, not very far north of the central part of the island.

SMÅLAND

LAKE HUMELN

At Lake Humeln in the Archaean district of Småland (on the mainland west of Öland) large accumulations of boulders deriving from Cambrian and Ordovician strata are found. At the farm Humlenäs, south-east of the lake, the limestone boulders may reach a considerable size, and have been used for the manufacture of quicklime.

The first report on these accumulations is due to HISINGER (1826). Fifty years later the locality was visited by LINNARSSON who made a thorough examination of the fossils and of the distribution of the boulders. He reports

(1878) that all the anthraconite boulders encountered contain *Agnostus pisiformis*. They indicate that the Upper Cambrian beds are as poorly developed here as in Northern Öland. The lowermost Ordovician beds are represented by limestones with *Plesiomegalaspis planilimbata*.

Large collections of boulders from the vicinity of the lake have been made by Professor E. STENSIÖ. They have been examined by WESTERGÅRD who published a report on their fossils and their stratigraphical position (1947, p. 10). He pointed to the resemblance of the Ordovician rocks of Humeln to those of Öland in lithological as well as palaeontological respect. The present author, who had the opportunity of seeing the collections which are kept in the State Museum of Nat. History in Stockholm, wants to offer a few further remarks.

The main part of the Upper Cambrian anthraconite boulders comes from the zone of *Agnostus pisiformis*. Boulders with *Olenus* spp. and *Orusia lenticularis* are rare. A single small piece contains *Peltura scarabaeoides* and *Sphaerophthalmus alatus*.

Boulders from the Tremadocian beds and the Hunneberg group are altogether lacking in the collections.

The limestones of the Billingen group are fairly well represented. Boulders of marly greenish grey limestone with red spots, and others of glauconitiferous and variegated (red, yellow, and green) limestone come from the zone of *Megalaspides dalecarlicus*. They contain *M. dalecarlicus* and *Nileus exarmatus*. Boulders of red and greenish limestone belonging to the zone of *Plesiomegalaspis estonica* have yielded *P. estonica*, *Nileus exarmatus*, *Agerina erratica*, and *Geragnostus* aff. *crassus*.

A stratigraphy founded on these boulders would agree with that of Northern Öland, where the Upper Cambrian beds, the Ceratopyge limestone, and the limestones of the Hunneberg group are poorly developed or lacking. Another similarity to the strata of Northern Öland is the red colour of the Upper Planilimbata limestone.

The boulders are believed to be derived from strata resting on the bottom of the lake where their preservation is due to faults. It is, however, just as likely that they have been transported as glacial drift from the bottom of the Baltic Sea. Similar accumulations of Cambrian and Ordovician boulders are known around Lake Erken in Uppland. A boring in the lake in 1954 by the Palaeontological Institution of Uppsala, on a grant by the Swedish Natural Science Research Council, did not strike any corresponding strata.

ÖSTERGÖTLAND

The preservation of the Palaeozoic rocks of Östergötland is due to faults. The rocks are of Cambrian, Ordovican, and, to a small extent, of Silurian age. WAHLENBERG and DALMAN were the first to study these rocks and their fossils

in the early part of the last century. Their work was continued by a number of prominent scientists. Of greatest value for the work of the present author have been the papers by WESTERGÅRD, based on sections and drilling cores through the Cambrian and early Ordovician beds.

VÄSTANÅ

At Västanå (Borensberg, Husbyfjöl), about 25 km NW of the town of Linköping, alum shales and limestones are quarried, and the Upper Cambrian and Lower Ordovician beds are well exposed. Reports on the latter were published by LINNARSSON & TULLBERG (1882, p. 23). The Cambrian and Tremadocian beds have been thoroughly investigated by WESTERGÅRD (1922, p. 46, 1940, p. 26, and 1944, p. 16 and pl. 2). He reports, *inter alia*, the following:

The Upper Cambrian series is terminated by alum shale belonging to the subzone of *Peltura scarabaeoides* and *Sphaerophthalmus alatus*.

The Tremadocian beds are made up of alum shale with sparse lenses of anthraconite and with layers of calcareous quartz sandstone, the latter occurring in the lower part of the shale. The upper and main part of the shale contains *Dictyonema flabelliforme flabelliforme*. The total thickness is about 5 m. No traces of the Ceratopyge beds have been observed.

The Arenigian limestones are known to the present author from a short visit to the quarry, and from fossils and slabs kept in the museum of the Palaeontological Institution of Uppsala.

Description of the section in text-fig. 20 (fossils recorded: PU nos. Ög 24–57):

TREMADOCIAN:

A. Dictyonema shale, not examined.

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

B. A thin layer of glauconite sand is followed by glauconitic limestone with thin, corroded layers of white limestone. The latter contain *Lycophoria laevis*. The total thickness of the zone is about 0.35 m.

Zone of *Plesiomegalaspis planilimbata*:

Greenish grey or brownish limestone, glauconitic at the base, about 0.5 m thick. It has yielded: *P. planilimbata*, *Megalaspides nericiensis*, *Promegalaspides stenorhachis*, *Niobe emarginula*, *Niobella bohlini*, *Varvia breviceps*, *Symphysurus angustatus*, and *Ampyx* cf. *pater*.

Billingen group:

Zone of *Megalaspides dalecarlicus*:

D. Grey limestone with thin layers of greenish grey clayey shale at the base of the zone, total thickness about 0.7 m. The limestone contains *Megalaspides dalecarlicus*, *M. paliformis*, *Niobella* aff. *imparilimbata*, and *Ampyx pater*. In

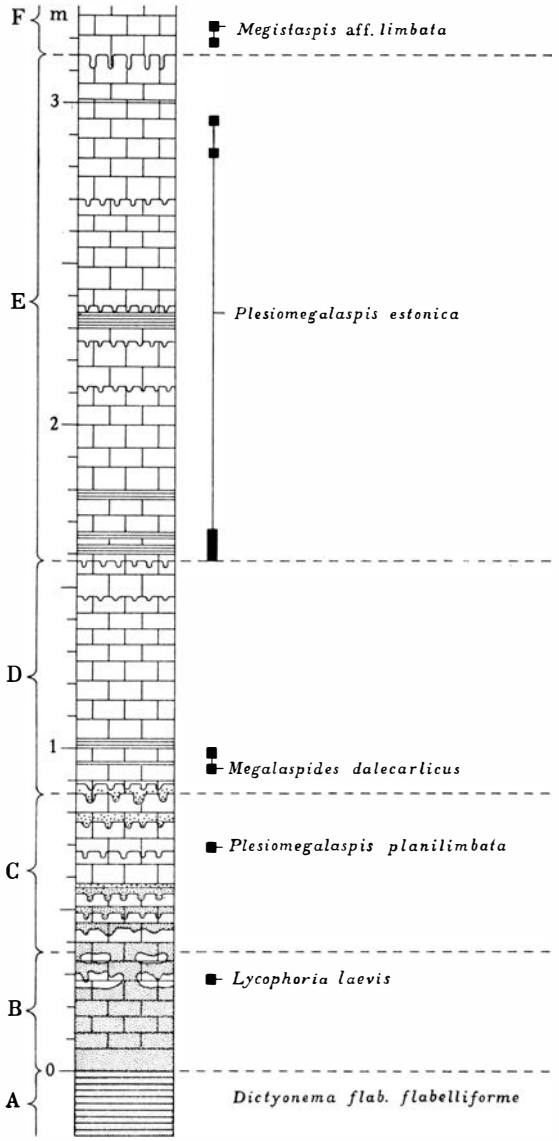


Fig. 20.

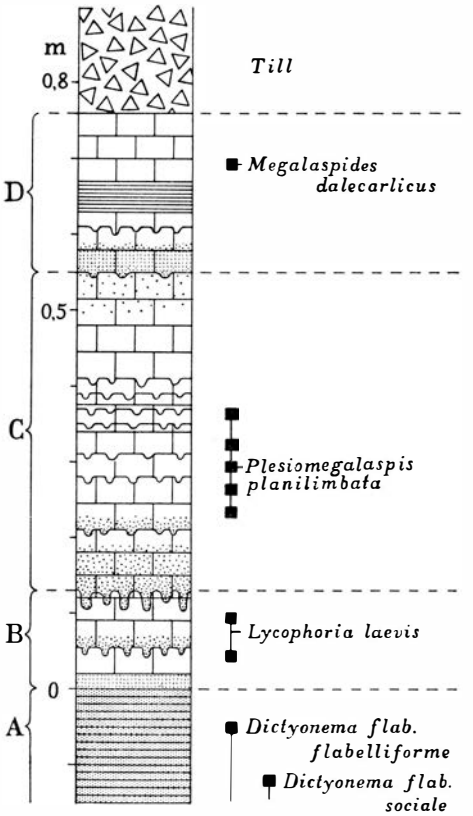


Fig. 21.

Fig. 20. Section through the early Ordovician limestone beds at Västanå, Östergötland.

Fig. 21. Section through the uppermost part of the early Ordovician beds at Knivinge, Östergötland.

the uppermost bed, included with some doubt into the zone, *Plesiomegalaspis* cf. *norvegica* and "*Endoceras*" sp. were encountered.

Zone of *Plesiomegalaspis estonica*:

E. Grey limestone with thin layers of clayey shale and marly limestone, particularly at the base of the zone. The thickness is about 1.6 m. During a hasty examina-

tion of the beds *P. estonica*, *Niobella* aff. *imparilimbata*, *Nileus exarmatus*, and *Euloma* cf. *laeve* were collected. A pronounced surface of discontinuity with deep and narrow pits forms the upper boundary of the zone.

Limbata limestone:

F. Slightly reddish limestone with *Megistaspis* aff. *limbata*.

KNIVINGE

Upper Cambrian alum shale and Dictyonema shale have been quarried at Knivinge, 11 km NW of Linköping. They are covered either by glacial drift or by Planilimbata limestone, the beds of which are disturbed. A section through the Dictyonema shale and through the limestone has been measured and examined. The figures of the thicknesses are at least approximately correct.

Description of the section in text-fig. 21 (fossils recorded: Ög 58–75):

TREMADOCIAN:

Dictyonema shale:

Zone of *Dictyonema flabelliforme sociale*:

A. Alum shale with thin layers of sandstone and anthraconite, 2.5 m thick. The shale contains *Dictyonema flabelliforme flabelliforme* and *D. f. sociale*. The latter subspecies still occurs at the top of the shale.

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

B. A thin layer of glauconite sand is followed by two beds of light-grey limestone, intercalated with a thin layer of glauconitic limestone. The total thickness is only 10–15 cm. In the grey limestone sparse *Lycophoria laevis* are found.

Zone of *Plesiomegalaspis planilimbata*:

C. A layer of glauconitic limestone is overlain by beds of pale, greenish grey limestone, in part glauconitiferous and with several surfaces of discontinuity. The total thickness is about 0.4 m. From the grey limestone the following species were collected: *P. planilimbata*, *Megalaspides nericiensis*, *Niobe emarginula*, *Niobella bohlini*, *Varvia breviceps*, and *Symphysurus angustatus*.

Billingen group:

Zone of *Megalaspides dalecarlicus*:

D. Greenish grey limestone, glauconitic at the base, and intercalated with a layer of greenish grey clayey shale and marly limestone. The thickness of the preserved beds is about 0.2 m. The grey limestone contains *M. dalecarlicus* and *Plesiomegalaspis* cf. *norvegica*.

These beds are overlain by glacial drift.

COMMENTS.—The Ordovician rocks of Östergötland are initiated by Dictyonema shale. This attains its greatest thickness in the south-western part of the district, and thins out eastwards. At Skåningstorp it is (according to WESTER-

GÅRD, 1944, p. 16) 7.5 m thick, at Storberg 5 m, and at Knivinge 2.5 m. At the bay of Slätbaken, near the Baltic Sea, it has thinned out to nothing as indicated by a boulder found at the inner part of the bay. The boulder consists of Upper Cambrian anthraconite in contact with Ordovician glauconitic limestone, certainly of Arenigian age (compare WESTERGÅRD, 1940, p. 28).

From Storberg in the north-western part of the district WESTERGÅRD (1909, p. 32) reports the find of *Dictyonema flabelliforme sociale* in the lowermost part of the shale, and of *D. flabelliforme flabelliforme* and *Clonograptus tenellus* in the upper layers. In the east on the contrary, at Knivinge and Pålstorp, *D.f. sociale* is common in the uppermost part of the shale (compare also BULMAN, 1954, p. 10). This discrepancy might be explained by the thinning out to nothing of the zones of *D. f. flabelliforme* and *C. tenellus* towards the east. A special paper on the subject is under preparation.

The existence of Ceratopyge beds in the district has not been proved.

Both zones of the Arenigian Hunneberg group are developed. Glauconitic limestones belonging to the zone of *Plesiomegalaspis armata* have been encountered at Västanå and Knivinge. The zone of *P. planilimbata* is known from several localities. WESTERGÅRD (1940, pp. 29 and 30) furnishes two lists of fossils from the Planilimbata limestone at Berg and Borghamn. Many of these species are characteristic of the last-mentioned zone.

The Billingen group is well developed. In a drilling core from Borghamn, described by WESTERGÅRD (1940, p. 20), the zone of *Megalaspides dalecarlicus* is made up of greenish grey clayey shales and beds of light-grey limestone. The latter contain *M. dalecarlicus*. In the shale from the lower part of the zone *Phyllograptus densus* was encountered. It occurs above and below layers containing the index trilobite. The find confirms the correlation of the zone of *Phyllograptus densus* with that of *Megalaspides dalecarlicus*.

The limestones belonging to the zone of *Plesiomegalaspis estonica* agree lithologically as well as faunistically with those of Närke.

SOUTH BOTHNIAN DISTRICT (North Baltic District)

The Swedish mainland west of the Gulf of Bothnia is built up of Archaean rocks. In certain parts of the coastal region, however, boulders of Cambrian sandstones and Ordovician limestones are fairly common—sometimes very common—in the glacial drift. They suggest that beds of early Palaeozoic age are resting upon the bottom of the Gulf. The area of these deposits was called by WIMAN the North Baltic District. This name has been changed by subsequent authors to the South Bothnian District.

The extension of the Palaeozoic rocks is, of course, unknown. In maps, published by LUNDQVIST (1935, p. 284), BACKLUND (1937, p. 260), EKLUND (1953, p. 9–10:4), and RUDBERG (1954, pl. 1), the western boundary of the district is drawn outside the coast from the island of Brämön in the north to

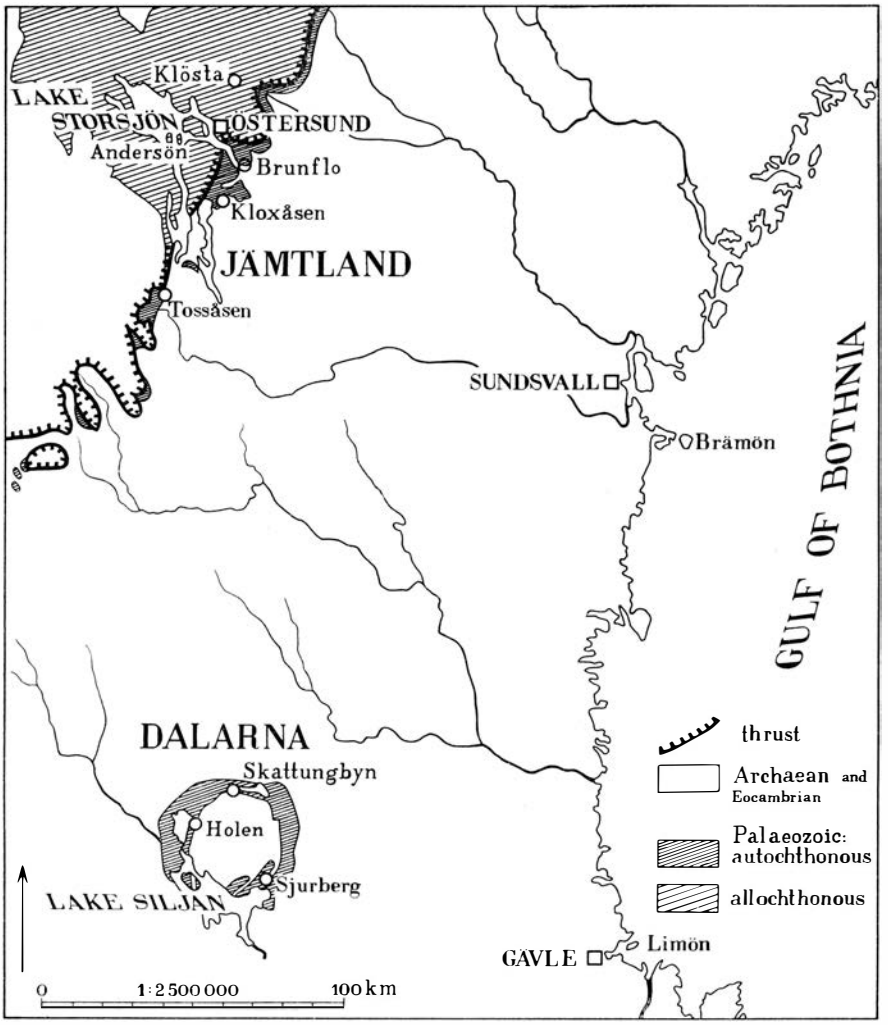


Fig. 22. Sketch-map showing the distribution of the localities in the Gulf of Bothnia, Dalarna, and Jämtland dealt with in the paper.

Limön in the south (compare the sketch-map in text-fig. 22). From this boundary it stretches eastwards, occupying about one third to two-thirds of the bottom area of the Gulf.

GÄVLE BAY

Best known are the Cambrian and Ordovician beds of the Gävle Bay. WESTERGÅRD (1939, p. 36) reports the find *in situ* of Lower Cambrian sandstones and clays during a drilling at Holmudden. This locality is situated on the northern shore of the bay, 11 km NE of the town of Gävle. Another drilling

carried out on Limön has shown that the Ordovician limestones of this island are underlain by moraine. They form a sheet thrust by the ice over the island during the Quaternary glaciation. Very likely the limestones on the island of Granskär have a similar history.

The Limön beds mainly consist of red Planilimbata and Limbata limestones. The lowermost Arenigian zone of *Plesiomegalaspis armata* is represented by grey or red-spotted limestone with *Lycophoria laevis*. Also the Ceratopyge limestone seems to be present. A thick bed of clay probably corresponds to the Lower Didymograptus shale of Västergötland.

The Ordovician rocks of the South Bothnian District, however, comprise far more subdivisions. They are known by the numerous boulders found upon the islands of the Gulf and on the mainland. By collecting and studying a large number of such boulders WIMAN (1903 and 1907) succeeded in unravelling the stratigraphy of the sub-marine beds. Their age varies from early Cambrian to late Middle Ordovician. In the Cambrian and Lower Ordovician beds WIMAN distinguished the following subdivisions (1903, p. 24):

Lower Ordovician:

Platyurus limestone
Gigas limestone
Asaphus limestone
Limbata limestone
Planilimbata limestone
Clayey shales, included in the Ceratopyge beds
Ceratopyge limestone
Ceratopyge shale
Obolus sandstone

Lower Cambrian:

Olenellus sandstone

For the comparison of the lowermost Ordovician limestones of the South Bothnian District with those of the rest of Sweden WIMAN's large collections of fossils, which are preserved in the museum of the Palaeontological Institution of Uppsala, have been studied. The following zones were recognized (fossils recorded: PU nos. B 244–259; N 877–911, and in the collections of WIMAN):

TREMADOCIAN:

Dictyonema beds:

Obolus conglomerate and sandstone with *Obolus apollinis*.

Ceratopyge beds:

Ceratopyge shale:

Alum shale, containing, *inter alia*, *Shumardia bottnica* WIMAN and *Ceratopyge forficula*.

Zone of *Apatokephalus serratus* (Ceratopyge limestone):

Light-grey limestone with pyrite and sparse grains of glauconite. The rock very much resembles the Ceratopyge limestone at Stenbrottet in Västergötland. The bed (or beds) are deeply corroded. Fossils occur in abundance. They are: *Ceratopyge forficula*, *Euloma ornatum*, *Apatokephalus serratus*, *Orometopus elatifrons*, *Niobe insignis*, *Niobella* cf. *obsoleta*, *Varvia longicauda*, *Symphysurus angustatus*, *Nileus limbatus*, *Parapilekia speciosa*, *Triarthrus angelini*, *Trinodus mobergi*, and *Eostrophomena elegantula*.

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

Limestones of varying colour: light-grey, light-grey with red spots, and variegated: grey, yellow and red. All are glauconitiferous and some contain in addition grains of quartz, small pebbles of phosphoritic sandstone, and worn fragments of *Obolus* sp. The following species have been collected: *Plesiomegalaspis armata*, *Lycophoria laevis*, *Apheoorthis*? *suecica*, and *Nanorthis*? *billingensis*. A boulder of light-grey limestone found in glacial clay at Örebro in Närke probably originates from the Gulf of Bothnia. It contains *Plesiomegalaspis armata*, *Orometopus grypos*, *Saltaspis viator*, *Pliomerops* sp., *Apatokephalus* sp., and *Nanorthis*? *billingensis*.

Zone of *Plesiomegalaspis planilimbata*:

The slabs collected consist of: (a) greenish grey limestone, in part yellow, with discontinuity surfaces green-coloured by glauconite, (b) reddish grey limestone, (c) red and yellow limestone, (d) red limestone. They are usually rich in fossils and contain *Plesiomegalaspis planilimbata*, *P. heroides*, *Megalaspides nericiensis*, *Promegalaspides stenorhachis*, *Niobe emarginula*, *Niobella bohlini*, *Varvia breviceps*, *Symphysurus angustatus*, *Cyclopyge gallica*, *Pliomerops actinurus*, *Diaphanometopus lineatus*, *Apatokephalus* cf. *pecten*, *Ampyx* cf. *pater*, *Parabolinella* sp. no. 2, *Geragnostus crassus*, and *G. wimani*.

Billingen group (Upper Planilimbata limestone):

Zone of *Megalaspides dalecarlicus*:

Greenish grey, red and yellow, and red limestones. They contain *Megalaspides dalecarlicus*, *M. paliformis*, *Plesiomegalaspis norvegica*, and *Nileus exarmatus*.

Zone of *Plesiomegalaspis estonica*:

Red and yellow, and red limestones with *Plesiomegalaspis estonica* and *Niobella* aff. *imparilimbata*. Boulders from Örebro contain *Euloma laeve*, *Agerina erratica*, *Nileus exarmatus*, *Remopleuridiella* sp. no. 2, *Ampyx obtusus*, and *Geragnostus*? sp. no. 2. Some ostracods have been encountered in boulders deriving probably from the zone. Dr. V. JAANUSSON has kindly supplied the following determinations: *Conchoprimitia* sp., *Rigidella* n. sp., and *Glossomorphites* n. sp.

BRÄMÖN and GRAN

About 175 km north of the Gävle Bay the small islands of Brämön and Gran are situated. The position of the former is 30 km SE of the town of Sundsvall, that of the latter 20 km farther to the south. Upon these islands SCHÖN (1912, p. 240) obtained a rather large collection of fossils from Ordovician boulders.

Such boulders are most common on the eastern shore of Brämön, and were interpreted by the said author as deriving from the bottom of the Gulf. He recognized several of the stratigraphical subdivisions which had been established by WIMAN on the boulders from the Gävle Bay.

The fossils and rock samples collected by SCHÖN are kept in the museum of the Palaeontological Institution of Uppsala. They show that the Ordovician begins with an Obolus conglomerate with pebbles of, *inter alia*, quartz and phosphorite in a matrix of calcareous sandstone. It contains *Obolus* cf. *apollinis*. No boulders indicating the presence of the Ceratopyge beds have been encountered.

The Hunneberg group is represented by boulders from the zone of *Plesiomegalaspis planilimbata*. This zone is made up of limestones very similar to those of the Gävle Bay. They are greenish grey or variegated, and contain *Plesiomegalaspis planilimbata*, *Promegalaspides stenorhachis*, *Niobella bohlini*, and *Symphysurus angustatus*.

A few boulders of red and yellow limestone from the Billingen group have been collected. They show that both zones of this subdivision are developed. From the zone of *Megalaspides dalecarlicus* there come boulders with *Megalaspides paliformis* and *Plesiomegalaspis scutata*, from the upper zone derive boulders with *Plesiomegalaspis estonica*, *Niobella* aff. *imparilimbata*, and *Nileus exarmatus*.

COMMENTS.—The fossils collected by WIMAN and SCHÖN from the early Ordovician limestones of the Bothnian Gulf are all known from the corresponding rocks of Västergötland and Närke. The stratigraphy and faunas of these rather widely separated limestone beds resemble each other even in details. Petrologically the lowermost Arenigian limestones of the Gulf differ from those of South Central Sweden by their strongly variegated, mostly red colouring. In this respect they agree with the corresponding limestones in the cliff of Köpings Klint in Öland, and with the limestones of Dalarna, described below.

DALARNA

In the north-western part of the province of Dalarna small exposures of sandstone and dark shales are found on the eastern slopes of the Scandinavian mountains of the Caledonides. They are of Cambrian age. Of far greater extension and thickness, however, are the remnants of Palaeozoic sediments situated in a circular belt at Lake Siljan. There the beds are preserved due to a large number of faults and, contrary to the corresponding rocks hitherto dealt with, rather strongly disturbed. The beds often dip very steeply, and are sometimes inverted. The rocks are of Ordovician and Silurian age. All the Cambrian is completely lacking.

The extension, stratigraphy, and faunas of the lowermost Ordovician beds have been studied and discussed by TÖRNQUIST (1874, 1884), HOLM (1882a),

HEDSTRÖM (1894, 1896), WIMAN (1906), WARBURG (1910), HADDING (1927), and THORSLUND (1936). They report, *inter alia*, the following:

The Dictyonema beds are represented by the Obolus conglomerate which was observed by H. v. POST at Klittberget in the parish of Boda, NE of Lake Siljan as early as 1844. It has been encountered later at Vikarbyn and Sjurberg in the south-eastern part of the district.

Above the Obolus conglomerate at Sjurberg WIMAN (1906, p. 451) found a thin limestone bed with *Lycophoria laevis*. This limestone he referred to the Ceratopyge beds, erroneously assuming this fossil as characteristic of the lower part of the Ceratopyge limestone at Kinnekulle.

The Planilimbata limestone is well developed and is found in all parts of the district: at Sjurberg and Vikarbyn in the south-east, at Skattungbyn in the north, and in the neighbourhood of Orsa in the north-west.

At Skattungbyn HOLM (1882 a) encountered a trilobite fauna characteristic of the zone of *Megalaspides dalecarlicus*. It occurs in beds of greenish limestone intercalated with layers of greenish clayey shales. From the latter TÖRNQUIST (1877, 1879) collected and described *Phyllograptus densus*.

The Planilimbata limestone is followed by Limbata limestone containing *Megistaspis limbata lata*, the type locality of this species being Vikarbyn.

SJURBERG

At Sjurberg the early Ordovician beds are exposed in a railway cutting. This interesting section described by HEDSTRÖM (1894, 1896), WIMAN (1906), and THORSLUND (1936) is still easily accessible. The results of a new examination carried out by the present author are presented below together with a diagrammatic drawing.

Description of the section in text-fig. 23 (fossils recorded: PU nos. D 438–496):

ARCHAEAN:

A. Granite, weathered to a depth of 0.1–0.4 m.

TREMADOCIAN:

Dictyonema beds:

B. Obolus conglomerate with pebbles of quartz and granite, pieces of red shale, and phosphorite grains. It contains *Obolus apollinis*. The thickness is 0.15–0.80 m.

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

C. The zone begins with a thin layer of glauconite sand with fragments of Archaean rocks, phosphorite grains, and worn fragments of *Obolus apollinis*. It is followed by a bed of light-grey limestone, glauconitiferous in part, and containing fragments of quartz, felspar, and phosphorite. It has yielded

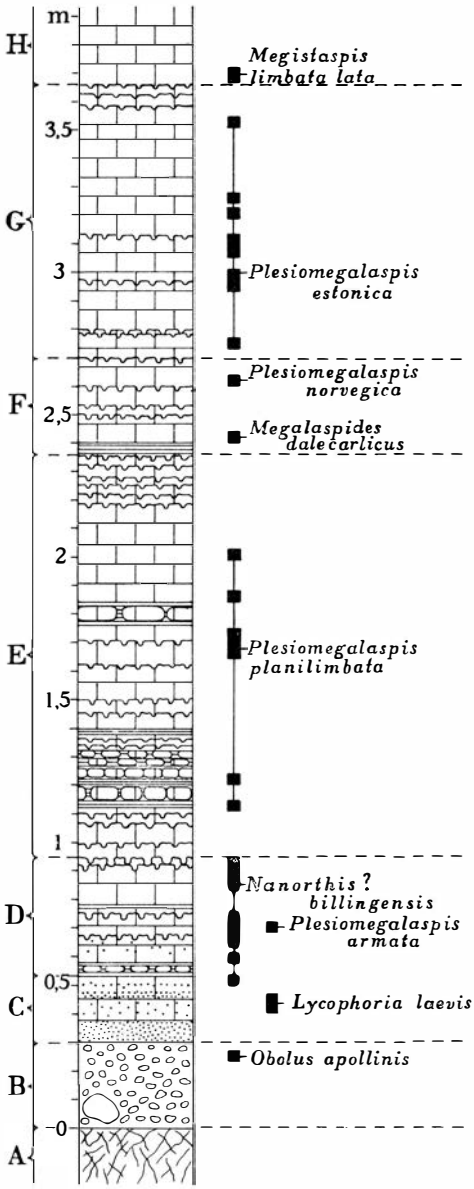


Fig. 23. Section through the early Ordovician beds at Sjurberg, Dalarna. The beds, which dip about 75°, are drawn as if horizontal.

Lycophoria laevis, *Apheoorthis*? *suecica*, and fragments of *Obolus* sp. In addition a pygidium of *Hunnebergia retusa* has been collected by Dr. V. JAANUSSON.

D. The light-grey limestone with *Lycophoria laevis* is overlain by a couple of beds of greenish or yellow limestone intercalated with thin layers of greenish grey clayey shale. From the limestone beds *Plesiomegalaspis armata*, *Niobe* sp., *Ampyx* sp., *Shumardia* sp., and *Nanorthis*? *billingensis* were collected.

The zone is terminated by a thick bed of red limestone with yellow-coloured surfaces of discontinuity. The rock is poor in fossils. Some specimens of *Nanorthis*? *billingensis* were, however, obtained.

The thickness of the zone is about 0.65 m.

Zone of *Plesiomegalaspis planilimbata*:

E. A layer of red shale with lumps and thin beds of red or grey limestone occurs near the base of the zone. It is followed by limestones intercalated with thin layers of shale. They are mostly red, in part, however, greenish grey. As in the preceding zone the uppermost beds consist of compact red limestone with a series of yellow-coloured surfaces of discontinuity. The following fossils were encountered: *Plesiomegalaspis planilimbata*, *Plesiomegalaspis*? sp. no. 2, *Megalaspides nericiensis*, *Promegalaspides stenorhachis*, *Niobe emarginula*, *Niobella bohlini*, *Varvia breviceps*, *Cyclopyge gallica*, *Pliomerops actinurus*, *Ampyx* cf. *pater*, and *Geragnostus wimani*.

The zone is about 1.4 m thick.

Billingen group (Upper Planilimbata limestone):

Zone of *Megalaspides dalecarlicus*:

F. Red limestone and thin layers of red or grey shale. The thickness of the zone seems to be 0.35 m. Only a few fossils have been collected. They are: *Megalaspides dalecarlicus*, *Plesiomegalaspis norvegica*, and *Niobella* aff. *imparilimbata*.

Zone of *Plesiomegalaspis estonica*:

G. Red limestone with thin layers of red marl and shale. Several yellow surfaces of discontinuity are discernible, and at the boundary towards the Limbata

limestone a small series of such surfaces is conspicuous. The thickness of the zone seems to be about 1.3 m. The limestone contains *Plesiomegalaspis estonica*, *Niobella* aff. *imparilimbata*, *Asaphus* sp., *Nileus exarmatus*, *Euloma laeve*, *Raymondaspis* sp., and "*Endoceras*" sp.

Limbata limestone:

H. Red limestone with *Megistaspis limbata lata*, *Niobella* cf. *imparilimbata*, and *Nileus exarmatus*.

COMMENTS.—At Sjurberg the weathered surface of the Archaean rock is covered by the Obolus conglomerate. This proves that the Tremadocian sea reached the south-eastern part of Dalarna. The lower Arenigian beds are well developed. They consist of limestones, and are stratigraphically complete, all the four zones of the Hunneberg and Billingen groups being present. As in the South Bothnian District the main part of the limestones is deeply red-coloured.

HOLEN

In the north-western part of the Siljan District the hiatus between the Archaean and the Ordovician rocks is widened. No traces of Tremadocian beds are found, and the lowermost Arenigian zone with *Plesiomegalaspis armata* has thinned out to nothing.

At Kårgärde, 4 km S of Orsa, WIMAN (1906, p. 455) uncovered the contact between the Archaean and the Palaeozoic rocks. On an uneven surface of porphyry he found a layer of glauconitic clay without fossils followed by variegated Planilimbata limestone.

In the autumn of 1952 the author had the opportunity of studying a section through the lowermost Ordovician beds at Holen, 3 km SSE of Orsa. The beds are disturbed by faults, and dip about 60° to the NNW. They were temporarily exposed in a digging for a water pipe. The following observations were made:

Archaean red porphyry, weathered at the top, is covered by a conglomerate about 0.1 m thick. This contains pebbles of porphyry, lumps of phosphatized limestone, and grains of glauconite. The matrix is devoid of fossils, the phosphatized limestone contains *Lingulella* sp.

The conglomerate is followed by a bed of glauconitic clay, 0.1–0.25 m thick, containing fragments of porphyry, quartz, sandstone, limestone, and phosphorite. Fossils were sought for by washing of the glauconitic clay, yet without result. At Sjurberg fragments of the resistant shells of *Obolus appollinis* are common in the glauconite sand overlying the Obolus conglomerate. They are absent at Holen, indicating that the Tremadocian sea never reached the north-western part of the Siljan District.

Nodules of greenish, glauconitic limestone are embedded in the uppermost part of the glauconitic clay. The limestone contains sparse fragments of Ar-

chaean rocks. In this respect as well as in its colour it resembles the limestone from the lowermost part of the zone of *Plesiomegalaspis armata* at Sjurberg. It lacks, however, the brachiopods of this zone. The only fossils encountered are specimens of *Nanorthis*?, similar to those found in the Planilimbata limestone.

The glauconitic clay is overlain by variegated limestone, red, yellow or greenish grey, belonging to the zone of *Plesiomegalaspis planilimbata*. The index fossils of this zone are found already in the lowermost bed. The following species were collected: *Plesiomegalaspis planilimbata*, *P. heroides*, *Megalaspides nericiensis*, *Promegalaspides stenorhachis*, *Niobe emarginula*, *Niobella bohlini*, *Varvia breviceps*, *Symphysurus angustatus*, *Lapidaria* cf. *rugosa*, and *Geragnostus crassus*. The thickness of the zone is one metre at least.

The variegated limestone is cut off by a small fault. Then follows red Limbata limestone.

COMMENTS.—VOGT (1924) and ASKLUND (1938) assume that during the early Cambrian epoch a ridge of Archaean rocks separated the geosynclinal sea west of Dalarna from the eastern sea covering the South Bothnian District. Apparently such a ridge existed throughout the whole Cambrian period and likewise during the Tremadocian epoch. No beds with Tremadocian fossils are found in the north-western part of the Siljan District. The sea very likely reached the neighbourhood of Orsa for the first time in early Arenigian and calcareous sediments with *Plesiomegalaspis planilimbata* were deposited on the weathered surface of the Archaean rocks. Probably the above ridge was completely submerged by this sea.

JÄMTLAND (Jemtland)

The Palaeozoic of Jämtland is known from investigations carried out by LINNARSSON, WIMAN, HADDING, WESTERGÅRD, ASKLUND, and, especially, by THORSLUND. The rocks are for the main part embodied in the vast overthrust masses, which constitute the mountains of Jämtland (compare the sketch-map in text-fig. 22). East of this mountainous district lies a comparatively narrow belt of autochthonous Cambrian and Ordovician beds. Several outcrops of the early Ordovician rocks have been studied by the author, and some of the sections examined are described below. To start with the autochthonous beds are treated.

TOSSÅSEN

Tossåsen is a village situated on a hill near the Inland Railway, about 6 km N of the Åsarna Station. The locality has been visited by several students, and its Palaeozoic beds have been dealt with by WIMAN (1894, pp. 7–9; 1897, p. 287), WESTERGÅRD (1922, p. 90), THORSLUND (1933, p. 10; 1940, p. 64), and BULMAN (1951, p. 389). In the village a wooden bridge crosses a rather deep ravine.

Below the eastern end of this bridge the contact between the Cambrian and Ordovician strata is accessible. At this boundary the following beds were encountered (fossils recorded: PU nos. J 11–35):

UPPER CAMBRIAN:

Zone of *Leptoplastus* and *Eurycare*:

Alum shale and lenses of anthraconite, the latter containing *Eurycare latum* (BOECK) and *Leptoplastus* sp.

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

Grey limestone, at the base rich in glauconite grains and lumps of phosphatized anthraconite. The limestone is in part very dark, and shows only a few surfaces of discontinuity coloured by glauconite. The total thickness is about 0.6 m. *Lycophoria laevis* was collected from the lowermost bed. The rest of the limestone contains *Apheoorthis? suecica*, *Nanorthis? billingensis*, *Plesiomegalaspis armata*, *Niobe* sp., *Lapidaria tenella*, *Nileus limbatus*, *Pliomerops* sp., and *Falanaspis aliena*. Dr. K. FAHLANDER has recorded *Apatokephalus serratus* from this limestone (compare THORSLUND, 1933, p. 10). The specimen encountered (a fragmentary pygidium) belongs, however, to another species.

No younger beds were observed in this small section. The zone of *Plesiomegalaspis armata* seems, however, to be followed by a dark-grey limestone belonging to the zone of *Plesiomegalaspis planilimbata*. From boulders of such limestone found at Tossåsen Miss ANNA MODIN has secured *Plesiomegalaspis planilimbata*, *P. heroides*, *Promegalaspides stenorhachis*, *Niobella bohlini*, and *Raymondaspis* cf. *brevicauda*. Another collection made by Messrs. K. FALANDER and E. JULIN contains, *inter alia*, *Megalaspides nericiensis* and *Nileus limbatus*.

The limestone is followed by Lower Didymograptus shale, exposed in the ravine about 400 m N of the bridge. From this shale and from limestone beds intercalated with it WIMAN and V. SCHMALENSEE collected *Phyllograptus densus*, *P. angustifolius elongatus*, *Didymograptus hirundo?*, *Plesiomegalaspis norvegica*, *P. scutata*, *P. estonica*, *Ampyx obtusus*, and *Lonchodomas* sp. These species are index fossils for the zones of the Upper Planilimbata limestone and of the upper part of the Lower Didymograptus shale. BULMAN (1951) described from the same beds several graptolites, e.g. *Didymograptus callotheca* BULMAN.

KLOXÅSEN

A similar series of early Ordovician strata are preserved at Kloxåsen, a small village situated about 25 km SSE of the town of Östersund. In a road-cutting near the western farm of the village Cambrian and Ordovician rocks are exposed. The beds of this section and their faunas have been studied by WESTERGÅRD (1922, p. 92) and THORSLUND (1940, p. 58). A new description

and a drawing of the section is given below. The beds are almost vertical, in the figure they are drawn as if horizontal.

Description of the section in text-fig. 24 (fossils recorded: PU nos. J 36–73):

UPPER CAMBRIAN:

Subzone of *Peltura minor*:

A. Alum shale, terminated by an anthraconite bed. From the latter *Protopeltura praecursor* (WESTERGÅRD), *Peltura minor*, and *Ctenopyge* spp. were obtained.

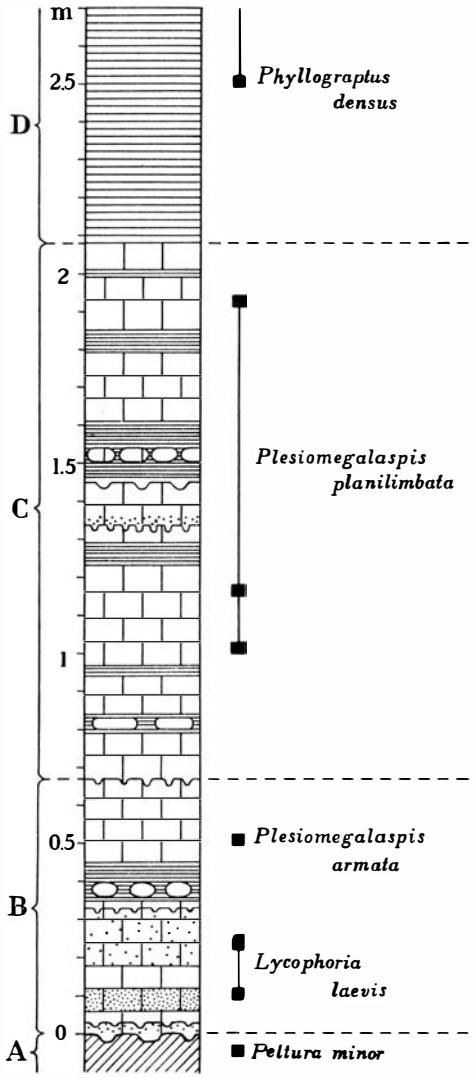


Fig. 24. Section through the early Ordovician beds at Kloxåsen, Jämtland. The beds, which are almost vertical, are drawn as if horizontal.

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

B. The corroded surface of the Cambrian anthraconite bed is covered by a grey limestone, rich in glauconite grains and lumps of anthraconite and phosphorite. Grains of quartz are present. The bed is about 0.1 m thick, and contains *Lycophoria laevis*. It is followed by grey limestone beds, in part somewhat glauconitic and intercalated with a layer of dark-grey clayey shale. The total thickness of the zone is about 0.7 m. The limestone below the shale contains *Lycophoria laevis*, *Apheoorthis? suecica*, *Niobe* cf. *incerta*, and *Saltaspis* sp. From the upper limestone beds *Nanorthis? billingensis*, *Plesiomegalaspis armata*, *Varvia falensis*, and *Niobella* cf. *bohlini* were obtained.

Zone of *Plesiomegalaspis planilimbata*:

C. Beds of grey, hard and fissured limestone, intercalated with layers of dark-grey clayey shale, total thickness about 1.4 m. From the limestone the following species were collected: *Plesiomegalaspis planilimbata*, *Megalaspides nericiensis*, *Promegalaspides stenorhachis*, *Niobe*? sp., *N.* cf. *emarginula*, *Niobella bohlini*, *Lapidaria* cf. *rugosa*, *Nileus exarmatus*, *Cyclopyge gallica*, *Ampyx* sp., and *Geragnostus wimani*.

The limestone is very poor in glauconite, and only one distinct surface of discontinuity has been observed.

Billingen group (Lower Didymograptus shale):

Zone of *Phyllograptus densus*:

D. Dark-grey, in part almost black shales, at the base disturbed by pressure. In the lower part a few specimens of *Phyllograptus densus* and *P. angustifolius* were encountered.

The total thickness of the shales exposed in the cutting is about 6 metres.

BRUNFLO

At Brunflo, about 15 km SE of Östersund, the boundary between the Cambrian and Ordovician has been exposed temporarily in a road cutting 1100 m SSE of the church. THORSLUND (1933, p. 10) reports that the Upper Cambrian alum shale is terminated upwards by a corroded anthraconite bed belonging to the zone of *Parabolina spinulosa* and *Orusia lenticularis*. It is followed by a thin bed of grey, glauconitiferous "Ceratopyge limestone" containing, *inter alia*, *Lycophoria laevis*. The other species collected are, according to the determination by the present author, *Apheoorthis? suecica*, *Nanorthis? billingensis*, *Orometopus grypos*, *Plesiomegalaspis* sp., *Niobe* sp., and *Pliomerops* sp. They indicate that the basal Ordovician limestone bed belongs to the zone of *Plesiomegalaspis armata*. This was confirmed on the occasion of a recent visit to the locality by Professor P. THORSLUND and the author.

COMMENTS.—Three sections through the autochthonous rocks of Jämtland have been described above. They agree in the respect that a great hiatus exists between the Cambrian and the Ordovician beds. The Upper Cambrian sequence is more or less incomplete in part owing to denudation in pre-Arenigian time. At Brunflo the three uppermost zones are absent. The Tremadocian is altogether lacking at all localities. During these times the geosynclinal sea, invading Jämtland from the west or north-west, did not reach the eastern part of the province. The basal Ordovician limestones, formerly referred to the Ceratopyge limestone, contain *Lycophoria laevis* and other fossils from the zone of *Plesiomegalaspis armata* which is regarded here as early Arenigian. The beginning of that epoch is indicated in Jämtland, as in Dalarna, Närke, and Southern Sweden by a large transgression.

ANDERSÖN

Andersön is an island in Lake Storsjön, and situated about 10 km WSW of Östersund. On its north-eastern shore an outcrop of allochthonous shales and limestones of early Ordovician age is found. The beds were described briefly by HADDING (1912, p. 591, text-fig. 1, pl. 7, fig. 2). His description is accompanied by a map of the island showing the site of the outcrop ("locality no. 8"). A renewed examination of the beds has been carried out recently at low water level, and an account of the results is given below.

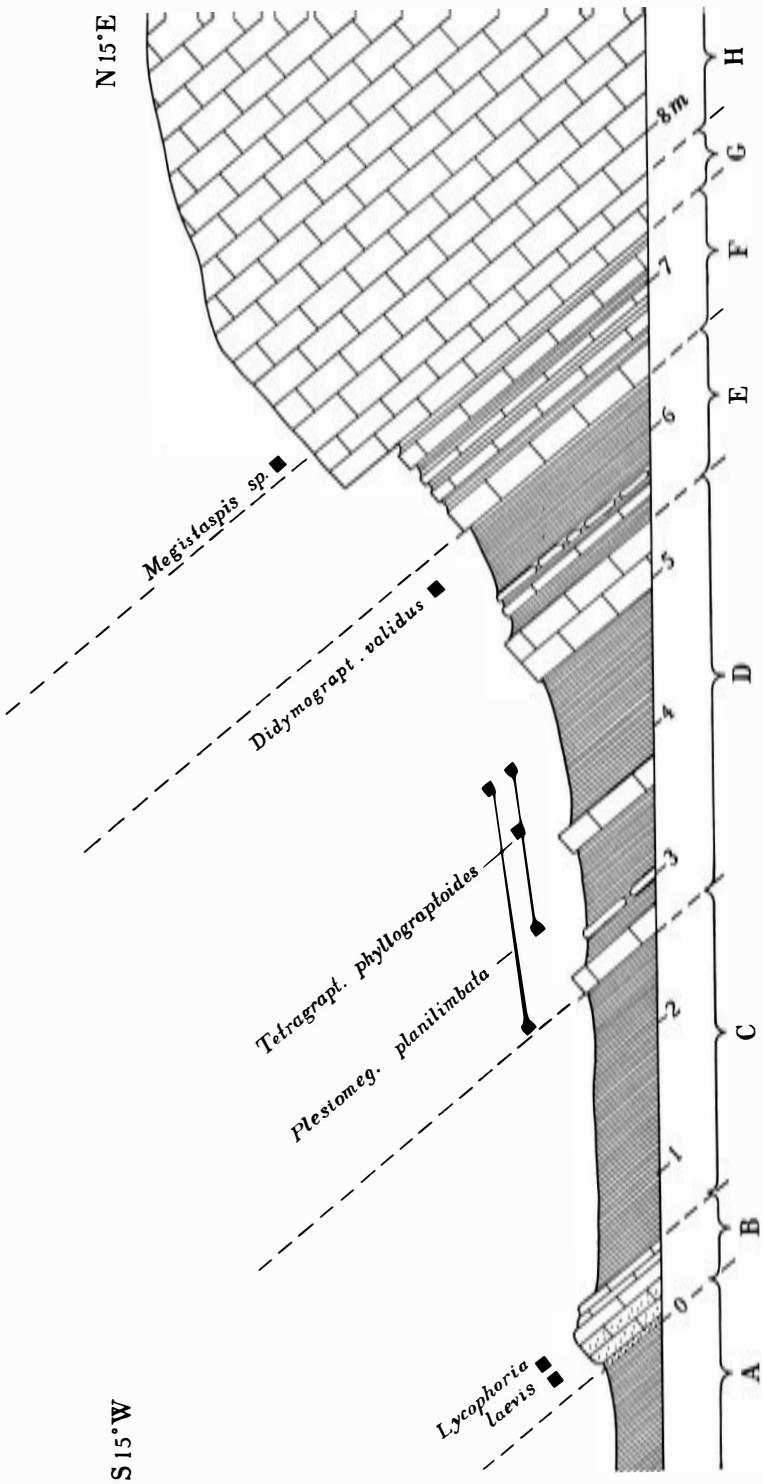


Fig. 25. Section through the allochthonous early Ordovician beds on the north-eastern shore of Andersön island in Lake Storsjön, Jämtland.

Description of the section in text-fig. 25 (fossils recorded: PU nos. J 82–131):

The beds dip 40°–70° towards W 15° N.

TREMADOCIAN?:

Dictyonema shale?:

A. Black alum shale strongly compressed and crushed without concretions of anthraconite and consequently devoid of determinable fossils. Most likely it is Dictyonema shale, because such shale is known to initiate the Ordovician beds in two of the surrounding overthrust nappes. In the westerly one it was reported from Kläppe, a locality on the western shore of Lake Storsjön (THORSLUND, 1933, p. 7). In the other, lying immediately east of the nappe dealt with here, it is known from the northern side of the island of Frösön (THORSLUND, 1937b, p. 22).

ARENIGIAN:

Hunneberg group:

Zone of *Plesiomegalaspis armata*:

B. A thin layer of glauconitic shale is followed by beds of hard, grey, nodular limestone, glauconitiferous at the base. The total thickness is about 0.6 m. The limestone contains *Lycophoria laevis*, *Apheoorthis*? *suecica*, *Nanorthis*? *billingensis*, *Lapidaria tenella*, and *Hunnebergia* cf. *retusa*. The brachiopods already occur in the lowermost bed.

C. Dark shale, about 2 m thick, without fossils.

Zones of *Plesiomegalaspis planilimbata* and *Tetragraptus phyllograptoides*:

D. Beds of hard, grey limestone embedded in dark-grey shale, total thickness about 2.8 m. *Plesiomegalaspis planilimbata*, *Megalaspides nericiensis*, and *Niobella bohlini* were collected from the lowermost limestone bed. In another bed, one metre above it, *Niobella bohlini*, *Niobe*? sp., *Cyclopyge gallica*, and *Pliomerops* cf. *actinurus* were encountered.

The shale contains graptolites as well as trilobites, at one level these fossils occur together. They are: *Tetragraptus phyllograptoides*, *T.* cf. *approximatus*, *Didymograptus undulatus*, *Plesiomegalaspis planilimbata*, *Promegalaspides stenorhachis*, *Niobella bohlini*, *Remopleuridiella* sp. no. 1, and *Parabolinella*? sp. no. 2.

Zone of *Didymograptus balticus*:

E. Dark shale, about 1 m thick, with a thin bed and nodules of grey limestone. This limestone has yielded no determinable fossils. The shale contains *Didymograptus validus* TÖRNQUIST subsp.

From this or from the underlying shale (D) HADDING (1912, p. 592) reports the find of *Phyllograptus* sp. According to the present writer's examination, however, the graptolites from Andersön, collected by the said author and referred by him to this genus, are poorly preserved specimens of a *Tetragraptus*, probably *T. phyllograptoides*.

Billingen group?:

F. Beds of hard, light-grey limestone intercalated with thin layers of hard, grey, marly shale, total thickness about 1 m. No fossils have been encountered.

G. Basal beds of the thick Orthoceratite limestone terminating the section. Probably they belong to the group, but are devoid of fossils.

Limbata limestone:

H. Grey, clayey, compressed limestone (20 m +) with *Megistaspis* sp.

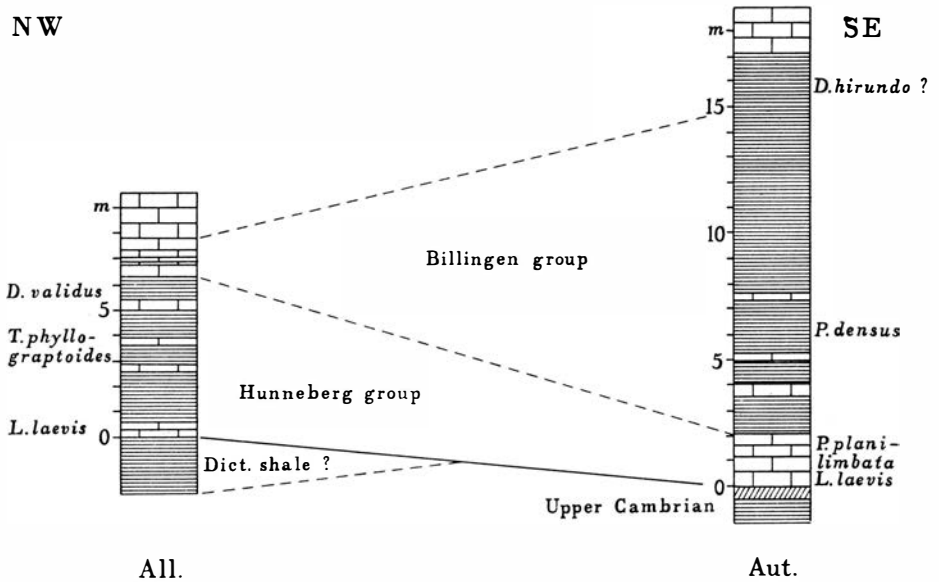


Fig. 26. Comparison between the lowermost autochthonous Ordovician rocks of the Lake Storsjön District (Aut.) and the corresponding allochthonous beds of Andersön (All.). The shales of the Hunneberg group thin out towards the south-east, where the group is developed as limestone beds. In a similar way the beds of the Billingen group thin out towards the north-west.

COMMENTS.—In text-fig. 26 a comparison is made between the lowermost autochthonous Ordovician rocks of the Lake Storsjön District and the allochthonous beds of Andersön in its central part. In the former we meet conditions similar to those of the Billingen mountain in Västergötland. The Dictyonema shale is lacking. The Hunneberg group is made up of limestone beds, glauconitiferous at the base, and with fairly rich trilobite and brachiopod faunas. At Kloxåsen these beds are about 2 metres thick. The Billingen group consists of clayey shales belonging to the zone of *Phyllograptus densus* (and higher stratigraphical subdivisions?), and containing, at least at Tossåsen, scattered beds of fossiliferous Upper Planilimbata limestone. The shales possibly correspond also to the lowermost part of the Limbata limestone, as indicated by the find of *Didymograptus hirundo* reported by WIMAN (1894, p. 9) from Tossåsen. According to an estimation by the same author the "Phyllograptus shales" at Tossåsen are 15 metres thick.

In the allochthonous beds of Andersön the Dictyonema shale seems to be present. The beds of the Hunneberg group resemble those of the Hunneberg mountain. They are made up of very dark graptolite bearing shales belonging to the zones of *Tetragraptus phyllograptoides* and *Didymograptus balticus*, and containing beds of Lower Planilimbata limestone. The thickness of the group is somewhat more than 6 metres. The presence of the Billingen group has not been proved with certainty. If present it must be very poorly developed, consist-

ing of a few limestone beds intercalated with thin layers of marly shale, all devoid of fossils. The beds show no indications of being deposited in the vicinity of a shore.

The sections demonstrate the successive transgression of the Ordovician sea towards the east or south-east. The "Dictyonema sea" probably reached the western part of the Lake Storsjön District. The "Hunneberg sea" invaded also the central and south-eastern parts of the District, depositing in its comparatively deeper western water dark shales with graptolites, in its shallower south-eastern part limestone beds with trilobites and brachiopods. The latter beds are overlain by the graptolite bearing shales of the Billingen group which indicate that the "Billingen sea" reached still farther to the east.

KLÖSTA

In the allochthonous parts of the Lake Storsjön District and of North-eastern Jämtland four other localities have been visited. The observations made there prove that the basal Ordovician limestones everywhere belong to the zone of *Plesiomegalaspis armata*.

At the railway stop of Klösta, situated in the parish of Lit, NE of Lake Storsjön, alum shales of unknown age are exposed in the railway cutting, 50 m east of the stopping-place building. They are covered by a thin layer of glauconitic shale, followed by beds of grey limestone, glauconitiferous at the base and containing *Lycophoria laevis*, *Apheoorthis? suecica*, and *Niobella* cf. *bohlini*.

RISSELÅSEN

The other localities visited are situated in the north-eastern part of the province (not shown in the sketch-map). On the southern slope of the Risselåsen hill at Strömsund the lowermost Ordovician strata are exposed in the alighting ground of a ski-jumping hill. Beds of grey limestone, measuring about six metres in thickness, rest upon alum shale in which no fossils have been encountered. Probably it is Dictyonema shale. From the basal limestone beds, which are devoid of glauconite, Dr. B. ASKLUND and the author have collected *Lycophoria laevis*, *Apheoorthis? suecica*, *Nanorthis? billingensis*, *Hunnebergia retusa*, and *Niobella* cf. *bohlini*.

VEDJEÖN

At Vedjeön on the western side of Lake Dragan, 25 km NW of Strömsund, a collection of fossils from the lowermost Ordovician limestone has been secured by Dr. B. ASKLUND, and kindly placed at the author's disposal. The species encountered are: *Lycophoria laevis*, *Apheoorthis? suecica*, *Nanorthis? billingensis*, *Hunnebergia* cf. *retusa*, and *Niobella* cf. *bohlini*.

SILJEÅSEN

A large exposure of Cambrian and Ordovician rocks is found at the outlet of the Fallån rivulet near the village of Siljeåsen on the north-eastern side of Lake Flåsjön (compare ASKLUND & THORSLUND, 1935, p. 98). The beds have been examined recently by Professor P. THORSLUND and the author. No fossils were encountered in the uppermost alum shale. This is overlain by limestones intercalated with dark shales. The lowermost limestone beds, which are grey and devoid of glauconite, contain *Lycophoria laevis*, *Nanorthis? billingensis*, and *Plesiomegalaspis armata.*

ABBORRFALLET

Some remarks can at last be made about the autochthonous beds at the Abborrfallet rapids in the river Sjoutälven near the boundary of the provinces of Ångermanland and Lappland. They have been described by ASKLUND & THORSLUND (1935). At this locality the Ordovician rocks begin with a layer of Dictyonema shale, 0.5–1 m thick, which is overlain by beds of grey limestone containing grains of glauconite, quartz, and felspar. These beds have been referred to the Ceratopyge limestone. During a short visit to the locality some fossils were collected from the limestone by Professor P. THORSLUND, Dr. B. ASKLUND, and the author. They are: *Apheoorthis? suecica*, *Broeggeria* sp., *Lapidaria tenella*, *Harpides* sp., *Shumardia* sp. (common), and an undescribed trilobite known also from the zone of *Plesiomegalaspis armata* at Stenbrottet in Västergötland. A more thorough examination of the beds is, however, necessary before the presence of the Ceratopyge limestone at this locality can be proved or denied.

COMMENTS.—The earliest Ordovician limestones of Jämtland often are dark, sometimes almost black, and, with the exception of the basal beds, poor in glauconite. Surfaces of discontinuity are rare and usually indistinct. In these respects the beds resemble the limestones at Hunneberg in Västergötland.

Owing to the difficulty of obtaining fossils from the hard and often fissured rocks few trilobite and brachiopod species have been secured. They show, however, that the early Ordovician faunas of Jämtland are almost identical with those of the southern provinces of Sweden. The very scarce occurrence of the species belonging to the genera *Symphysurus* and *Varvia*, so very common in other districts of Sweden, is, however, remarkable.

LAPPLAND

In Lappland boulders of Ceratopyge limestone, containing, *inter alia*, *Ceratopyge forficula*, have been collected from the neighbourhood of the lakes of Malgomaj and Vojmsjön. These collections have been described by LINNARSSON (1874) and HOLM (1890). At the mountain of Baktoberget, SE of Malgomaj, KULLING (1942) has encountered boulders of fossiliferous Ceratopyge shale.

Stratigraphical Summary

In the preceding pages an account has been given of the present author's studies on the early Ordovician rocks of Sweden. They have been devoted chiefly to the lower Arenigian Planilimbata limestone, the corresponding graptolite bearing shales, and the relation of these strata to the underlying and the superposed beds.

The aim of these studies has been an improved stratigraphical classification of the limestone beds examined, and a correlation of the subdivisions thus established with the zones of the Lower Didymograptus shale. Such a correlation, if successful, would certainly facilitate a closer correlation of the Swedish trilobite bearing limestones with the graptolite shales of Great Britain.

A number of sections through the lowermost Ordovician beds have been described, and the vertical distribution of some index fossils for these beds has been demonstrated. On these sections and their fossil content the following classification of the uppermost Tremadocian and the lower Arenigian rocks of Sweden has been founded.

TREMADOCIAN.—The Ceratopyge limestone, i.e. the zone of *Apatokephalus serratus*, is interpreted as the uppermost Tremadocian of Sweden. It contains a very characteristic fauna, known of old and comprising, *inter alia*, the following species:

Ceratopyge forficula (SARS)
Euloma ornatum ANGELIN
Triarthrus angelini LINNARSSON
Apatokephalus serratus (BOECK)
Orometopus elatifrons (ANGELIN)
Symphysurina? oriens (MOBERG & SEGERBERG)
Varvia longicauda n. gen. & n. sp.
Niobe insignis LINNARSSON
Niobella obsoleta (LINNARSSON)
"*Protopliomerops*" *primigenius* (ANGELIN)
Parapilekia speciosa (DALMAN)
Geragnostus sidenbladhi (LINNARSSON)
Nanorthis? christianiae (KJERULF)
Eostrophomena elegantula WALCOTT

None of these species is known from the overlying Arenigian beds.

The regional distribution of the Ceratopyge limestone is comparatively limited. It is found in Skåne, Southern Öland, Southern and Western Västergötland, the South Bothnian District, and in Lappland.

Corresponding graptolite bearing shales are unknown.

ARENIGIAN.—As a rule the Ceratopyge beds are overlain by limestones containing at their base *Lycophoria laevis* STOLLEY and higher up *Plesiomegalaspis planilimbata* (ANGELIN). The beds with *Lycophoria laevis* were included by WIMAN (1906) into the Ceratopyge limestone. Without drawing a definite upper stratigraphical boundary MOBERG (1906) referred to his Ceratopyge Region also limestone beds with *Plesiomegalaspis planilimbata*.

The faunas of the said limestones unquestionably exhibit several Tremadocian features. They differ, however, distinctly from that of the Ceratopyge limestone. Furthermore, the hitherto known graptolite bearing shales corresponding to the limestones can be correlated with the lowermost part of the British Arenigian zone of *Didymograptus extensus*. These limestones and shales are here referred to a new stratigraphical subdivision, the Hunneberg group which is regarded as the lowermost Arenigian of Sweden.

The beginning of the Arenigian is indicated by a large transgression. The beds of the Hunneberg group have a far wider distribution than the Ceratopyge limestone, being deposited also in Northern Öland, North-eastern Västergötland, Östergötland, Närke, Dalarna, and Jämtland.

Faunistically the limestones of the Hunneberg group can be divided into two zones. The lower one, the zone of *Plesiomegalaspis armata*, contains a hitherto almost unknown fauna. Its index fossils are:

Plesiomegalaspis (*Ekeraspis*) *armata* n.subgen. & n.sp.
Niobe incerta n.sp.
Lapidaria tenella n.gen. & n.sp.
Hunnebergia retusa n.gen. & n.sp.
Varvia falensis n.sp.
Saltaspis viator n.sp.
Falanaspis aliena n.gen. & n.sp.
Orometopus grypos n.sp.
Geragnostus lepidus n.sp.
Lycophoria laevis STOLLEY
Apheoorthis? *suecica* n.sp.
Nanorthis? *billingensis* n.sp.

This zone is followed by the Lower Planilimbata limestone which in this paper is called the zone of *Plesiomegalaspis planilimbata*. It is not equivalent to the *Megalaspis planilimbata* zone or *Planilimbata* zone of WESTERGÅRD (1931, 1940), THORSLUND (1937, 1940), REGNÉLL (1942), and TJERNVIK (1952) which subdivision includes the whole of the Planilimbata limestone. The trilobite fauna of the zone of *Plesiomegalaspis planilimbata* is known of old, and is characterized by the following species:

Plesiomegalaspis (*Plesiomegalaspis*) *planilimbata* (ANGELIN)
Plesiomegalaspis (*Ekeraspis*) *heroides* (BRÖGGER)
Megalaspides (*Lannacus*) *nericiensis* WIMAN

Promegalaspides (*Borogothus*) *stenorhachis* (ANGELIN)
Niobe emarginula ANGELIN
Niobella bohlini n. sp.
Varvia breviceps (ANGELIN)
Cyclopyge gallica n. sp.
Apatokephalus pecten WIMAN
Shumardia nericiensis WIMAN
Pliomerops actinurus (DALMAN)
Geragnostus wimani n. sp.

As mentioned above the faunas of the Hunneberg group show several Tremadocian features. The vertical distribution of some genera or subgenera is confined to this group and to the Ceratopyge beds. They are: *Apatokephalus*, *Orometopus*, *Saltaspis*, *Symphysurina*?, *Varvia*, and *Promegalaspides* (*Borogothus*). Furthermore, there exists close relation between the species of *Niobe*, while those of *Symphysurus* and *Nileus* seem to be common to both divisions.

The faunas of the Hunneberg group are, however, distinguished by the first appearance of some important genera: *Plesiomegalaspis*, *Megalaspides*, *Ampyx*, and *Pliomerops*. Here we meet also the first representatives of the families Illaenidae, Rhaphiophoridae, Remopleurididae, and Odontopleuridae.

The faunas of the two zones of the group agree in certain respects with each other. The occurrence of the genus *Lapidaria* and the subgenus *Plesiomegalaspis* (*Ekeraspis*) is confined to the two zones. The species of *Orometopus* as well as those of *Varvia* are much more closely related to each other than to those from the Ceratopyge limestone, while the species of *Niobella* and *Parabolinella*? are probably the same.

At Storeklev on Hunneberg the limestones belonging to the zone of *Plesiomegalaspis armata* are accompanied by shales containing a small, undescribed graptolite fauna. The most common species is a large, incompletely known dichograptid, probably a peculiar *Tetragraptus*. Possibly this shale can be correlated with some part of the British zone of *Dichograptus*.

It has been proved that at least the lower part of the succeeding zone of *Plesiomegalaspis planilimbata* corresponds in age to the zone of *Tetragraptus phyllograptoides*. Trilobites and graptolites from these two zones are mixed with each other in the shales of the Hunneberg mountain and in those of the Andersön island in Jämtland. The zone of *Didymograptus balticus* seems to be equivalent in age to the uppermost part of the same trilobite zone. "*Protorthis*" *hunnebergensis* is known only from the shales belonging to the zone of *D. balticus* at Hunneberg and from the uppermost limestone beds of the zone of *P. planilimbata* at Gymninge in Närke and at Köpings Klint in Öland. At Gymninge the said brachiopod is accompanied by several trilobite species which are lacking in the lower beds of the zone of *P. planilimbata*. Some of them are related to species from the overlying Billingen group.

The term Hunneberg group has been chosen on account of the fact that at the mountain of this name beds of Lower Planilimbata limestone and limestones belonging to the preceding zone of *Plesiomegalaspis armata* occur together with graptolite bearing shales, thus permitting a correlation of the strata. For similar reasons the Upper Planilimbata limestone and the corresponding shales have been distinguished as the Billingen group.

The fauna of the Upper Planilimbata limestone differs strongly from that of the Lower Planilimbata limestone, but shows on the other hand a rather close relation to the fauna of the overlying Limbata limestone. The commonest and most valuable of its index fossils belong, however, to the genera *Megalaspides* and *Plesiomegalaspis* as is the case also in the Lower Planilimbata limestone. Both these genera have vanished in the Limbata limestone. The Tremadocian *Euloma*, "*Protopliomerops*", and *Harpides* are still present in the Upper Planilimbata limestone. *Cyrtometopus*, *Lonchodomas*, and *Menoparia*? make their first appearance, as well as the Endoceratidae and some brachiopod genera, e.g. *Productorthis*? One species of *Asaphus* occurs very sparsely in the uppermost beds.

The upper Planilimbata limestone has been divided into two zones. In the lower one, the zone of *Megalaspides dalecarlicus*, the lower beds can be crowded with specimens of *M. dalecarlicus*. The upper beds are distinguished by large species of *Plesiomegalaspis*. They contain in addition some peculiar forms still insufficiently known. The most characteristic fossils of the zone are:

Megalaspides (*Megalaspides*) *dalecarlicus* (HOLM)
Megalaspides (*Megalaspides*) *paliformis* n. sp.
Plesiomegalaspis norvegica n. sp.
Plesiomegalaspis scutata n. sp.

Four common trilobite species are found also in the succeeding zone of *Plesiomegalaspis estonica*. They are: *Niobella* sp. aff. *imparilimbata* (BOHLIN), *Nileus exarmatus* n. sp., *Ampyx pater* HOLM, and *Ampyx obtusus* MOBERG & SEGERBERG.

The zone of *Plesiomegalaspis estonica* is characterized by the following species of which several are still undescribed:

Plesiomegalaspis (*Plesiomegalaspis*) *estonica* n. sp.
Megalaspides sp.
Euloma laeve ANGELIN (occurs sparsely already in the upper beds of the preceding zone)
Menoparia? *nericiensis* n. sp.
Agerina erratica n. sp.
Cyrtometopus priscus n. sp.
Lonchodomas sp.

"*Endoceras*" sp.
Protocycloceras? sp.
Productorthis? sp.

The Upper Planilimbata limestone corresponds in age to that part of the Lower Didymograptus shale which is developed, e.g., in the Billingen and the Mösseberg mountains in Västergötland, and at Skattungbyn in Dalarna. This shale has been referred by TÖRNQUIST to the zone of *Phyllograptus densus*. At Skattungbyn and at Borghamn in Östergötland *P. densus* occurs together with *Megalaspides dalecarlicus*, as established by HOLM and WESTERGÅRD. In the upper part of the shale with *P. densus* another species, *P. angustifolius elongatus* is common. In Norway these beds have been distinguished by MONSEN as the zone of *Phyllograptus angustifolius elongatus*. MONSEN's classification has been used in this paper, and the author has tried to prove that the two zones of *Phyllograptus densus* and *Phyllograptus angustifolius elongatus* correspond in age approximately to the zones of *Megalaspides dalecarlicus* and of *Plesiomegalaspis estonica*, respectively.

The beds of the Billingen group are overlain by the Limbata limestone. In this limestone the index fossils mostly belong to trilobite genera which are very sparsely or not at all represented in the underlying beds. They are *Megistaspis* of the large *limbata* group, *Ptychopyge*, and *Asaphus*.

Graptolite shales corresponding to the lowermost part of the Limbata limestone have been encountered at Hällekis on Kinnekulle. They demonstrate that also the graptolite fauna has undergone obvious changes, the commonest species in these shales being an early form of *Didymograptus hirundo* SALTER and *Phyllograptus* cf. *nobilis* HARRIS & KEBLE. These graptolites are regarded by the writer as characteristic of the lowermost part of the zone of *Isograptus gibberulus* (compare pp. 142 and 143).

An interesting study of the early Ordovician conodont faunas of Sweden was carried out by LINDSTRÖM (1954). He described and revised a large number of species secured from samples which had been collected from different levels of the Ceratopyge and the Planilimbata limestone, respectively. He subdivided these limestones into conodont zones and made the following correlations:

Zone with *Prioniodina densa* and *Prioniodus navis*	Limbata limestone
Zone with *Oepikodus smithensis*, *Oistodus lanceolatus*, *O. triangularis*, and *Prioniodus evae*	Upper Planilimbata limestone
Zone with *Drepanodus proteus* and *Paltodus inconstans*	Lower Planilimbata limestone
Zone characterized chiefly by *Acodus tetrahedron*, *Cordylodus angulatus*, *C. rotundatus*, and *Oneotodus variabilis*	Ceratopyge limestone

Correlations Proposed with Beds in Great Britain, Norway, and the East Baltic

In the correlation table, p. 185, the Ordovician zones distinguished at the researches dealt with in this paper are compared with the graptolite zones of Norway and Great Britain. In the comparison with the British beds ELLES' classification of 1933 has been used. The correlation with the Norwegian zones is founded on the tables drawn up by MONSEN (1937 p. 258b) and STØRMER (1953, p. 130). In addition the report by SPJELDNÆS (1953, p. 172) on the vertical range of the graptolite species in the Lower Didymograptus shale at Slemmestad in Norway has been of great importance for this correlation.

GREAT BRITAIN.—ELLES (1933, p. 107) has compared the subdivisions of the Skiddaw slates with those of the graptolite shales of Västergötland. She makes, *inter alia*, the following remarks (condensed here):

"In TÖRNQUIST's Zone of *Tetragraptus phyllograptoides*, which (according to MOBERG & SEGERBERG, 1906) rests directly upon the Ceratopyge Limestone, the whole fauna recalls very strongly the subzone at the base of the Zone of *D. extensus* in the Skiddaw Slates. This suggests that the Dichograptus Zone is represented by Ceratopyge Limestone. The evidence for the inclusion of the *T. phyllograptoides* Zone also in the Ceratopyge Limestone is not so convincing and may be questioned."

To this statement the author wants to offer the following remarks. At the Hunneberg mountain the Mossebo section, redescribed in this paper, demonstrates that the shales with *Tetragraptus phyllograptoides* do not rest upon the Tremadocian Ceratopyge limestone. They overlie limestone beds belonging to the lower part of the Arenigian zone of *Plesiomegalaspis planilimbata*. Between these beds and the Ceratopyge limestone there are, in addition, the limestones referred to the zone of *Plesiomegalaspis armata*. These, too, appear from their fauna and distribution to be of Arenigian age. At Storeklev, Hunneberg, a limestone bed with *P. armata* is followed by shales containing a graptolite fauna which seems to be new to Sweden. These shales and corresponding limestone beds can possibly be correlated with the British zone of *Dichograptus*.

According to ELLES (1933, p. 107) TÖRNQUIST's zones of *Didymograptus balticus* and *Phyllograptus densus* must together represent the British subzones of *Didymograptus deflexus* and *D. nitidus* somewhat differently subdivided. The zone of *D. balticus* can be correlated with the upper limestone beds of the zone of *Plesiomegalaspis planilimbata*, and these beds consequently correspond approximately to the British subzone of *D. deflexus*. TÖRNQUIST's zone of *Phyllograptus densus* is divided here into the two zones of *P. densus* and *P. angustifolius elongatus*. The shales belonging to these zones underlie the Limbata limestone which is looked upon of old as representing the Swedish zone of

Isograptus gibberulus. Accordingly, the zones of *P. densus* and *P. angustifolius elongatus* ought together to correspond to the subzone of *Didymograptus nitidus*.

The Swedish zone of *Isograptus gibberulus* is according to ELLES rather more embracing than the British subzone of this name, and seems also to include the fauna of the zone of *Didymograptus hirundo*, as expressed in the correlation table.

NORWAY.—The subdivisions distinguished in the Swedish graptolite shales belonging to the Hunneberg and the Billingen groups seem to correspond fairly well to be subdivisions 3bα–3bδ of the excellently classified Norwegian shales. In Norway no zone of *Isograptus gibberulus* has been established, and the zone of *Phyllograptus angustifolius elongatus* has been correlated with the lower part of the Swedish zone of *I. gibberulus*. The upper part of the latter zone is so far looked upon as corresponding to the zone of *Didymograptus hirundo* (3bε) in Norway. As mentioned above, however, the Limbata limestone, representing approximately the zone of *I. gibberulus*, overlies the Swedish shales with *P. angustifolius elongatus*. Furthermore, at Hällekis, Kinnekulle, the shales corresponding to the lowermost part of the Limbata limestone contain an early form of *Didymograptus hirundo* and *Phyllograptus* cf. *nobilis*. The same species are recorded by SPJELDNÆS (1953, p. 172) from the shales belonging to the Norwegian zone of *D. hirundo* at Slemmestad. These shales contain, in addition, typical specimens of *Isograptus gibberulus* agreeing well with those described by BULMAN (1936) from Sweden. In the underlying beds with *Phyllograptus angustifolius elongatus* at Slemmestad *I. gibberulus* seems to be lacking. In consequence, the present writer has correlated the Norwegian zone of *Didymograptus hirundo* with the Swedish zone of *Isograptus gibberulus*.

The lower Arenigian strata of Norway are made up of shales in which trilobite bearing limestones are comparatively rare. SKJESETH (1952) has proved the occurrence of Planilimbata limestone at Krekling in Eiker, and at Heramb in Ringsaker. He demonstrates that the small fauna described by BRÖGGER (1882) from the limestone beds at Krekling includes *Plesiomegalaspis planilimbata*. From Heramb he describes a trilobite fauna encountered in limestone lenses in the uppermost part of the Lower Didymograptus shale, where the trilobites are associated with *Phyllograptus angustifolius elongatus*. He also describes a pygidium collected from a limestone lens in the Lower Didymograptus shale at Ottestad in the Mjøsa District, and refers it to *Megalaspis planilimbata* (compare below).

Due to the investigations carried out by BRÖGGER and by SKJESETH trilobite species representing all the zones of the Planilimbata limestone are known from Norway. The Krekling beds contain *Plesiomegalaspis planilimbata*, *P. heroides*, and *Promegalaspides stenorhachis*, and must be referred to the zone of *Plesiomegalaspis planilimbata*. The pygidium from Ottestad has been chosen by the present author as the holotype of a new species, *Plesiomegalaspis norvegica*. It

is an index fossil for the upper part of the zone of *Megalaspides dalecarlicus*. The beds at Heramb contain a couple of new species not encountered in the Swedish Planilimbata limestone; on the whole, however, the beds can be referred to the zone of *Plesiomegalaspis estonica*.

THE EAST BALTIC.—The East Baltic strata consisting of glauconite sand and calcareous glauconite sandstones, and belonging to the subdivisions $B_{I\alpha}$ and $B_{I\beta}$ have hitherto been considered as corresponding to the Tremadocian Ceratopyge beds of Scandinavia.

$B_{I\beta}$ was correlated by ÖPIK (1937, p. 103) with the Ceratopyge limestone. The overlying limestone beds, distinguished as $B_{I\gamma}$, were regarded by JAANUSSON (1951) as possibly corresponding to the Lower Planilimbata limestone of Sweden. The trilobite and brachiopod faunas of $B_{I\beta}$, however, include species of *Plesiomegalaspis*, *Megalaspides* (*Megalaspides*), *Panderina*, *Productorthis*, *Paurorthis*, and *Plectella*. None of these genera occurs in the Ceratopyge limestone, and "*Protopliomerops*" *primigenius lamanskii* F. SCHMIDT, encountered in the beds of $B_{I\beta}$, is not conspecific with "*Protopliomerops*" *primigenius* (ANGELIN). In fact, the fauna recalls that of the Upper Planilimbata limestone, where species of *Megalaspides* with a convex pygidial border predominate in the lower beds, and where "*Protopliomerops*" still occurs. Also *Productorthis* seems to be present. Anyhow, no East Baltic species permitting a closer correlation have been found in the Swedish strata, but the two subdivisions $B_{I\beta}$ and $B_{I\gamma}$ seem together to correspond to the zone of *Megalaspides dalecarlicus*, which zone might readily be divided into two subzones, a lower one with *Megalaspides dalecarlicus*, and an upper one with *Plesiomegalaspis norvegica* and *P. scutata*.

The underlying often very thick beds of glauconite sand referred to the division $B_{I\alpha}$ probably belong to the Tremadocian.

$B_{II\alpha}$ is made up of beds of glauconitiferous limestone containing *Plesiomegalaspis estonica* and, at a higher level, *Megistaspis limbata lata*. This subdivision can be correlated with the zone of *P. estonica* and with the lowermost part of the Limbata limestone.

Correlation Table

Sweden					Norway	Great Britain		East Baltic	
Wiman 1907	Tjernvik 1952	This paper	Shelly facies	Graptolite facies	Shelly and graptolite facies	Graptolite facies			
Limbata limestone	Limbata limestone	Limbata limestone	Limbata limestone	Zone of *Isograptus gibberulus*	3bε *Didymograptus hirundo*	Zone of *Didymograptus hirundo*			Arenigian
						Subzone of *Isograptus gibberulus*	Zone of *Didymograptus extensus*	$B_{II\alpha}$	
Planilimbata limestone	Upper Planilimbata limestone	Billingen group	Zone of *Plesiomegalaspis estonica*	Zone of *Phyllograptus angustifolius elongatus*	3bδ *Phyllograptus angustifolius elongatus*	Subzone of *Didymograptus nitidus*		$B_{I\gamma}$	
			Zone of *Megalaspides dalecarlicus*	Zone of *Phyllograptus densus*	3bγ *Phyllograptus densus*			$B_{I\beta}$	
	Lower Planilimbata Limestone	Hunneberg group	Zone of *Plesiomegalaspis planilimbata*	Zone of *Didymograptus balticus*	3bβ *Didymograptus balticus*	Subzone of *Didymograptus deflexus*			
				Zone of *Tetragraptus phyllograptoides*	3bα *Tetragraptus phyllograptoides*	Upper subzone of *Tetragraptus*			
Ceratopyge limestone	Ceratopyge limestone		Zone of *Plesiomegalaspis armata*	Undescribed dichograptids	?	? Zone of *Dichograptus*			Tremadocian
		Ceratopyge limestone	Zone of *Apatokephalus serratus*	?	3aγ *Ceratopyge forficula*	?			
Ceratopyge shale	Ceratopyge shale	Ceratopyge shale	"*Shumardia* zone"	Zone of *Clonograptus heres*	3aβ *Didymograptus kiaeri*			?$B_{I\alpha}$	

II. FAUNA

Description of Species

Brachiopoda

REMARKS.—A large number of brachiopod species occurs in the beds dealt with in this paper. Often they are good index fossils. A couple of species are figured here, the description of the rest has been postponed until further study.

Family *Billingsellidae* WALCOTT & SCHUCHERT, 1908

Genus *Apheoorthis* ULRICH & COOPER, 1936

GENOTYPE.—*Eoorthis lineocosta* WALCOTT, 1924.

REMARKS.—The genus *Apheoorthis* occurs in the Upper Cambrian and the lowermost Ordovician beds of North America, particularly in the Cordilleran region of the United States and its extension through Canada. According to ULRICH & COOPER (1938) it appears to be a derivative from *Eoorthis*. It differs from this genus in the development of a pseudospondylium, and is characterized by rather sharp ribs or bundles of ribs which produce a strongly fasciculate surface.

The interior of the species described below is unknown, consequently the attribution to the genus is doubtful.

Apheoorthis? *suecica* n. sp.

Pl. I, figs. 1, 2.

NAME.—Latin *suecicus* = Swedish.

HOLOTYPE (here selected).—Ventral valve: PU no. Vg 590. Pl. I, fig. 1.

OTHER MATERIAL.—Ventral and dorsal valves: PU nos. Vg 456–459, 498, 590, 591; Öl 158–160; N 21–23; B 252; D 442.

TYPE STRATUM and TYPE LOCALITY.—Glauconitic limestone, Kinnekulle, Västergötland.

DIAGNOSIS.—Shell small, widest at the hinge, concave in front, with a few strong plications, and one or a couple of prominent tranverse ridges.

DESCRIPTION.—Shell small, wider than long, length about two-thirds the width; the straight hinge being the widest part of the valves. Lateral and frontal margins rounded. Valves subequally biconvex, concave in front and laterally. Umbo moderately convex, beak small. Shells with five to eight large plications.

Ventral valve with median plication or fascicle, dorsal one with narrow median sulcus. The radial ornamentation is crossed by one or two prominent transverse ridges.

DIMENSIONS.—Length of ventral valve (holotype) 3.6 mm, reconstructed width about 5.5 mm. Length of dorsal valve (pl. I, fig. 2) 3.8 mm, width about 6 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — The species is a very good index fossil for the zone, being both common and easily recognized.

Family *Orthidae* WOODWARD, 1852

Genus *Nanorthis* ULRICH & COOPER, 1936

GENOTYPE.—*Orthis hamburgensis* WALCOTT, 1884.

REMARKS.—Some species from the late Tremadocian and the early Arenigian of Sweden probably belong to this genus. Their hinge is narrower than the greatest width of the valves. The surface is multicostellate. The brachiophores are short and supported by the notothyrial platform. The teeth of the ventral valve are small and buttressed by short dental plates.

One of the species is *Nanorthis? christianiae* (KJERULF, 1865). Another species tentatively referred to the genus is described below.

Nanorthis? billingensis n. sp.

Pl. I, figs. 3, 4.

NAME.—The species is named after Billingen mountain where the first specimens were encountered.

HOLOTYPE (here selected).—Dorsal valve: PU no. Vg 460. Pl. I, fig. 4.

OTHER MATERIAL.—Ventral and dorsal valves: PU nos. Vg 461–463, 499–501, 535–537.

TYPE STRATUM and TYPE LOCALITY.—Thin layers of white limestone in glauconitic limestone, Stenbrottet, Västergötland.

DESCRIPTION.—Shell comparatively large and broad, the length about two-thirds the breadth, subsemicircular in outline; hinge line straight, representing the greatest width of the shell. Ventral valve evenly and rather highly convex; postero-lateral portions, however, gently concave; surface marked by about 50 costellae of unequal size. Dorsal valve less convex, with a wide and shallow sulcus; surface with about 50 costellae. Interior of valves unknown.

DIMENSIONS.—Length of dorsal valve (holotype) 7.5 mm, width 11.5 mm. Length of ventral valve (pl. I, fig. 3) 8.5 mm, width 12 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Common.

Genus *Productorthis* KOZLOWSKI, 1927

GENOTYPE.—*Productus obtusus* PANDER, 1830.

Productorthis? sp.

MATERIAL.—Fragmentary valves and one complete specimen: PU no. N 714.

REMARKS.—The shell is semicircular in outline and plano-convex; the surface multicostellate with imbrications.

OCCURRENCE.—Zone of *Plesiomegalaspis estonica* (Arenigian). — Närke: Yxhult.

Trilobita

Family *Agnostidae* M'COY, 1849

Genus *Geragnostus* HOWELL, 1935

GENOTYPE.—*Agnostus sidenbladhi* LINNARSSON, 1869, d. HOWELL, 1935.

Geragnostus sidenbladhi (LINNARSSON, 1869).

Pl. I, figs. 5, 6. Text-fig. 27 A.

1869 *Agnostus sidenbladhi* LINNARSSON, Vestergötl. Cambr. Silur. aflagr., p. 82, pl. 2, figs. 60, 61. (Description and figs. of cephalon and pygidium.)

1906 *Agnostus sidenbladhi* LINNARSSON.—MOBERG & SEGERBERG, Ceratopygeregionen, p. 77, pl. 4, fig. 1. (Description and fig. of pygidium.)

?1906 *Agnostus sidenbladhi* LINNARSSON.—LAKE, British Cambr. Trilobites, p. 22, pl. 2, fig. 17. (Description and fig. of complete specimen.)

MATERIAL.—Cephala: PU nos. Vg 152–155. Pygidia: SGU (original of MOBERG & SEGERBERG, 1906); PU nos. Vg 156–159.

REMARKS.—LINNARSSON's type specimens seem to be lost. The pygidium figured by MOBERG & SEGERBERG (1906) was collected at the type locality, Mossebo in Västergötland, probably by LINNARSSON himself. It belongs beyond doubt to the species. However, it does not agree in some respects with the diagnosis and figure given by LINNARSSON, as pointed out by MOBERG. It is wider than long. The rhachis is not subequal in breadth, the end lobe being wider than the second ring. The latter is about twice as long exsagittally as the first one. A comparison with other specimens collected at the type locality shows that the above pygidium is not of typical shape.

The material available is insufficient for the selection of a neotype, and some remarks only shall be made on the species.

LINNARSSON gave the following diagnosis: Cephalon and pygidium smooth, moderately convex, surrounded by a fairly wide, depressed border. Glabella narrow, one-lobed, occasionally, however, slightly depressed somewhat in front of the middle of the glabella, its length about two-thirds the length of cephalon. Cheeks subequal in width, confluent in front of glabella, not separated by median furrow.

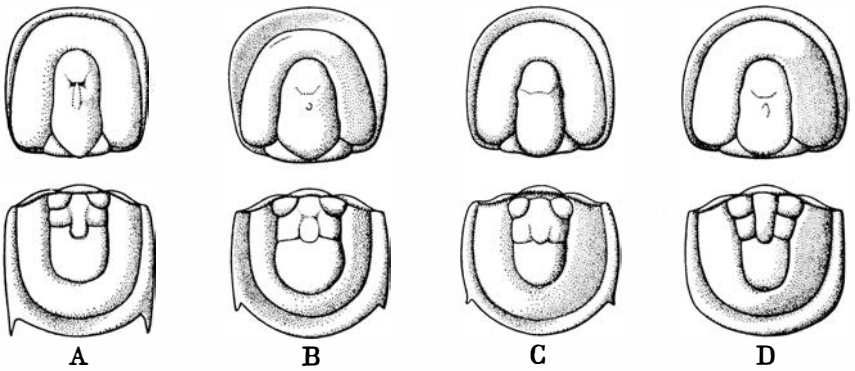


Fig. 27. Comparison between four species of *Geragnostus* HOWELL described or discussed below. A: *G. sidenbladhi* (LINNARSSON) from the zone of *Apatokephalus serratus* (late Tremadocian). B: *G. crassus* n. sp. (late Tremadocian to early Arenigian). C: *G. lepidus* n. sp., zone of *Plesiomegalaspis armata* (early Arenigian). D: *G. wimani* n. sp., zone of *Plesiomegalaspis planilimbata* (early Arenigian). — About 8 ×.

Pygidium with marginal spines. Rhachis subequal in width, its length more than half the length of pygidium, longer than wide, trilobed by transverse furrows. First ring not fully detached from second one, the delimiting transverse furrow being interrupted medially. First ring trilobed by two longitudinal furrows; second one less distinctly trilobed, its median portion, however, rising above the level of the lateral parts. End lobe at least one half the length of rhachis, and fully as wide as second ring, its posterior end obtusely rounded or almost truncated. Side lobes not separated by median furrow.

Three agnostids have been encountered in the Ceratopyge limestone at Mossebo. Two species, *Trinodus mobergi* and *Geragnostus crassus*, described in the following, are rare. The third species is much more common. Its pygidium answers well to LINNARSSON's diagnosis and figure, while its cephalon is of a fairly different shape. This species has been identified with *Geragnostus sidenbladhi*. The following additions to and corrections of LINNARSSON's diagnosis, based on the specimens encountered, might be made:

Cephalon and pygidium subquadratic in outline, about as wide as long. Pygidial rhachis of varying length, bounded by deep and wide furrows. Median keel narrow, low on first ring, its rear portion rising into an elongate tubercle. First ring nearly as long exsagittally as second one. Cephalic border narrow. Dorsal and preglabellar furrows well defined. Cheek lobes and preglabellar area about as wide as glabella. Glabella about twice as long as wide, tapering sligthly forwards, rounded in front, two-lobed; anterior lobe short, lower than main lobe. Transverse furrow deep on middle of glabella only, its lateral prolongations shallow and directed obliquely forwards. Sometimes a pair of very faint furrows running obliquely backwards from the transverse furrow are discernible. Immediately behind the latter furrow a spine-like median tubercle is situated.

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian). — Västergötland: Mossebo, Stenbrottet.

Geragnostus crassus n. sp.

Pl. I, figs. 7, 8. Text-fig. 27 B.

1905 *Agnostus glabratus* ANGELIN var. *ingricus* F. SCHMIDT.—WIMAN, Ein Shumardiaschiefer, p. 13, pl. 1, figs. 23, 24. (Description and figs. of pygidium.)

NAME.—Latin *crassus* = coarse.

HOLOTYPE (here selected).—Internal mould of pygidium: PU no. Vg 279. Pl. I, fig. 8.

OTHER MATERIAL.—Complete specimen: RM no. Ar. 12242. Cephala: PU nos. Vg 276–278, 449, 450; N 310–312. Pygidia: PU nos. Vg 160, 280, 451–453; N 313–316. RM nos. Ar. 12136, 12137 (originals of WIMAN, 1905), and Ar. 12317–12327.

TYPE STRATUM and TYPE LOCALITY.—Thin bed of light-grey Ceratopyge limestone, Stenbrottet, Västergötland.

DIAGNOSIS.—Shields highly convex. Cheek lobes and preglabellar area, as well as side lobes and post-rhachial area of pygidium very narrow, distally sloping almost vertically down to border. Pygidial rhachis very long and wide; first ring distinctly shorter exsagittally than second one; end lobe somewhat more than half the length of rhachis, evenly rounded at rear end.

DESCRIPTION.—Shields highly convex. Cephalon about as wide as long. Dorsal and preglabellar furrows deep and wide. Glabella tapering forward, its length about two-thirds the cephalic length. Transverse furrow usually faint on outside of test, distinct on internal mould, its lateral portions running obliquely forwards. Anterior lobe short, lower than main lobe. Main lobe with elongate median tubercle close to transverse furrow; lobe indented laterally opposite posterior end of tubercle. Basal lobes broadly triangular, meeting behind glabella. Cheek lobes and preglabellar area narrower than glabella. Border wide, narrowing backwards.

Pygidium somewhat wider than long. Dorsal and post-rhachial furrows deep and wide. Rhachis long and wide, its length about three-fourths the pygidial length, subequal in breadth. Transverse furrows well defined. First ring distinctly shorter exsagittally than second one; end lobe somewhat more than half the length of rhachis, evenly rounded at posterior end. Median keel of anterior rings narrow; low on first ring, rising into an elongate tubercle on second one. Side lobes and post-rhachial area very narrow. Border wide. Marginal spines short, but strong.

DIMENSIONS.—Length of cephalon (pl. I, fig. 7) 3 mm, width about 3 mm. Length of pygidium (holotype) 2.5 mm, width 2.7 mm.

REMARKS.—The species makes its first appearance in the late Tremadocian Ceratopyge limestone. A couple of closely related forms are met with in the early Arenigian beds. They have been included into the species. Such a form was described by WIMAN (1905) from a layer of greenish grey shale in the Lower Planilimbata limestone at Lanna in Närke. He identified it with *Agnostus*

glabratus ingricus F. SCHMIDT, 1894, collected from the lower Ordovician beds S of Leningrad. The pygidium of the latter form differs, however, in having a relatively narrow rhachis, and in its first rhachial rings being subequal in length. Furthermore the Russian species derives from considerably younger beds.

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian). — Västergötland: Stenbrottet, Mossebo. Öland: Ottenby. — Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Stenbrottet. — Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Västergötland: Ödegården. Öland: Äleklinta. Närke: Lanna, Latorp. Dalarna: Holen. South Bothnian District: Raggarön (boulder).

Geragnostus sp. aff. *crassus* n. sp.

1942 *Geragnostus* sp. (partim).—REGNÉLL, Stratigr. Paleont. N. Öland, p. 13, text-fig. 6b. (Discussion on species, fig. of pygidium.)

MATERIAL.—Cephala and pygidia: LP no. LO 3417 t; PU nos. N 566–568, 723–726.

REMARKS.—Agnostids occur far more sparsely in the Upper Planilimbata limestone than in the underlying beds. The species most frequently encountered is related to *G. crassus*. It differs from this species in having a more narrow pygidial rhachis and a very faint transverse furrow on the glabella.

OCCURRENCE.—Zone of *Plesiomegalaspis estonica* (Arenigian). — Närke: Lanna, Yxhult. Öland: Äleklinta.

Geragnostus lepidus n. sp.

Pl. I, figs. 9, 10. Text-fig. 27 C.

NAME.—Latin *lepidus* = pretty.

HOLOTYPE (here selected).—Internal mould of pygidium: PU no. Vg 441. Pl. I, fig. 10.

OTHER MATERIAL.—Cephala and pygidia: PU nos. Vg 442–447.

TYPE STRATUM and TYPE LOCALITY.—Thin layers of white limestone in glauconitic limestone, Stenbrottet, Västergötland.

DIAGNOSIS.—The species differs from the genotype in the following features: Shields more convex and more evenly rounded in outline. Pygidial rhachis more pointed at posterior end. Pygidial border narrow and of nearly uniform width. Marginal spines very short.

DESCRIPTION.—Shields convex, with a narrow, flattened border and well defined dorsal furrows. Cephalon as wide as long. Glabella short and narrow, about three-fifths the length and not fully one-third the width of cephalon, posteriorly rather highly convex, sloping forwards, tapering slightly in front. Transverse furrow faint on outside of test, on internal mould distinct and straight medially, lateral portions faint and directed obliquely forwards. Behind the furrow a low tubercle present or absent. Anterior lobe low and short; main

lobe twice as long, with a pair of lateral impressions opposite the tubercle. Basal lobes small. Cheek lobes and preglabellar area about as wide as glabella.

Pygidium as wide as long, well rounded in outline. Rhachis short and narrow, about two-thirds the length and one-third the width of pygidium. Transverse furrows distinct. Median keel low on first ring, rising into a blunt tubercle on rear part of second one. End lobe about half the length of rhachis, tapering backwards, rather pointed and with a small tubercle at posterior end. Border of nearly uniform width. Marginal spines very short.

DIMENSIONS.—Length and width of cephalon (pl. I, fig. 9) 3 mm. Length and width of pygidium (holotype) 2.5 mm; of another pygidium 3.7 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Stenbrottet.

Geragnostus wimani n. sp.

Pl. I, figs. 11, 12. Text-fig. 27 D.

1905 *Agnostus glabratus* ANGELIN.—WIMAN, Ein Shumardiaschiefer, p. 12, pl. 1, figs. 27, 28. (Description and figs. of cephalon and pygidium.)

NAME.—The species is named in honour of the late Professor C. WIMAN, Uppsala.

HOLOTYPE (here selected).—Pygidium: RM no. Ar. 12291. Pl. I, fig. 12.

OTHER MATERIAL.—Complete specimen: RM no. Ar. 12240. Cephala and pygidia: RM nos. Ar. 12315, 12316 (originals of WIMAN, 1905), 12139–12314. PU nos. Vg 579–581; N 317–325, 762, 855; Öl 288, 289.

TYPE STRATUM and TYPE LOCALITY.—Layer of greenish grey clayey shale in Lower Planilimbata limestone, Lanna, Närke.

REMARKS.—WIMAN's specimens were collected from clayey shale. Owing to the mode of preservation the transverse furrow of their glabella is obliterated. It made WIMAN describe the glabella as one-lobed, identifying the species with *Trinodus glabratus* (ANGELIN). A new description likewise founded on specimens preserved in limestone is given below.

DIAGNOSIS.—Glabella with transverse furrow. Two first rings of pygidial rhachis tapering backwards; end lobe often long, narrow, rather pointed at posterior end. Marginal spines ill-defined.

DESCRIPTION.—Shields rather highly convex. Cephalon somewhat wider than long, subsemicircular in outline, with narrow border. Glabella about two-thirds the length of cephalon, narrow, tapering forwards. Transverse furrow present in specimens preserved in limestone. It is straight and well defined medially, its lateral prolongations usually faint and directed obliquely forwards. Anterior lobe low; main lobe more convex, with an elongate median tubercle close to transverse furrow, lobe indented laterally opposite the tubercle. Basal lobes broadly triangular, meeting behind glabella. Cheek lobes and preglabellar area about as wide as glabella.

Pygidium often highly convex. It varies in outline from subquadrate with

postero-lateral angles to subsemicircular with very short marginal spines. Rhachis about three-fourths the length of pygidium. Anterior rings tapering backwards; end lobe narrow, subequal in width or tapering backwards, rather pointed at posterior end, its length usually more than half the rhachial length. Transverse furrows shallow, but distinct. Median keel low on first ring, its rear part rising into an elongate tubercle. First ring nearly as long exsagittally as second one. End lobe with a low tubercle at its rear extremity. Sometimes the posterior portion of the end lobe is but faintly delimited by the dorsal furrows.

DIMENSIONS.—Length of cephalon (pl. I, fig. 11) 3.3 mm, width about 3.5 mm. Length of pygidium (holotype) about 2 mm, width about 2.2 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Lanna, Hagaberg, Gymninge, Yxhult. Västergötland: Oltorp, Tomten. Öland: Äleklinta, Grönviken. South Bothnian District: Biludden (boulder). Dalarna: Sjurberg. Jämtland: Kloxåsen, Åsan.

Geragnostus? explanatus n.sp.

Pl I, figs. 13, 14.

NAME.—Alludes to the effaced pygidial rhachis.

HOLOTYPE (here selected).—Pygidium: PU no. N 290. Pl. I, fig. 14.

OTHER MATERIAL.—Cephala: PU nos. N 290, 793. Pygidia: PU nos. N 291, 856.

TYPE STRATUM and TYPE LOCALITY.—Grey Lower Planilimbata limestone, Lanna, Närke.

DIAGNOSIS.—Pygidium long, semi-elliptical in outline. Rhachis but faintly indicated on outside of test. On internal mould the two anterior rings and their median keel are well defined; the end lobe is almost obliterated. No marginal spines. Cephalon subsemicircular in outline. Glabella with a straight transverse furrow not reaching to dorsal furrows.

DESCRIPTION.—Cephalon about as wide as long, subsemicircular in outline, moderately convex, with a narrow border. Dorsal and preglabellar furrows deep, narrow. Glabella short, about three-fifths the length of cephalon, tapering forwards, rounded in front. Transverse furrow shallow, straight, not reaching to dorsal furrows. Anterior lobe depressed. Main lobe high, with a prominent elongate tubercle or a low spine close to transverse furrow; lobe indented laterally opposite tubercle. Basal lobes broadly triangular, confluent behind glabella. Cheek lobes and preglabellar area about as wide as glabella.

Pygidium longer than wide, semi-elliptical in outline, highly convex. Border widest at posterior end. No marginal spines. Dorsal furrows as well as transverse furrows of rhachis very faint on outside of test. On internal moulds the two anterior rings of rhachis are well defined, as well as a narrow median keel, rising into a tubercle on second ring. End lobe long and narrow, faintly delimited by the almost obliterated dorsal furrows; its rear end indicated by a low tubercle.

AFFINITIES.—The species seems to be related to *Geragnostus? toernquisti* (HOLM) collected from somewhat younger beds. In both species the pygidium is semi-elliptical in outline, and the end lobe of the rhachis is almost obliterated. Marginal spines are lacking. However, the cephalon attributed to *G.? toernquisti* differs from that of *G.? explanatus* in its glabella having a very prominent transverse furrow reaching to the dorsal furrows.

DIMENSIONS.—Length of cephalon (pl. I, fig. 13) 2.3 mm, width 2.5 mm. Length of pygidium (holotype) 3.2 mm, width 3 mm.

OCCURRENCE.—Upper part of the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Lanna, Hagaberg, Gymninge.

Geragnostus? toernquisti (HOLM, 1882).

1882 *Agnostus törnquisti* HOLM, Phyllogr. schiefer Dalecarl., p. 13, pl. 1, figs. 15–17. (Description and figs. of cephalon and pygidium.)

1939 *Agnostus tornquisti* HOLM.—KOBAYASHI, On the Agnostids, p. 172. (Remarks on species.)

MATERIAL.—Pygidium: PU no. N 425.

REMARKS. The species is imperfectly known. One cephalon, the internal mould of one pygidium (fig. 16), and one pygidium with an obsolete rhachis were figured by HOLM, 1882. Probably they are not conspecific. One pygidium only, similar to that shown in HOLM's fig. 17, has been collected by the present author.

OCCURRENCE.—Zone of *Megalaspides dalecarlicus* (Arenigian). — Närke: Lanna.

Geragnostus? sp. no. 1.

MATERIAL.—Cephalon: PU no. N 791. Pygidium: PU no. N 792.

REMARKS.—The species is characterized by its median glabellar tubercle being situated close to the anterior end of the glabella. The pygidium resembles that of *Geragnostus wimani*, the rhachis is, however, broader.

OCCURRENCE.—Uppermost part of the zone of *Plesiomegalaspis planilimbata* (early Arenigian).—Närke: Gymninge.

Geragnostus? sp. no. 2.

Pl. I, fig. 15.

MATERIAL.—Cephala: PU nos. N 423, 570, 571, 877, 912. Pygidia: PU nos. Öl 195; N 727, 876.

REMARKS.—The cephalon agrees well with that of *Geragnostus?* sp. no. 1, the pygidium differs in having a shorter rhachis.

OCCURRENCE.—Zones of *Megalaspides dalecarlicus* and of *Plesiomegalaspis estonica* (Arenigian).—Öland, Ottenby. Östergötland: Storberg. Närke: Lanna, Yxhult, Sätterböl. South Bothnian District?: boulders in glacial clay at Örebro, Närke.

Genus *Trinodus* M'Coy, 1846

Genotype.—*Trinodus agnostiformis* M'Coy, 1846.

Trinodus mobergi n. sp.

Pl. I, figs. 18, 19. Text-fig. 28 A.

1906 *Agnostus trinodus* Salter var.—Moberg & Segerberg, Ceratopygeregionen, p. 78, pl. 4, fig. 5. (Description and fig. of pygidium.)

Name.—The species is named in honour of the late Professor J. C. Moberg, Lund.

Holotype (here selected).—Cephalon: PU no. Vg 281. Pl. I, fig. 18.

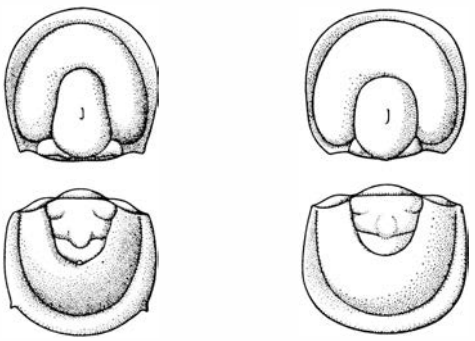


Fig. 28. Comparison between two species of *Trinodus* M'Coy described below. A: *T. mobergi* n. sp. from the zone of *Apatokephalus serratus* (late Tremadocian). B: *T. elliptifrons* n. sp., zone of *Plesiomegalaspis planilimbata* (early Arenigian). — About 8 ×.

Other material.—Cephala: PU nos. Vg 282, 283. Pygidia: PU nos. Vg 284–287.

Type stratum and type locality.—Bed of light-grey Ceratopyge limestone in glauconitic limestone, Stenbrottet, Västergötland.

Diagnosis.—Cephalon wider than that of genotype. Glabella more than half as long as cephalon, slightly pear-shaped in outline. Pygidial rhachis about half the length of pygidium. Small marginal spines.

Description.—Shields rather highly convex, with flattened border. Cephalon about as wide as long, subsemicircular in outline. Glabella bounded by well defined dorsal and preglabellar furrows, short, its length about three-fifths the length of cephalon, slightly pear-shaped in outline, one-lobed, sloping forwards, with a faint elongate median tubercle. Basal lobes broadly triangular, with a sigmoid transverse furrow close to posterior margin. Cheek lobes convex, sloping steeply down to border. Border wide anteriorly and antero-laterally, narrowing to posterior margin of cephalon. Genal angles bluntly pointed.

Pygidium about as wide as long, subsemicircular in outline. Marginal spines very short. Dorsal furrows deep and broad. Rhachis about half the length of

pygidium, trilobed by faint transverse furrows. Median keel low on first ring, rising into a blunt elongate tubercle on second one, passing unto anterior portion of end lobe. End lobe very short, less than one-third the length of rhachis, broadly pointed at rear end; on its posterior extremity a tiny tubercle.

DIMENSIONS.—Length and width of cephalon (holotype) 2.3 mm. Length of pygidium (Pl. I, fig. 19) 2.2 mm, width 2.3 mm.

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian). — Västergötland: Stenbrottet, Mossebo, Skår. Öland: Ottenby. South Bothnian District: Biludden (boulder).

Trinodus elliptifrons n. sp.

Pl. I, figs. 16, 17. Text-fig. 28 B.

1905 *Agnostus lentiformis* ANGELIN.—WIMAN, Ein Shumardiaschiefer, p. 13, pl. 1, figs. 21, 22. (Description and figs. of cephalon and pygidium.)

NAME.—Alludes to the shape of the glabella.

HOLOTYPE (here selected).—Complete specimen: RM no. Ar. 12331a (original of WIMAN, 1905). In this paper, pl. I, figs. 16, 17.

OTHER MATERIAL.—Cephala and pygidia: PU nos. N 95, 326–329. RM nos. Ar. 12330, 12333–12339.

TYPE STRATUM and TYPE LOCALITY.—Layer of greenish grey clayey shale in Lower Planilimbata limestone, Lanna, Närke.

DIAGNOSIS.—Glabella short, about half the length of cephalon, tapering but slightly forward. Pygidial rhachis less than half the length of pygidium. Marginal spines very small or absent.

DESCRIPTION.—Shields about as wide as long, subsemicircular in outline, moderately convex. Cephalon with narrow, flattened border. Glabella bounded by narrow, but distinct dorsal and preglabellar furrows, short, a little more than half the length of cephalon, tapering slightly forwards, rounded in front, one-lobed, with a faint elongate median tubercle on middle of glabella. Basal lobes small, triangular.

Pygidial border wide postero-laterally. Marginal spines very small or absent. Rhachis less than half the length of pygidium, tapering backwards. Elongate tubercle on second ring; end lobe very short sagittally, triangular.

DIMENSIONS.—Length and width of cephalon and pygidium (holotype) about 2.5 mm.

REMARKS.—WIMAN identified the species with *Trinodus lentiformis* (ANGELIN). The type specimen of the latter seems to be lost. It was collected at Fågelsång in Skåne from a limestone belonging to ANGELIN's Regio C, probably from the late Arenigian Expansus limestone. Some complete specimens from the Expansus limestone of Närke agree with ANGELIN's figure in having a relatively long glabella, its length being about two-thirds the length of cephalon. The glabella of *T. elliptifrons* is much shorter.

T. chinianensis HOWELL (1935) from the early Arenigian shales of Hérault, France, also differs in having a somewhat longer glabella.

OCCURRENCE.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Lanna, Latorp.

Genus *Leiagnostus* JAEKEL, 1909

GENOTYPE.—*Leiagnostus erraticus* JAEKEL, 1909.

Leiagnostus peltatus n. sp.

Pl. I, figs. 20, 21.

1905 *Agnostus* sp. WIMAN, Ein Shumardiaschiefer, p. 14, pl. 1, figs. 25, 26. (Remarks on species. Figs. of cephalon and pygidium.)

1939 Phalacromid, KOBAYASHI, On the Agnostids, p. 138. (Discussion on the species figured by WIMAN, 1905.)

NAME.—Latin (from Greek) *peltatus* = resembling a small shield.

HOLOTYPE (here selected).—Pygidium: RM no. Ar. 12340 (original of WIMAN, 1905, pl. 1, fig. 25). In this paper, pl. I, fig. 21.

OTHER MATERIAL.—Cephala: RM no. Ar. 12341. PU no. Vg 608. Pygidia: PU nos. N 330, 331.

TYPE STRATUM and TYPE LOCALITY.—Layer of greenish grey clayey shale in Lower Planilimbata limestone, Lanna, Närke.

DIAGNOSIS.—Cephalon longer than wide, highly convex, smooth, with exception of a low median tubercle. Border absent. Pygidium about as wide as long, smooth, with extremely narrow border.

DESCRIPTION.—Cephalon longer than wide, its greatest width at a distance slightly exceeding one-third the cephalic length from posterior margin, subsemi-elliptical in outline, with a straight posterior margin; when preserved in limestone highly convex, sloping evenly and moderately down to anterior margin, steeply to posterior and lateral ones; smooth, with exception of a low median tubercle situated somewhat behind middle of glabella. Border absent.

Pygidium about as wide as long, subsemi-elliptical in outline, probably less convex than cephalon, smooth, with extremely narrow border.

DIMENSIONS.—Length of cephalon (pl. I, fig. 20) 3 mm, width 2.8 mm. Length and width of pygidium (holotype) 2.2 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Lanna. Västergötland: Stenbrottet.

Family *Bathyuridae* WALCOTT, 1886

Genus *Agerina* n. gen.

GENOTYPE (here selected).—*Agerina erratica* n. sp.

NAME.—The genus is named after Västra Mark, latinized *Ager Occidentalis*, at Örebro in Närke at which locality the first specimens of the genotype were encountered.

DIAGNOSIS.—Cephalon subsemicircular in outline, with well defined border furrow, and narrow, convex border. Free cheeks sloping steeply down to border, with or without genal spine. Glabella reaching to anterior border furrow, subrectangular in outline, rounded in front, convex transversally and longitudinally. Occipital ring defined by narrow occipital furrow. Three pairs of short and faint glabellar furrows. Fixed cheeks very narrow. Eyes situated close to dorsal furrows and opposite middle of glabella or somewhat farther back. Anterior branches of facial suture diverge slightly in front of eyes, run obliquely inwards across the border, and seem to follow the cranidial margin in front. Rostrum triangular or, in a late species, trapezoidal in outline. Eight thoracic segments in the late species. Pygidium short sagittally, convex, with rounded posterior margin. Border furrow present or absent. Rhachis with three or four rings and terminal portion; side lobes with three pleurae.

SPECIES.—Three species are known: *A. erratica* n.sp., and *A. praematura* n.sp. from Sweden, *A. woehrmanni* (F. SCHMIDT) from Popowka, South of Leningrad.

OCCURRENCE.—Late Tremadocian, Arenigian.

Agerina erratica n.sp.

Pl. I, figs. 24–26. Text-fig. 29.

1952 *Proetus* sp. aff. *wöhrmanni* F. SCHMIDT.—TJERNVIK, Lägsta ordov. lagren, p. 60. (Remark on occurrence.)

NAME.—Latin *erraticus* = vagrant. The first known specimens were collected from boulders in glacial clay.

HOLOTYPE (here selected).—Cephalon: PU no. N 557. Pl. I, fig. 24.

OTHER MATERIAL.—Cephalon: PU no. N 562. Cranidia: PU nos. N 558, 686, 880. Free cheeks: PU nos. N 208, 559, 561, 878. Pygidia: PU nos. N 209, 560, 564, 879.

TYPE STRATUM and TYPE LOCALITY.—Grey marly Upper Planilimbata limestone, Lanna, Närke.

DIAGNOSIS.—Cephalon with short genal spines. Glabellar furrows very faint. Palpebral lobes situated opposite middle of glabella. Rostrum triangular in outline. No pygidial border furrow.

DESCRIPTION.—Cephalon with short genal spines directed obliquely outwards. Anterior and lateral border furrow deep; posterior one well defined on posterior limbs of cranidium only. Border widening slightly backwards. Dorsal furrows narrow and deep, preglabellar furrow shallower, confluent with anterior border furrow in front. Anterior pits deep, elongate, situated somewhat ahead of the most anterior glabellar furrows. Glabella slightly contracted in front of eyes, rounded or very bluntly pointed anteriorly; its width about two-thirds the length. Occipital ring smooth, its sagittal length about one-sixth

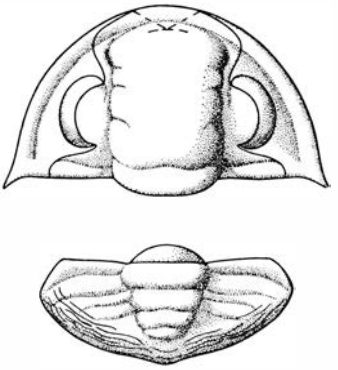


Fig. 29. *Agerina erratica* n.gen. and n.sp. from the zone of *Plesiomegalaspis estonica* (Arenigian). The broken line indicates the shape and the size of the rostrum. The anterior branches of the suture probably follow the margin of the cephalon in front. — Cephalon: 8 ×.

the length of glabella. Glabellar furrows short and faint, the most posterior ones curving inwards and backwards. Palpebral lobes situated opposite middle of glabella, subsemicircular in outline, sloping inwards, not rising above level of glabella, their length exsagittally about one-third the cranidial length. Posterior limbs slender with deep posterior border furrow and convex posterior border. Anterior branches of facial suture diverge slightly in front of eyes; beyond the border furrow they curve inwards, then cross the border in an oblique direction, and seem to follow the frontal margin. Posterior branches cut the cranidial margin at a distance from dorsal furrow exceeding half the width of glabella. Rostrum triangular in outline, its width at anterior margin somewhat more than half the maximal width of glabella. Hypostome and thorax unknown.

Pygidium about twice as wide as long, with an indication of a blunt point at rear end. No border furrow. Rhachis occupying about one-third the pygidial width, tapering backwards, strongly convex, with three rings and terminal portion. Side lobes with three pleurae. Test of cephalic and pygidial border ornamented with raised lines parallel to margin.

AFFINITIES.—The Russian species "*Proetus*" *woehrmanni* F. SCHMIDT, 1907, which appears later than *A. erratica*, has been included into the genus. It agrees well with the genotype in the shape of the glabella and the pygidium. It differs in having no genal spines. Furthermore its rostrum is trapezoidal in outline, an interesting development from the triangular rostrum of the genotype. Its thorax possesses eight segments.

DIMENSIONS.—Length of cephalon (holotype) 3.2 mm, width about 4.8 mm. Length of pygidium (pl. I, fig. 26) 1.2 mm, width 2.4 mm.

OCCURRENCE.—Upper part of the zone of *Plesiomegalaspis estonica* (Arenigian). — Närke: Lanna, Latorp, Yxhult. South Bothnian District?: boulders in glacial clay, Örebro, Närke.

Agerina praematura n.sp.

Pl. I, figs. 22, 23.

1906 *Orometopus elatifrons* (ANGELIN) (partim).—MOBERG & SEGERBERG, Ceratopygeregionen, p. 99, pl. 7, figs. 4, 5. (Description and figs. of pygidium.)

NAME.—The specific name alludes to the early appearance of the species.

HOLOTYPE (here selected).—Cranidium: PU no. Vg 267. Pl. I, fig. 22.

OTHER MATERIAL.—Cephalon: PU no. Öl 150. Cranidia: PU nos. Vg 268–270. Pygidia: PU nos. Vg 271–273. LP no. LO 1875 t.

TYPE STRATUM and TYPE LOCALITY.—Thin layer of light-grey Ceratopyge limestone, Stenbrottet, Västergötland.

DIAGNOSIS.—Cephalon with genal spines. Glabella narrower than that of genotype, and with better defined glabellar furrows. Palpebral lobes situated farther back. Anterior branches of suture subparallel in front of eyes. Rostrum triangular in outline. Pygidium with shallow border furrow.

DESCRIPTION.—Cephalon with genal spines. Glabella evenly rounded in front, its width less than two-thirds the length. Low median keel. Most posterior pair of glabellar furrows distinct, curving inwards and backwards. Palpebral lobes situated behind middle of glabella. Anterior branches of facial suture subparallel in front of eyes. Rostrum triangular in outline. Hypostome and thorax unknown.

Pygidium with shallow border furrow. Rhachis with three or four rings and triangular terminal portion. Side lobes with three pleurae. Test granulated. Border with raised lines parallel to margin.

DIMENSIONS.—Length of cranidium (holotype) 3.5 mm. Length of pygidium (pl. I, fig. 23) 1.7 mm, width 3.5 mm.

OCCURRENCE. — Zone of *Apatokephalus serratus* (late Tremadocian). — Västergötland: Stenbrottet. Öland: Ottenby, Köpings Klint.

Family *Olenidae* BURMEISTER, 1843

Genus *Parabolinella* BRÖGGER, 1882

GENOTYPE.—*Parabolinella limitis* BRÖGGER, 1882.

Parabolinella sp.

MATERIAL.—One fragmentary cranidium: collections of SGU.

REMARKS.—The cranidium agrees with that of *P. limitis* from the Norwegian zone of *Symphysurus incipiens* in its preglabellar field being rather wide longitudinally (compare the next species).

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian). — Västergötland: Storeklev.

Parabolinella? sp. no. 1

MATERIAL.—Fragments of cranidia and one free cheek: PU nos. Vg 435–439.

REMARKS.—The cranidium differs from that of *P. limitis* in its very narrow preglabellar field, and in having only two pairs of glabellar furrows. A row of small pits accompanies the inner margin of the anterior border.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Stenbrottet.

Parabolinella? sp. no. 2

1907 Trilobite, WIMAN, Nordbalt. Silurgebiet, II, p. 100, pl. 7, fig. 15. (Fig. of cranidium.)

MATERIAL.—Five fragmentary or distorted cranidia: PU nos. B 132; N 853; J 122–124.

REMARKS.—The cranidia resemble those from the zone of *Plesiomegalaspis armata* in having a very narrow preglabellar field and only two pairs of glabellar furrows.

OCCURRENCE.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — South Bothnian District: Limön (boulder). Närke: Hagaberg. Jämtland: Andersön.

Genus *Triarthrus* GREEN, 1832

GENOTYPE.—*Triarthrus beckii* GREEN, 1832.

Triarthrus sp.

MATERIAL.—Cranidia and pygidium: PU nos. Vg 432–435; N 15.

REMARKS.—In *T. angelini* LINNARSSON from the Ceratopyge limestone the third pair of glabellar furrows is indicated by shallow pits. These pits are absent in the above species, furthermore the species differs in its occipital furrow not being bent forward at the median line.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Mossebo, Stenbrottet. Närke: Latorp.

Genus *Saltaspis* HARRINGTON & LEANZA, 1952

GENOTYPE.—*Jujuyaspis steinmanni* KOBAYASHI, 1936.

Saltaspis viator n.sp.

Pl. II, figs. 1–3. Text-fig. 30.

NAME.—Latin *viator* = traveller. It alludes to the inexpected occurrence of this South American genus in the Swedish beds.

HOLOTYPE (here selected).—Internal mould of cranidium: PU no. Vg 412. Pl. II, fig. 1.

OTHER MATERIAL.—Cranidia: PU nos. Vg 413–421. Free cheeks: PU nos. Vg 422–426. Pygidia: PU nos. Vg 427–431.

TYPE STRATUM and TYPE LOCALITY.—Thin layers of white limestone in glauconitic limestone, Stenbrottet, Västergötland.

DIAGNOSIS.—Posterior limbs of cranidium exsagittally wider than those of genotype. Palpebral lobes situated closer to anterior margin of cranidium. Anterior branches of facial suture convergent in front of eyes. Pygidial border very much wider.

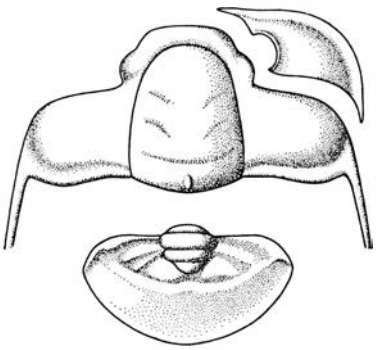


Fig. 30. *Saltaspis viator* n.sp. from the zone of *Plesiomegalaspis armata* (early Arenigian). — Cranidium: 5 ×.

DESCRIPTION.—Cranidium more than twice as wide as long. Dorsal and preglabellar furrows well defined. Glabella large, reaching to anterior border, its width at posterior end about three-fourths the length, tapering forwards, rounded in front, moderately convex, rising above level of fixed cheeks. Two or three pairs of faint glabellar furrows discernible on internal mould. Occipital furrow distinct, curving slightly backwards; occipital ring with an elongate median tubercle. Anterior border convex. Anterior margin curving slightly forwards. Palpebral lobes narrow transversally, their distance from anterior margin of cranidium subequal to one-fourth the cranidial length. Posterior limbs large, their inner portion as wide exsagittally as half the length of cranidium, carrying a pair of long genal spines directed backwards and somewhat outwards. Posterior border furrow describing a sigmoid curve. Facial suture proparian; anterior branches curving evenly forward and inward from palpebral lobes; posterior branches running outwards at first almost perpendicularly to median line, then turning backwards to lateral margin of cranidium, ending in front of genal spine. Free cheeks with evenly rounded margin and prominent, convex border.

Hypostome and thorax unknown.

Pygidium semicircular in outline, with evenly rounded posterior margin. Border very wide, slightly concave. Rhachis strongly convex, short, tapering backwards, with two rings and terminal portion. Pleural platforms flattened, showing one pair of well defined pleurae, with faint traces of segmentation behind them. Doublure wide, with seven or eight terrace lines parallel to pygidial margin.

DIMENSIONS.—Length of cranidium along median line (holotype) 4.3 mm, reconstructed width about 9.5 mm. Length of pygidium (pl. II, fig. 3) 3 mm, width 5.3 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Väster-

götland: Stenbrottet, Mossebo, Stora Stolan. Jämtland: Kloxåsen. South Bothnian District?: boulder in glacial clay, Örebro, Närke.

Saltaspis sp.

Pl. II, fig. 4.

1955 *Saltaspis* sp.—Tjernvik, Nericiaspis, text-fig. 1 D. (Drawing of cranidium.)

Material.—Three fragmentary cranidia: PU nos. Vg 300–302.

Remarks.—The cranidium differs from that of *S. viator* in the following features: The palpebral lobes are situated farther back, the posterior limbs are narrower exsagittally, the anterior branches of the facial suture seem to be subparallel in front of the eyes, then curve sharply inwards. In all these respects the species agrees better with the genotype than with *S. viator*.

Occurrence.—Zone of *Apatokephalus serratus* (late Tremadocian). — Västergötland: Stenbrottet.

Family *Remopleurididae* Hawle & Corda, 1847

Genus *Remopleuridiella* Ross, 1951

Genotype.—*Remopleuridiella caudalimbata* Ross, 1951.

Remarks.—The genus differs from *Remopleurides* Portlock especially in the following features: The cephalon has a distinct border furrow, the cranidium possesses long posterior limbs, the genal spine issues from the antero-lateral part of the free cheek, and the pygidium carries more than two pairs of spines of which the innermost pair is the smallest.

Remopleuridiella sp. no. 1

Pl. II, figs. 5, 6. Text-fig. 31.

Material.—Cranidia: PU nos. N 293, 763, 854; Vg 523. Free cheek: PU no. N 292.

Remarks.—The cranidium has a pair of slender posterior limbs. They are smaller than those of the genotype, yet they extend beyond the outer margin of the palpebral lobes. On internal moulds the glabella shows three pairs of glabellar furrows, a low median keel, and a median tubercle. The distance of the latter from the anterior margin is subequal to one-third the cranidial length.

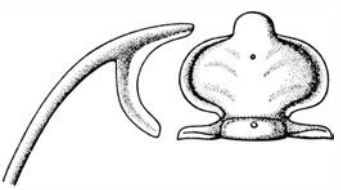


Fig. 31. *Remopleuridiella* sp. no. 1 from the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — 3 ×.

Another median tubercle is situated on the occipital ring near the occipital furrow. The test is finely granulated. The free cheek is narrow and crescent-shaped, with a distinct border furrow, and a long genal spine issuing from the antero-lateral part of the cheek. Thorax and pygidium are unknown.

OCCURRENCE.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Lanna, Hagaberg, Gymninge. Västergötland: Stora Stolan. Jämtland: Andersön.

Remopleuridiella sp. no. 2

?1952 *Remopleurides* aff. *nanus* V. LEUCHTENBERG.—SKJESETH, L. Didymograptus Zone, p. 157, pl. 5, figs. 4a, 6, 10. (Description and figs. of cranidium.)

MATERIAL.—Cranidia: PU nos. N 218, 523, 881, 882. Free cheek: PU no. N 883. Pygidium: PU no. N 884. All are fragmentary.

REMARKS.—The posterior limbs of the cranidium are probably somewhat shorter than those of the preceding species. The glabella has three pairs of glabellar furrows, and is ornamented with fine, raised, transversal lines. The free cheek is narrow, with a deep border furrow, and a genal spine issuing from the antero-lateral part of the cheek. The pygidium has a short rhachis and three or four pairs of pleural spines of which the innermost pair is the smallest.

OCCURRENCE.—Zone of *Plesiomegalaspis estonica* (Arenigian). — Närke: Latorp, Lanna. South Bothnian District?: boulder of red limestone in glacial clay, Örebro, Närke.

Family *Kainellidae* ULRICH & RESSER, 1930, emend. KOBAYASHI, 1953

Genus *Apatokephalus* BRÖGGER, 1897

GENOTYPE.—*Trilobites serratus* BOECK, 1838.

Apatokephalus serratus (BOECK, 1838)

Pl. II, figs. 7, 8. Text-fig. 32 A.

1838 *Trilobites serratus* BOECK, Übersicht gefund. Formen, p. 139. (Diagnosis.)
1854 *Centropleura serrata* SARS et BOECK.—ANGELIN, Palaeont. Scand., p. 88, pl. 41, fig. 10. (Diagnosis and drawing of pygidium.)
1882 *Dicelocephalus serratus* BOECK.—BRÖGGER, Silur. Etagen, p. 126, pl. 3, figs. 7, 8. (Description and figs. of pygidium.)
1897 *Dicellocephalus serratus* (ANGELIN).—HOLM, Palaeont. notiser 4, p. 465, pl. 8, figs. 3–5. (Description and figs. of cranidium and pygidium.)
1906 *Apatocephalus serratus* SARS et BOECK.—MOBERG & SEGERBERG, Ceratopygeregionen, p. 88, pl. 5, figs. 9, 11. (Description and figs. of cranidium and pygidium.)
1931 *Apatokephalus serratus* (BOECK).—LAKE, British Cambr. Trilobites, p. 122, pl. 14, fig. 14. (Description and fig. of cranidium.)
1941 *Apatocephalus serratus* (BOECK).—STØRMER, Early descriptions, p. 139, (Original diagnosis and remarks.)

LECTOTYPE (selected by STØRMER, 1941).—Pygidium: OPM no. 61751.

REMARKS.—The species, which is fairly common in the Ceratopyge limestone of Sweden and Norway, is still incompletely known. A recapitulation of earlier descriptions, some figures, and a few new observations are given below.

The species is characterized by the following features:

The dorsal furrows of the cranidium are subparallel in front of the eyes. The frontal lobe of the glabella is long and narrow; its anterior portion is bent steeply down. The most anterior pair of glabellar furrows is very short and usually directed obliquely backwards. The most posterior furrows are long and sigmoid, and do not meet on the middle of the glabella. A narrow preglabellar field is present. The posterior limbs, which are insufficiently known, are reconstructed in text-fig. 32 A. The test of the glabella is ornamented with pustules.

The free cheek figured in this paper was collected by Dr. A. H. WESTERGÅRD from a light-grey limestone at Trolmen, Kinnekulle. Other fossils, present on the slab, show that the limestone derives from the zone of *Apatokephalus serratus*. The cheek is wide, with a broad, convex lateral border. The genal spine, which is broad and long, issues from a point situated rather far ahead on the side of the cheek.

The pygidial rhachis is long, with four or five rings and a triangular terminal portion. The test of the rhachis is granulated. The pleural lobes have six or seven pleurae ending in spines.

AFFINITIES.—Several forms more or less closely related to *A. serratus* have been identified with this species. The cranidium of such a form was described by STØRMER (1922) from the Norwegian zone of *Symphysurus incipiens*, i.e. from beds somewhat older than those belonging to the Swedish zone of *Apatokephalus serratus*. It differs from the cranidium of *A. serratus* by having its most posterior pair of glabellar furrows confluent across the median line of the glabella. Probably it constitutes a new species.

Similar to this cranidium are those from the zone of *Asaphellus* in Northern Argentine, described by HARRINGTON (1938).

A. serratus has lately been reported by WILSON (1954) from the Marathon Uplift of Texas. The cranidium figured differs, however, from that of the said species in its anteriorly wide glabella which reaches the anterior border furrow, and in its most anterior pair of glabellar furrows being directed obliquely forwards.

Beside *Apatokephalus serratus* another species of the genus seems to occur in the Swedish Ceratopyge limestone. A cranidium of this species was figured and described by MOBERG & SEGERBERG (1906). It differs from that of *A. serratus* in its posteriorly wide glabella, its transversally broad occipital ring which carries a very small median tubercle, in its comparatively long anterior glabellar furrows, and in its ornamentation of the test. The latter consists of fine transversal, arched, and raised lines grading into rows of granulae. The

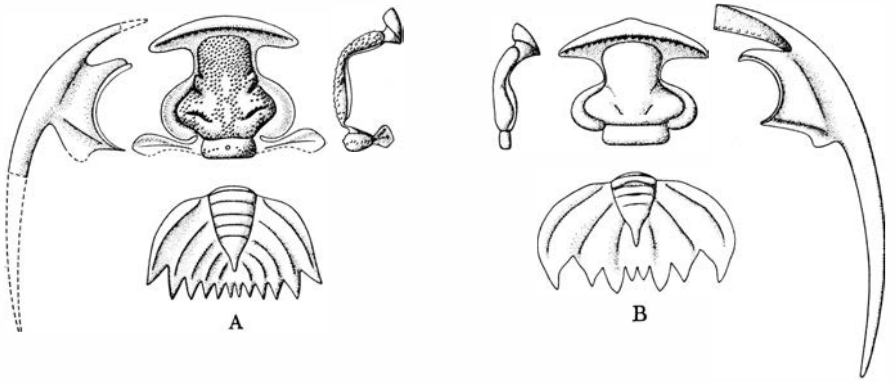


Fig. 32. A: Cranidium in dorsal and lateral view, free cheek, and pygidium of *Apatokephalus serratus* (BOECK) from the zone of *A. serratus* (late Tremadocian). — Cranidium: 3 ×. B: The same elements in *Menoparia? nericiensis* n. sp. from the zone of *Plesiomegalaspis estonica* (Arenigian). — Cranidium: 2 ×.

pygidium is unknown. This species was called by MOBERG & SEGERBERG *A. serratus* var. *dubius*. An identification with *A. dubius* (LINNARSSON, 1869) is at present impossible as the type specimen of the latter species seems to be lost. According to the description and drawing by LINNARSSON it lacked, however, the pustules characteristic of the test of *A. serratus*.

The insufficient knowledge of this Swedish species makes impossible a comparison with *A. dubius* from the Upper Tremadocian of Argentine, excellently figured and described by HARRINGTON (1938).

OCCURRENCE of *A. serratus*.—Zone of *Apatokephalus serratus* (late Tremadocian). — Skåne: Fågelsång, Öland: Ottenby. Västergötland: Storeklev, Mossebo, Stenbrottet, Stora Backor, Trolmen. South Bothnian District: Grisslehamn, Biludden (boulders).

Apatokephalus sp.

MATERIAL.—Fragments of cranidia, free cheeks, and one pygidium: PU nos. Vg 387, 388; Öl 164. They are too incomplete to permit a comparison with *A. serratus*.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Stenbrottet. Öland: Ottenby.

Genus *Menoparia* ROSS, 1951

GENOTYPE.—*Menoparia genalunata* ROSS, 1951.

Menoparia? nericiensis n. sp.

Pl. II, figs. 9–11. Text-fig. 32 B.

?1907 *Apatocephalus serratus* SARS et BOECK sp. var. *dubius* MOBERG.—FR. SCHMIDT, Rev. Ostbalt. Trilobiten, VI, p. 66, pl. 3, fig. 13. (Description and fig. of cranidium.)

NAME.—Latin *nericiensis* = from the Swedish province of Närke.

HOLOTYPE (here selected).—Internal mould of cranidium: PU no. N 669. Pl. II, fig. 9.

OTHER MATERIAL.—Cranidia: PU nos. N 525, 672–676, 885. Free cheeks: PU nos. N 670, 677–680. Pygidia: PU nos. N 671, 681–684.

TYPE STRATUM and TYPE LOCALITY.—Layer of greenish grey clayey shale in Upper Planilimbata limestone, Yxhult, Närke.

DIAGNOSIS.—Posterior part of cephalic dorsal furrows coincident with palpebral furrows. Anterior portion of glabella broad and widening slightly forwards. First pair of glabellar furrows very short, third pair lacking. Cranidial surface ornamented with dense and fine raised lines. Free cheek large, with a long and strong genal spine posteriorly inserted. Pygidium with four pairs of spines, the median pair shorter than the other ones.

DESCRIPTION.—Cranidium about as wide as long. Posterior part of dorsal furrows coincident with palpebral furrows, curving strongly outwards. Glabella reaching to anterior border furrow; its anterior portion broad and widening slightly forwards, evenly rounded in front, sloping moderately forwards. First pair of glabellar furrows very short, slightly sigmoid in shape, directed obliquely backwards; second pair faint, subparallel to first pair; third pair lacking. Frontal portion of cranidium wider transversally than remainder of cranidium. Anterior border broadly subtriangular in outline. Border furrow with a row of small pits. Exsagittal length of palpebral lobes somewhat less than half the length of cranidium. Posterior limbs unknown. Test of cranidium ornamented with dense and fine raised lines, longitudinal on palpebral lobes, curving forwards on glabella. Free cheeks separated by median suture, large, with a wide, slightly convex border and with a long and broad genal spine, issuing from the postero-lateral portion of the cheek. Doublure narrow, extending to border furrow.

Hypostome and thorax unknown.

Pygidium about twice as wide as long. Rhachis prominent, tapering backwards, with three rings and triangular terminal portion, continued by a postrhachial ridge. Each side lobe with four flat, grooved pleurae, ending in broad spines; the median pair shorter than the other ones. Doublure nearly as wide as side lobes.

DIMENSIONS.—Length of cranidium (holotype) about 10 mm, width at palpebral lobes 9.5 mm. Length of pygidium (pl. II, fig. 11) 6 mm, reconstructed width about 10 mm.

AFFINITIES.—The species agrees with the genotype of *Menoparia* in the general shape of the cranidium and of the pygidium, in the anteriorly wide glabella, the number and shape of the glabellar furrows, the ornamentation of the cephalic test, and in the number of the pleural spines in the pygidium. It differs in having a large free cheek with the genal spine posteriorly inserted, and by the absence of a crescentic portion of the fixed cheeks between the dorsal and the palpebral furrows. In the last respect it agrees with *Apatokephalus*? sp.

described by Ross (1953) from the base of the "G" zone of the Garden City formation of Utah. In the opinion of the said author this species may be one of the first forms of *Menoparia* derived from an *Apatokephalus*-like stock.

A fragmentary cranidium figured by Fr. Schmidt (1907) agrees with that of *M.? nericiensis* in the outline of the glabella and in the shape of the first pair of glabellar furrows (no second pair is discernible possibly on account of weathering). The cranidium was collected at Pawlowsk, S of Leningrad, from beds probably not younger than the Limbata limestone.

Occurrence.—Zone of *Plesiomegalaspis estonica* (Arenigian). — Närke: Yxhult, Lanna. South Bothnian District?: boulder in glacial clay, Örebro, Närke.

Family *Nileidae* Angelin, 1854, emend. Brögger, 1886

Genus *Nileus* Dalman, 1827

Genotype.—*Asaphus* (*N.*) *armadillo* Dalman, 1827.

Nileus armadillo (Dalman, 1827)

Text-fig. 33 D.

Remarks.—*N. armadillo* was collected by Dalman (1827, p. 61) from the uppermost beds of impure limestone at Husbyfjöl in Östergötland, probably from the Expansus limestone which is of late Arenigian age. His drawings of the species agree well with specimens obtained from the Expansus limestone of Östergötland and Närke (compare text-fig. 33 D).

The species is characterized by its subquadratic glabella which is nearly as wide as long. The dorsal furrows are subparallel. The palpebral lobes are long, their length being almost half the length of glabella. The anterior margin of the cranidium is evenly rounded. The pygidium is twice as wide as long; the border is slightly concave.

N. armadillo is not identical with anyone of the forms met with in the late Tremadocian and early Arenigian beds. These forms are dealt with below.

Nileus limbatus Brögger, 1882.

Pl. II, figs. 12–15. Text-fig. 33 A.

1882 *Nileus limbatus* Brögger, Silur. Etagen, p. 62, pl. 12, fig. 7. (Description and fig. of cranidium and pygidium.)

1906 *Nileus armadillo* Dalman.—Moberg & Segerberg, Ceratopygeregionen, p. 93, pl. 6, figs. 1–5. (Description and figs. of cranidium, hypostome, thorax, and pygidium.)

Material.—Fragmentary cephalon: PU no. Öl 145. Cranidia: LP no. LO 1851 t; PU nos. Vg 253, 254; Öl 146; N 81, 281, 850. Hypostome: LP no. LO 1855 t. Thorax and pygidium: LP no. LO 1852 t. Pygidia: LP no. LO 1853 t; PU nos. Vg 255–257.

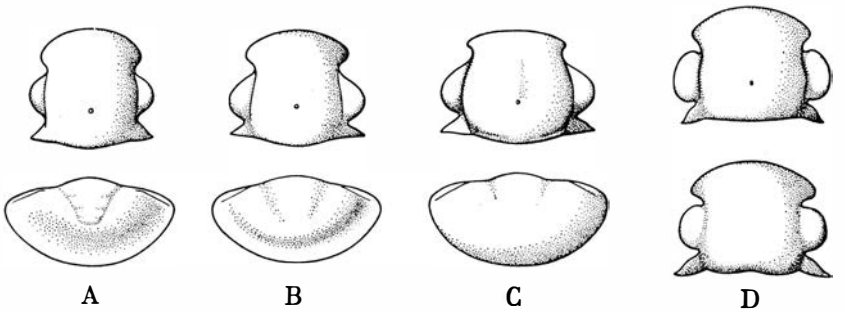


Fig. 33. Comparison between four species of *Nileus* DALMAN described or discussed in the paper. A: Cranidium and pygidium of *N. limbatus* BRÖGGER (late Tremadocian to early Arenigian). — About 2.5 ×. B: *N. exarmatus* n.sp. (Arenigian). — About 2 ×. C: *N. orbiculatus* n.sp. from the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — About 2 ×. D: Cranidia of *N. armadillo* (DALMAN); the upper from the Expansus limestone (late Arenigian), the lower redrawn after the figure given by DALMAN (1827). — About 0.75 ×.

REMARKS.—The species was recorded by BRÖGGER from the Ceratopyge limestone at Vestfossen in Norway. It differs from the genotype in the following features: The glabella is narrower, its width being about two-thirds the length. The palpebral lobes are situated farther forwards. They are shorter exsagittally; their length being one-third or somewhat more the cranidial length. The dorsal furrows of the thorax are better defined, and the rhachis is slightly more convex. The pygidium has a wide, concave border.

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian). — Västergötland: Trolmen, Storeklev, Stenbrottet. Öland: Ottenby. South Bothnian District: Grisslehamn, Häverö, (boulders). — Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Storeklev. Jämtland: Tossåsen. — Lower part of the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Lanna, Latorp, Gymninge, Hagaberg.

Nileus exarmatus n.sp.

Pl. II, figs. 16–21. Text-fig. 33 B.

NAME.—Latin *exarmatus* = disarmed; adult specimens do not carry genal spines.

HOLOTYPE (here selected).—Almost complete specimen: PU no. N 155. Pl. II, figs. 18, 19.

OTHER MATERIAL.—Cephala with genal spines: PU nos. N 497, 886. Cranidia: PU nos. N 158, 159, 205, 206, 408, 500, 501, 509. Free cheeks: PU no. N 207. Hypostomes: PU nos. N 504, 728; Öl 290. Pygidia: PU nos. N 156, 400, 407, 502, 513, 518.

TYPE STRATUM and TYPE LOCALITY.—Grey Upper Planilimbata limestone, Latorp, Närke.

DIAGNOSIS.—Small species. Carapace narrower than in genotype. Dorsal furrows of cranidium converge forwards. Glabella narrow. Palpebral lobes

exsagittally longer than in *N. limbatus*, and situated somewhat farther back. Pygidium with narrow, depressed border. Immature specimens with genal spines.

DESCRIPTION.—Small species, intermediate between *N. limbatus* and *N. armadillo*. Carapace narrower than in the latter. Cephalon in adult specimens with rounded genal angles; small cephala, measuring two or three millimetres in length, carry a pair of short genal spines. Dorsal furrows converge moderately forwards as far as the anterior end of the palpebral lobes. Glabella narrower than in genotype, its width at palpebral lobes being about three-forths the cranidial length. Small median tubercle opposite posterior portion of palpebral lobes; in front of it a long, low median keel visible on internal moulds. Palpebral lobes situated somewhat farther back than in *N. limbatus*, their exsagittal length about two-fifths the length of cranidium. Posterior limbs slender, pointed distally. Anterior branches of facial suture joining each other frontally, describing an evenly rounded line, or meeting at a very blunt angle.

Hypostome differs from that of genotype in its posterior lobe of central body being shorter and more triangular.

Thorax with eight segments. Dorsal furrows shallow. Rhachis wide, tapering backwards, low.

Pygidium semicircular in outline, about twice as wide as long, with narrow, depressed border.

DIMENSIONS.—Length of cephalon (holotype) 7.5 mm, width (reconstructed) about 12 mm. Length of pygidium (holotype) 5.7 mm, width about 10.5 mm.

OCCURRENCE.—Uppermost part of the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Gymninge. — In the succeeding zones of *Megalaspides dalecarlicus* and of *Plesiomegalaspis estonica* it is common at all localities. The same species or a closely related one occurs throughout the overlying Limbata limestone.

Nileus orbiculatus n.sp.

Pl. II, figs. 22, 23. Text-fig. 33 C.

NAME.—Latin *orbiculatus* = circular. Alludes to the shape of the glabella.

HOLOTYPE (here selected).—Internal mould of cranidium: PU no. N 796. Pl. II, fig. 22.

OTHER MATERIAL.—Cranidium: PU no. N 798. Pygidia: PU nos. N 797, 799.

TYPE STRATUM and TYPE LOCALITY.—Grey Lower Planilimbata limestone, Gymninge, Närke.

DIAGNOSIS. Glabella rounded in outline. Pygidium without concave border.

DESCRIPTION.—Dorsal furrows of cranidium forming circular segments stretching from posterior margin of cranidium until near anterior margin, thence curving outwards. Glabella moderately and evenly convex longitudinally as well as transversally, about as wide as long, rounded in outline, the widened anterior portion being very short exsagittally. Distance of median tubercle from

posterior margin of cranidium about one-third the cranidial length; in front of tubercle a long, low median keel. Length of palpebral lobes about two-fifths the length of the cranidium. Posterior limbs slender, pointed distally.

Free cheeks, hypostome, and thorax unknown.

Pygidia associated with cranidia of the species about twice as wide as long, semicircular in outline, convex, without concave border. Rhachis faint on outside of test, on internal mould well defined, tapering backwards, truncated at rear end, showing three rings and terminal portion. Test with transversal terrace lines.

DIMENSIONS.—Length of cranidium (holotype) 9.2 mm, width about 12 mm. Length of pygidium (pl. II, fig. 23) 5.6 mm, width 11 mm.

OCCURRENCE.—Uppermost part of the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Gymninge.

Nileus? sp.

MATERIAL.—Fragmentary cranidium: PU no. Vg 681. Pygidia: PU nos. Vg 682, 683; N 519.

REMARKS.—The cranidium resembles that of *Nileus*. The pygidia are semicircular in outline, smooth, with narrow, concave border. The pygidial rhachis is obliterated also on internal moulds.

OCCURRENCE.—Zone of *Plesiomegalaspis estonica* (Arenigian). — Närke: Lanna. Västergötland: Skultorp.

Genus *Symphysurus* GOLDFUSS, 1843

GENOTYPE.—*Asaphus palpebrosus* DALMAN, 1827, d. BARRANDE, 1852.

Subgenus *Symphysurus* (*Symphysurus*) GOLDFUSS, 1843

SUBGENOTYPE.—*Asaphus palpebrosus* DALMAN, 1827.

Symphysurus (*Symphysurus*) *angustatus* (SARS & BOECK)

Pl. II, figs. 24, 25.

1838 *Trilobites angustatus* SARS & BOECK.—BOECK, Übersicht gefund. Formen, p. 182. (Diagnosis.)

1869 *Symphysurus socialis* LINNARSSON, Vestergötl. Cambr. Silur. aflagr. p. 74, pl. 2, figs. 33, 34. (Description and figs. of cranidium and pygidium.)

1882 *Symphysurus angustatus* SARS & BOECK.—BRÖGGER, Silur. Etagen, p. 60, pl. 3, figs. 9–11. (Description and figs. of cranidium and pygidium.)

1906 *Symphysurus angustatus* SARS et BOECK.—MOBERG & SEGERBERG, Ceratopygeregionen, p. 90, pl. 5, figs. 15–21. (Description and figs. of cephalon and pygidium.)

1941 *Symphysurus angustatus* (SARS et BOECK MS).—STØRMER, Early descriptions, p. 143. (Original diagnosis and remarks.)

LECTOTYPE (selected by STØRMER, 1941).—Internal mould of cranidium: OPM no. 56215 a.

REMARKS.—The species is one of the commonest fossils of the Ceratopyge limestone. It is characterized by its long, subrectangular glabella which is rather evenly convex longitudinally. Its width is usually somewhat more than two-thirds the length, often, however, the glabella is wider. The posterior limbs are long exsagittally and narrow transversally. The pygidium is subsemicircular in outline, its length varying from two-fifths to nearly two-thirds the width. It is convex, without concave border. The pygidial rhachis is long; on outside of test low, on internal moulds prominent and showing four or five rings and terminal portion.

Forms very closely related to the species are met with in the early Arenigian limestones. Their glabella and pygidium may be wider than in the specimens from the Ceratopyge limestone. In one small carapace (PU no. N 773) part of the thorax is preserved. It has smooth segments, well defined dorsal furrows, and a fairly convex rhachis. The width of the latter is about one-third the total width of thorax. These late forms, which may reach a large size, are hardly distinguishable from broad specimens of *S. angustatus*, and have been included into this species.

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian). — Common. — Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Storeklev, Stenbrottet. — Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Common.

Symphysurus sp.

MATERIAL.—Two cranidia: PU nos. N 496; Öl 190.

REMARKS.—The cranidia differ from that of *S. angustatus* in having a considerably broader glabella; the width at the palpebral lobes being about four-fifths the length.

OCCURRENCE.—Zone of *Plesiomegalaspis estonica* (Arenigian). — Närke: Lanna. Öland: Ottenby.

Family *Asaphidae* BURMEISTER, 1843

Genus *Varvia* n. gen.

GENOTYPE (here selected).—*Symphysurus breviceps* ANGELIN, 1854.

NAME.—The genus is named after Varvsberget mountain on the slope of which the type locality of the genotype is situated.

DIAGNOSIS.—The genus resembles *Symphysurus* in the general shape of the carapace; the free cheeks are, however, separated by a median suture. The anterior portion of the glabella is bent steeply downwards. The median tubercle is situated opposite the palpebral lobes. The palpebral lobes are fairly small, with their rear end considerably farther from the dorsal furrow than the

anterior one. The anterior branches of the facial suture curve evenly forwards and inwards, and follow the anterior margin of the cephalon in front. The posterior branches describe a slightly sigmoid curve, and are directed strongly backwards. The existence of Panderian organs is not proved. The thorax possesses eight or occasionally but seven segments. The pygidial doublure is wide. The test is, as in *Symphysurus*, ornamented with terrace lines.

REMARKS.—Because of the median suture the genus is tentatively referred to the family *Asaphidae*.

SPECIES.—Three species are included into the genus: *Varvia breviceps* (ANGELIN), *V. falensis* n. sp., and *V. longicauda* n. sp.

OCCURRENCE.—The occurrence of the genus is restricted to the late Tremadocian and the earliest Arenigian beds. The species are, contrary to those of the genus *Symphysurus*, good index fossils.

Varvia breviceps (ANGELIN, 1854)

Pl. III, figs. 1–6. Text-fig. 34 C.

1854 *Symphysurus breviceps* ANGELIN, Palaeont. Scand., p. 61, pl. 33, fig. 13. (Diagnosis and drawing of cranidium.)

1905 *Symphysurus breviceps* ANGELIN.—WIMAN, Ein Shumardiaschiefer, p. 11, pl. 1, figs. 1–6. (Description and figs. of complete specimen, free cheeks and pygidium.)

LECTOTYPE (here selected).—Internal mould of cranidium: RM no. Ar. 14651. Pl. III, fig. 1. The cranidium is one of the specimens collected by ANGELIN at the type locality. These specimens are labelled in the hand of the said author: "*Symphysurus breviceps* Ang. Vestergötland". Later on has been added in another hand: "trol. från Oltorp" ("probably from Oltorp"). Beyond doubt the specimens originate from this locality, Oltorp being the only one from which ANGELIN reports the find of *S. breviceps*. The fossils are preserved in a dark-grey limestone, and some of the shells are covered with a crust of pyrite, in part replaced by haematite(?). This is characteristic of the fossils from the Lower Planilimbata limestone at Oltorp. Furthermore, one of the pygidia referred to *S. breviceps* belongs to *Symphysurina? perseverans* n. sp. This species is extremely rare, and has been encountered at Oltorp only.

OTHER MATERIAL.—Cranidia: RM nos. Ar. 14650, 14652, 14653, and pygidia: RM nos. Ar. 14654, 14655, all from the collection of ANGELIN. Complete specimen: RM no. Ar. 12824. Cranidium and thorax: PU no. N 266. Cranidia, free cheeks, pygidia, and one hypostome: PU nos. Vg 595–600, 604, 684; N 77, 268–271, 732, 741–743, 849.

TYPE STRATUM and TYPE LOCALITY.—Dark-grey Lower Planilimbata limestone, Oltorp, Västergötland.

DIAGNOSIS.—Glabella short, somewhat wider than long, expanding forwards. Occipital furrow present on internal moulds.One specimen with seven thoracic segments, another with eight segments are known. Pygidium short sagittally, with depressed border, and short, truncated rhachis.

DESCRIPTION.—ANGELIN's diagnosis is insufficient for separating species of the genus, and his drawing is poor. According to his figure the cranidium possesses an occipital furrow.

A detailed description and good figures were furnished by WIMAN (1905). He denies the existence of an occipital furrow. He points out that the free cheeks are separated by a median suture, and figures a complete specimen (RM no. Ar. 12824) with seven thoracic segments. To his description might be added:

Occipital furrow lacking on outside of test, present on internal moulds, curving forwards medially. Occipital ring very narrow sagittally. Median tubercle opposite middle of palpebral lobes, in front of it a low median keel. Palpebral lobes semicircular in outline, their exsagittal length less than one-third the length of glabella. Posterior limbs subtriangular in shape.

Associated with numerous cranidia of the species one fragmentary hypostome, wider than long, with evenly rounded anterior margin. Central body moderately convex, about as wide as long. Anterior lobe elliptical in outline, its length somewhat more than half the length of central body, delimited from posterior lobe by a very shallow middle furrow and by two lateral elongate pits directed obliquely backwards. Posterior lobe short, subtriangular in outline. Maculae long, elliptical. Lateral border wide, with rounded margin. Posterior border narrow; posterior margin straight with a short, broad, pointed process bent in dorsal direction.

Thorax with seven or eight smooth segments. Rhachis well defined, its width somewhat more than one-third the total width of thorax.

Pygidium about twice as wide as long or wider, with depressed border. Rhachis obsolete on outside of test, short, truncated, about half as long as pygidium, showing three rings and terminal portion on internal mould. Pleural platforms with anterior furrow only. Doublure surrounding two-thirds of rhachis.

DIMENSIONS.—Length of cranidium (lectotype) about 7.7 mm, width 11.4 mm. Length of cranidium (pl. III, fig. 2) 8.8 mm, width 12 mm. Length of pygidium (pl. III, fig. 5) 5 mm, width 10 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). Very common in the lower beds. One form with a somewhat narrower glabella is met with in the bottom beds of the zone.

Varvia falensis n. sp.

Pl. III, figs. 7–9. Text-fig. 34 B.

1906 *Symphysurus breviceps* ANGELIN.—MOBERG & SEGERBERG, Ceratopygeregionen, p. 92, pl. 5, figs. 23 a–d. (Description and figs. of an almost complete specimen.)

NAME.—Latin *falensis* = from the plain of Falan in Västergötland.

HOLOTYPE (here selected).—Cranidium: PU no. Vg 358. Pl. III, fig. 8.

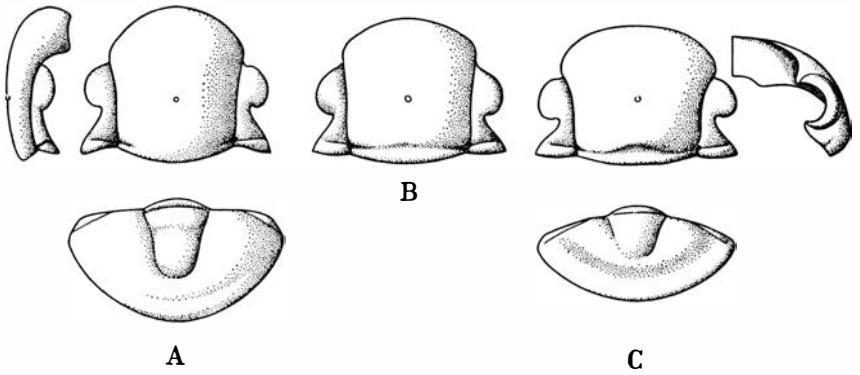


Fig. 34. Comparison between three species of *Varvia* n. gen. described here. A: Cranidium in dorsal and lateral view, and pygidium of *V. longicauda* n. sp. from the zone of *Apatokephalus serratus* (late Tremadocian). — 3 ×. B: Cranidium of *V. falensis* n. sp., zone of *Plesiomegalaspis armata* (early Arenigian). — 3 ×. C: Cranidium, free cheek, and pygidium of *V. breviceps* (ANGELIN), zone of *Plesiomegalaspis planilimbata* (early Arenigian). — 2.5 ×.

OTHER MATERIAL.—Almost complete specimen: LP no. LO 1849 t. Cranidia, pygidia, free cheeks, and one fragmentary hypostome: PU nos. Vg 357, 359–369.

TYPE STRATUM and TYPE LOCALITY.—Thin layers of white limestone in glauconitic limestone, Stenbrottet, Västergötland.

DIAGNOSIS.—Glabella short, yet longer than wide, not expanding forwards. Pygidium similar to that of genotype.

DESCRIPTION.—Cranidium wider than long, rather highly convex transversally, with evenly rounded anterior margin. Dorsal furrows straight, subparallel, diverging slightly forwards on internal mould. Glabella somewhat longer than wide, longitudinally but slightly convex, anterior portion, however, bent steeply downwards. Median tubercle opposite posterior part of palpebral lobes. Occipital furrow on internal moulds only, close to posterior margin of cranidium. Palpebral lobes and posterior limbs as in genotype. Free cheeks separated by a median suture; genal angles rather sharply rounded. Hypostome and pygidium similar to those of genotype. Thorax with eight segments.

DIMENSIONS.—Length of cranidium (holotype) 5 mm, width at palpebral lobes 6 mm. Length of cranidium (pl. III, fig. 7) 7 mm, width 9.2 mm. Length of pygidium (pl. III, fig. 9) 3.2 mm, width 6.9 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Stenbrottet, Storeklev, Stora Stolan. Öland: Ottenby. Jämtland: Kloxåsen.

Varvia longicauda n. sp.

Pl. III, figs. 10, 11. Text-fig. 34 A.

NAME.—Latin *longicauda* = with a long tail.

HOLOTYPE (here selected).—Almost complete specimen: PU no. Vg 248. Pl. III, fig. 11.

OTHER MATERIAL.—External mould of an almost complete specimen: collections of SGU from Hunneberg. Cranidia, free cheeks, pygidia: PU nos. Vg 150, 249–251, 587–589.

TYPE STRATUM and TYPE LOCALITY.—Thin layer of light-grey Ceratopyge limestone, Stenbrottet, Västergötland.

DIAGNOSIS.—Glabella longer than wide, expanding moderately forwards. Thorax with eight segments. Pygidium considerably longer than that of genotype, convex or with slightly concave border; rhachis somewhat more than half the length of pygidium.

DESCRIPTION.—Cranidium wider than long, rather highly convex transversally; anterior margin evenly rounded. Dorsal furrows diverging slightly forwards. Glabella longer than wide, expanding moderately forwards, posterior portion slightly convex longitudinally, anterior part bent steeply downwards. Median tubercle opposite posterior part of palpebral lobes. No occipital furrow. Posterior limbs fairly slender, their posterior margin running obliquely backwards. Free cheeks separated by a median suture. Hypostome unknown. Thorax with eight segments; rhachis well defined, tapering backwards, its width at anterior end about one-third the total width of thorax. Pygidium long, its length more than half the width, convex or with slightly concave border; rhachis well defined, tapering backwards, its length somewhat more than half the length of pygidium; showing four rings and terminal portion on internal mould. Pleural lobes with one anterior furrow only. Doublure wide.

DIMENSIONS.—Length of cranidium (holotype) 6.3 mm, width at palpebral lobes 8.5 mm. Length of pygidium (holotype) 5.5 mm, width 9.2 mm.

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian). — Common.

Genus *Symphysurina* ULRICH in WALCOTT, 1924

GENOTYPE.—*Symphysurina woosteri* ULRICH, 1924.

REMARKS.—Two species have been referred to the genus, yet with some doubt since the material available is small and consists almost entirely of internal moulds.

The two species agree with the genotype in the general outline and convexity of the cranidium, in the course of the facial suture, in the shape of the glabella, and in the wire-like anterior border which is ornamented with dense raised lines. One of the species, *S.? oriens*, differs in having long palpebral lobes, and in the median tubercle of the glabella being situated farther back. The other species agrees better with the genotype in both respects.

Only one free cheek has been encountered. Its genal angle and doublure are missing.

The pygidia resemble that of *S. globocapitella* HINTZE, 1952.

OCCURRENCE.—Late Tremadocian and early Arenigian.

Symphysurina? oriens (MOBERG & SEGERBERG, 1906)

Pl. III, figs. 12–18.

1906 *Illaenus oriens* MOBERG & SEGERBERG, Ceratopygeregionen, p. 98, pl. 7, figs. 2 a–c. (Description and figs. of cranidium.)

1906 Indeterminable species, v. POST, Ceratopygereg. Falbygd., p. 476, pl. 13, figs. 6, 7. (Figs. of pygidia.)

HOLOTYPE (by monotypy).—Internal mould of cranidium: LP no. LO 1873 T (original of MOBERG & SEGERBERG, 1906, pl. 7, figs. 2 a–c). In this paper pl. III, figs. 12–14.

OTHER MATERIAL.—Cranidia: PU nos. Vg 258, 259, 685. Free cheek: PU no. Vg 260. Pygidia: PU nos. Vg 261–264; Öl 147, 148; collections of SGU (original of v. POST, 1906, pl. 13, figs. 6, 7.)

TYPE STRATUM and TYPE LOCALITY.—Grey Ceratopyge limestone, Ottenby, Öland.

DIAGNOSIS.—Cranidium strongly convex longitudinally, anterior and posterior portions being about perpendicular to each other. Median tubercle of glabella situated far back, somewhat behind the posterior edge of the palpebral lobes. Palpebral lobes long exsagittally. Anterior branches of facial suture subparallel in front of eyes. Pygidial doublure very narrow.

DESCRIPTION.—Of the cranidium only internal moulds with attached small portions of the test are known.

Cranidium subquadrate in outline, slightly wider than long, strongly convex longitudinally, its anterior and posterior portions being about perpendicular to each other; less convex transversally, cranidium sloping evenly downwards from median line to outer edge of palpebral lobes. Anterior border narrow, wire-like, with raised lines parallel to margin. Dorsal furrows well defined in their rear part only. Preglabellar furrow very faint. Glabella large, tapering slightly forwards, rounded in front, unfurrowed. Small median tubercle situated somewhat behind posterior edge of palpebral lobes, the distance to posterior margin being about one-sixth the length of cranidium; in front of tubercle a faint median ridge. Fixed cheeks narrow. Palpebral lobes long exsagittally, their length about one-third the cranidial length, narrow transversally, with faint palpebral furrow; anterior edge situated at mid-length of cranidium. Anterior branches of facial suture subparallel in front of eyes, describing a faintly sigmoid curve to anterior margin, thence following the ventral edge of anterior border. Posterior branches directed obliquely backwards. Posterior limbs not extending beyond palpebral lobes; posterior border furrow present on internal mould.

Incomplete free cheek moderately convex, probably without genal spine. Doublure of cheek unknown.

Internal mould of pygidium semicircular in outline, twice as wide as long, in one large specimen longer. Pleural platforms gently convex; border sloping rather steeply down, convex. Dorsal furrows well defined. Rhachis three-

fourths to four-fifths the length of pygidium, tapering backwards, truncated at rear end, moderately convex, rising above level of pleural platforms, showing about six rings and terminal portion. In some specimens a tiny post-rhachial ridge similar to that in *S. robusta* POULSEN (1937). Pleural platforms delimited from border by a furrow at inner edge of doublure, smooth, with exception of anterior furrow. Doublure very narrow, at median line occupying about one-fifth the length of pygidium.

The external mould of one very fragmentary pygidium resembles that of *S. globocapitella* HINTZE (1952). The rhachis is rather vaguely delimited by shallow dorsal furrows. No traces of segmentation are descernible on rhachis and side lobes. The ornamentation of the test is unknown.

DIMENSIONS.—Length of cranidium (holotype) 12.8 mm, width 14.5 mm. Length of pygidium (pl. III, fig. 17) 4.4 mm, width about 7.5 mm. Length of large pygidium 11 mm, width 19 mm.

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian). — Öland: Ottenby, Köpings Klint. Västergötland: Stenbrottet, Stora Backor, Skår, Brattefors.

Symphysurina? perseverans n. sp.

Pl. III, figs. 19–22.

NAME.—Latin *perseverans* = persisting.

HOLOTYPE (here selected).—Internal mould of cranidium: PU no. Vg 576. Pl. III, figs. 19–21.

OTHER MATERIAL.—Pygidium: RM no. Ar. 14657, collected by ANGELIN.

TYPE STRATUM and TYPE LOCALITY.—Dark-grey Lower Planilimbata limestone, Oltorp, Västergötland.

DIAGNOSIS.—The species differs from *S.? oriens* in the following features: Cranidium less convex longitudinally as well as transversally. Palpebral lobes shorter exsagittally. Median tubercle of glabella situated farther ahead. Anterior branches of facial suture diverge forwards, consequently the anterior margin of the cranidium is wider. Pygidial doublure wider.

DESCRIPTION.—Only one internal mould of the cranidium and another of the pygidium are known.

Cranidium slightly wider than long, strongly convex longitudinally, moderately so transversally. Anterior border wire-like. Anterior border furrow narrow, well defined. Preglabellar furrow and dorsal furrows in front of eyes very faint. Median tubercle of glabella situated opposite middle of palpebral lobes, the distance to posterior margin being about two-fifths the length of cranidium; in front of tubercle a faint median ridge. Length of palpebral lobes about one-fourth the cranidial length; their anterior edge at mid-length of cranidium. Anterior branches of facial suture curve moderately outwards and forwards from eyes to anterior margin.

Internal mould of pygidium subsemicircular in outline. Dorsal furrows well

defined. Rhachis tapering backwards, showing about five rings and terminal portion. Side lobes with anterior furrow and a furrow at inner edge of doublure. Doublure occupying about one-third the length of pygidium at median line.

DIMENSIONS.—Length of cranidium (holotype) 9 mm, width about 10 mm. Length of pygidium (pl. III, fig. 22) 4.4 mm, width about 8 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Västergötland: Oltorp.

Genus *Platypeltoides* PŘIBYL, 1948

GENOTYPE.—*Platypeltis croftii* CALLAWAY, 1877.

REMARKS.—The genus is characterized by the following features:

The glabella is subrectangular in outline, smooth, with a median tubercle situated opposite the posterior end of the palpebral lobes. The posterior branches of the facial suture run outwards and backwards in a sigmoid curve, and meet the posterior margin at a distance from the dorsal furrow subequal to half the width of the glabella. The number of the thoracic segments is seven. The thoracic and pygidial rhachis are prominent.

The hypostome agrees fairly well with that of *Symphysurus*, it has, however, no median process in the posterior emargination.

OCCURRENCE.—Tremadocian of Great Britain. One species from the earliest Arenigian beds is here referred to the genus.

Platypeltoides serus n. sp.

Pl. III, fig. 23. Pl. IV, figs. 1, 2. Text-fig. 35 B.

1906 *Niobe laeviceps* DALMAN (partim).—MOBERG & SEGERBERG, Ceratopygeregionen, p. 96, pl. 6, fig. 17. (Fig. of fragmentary cranidium.)

NAME.—Latin *serus* = late.

HOLOTYPE (here selected).—Almost complete specimen with attached hypostome: collections of SGU from Hunneberg. Pl. III, fig. 23; pl. IV, fig. 1.

OTHER MATERIAL.—Two fragmentary cranidia: LP no. LO 1867 t.

DIAGNOSIS.—Large species. Glabella widest in front of eyes; anterior portion bent moderately downwards. Anterior border of uniform width, narrow, flattened. Posterior branches of suture curve outwards, almost perpendicularly to median line, then turn backwards. Hypostome broad; its posterior margin with a wide and shallow emargination.

DESCRIPTION.—Large species. Anterior portion of cranidium bent moderately downwards. Anterior border of uniform width, narrow, flattened. Dorsal furrows well defined as far forward as anterior edge of palpebral lobes, thence faint and diverging. Glabella expanded in front of eyes. Occipital furrow very faint or absent; no glabellar furrows. Median tubercle opposite posterior end of palpebral lobes. Palpebral lobes large, their length exsagittally almost one-

third the cranidial length. Posterior limbs fairly long transversally, narrow exsagittally, with strong posterior border furrow. Anterior branches of facial suture curving strongly and evenly outwards in front of eyes, thence turning inwards, probably describing an even curve along the front margin. Posterior branches run outwards and backwards in a sigmoid curve in part perpendicular to median line, meeting the posterior margin at a distance from dorsal furrow subequal to half the width of the glabella. Free cheeks unknown. Hypostome wide. Its lateral margin curves strongly outwards, lateral border wide. Posterior margin with a wide and shallow emargination, lacking median process. Central body delimited by wide furrows, anterior lobe broad, posterior one narrow, elliptical in outline. Test with dense terrace lines.

Thorax with seven segments. Rhachis well defined, moderately convex, tapering slowly backwards, occupying in front somewhat more than one-third the width of thorax. Fulcrum very close to rhachis in first segment, at an increasing distance in the following ones. Pleural furrow strong, oblique. Facets large.

Outline of pygidium and shape of its border unknown. Rhachis long, prominent, tapering backwards, showing no segmentation. Pleural platforms with a distinct furrow behind the half-rib and with three or four low pleural ribs, with shallow rib furrow.

DIMENSIONS.—Reconstructed length of complete specimen (holotype) about 135 mm, width about 75 mm. Length of cranidium (pl. IV, fig. 2) 42.5 mm.

AFFINITIES.—The species is related to "*Symphysurus*" *incipiens* BRÖGGER from the Tremadocian beds of Norway. According to STØRMER (1922, p. 7, pl. 1) "*S*". *incipiens* has a concave border on cephalon. In the opinion of LAKE (1942, p. 315) it should be placed in the same genus as *Platypeltoides croftii*.

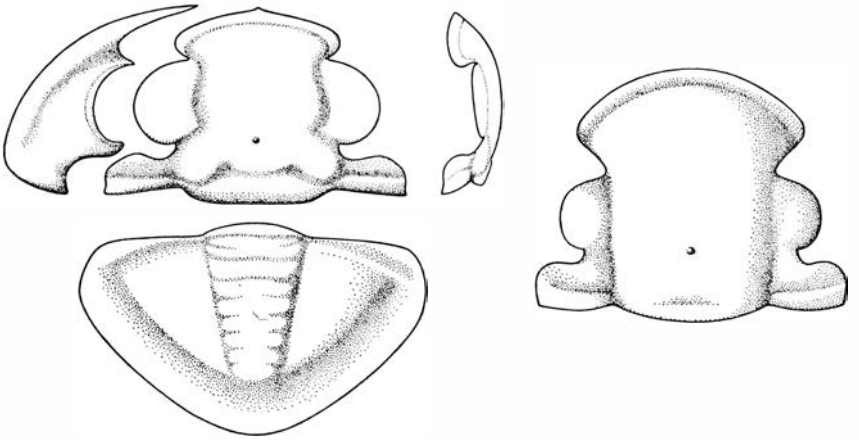
OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — The determination of the stratigraphical position, as well as the description of the species, is based on material from museums only. The holotype was collected by G. v. SCHMALENSEE, 1893, from "the upper part of the Ceratopyge limestone" at Nygård, Hunneberg; the two cranidia by C. SEGERBERG from corresponding beds at Fågelsång, Scania. One of the cranidia is associated with the frontal portion of a cephalon belonging to *Falanaspis aliena*.

Genus *Lapidaria* n. gen.

GENOTYPE (here selected).—*Lapidaria tenella* n. sp.

NAME.—Latin *lapidarius* = stone-cutter. It alludes to the type locality of the genotype, Stenbrottet (The Quarry).

DIAGNOSIS.—Glabella urn-shaped, expanded in front of eyes, with large basal lobes and occipital furrow. Preglabellar furrow faint, in one late species obliterated. Preglabellar area (when present) and anterior portion of glabella



A B

Fig. 35. A: Cranidium in dorsal and lateral view, free cheek, and pygidium of *Lapidaria tenella* n. gen. and n. sp. from the zone of *Plesiomegalaspis armata* (early Arenigian). — 3 ×. B: Reconstructed cranidium of *Platypeltoides serus* n. sp. from the same zone. — About 1 ×.

bent more or less steeply down. Palpebral lobes very large, rounded. Posterior limbs similar to those in *Niobella.* Free cheeks separated by short median suture. Genal angle sharply rounded; border of cheek flattened. Pygidium subtriangular in outline, with flattened border and prominent rhachis. Segmentation of pleural platforms almost obliterated.

Remarks.—The genus seems to be related to *Niobe* and *Niobella.* This is suggested by the course of the facial suture, by the urn-shaped glabella with its occipital furrow and basal lobes, and by the shape of the preglabellar area, the posterior limbs, the free cheeks, and of the pygidium.

The genus shows an evolution towards *Symphysurus*-like forms. In one species, appearing later than the genotype, the glabella has expanded forwards obliterating the preglabellar area.

Occurrence.—Early Arenigian.

Lapidaria tenella n. sp.

Pl. IV, Figs. 3–7. Text-fig. 35 A.

Name.—Alludes to the small size of the species.

Holotype (here selected).—Cranidium: PU no. Vg 370. Pl. IV, fig. 3.

Other material.—Cranidia: PU nos. Vg 371–374. Free cheeks: PU nos. Vg 376–378. Pygidia: PU nos. Vg 379–386.

Type stratum and type locality.—Thin layers of white limestone in glauconitic limestone, Stenbrottet, Västergötland.

Diagnosis.—See that of genus.

Description.—Frontal portion of cranidium bent downwards. Dorsal furrows well defined and curving outwards between palpebral lobes, diverging and

following the rear part of the facial suture in front of eyes. Preglabellar furrow very faint in adult specimens, distinct in immature ones. Glabella urn-shaped, expanded in front of eyes. Basal lobes large, bulging outwards. Occipital furrow faint at mid-line, straight, forming a pair of lateral pits inside of basal lobes, then curving backwards behind the lobes. No glabellar furrows. Small median tubercle opposite most posterior part of palpebral lobes. Preglabellar area very narrow sagittally, sloping forwards, in small specimens horizontal and similar to that in *Niobe*. Palpebral lobes very large, their length nearly half the length of cranidium, rounded in outline. Posterior limbs large, fairly slender, with pronounced posterior border furrow. Anterior branches of facial suture curve strongly and evenly outwards in front of eyes, then turn inwards, including an angle of about 150°, at median line delimiting a very short and broad point. Posterior branches describe a distinctly sigmoid curve, directed at first outwards, then backwards, cutting the posterior margin of cranidium at a distance from dorsal furrow subequal to half the width of glabella at the same margin. Free cheeks separated by short median suture. Genal angle sharply rounded; border furrow pronounced, yet obliterated postero-laterally; border flattened; frontal portion of doublure narrow and bent inwards.

Hypostome and thorax unknown.

Pygidium subtriangular in outline. Border furrow well defined; border horizontal, slightly convex. Rhachis reaching to border furrow, convex, tapering backwards, showing seven or eight rings and terminal portion on internal moulds; transverse furrows obliterated at median line. Pleural platforms with anterior furrow, otherwise but faint traces of segmentation.

Test ornamented with terrace lines, transversal on preglabellar area, longitudinal on antero-lateral portions of glabella, subparallel to lateral margin on free cheek, and to posterior margin on pygidial border and distal part of pleural platforms.

DIMENSIONS.—Length of cranidium (holotype) 8.2 mm, width at palpebral lobes 10 mm. Length of pygidium (pl. IV, fig. 7) 9.8 mm, width about 16 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Stenbrottet, Mossebo. Jämtland: Tossåsen, Andersön, Abborrfallet.

Lapidaria rugosa n. sp.

Pl. IV, figs. 8, 9.

NAME.—Latin *rugosus* = wrinkled. Alludes to the strong and numerous terrace lines of the test.

HOLOTYPE (here selected).—Cranidium: PU no. N 627. Pl. IV, fig. 8.

OTHER MATERIAL.—Cranidia: PU nos. N 740; Vg 544; J 139. Pygidium: PU no. N 78.

TYPE STRATUM and TYPE LOCALITY.—Grey Lower Planilimbata limestone, Yxhult, Närke.

DIAGNOSIS.—Large species, differing from the genotype in the following features: Frontal portion of cranidium bent more strongly downwards. Glabella reaching to anterior margin of cranidium in adult specimens. Palpebral lobes smaller. Test with numerous, strong terrace lines.

DESCRIPTION.—Large species. Frontal portion of cranidium more strongly convex longitudinally than in genotype. Glabella reaching to anterior margin of cranidium in adult specimens; preglabellar furrow obliterated, preglabellar area indicated by the transverse terrace lines only. Palpebral lobes not as large as in genotype, their length exsagittally about one-third the length of cranidium. Posterior limbs long transversally.

Free cheek, hypostome, and thorax unknown. Pygidium very similar to that of genotype. Test with numerous and strong terrace lines distributed as in genotype, on glabella undulating and curving backwards.

DIMENSIONS.—Length of cranidium (holotype) 33 mm, width at palpebral lobes: 38.5 mm. Length of pygidium (pl. IV, fig. 9) 29.5 mm.

OCCURRENCE.—Lowermost part of the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Yxhult, Latorp, Gymninge. Västergötland: Skultorp, Storeklev. Jämtland: Åsan.

Genus *Niobe* ANGELIN, 1851

REMARKS.—A number of species referred to the genus *Niobe* appear in the lower Ordovician beds of Sweden. As pointed out by BOHLIN, 1955, p. 146, these species may be arranged into three groups, representing separate branches of evolution.

I. In *Niobe frontalis* and some much earlier species the pleural ribs of the pygidium extend beyond the inner margin of the invariably wide doublure, and reach to the inner boundary of the flattened border (compare text-fig. 36). The ribs are, at least distally, rounded in cross section. Their ends bulge outwards, giving an undulating course to the line of demarcation between the central elevated part of the pygidium and the flattened border. *Niobe frontalis* being the genotype of *Niobe*, the species of the group are to be considered as typical members of the genus.

II. In *Niobe explanata* the pleural ribs reach to the margin of the pygidium. The systematic position of this species is uncertain.

III. In *Niobe laeviceps* and several earlier species the pleural ribs end as a rule at the inner margin of the doublure. When extending beyond that margin the prolongations are faint, and their terminations merge imperceptibly into the flattened border. The ribs show a shallow rib furrow. Furthermore, the Tremadocian and early Arenigian species of the group have a narrow pygidial doublure, contrary to contemporaneous species belonging to the first group. The species of group III are referred here to the genus *Niobella*.

GENOTYPE of *Niobe* s. str.—*Asaphus frontalis* DALMAN, 1827.

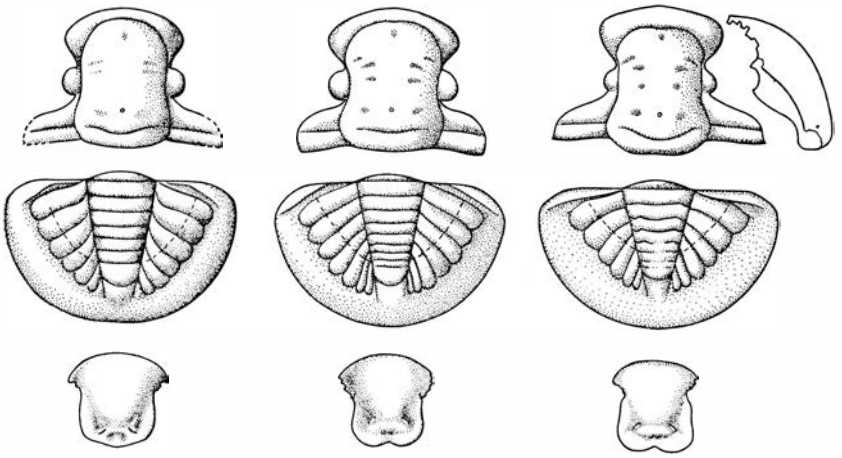


Fig. 36. Comparison between three species of *Niobe* ANGELIN. A: Cranidium, pygidium, and hypostome of *N. insignis* LINNARSSON from the zone of *Apatokephalus serratus* (late Tremadocian). — Pygidium: 0.5 ×. B: *N. incerta* n.sp., zone of *Plesiomegalaspis armata* (early Arenigian). — Pygidium: about 1 ×. C: *N. emarginula* ANGELIN, zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Pygidium: about 0.5 ×. Ventral view of a free cheek showing the site of the Panderian organ. Broken line = inner margin of doublure.

DIAGNOSIS.—Pygidial doublure wide. Pleural ribs extend beyond inner margin of doublure, their terminations being well defined and bulging outwards.

Evolution towards a frontally expanded glabella, and a hypostome with a pair of large, rounded posterior limbs.

OCCURRENCE.—Lower Ordovician.

Niobe insignis LINNARSSON, 1869

Pl. IV, fig. 10. Text-fig. 36 A.

1869 *Niobe insignis* LINNARSSON, Vestergötl. Cambr. Silur. aflagr., p. 75, pl. 2, fig. 36. (Description and fig. of pygidium.)

1882 *Niobe insignis* LINNARSSON.—BRÖGGER, Silur. Etagen, p. 66, pl. 4, figs. 1a–d. (Description and figs. of cranidium, free cheek, hypostome, and pygidium.)

1886 *Niobe insignis* LINNARSSON.—BRÖGGER, Ausbild. des Hypostomes, p. 48, pl. 2, figs. 28–31. (Remarks on species, figs. of hypostome.)

1901 *Niobe insignis* LINNARSSON.—HOLM, Kinnekulle, text-fig. 30. (Fig. of pygidium.)

1906 *Niobe insignis* LINNARSSON.—MOBERG & SEGERBERG, Ceratopygeregionen, p. 94, pl. 6, figs. 6–9. (Description and figs. of cranidium, free cheek, and pygidium.)

REMARKS.—According to LINNARSSON's short description and drawing the pygidium is semicircular in outline, with evenly rounded posterior margin. The rhachis is long and occupies about one-fourth the pygidial width at the anterior margin. It has about seven rings and terminal portion. The side lobes show a half-rib and seven or eight pleural ribs.

The pygidia figured by BRÖGGER, MOBERG, and HOLM are obtuse at the rear

end. The rhachis is shorter and wider than in the drawing given by LINNARSSON, its breadth at anterior margin being more than one-fourth the pygidial width. It shows six rings and terminal portion delimited by straight transverse furrows. On the side lobes but six pleural ribs are discernible. Their terminations are obtusely rounded.

LINNARSSON's type specimen is probably lost. The well known and common form, described and identified with the species by BRÖGGER, MOBERG, and HOLM, is looked upon by the present author as identical with *Niobe insignis*. No other form, referable to the species, has been encountered in the Ceratopyge limestone.

The cranidium and the hypostome were described by BRÖGGER. The anterior portion of the glabella tapers forwards, and is obtuse in front. The glabellar furrows are but faintly indicated. The occipital furrow is long transversally. Its lateral portions are about perpendicular to median line; the middle part curves backwards. The palpebral lobes are semicircular in outline, and situated opposite the middle of the glabella; their exsagittal length is about one-fifth the cranidial length. The preglabellar area is narrow sagittally. The posterior limbs are fairly slender. The anterior branches of the suture run obliquely forwards and outwards from the eyes, then turn rather sharply inwards, in front describing an evenly rounded curve.

The posterior margin of the hypostome is straight or curves backwards. It shows no indications of posterior limbs, the margin being even or but slightly indented at median line. In the furrow behind the central body there is a pair of small pits.

The test is ornamented with terrace lines and minute pits, the latter are all of about the same size.

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian).

Niobe incerta n. sp.

Pl. IV, figs. 11–13. Text-fig. 36 B.

NAME.—Latin *incertus* = uncertain. The species answers better to LINNARSSON's description of *N. insignis* than the Tremadocian form identified with his species.

HOLOTYPE (here selected).—Pygidium: PU no. Vg 113. Pl. IV, fig. 13.

OTHER MATERIAL.—Cranidium: PU no. Vg 114. Hypostomes: PU nos. Vg 342–345. Pygidia: PU nos. Vg 346, 347.

TYPE STRATUM and TYPE LOCALITY.—Bed of dark-grey limestone overlying the Ceratopyge beds, Storeklev, Västergötland.

DIAGNOSIS.—Pygidium subsemicircular in outline, with evenly rounded posterior margin. Side lobes with half-rib and seven pleural ribs, the terminations of the latter more or less pointed.

DESCRIPTION.—Glabella urn-shaped, broad, its width at palpebral lobes about two-thirds the length, evenly rounded in front of eyes, yet slightly

emarginated at median line. Occipital furrow curving but slightly backwards, obliterated laterally. Three pairs of short glabellar furrows; between the most posterior ones a median tubercle. In front of eyes a pair of furrows close to dorsal furrows and directed obliquely forwards. Shallow median pit close to frontal end of glabella. Preglabellar area narrow sagittally. Exsagittal length of palpebral lobes more than one-fifth the cranidial length. Posterior limbs fairly short transversally. Anterior branches of suture describing a more evenly rounded curve than in *N. insignis*, meeting at an extremely wide angle in front.

Posterior margin of hypostome with a distinct notch at median line, a pair of rounded posterior limbs being indicated. In front of notch two small pits. Posterior lobe of central body larger than that of *N. insignis*.

Thorax unknown.

Pygidium subsemicircular in outline, its length about three-fourths the width. Posterior margin evenly rounded. Border wide, flattened, and of uniform breadth. Dorsal furrows deep, rhachis about three-fourths the length of pygidium, its width at frontal end exceeding one-fourth the pygidial width, tapering moderately backwards, showing eight or nine rings and terminal portion. Low subtriangular post-rhachial ridge passing unto the border. Transverse furrows almost straight, on posterior part of rhachis sometimes obliterated medially, posterior furrows, when discernible, undulating. Side lobes with half-rib and seven pleural ribs; the terminations of the latter more or less pointed. Doublure wide, with an undulating inner margin.

Test ornamented with minute pits and terrace lines, the latter running transversally on preglabellar area and antero-lateral portion of pygidial border, subparallel to margin on posterior part of border, and on doublure.

DIMENSIONS.—Length of cranidium (pl. IV, fig. 11) 16 mm, width at palpebral lobes about 13.5 mm. Length of pygidium (holotype) about 17.5 mm, width 27 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian).—Västergötland: Storeklev, Mossebo, Stenbrottet.

Niobe emarginula ANGELIN, 1851

Pl. IV, figs. 14–17. Text-fig. 36 C.

1851 *Niobe emarginula* ANGELIN, Palaeont. Suecica, p. 15, pl. 11, fig. 3. (Diagnosis and drawings of cranidium and pygidium.)

1886 *Niobe emarginula* ANGELIN.—BRÖGGER, Ausbild. des Hypostomes, p. 48, pl. 2, fig. 33. (Discussion on species, description and fig. of hypostome, correction of the determination, 1882.)

LECTOTYPE (here selected).—Fragmentary internal mould of cranidium: RM no. Ar. 14284, collected by ANGELIN at the type locality; probably the original of his pl. 11, fig. 3. In this paper, pl. IV, fig. 14.

OTHER MATERIAL.—Fragmentary cranidia, hypostome, and pygidium: RM nos. Ar. 14283, 14285–14287, collected by ANGELIN at the type locality. The

hypostome is the original of BRÖGGER, 1886, pl. 2, fig. 33. Cranidia: PU nos. N 621, 836; Vg 479. Hypostome: PU no. N 837. Pygidia: PU nos. Vg 607; N 254, 770, 838; Öl 172.

TYPE STRATUM and TYPE LOCALITY.—Grey Lower Planilimbata limestone, Oltorp, Västergötland.

DIAGNOSIS.—Glabella somewhat narrower than in *N. insignis* and *N. incerta*. Occipital furrow curving strongly backwards. Three pairs of pit-like glabellar furrows. Preglabellar area wide sagittally. Palpebral lobes small, situated farther ahead than in the above species. Posterior limbs long and slender. Posterior margin of hypostome distinctly indented. Pygidial rhachis short and broad, tapering rapidly backwards. Side lobes with half-rib and six pleural ribs.

DESCRIPTION.—Large species. Glabella somewhat narrower than in *N. insignis* and *N. incerta*, the width at palpebral lobes being about three-fifths the length; most anterior portion tapering abruptly forwards, obtuse and somewhat emarginated in front. Occipital furrow curving strongly backwards. Three pairs of pit-like glabellar furrows; in front of eyes a pair of furrows close to dorsal furrows and directed obliquely forwards. Median tubercle situated half-way between occipital furrow and a line through posterior edges of palpebral lobes. Median pit near the front of glabella. Preglabellar area wide sagittally. Palpebral lobes situated farther from posterior margin of cranidium than in both the above species, small, their exsagittal length about one-seventh the cranidial length. Posterior limbs long and slender. Anterior branches of suture curve outwards and forwards from eyes, then turn abruptly inwards, and meet at an extremely obtuse angle. Posterior branches run obliquely backwards, then turn sharply backwards, near cranidial margin somewhat outwards. Free cheeks with a wide doublure and small Panderian organs situated midway between facial suture and lateral margin of cephalon (compare text-fig. 36 C).

Hypostome similar to that in *N. incerta*. Behind the central body a pair of small pits. Posterior margin with a distinct notch at median line; a pair of rounded posterior limbs indicated.

Thorax unknown.

Pygidium subsemicircular in outline, evenly rounded or slightly obtuse at rear end. Rhachis short and broad, in front more than one-fourth the pygidial width, tapering rapidly backwards. Seven to nine rings and terminal portion. Transverse furrows straight medially, their lateral parts undulating. Side lobes with half-rib and six pleural ribs, their terminations rounded or pointed.

Ornamentation of test as in *N. insignis*.

AFFINITIES.—The species resembles *Niobe fourneti* THORAL, 1946, from the Arenig moyen inférieur (?) of France in the course of the facial suture, the shape of the hypostome, the short and broad pygidial rhachis which tapers rapidly backwards, the nine rhachial rings with terminal portion, and in the side lobes with half-rib and six pleural ribs.

DIMENSIONS.—Length of cranidium (lectotype) about 35 mm, width at

palpebral lobes 25 mm. Length of pygidium (pl. IV, fig. 16) 41.5 mm, width about 65 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Encountered at a large number of localities in Västergötland, Östergötland, Öland, Närke, Dalarna, and in boulders from the South Bothnian District.

Genus *Niobella* REED, 1931

GENOTYPE.—*Niobe homfrayi* SALTER, 1866.

REMARKS.—Four forms have hitherto been included with the genus *Niobella*, three from the Lower Ordovician of Great Britain and one from the Upper Cambrian of Sweden. Some other species from the upper Tremadocian and the Arenigian beds of Scandinavia are here referred to the genus.

According to REED (1931, p. 462) the hypostome and pygidium of *Niobella* are characterized by the following features: "Hypostome suboval, more or less pointed behind, not emarginate, with subparallel sides and small anterior ears. Pygidium with well defined annulated axis touching inner end of border; pleurae flattened, more or less clearly marked with median furrow; border flattened, broad; caudal fascia of same uniform width as border."

With REED the chief reason for separating *Niobe homfrayi* from the genus *Niobe* is the shape of its hypostome. Yet, as pointed out by LAKE (1942, p. 330), the hypostome in *Niobe* undergoes a progressive change from shapes with a rounded posterior margin, occasionally with a faint median notch (as in the late Tremadocian species *N. insignis*) to types with a deep notch and a pair of large, rounded posterior limbs (as in *N. "frontalis"*, BRÖGGER, 1886, from the late Arenigian beds). A hypostome like that in *Niobella homfrayi* might be expected in early members of the genus *Niobe*.

Differences in the pygidium seem to supply a better base for a division of *Niobe* into two genera. The pygidium of *Niobe* s. str. has been described above. That of *Niobella* is characterized by its low, flattened pleural ribs which show a rib furrow, and become obliterated at or slightly beyond the inner margin of the doublure. In these features, as well as in the shape of the rhachis, in the narrow concave border, and in the narrow doublure, the late Upper Cambrian species *Niobella aurora* WESTERGÅRD resembles the late Tremadocian *Niobe obsoleta* LINNARSSON. The latter and some species from the Arenigian beds are here included with the genus *Niobella*.

DIAGNOSIS.—Pygidial pleural ribs obliterating at or slightly beyond the inner margin of the doublure. Ribs low, flattened, with a shallow rib furrow. Doublure in early species narrow.

Evolution, as in the genus *Niobe*, towards a frontally expanded glabella, a hypostome with a pair of large, rounded posterior limbs, and a broad pygidial doublure.

OCCURRENCE.—Late Upper Cambrian, Tremadocian, and Arenigian.

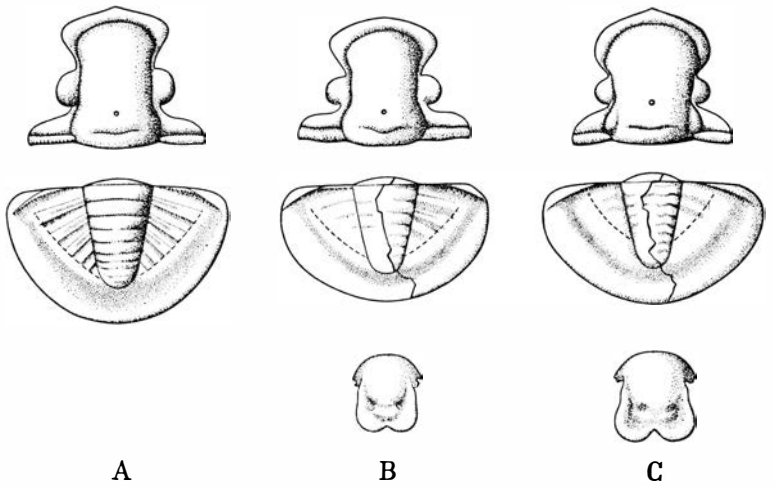


Fig. 37. Comparison between three species of *Niobella* REED. A: Cranidium attributed to, and pygidium of *N. obsoleta* (LINNARSSON) from the zone of *Apatokephalus serratus* (late Tremadocian). — Pygidium: about 1 ×. B: Cranidium, pygidium, and hypostome of *N. bohlini* n.sp., zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Pygidium: about 1 ×. C: *N.* sp. aff. *imparilimbata* (BOHLIN), zone of *Plesiomegalaspis estonica* (Arenigian). — Pygidium: about 0.6 ×. Broken line = inner margin of doublure.

Niobella obsoleta (LINNARSSON, 1869)

Pl. V, figs. 1, 2. Text-fig. 37 A.

1869 *Niobe obsoleta* LINNARSSON, Vestergötl. Cambr. Silur. aflagr., p. 74, pl. 2, fig. 35. (Description and fig. of pygidium.)

1882 *Niobe obsoleta* LINNARSSON.—BRÖGGER, Silur. Etagen, p. 66, pl. 4, fig. 2. (Remarks on cranidium, fig. of pygidium.)

1886 *Niobe obsoleta* LINNARSSON.—BRÖGGER, Ausbild. des Hypostomes, p. 49. (Discussion on species.)

1906 *Niobe obsoleta* LINNARSSON.—MOBERG & SEGERBERG, Ceratopygeregionen, p. 95, pl. 6, figs. 15, 16. (Description and figs. of pygidium.)

LECTOTYPE (here selected).—Pygidium: SGU no. K.V.A.H. VIII, 2 (collected by LINNARSSON at the type locality, probably the original of his drawing, 1869, pl. 2, fig. 35). In this paper, pl. V, fig. 2.

OTHER MATERIAL.—Pygidia: OPM no. H 2620 (figured by BRÖGGER, 1882); LP nos. LO 1865 t, 1866 t (figured by MOBERG & SEGERBERG, 1906); PU nos. Öl 141, 142. Cranidium: PU no. Öl 139. Hypostome: PU no. Öl 140.

TYPE STRATUM and TYPE LOCALITY.—According to LINNARSSON: Ceratopyge limestone, Mossebo, Västergötland.

DIAGNOSIS.—Pygidium subsemicircular in outline with evenly rounded posterior margin. Flattened border narrow and of uniform width. Transverse furrows of rhachis nearly straight. Pleural platforms with half-rib and five or six pleural ribs, reaching to inner margin of doublure. Doublure narrow, its inner edge subparallel to pygidial margin.

DESCRIPTION.—LINNARSSON gave the following short description: Pygidium one and a half time as wide as long. Border smooth, depressed, narrow, occupying in front only one-third the width of lateral lobe. Rhachis about three-fourths the length and more than one-fourth the width of pygidium, with seven or eight indistinct rings. Lateral lobes with four or five pleural ribs becoming obsolete before reaching the border.

To this description might be added: Pygidium subsemicircular in outline, posterior margin evenly rounded. Flattened border of uniform width. Transverse furrows of rhachis nearly straight. Pleural platforms with half-rib and five or six low, flattened pleural ribs, reaching to inner margin of doublure, showing a faint rib furrow. Pleural furrows shallow. Doublure narrow, about one and a half time as wide as the flattened border, its inner edge subparallel to pygidial margin. Border with terrace lines, on antero-lateral portion running inwards and backwards, on rear part subparallel to margin. Between the lines the test is ornamented with minute pits. Short terrace lines, curving inwards, have been observed on the pleural ribs of one specimen.

A small cranidium, probably belonging to the species, has been collected by Dr. B. BOHLIN at Ottenby in Öland. It resembles the cranidium of *N. insignis* from which it differs in a few features: The glabella is narrower and more evenly rounded in front, the palpebral lobes are larger, and the anterior branches of the facial suture meet at a blunt angle in front.

One hypostome associated with and probably belonging to the species has been encountered. It resembles very much that of *N. insignis*, but is somewhat shorter. The posterior margin is obtusely rounded with a slight median notch.

DIMENSIONS.—Length of pygidium (lectotype) about 17 mm, width 27 mm.

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian). —Västergötland: Mossebo, Storeklev, Stora Backor, Trolmen. Skåne: Fågelsång. Öland: Ottenby. — Norway: Vestfossen.

Niobella sp. aff. *obsoleta* (LINNARSSON) no. 1

1906 *Niobe obsoleta* LINNARSSON.—v. POST, Ceratopygereg. Falbygden, p. 476, pl. 13, figs. 1, 2. (Figs. of pygidia.)

MATERIAL.—Pygidia: collections of SGU (originals of v. POST, 1906); PU no. Vg 246.

REMARKS.—The pygidium is longer than that of *N. obsoleta*, and the concave border is narrow posteriorly. The transverse furrows of the rhachis undulate slightly. In addition to the half-rib the pleural platforms possess only four or five pleural ribs with sharp edges. The doublure is wider than in *N. obsoleta*.

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian). — Västergötland: Stenbrottet.

Niobella sp. aff. *obsoleta* (LINNARSSON) no. 2

Pl. V, fig. 3.

MATERIAL.—Pygidia: PU nos. N 794, 795.

REMARKS.—The pygidium is much broader than that of *N. obsoleta*, being nearly twice as wide as long. The pleural platforms show only four pleural ribs in addition to the half-rib.

OCCURRENCE.—Uppermost part of the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Gymninge.

Niobella bohlini n.sp.

Pl. V, figs. 4–9. Text-fig. 37 B.

1905 *Niobe laeviceps* DALMAN, and *Niobe* sp. nos. 1 and 2.—WIMAN, Ein Shumardiaschiefer, p. 10, pl. 2, figs. 12, 14. (Descriptions and figs. of pygidia.)

1906 *Niobe laeviceps* DALMAN (partim).—MOBERG & SEGERBERG, Ceratopygeregionen, p. 96, pl. 6, fig. 19. (Remarks on species, fig. of pygidium.)

1952 *Niobe* sp. aff. *obsoleta* LINNARSSON.—TJERNVIK, Lägsta ordov. lagren, p. 57, text-fig. 4 A. (Remarks on species, drawings of cranidium and pygidium.)

NAME.—The species is named after Dr. B. BOHLIN of Uppsala who has recently studied the genus *Niobe*.

HOLOTYPE (here selected).—Almost complete small specimen: PU no. N 839. Pl. V, figs. 4, 5.

OTHER MATERIAL.—Almost complete specimen: PU no. N 747. Cranidia: PU nos. N 622–624, 748–750, 840, 842. Free cheek: PU no. N 262. Hypostomes: PU nos. Vg 586; N 841, 845. Pygidia: PU nos. N 260, 261, 745, 746, 752–754, 847, 848.

TYPE STRATUM and TYPE LOCALITY.—Grey Lower Planilimbata limestone, Hagaberg, Närke.

DIAGNOSIS.—Glabella similar to that of *N. obsoleta*, expanding in front of eyes, yet without reaching to facial suture laterally. Anterior branches of suture diverge in front of palpebral lobes, then turn sharply inwards, describing an even curve or meeting at a very blunt angle in front. Pygidium semicircular in outline with a flattened border which is broadest postero-laterally. Transverse furrows of rhachis undulating. Pleural platforms with pronounced half-rib and four low pleural ribs, very faint on outside of test. Doublure narrow, yet broader than in *N. obsoleta*.

DESCRIPTION.—Cephalon semicircular in outline with a flattened border which is narrow in front of glabella. Glabella narrow, its length nearly twice the width at palpebral lobes, expanding in front of eyes, yet without reaching to facial suture laterally, obtusely rounded frontally. Occipital furrow short transversally, curving backwards. Median tubercle somewhat behind posterior edge of palpebral lobes. Faint median pit at front of glabella. Preglabellar area

narrow sagittally. Exsagittal length of palpebral lobes more than one-fifth the cranidial length. Posterior limbs fairly slender. Anterior branches of facial suture diverge in front of eyes, then turn sharply inwards, describing an even curve or meeting at a very blunt angle. Genal angle of free cheek obtusely rounded; flattened border of cheek narrowing backwards, border furrow almost obliterated postero-laterally.

Hypostome short. Lateral margin partly straight. Notch well developed; posterior limbs short exsagittally, rounded. Two faint pits in front of notch. Anterior lobe of central body rounded in outline, posterior lobe bent backwards medially, delimited by middle furrow from anterior lobe.

Thorax with eight segments. Rhachis well defined, convex, occupying about one-third the thoracic breadth in front. Fulcrum near the dorsal furrow in first segment, at an increasing distance from it in the following ones.

Pygidium semicircular in outline, its length three-fifths or less the width. Border flattened, broadest postero-laterally. Rhachis with seven or eight rings and terminal portion; transverse furrows undulating. Pleural platforms with pronounced half-rib and four low pleural ribs, very faint on outside of test. Doublure somewhat wider than in *N. obsoleta*.

Test ornamented with dense minute pits and terrace lines, transverse on preglabellar area and central body of hypostome, parallel to posterior margin on border of hypostome and pygidium as well as on pygidial doublure, longitudinal on antero-lateral parts of glabella.

DIMENSIONS.—Length of cranidium (pl. V, fig. 6) 17 mm, width at palpebral lobes 15 mm. Length of pygidium (pl. V, fig. 9) about 16 mm, width 28 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Common. — A form closely related to or identical with the species is met with in the underlying zone of *Plesiomegalaspis armata*.

Niobella imparilimbata (BOHLIN, 1955)

Pl. V, fig. 10.

1955 *Niobe imparilimbata* BOHLIN, Lower Ordov., Böda Hamn, p. 149, pl. 6, figs. 11, 12. (Description and figs. of free cheek and pygidium.)

MATERIAL.—Free cheek and pygidium (originals of BOHLIN, 1955): Öl 54, 55. Pygidium: PU no. N 599.

REMARKS.—The pygidium is short, about twice as wide as long. The flattened border is very narrow at the posterior end of the pygidium, and very broad laterally. It is figured for comparison with the earlier form described below.

OCCURRENCE.—Lowermost part of the Limbata limestone (Arenigian). The short pygidium, which is easily recognized, seems to make the species a good index fossil.

Niobella sp. aff. *imparilimbata* (BOHLIN)

Pl. V, figs. 11–14. Text-fig. 37 C.

1952 *Niobe laeviceps* (DALMAN).—SKJESETH, L. Didymograptus Zone, p. 169, pl. 2, figs. 5, 12, 13. (Description and figs. of cranidium and pygidia.)

1952 *Niobe* sp. aff. *laeviceps* (DALMAN).—TJERNVIK, Lägsta ordov. lagren, p. 57, text-fig. 4 B. (Remarks on species, drawings of cranidium and pygidium.)

MATERIAL.—Cranidia: PU nos. N 387, 393, 475, 635; Öl 272. Hypostomes: PU nos. N 385, 479, 495. Free cheeks: PU nos. N 476, 664. Pygidia: PU nos. N 394, 477, 486, 489, 663, 668; Öl 181, 258, 281.

REMARKS.—A form closely related to *N. imparilimbata* is met with in the Upper Planilimbata limestone. Its pygidium is of rather varying shape, yet always longer than that of *N. imparilimbata.* In order to establish its true relation to the said species the examination of a larger material appears necessary. The following observations might be mentioned:

The dorsal furrows of the cranidium run along the rear of the anterior branches of the suture, thus abruptly increasing the width of the glabella in front of the eyes. The most anterior portion of the glabella tapers strongly forwards; in front it is truncated and slightly emarginate. The occipital furrow, which is faint on outside of test, curves slightly backwards. The basal lobes are narrow transversally. The palpebral lobes are small, and situated somewhat behind the middle of the glabella. The anterior branches of the suture describe an almost even curve in front of the eyes, and meet at a distinct angle. The hypostome has a wide V-shaped notch; the posterior limbs are broad and rounded.

The pygidium varies in outline, being evenly or obtusely rounded posteriorly. It is always longer than that of *N. imparilimbata.* The transverse rhachial furrows undulate strongly. The pleural platforms show a prominent half-rib and about four low pleural ribs, very faint on the outside of the test. The border varies in shape. The doublure is wider than that of *N. bohlini.*

The test is ornamented with terrace lines and minute pits of nearly uniform size.

OCCURRENCE.—Common in the zones of *Megalaspides dalecarlicus* and of *Plesiomegalaspis estonica* (Arenigian), as well as in the lowermost part of the overlying Limbata limestone.

Niobella laeviceps (DALMAN, 1827)

Pl. V, figs. 15, 16.

MATERIAL.—Complete specimens: RM nos. Ar. 46000–46002, 16087, 16088; PU no. N 913. One cephalon and one pygidium (probably the originals of ANGELIN, 1851, pl. 11, fig. 1) are figured for comparison with the species of *Niobella* described above.

REMARKS.—*N. bohlini* and *N.* sp. aff. *imparilimbata* have previously been identified with *N. laeviceps.* The latter differs, however, from the former species

in the following features (compare TJERNVIK, 1952, p. 57, and BOHLIN, 1955, p. 150):

The glabella is shorter sagittally. The palpebral lobes are larger, and situated farther ahead. The posterior branches of the facial suture describe a strongly sigmoid curve. The pygidium is very short with a broad rhachis. The pits of the test are alternately small and large.

OCCURRENCE.—In or immediately below the Expansus limestone (Arenigian). Östergötland: Husbyfjöl, Kungs-Norrby. Närke: Lanna.

Genus *Niobina* LAKE, 1946

GENOTYPE.—*Niobina davidis* LAKE, 1946.

REMARKS.—The pygidium of the genus differs from that of *Niobe* by having its rib furrows about as strong as the pleural furrows.

N. davidis occurs in the Upper Tremadocian beds of Great Britain.

Niobina sp.

Pl. V, fig. 17.

MATERIAL.—Pygidium: SGU no. Aa 40, collected by G. v. SCHMALENSEE, 1879.

REMARKS.—The pygidium encountered is large, its length being about 50 mm, its width about 80 mm. It differs from that of the genotype in having a greater number of segments; thus the pleural platforms show about nine pleurae. On the right side they are distorted pathologically.

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian).—Västergötland: Hunneberg.

Genus *Plesiomegalaspis* THORAL, 1946

GENOTYPE.—*Plesiomegalaspis graffi* THORAL, 1946

Subgenus *Plesiomegalaspis* (*Plesiomegalaspis*) THORAL, 1946

SUBGENOTYPE.—*Plesiomegalaspis graffi* THORAL, 1946.

REMARKS.—The genus *Plesiomegalaspis*, known from the early Ordovician beds of France, is divided here into two subgenera, a typical one, *Plesiomegalaspis* (*Plesiomegalaspis*) and another one named *Plesiomegalaspis* (*Ekeraspis*). Four species from the Arenigian beds of Sweden have been referred to the former subgenus. They agree fairly well with the subgenotype in the shape of the cephalon. The dorsal furrows of the cranidium become shallower forwards. The preglabellar furrow is faint. The glabella occupies about two-thirds the cranidial length, it is low and almost smooth, subrectangular in outline, somewhat contracted between the eyes, rounded and ill defined in

front. The occipital and lateral glabellar furrows are obliterated. No basal lobes are developed. A median tubercle, when present, is situated about mid-way between the rear end of the palpebral lobes and the posterior cranidial margin. The preglabellar area is wide sagittally. The fixed cheeks are very narrow. The palpebral lobes are small, rounded, and situated opposite the middle of the glabella. The posterior border furrow is weak or obliterated. The anterior branches of the facial suture diverge more or less strongly in front of the eyes. In this respect they differ from the subgenotype in which the branches are nearly parallel to each other. The free cheek is large, with a flattened border which is wide in front, narrows backwards, and ends at the base of the genal spine. The doublure encloses a comparatively spacious cavity. The cheek merges evenly into the genal spine which is broad at the base. The middle furrow of the hypostome is shallow. The posterior lobe of the central body is well developed, crescent-shaped. The thoracic segments are similar to those of the subgenotype.

The pygidium of *P. planilimbata* agrees well with that of the subgenotype in its outline, its flattened border, and in its comparatively broad rhachis. The pygidia of the other Swedish species vary in their outline, the concavity of the border, and in the width of the doublure. *P. norvegica* and *P. scutata*, described below, probably ought to be referred to new subgenera. The material available is, however, small and in part of problematic value.

The test of the hypostome and the articulating facets, as well as of the doublure is ornamented with terrace lines. On one pygidium of *P. planilimbata* dense, minute pits have been observed.

OCCURRENCE.—Arenigian.

Plesiomegalaspis (*Plesiomegalaspis*) *planilimbata* ANGELIN, 1851.

Pl. VI, figs. 1–9. Text-fig. 38 A.

1851 *Megalaspis planilimbata* ANGELIN, Palaeont. Suecica, p. 18, pl. 16, figs. 2, 2a. (Diagnosis and drawings of cephalon, pygidium, and hypostome.)

1882 *Megalaspis stenorhachis* ANGELIN (partim).—BRÖGGER, Silur. Etagen, pl. 4, fig. 6. (Fig. of pygidium.) Compare SKJESETH, 1952.

1886 *Megalaspis planilimbata* ANGELIN.—BRÖGGER, Ausbild. des Hypostomes, p. 39, 41, pl. 2, fig. 21, pl. 3, fig. 47. (Description of hypostome, figs. of hypostome and pygidium.)

1898 *Megalaspis planilimbata* ANGELIN.—KAYSER, Älteren paläoz. Faunen, pl. 16, fig. 5. (Fig. of cranidium from Öland.)

1901 *Megalaspis planilimbata* ANGELIN.—G. LINDSTRÖM, Visual organs, p. 61, pl. 5, fig. 8. (Remarks on and fig. of hypostome.)

1905 *Megalaspis planilimbata* ANGELIN.—WIMAN, Ein Shumardiaschiefer, p. 8, pl. 2, figs. 5–10. (Discussion on species, figs. of cranidium and pygidium.)

1906 *Megalaspis planilimbata* ANGELIN.—MOBERG & SEGERBERG. Ceratopygeregionen, p. 97, pl. 7, fig. 1. (Discussion on species, fig. of pygidium.)

1907 *Megalaspis planilimbata* ANGELIN.—WIMAN, Nordbalt. Silurgebiet, II, p. 90, pl. 7, fig. 23. (Remarks on species, fig. of pygidium.)

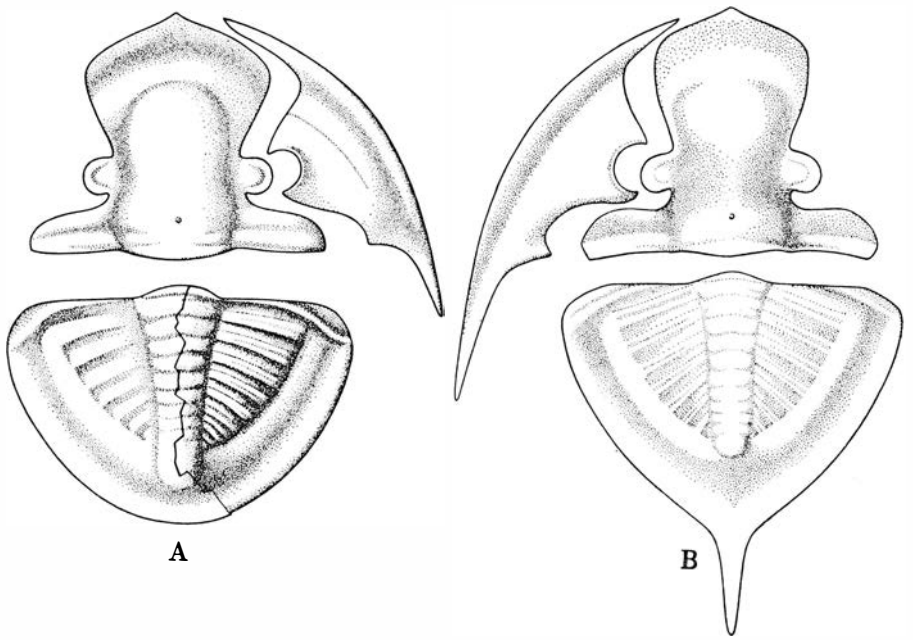


Fig. 38. A: Cranidium, free cheek, and pygidium of *Plesiomegalaspis* (*Plesiomegalaspis*) *planilimbata* (ANGELIN) from the zone of *P. planilimbata* (early Arenigian). — About 1 ×. B: The same elements in *Plesiomegalaspis* (*Ekeraspis*) *armata* n. subgen. and n. sp., zone of *P. armata* (early Arenigian). — About 1 ×.

?1951 *Megalaspis* sp. cf. *M. planilimbata* ANGELIN.—HARRINGTON & KAY, Faunas of E. Colombia, p. 665, pl. 97, fig. 21. (Description and fig. of pygidium.)

1952 *Megalaspis planilimbata* ANGELIN (partim).—SKJESETH, L. Didymograptus Zone, p. 158, text-fig. 6. (Remarks on species, fig. of pygidium.)

1952 *Megalaspis planilimbata* ANGELIN (partim).—TJERNVIK, Lägsta ordov. lagren, p. 56, text-fig. 3 A. (Remarks on species, drawing of cranidium.)

REMARKS.—ANGELIN collected his specimens of *P. planilimbata* at Oltorp in Västergötland. At this locality a thin bed of fossiliferous Lower Planilimbata limestone is intercalated between the Upper Cambrian alum shale and the Limbata limestone. The Tremadocian beds, the limestone with *Lycophoria laevis*, and the Upper Planilimbata limestone are lacking. The bed of Lower Planilimbata limestone contains *P. planilimbata* which species is equivalent to the "early form of *Megalaspis planilimbata*" figured by TJERNVIK (1952).

ANGELIN's type specimen is lost, and none of the specimens collected by the present author at the type locality is good enough to serve as a neotype.

OTHER MATERIAL.—Complete specimen: RM no. Ar. 14405. Cranidia: RM nos. Ar. 12476–12478 (originals of WIMAN, 1905, pl. 2, figs. 6, 7, 9); PU nos. N 31, 49, 246, 612, 733. Free cheeks: PU nos. N 32, 38, 826–828. Hypostomes: PU nos. Vg 552; Öl 285; N 48, 735, 914. Pygidia: RM nos. 12474–12475 (originals of WIMAN, 1905, pl. 2, figs. 5, 8); LP no. LO 1872 t (original of Mo-

BERG & SEGERBERG, 1906, pl. 7, fig. 1); OPM no. H 2692 (original of BRÖGGER, 1882, pl. 4, fig. 6); PU nos. Vg 548, 553; Öl 285; N 613, 616, 737, 738, 829, 830.

TYPE STRATUM and TYPE LOCALITY.—Dark-grey Lower Planilimbata limestone, Oltorp, Västergötland.

DIAGNOSIS.—Anterior branches of facial suture diverge more strongly in front of eyes than those of the genotype. Glabella tapering slightly forwards. Median tubercle present. Posterior limbs of nearly uniform exsagittal width, obtuse at distal end. Posterior border furrow not entirely obliterated. Pygidium subsemicircular to semi-elliptical in outline, with narrow, flattened border. Rhachis with ten or eleven rings and terminal portion; side lobes with half-rib and seven pleural ribs. Doublure narrow.

DESCRIPTION.—Glabella tapering slightly forwards, rounded or slightly emarginated at frontal end; on outside of test smooth with exception of a faint median keel, a small median tubercle, a shallow furrow close to posterior margin of cranidium, and in front of it a pair of faint lateral furrows indicating the occipital furrow. These features are more prominent on internal moulds, where also four pairs of low muscle scars in front of the tubercle are visible. Preglabellar area concave. Posterior limbs of nearly uniform exsagittal width, rather obtuse at distal end. Posterior border furrow not entirely obliterated, always discernible on internal moulds. Anterior branches of suture diverge moderately in front of eyes, including an angle of 50°–70°, then turn abruptly inwards, the angle between them being 110°–130°; close to median line the branches curve more strongly forwards, giving the cranidium a broadly pointed frontal end. Posterior branches curve backwards and outwards from eye, then run outwards almost perpendicularly to median line, at last bend backwards, hindmost part being at right angles to posterior cranidial margin; the latter is cut at a distance from dorsal furrow subequal to two-thirds or three-fourths the width of glabella.

Free cheek moderately convex, with a flattened border which narrows backwards and vanishes at the base of the genal spine. Posterior margin curving evenly outwards and backwards. Strong genal spine, broad at the base, somewhat flattened. Doublure concave, twice as wide as flattened border, tapering backwards, slightly emarginated in front of hypostome, ornamented with about 20 terrace lines parallel to lateral margin. Panderian organs situated near inner margin of doublure, the distance being about one-fourth the width of doublure, and about twice as far from posterior margin of cheek.

Hypostome of somewhat varying shape. Central body large, oviform, delimited by wide and deep posterior and lateral furrows; the posterior one sometimes more shallow at median line. Anterior lobe large, posterior one short sagittally, crescent-shaped. Transverse middle furrow shallow, uniting a pair of deep pre-macular pits; maculae ridge-shaped. Anterior margin straight or curving slightly forwards; close to margin a median pit. Anterior wings large, with sharp posterior angle. Lateral border wide, subtriangular in shape.

Posterior margin usually drawn out into a tongue-shaped median process. This process is often bent in dorsal direction. In this case the posterior border is concave, and appears to be rounded or emarginated at the rear. Terrace lines on anterior lobe of central body subparallel to margin of lobe, transverse on posterior lobe, subparallel to margin on lateral border.

Thorax with eight segments. Rhachis prominent, tapering slightly backwards, occupying in front less than one-third the total width of thorax. Inner part of pleurae horizontal, outer part steeply bent down. Pleurae of anterior segments directed slightly backwards, those of posterior segments almost perpendicular to median line. Pleural furrow deep and wide, in posterior segments almost straight. Articulating facets large. Pleural ends bluntly rounded.

Pygidium subsemicircular to semi-elliptical in outline, moderately convex, with flattened border, pygidial length about two-thirds the width. Anterior margin straight; facets large; dorsal furrows well defined, curving somewhat inwards. Rhachis four-fifths to five-sixths the pygidial length, comparatively broad, occupying at anterior margin more than one-fifth, but less than one-fourth the pygidial width, anterior portion tapering backwards, posterior one subequal in width, moderately convex, rising above level of pleural platforms; transverse furrows fairly wide, widest and deepest laterally, faint on posterior portion of rhachis; ten or eleven rings and terminal portion discernible on internal moulds. Pleural platforms gently convex, on internal moulds showing half-rib and seven pleural ribs with a shallow rib furrow, pleural furrows wide and shallow; the segmentation often but faintly indicated on outside of test. Doublure narrow, about twice as wide as the flattened border.

DIMENSIONS.—Length of cranidium (pl. VI, fig. 2) 32.8 mm, width at posterior margin about 38 mm. Length of pygidium (pl. VI, fig. 7) 22.3 mm, width about 32 mm. Length of pygidium (pl. VI, fig. 6) 12.4 mm, width 18.9 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Common.

Plesiomegalaspis (*Plesiomegalaspis*) *estonica* n. sp.

Pl. VI, figs. 10–15. Text-fig. 39 A.

1906 *Megalaspis planilimbata* ANGELIN.—FR. SCHMIDT, Rev. Ostbalt. Trilobiten, V, p. 10, text-figs. 2, 3, pl. 1, figs. 1–4, pl. 2, figs. 1–4. (Description and figs. of cranidium, part of thorax, and pygidium.)

NAME.—Latin *estonicus* = Esthonian.

HOLOTYPE (here selected).—Pygidium: PU no. N 863. Pl. VI, fig. 15.

OTHER MATERIAL.—Almost complete specimen: SGU no. Ac 8. Cranidia: PU nos. N 428, 646–653, 865, 866. Free cheeks: PU nos. N 429, 439, 651. Hypostomes: PU nos. N 167, 430, 655. Thoracic segment: PU no. N 656. Pygidia: PU nos. N 431, 452, 658, 660, 663; Vg 592; Öl 187.

TYPE STRATUM and TYPE LOCALITY.—Grey Upper Planilimbata limestone, Vilhelmsberg, Närke.

DIAGNOSIS.—The species differs from *P. planilimbata* in the following features: Carapax wider. Anterior branches of suture include a more obtuse angle in front. Glabella not tapering forwards. Median tubercle faint or absent. Posterior border furrow obliterated. Free cheek broader. Hypostome seems to undergo an evolution towards a forked posterior margin. Pygidium much wider. Pygidial rhachis narrower, with about thirteen rings and terminal portion; side lobes with half-rib and eight or nine pleural ribs.

DESCRIPTION.—Carapax broadly elliptical in outline. Anterior portion of glabella slightly expanded. Median tubercle faint or absent. On internal mould a very low median keel on posterior part of preglabellar area. Posterior limbs long and slender, of nearly uniform exsagittal breadth, obtuse at distal end. Posterior border furrow obliterated. Anterior branches of facial suture diverge rather strongly in front of eyes, the angle between them being about 65°, then turn inwards, including a very obtuse angle, delimiting at median line a short and broad point. Posterior branches curve obliquely backwards from eye, then run outwards almost perpendicularly to median line, at last turn backwards at right angles to posterior cranidial margin, cutting this margin at a distance from dorsal furrow subequal to width of glabella.

Free cheek very wide, with a long genal spine, somewhat flattened in cross-section and with a sharp outer edge.

The hypostome seems to undergo an evolution towards a forked posterior margin. One specimen from the lowermost part of the zone of *Plesiomegalaspis estonica* has a pair of blunt posterior processes, and the margin between them is bent in a dorsal direction. Two other specimens attributed to the species are more or less distinctly forked. The anterior wings resemble those of *P. planilimbata.*

Thorax with eight segments. Rhachis narrow, its width about one-fifth the total width of thorax. Panderian organ and shape of pleural doublure, see text-fig. 39 A.

Pygidium distinctly wider than that of *P. planilimbata*, its length being less than two-thirds the width. Rhachis narrow, occupying at anterior margin about one-sixth the pygidial width, its anterior portion tapering slightly backwards. About thirteen rhachial rings and terminal portion separated by straight transverse furrows, obsolete on posterior part of rhachis. Pleural platforms showing on internal moulds half-rib and eight or nine pleural ribs with a very shallow rib furrow. Border flattened, somewhat wider than that of *P. planilimbata.* Doublure narrow.

DIMENSIONS.—Length of cranidium (pl. VI, fig. 10) 35.2 mm, width at posterior margin 44 mm. Length of pygidium (holotype) 54 mm, width 84 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis estonica* (Arenigian). Common.

Plesiomegalaspis (*Plesiomegalaspis*) sp. aff. *estonica* n. sp.

MATERIAL.—Fragmentary cranidia: PU nos. N 816–818; Öl 221. Hypostomes: PU nos. N 819–821. Pygidia: PU nos. N 822–825, 857; Öl 222.

REMARKS.—The cranidium resembles that of *P. planilimbata* in having a median tubercle on the glabella and a shallow posterior border furrow on the fixed cheek. The hypostome has a sagittally narrow posterior border with rounded margin. The pygidium is longer than that of *P. estonica*, but agrees with this species in the segmentation, the rhachis having about thirteen rings and terminal portion, and the side lobes eight or nine pleural ribs.

OCCURRENCE.—Uppermost part of the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Gymninge, Hagaberg. Öland: Köpings Klint. Pygidia similar to that of the form occur sparsely in the succeeding zone of *Megalaspides dalecarlicus*.

Plesiomegalaspis (*Plesiomegalaspis*) *norvegica* n. sp.

Pl. VII, figs. 1–3.

1952 *Megalaspis planilimbata* ANGELIN (partim).—SKJESETH, L. Didymograptus Zone, p. 158, pl. 1, fig. 10. (Description and fig. of pygidium.)

NAME.—Latin *norvegicus* = Norwegian.

HOLOTYPE (here selected).—Pygidium: OPM no. 61137 (original of SKJESETH, 1952, pl. 1, fig. 10). In this paper, pl. VII, fig. 2.

OTHER MATERIAL.—Cranidium: PU no. N 371. Free cheek: PU no. N 376. Pygidia: PU nos. N 372–374, 378, 379, 636, 637.

TYPE STRATUM and TYPE LOCALITY.—Small lens of grey limestone in Lower Didymograptus shale, Ottestad, Norway.

DIAGNOSIS.—Pygidium subsemicircular in outline, with concave border. Rhachis broad in front, tapering more or less rapidly backwards. Side lobes with half-rib and six or seven pleural ribs. Doublure wide. Cranidium attributed to the species wide in front of glabella. Posterior border furrow obliterated. Posterior limbs tapering outwards, obtuse at distal end.

DESCRIPTION.—Pygidium subsemicircular in outline, often slightly obtuse at rear end. Border concave. Rhachis about three-fourths the length of pygidium, moderately convex, rising above level of side lobes, broad in front, tapering more or less rapidly backwards; transverse furrows wide; eleven to thirteen rings and terminal portion discernible on internal moulds. Pleural platforms slightly convex, almost horizontal, with six or seven pleural ribs. Doublure wide, occupying at anterior margin of pygidium more than one-third, in large specimens about one-half the width of the side lobes. Facets narrow.

One cranidium associated with pygidia of the species resembling that of *Plesiomegalaspis estonica*, wide in front of glabella. Median tubercle faint or absent. Posterior limbs tapering outwards, obtuse at distal end. Posterior border furrow obliterated. Anterior branches of facial suture diverge strongly in front of eyes, the angle between them being about 75°, then curve inwards and forwards, including an angle of about 130°. At median line they delimit a short broad point. Posterior branches form an almost straight line directed obliquely

backwards and outwards, then turn rapidly backwards, the hindmost part being about perpendicular to posterior margin of cranidium, cutting the margin at a distance from dorsal furrow subequal to width of glabella.

One fragmentary free cheek resembles that of *P. planilimbata*, the concave border is, however, wider. Hypostome and thorax unknown.

DIMENSIONS.—Length of cranidium (pl. VII, fig. 1) 37.5 mm, width at posterior margin 39.5 mm. Length of pygidium (holotype) 31.5 mm, width 45.5 mm.

OCCURRENCE.—Upper part of the zone of *Megalaspides dalecarlicus* (Arenigian). — Närke: Lanna, Latorp, Yxhult. Östergötland: Västanå. Öland: Ottenby, Köpings Klint, Horns Udde. South Bothnian District: Limön. — Lower Didymograptus shale. — Norway: Ottestad. Jämtland: Tossåsen.

Plesiomegalaspis (*Plesiomegalaspis*) *scutata* n. sp.

Pl. VII, figs. 4–6.

NAME.—Latin *scutatus* = with a shield; heavy infantryman.

HOLOTYPE (here selected).—Internal mould of pygidium: PU no. N 859. Pl. VII, fig. 5.

OTHER MATERIAL.—Cranidia: PU nos. N 150, 858. Pygidia: PU nos. N 151, 381, 861, 862; Öl 269.

TYPE STRATUM and TYPE LOCALITY.—Grey Upper Planilimbata limestone, Vilhelmsberg, Närke.

DIAGNOSIS.—Large species. Cranidium wide in front of glabella. Eyes very small. Posterior limbs slender, with a shallow posterior border furrow, and with a rather pointed postero-lateral end. Pygidium comparatively long, subsemi-elliptical in outline. Border convex posteriorly, slightly concave laterally. Side lobes with half-rib and eight or nine pleural ribs. Doublure wide.

DESCRIPTION.—Large species. Cranidium resembles that of *P. planilimbata*, but is wider in front of glabella. Two faint lateral depressions on posterior part of glabella indicate an occipital furrow. The median tubercle seems to be absent. Eyes very small. Posterior limbs long and slender transversally, fairly pointed at distal end, directed somewhat backwards. Shallow posterior border furrow. Anterior branches of facial suture diverge strongly in front of eyes, the angle between them being about 80°, then curve inwards and forwards, including an angle of about 130°. Cranidium broadly pointed at frontal end. Hindmost part of posterior branches curves obliquely backwards, cutting the posterior cranidial margin at a distance from dorsal furrow subequal to width of glabella.

Free cheek, hypostome, and thorax unknown.

Pygidium semi-elliptical in outline, its length about three-fourths the width. Border convex posteriorly, slightly concave and steep laterally. Rhachis about four-fifths the length of pygidium, narrow, moderately convex, rising slightly above level of side lobes, tapering backwards; transverse furrows wide, fourteen

rings and terminal portion discernible on internal mould. Pleural platforms moderately convex, nearly horizontal, with eight or nine pleural ribs with shallow rib-furrow. Doublure wide, with about 20 terrace lines. Facets wide, concave. Test of facets and antero-lateral part of border with terrace lines running about perpendicular to lateral margin of pygidium.

AFFINITIES.—Pygidia of the species have been compared with one pygidium of "*Megalaspis*" *pogrebowi* LAMANSKY, 1905 (RM no. Ar. 34044) collected from the Glauconite limestone at Tallinn in Esthonia. The two species appear to be closely related, the pygidium of "*M*". *pogrebowi* differs, however, in its more triangular shape and in its border being concave also behind the rhachis.

DIMENSIONS.—Length of cranidium (pl. VII, fig. 4) 45.5 mm, width at posterior margin 51 mm. Length of large cranidium about 62 mm. Length of pygidium (holotype) about 56 mm. Length of another pygidium: 59 mm, width about 76 mm.

OCCURRENCE.—Upper part of the zone of *Megalaspides dalecarlicus* (Arenigian). — Närke: Lanna, Latorp, Yxhult, Vilhelmsberg. Öland: Horns Udde. South Bothnian District: Brämön (boulder).

Subgenus *Plesiomegalaspis* (*Ekeraspis*) n. subgen.

SUBGENOTYPE (here selected).—*Plesiomegalaspis* (*Ekeraspis*) *armata* n. sp.

NAME.—The subgenus is named after Eker, the Norwegian district in which the first known member of the subgenus was encountered.

DIAGNOSIS.—Cephalon with flattened border and long genal spines. Glabella delimited by shallow dorsal and preglabellar furrows, subrectangular in outline, without occipital and lateral glabellar furrows, somewhat depressed between and behind the eyes. Preglabellar area wide sagittally. Eyes situated opposite middle of glabella. Posterior border furrow wide and deep. Anterior branches of facial suture diverge but slightly in front of eyes, then become subparallel to each other, at last turn rapidly inwards. Posterior branches describe a distinctly sigmoid curve. Hypostome short, with rounded posterior margin. Pygidium subtriangular in outline, with flattened border and strong median spine. Rhachis narrow. Pleural platforms possessing distinct pleural ribs with rib furrow. Doublure narrow.

REMARKS.—The subgenus is distinguished from the typical subgenus by the wide and deep posterior border furrow of the fixed cheek, the course of the facial suture, and by the strong median spine of the pygidium.

OCCURRENCE.—Early Arenigian.

Plesiomegalaspis (*Ekeraspis*) *armata* n. sp.

Pl. VII, figs. 7–13. Text-figs. 38 B, 39 B.

NAME.—Latin *armatus* = armed.

HOLOTYPE (here selected).—Internal mould of pygidium: PU no. Vg 329. Pl. VII, fig. 11.

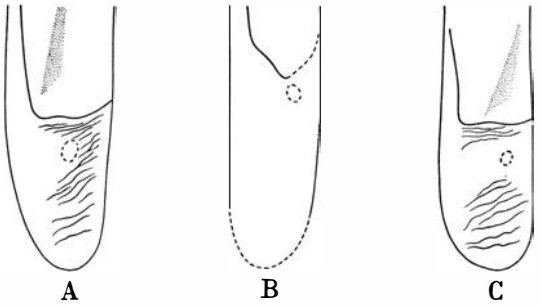


Fig. 39. Ventral view of thoracic pleurae in *Plesiomegalaspis* and *Megalaspides* showing the course of the inner margin of the doublure and the site of the Panderian organ. A: *Plesiomegalaspis* (*Plesiomegalaspis*) *estonica* n. sp. B: *Plesiomegalaspis* (*Ekeraspis*) *armata* n. subgen. and n. sp. C: *Megalaspides* (*Megalaspides*) *dalecarlicus* (HOLM). — About 4 ×.

OTHER MATERIAL.—Cranidia: PU nos. Vg 303, 304, 310–316. Free cheeks: PU nos. Vg 309, 317–319. Hypostomes: PU nos. Vg 320–325. Thoracic segments: PU nos. Vg 326–328. Pygidia: PU nos. Vg 305–308, 329–337.

TYPE STRATUM and TYPE LOCALITY.—Thin layers of white limestone in glauconitic limestone, Stenbrottet, Västergötland.

DIAGNOSIS.—Glabella about three-fourths the cranidial length. Flattened border of pygidium widens backwards and merges into the median spine which is broad at the base in adult specimens. Pygidial rhachis with about eleven rings and terminal portion; side lobes with half-rib and seven pleural ribs. Rear end of rhachis slopes steeply down to border.

DESCRIPTION.—Length of cranidium about four-fifths the width at posterior margin. Dorsal furrows issuing from pit at posterior margin of cranidium, growing shallow forwards. Preglabellar furrow very faint. Glabella about three-fourths the length of cranidium, contracted between eyes, rounded in front; posterior portion depressed, particularly between the rear parts of the palpebral lobes, anterior portion fairly convex. Small median tubercle, its distance from posterior margin of cranidium subequal to one-fifth the length of glabella; in front of it a faint median keel. Palpebral lobes rounded, with a rounded palpebral furrow; lobes sloping gently inwards, rising well above level of glabella. Frontal portions of anterior branches of suture include an angle of about 130°, and delimit at median line a very short and broad point. Posterior branches cut posterior margin of cranidium at a distance from dorsal furrow somewhat less than width of glabella. Free cheek with a narrow flattened border which tapers backwards, and a long, flattened genal spine. Doublure narrow. Panderian organ situated near posterior margin of cheek.

Hypostome about as wide as long. Central body delimited by deep furrows, pear-shaped, convex. Large anterior and small crescent-shaped posterior lobe, separated by a pair of deep pre-macular pits and a weak middle furrow. Maculae ridge-shaped. Anterior margin straight. Anterior wings large, their posterior margin curving backwards, posterior angle rounded. Lateral border wide,

subtriangular in outline. Posterior border narrow sagittally, with rounded margin. Test ornamented with terrace lines.

Thoracic rhachis narrow, well defined, moderately convex. Rhachial rings with a straight articulating furrow, and a sagittally narrow articulating half-ring. Pleural furrow slightly oblique, deepest at fulcrum; distance of fulcrum from dorsal furrow less than half the transverse length of pleura. Facet large, its inner portion forming a deep, V-shaped furrow. Inner margin of pleural doublure seems to curve outwards, and the Panderian organ to be situated near the same margin, see text-fig. 39 B.

Pygidium subtriangular in outline, with a flattened border which widens backwards, and merges into the median spine which is broad in adult specimens. Dorsal furrows curve slightly inwards. Rhachis narrow, its width at anterior margin somewhat more than one-fifth the pygidial width, convex, rising above level of pleural platforms, tapering backwards until middle of rhachis, then subequal in width, rear end sloping steeply down to border. Ten or eleven rhachial rings and terminal portion, first six rings delimited by distinct transverse furrows, curving forwards laterally as well as at median line. Inner portion of pleural platforms moderately convex, with seven pleural ribs. Pleural furrows wide and shallow. Facet narrow. Doublure one and a half time as wide as flattened border.

DIMENSIONS.—Cranidium (pl. VII, fig. 7): length 33.5 mm, width at posterior margin about 42 mm. Pygidium (holotype): length with exception of spine about 20 mm, width about 28 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Stenbrottet, Storeklev, Mossebo, Skultorp, Stora Stolan. Öland: Ottenby. Närke: Latorp. South Bothnian District: Limön. Dalarna: Sjurberg. Jämtland: Kloxåsen, Tossåsen, Siljeåsen.

Plesiomegalaspis (*Ekeraspis*) *heroides* (BRÖGGER, 1882)

Pl. VIII, figs. 1–4.

1882 *Megalaspis heroides* BRÖGGER, Silur. Etagen, p. 82, pl. 4, figs. 3, 4. (Description and figs. of pygidium.)

1907 *Megalaspis heroides* BRÖGGER.—WIMAN, Nordbalt. Silurgebiet, II, p. 91. (Report on find of pygidia.)

1952 *Megalaspis heroides* BRÖGGER (partim).—SKJESETH, L. Didymograptus zone, p. 164, pl. 1, fig. 8. (Fig. of pygidium.)

LECTOTYPE (selected by SKJESETH, 1952).—Pygidium showing the pointed posterior end: OPM no. H 2698 (original of BRÖGGER 1882, pl. 4, fig. 4).

OTHER MATERIAL.—Cranidium: PU no. Vg 475. Pygidia: OPM no. H 2643 (original of BRÖGGER 1882, pl. 4, fig. 3); PU nos. Vg 131, 132; J 26; B 253, and one specimen from the collections of SGU.

TYPE STRATUM and TYPE LOCALITY.—Dark-grey limestone, Krekling, Norway.

REMARKS.—According to BRÖGGER (1882, p. 82) the pygidia of the species were collected from beds belonging probably to the upper part of the Ceratopyge limestone. In a later paper (1886, p. 41) the same author pretends them to come from the upper part of the Lower Didymograptus shale, i.e., from beds corresponding to the Upper Planilimbata limestone of Sweden, which is also the opinion of SKJESETH (1952). However, BRÖGGER's specimens are associated with *Plesiomegalaspis planilimbata*, *Promegalaspides stenorhachis*, and *Niobella bohlini* (a pygidium of which is present on the slab containing the lectotype of *P. heroides*). These species are index fossils for the Lower Planilimbata limestone of Sweden, i.e. for the zone of *Plesiomegalaspis planilimbata*. In the lowermost part of this zone a species with a pointed pygidium is fairly common. It has been identified with *P. heroides* and is described below.

DIAGNOSIS.—Flattened border of pygidium narrow, and of nearly uniform width. Median spine narrow at the base. Rhachis with about thirteen rings and terminal portion; side lobes with half-rib and eight or nine pleural ribs. Rear end of rhachis low. Doublure narrow.

DESCRIPTION.—Pygidium subtriangular in outline, its length exclusive of spine about three-fifths the width. Border narrow, flattened, and of nearly uniform width. Basal portion of spine more or less narrow. Rhachis about four-fifths the pygidial length, narrow, its width at anterior margin less than one-fifth the width of pygidium, tapering backwards, moderately convex, rising but slightly above level of pleural platforms, and showing a faint median keel. About thirteen rhachial rings and terminal portion separated by straight, shallow transverse furrows. Eight or nine pleural ribs. Doublure narrow.

The internal mould of one cranidium only, referable to the species, has been found. Its length is about three-fourths the width at posterior margin. Glabella about two-thirds the cranidial length, tapering slightly in front of eyes, low posteriorly as in *P. armata*. Middle portion of glabella with several pairs of faint, elongate muscle scars. Posterior limbs long transversally, their length subequal to width of glabella; their anterior margin markedly sigmoid, the limb being very narrow behind outer edge of palpebral lobes; lateral ends pointed. Palpebral lobes sloping inwards, rising slightly above level of glabella. Frontal portions of anterior branches include an angle of about 140°, and delimit a short broad point at median line.

DIMENSIONS.—Length of pygidium (pl. VIII, fig. 3) exclusive of caudal spine about 23 mm, width about 37 mm. Length of cranidium (pl. VIII, fig. 1) 38.5 mm, width at posterior margin 50 mm.

OCCURRENCE.—Lowermost part of the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Västergötland: Storeklev, Mossebo, Stenbrottet, Oltorp, Skultorp. Närke: Örsta. South Bothnian District: Limön. Dalarna: Holen. Jämtland: Tossåsen. — In corresponding beds at Krekling, Norway.

Plesiomegalaspis? spp. nos. 1 and 2

Pl. VIII, figs. 5, 6.

MATERIAL.—Pygidia: PU nos. Vg 339, 340; D 463; B 254; semicircular in outline, with very narrow, concave border and narrow doublure. The rhachis tapers rapidly backwards. The pleural ribs have a shallow rib furrow.

OCCURRENCE.—Sp. no. 1 in the zone of *Plesiomegalaspis armata*. Västergötland: Stenbrottet. — Sp. no. 2 in the lowermost part of the zone of *Plesiomegalaspis planilimbata*. Dalarna: Sjurberg. South Bothnian District: Biludden (boulder).

Plesiomegalaspis? sp. no. 3

MATERIAL.—Pygidium: SGU no. Aa 40, collected by G. v. SCHMALENSEE, 1891, from the limestone bed "Blåa kakan" (Blue cake) at Hunneberg. The pygidium is large, its length being about 45 mm, trapezoidal in outline, with concave border and narrow doublure.

OCCURRENCE.—Probably in the zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Mossebo.

Genus *Megistaspis* JAANUSSON, 1956

REMARKS.—According to JAANUSSON (1956 b) the name of the trilobite genus *Megalaspis* is preoccupied. It has been changed by him to *Megistaspis*.

OCCURRENCE.—Limbata limestone and higher units.

Genus *Megalaspides* BRÖGGER, 1886

GENOTYPE.—*Megalaspis dalecarlicus* HOLM, 1882.

AFFINITIES.—The genus is split below into two subgenera, *Megalaspides* (*Megalaspides*) and *Megalaspides* (*Lannacus*). The latter, being the older, seems to derive from an *Asaphellus*-like stock. It agrees with *Asaphellus* in its concave cephalic and pygidial border; in its large, low, and smooth glabella weakly defined by shallow dorsal and preglabellar furrows; in the shape of its thoracic segments and the weak segmentation of its pygidium; in its pygidial rhachis tapering rapidly backwards; and in its pleural ribs showing a shallow rib furrow.

Distinguishing features, either primitive or due to evolution, are the more slender shape of the posterior limbs, and the comparatively large size of the semicircular palpebral lobes which are situated farther back than those of *Asaphellus*. An evolution seems to have taken place towards an obliteration of the posterior border furrow of the fixed cheeks, and towards the formation of a forked hypostome in which the posterior lobe of the central body is still present.

From such forms the later subgenus *Megalaspides* (*Megalaspides*) might be derived. A continued evolution has led to the loss of the posterior lobe of the hypostome, and to the obliterating of the concave border of the pygidium.

Such a modification of the border is met with also in other genera. In *Plesiomegalaspis scutata* the concave pygidial border of the genus is obliterated posteriorly, and the genus *Paramegalaspis* THORAL includes one species with a concave border and another with a convex one. In the genus *Megistaspis* there is a similar variation.

According to BRÖGGER (1886, p. 38) the systematical position of *Megalaspides* (i.e. *Megalaspides* (*Megalaspides*) is intermediate between the genera "*Megalaspis*" and *Asaphus*. It is probably related rather closely to *Plesiomegalaspis*, as appears, *inter alia*, from the shape of the glabella, the course of the margin of the thoracic pleural doublure, the narrow pygidial border which encloses a cavity, and from the rib furrow of the pygidial pleural ribs. The agreement with *Asaphus* in the possession of a convex pygidial border and a forked hypostome is more likely a result of a parallel development than a manifestation of relationship.

Subgenus *Megalaspides* (*Megalaspides*) BRÖGGER, 1886

SUBGENOTYPE.—*Megalaspis dalecarlicus*, HOLM, 1882.

DIAGNOSIS.—Cephalon with a narrow concave border, tapering backwards. Genal spines narrow at the base. Dorsal and preglabellar furrows very weak. Glabella occupying three-fourths to four-fifths the cranidial length, subrectangular in outline, low, smooth, and ill defined, particularly in front. Median tubercle situated about mid-way between a line through rear edges of palpebral lobes and the posterior cranidial margin. Palpebral lobes opposite middle of glabella. Posterior limbs fairly slender. Posterior border furrow not entirely obliterated. Anterior branches of facial suture subparallel in front of eyes, turning abruptly inwards on anterior border, delimiting a short, broad point at median line. Hypostome forked; posterior lobe of central body absent.

Thoracic rhachis well defined, its posterior portion tapering slightly backwards. Pleural terminations rounded postero-laterally. Position of Panderian organs and course of inner margin of pleural doublure resemble those of *Plesiomegalaspis*, see text-fig. 39.

Pygidium with convex border. Rhachis tapering rapidly backwards. Segmentation weakly indicated on outside of test, better defined on internal moulds; pleural ribs with a shallow low rib furrow. Doublure narrow, enclosing a comparatively spacious cavity.

Test smooth, with exception of terrace lines on hypostome, articulating facets, and doublure.

OCCURRENCE.—Arenigian.

Megalaspides (*Megalaspides*) *dalecarlicus* (HOLM, 1882).

Pl. VIII, figs. 7–13. Text-figs. 39 C, 40 A.

1882 *Megalaspis dalecarlicus* HOLM, Phyllogr. schiefer Dalecarl. p. 8, pl. 1, figs. 6–12. (Description and figs. of cephalon with attached thoracic segments, hypostome, and pygidium)

1886 *Megalaspides dalecarlicus* (HOLM).—BRÖGGER, Ausbild. des Hypostomes, p. 38, pl. 1, figs. 19, 20(?), pl. 3, fig. 48. (Discussion on species, figs. of hypostome and pygidium).

1907 *Megalaspides* sp. (partim) WIMAN, Nordbalt. Silurgebiet, II, p. 92, pl. 5, figs. 7, 9. (Notes on genus, figs. of pygidia).

LECTOTYPE (here selected).—Cephalon with attached thoracic segments: RM no. Ar. 9294 (original of HOLM, 1882, pl. 1, fig. 6). — In this paper, pl. VIII, fig. 13.

OTHER MATERIAL.—The specimens figured by HOLM: RM nos. Ar. 9291–9296, 9299, by BRÖGGER: collections of SGU, and by WIMAN: PU nos. B 109, 111. Furthermore a collection by the present author: PU nos. Vg 545; N 96–138, 338–368.

TYPE STRATUM and TYPE LOCALITY.—Beds of greenish limestone in Lower Didymograptus shale, Skattungbyn, Dalarna.

DIAGNOSIS.—See that of subgenus.

DESCRIPTION.—The description given by HOLM is thorough, and some facts only shall be added or pointed out:

Glabella occupies about four-fifths the cranidial length. Preglabellar area short sagittally, concave. Palpebral lobes slope inwards, and rise distinctly above the level of glabella. Anterior branches of suture include in front an angle of about 130°. Genal spine somewhat flattened in cross section. Panderian organ of free cheek situated somewhat farther from inner margin of doublure than in *Plesiomegalaspis*.

Hypostome long, with long anterior lobe of central body. Posterior lobe absent. Margin of lateral border curves evenly outwards. Posterior limbs large, more or less rounded at their rear end. Lateral margin of anterior wings curves more strongly outwards than in *Plesiomegalaspis*.

Thorax with eight segments. Posterior portion of rhachis tapers slightly backwards. Articulating facets large. Position of Panderian organs and course of inner margin of pleural doublure similar to those in *Plesiomegalaspis*, the margin, however, curving less strongly inwards at anterior margin of pleura, see text-fig. 39.

Pygidium semi-elliptical in outline, its length about two-thirds the width. Posterior margin often slightly emarginated at median line, equally often, however, evenly rounded. Rhachis more than three-fourths the pygidial length, low, rising but slightly above level of side lobes, sometimes showing a low knob at rear end; segmentation faint on outside of test, on internal moulds about eleven rings and terminal portion are discernible. Pleural platforms moderately convex, nearly smooth, with exception of the anterior pleural furrow; on internal moulds the segmentation is, as a rule, distinct; half-rib and six or seven pleural ribs are visible. Border evenly convex, sloping most strongly downwards laterally.

DIMENSIONS.—Length of almost complete specimen (pl. VIII, fig. 7) 35.5 mm,

width at middle of thorax about 21 mm. Length of cranidium (pl. VIII, fig. 10) 20.8 mm, width at posterior margin 26.5 mm. Length of pygidium (pl. VIII, fig. 12) 15.3 mm, width about 23.7 mm.

OCCURRENCE.—Zone of *Megalaspides dalecarlicus* (Arenigian). — Common in the lower part of the zone.

Megalaspides (*Megalaspides*) sp. aff. *dalecarlicus* (HOLM).

MATERIAL.—Fragmentary cranidium: PU no. N 780. Pygidia: PU nos. N 781–785, 857.

REMARKS.—The form occurs somewhat earlier than *M. dalecarlicus* to which it is closely related. The pygidial border slopes most strongly downwards posteriorly. It is, as a rule, convex, sometimes, however, slightly concave, particularly behind the rhachis.

OCCURRENCE.—Upper part of the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Gymninge, Hagaberg.

Megalaspides (*Megalaspides*) *paliformis* n. sp.

Pl. VIII, figs. 14, 15.

NAME.—The name *paliformis* alludes to the spade-shaped pygidium of the species.

HOLOTYPE (here selected).—Internal mould of pygidium: PU no. N 140. Pl. VIII, fig. 15.

OTHER MATERIAL.—Cranidia: PU nos. N 141–143, 871. Free cheeks: PU nos. N 144, 145. Pygidia: PU nos. N 146–149, 872.

TYPE STRATUM and TYPE LOCALITY.—Grey Upper Planilimbata limestone, Latorp, Närke.

DIAGNOSIS.—Cranidium longer and more pointed frontally than in *M. dalecarlicus*. Preglabellar area long sagittally, not or but slightly concave. Eyes situated somewhat farther back. Pygidium elongated behind rhachis. Border convex laterally, at rear end somewhat concave. Doublure wide posteriorly.

DESCRIPTION.—Cranidium long, its length subequal to the width at posterior margin. Glabella less than four-fifths the cranidial length, showing on internal moulds a transverse furrow close to posterior cranidial margin, and two pairs of muscle scars. Posterior limbs slender; posterior border furrow well defined on internal moulds, shallow on outside of test. Palpebral lobes situated somewhat behind middle of glabella. Preglabellar area long sagittally, not or but slightly concave. Anterior branches of suture include in front an angle of about 110°. Free cheek like that in *M. dalecarlicus*, the concave border is, however, wider anteriorly.

Hypostome and thorax unknown.

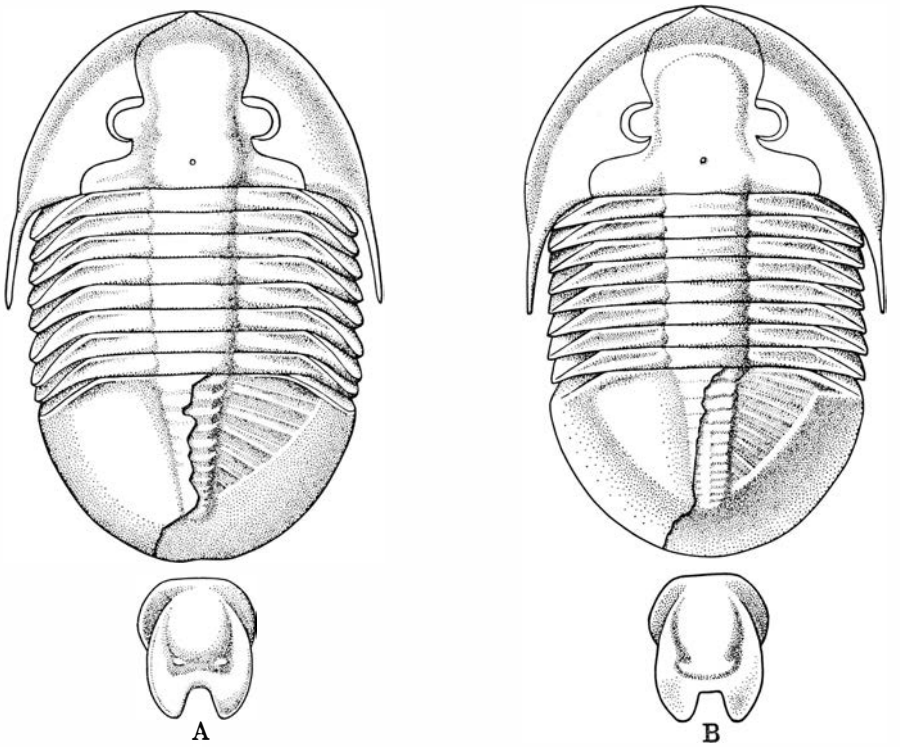


Fig. 40. A: *Megalaspides* (*Megalaspides*) *dalecarlicus* (HOLM) from the zone of *M. dalecarlicus* (Arenigian). — 2 ×. B: *Megalaspides* (*Lannacus*) *nericiensis* WIMAN from the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — About 1 ×.

Pygidium more or less elongated, the length as much as three-fourths the width. Margin bent upwards at rear end and, as a rule, somewhat emarginated. Border convex laterally, behind rhachis slightly concave. Rhachis less than three-fourths the pygidial length, showing about eleven rings and terminal portion. Pleural platforms with half-rib and six or seven pleural ribs. Doublure wide posteriorly.

DIMENSIONS.—Length of cranidium (pl. VIII, fig. 14) 35.5 mm, width at reconstructed posterior margin about 39 mm. Length of pygidium (holotype) about 21.5 mm, width 30 mm. Length of another pygidium 35 mm, width 48.5 mm.

OCCURRENCE.—Upper part of the zone of *Megalaspides dalecarlicus* (Arenigian). — Närke: Latorp, Lanna, Yxhult. Östergötland: Västanå. Öland: Grönviken. South Bothnian District: Brämön (boulder).

REMARKS.—In the lower part of the above mentioned zone at Yxhult in Närke a form probably intermediate between *M. dalecarlicus* and *M. paliformis* has been encountered (PU nos. N 873, 874). Its pygidium is shorter, also its preglabellar area is shorter sagittally and more concave than in *M. paliformis*.

Subgenus *Megalaspides* (*Lannacus*) n. subgen.

SUBGENOTYPE (here selected).—*Megalaspides nericiensis* WIMAN, 1905.

NAME.—The subgenus is named after the type locality of the subgenotype, Lanna in Närke.

DIAGNOSIS.—Cephalon with a narrow, concave border subequal in width. Dorsal furrows and glabella still flatter than in the typical subgenus. Posterior limbs fairly wide exsagittally. Posterior border furrow almost obliterated. Hypostome forked; posterior lobe of central body present. Thoracic rhachis of uniform width. Pleural terminations bluntly pointed postero-laterally. Pygidium with concave border.

OCCURRENCE.—Early Arenigian.

Megalaspides (*Lannacus*) *nericiensis* WIMAN, 1905

Pl. IX, figs. 1–5. Text-fig. 40 B.

1905 *Megalaspides nericiensis* WIMAN, Ein Shumardiaschiefer, p. 8, pl. 2, figs. 1–4. (Description and figs. of cranidium and hypostome).

1907 *Megalaspides* sp. (partim), WIMAN, Nordbalt. Silurgebiet, II, p. 92, pl. 5, figs. 8, 10. (Notes on genus, figs. of pygidia).

LECTOTYPE (here selected).—Cranidium: RM no. Ar. 12820 (original of WIMAN, 1905, pl. 2, fig. 3). — In this paper, pl. IX, fig. 2.

OTHER MATERIAL.—Specimens figured by WIMAN, 1905: RM nos. Ar. 12818, 12819, 12473, and 1908: PU nos. B 110, 112. Complete specimen with hypostome: PU no. Vg 215. Cranidia: PU nos. N 51, 755, 756, 831, 832. Pygidia: RM no. Ar. 12471, PU nos. N 57, 59, 617, 757, 758, 833, 834.

TYPE STRATUM and TYPE LOCALITY.—Layer of greenish grey shale in Lower Planilimbata limestone, Lanna, Närke.

DIAGNOSIS.—See that of subgenus.

DESCRIPTION.—WIMAN knew the cranidium and hypostome only. A new description, based on a more complete material is given here.

Carapace broadly elliptical in outline, its width at middle of thorax not fully two-thirds the length. Cephalon and pygidium equal in length, thorax somewhat shorter. Cephalon semicircular in outline. Border concave, subequal in width, its most posterroi portion, however, rapidly narrowing backwards, ending at genal spine. Cranidium but slightly convex. Dorsal and preglabellar furrows very faint. Glabella about three-fourths the cranidial length, very low, with faint median keel and tubercle. Preglabellar area but slightly concave. Palpebral lobes semicircular in outline, rising but slightly above level of glabella, palpebral furrow parallel to margin. Posterior limbs fairly wide exsagittally; posterior border furrow almost obliterated. Anterior branches of suture usually not forming a smooth curve, running forwards and somewhat outwards from eyes, then slightly inwards, at last turning rapidly inwards, including an angle of about 130°, delimiting at median line a broad point. Often, however, the

branches describe a more evenly rounded curve, similar to that in *M. dalecarlicus*. Posterior branches curve obliquely backwards, then almost directly outwards, and at last backwards, cutting posterior margin of cranidium at a distance from dorsal furrow subequal to width of glabella. Position of Panderian organs similar to that in *Plesiomegalaspis*. Genal spine somewhat wider at the base than in *M. dalecarlicus*.

Hypostome long, forked. Posterior limbs rounded at their rear end. Central body long, surrounded by deep furrows. Posterior lobe fairly large, crescent-shaped, delimited from anterior lobe by the premacular pits only. Shape of anterior wings unknown.

Thoracic rhachis well defined by dorsal furrows, low, and of uniform width. Pleural ends with a more or less sharp postero-lateral angle, rounded antero-laterally. Panderian organs unknown.

Pygidium subsemicircular or semi-elliptical in outline. Border moderately concave. Dorsal furrow very shallow. Anterior portion of rhachis rapidly tapering backwards, posterior part subequal in width. About twelve rhachial rings and terminal portion, separated by shallow transverse furrows. Segmentation of pleural platforms very faint on outside of test, on internal moulds wide and shallow pleural furrows and up to nine very low pleural ribs with a shallow rib furrow are visible.

DIMENSIONS.—Length of complete specimen (pl. IX, fig. 1) 70.5 mm, width at middle of thorax about 44 mm. Length of cranidium (lectotype) 29.5 mm, width at posterior margin 36.3 mm. Length of pygidium (pl. IX, fig. 3) 18 mm, width 27 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Common.

Genus *Promegalaspides* WESTERGÅRD, 1939

GENOTYPE.—*Promegalaspides kinnekullensis* WESTERGÅRD, 1939.

REMARKS.—The genus is split below into two subgenera. The typical subgenus comprises the two species described by WESTERGÅRD from the late Upper Cambrian beds. To the other subgenus three early Ordovician species have been referred.

Subgenus *Promegalaspides* (*Promegalaspides*) WESTERGÅRD, 1939

SUBGENOTYPE.—*Promegalaspides kinnekullensis* WESTERGÅRD, 1939.

DIAGNOSIS.—Cephalon semicircular in outline, with narrow concave border and genal spines. Facial suture niobiform. Glabella long, reaching to anterior border, subrectangular in outline, rounded in front, with short and faint glabellar furrows, occipital furrow, and a pair of basal lobes. Palpebral lobes close to dorsal furrow, their rear edge opposite middle of glabella. Posterior limbs long transversally, with a well defined posterior border furrow. Panderian

organ of free cheek at the very margin of doublure. Hypostome forked, with rounded posterior limbs, central body with short posterior lobe.

Thoracic rhachis prominent. Pleurae with pronounced fulcrum and strong oblique pleural furrow. Pleural terminations pointed, in last segment continued into very long, slender, backwardly directed spines.

Pygidium semi-elliptical in outline, with narrow concave border. Rhachis prominent, long. Pleural ribs with rib furrow. Doublure narrow. Test with minute pits.

SPECIES.—*P.* (*P.*) *kinnekullensis* and *P.* (*P.*) *pelturae* WESTERGÅRD, 1939.

OCCURRENCE.—Subzone of *Peltura scarabaeoides* (late Upper Cambrian). — Sweden.

Subgenus *Promegalaspides* (*Borogothus*) n. subgen.

SUBGENOTYPE.—*Megalaspis stenorhachis* ANGELIN, 1851.

NAME.—From latin *Gothus* = inhabitant of the province of Östergötland, and from the stem *Bor-* in Lake Boren at which the type locality of *P.* (*B.*) *stenorhachis* is situated.

DIAGNOSIS.—*Borogothus* agrees with the typical subgenus in having a narrow concave border on cephalon and pygidium; genal spines; long glabella reaching to, or approaching anterior border, short and faint glabellar furrows, occipital furrow; long posterior limbs with posterior border furrow; forked hypostome; prominent thoracic rhachis, thoracic pleurae with pronounced fulcrum and strong oblique pleural furrow, last segment continued into very long, slender spines directed backwards; pygidium with long prominent rhachis, pleural ribs with rib furrow; narrow doublure; test with minute pits.

It is distinguished by the following features: Facial suture approaching isoteliform pattern. Glabella contracted between eyes. Basal lobes absent. Palpebral lobes situated farther backwards. Panderian organ of free cheek at some distance from margin of doublure. Posterior limbs of hypostome pointed; posterior lobe of central body lacking. First ring of pygidial rhachis conspicuously convex and delimited by deep transverse furrow, segmentation of remainder of rhachis indicated by lateral pits and knobs only.

SPECIES.—*P.* (*B.*) *stenorhachis* (ANGELIN), *P.* (*B.*) *intactus* (MOBERG & SEGERBERG), and *P.* (*B.*) *goniopleura* (THORAL, 1935).

OCCURRENCE.—Late Tremadocian and early Arenigian. — Sweden, Norway, France.

Promegalaspides (*Borogothus*) *stenorhachis* (ANGELIN, 1851)

Pl. IX, figs. 6–14. Text-fig. 41 A.

1851 *Megalaspis stenorachis* ANGELIN, Palaeont. Suecica, p. 17, pl. 16, fig. 1. (Description and drawing of pygidium with five attached thoracic segments).

1882 *Megalaspis stenorachis* ANGELIN (partim).—BRÖGGER, Silur. Etagen, p. 76, pl. 4, fig. 7. (Description and fig. of pygidium).

1905 Pygidium N:o 2, WIMAN, Ein Shumardiaschiefer, p. 10, pl. 2, fig. 11. (Description and fig. of pygidium).
1906 *Megalaspis stenorhachis* ANGELIN.—MOBERG & SEGERBERG, Ceratopygeregionen, p. 97. (Description of pygidium, discussion on species).
1952 *Megalaspis planilimbata* ANGELIN (partim) and *Ptychopyge* sp.—SKJESETH, L. Didymograptus Zone, pl. 1, fig. 9, pl. 4, fig. 7. (Figs. of pygidium and cranidium).

REMARKS.—ANGELIN's type specimen was collected from limestone beds belonging to his Regio C at Husbyfjöl in Östergötland. It is lost, and no good specimens from the type locality are known to the present author. Consequently no neotype has been selected.

MATERIAL.—Almost complete specimens: RM no. Ar. 14462; SGU Aa 40. Cranidia: PU nos. Vg 585; N 765, 766. SGU no. Aa 130 (Borghamn). Free cheeks: PU nos. Vg 478, 583; N 250, 619. Hypostomes: PU nos. N 60, 251. Thoracic pleura with spine: PU no. Vg 605. Pygidia: PU nos. Vg 562, 584, 594; Ög 28; N 764, 835.

DIAGNOSIS.—See that of subgenus. Distinguishing features are: Glabella not reaching to anterior border of cranidium, anterior portion distinctly wider and more convex than posterior part. Pygidial rhachis with up to fifteen rings; side lobes with eight to ten pleural ribs.

DESCRIPTION.—Cephalon subsemicircular in outline, with narrow concave border and long genal spines, circular in cross-section. Dorsal furrows of cranidium and preglabellar furrow well defined. Glabella four-fifths or more the length of cranidium, not reaching to anterior border, evenly rounded in front, contracted between eyes, anterior portion wider and more convex than posterior part. Two or three pairs of short and faint glabellar furrows close to dorsal furrows, between the most posterior ones a small median tubercle; occipital furrow shallow. Palpebral lobes opposite middle of glabella, semicircular in outline, with a faint palpebral furrow parallel to margin. Posterior limbs long transversally and fairly slender, with well defined posterior border furrow; posterior border bent upwards opposite thoracic fulcrum. Anterior branches of facial suture diverge in front of eyes. Before reaching border they curve rapidly inwards and forwards, including an angle of about 140°, at median line delimiting a short broad frontal point. Posterior branches run outwards and slowly backwards, cutting posterior margin of cranidium at a distance from dorsal furrow exceeding width of glabella at the same margin. Doublure of free cheek about twice as wide as concave border. Panderian organs situated near inner margin of doublure and posterior margin of cranidium. Hypostome forked. Posterior limbs long, subequal in breadth anteriorly, posterior portion tapering rapidly backwards, rear end pointed. Rounded tongue-like process, bent in dorsal direction, extending from posterior margin of hypostome between the limbs. Anterior lobe of central body subquadrate in outline, posterior lobe lacking; maculae small, rounded. Anterior wings large, with rounded posterior angle. Terrace lines on posterior limbs subparallel to outer margin.

Thorax of eight segments. Rhachis well defined, tapering backwards, occupying in front about one-fourth, at rear end about one-fifth the width of thorax. Pleurae straight, with pronounced, knob-like fulcrum situated at a distance from dorsal furrow subequal to two-thirds the transversal length of pleura; inner part horizontal, outer part, with exception of that of last segment, bent steeply down; pleural furrow long, narrow, pleural ends probably pointed, in last segment continued into very long spines directed backwards and extending beyond pygidium.

Pygidium semi-elliptical to subsemicircular in outline; anterior margin straight; posterior margin bent upwards at rear end. Border narrow, strongly concave. Dorsal furrows straight, narrow. Rhachis prominent, long, narrow, reaching to border, tapering evenly backwards, at posterior end forming a low knob; first ring very conspicuous, more strongly vaulted then rest of rhachis, delimited by deep transverse furrow. Segmentation of remainder of rhachis marked as a rule by shallow pits and knobs close to dorsal furrow; sometimes six or seven pairs of more distinct pits are present on rear portion of rhachis in which case about fifteen rings and terminal portion are discernible. Occasionally the rhachial rings following upon the first are delimited by shallow transverse furrows as in ANGELIN's drawing of the species. Inner portion of pleural platforms almost horizontal, moderately convex, outer part sloping steeply down. Eight to ten pleural ribs with rib furrow. Doublure narrow.

DIMENSIONS.—Length of cranidium (pl. IX, fig. 6) 30.5 mm, width at reconstructed posterior margin about 40 mm. Length of pygidium (pl. IX, fig. 11) 16.5 mm, width about 25 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Encountered at a large number of localities. Commonest in the lowermost beds of the zone.

Promegalaspides (*Borogothus*) *intactus* (MOBERG & SEGERBERG, 1906)

Pl. X, figs. 1–4.

1882 *Megalaspis stenorachis* ANGELIN (partim).—BRÖGGER, Silur. Etagen, p. 76, pl. 4, fig. 5. (Fig. of pygidium).

?1886 *Asaphus* sp., BRÖGGER, Ausbild. des Hypostomes, p. 26, pl. 1, fig. 1. (Description and fig. of hypostome).

1906 *Megalaspis intacta* MOBERG & SEGERBERG, Ceratopygeregionen, p. 96, pl. 6, figs. 20, 21. (Description and figs. of pygidium).

LECTOTYPE (here selected).—Pygidium LP no. LO 1871 t (original of MOBERG & SEGERBERG, 1906, pl. 6, fig. 21). — In this paper, pl. X, fig. 3.

OTHER MATERIAL.—Cranidia: RM, G. HOLM's collection from the Oslo Region. Hypostomes: RM, the same collection; SGU, collections from Hunneberg.

TYPE STRATUM and TYPE LOCALITY.—Dark-grey Ceratopyge limestone, Fågelsång, Skåne.

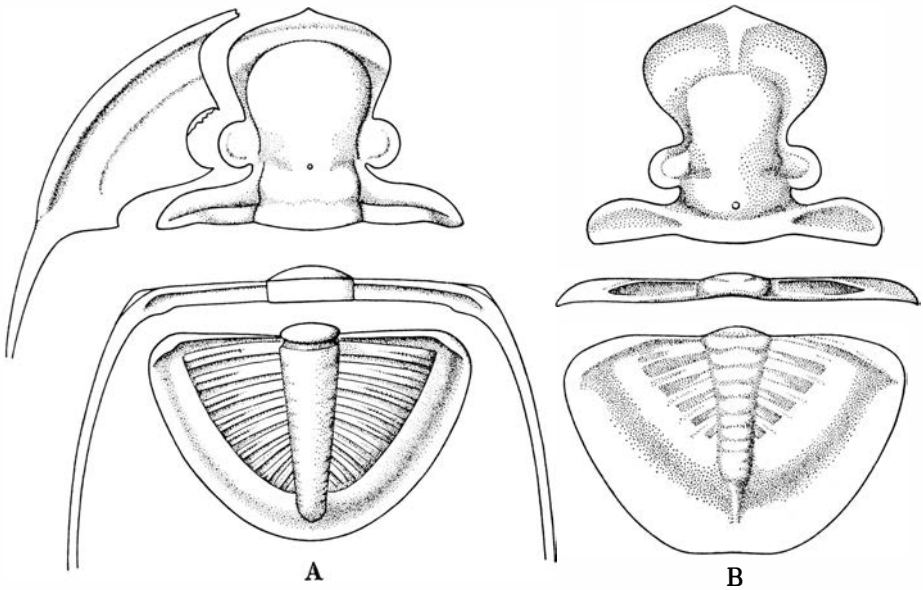


Fig. 41. A: Cranidium, free cheek, hindmost thoracic segment, and pygidium of *Promegalaspides* (*Borogothus*) *stenorhachis* (ANGELIN) from the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — About 1.5 ×. B: *Hunnebergia retusa* n.gen. and n.sp., zone of *Plesiomegalaspis armata* (early Arenigian). — About 1 ×.

DIAGNOSIS.—The species differs from *P.* (*B.*) *stenorhachis* in the following features: Cranidium narrower in front of eyes. Glabella reaching to anterior border. Palpebral lobes smaller. Pygidium shorter, with dorsal furrows curving slightly outwards. Pleural platforms with half-rib and about six pleural ribs.

DESCRIPTION.—The pygidium only was described by MOBERG & SEGERBERG. It is nearly semicircular in outline. Dorsal furrows curve slightly outwards. Rhachis with prominent first ring, delimited by strong transverse furrow: segmentation of remainder of rhachis indicated by faint lateral pits only. Pleural platforms with half-rib and about six pleural ribs.

Two cranidia, both fragmentary, are known. Glabella reaches to anterior border. Palpebral lobes fairly small, situated opposite middle of glabella. Anterior branches of facial suture diverge but slightly in front of eyes. Hypostome resembling that of *P.* (*B.*) *stenorhachis*. Free cheek and thorax unknown. Test of one pygidium, LP no. LO 1870 T, with minute pits.

DIMENSIONS.—Length of pygidium (lectotype) 8.7 mm, reconstructed width about 16 mm. Length of cranidium (pl. X, fig. 1) 15.3 mm, width at posterior margin about 21 mm.

REMARKS.—The cranidia were secured by G. HOLM from Ceratopyge limestone at Bjerkaasholmen, Oslo Fjord, Norway. One of the slabs collected contains in addition *Ceratopyge forficula*, *Euloma ornatum*, and *Triarthrus angelini*.

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian). — Skåne: Fågelsång. Västergötland: Storeklev. — Ceratopyge limestone: Bjerkaasholmen, Norway.

Promegalaspides (*Borogothus*) sp.

MATERIAL.—One hypostome: PU no. Vg 341, similar to that of *P.* (*B.*) *stenorhachis*.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Stenbrottet.

Genus *Hunnebergia* n. gen.

GENOTYPE (here selected).—*Hunnebergia retusa* n. sp.

NAME.—The genus is named after Hunneberg mountain, where the type locality of the genotype is situated.

DIAGNOSIS.—Glabella about two-thirds the cranidial length, subrectangular in outline, with shallow occipital furrow and indications of glabellar furrows. Posterior limb of fixed cheek slender, with wide and deep posterior border furrow. Anterior branches of suture diverge strongly in front of eyes; posterior branches describe a distinctly sigmoid curve. Hypostome, attributed to the genus, with rounded posterior margin. Thoracic pleural furrow very wide; pleural terminations pointed and directed somewhat backwards. Pygidium with concave border and very wide doublure.

OCCURRENCE.—Early Arenigian.

Hunnebergia retusa n. sp.

Pl. X, figs. 5, 6. Text-fig. 41 B.

NAME.—The specific name alludes to the obtuse posterior end of the pygidium.

HOLOTYPE (here selected).—Pygidium collected by G. LINNARSSON?: SGU no. Aa 40. Pl. X, fig. 6.

OTHER MATERIAL.—Cranidium: PU no. Vg 109. Fragment of free cheek: PU no. Vg 110. Hypostome: PU no. Vg 111. Pygidia: PU no. Vg 112; SGU no. Aa 40; RM no. Ar. 47122.

TYPE STRATUM and TYPE LOCALITY.—Bed of dark-grey limestone above the Ceratopyge beds, Hunneberg, Västergötland.

DIAGNOSIS.—See that of genus.

DESCRIPTION.—Dorsal furrows of cranidium and preglabellar furrow shallow. Glabella somewhat more than two-thirds the cranidial length, subrectangular in outline, rounded in front, somewhat contracted between eyes. Occipital furrow curving backwards, very faint medially. One pair of short, shallow glabellar furrows opposite posterior part of palpebral lobes. Small median tubercle just in front of occipital furrow. Fixed cheeks very narrow. Preglabellar area long sagittally, moderately concave, with a low median keel issuing from

glabella. Palpebral lobes rounded, situated behind middle of glabella. Palpebral furrow parallel to margin of lobe. Posterior limbs long and slender, widest exsagittally beyond the palpebral lobes. Posterior border furrow wide and deep. Anterior branches of suture diverge strongly in front of eyes, then curve evenly forwards and at last rapidly inwards, including an angle of about 140°. Posterior branches describe a distinctly sigmoid curve, cutting posterior margin of cranidium at a distance from dorsal furrow subequal to width of glabella. A fragment of a free cheek, probably belonging to the species, shows a wide concave border, and a flattened genal spine, broad at the base. Associated fragmentary hypostomes resemble that of *Plesiomegalaspis armata*, and have a rounded posterior margin.

Fragments of thoracic segments have a very wide pleural furrow and pointed pleural terminations directed somewhat backwards.

Pygidium broadly semi-elliptical in outline, obtuse and slightly emarginated at rear end. Border wide, concave. Dorsal furrows shallow. Rhachis about two-thirds the pygidial length, narrow, anterior portion tapering backwards, posterior one subequal in width, moderately convex, rising above level of side lobes, continued by a low, triangular ridge passing unto the border. About eleven rhachial rings and terminal portion discernible. Pleural platforms nearly horizontal, showing half-rib and six pleural ribs with a faint rib furrow. Doublure very wide, surrounding the posterior part of rhachis.

DIMENSIONS.—Length of pygidium (holotype) 25 mm, width about 35 mm. Length of cranidium (pl. X, fig. 5) 14 mm, width at posterior margin about 17.5 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Storeklev (common), Stenbrottet. Dalarna: Sjurberg. Jämtland: Risselåsen.

Genus *Asaphus* BROGNIART, 1822

GENOTYPE.—*Entomolithus paradoxus* α *expansus* LINNÆUS, 1759.

Asaphus sp.

MATERIAL.—Two poorly preserved pygidia: PU nos. N 227, and D 490, resembling that of *Asaphus broeggeri* F. SCHMIDT from the stratigraphical subdivision $B_{II\,\alpha}$ of the East Baltic.

OCCURRENCE.—Uppermost part of the zone of *Plesiomegalaspis estonica* (Arenigian). — Närke: Latorp. Dalarna: Sjurberg.

Genus and species indet.

Pl. X, figs. 7, 8.

MATERIAL.—One distorted cranidium: PU no. N 396, and two fragmentary internal moulds of pygidia: PU nos. N 397, 398.

REMARKS.—The genus is possibly ancestral to *Asaphus*. The frontal portion of the cranidium resembles that of *Asaphus* in the shape of the large glabella, and in the course of the facial suture. The posterior part of the cranidium is too badly damaged for comparison. The pygidium is short, with a rounded posterior margin, emarginated at the rear end. The border is convex. The rhachis is prominent; the mode of its segmentation, as well as the segmentation of the pleural platforms, resembles that of *Asaphus*. The pygidium differs from that of the latter genus in having a narrow doublure.

The species shows some similarity to *Aulacoparia venta* (HINTZE, 1952, p. 134, pl. 26) from the zone "G-2" of the Pogonip group of Utah and Nevada.

OCCURRENCE.—Uppermost part of the zone of *Megalaspides dalecarlicus* (Arenigian).—Närke: Lanna.

Family *Cyclopygidae* RAYMOND, 1925

Genus *Cyclopyge* HAWLE & CORDA, 1847

GENOTYPE.—*Egle rediviva* BARRANDE, 1846.

REMARKS.—Three species of the genus are known by now from the Lower Ordovician of Sweden. They exhibit a successive decrease of the distance between the eyes in front of the cranidium (compare text-fig. 42).

Cyclopyge latifrons n. sp.

Pl. X, figs. 9–11. Text-fig. 42 A.

NAME.—Alludes to the great width of the glabella along the anterior margin.

HOLOTYPE (here selected).—Cranidium: PU no. Öl 153. Pl. X, figs. 9–11.

TYPE STRATUM and TYPE LOCALITY.—Grey Ceratopyge limestone, Ottenby, Öland.

DIAGNOSIS.—Distance between eyes in front of glabella about five-sixths the width of the glabella at rear end.

DESCRIPTION.—Anterior margin of cranidium curves inwards. Dorsal furrows diverge slightly from posterior cranidial margin as far forward as to alignment with median tubercle of glabella, thence running obliquely forward and inward. Glabella occupies nearly all the cranidium and reaches to anterior margin; its posterior portion almost plane longitudinally and moderately convex transversally; anterior portion strongly convex, bent forward and downward, in front somewhat backward. Width of glabella in front about five-sixth the width at rear end. Glabella smooth, with exception of a median tubercle, situated at a distance from posterior cranidial margin subequal to two-thirds the width of the glabella at the same margin. Posterior limbs very small, triangular, pointed distally. Test ornamented with transverse terrace lines on anterior and most posterior portion of glabella; the lines curve forward.

Thorax and pygidium unknown.

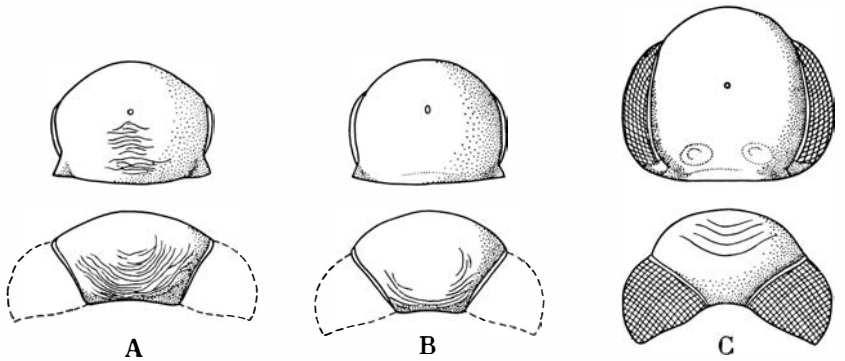


Fig. 42. Dorsal and anterior view of the cranidium in three species of *Cyclopyge* RAYMOND showing a successive decrease of the distance between the eyes in front. A: *C. latifrons* n. sp. from the zone of *Apatokephalus serratus* (late Tremadocian). — 2.5 ×. B: *C. gallica* n. sp., zone of *Plesiomegalaspis planilimbata* (early Arenigian). — 4 ×. C: *C. umbonata* (ANGELIN) from medial or late Arenigian. — About 4 ×.

DIMENSIONS.—Length of cranidium (holotype) 7.3 mm, width at posterior margin 8 mm.

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian). — Öland: Ottenby.

Cyclopyge gallica n. sp.

Pl. X, figs. 12–16. Text-fig. 42 B.

?1935 *Symphysurus*? THORAL, Contrib. l'Ordovicien inférieur, p. 315, pl. 22, fig. 6. (Description and fig. of an indistinct carapace).

NAME.—The specific name alludes to the similarity between the species and the French form described by THORAL.

HOLOTYPE (here selected).—Cranidium: PU no. N 851. Pl. X, figs. 12–14.

OTHER MATERIAL.—Cranidia: PU nos. N 284, 285, 915–917; B 258. Fragmentary free cheeks: PU nos. N 809–811. Pygidia: PU nos. N 282, 283, 286, 802, 812–815, 918.

TYPE STRATUM and TYPE LOCALITY.—Grey Lower Planilimbata limestone, Hagaberg, Närke.

DIAGNOSIS.—Distance between eyes in front of glabella about half the width of the glabella at rear end. Pygidium subtriangular in outline, with a wide, flattened border.

DESCRIPTION.—Anterior margin of cranidium curves inwards. Dorsal furrows subparallel from posterior cranidial margin as far forward as to alignment with median tubercle of glabella, thence running obliquely forward and inward. Posterior portion of glabella almost plane longitudinally and moderately convex transversally; anterior portion strongly convex, bent forward and downward, in front somewhat backward. Width of glabella in front about half the width at rear end. Glabella smooth with exception of a shallow transverse furrow close to posterior margin, a faint median ridge, and an elongate median tubercle,

situated at a distance from posterior cranidial margin subequal to half the width of the glabella at rear end. Posterior limbs very small, triangular. Fragments of free cheeks show the wire-like border and portions of the large, multifaceted eye.

Hypostome and thorax unknown.

Pygidium subtriangular in outline, its anterior margin running obliquely backward from rhachis. Border flattened, broad, narrowing forward. Rest of pygidium strongly convex. Rhachis short, not reaching to border, tapering rapidly backwards; on internal moulds about three rings and terminal portion are visible. Pleural platforms with a pronounced furrow behind anterior half-rib and traces of about three pleurae.

Test ornamented with transverse terrace lines on most anterior portion of glabella; the lines curve forward.

DIMENSIONS.—Length of cranidium (holotype) 4.7 mm, width at posterior margin about 5 mm. Length of pygidium (pl. X, fig. 15) 3 mm, width 5.3 mm.

AFFINITIES.—The pygidium resembles that of a poorly preserved carapace collected from the lower Arenigian beds of Montagne Noire and figured by THORAL, 1935. The specimen is associated with *Miquelina miqueli* BERGERON. Its cephalon is too indistinct for a comparison with the Swedish species.

OCCURRENCE.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). Occasionally very common in the uppermost beds. — Närke: Lanna, Latorp, Hagaberg, Gymninge. Västergötland: Stora Backor. South Bothnian District: Raggarön (boulder). Jämtland: Kloxåsen, Andersön.

Family *Styginidae* VOGDES, 1893

Genus *Bronteopsis* NICHOLSON & ETHERIDGE, 1879

GENOTYPE.—*Ogygia? concentrica* LINNARSSON, 1869.

Bronteopsis? toernquisti (MOBERG & SEGERBERG, 1906)

Pl. X, fig. 17.

1906 *Holometopus Törnquisti* MOBERG & SEGERBERG, Ceratopygeregionen, p. 99, pl. 7, fig. 6. (Description and fig. of pygidium).

1955 *Bronteopsis? törnquisti* (MOBERG & SEGERBERG, 1906).—SKJESETH, Fam. Styginidae, p. 19, (Remarks on affinity).

HOLOTYPE (by monotypy). — Pygidium: LP no. LO 1877 T (original of MOBERG & SEGERBERG, 1906, pl. 7, fig. 6). In this paper, pl. X, fig. 17.

TYPE STRATUM and TYPE LOCALITY.—Grey limestone, Ottenby, Öland.

DIAGNOSIS.—Pygidium about twice as wide as long, with concave border. Segmentation of pleural platforms indicated by five pairs of pits at inner margin of doublure, a similar pit being present on rhachis.

DESCRIPTION.—Only the pygidium is known. It is semicircular in outline, about twice as wide as long, with concave border. Dorsal furrows deep, reaching to inner margin of doublure. Rhachis very narrow, its anterior portion tapering backwards, posterior part subequal in width, continued from inner margin of doublure by a post-rhachial ridge tapering backwards and ending at pygidial margin. Two rings indicated at front of rhachis. Pleural platforms convex, with pronounced furrow behind half-rib; at inner margin of doublure five pairs of pits indicating the pleural furrows. A similar pit present on rhachis just in front of post-rhachial ridge. Test ornamented with minute pits and fine, undulating striae.

AFFINITIES.—As pointed out by SKJESETH, 1955, the pygidium shows intermediate characters between *Bronteopsis* and *Raymondaspis*, the development of its pleurae suggesting closer affinity with the former genus.

DIMENSIONS.—Length of pygidium 8 mm, width 15 mm.

OCCURRENCE.—The specimen was collected by TÖRNQUIST at Ottenby in Öland, according to MOBERG from the Ceratopyge limestone (late Tremadocian).

Genus *Raymondaspis* PŘIBYL, 1949

GENOTYPE.—*Holometopus limbatus* ANGELIN, 1854.

REMARKS.—Several species of the genus occur sparsely in the lower Arenigian beds of Sweden. The material available is very small; an attempt is made, however, to distinguish some of the forms encountered.

Raymondaspis brevicauda n. sp.

Pl. X, fig. 18.

HOLOTYPE (here selected). — Pygidium: PU no. N 800. Pl. X, fig. 18.

OTHER MATERIAL.—Pygidia: PU nos. N 801, 802.

TYPE STRATUM and TYPE LOCALITY.—Grey Lower Planilimbata limestone, Gymninge, Närke.

DIAGNOSIS.—Pygidium somewhat more than twice as wide as long, with convex border. Rhachis prominent as far as inner margin of doublure, from there continued by a very faint, triangular ridge. Doublure wide.

DESCRIPTION.—Only the pygidium is known. It is subsemicircular in outline, somewhat more than twice as wide as long. Border convex, sloping steeply down. Rhachis prominent as far as inner margin of doublure, tapering evenly backwards, on doublure border continued by a very faint, triangular ridge. Two rings indicated at front of rhachis. Pleural platforms slightly convex, horizontal, with furrow behind half-rib, otherwise no trace of segmentation. Doublure wide. Ornamentation of test not observed.

DIMENSIONS.—Length of pygidium (holotype) 4 mm, width 8.8 mm.

OCCURRENCE.—Uppermost part of the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Gymninge.

Raymondaspis infundibularis n. sp.

Pl. X, fig. 19.

NAME.—Latin *infundibulum* = funnel. It alludes to the funnel-shaped pygidial rhachis.

HOLOTYPE (here selected).—Pygidium: PU no. N 867. Pl. X, fig. 19.

TYPE STRATUM and TYPE LOCALITY.—Grey Upper Planilimbata limestone, Vilhelmsberg, Närke.

DIAGNOSIS.—Pygidium semicircular in outline with a narrow, concave border. Rhachis tapering rapidly backwards at first, then of uniform breadth, most posterior portion triangular. Post-rhachial ridge very faint.

DESCRIPTION.—Pygidium about twice as wide as long, semicircular in outline, with a narrow, concave border of uniform breadth. Rhachis wide in front, the width being about one-fifth the pygidial width; tapering rapidly backwards at first, then of uniform breadth, most posterior portion triangular, reaching to inner margin of doublure. Post-rhachial ridge very faint and narrow, vanishing before contact with pygidial margin. Three rings discernible on anterior portion of rhachis. Pygidial platforms horizontal, gently convex, with half-rib and adjoined furrow as only traces of segmentation. Doublure border sloping steeply down from pleural platforms. Test without ornamentation, probably due to mode of preservation.

DIMENSIONS.—Length of pygidium (holotype) 6 mm, width about 12.5 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis estonica* (Arenigian). — Närke: Vilhelmsberg.

Raymondaspis sp. no. 1

MATERIAL.—Pygidia: PU nos. N 526–528, 875. Cranidium: PU no. Öl 194.

REMARKS.—The pygidium is less convex than those of the other species encountered, and has a wider and more flattened border. The rhachis is narrow and tapers evenly backwards.

OCCURRENCE.—Zone of *Megalaspides dalecarlicus* (Arenigian). — Närke: Vintrosa. Öland: Köpings Klint. — Lower part of the zone of *Plesiomegalaspis estonica* (Arenigian). — Närke: Lanna, Yxhult. Öland: Ottenby.

Raymondaspis sp. no. 2

1906 *Holometopus limbatus* ANGELIN.—WIMAN, Palaeont. Notizen 7–12, p. 293, pl. 29, figs. 21, 22. (Description and figs. of pygidium).

1952 *Raymondaspis limbatus* (ANGELIN).—SKJESETH, L. Didymograptus Zone, p. 171, pl. 4, figs. 16, 17, 19–21. (Description and figs. of cranidium and pygidium).

MATERIAL.—Cranidium: PU no. N 530. Fragmentary pygidium: PU no. N 529.

REMARKS.—The pygidium differs from that of *Raymondaspis* sp. no. 1 in having a strongly concave border and more convex pleural platforms.

OCCURRENCE.—Uppermost part of the zone of *Plesiomegalaspis estonica* (Arenigian).—Närke: Lanna. Öland: Ottenby.

Family *Illaenidae* Hawle & Corda, 1847

Dysplanus? sp. no. 1

Material.—Fragmentary internal mould of cranidium, PU no. N 870, with short, subparallel dorsal furrows.

Occurrence.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Yxhult.

Dysplanus? sp. no. 2

Material.—Fragmentary cranidium, PU no. Öl 229, showing the right dorsal furrow, fixed cheek, and palpebral lobe. The test is ornamented with terrace lines and minute pits.

Occurrence.—Zone of *Megalaspides dalecarlicus* (Arenigian). — Öland: Köpings Klint.

Illaenus? sp.

Material.—Fragmentary internal mould of cranidium, PU no. Vg 75 (= ar. 4274), with fairly long dorsal furrows and a distinct occipital furrow. It will be described by Dr. V. Jaanusson in a future paper on the Lower Ordovician Illaenidae.

Occurrence.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Stenbrottet.

Family *Odontopleuridae* Burmeister, 1843

Odontopleurid trilobite

Material.—Free cheek, fragments of thoracic segments, and pygidium: PU nos. Vg 409–411.

Remarks.—The species resembles those of *Acidaspis* and *Odontopleura*. The free cheek carries a long and strong genal spine and small spines perpendicular to the lateral margin. The pleural ends of the thoracic segments have a short anterior and a long posterior spine. The pygidial rhachis possesses three rings and a terminal portion; the side lobes one pair of pleurae drawn out into marginal spines.

Occurrence.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Stenbrottet.

Family *Glaphuridae* Hupé, 1955

Genus *Glaphurina* Ulrich, 1930

Genotype.—*Glaphurina lamottensis* Ulrich, 1930.

Remarks.—The two genera *Glaphurus* and *Glaphurina* are met with in the Chazyan of North America. An early Arenigian species, tentatively referred to the latter genus, is described below.

Glaphurina? *insolita* n. sp.

Pl. X, figs. 20, 21.

1952 *Crotalurus* n. sp.—TJERNVIK, Lägsta ordov. lagren, p. 61 and 64. (Report on occurrence).
1956 Glaphurid JAANUSSON, Genus *Celmus*, p. 39. (Note on species).

NAME.—Latin *insolitus* = rare.

HOLOTYPE (here selected).—Cranidium: PU no. N 86. Pl. X, figs. 20, 21.

OTHER MATERIAL.—Cranidia: PU nos. N 779; B 277.

TYPE STRATUM and TYPE LOCALITY.—Grey Lower Planilimbata limestone, Latorp, Närke.

DESCRIPTION.—Anterior portion of cranidium bent downwards. Glabella ovate, rising high above fixed cheeks, defined by deep dorsal furrows and a more shallow preglabellar furrow. Occipital furrow deep and wide. Three pairs of glabellar furrows; first and second pairs confluent with each other forming a sickle-shaped figure as in *Glaphurina falcifera* ULRICH, 1930, third pair very short, issuing from dorsal furrow. Fixed cheeks convex. Palpebral lobes probably small, situated opposite third glabellar lobe. Anterior border narrow, convex, curving slightly backwards. Preglabellar field narrow sagittally. Posterior border furrow wide and deep. Anterior branches of facial suture converge moderately in front of eyes, posterior branches describe a gently sigmoid curve directed obliquely backwards, intersecting the posterior cranidial margin at a distance from dorsal furrow subequal to two-thirds the width of the glabella. Test covered with spines(?) broken in the specimens encountered.

DIMENSIONS.—Length of cranidium (holotype) 7.8 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Latorp, Gymninge, Hagaberg.

Family *Pliomeridae* RAYMOND, 1913

Genus *Protopliomerops* KOBAYASHI, 1934

GENOTYPE.—*Protopliomerops seisonensis* KOBAYASHI, 1934.

"*Protopliomerops*" spp.

REMARKS.—*Pliomera primigenia* ANGELIN from the zone of *Apatokephalus serratus* (late Tremadocian) and *P. toernquisti* HOLM from the zone of *Megalaspides dalecarlicus* (Arenigian) seem to differ from the genotype of *Protopliomerops* in the posterior position of the eyes, and in the shape and direction of the ocular ridges. They ought certainly to be referred to a new genus or to new genera.

Genus *Pliomerops* RAYMOND, 1905

GENOTYPE.—*Amphion canadensis* BILLINGS, 1859.

Pliomerops spp.

REMARKS.—The species *Pliomera actinura* (DALMAN) from the zone of *Plesiomegalaspis planilimbata* (early Arenigian) and a closely related, undescribed species from the preceding zone of *P. armata* are referred here to the genus *Pliomerops*. In both species the median furrow of the glabella, characteristic of *Pliomera* as well as the denticulation of the anterior border of the cephalon is absent. In *Pliomerops actinurus* as in *Pliomerops senilis* (BARRANDE) the thorax possesses but fourteen segments while in the genotype of *Pliomera* the number is eighteen.

Family *Cheiruridae* CORDA, 1847

Genus *Cyrtometopus* ANGELIN, 1854

GENOTYPE.—*Calymene? clavifrons* DALMAN, 1827, d. BARTON, 1920.

REMARKS.—According to ÖPIK (1937, pp. 89 and 110) a false palpebral ridge is characteristic of the *Cyrtometopinae*. It does not continue to the fifth cephalic segment, but follows the margin of the fixed cheek and is united anteriorly with the border. The said author gives the following explanation for the development of this ridge:

The true palpebral ridge has been reduced to obliteration. The palpebral furrow, however, remains. The area between this furrow and the margin of the cheek has developed into a marginal ridge. Since the anterior border furrow is obliterated distally the ridge unites with the anterior border of the cranidium.

In addition the anterior pits have been moved backwards and are situated opposite the most anterior lateral lobe of the glabella.

The species described below occurs considerably earlier than those studied by ÖPIK. It possesses a true palpebral ridge, running along the margin of the fixed cheek and the still persisting anterior border furrow. It ends at the dorsal furrow opposite the most anterior glabellar furrow. The anterior pit is situated somewhat farther ahead. This early species has been referred to the genus *Cyrtometopus* even though it differs from the genotype *C. clavifrons* in the above respects since intermediate forms seem to be present in the Limbata limestone and in the Danish Umbonata limestone.

Cyrtometopus priscus n. sp.

Pl. XI, figs. 6–8.

1952 *Cyrtometopus* cf. *clavifrons* (DALMAN, 1826).—SKJESETH, L. Didymograptus Zone, p. 173, pl. 4, figs. 3, 4, 6. (Description and figs. of cranidium and pygidium).

NAME.—Latin *priscus* = old-fashioned.

HOLOTYPE (here selected).—Pygidium: PU no. N 709. Pl. XI, fig. 8.

OTHER MATERIAL.—Cranidia: PU nos. N 549, 710, 711. Hypostome: PU no. N 712.

TYPE STRATUM and TYPE LOCALITY.—Greenish grey clayey shale in Upper Planilimbata limestone, Yxhult, Närke.

DIAGNOSIS.—The species differs from the genotype in having a pair of true palpebral ridges following the margin of the fixed cheek and the well defined anterior border furrow, and ending at the dorsal furrow. The pygidium is short, with three pairs of pleural spines, the foremost very long, the two posterior pairs being short points directed almost vertically downwards.

DESCRIPTION.—Cranidium subsemicircular in outline. Dorsal furrows narrow and deep. Glabella strongly convex, subelliptical in outline, its greatest width at second pair of glabellar furrows, being there about two-thirds the length. Anterior pairs of glabellar furrows narrow, and directed but slightly backwards; posterior pair curving inwards and backwards to occipital furrow, outer part being wide and deep, inner part shallow. The last mentioned furrows limit a shallow depression crossing the glabella. Occipital ring narrow, convex, with a blunt median tubercle. Fixed cheeks moderately convex, sloping downwards laterally and anteriorly. Palpebral lobes small, situated opposite third pair of glabellar side lobes. Low palpebral ridges widening inwards, running obliquely inwards and forwards, following the facial suture and the well defined anterior border furrow, and ending at the dorsal furrows opposite third pair of glabellar furrows. There the anterior pits are situated. Anterior border narrow, convex. Genal spines long and strong, curving outwards and backwards. Test of glabella, palpebral ridges, and border finely granulated, that of fixed cheeks covered by small pits.

One poorly preserved hypostome resembles that of the genotype, but is longer.

Free cheek and thorax unknown.

Pygidium short, its length at median line somewhat more than one-third the width at the straight anterior margin. Rhachis with three deep transverse furrows delimiting three rings. Side lobes with three pairs of pleurae, separated by deep furrows. Most anterior pair broad, furrowed, continued by a long moderately curving spine of elliptical cross section. Two posterior pairs of pleurae narrow, unfurrowed, convex, ending in short triangular points directed almost vertically downwards.

DIMENSIONS.—Length of cranidium (pl. XI, fig. 6) 9 mm, width exclusive of the genal spines about 16 mm. Length of pygidium (holotype) at median line 5.3 mm, width at anterior margin about 14 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis estonica* (Arenigian). — Närke: Yxhult, Lanna.

Genus *Sphaerexochus* BEYRICH, 1845

GENOTYPE.—*Sphaerexochus mirus* BEYRICH, 1845.

Sphaerexochus? sp.

Pl. X, fig. 22.

MATERIAL.—One fragmentary cranidium: PU no. N 713, preserved in clayey shale. The glabella is rounded in front of the occipital furrow. The first pair of glabellar furrows is deep and curves backwards, yet without reaching the occipital furrow. In addition one anterior pair of very narrow and shallow glabellar furrows, curving obliquely forwards, is discernible.

OCCURRENCE.—Zone of *Plesiomegalaspis estonica* (Arenigian). — Närke: Yxhult.

Family *Harpididae* HUPÉ, 1955

Genus *Harpides* BEYRICH, 1846

GENOTYPE.—*Harpides hospes* BEYRICH, 1846.

Harpides spp.

REMARKS.—*Harpides rugosus* (SARS & BOECK) is fairly common in the zone of *Apatokephalus serratus* (late Tremadocian). In all the succeeding Arenigian zones dealt with in this paper one or several species of the genus occur very sparsely. Small fragmentary cephala: PU nos. Vg 593; N 706–708.

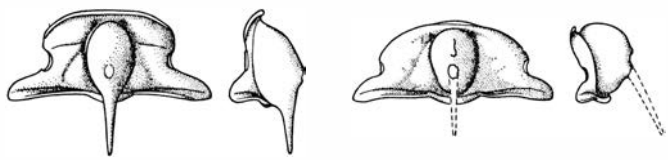
Family *Harpidae* HAWLE & CORDA, 1847

Genus *Selenoharpes* WHITTINGTON, 1950

GENOTYPE.—*Harpes* (*Eoharpes*) *youngi* REED, 1914.

Selenoharpes spp.

REMARKS.—A few cephala belonging to species of the genus have been encountered in the Arenigian beds examined by the present writer: *Selenoharpes excavatus* (LINNARSSON) in the zone of *Megalaspides dalecarlicus* (PU no. N 427), and *Selenoharpes* spp. in the two other zones of the Planilimbata limestone (PU nos. Ög 76; N 705).



A B

Fig. 43. Dorsal and lateral view of the cranidium in two species of *Orometopus* BRÖGGER. A: *O. elatifrons* (ANGELIN) from the zone of *Apatokephalus serratus* (late Tremadocian). B: *O. grypos* n.sp., zone of *Plesiomegalaspis armata* (early Arenigian). — 4 ×.

Family *Orometopidae* Hupé, 1955

Genus *Orometopus* Brögger, 1896

Genotype.—*Holometopus? elatifrons* Angelin, 1854, d. Brögger, 1896.

Orometopus grypos n. sp.

Pl. XI, figs. 9–12. Text-fig. 43 B.

Name.—Latin (from Greek) *Grypos* = aquiline nose. It alludes to the strongly convex glabella of the species.

Holotype (here selected).—Internal mould of cranidium: PU no. Vg 399. Pl. XI, fig. 10.

Other material.—Cranidia: PU nos. Vg 400–404. Free cheek: PU no. N 891. Pygidia: PU nos. Vg 405–408.

Type stratum and type locality.—Thin layers of white limestone in glauconitic limestone, Stenbrottet, Västergötland.

Diagnosis.—The species differs from the genotype in its strongly convex glabella which is almost vertical in front, in its wide fixed cheeks, and in its anterior branches of the suture curving more evenly inwards and forwards.

Description.—Cranidium somewhat more than twice as wide as long, rounded in front, with a transversally short anterior border. Dorsal furrows deep, with a deep anterior pit near anterior end of glabella. Glabella long, strongly convex, almost vertical in front, with a long median, backwardly directed spine issuing from a point situated at a distance from posterior margin of cranidium exceeding one-third the length of the glabella; in front of spine an elongated median tubercle. Narrow occipital ring curving backwards. Fixed cheeks wider than those of *O. elatifrons*. Eyes small, situated far backwards. Posterior border furrow deep. Anterior branches of facial suture curve evenly forwards and inwards. Free cheek, attributed to the species, with a narrow wire-like border, and a very long, almost straight genal spine of rounded cross section.

Hypostome and thorax unknown.

Pygidium very short, more than three times as wide as long. Border widest at posterior end, bent vertically down, with a wide median emargination. Rhachis reaching to border, convex, with four or five rings. Pleural platforms with two pairs of pleural furrows.

Test probably ornamented with fine, raised, transverse lines.

Dimensions.—Length of large cranidium 3 mm, width 6.5 mm. Length of pygidium (pl. XI, fig. 12) 0.8 mm, width 2.8 mm.

Occurrence.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Stenbrottet, Mossebo. Jämtland: Brunflo. South Bothnian District?: boulder in glacial clay, Örebro, Närke. — A closely related species occurs sparsely in the succeeding zone of *Plesiomegalaspis planilimbata* (PU nos. N 304–309).

Family *Raphiophoridae* Angelin, 1854

Genus *Ampyx* Dalman, 1827

Genotype.—*Ampyx nasutus* Dalman, 1827.

Ampyx pater Holm, 1882

Pl. XI, figs. 13, 14.

1882 *Ampyx pater* Holm, Phyllogr. schiefer Dalecarl., p. 12, pl. 1, figs. 13, 14. (Description and figs. of cranidium).

1952 *Ampyx pater* Holm.—Skjeseth, L. Didymograptus Zone, p. 176, pl. 5, figs. 2, 4b, 7, 12–16. (Description and figs. of cranidium and free cheek).

Material.—Fragmentary carapace: PU no. N 687. Cranidia: RM nos. Ar. 9254 a, b, 9256. PU nos. N 417, 420, 532–534, 536, 537, 896. Free cheeks: PU nos. N 688, 689. Pygidia: PU nos. N 414, 418, 419, 535, 690–697.

Type data.—Lectotype (selected by Skjeseth, 1952) is the cranidium figured by Holm: RM no. Ar. 9254 a. It was collected at Skattungbyn in Dalarna from limestone beds intercalated with Lower Didymograptus shale and belonging to the zone of *Megalaspides dalecarlicus*.

Remarks.—The cranidium is short and wide, subsemicircular in outline, with a pear-shaped glabella not reaching to the anterior margin of the cranidium. It carries a long spine directed forwards and somewhat upwards. The muscle scars on the posterior portion of the glabella, if discernible, are extremely faint. No anterior border furrow is present. The posterior border furrow is well defined, curving forwards distally, and with a pit close to the facial suture. The free cheek is small, triangular, and drawn out into a long, curved genal spine, with a longitudinal furrow. The pygidium has not been figured so far. It is triangular in outline, short, about three times as wide as long. The border, which is widest at the rear end of the pygidium, is bent steeply down. In specimens preserved in shale or marl the border is delimited from the pleural platforms by a straight and sharp edge, while in pygidia collected from limestones the boundary is less distinct. The rhachis occupies in front about one-fifth the pygidial width. It tapers backwards and becomes nearly obliterated on the border. Five rings may be counted. The pleural platforms are horizontal, with a distinct anterior pleural furrow curving forwards laterally; occasionally traces of several furrows are discernible.

Occurrence.—Zone of *Megalaspides dalecarlicus* (Arenigian). — Dalarna: Skattungbyn. Närke: Lanna, Latorp. Östergötland: Västanå. South Bothnian District(?): boulder in glacial clay, Örebro, Närke. — Zone of *Plesiomegalaspis estonica* (Arenigian). — Närke: Lanna, Latorp, Yxhult. Öland: Ottenby.

Ampyx cf. *pater* Holm

Pl. XI, fig. 15.

Material.—Cranidia: PU nos. N 287, 788–790; D 447. Pygidium: PU no. N 778.

REMARKS.—A form closely related to or identical with *A. pater* appears already in the beds of the Hunneberg group. The internal mould of a pygidium preserved in limestone is figured here. Its rhachis reaches to the posterior margin and shows about ten rings. The pleural platforms have three pairs of pleural furrows.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Dalarna: Sjurberg. — Zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Närke: Lanna, Gymninge.

Ampyx obtusus MOBERG & SEGERBERG, 1906

Pl. XI, figs. 16–18.

1906 *Ampyx obtusus* MOBERG & SEGERBERG, Ceratopygeregionen, p. 100, pl. 7, figs. 8–10. (Description and figs. of cranidium and pygidium).

LECTOTYPE (here selected).—Cranidium: LP no. LO 1879 t (original of MOBERG & SEGERBERG, 1906, pl. 7, fig. 9). In this paper pl. XI, fig. 16.

OTHER MATERIAL.—Cranidia: LP no. LO 1878 T, PU nos. N 542–545, 699–701, 704, 897–901. Free cheeks: PU nos. N 217, 698. Pygidia: PU nos. N 166, 421, 703.

TYPE STRATUM and TYPE LOCALITY.—Layer of greenish grey marly shale in Upper Planilimbata limestone(?), Berg, Östergötland.

DIAGNOSIS.—Glabella strongly convex, with median keel and a spine issuing from middle of glabella and directed backwards. Distinct muscle scars on posterior portion of glabella. Anterior border furrow present. Pygidium subtriangular in outline, twice to nearly three times as wide as long. Border sloping steeply down, narrowest posteriorly. Posterior margin with a shallow emargination behind rhachis.

DESCRIPTION.—Cranidium subsemicircular in outline, about twice as wide as long. Dorsal and preglabellar furrows shallow, in the dorsal ones an elongated anterior pit somewhat ahead of greatest width of glabella. Glabella reaching to or close to anterior border furrow, pear-shaped, strongly convex in specimens preserved in limestone, vertical in front. Two pairs of rounded muscle scars on posterior portion of glabella close to dorsal furrows. Small median tubercle situated at a distance from front of glabella subequal to one-fourth the glabellar length; from this tubercle a median keel runs backwards to occipital furrow; a backwardly directed spine issues from the keel on midst of glabella. Occipital furrow broad; occipital ring narrow, curving backwards. Fixed cheek moderately convex. Anterior border sagittally narrow, flattened; anterior border furrow shallow. Posterior border furrow nearly straight, wide and deep, with a pit close to facial suture. Posterior border strongly convex. Free cheek small, triangular, drawn out into a long curved, flattened spine. Doublure narrow, continuous in front. Hypostome unknown.

Thoracic pleurae horizontal, bent down vertically at distal end, with a straight pleural furrow deepening outwards.

Pygidium subtriangular to subsemicircular in outline, twice to nearly three times as wide as long. Border sloping steeply down, narrowest posteriorly. Posterior margin with a wide and shallow emargination behind rhachis. Dorsal furrows well defined. Rhachis occupying about one-fourth the pygidial width in front, tapering strongly backwards, passing unto border. Five to ten rhachial rings discernible on internal moulds of specimens preserved in limestone. Pleural platforms horizontal, slightly convex, with two to six pairs of pleural furrows; the most anterior one always distinct, curving forwards distally, the others more or less faint.

AFFINITIES.—The species is related to *A. linnarssoni* F. SCHMIDT from the East Baltic limestones belonging to the subdivision $B_{II\alpha}$. In the latter species, however, the glabellar spine seems to be missing.

OCCURRENCE.—Zones of *Megalaspides dalecarlicus* and of *Plesiomegalaspis estonica* (Arenigian). — Östergötland: Berg. Närke: Lanna, Latorp, Yxhult. South Bothnian District(?): boulders in glacial clay, Örebro, Närke.

Genus *Lonchodomas* ANGELIN, 1854

GENOTYPE.—*Ampyx rostratus* SARS, d. BASSLER, 1915.

Lonchodomas sp.

MATERIAL.—Cranidium and pygidium: PU nos. N 547, 548.

REMARKS.—The cranidium is long, with a narrow, keeled glabella. The pygidium is somewhat more than twice as wide as long, with a narrow border of uniform breadth bent down vertically.

OCCURRENCE.—Zone of *Plesiomegalaspis estonica* (Arenigian). — Närke: Lanna.

Family *Selenecemidae* WHITTINGTON, 1952

Genus *Falanaspis* n. gen.

GENOTYPE (here selected). — *Falanaspis aliena* n. sp.

NAME.—The genus is named after the plain Falan in Västergötland, in which the type locality of the genotype is situated.

DIAGNOSIS.—Cephalon triangular, with long frontal and genal spines. Glabella circular in outline, smooth, with traces of an occipital furrow which delimits a short and narrow occipital ring. Cheeks continuous with a broad preglabellar area. Eyes absent. Plates uniting free cheeks in front carrying the frontal spine. Pygidium probably very small.

REMARKS.—The genus resembles *Seleneceme* CLARK in having a circular glabella, indications of a short and narrow occipital ring, faint traces of a pair of longitudinal furrows running forwards from the occipital furrow, a deep,

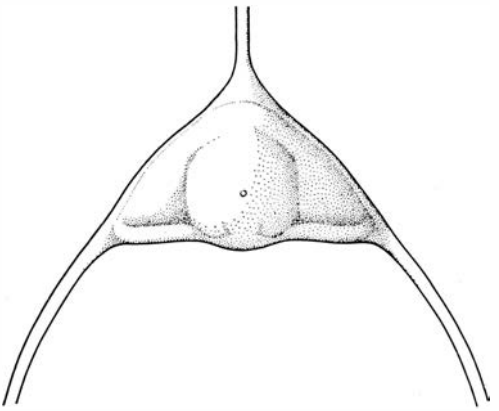


Fig. 44. Cephalon of *Falanaspis aliena* n. gen. and n. sp. from the zone of *Plesiomegalaspis armata* (early Arenigian). — 6 ×.

gently curving posterior border furrow, and cheeks continuous with a broad preglabellar area. It differs in lacking a median glabellar furrow, furthermore its frontal spine is separated from the cranidium by the facial suture.

Falanaspis aliena n. sp.

Pl. XI, figs. 19–21. Text-fig. 44.

NAME.—Latin *alienus* = strange.

HOLOTYPE (here selected). — Cranidium: PU no. Vg 389. Pl. XI, fig. 20.

OTHER MATERIAL.—Cranidia: PU nos. Vg 390–395. Free cheek: PU no. Vg 396. Frontal portion of cephalon: PU nos. 397, 398.

TYPE STRATUM and TYPE LOCALITY.—Thin layers of white limestone in glauconitic limestone, Stenbrottet, Västergötland.

DIAGNOSIS.—See that of genus.

DESCRIPTION.—Cephalon triangular in outline, with a long frontal spine and a pair of long, curving genal spines of rectangular cross section. Cranidium subtriangular in shape, with rounded anterior margin. Dorsal furrows shallow, with a shallow anterior pit. Preglabellar furrow faint. Glabella circular in outline, moderately convex, showing lateral traces of an occipital furrow delimiting a short and narrow occipital ring, and a pair of short and very faint longitudinal furrows issuing from the occipital furrow and running forwards. In front of these furrows two pairs of rounded muscle scars are often discernible. Low median tubercle situated somewhat behind middle of glabella. Fixed cheeks slope gently down to lateral margin. Preglabellar area broad sagittally, sloping forwards, continuous with fixed cheeks. Posterior border furrow slightly sigmoid, deep. Eyes absent. Course of facial suture as follows: laterally marginal; in front describing an even curve crossing the dorsal surface at base of frontal spine; postero-laterally curving across the same surface inside of genal spines.

Free cheeks drawn out into long genal spines, directed backwards and outwards; cheeks connected by triangular dorsal and ventral plates, carrying the long, straight frontal spine.

Hypostome, thorax and pygidium unknown.

DIMENSIONS.—Length of cranidium (holotype) 3.3 mm, width 5.8 mm.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Stenbrottet, Storeklev, Mossebo, N. Skagen (drilling core). Öland: Ottenby. Jämtland: Tossåsen.

Family uncertain

Genus *Euloma* ANGELIN, 1854

GENOTYPE.—*Euloma laeve* ANGELIN, 1854, d. VOGDES, 1925

Euloma laeve ANGELIN, 1854

Pl. XI, figs. 1–3. Text-fig. 45 B.

1854 *Euloma laeve* ANGELIN, Palaeont. Scand., p. 61, pl. 33, figs. 14 a, b. (Diagnosis and drawings of cranidium).

1940 *Euloma laeve* ANGELIN.—LAKE, British Cambr. Trilobites, p. 301. (Discussion on species).

LECTOTYPE (here selected). — Cranidium: RM no. Ar. 15812, labelled in the hand of ANGELIN: *Euloma laeve*, Östergötland. In this paper pl. XI, fig. 1.

OTHER MATERIAL.—Cranidia: PU nos. N 215, 717–720, 868, 888; RM nos. Ar. 21456, 21461, 21462. Free cheeks: RM no. Ar. 15812 (on the same slab as lectotype); N 550. Hypostome: N 887. Pygidia: PU nos. N 411, 722, 889, 890; RM nos. Ar. 21457–21460.

ORIGINAL DIAGNOSIS (translation). — *E.* cephalon with the apical groove intramarginal, devoid of excavated points.

REMARKS.—This diagnosis is neither sufficient for separating species of the genus *Euloma*, nor is it correct. On the type specimen no punctation is discernible (probably due to the careless preparation). A fragmentary cranidium on the same slab shows, however, some faint pits in the anterior border furrow.

NEW DIAGNOSIS.—The cranidium differs from that of *E. ornatum* in the following features: Anterior border more flattened; glabella somewhat shorter and with only two pairs of glabellar furrows; palpebral lobes considerably larger.

DESCRIPTION.—Cranidium twice as wide as long. Anterior border flattened. Anterior border furrow with a row of small pits, faint or absent on outside of test, distinct on internal mould. Dorsal furrows deep. Anterior pits well defined. Glabella convex, short, with two pairs of glabellar furrows. Fixed cheeks sloping steeply down to dorsal furrows. Ocular ridges, when discernible, run obliquely forwards, issuing from dorsal furrows opposite anterior margin of second glabellar furrow. Palpebral lobes very large, rising on type specimen to level

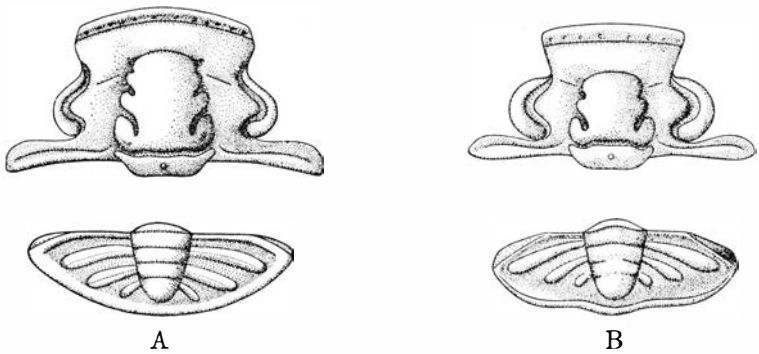


Fig. 45. A: Cranidium and pygidium of *Euloma ornatum* ANGELIN from the zone of *Apatokephalus serratus* (late Tremadocian). — About 1.5 ×. B: The same elements in *Euloma laeve* ANGELIN, zone of *Plesiomegalaspis estonica* (Arenigian). — About 2.5 ×.

of glabella. Posterior limbs long and slender, bent downwards laterally; posterior border furrow deep. The free cheek and a fragmentary hypostome resemble those of *E. ornatum.*

Thorax unknown.

Posterior margin of pygidium not as evenly rounded as in *E. ornatum*, curving inwards at both sides of rhachis. Rhachis with three rings and terminal portion. Side lobes bent downwards laterally, showing half-rib and three pairs of pleural ribs.

Test finely and densely granulated, pygidial border with terrace lines parallel to margin.

DIMENSIONS.—Length of cranidium (lectotype) 9 mm, width at posterior margin 17 mm. Length of pygidium (pl. XI, fig. 3) 2.5 mm, reconstructed width about 7 mm.

OCCURRENCE.—In the upper part of the zone of *Megalaspides dalecarlicus* and all through the zone of *Plesiomegalaspis estonica* (Arenigian). — Östergötland: Berg? Öland: Degerhamn, Borgholm, Äleklinta, Böda Hamn. Närke: Lanna, Latorp, Yxhult, Vilhelmsberg. Dalarna: Sjurberg. South Bothnian District?: boulders in glacial clay at Örebro, Närke.

Euloma ornatum ANGELIN, 1854

Pl. XI, figs. 4, 5. Text-fig. 45 A.

REMARKS.—One cranidium (PU no. Vg 151) is figured for comparison with that of *E. laeve.* The hypostome, hitherto not figured, resembles those of the olenids. It is lingulate, with narrow border. The central body is long and convex, and divided by a shallow transverse furrow into a long anterior and a short posterior lobe.

OCCURRENCE.—Zone of *Apatokephalus serratus* (late Tremadocian). — Common.

Euloma sp. no. 1

MATERIAL.—Three cranidia and one pygidium, too fragmentary for illustration, and one free cheek: PU nos. Vg 119–122.

REMARKS.—The specimens probably belong to a new species. It resembles *E. ornatum* in its three pairs of glabellar furrows. It differs in the following features: The convexity of the glabella and of the fixed cheeks is less pronounced, the glabella is somewhat shorter and wider; the pygidium is longer and more rectangular in outline, its posterior margin bent upwards and forwards.

OCCURRENCE.—Zone of *Plesiomegalaspis armata* (early Arenigian). — Västergötland: Storeklev.

Euloma sp. no. 2

MATERIAL.—One small cranidium with two pairs of glabellar furrows, and one fragmentary and poorly preserved pygidium, the latter resembling that of *E. ornatum*: PU nos. Vg 137–138.

OCCURRENCE.—Lowermost part of the zone of *Plesiomegalaspis planilimbata* (early Arenigian). — Västergötland: Storeklev.

Vertical distribution of brachiopod and trilobite species

Arenigian:

B 4. Zone of *Plesiomegalaspis estonica*.
B 3. ,, ,, *Megalaspides dalecarlicus*.
B 2. ,, ,, *Plesiomegalaspis planilimbata*.
B 1. ,, ,, *Plesiomegalaspis armata*.

Tremadocian:

A 6. Zone of *Apatokephalus serratus*.

	A6	B1	B2	B3	B4
Brachiopoda:					
Apheoorthis? suecica n. sp.		+			
Nanorthis? christianiae (KJERULF)	+				
N.? billingensis n. sp.		+			
"*Protorthis*" *hunnebergensis* WALCOTT			+		
Productorthis? sp.					+
Eostrophomena elegantula WALCOTT	+				
Lycophoria laevis STOLLEY		+			
L. sp.			+		
Trilobita:					
Geragnostus sidenbladhi (LINNARSSON)	+				
G. crassus n. sp.	+	+	+		
G. sp. aff. *crassus*					+
G. lepidus n. sp.		+			
G. wimani n. sp.			+		
Geragnostus? explanatus n. sp.			+		
G.? toernquisti (HOLM)				+	
G.? sp. no. 1			+		
G.? sp. no. 2				+	+
Trinodus mobergi n. sp.	+				
T. elliptifrons n. sp.			+		
Leiagnostus peltatus n. sp.			+		
Agerina praematura n. sp.	+				
A. erratica n. sp.					+
Shumardia cf. *pusilla* (SARS)	+				
S. sp.		+			
S. nericiensis WIMAN			+		
Ceratopyge forficula (SARS)	+				
Parabolinella sp.	+				
Parabolinella? spp. nos. 1 and 2		+	+		
Peltura? norvegica (MOBERG & MÖLLER)	+				
Triarthrus angelini LINNARSSON	+				
T. sp.		+			
Saltaspis sp.	+				
S. viator n. sp.		+			

	A6	B1	B2	B3	B4
Remopleuridiella sp. no. 1			+		
R. sp. no. 2					+
Apatokephalus serratus (BOECK)	+				
A. sp.		+			
A. pecten WIMAN			+		
Menoparia? *nericiensis* n. sp.					+
Dikelokephalina dicraeura (ANGELIN)	+				
Nileus limbatus BRÖGGER	+	+	+		
N. exarmatus n. sp.			+	+	+
N. orbiculatus n. sp.			+		
Nileus? sp.					+
Symphysurus (*Symph.*) *angustatus* (SARS & BOECK)	+	+	+		
S. sp.					+
Platypeltoides serus n. sp.		+			
Varvia longicauda n. sp.	+				
V. falensis n. sp.		+			
V. breviceps (ANGELIN)			+		
Symphysurina? *oriens* (MOBERG & SEGERBERG)	+				
S? *perseverans* n. sp.			+		
Lapidaria tenella n. sp.		+			
L. rugosa n. sp.			+		
Niobe insignis LINNARSSON	+				
N. incerta n. sp.		+			
N. emarginula ANGELIN			+		
Niobella obsoleta (LINNARSSON)	+				
N. bohlini n. sp.		?	+		
N. sp. aff. *imparilimbata* (BOHLIN)				+	+
Niobina sp.	+				
Plesiomegalaspis (*Ples.*) *planilimbata* (ANG.)			+		
P. (*Ples.*) *estonica* n. sp.					+
P. (*Ples.*) aff. *estonica*			+		
P. (*Ples.*) *norvegica* n. sp.				+	
P. (*Ples.*) *scutata* n. sp.				+	
P. (*Eker.*) *armata* n. sp.		+			
P. (*Eker.*) *heroides* (BRÖGGER)			+		
Plesiomegalaspis? spp. nos. 1–3		+	+		
Megalaspides (*Lann.*) *nericiensis* WIMAN			+		
M. (*Meg.*) *dalecarlicus* (HOLM)				+	
M. (*Meg.*) *paliformis* n. sp.				+	
M. (*Meg.*) sp.					+
Promegalaspides (*Borog.*) *intactus* (MOB. & SEG.)	+				
P. (*Borog.*) sp.		+			
P. (*Borog.*) *stenorhachis* (ANG.)			+		
Hunnebergia retusa n. sp.		+			
Asaphus sp.					+
Genus and species indet.				+	
Cyclopyge latifrons n. sp.	+				
C. gallica n. sp.			+		

	A6	B1	B2	B3	B4
Raymondaspis brevicauda n. sp.			+		
R. sp. no. 1				+	
R. sp. no. 2					+
R. infundibularis n. sp.					+
Illaenus? sp.		+			
Dysplanus? sp. no. 1			+		
D.? sp. no. 2				+	
Odontopleurid trilobite		+			
Glaphurina? *insolita* n. sp.			+		
"*Protopliomerops*" *primigenius* (ANGELIN)	+				
"*P.*" *toernquisti* (HOLM)				+	
Pliomerops sp.		+			
P. actinurus (DALMAN)			+		
Cyrtometopus priscus n. sp.					+
Parapilekia speciosa (DALMAN)	+				
Sphaerexochus? sp.					+
Harpides rugosus (SARS & BOECK)	+				
H. spp.		+	+	+	+
Selenoharpes excavatus (LINNARSSON)				+	
S. spp.			+		+
Orometopus elatifrons (ANGELIN)	+				
O. grypos n. sp.		+			
O. sp.			+		
Ampyx pater HOLM				+	+
A. cf *pater*		+	+		
A. obtusus MOBERG & SEGERBERG				+	+
A. cf. *obtusus*			+		
Lonchodomas sp.					+
Falanaspis aliena n. sp.		+			
Diaphanometopus lineatus (DALMAN)			+		
D. sp.				+	
Euloma ornatum ANGELIN	+				
E. sp. no. 1		+			
E. sp. no. 2			+		
E. laeve ANGELIN				+	+

References

Abbreviations:

G.F.F. = Geologiska Föreningens Förhandlingar.
N.G.T. = Norsk Geologisk Tidskrift.
S.G.U. = Sveriges Geologiska Undersökning.

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PLATES

Explanation of Plates

All the specimens illustrated were photographed after whitening with ammonium chloride by Mr. N. HJORTH at the Palæontological Institution of Uppsala. External moulds were taken in inversed light.

The plates were mounted by Mr. E. STÅHL, and the figures retouched slightly by the author.

Unless stated otherwise, the specimens are preserved in limestone.

Plate I

Apheoorthis? suecica n.sp. (Zone of *P. armata.*)—Page 186.

Fig. 1. Ventral valve. Holotype. Kinnekulle mountain, Västergötland. Coll. E. WIRÉN. PU no. Vg 590. 5 ×.

2. Dorsal valve. Stora Stolan, Västergötland. PU no. Vg 498. 5 ×.

Nanorthis? billingensis n.sp. (Zone of *P. armata.*)—Page 187.

Fig. 3. Ventral valve. Stenbrottet, Västergötland. PU no. Vg 499. 2.5 ×.

4. Dorsal valve. Holotype. Stora Stolan, Västergötland. PU no. Vg 460. 2.5 ×.

Geragnostus sidenbladhi (LINNARSSON). (Zone of *A. serratus.*)—Page 188.

Fig. 5. Cephalon. Mossebo, Västergötland. Coll. G. HOLM. PU no. Vg 155. 8 ×.

6. Pygidium. Mossebo, Västergötland. Coll. G. HOLM. PU no. Vg 156. 7 ×.

Geragnostus crassus n.sp.—Page 190.

Fig. 7. Internal mould of cephalon. (Zone of *P. armata.*) Stenbrottet, Västergötland. PU no. Vg 448. 7 ×.

8. Internal mould of pygidium. Holotype. (Zone of *A. serratus.*) Stenbrottet, Västergötland. PU no. Vg 279. 8 ×.

Geragnostus lepidus n.sp. (Zone of *P. armata.*)—Page 191.

Fig. 9. Cephalon. Stenbrottet, Västergötland. PU no. Vg 441. 6 ×.

10. Internal mould of pygidium. Holotype. Stenbrottet, Västergötland. PU no. Vg 444. 8.5 ×.

Geragnostus wimani n.sp. (Zone of *P. planilimbata.*)—Page 192.

Fig. 11. Internal mould of cephalon. Grönviken, Öland. PU no. Öl 288. 6 ×.

12. Pygidium, in shale. Holotype. Lanna, Närke. Coll. J. G. ANDERSSON. RM no. Ar. 12291. 9 ×.

Geragnostus? explanatus n.sp. (Zone of *P. planilimbata.*)—Page 193.

Fig. 13. Cephalon. Gymninge, Närke. PU no. N 793. 9 ×.

14. Pygidium. Holotype. Lanna, Närke. PU no. N 290. 7 ×.

Geragnostus? sp. no. 2. (Zone of *M. dalecarlicus.*)—Page 194.

Fig. 15. Cephalon. South Bothnian District?: Örebro (boulder) PU no. N 877. 9 ×.

Trinodus elliptifrons n.sp. (Zone of *P. planilimbata.*)—Page 196.

Fig. 16. Cephalon, in shale. Holotype. Original of WIMAN, 1905, pl. 1, fig. 21. Lanna, Närke. RM no. Ar. 12331a. 8 ×.

17. Pygidium of the same specimen. WIMAN, 1905, pl. 1, fig. 22. 8 ×.

Trinodus mobergi n.sp. (Zone of *A. serratus.*)—Page 195.

Fig. 18. Cephalon. Holotype. Stenbrottet, Västergötland. PU no. Vg 281. 10 ×.

19. Pygidium. Stenbrottet, Västergötland. PU no. Vg 284. 10 ×.

Leiagnostus peltatus n.sp. (Zone of *P. planilimbata.*)—Page 197.

Fig. 20. Cephalon, in shale. Original of WIMAN, 1905, pl. 1, fig. 26. RM no. Ar. 12341. Lanna, Närke. 8 ×.

21. Pygidium, in shale. Holotype. WIMAN, 1905, pl. 1, fig. 25. RM no. Ar. 12340. Lanna, Närke. 9 ×.

Agerina praematura n.sp. (Zone of *A. serratus.*)—Page 200.

Fig. 22. Cranidium. Holotype. Stenbrottet, Västergötland. PU no. Vg 267. 5 ×.

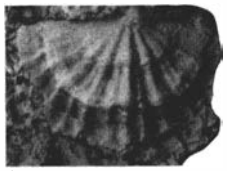
23. Pygidium. Stenbrottet, Västergötland. PU no. Vg 271. 6 ×.

Agerina erratica n.sp. (Zone of *P. estonica.*)—Page 198.

Fig. 24. Cephalon. Holotype. Lanna, Närke. PU no. N 557. 6 ×.

25. Free cheek. South Bothnian District?: Örebro (boulder). PU no. N 878. 10 ×.

26. Pygidium. South Bothnian District?: Örebro (boulder). PU no. N 879. 12 ×.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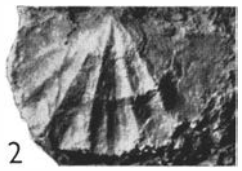
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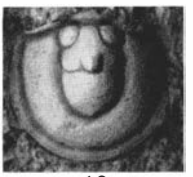
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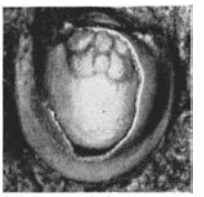
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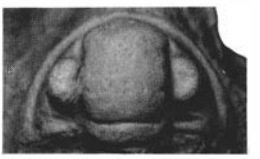
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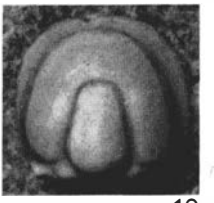
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Plate II

Saltaspis viator n.sp. (Zone of *P. armata*.)—Page 201.

Fig. 1. Internal mould of cranidium. Holotype. Stenbrottet, Västergötland. PU no. Vg 412. 5 ×.
2. Internal mould of free cheek. Stenbrottet, Västergötland. PU no. Vg 422. 4 ×.
3. Internal mould of pygidium. Stenbrottet, Västergötland. PU no. Vg 427. 5 ×.

Saltaspis sp. (Zone of *A. serratus*.)—Page 203.

Fig. 4. Cranidium. Stenbrottet, Västergötland. PU no. Vg 300. 3 ×.

Remopleuridiella sp. no. 1. (Zone of *P. planilimbata*.)—Page 203.

Fig. 5. Cranidium. Hagaberg, Närke. PU no. N 854. 3 ×.
6. External mould of free cheek, in shale. Lanna, Närke. PU no. N 292. 5 ×.

Apatokephalus serratus (Boeck). (Zone of *A. serratus*.)—Page 204.

Fig. 7. Cranidium. Stenbrottet, Västergötland. PU no. Vg 243. 3 ×.
8. Free cheek. Trolmen, Västergötland. Coll. A. H. Westergård. SGU. 2.5 ×.

Menoparia? nericiensis n.sp. (Zone of *P. estonica*.)—Page 206.

Fig. 9. Internal mould of cranidium, in shale. Holotype. Yxhult, Närke. PU no. N 669. 2 ×.
10. Internal mould of free cheek, in shale. Yxhult, Närke. PU no. N 670. 2 ×.
11. External mould of pygidium, in shale. Yxhult, Närke. PU no. N 671. About 3 ×.

Nileus limbatus Brögger. (Zone of *A. serratus*.)—Page 208.

Fig. 12. Hypostome. Original of Moberg & Segerberg, 1906, pl. 6, fig. 5. Ottenby, Öland. LP no. LO 1855t. 3 ×.
13. Internal mould of cranidium. Stenbrottet, Västergötland. PU no. Vg 253. 3 ×.
14. Fragmentary cephalon. Ottenby, Öland. PU no. Öl 145. 3.5 ×
15. Posterior portion of thorax and pygidium. Original of Moberg & Segerberg, 1906, pl. 6, fig. 2. Fågelsång, Skåne. LP no. LO 1852t. 1.5 ×.

Nileus exarmatus n.sp.—Page 209.

Fig. 16. Hypostome. (Zone of *P. estonica*.) Grönhögen, Öland. Coll. B. Bohlin. PU no. Öl 290. 4 ×.
17. Cranidium. (Zone of *M. dalecarlicus*.) Lanna, Närke. PU no. N 399. 3 ×.
18, 19. Almost complete specimen. Holotype. (Zone of *M. dalecarlicus*.) Latorp, Närke. PU no. N 155. 2.5 ×.
20. Small cephalon with genal spines. (Zone of *P. estonica*.) Lanna, Närke. PU no. N 497. 5 ×.
21. Pygidium. Lowermost Limbata limestone. Lanna, Närke. PU no. N 518. 2 ×.

Nileus orbiculatus n.sp. (Zone of *P. planilimbata*.)—Page 210.

Fig. 22. Internal mould of cranidium. Holotype. Gymninge, Närke. PU no. N 796. 2 ×.
23. Pygidium. Gymninge, Närke. PU no. N 797. 2.5 ×.

Symphysurus angustatus (Sars & Boeck). (Zone of *P. planilimbata*.)—Page 211.

Fig. 24. Internal mould of cranidium. Gymninge, Närke. PU no. N 771. 1.75 ×.
25. Pygidium. Gymninge, Närke. PU no. N 772. 1.5 ×.


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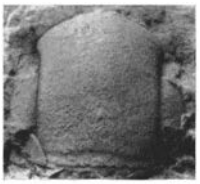
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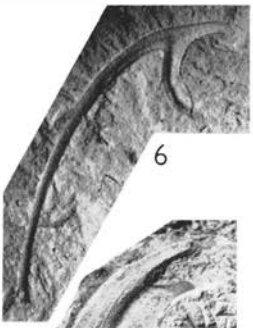
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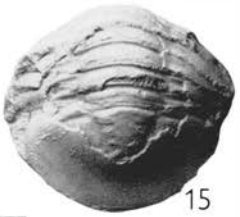
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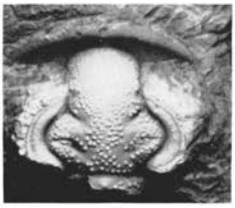
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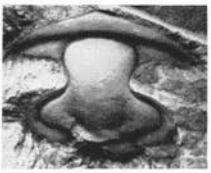
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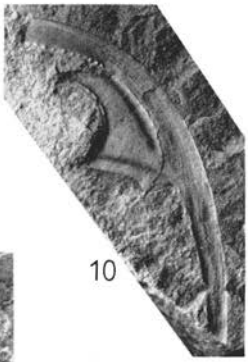
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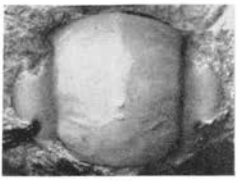
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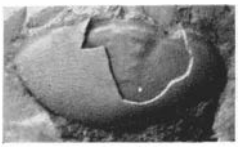
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Plate III

Varvia breviceps (ANGELIN). (Zone of *P. planilimbata.*)—Page 213.

Fig. 1. Internal mould of cranidium. Lectotype. Oltorp, Västergötland. Coll. N. P. ANGELIN. RM no. Ar. 14651. 2.5 ×.
2. Internal mould of cranidium. Gymninge, Närke. PU no. N 741. 2.5 ×.
3. Free cheek in ventral view, in shale. Stenbrottet, Västergötland. Coll. B. WÆRN. PU no. Vg 595. 4 ×.
4. External mould of hypostome, in shale. Stenbrottet, Västergötland. Coll. B. WÆRN. PU no. Vg 604. 5 ×.
5. Pygidium, in shale. Stenbrottet, Västergötland. Coll. B. WÆRN. PU no. Vg 596. 2.5 ×.
6. Internal mould of pygidium. Örsta, Närke. PU no. N 732. 2.5 ×.

Varvia falensis n.sp. (Zone of *P. armata.*)—Page 214.

Fig. 7. Internal mould of cranidium. Stenbrottet, Västergötland. PU no. Vg 357. 3 ×.
8. Cranidium. Holotype. Stenbrottet, Västergötland. PU no. Vg 358. 4 ×.
9. Pygidium. Stenbrottet, Västergötland. PU no. Vg 366. 3.5 ×.

Varvia longicauda n.sp. (Zone of *A. serratus.*)—Page 215.

Fig. 10. Internal mould of cranidium. Stenbrottet, Västergötland. PU no. Vg 249. 1.75 ×.
11. Rubber cast of cranidium, thorax, and pygidium. Holotype. Stenbrottet, Västergötland. PU no. Vg 248. 3 ×.

Symphysurina? *oriens* (MOBERG & SEGERBERG). (Zone of *A. serratus.*)—Page 217.

Fig. 12, 13, 14. Internal mould of cranidium in anterior, dorsal, and lateral view. Holotype. Original of MOBERG & SEGERBERG, 1906, pl. 7, fig. 2. Ottenby, Öland. LP no. LO 1873T. 2 ×.
15. Internal mould of cranidium in anterior view. Stenbrottet, Västergötland. Coll. L. v. POST. PU no. Vg 258. 3 ×.
16. Free cheek. Stenbrottet, Västergötland. PU no. Vg 260. 6 ×.
17. Internal mould of pygidium. Ottenby, Öland. PU no. Öl 147. 3.2 ×.
18. Pygidium in ventral view showing the doublure. Stenbrottet, Västergötland. PU no. Vg 261. 4 ×.

Symphysurina? *perseverans* n.sp. (Zone of *P. planilimbata.*)—Page 218.

Fig. 19, 20, 21. Internal mould of cranidium in posterior, lateral, and anterior view. Holotype. Oltorp, Västergötland. PU no. Vg 576. 2.5 ×.
22. Pygidium. Oltorp, Västergötland. Coll. N. P. ANGELIN. RM no. Ar. 14657. About 3 ×.

Platypeltoides serus n.sp. (Zone of *P. armata.*)—Page 219.

Fig. 23. Hypostome, belonging to the specimen illustrated in Plate IV, fig. 1. 1 ×.


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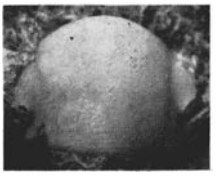
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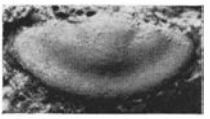
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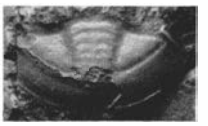
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Plate IV

Platypeltoides serus n.sp. (Zone of *P. armata*.)—Page 219.

Fig. 1. Almost complete specimen. Holotype. Nygård, Hunneberg mountain. Coll. G. v. SCHMALENSEE. SGU. 0.5 ×.

2. Fragmentary cranidium. Fågelsång, Skåne. Coll. C. O. SEGERBERG. LP. 0.5 ×.

Lapidaria tenella n.sp. (Zone of *P. armata*.)—Page 221.

Fig. 3. Cranidium. Holotype. Stenbrottet, Västergötland. PU no. Vg 370. 3 ×.

4. Internal mould of small cranidium. Stenbrottet, Västergötland. PU no. Vg 371. 6 ×.

5. Free cheek. Stenbrottet, Västergötland. PU no. Vg 377. 1.5 ×.

6. Internal mould of free cheek. Stenbrottet, Västergötland. PU no. Vg 376. 3 ×.

7. Internal mould of pygidium (rubber cast). Stenbrottet, Västergötland. PU no. Vg 379. About 2.5 ×.

Lapidaria rugosa n.sp. (Zone of *P. planilimbata*.)—Page 222.

Fig. 8. Cranidium. Holotype. Yxhult, Närke. Coll. R. JOHANSSON. PU no. N 627. 1 ×.

9. Pygidium. Latorp, Närke. PU no. N 78. 1 ×.

Niobe insignis LINNARSSON. (Zone of *A. serratus*.)—Page 224.

Fig. 10. Hypostome. Hunneberg. Coll. G. v. SCHMALENSEE. SGU no. Aa. 40. 1 ×.

Niobe incerta n.sp. (Zone of *P. armata*.)—Page 225.

Fig. 11. Cranidium. Storeklev., Hunneberg. PU no. Vg 114. 1.5 ×.

12. Hypostome. Stenbrottet, Västergötland. PU no. Vg 342. 3 ×.

13. Pygidium. Holotype. Storeklev, Hunneberg. PU no. Vg 113. 1.5 ×.

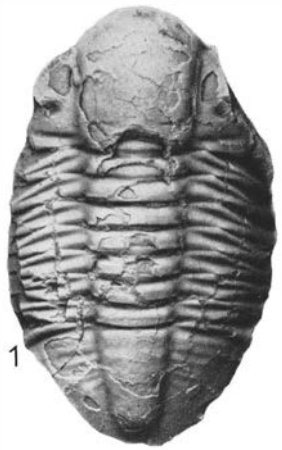
Niobe emarginula ANGELIN. (Zone of *P. planilimbata*.)—Page 226.

Fig. 14. Internal mould of cranidium. Lectotype. Oltorp, Västergötland. Coll. N. P. ANGELIN. RM no. Ar. 14284. 1 ×.

15. Internal mould of hypostome. Oltorp, Västergötland. Coll. N. P. ANGELIN. Original of BRÖGGER, 1886, pl. 2, fig. 33. RM no. Ar. 14283. 1 ×. Background softened.

16. Pygidium. Stenbrottet, Västergötland. Coll. TUNBLAD. PU no. Vg 607. 0.7 ×.

17. Fragmentary pygidium. Oltorp, Västergötland. Coll. N. P. ANGELIN. RM no. Ar. 14285. 1 ×.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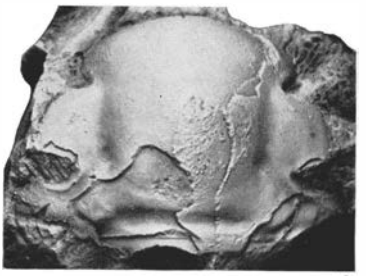
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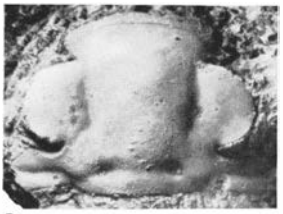
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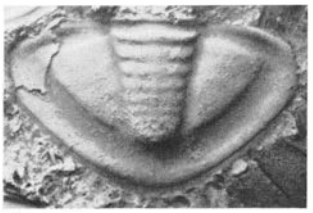
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Plate V

Niobella obsoleta (LINNARSSON). (Zone of *A. serratus*.)—Page 229.

Fig. 1. Internal mould of cranidium, attributed to the species. Ottenby, Öland. Coll. B. BOHLIN. PU no. Öl 139. 2.5 ×.

2. Pygidium. Lectotype. Mossebo, Hunneberg. Probably the original of LINNARSSON, 1869, pl. 2, fig. 35. SGU. 1.5 ×.

Niobella sp. aff. *obsoleta* (LINNARSSON) no. 2. (Zone of *P. planilimbata*.)—Page 231.

Fig. 3. Fragmentary pygidium. Gymninge, Närke. PU no. N 794. 1 ×.

Niobella bohlini n.sp. (Zone of *P. planilimbata*.)—Page 231.

Fig. 4. Cephalon of almost complete specimen. Holotype. Hagaberg, Närke. PU no. N 839. 3 ×.

5. Pygidium of the same specimen. Holotype. Hagaberg, Närke. 3 ×.

6. Internal mould of cranidium (plaster cast). Hagaberg, Närke. PU no. N 840. 1.5 ×.

7. Internal mould of hypostome. Hagaberg, Närke. PU no. N 841. 2.5 ×.

8. Pygidium. Gymninge, Närke. PU no. N 746. 2.5 ×.

9. Pygidium. Gymninge, Närke. PU no. N 745. 1.5 ×.

Niobella imparilimbata (BOHLIN). Lowermost Limbata limestone.—Page 232.

Fig. 10. Pygidium. Lanna, Närke. PU no. N 599. 1.5 ×.

Niobella sp. aff. *imparilimbata* (BOHLIN). (Billingen group.)—Page 233.

Fig. 11. Cranidium. (Zone of *P. estonica*.) Lanna, Närke. PU no. N 475. 1.5 ×.

12. Internal mould of hypostome. (Zone of *M. dalecarlicus*.) Lanna, Närke. PU no. N 385. 1.5 ×.

13. Pygidium (plaster cast). (Zone of *P. estonica*.) Lanna, Närke. PU no. N 477. 1 ×.

14. Free cheek, mould of ventral surface. (Zone of *P. estonica*.) Yxhult, Närke. PU no. N 664. 1 ×.

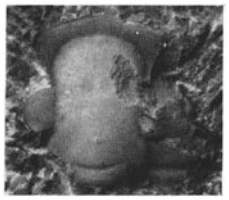
Niobella laeviceps (DALMAN). Expansus limestone?—Page 233.

Fig. 15. Cephalon and anterior portion of thorax. Probably the original of ANGELIN, 1851, pl. 11, fig. 1. Husbyfjöl, Östergötland. Coll. J. W. DALMAN, 1827. RM no. Ar. 46001. 1 ×.

16. Pygidium of almost complete specimen. Probably the original of ANGELIN, 1851, pl. 11, fig. 1. Husbyfjöl, Östergötland. RM no. Ar. 46000. 1 ×.

Niobina sp. (Zone of *A. serratus*.)—Page 234.

Fig. 17. Pygidium. Hunneberg, Västergötland. Coll. G. VON SCHMALENSEE. SGU no. Aa. 40. 0.75 ×. The pleurae of the right side lobe are distorted pathologically.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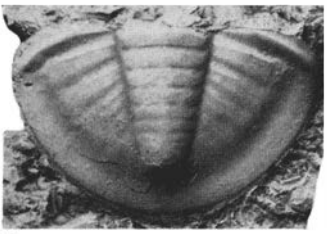
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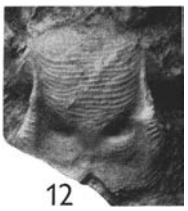
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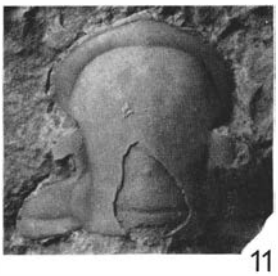
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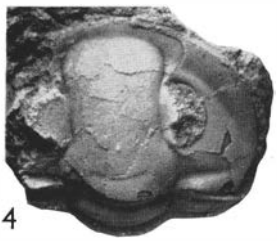
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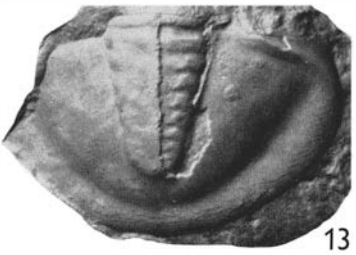
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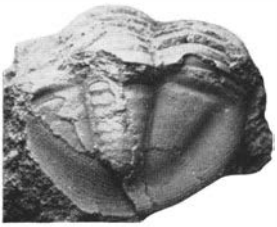
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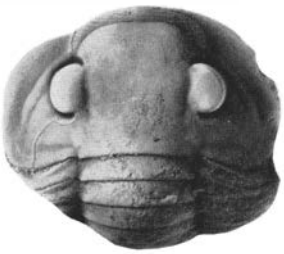
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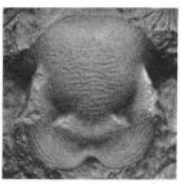
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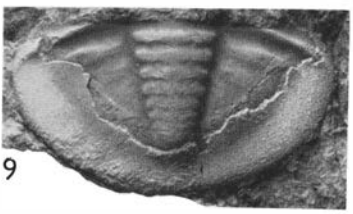
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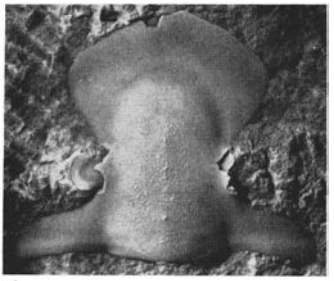
Plate VI

Plesiomegalaspis (*Plesiomegalaspis*) *planilimbata* (ANGELIN). (Zone of *P. planilimbata*.)—Page 235.

Fig. 1. Cranidium. Lanna, Närke. PU no. N 246. 2 ×.
2. Internal mould of cranidium (plaster cast). Latorp, Närke. PU no. N 31. 1 ×.
3. Internal mould of free cheek. Latorp, Närke. PU no. N 32. 1 ×.
4, 5. Hypostome in ventral and lateral view. Vilhelmsberg, Närke. PU no. N 914. 1.5 ×.
6. Pygidium. Grönviken, Öland. PU no. Öl 286. 2 ×.
7. Internal mould of pygidium from the type stratum of the type locality. Oltorp, Västergötland. PU no. Vg 548. 1.5 ×.
8. Hypostome attributed to the species. Grönviken, Öland. PU no. Öl 285. 2.5 ×.
9. Panderian organ of the free cheek. Hagaberg, Närke. PU no. N 826. 2 ×.

Plesiomegalaspis (*Plesiomegalaspis*) *estonica* n.sp. (Zone of *P. estonica*.)—Page 238.

Fig. 10. Internal mould of cranidium (plaster cast). Lanna, Närke. PU no. N 428. 1 ×.
11. Free cheek. Lanna, Närke. PU no. N 429. 0.75 ×.
12. Hypostome collected from the lowermost part of the zone. Lanna, Närke. PU no. N 430. 1 ×.
13. Internal mould of forked hypostome attributed to the species. Latorp, Närke. PU no. N 167. 1.25 ×.
14. Internal mould of pygidium. Tomten, Västergötland. PU no. Vg 592. 1 ×.
15. Pygidium. Holotype. Vilhelmsberg, Närke. PU no. N 863. About 0.75 ×.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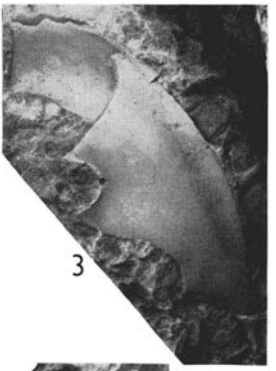
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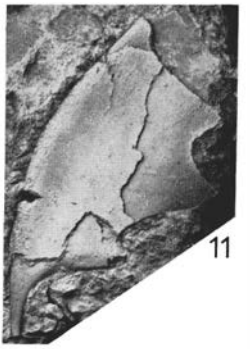
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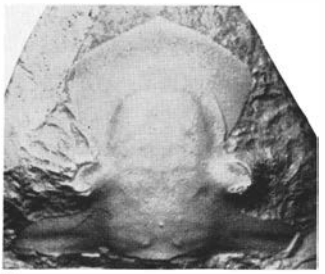
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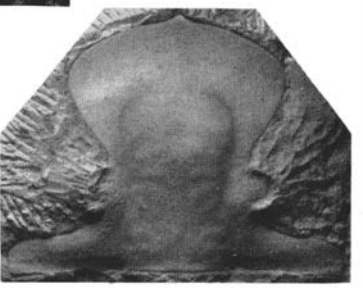
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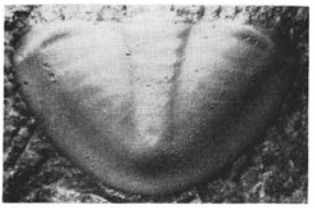
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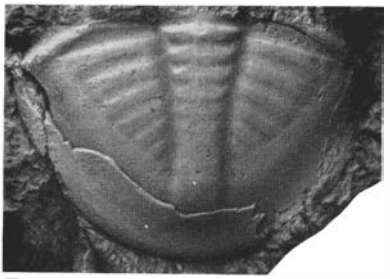
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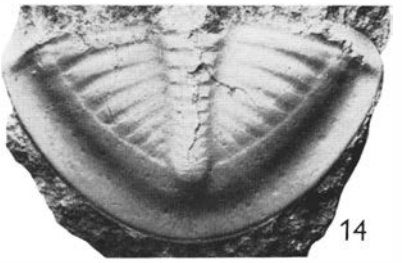
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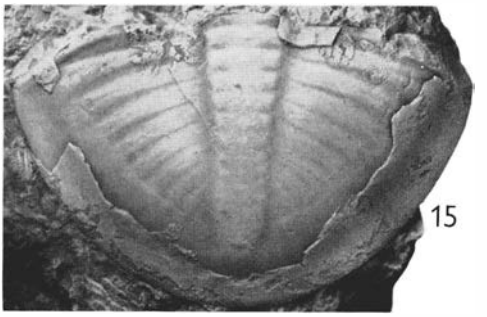
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Plate VII

Plesiomegalaspis (*Plesiomegalaspis*) *norvegica* n. sp. (Zone of *M. dalecarlicus*.)—Page 240.

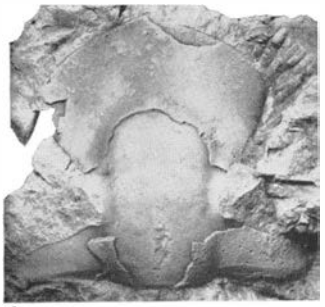
Fig. 1. Cranidium attributed to the species. Lanna, Närke. PU no. N 371. About 1 ×.
2. Pygidium. Holotype. Ottestad, Mjøsa District, Norway. OPM no. 61137. 1 ×.
3. Internal mould of pygidium. Lanna, Närke. PU no. N 372. 1 ×.

Plesiomegalaspis (*Plesiomegalaspis*) *scutata* n. sp. (Zone of *M. dalecarlicus*.)—Page 241.

Fig. 4. Cranidium. Vilhelmsberg, Närke. PU no. N 858. About 1 ×.
5. Internal mould of pygidium. Holotype. Vilhelmsberg, Närke. PU no. N 859. 0.7 ×.
6. Internal mould of fragmentary pygidium (plaster cast). Lanna, Närke. PU no. N 381. 0.75 ×.

Plesiomegalaspis (*Ekeraspis*) *armata* n. sp. (Zone of *P. armata*.)—Page 242.

Fig. 7. Internal mould of cranidium (rubber cast). Stenbrottet, Västergötland. PU no. Vg 310. About 1 ×.
8. Hypostome. Stenbrottet, Västergötland. PU no. Vg 320. 3 ×.
9. Hypostome in lateral view. Stenbrottet, Västergötland. PU no. Vg 321. 4 ×.
10. Small free cheek. Stenbrottet, Västergötland. PU no. Vg 317. 3 ×.
11. Internal mould of pygidium. Holotype. Stenbrottet, Västergötland. PU no. Vg 329. 1.5 ×.
12. Internal mould of large pygidium. Stenbrottet, Västergötland. PU no. Vg 307. 1 ×.
13. Panderian organ of free cheek. Stenbrottet, Västergötland, PU no. Vg 318. 2 ×.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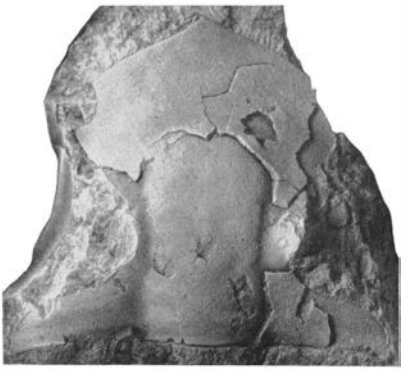
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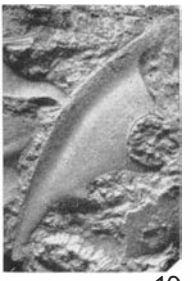
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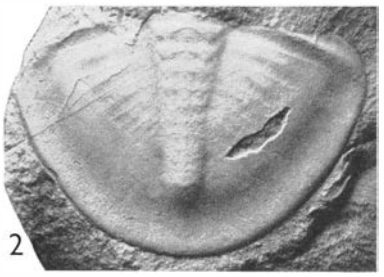
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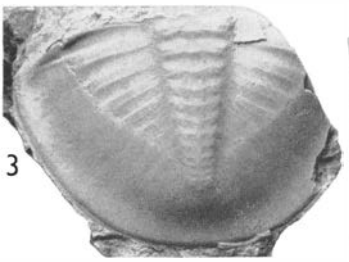
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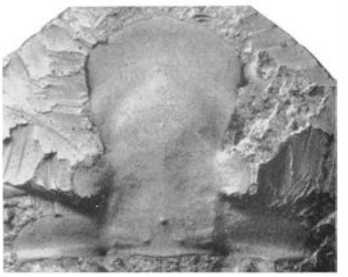
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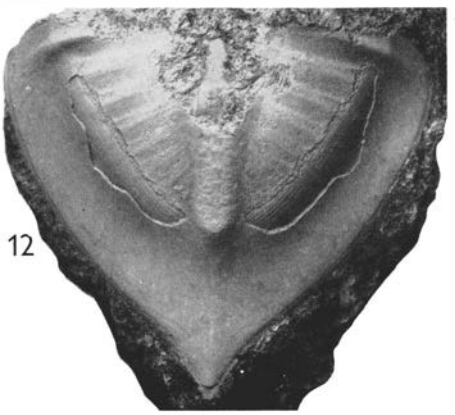
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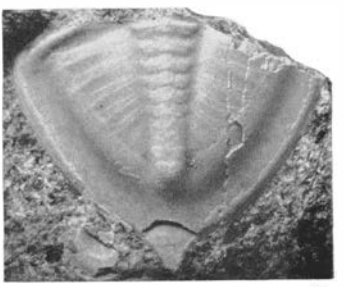
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Plate VIII

Plesiomegalaspis (*Ekeraspis*) *heroides* (BRÖGGER). (Zone of *P. planilimbata*.)—Page 244.

Fig. 1. Internal mould of cranidium. Stenbrottet, Västergötland. PU no. Vg 475. 1 ×.
2. Pygidium. Original of BRÖGGER, 1882, pl. 4, fig. 3. Krekling, Norway. OPM no. H 2643. 1 ×.
3. Pygidium. Mossebo, Hunneberg. Coll. G. VON SCHMALENSEE. SGU 1 ×.
4. Pygidium. Limön, South Bothnian District. Coll. C. WIMAN. PU no. B 253. 1 ×.

Plesiomegalaspis? sp. no. 1. (Zone of *P. armata*.)—Page 246.

Fig. 5. Pygidium. Stenbrottet. Västergötland. PU no. Vg 339. 3 ×.

Plesiomegalaspis? sp. no. 2. (Zone of *P. planilimbata*.)—Page 246.

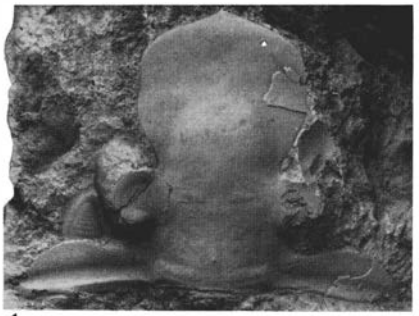
Fig. 6. Fragmentary pygidium. Sjurberg, Dalarna. PU no. D 463. 1 ×.

Megalaspides (*Megalaspides*) *dalecarlicus* (HOLM). (Zone of *M. dalecarlicus*.)—Page 247.

Fig. 7. Almost complete specimen. Skultorp, Västergötland. PU no. Vg 545. 1.75 ×.
8, 9. Hypostome in ventral and lateral view. Latorp, Närke. PU no. N 137. 3 ×.
10. Cranidium. Latorp, Närke. PU no. N 136. About 1.5 ×.
11. Panderian organ of free cheek. Lanna, Närke. PU no. N 338. 1.5 ×.
12. Internal mould of pygidium. Latorp, Närke. PU no. N 138. 1.5 ×.
13. Cephalon and anterior portion of thorax of small specimen. Lectotype. Original of HOLM, 1882a, pl. 1, fig. 6. Skattungbyn, Dalarna. RM no. Ar. 9294. 2 ×.

Megalaspides (*Megalaspides*) *paliformis* n. sp. (Zone of *M. dalecarlicus*.)—Page 249.

Fig. 14. Internal mould of cranidium. Latorp, Närke. PU no. N 141. About 1 ×.
15. Internal mould of pygidium. Holotype. Latorp, Närke. PU no. N 140. 1.5 ×.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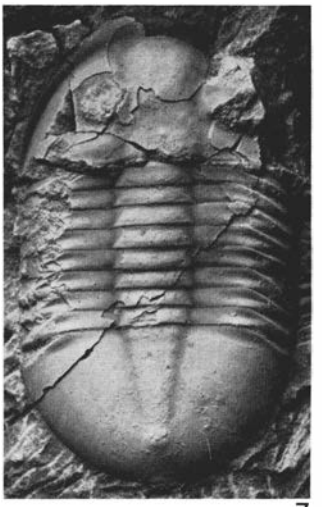
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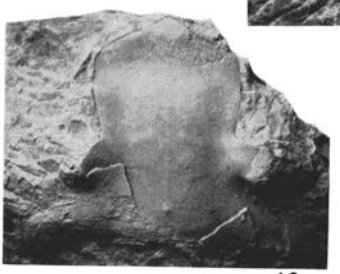
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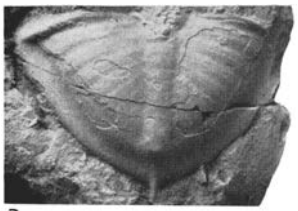
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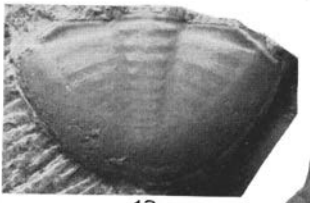
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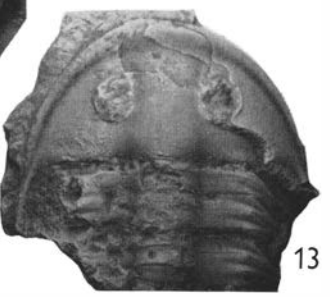
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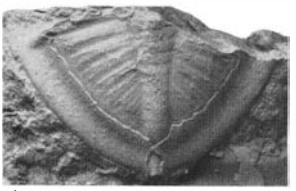
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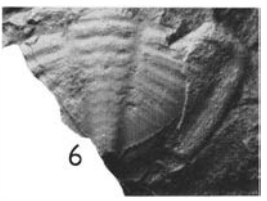
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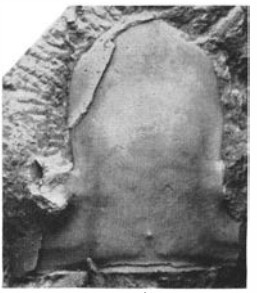
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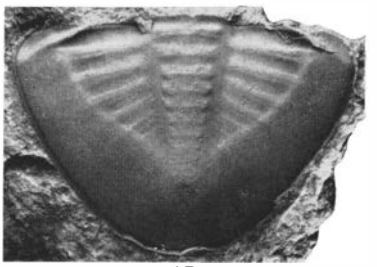
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Plate IX

Megalaspides (*Lannacus*) *nericiensis* WIMAN. (Zone of *P. planilimbata*.)—Page 251.

Fig. 1. Almost complete specimen from a nodule of limestone embedded in dark shale belonging to the zone of *Didymograptus balticus*. Left side lobe deformed pathologically. Mossebo, Hunneberg. Coll. R. TILSTAM. PU no. Vg 215. About 1 ×.

2. Cranidium, in shale. Lectotype. Original of WIMAN, 1905, pl. 2, fig. 3. Lanna, Närke. RM no. Ar. 12820. 1 ×.

3. Pygidium. Yxhult, Närke. Coll. J. G. ANDERSSON. PU no. N 617. 1.5 ×.

4. Hypostome belonging to the specimen illustrated in fig. 1 (rubber cast). 2 ×.

5. Free cheek belonging to the same specimen (rubber cast). 1 ×.

Promegalaspides (*Borogothus*) *stenorhachis* (ANGELIN). (Zone of *P. planilimbata*.)—Page 253.

Fig. 6. Internal mould of cranidium. Borghamn, Östergötland. Coll. G. VON SCHMALENSEE. SGU no. Aa 130. About 1 ×.

7. Internal mould of free cheek (rubber cast). Oltorp, Västergötland. PU no. Vg 583. 3 ×.

8. Panderian organ of free cheek. Stenbrottet, Västergötland. PU no. Vg 478. 2 ×.

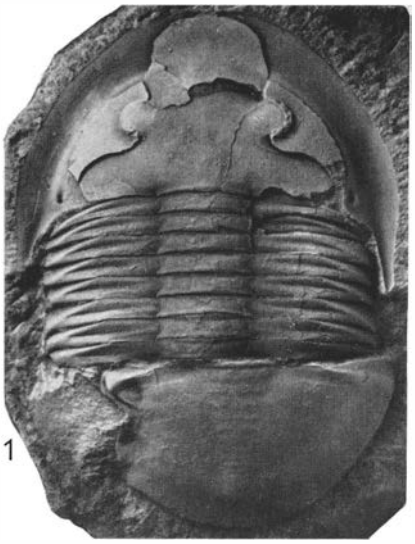
9, 10. Hypostome in ventral and lateral view. Latorp, Närke. PU no. N 60. 2 ×.

11. Pygidium. Uddagården, Västergötland. PU no. Vg 584. 1.5 ×.

12. Internal mould of pygidium. Gymninge, Närke. PU no. N 764. 1.5 ×.

13. Pleura of last thoracic segment, in shale. Stenbrottet, Västergötland. Coll. B. WÆRN. PU no. Vg 605. 1.25 ×.

14. Almost complete specimen of the same species (?) Mossebo, Hunneberg. Coll. G. VON SCHMALENSEE. SGU Aa 40. 1.5 ×.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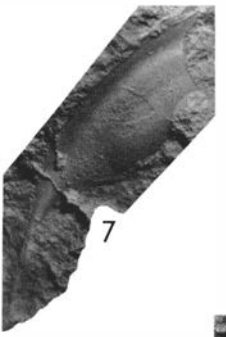
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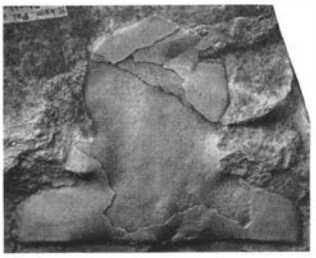
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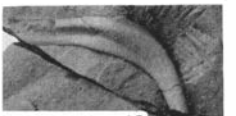
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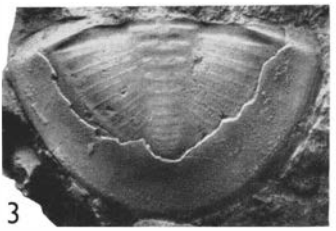
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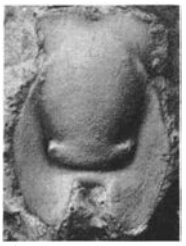
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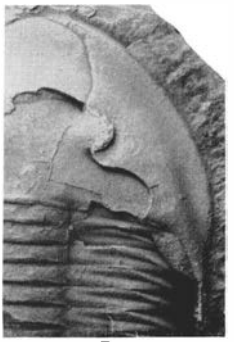
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Plate X

Promegalaspides (*Borogothus*) *intactus* (MOBERG & SEGERBERG). (Zone of *A. serratus*.)—Page 255.

Fig. 1. Internal mould of fragmentary cranidium. Bjerkaasholmen, Oslo Fjord, Norway. Coll. G. HOLM. RM. About 2 ×.

2. Fragmentary cranidium. Tyri Fjord, Norway. Coll. G. HOLM. RM. 1.5 ×.

3. Fragmentary pygidium. Lectotype. Original of MOBERG & SEGERBERG, 1906, pl. 6, fig. 21. Fågelsång, Skåne. LP no. LO 1871t. About 3 ×.

4. Fragmentary pygidium. Original of MOBERG & SEGERBERG, pl. 6, fig. 20. Fågelsång, Skåne. LP no. LO 1870T. 2 ×.

Hunnebergia retusa n. sp. (Zone of *P. armata*.)—Page 257.

Fig. 5. Cranidium (rubber cast). Storeklev, Hunneberg. PU no. Vg 109. 2 ×.

6. Pygidium (plaster cast). Holotype. Hunneberg, Västergötland. Coll. G. LINNARSSON?. SGU no. Aa 40. 1 ×.

Genus and species indet. (Zone of *M. dalecarlicus*.)—Page 258.

Fig. 7. Distorted cranidium. Lanna, Närke. PU no. N 396. 1.5 ×.

8. Internal mould of pygidium. Lanna, Närke. PU no. N 397. 1.5 ×.

Cyclopyge latifrons n. sp. (Zone of *A. serratus*.)—Page 259.

Fig. 9, 10, 11. Cranidium in dorsal, lateral, and anterior view. Holotype. Ottenby, Öland. PU no. Öl 153. 2.5 ×.

Cyclopyge gallica n. sp. (Zone of *P. planilimbata*.)—Page 260.

Fig. 12, 13, 14. Cranidium in dorsal, lateral, and anterior view. Holotype. Hagaberg, Närke. PU no. N 851. 4 ×.

15. Pygidium. Gymninge, Närke. PU no. N 808. 4 ×.

16. Internal mould of fragmentary pygidium. Lanna, Närke. PU no. N 286. 4 ×.

Bronteopsis? *toernquisti* (MOBERG & SEGERBERG). (Zone of *A. serratus*?)—Page 261.

Fig. 17. Internal mould of pygidium. Ottenby, Öland. Coll. S. L. TÖRNQUIST. Original of MOBERG & SEGERBERG, 1906, pl. 7, fig. 6. LP no. LO 1877T. 2 ×.

Raymondaspis brevicauda n. sp. (Zone of *P. planilimbata*.)—Page 262.

Fig. 18. Pygidium. Holotype. Gymninge, Närke. PU no. N 800. 3 ×.

Raymondaspis infundibularis n. sp. (Zone of *P. estonica*.)—Page 263.

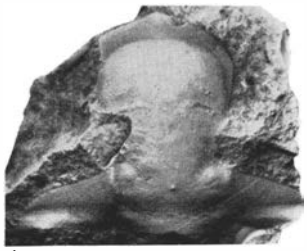
Fig. 19. Pygidium. Holotype. Vilhelmsberg, Närke. PU no. N 867. 2.5 ×.

Glaphurina? *insolita* n. sp. (Zone of *P. planilimbata*.)—Page 265.

Fig. 20, 21. Cranidium in anterior and dorsal view. Holotype. Latorp, Närke. PU no. N 86. 3 ×.

Sphaerexochus? sp. (Zone of *P. estonica*.)—Page 268.

Fig. 22. Internal mould of cranidium, in shale. Yxhult, Närke. PU no. N 713. 2 ×.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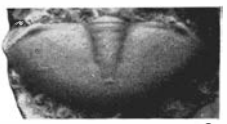
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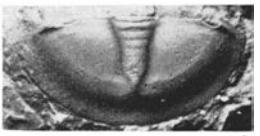
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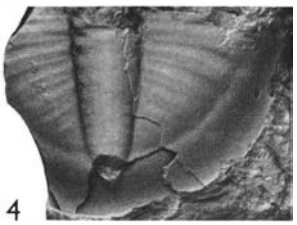
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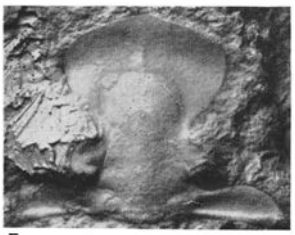
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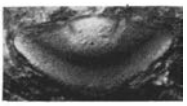
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Plate XI

Euloma laeve ANGELIN. (Zone of *P. estonica*.)—Page 274.

Fig. 1. Cranidium. Lectotype. Original of ANGELIN, 1854, pl. 33, fig. 14?. Berg?, Östergötland. Coll. J. BERZELIUS. RM no. Ar. 15812. 2.5 ×.

2. Fragmentary cranidium, in shale. Yxhult, Närke. PU no. N 717. 2.5 ×.

3. Fragmentary pygidium. Borgholm, Öland. Coll. G. HOLM. RM no. Ar. 21460. 5 ×.

Euloma ornatum ANGELIN. (Zone of *A. serratus*.)—Page 275.

Fig. 4. Internal mould of cranidium. Mossebo, Hunneberg. Coll. G. HOLM. PU no. Vg 151. 1.5 ×.

5. Internal mould of hypostome. Hunneberg, Västergötland. Coll. G. VON SCHMALENSEE. SGU. 4 ×.

Cyrtometopus priscus n.sp. (Zone of *P. estonica*.)—Page 266.

Fig. 6, 7. Fragmentary cranidium in dorsal and lateral view. Yxhult, Närke. PU no. N 549. About 3 ×.

8. Pygidium, in shale. Holotype. Yxhult, Närke. PU no. N 709. 2.5 ×.

Orometopus grypos n.sp. (Zone of *P. armata*.)—Page 269.

Fig. 9, 10. Internal mould of cranidium in lateral and dorsal view. Holotype. Stenbrottet, Västergötland. PU no. Vg 399. 10 ×.

11. Free cheek attributed to the species. South Bothnian District?, Örebro, Närke (boulder). PU no. N 891. 10 ×.

12. Pygidium. Stenbrottet, Västergötland. PU no. Vg 405. 10 ×.

Ampyx pater HOLM. (Zone of *M. dalecarlicus*.)—Page 270.

Fig. 13. Cranidium. South Bothnian District?, Örebro, Närke (boulder). PU no. N 896. 5 ×.

14. Internal mould of pygidium. Lanna, Närke. PU no. N 414. 4 ×.

Ampyx cf. *pater* HOLM. (Zone of *P. planilimbata*.)—Page 270.

Fig. 15. Internal mould of pygidium. Gymninge, Närke. PU no. N 778. 4 ×.

Ampyx obtusus MOBERG & SEGERBERG. (Billingen group.)—Page 271.

Fig. 16. Internal mould of cranidium, in shale. Lectotype. Original of MOBERG & SEGERBERG, 1906, pl. 7, fig. 9. Berg, Östergötland. (Zone of *M. dalecarlicus*?) LP no. LO 1879t. 3 ×.

17. Posterior portion of thorax and pygidium, in shale. Original of MOBERG & SEGERBERG, 1906, pl. 7, fig. 10. Berg, Östergötland. (Zone of *M. dalecarlicus*?) LP no. LO 1880t. 2.5 ×.

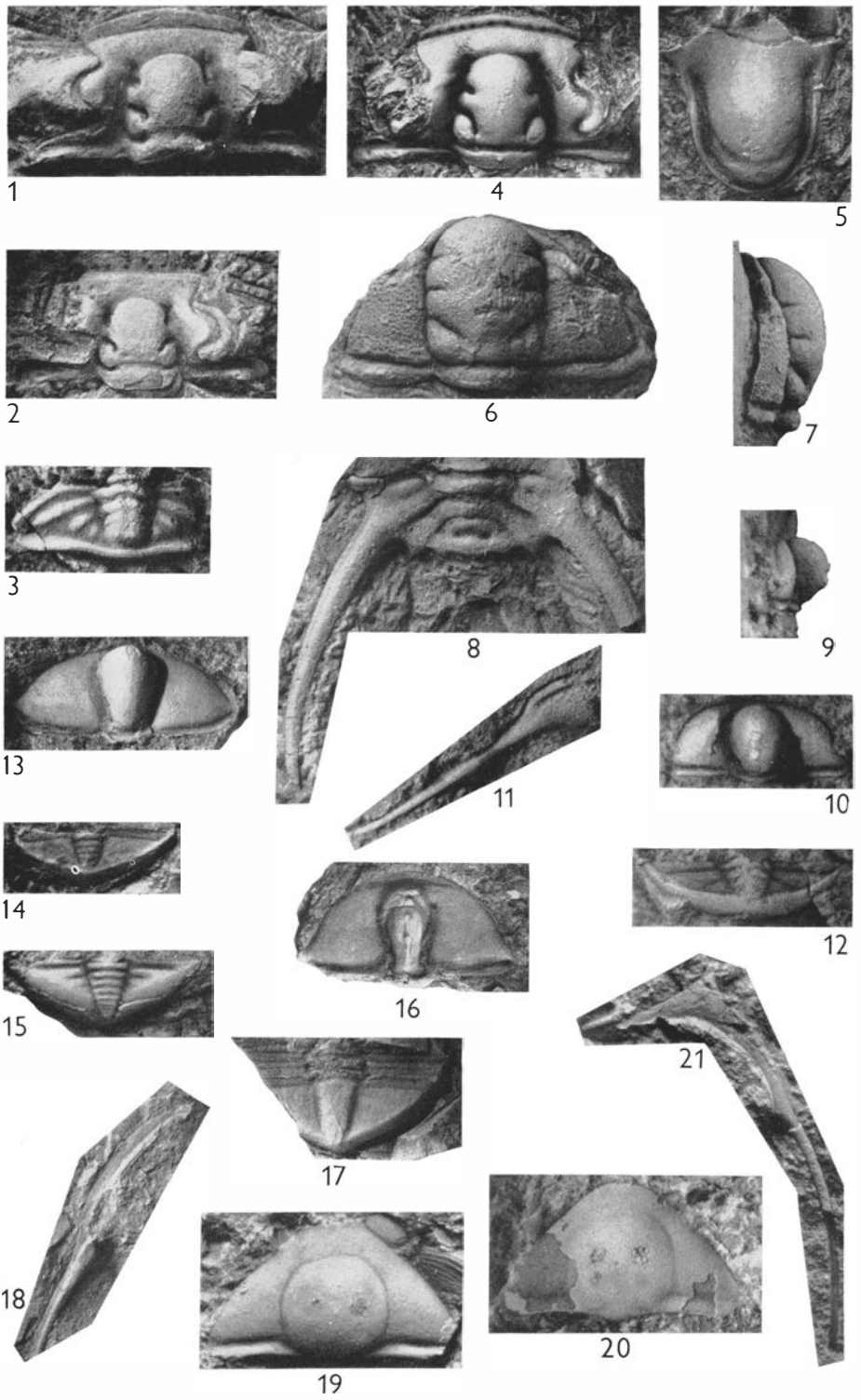
18. Free cheek, in shale. Yxhult, Närke. (Zone of *P. estonica*.) PU no. N 698. 3 ×.

Falanaspis aliena n.sp. (Zone of *P. armata*.)—Page 273.

Fig. 19. Internal mould of cranidium. Stenbrottet, Västergötland. PU no. Vg 390. 5 ×.

20. Cranidium. Holotype. Stenbrottet, Västergötland. PU no. Vg 389. 6 ×.

21. Frontal portion of cephalon and free cheek. Stenbrottet, Västergötland. PU no. Vg 396. 6 ×.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