Lower and Middle Viruan (Middle Ordovician) of the Siljan District

By

Valdar Jaanusson

ABSTRACT.—The described sequence comprises the Viruan (Middle Ordovician) Lasnamägi and Uhaku Stages and the Dalby Limestone (Kukruse and Idavere Stages of the Estonian sequence). For the local sequence of the Siljan district the topo-stratigraphic and litho-stratigraphic divisions previously distinguished on southern Öland (JAANUSSON 1960 a) are used. New topo-stratigraphic terms are Vikarby Limestone and Kårgärde Limestone, members of the Segerstad Limestone, for subdivisions previously termed in the Siljan district the zones of *Illaenus planifrons* and *Angelinoceras latum*, respectively. In the western and evidently also the north-eastern part of the district the Lasnamägian Skärlöv, Seby, and Folkeslunda Limestones are fully developed, and their thickness is close to that of these formations on southern Öland. In the south-eastern part of the district (the Vikarby section) the Skärlöv Limestone is missing, and a considerably reduced sequence of the Seby Limestone overlies directly the Aserian Segerstad Limestone. The Uhakuan Furudal Limestone consists of calcilutites; its total thickness is still unknown. The Dalby Limestone is preponderantly a calcarenite, and its thickness seems to agree closely with that in Östergötland.

Reasons are given, why the use of the terms *Schroeteri* Limestone (or Stage) and *Crassicauda* Limestone (or Stage) in the current sense ought to be discontinued.

Contents

Introduction

This paper deals with the description of the Lower and Middle Viruan (Middle Ordovician) sequence of the Siljan district. It covers the interval between the top of the Segerstad Limestone (described as the *Platyurus* Limestone by JAANUSSON & MUTVEI 1953) and the top of the complex of bentonitic beds. In the general account of the Viru Series of the district the present paper is a direct continuation of the description of the *Platyurus* (= Segerstad) Limestone by JAANUSSON & MUTVEI (1953) and can be said to be continued, as far as the description of the lithology is concerned, by the paper by MARTNA (1955) dealing with the suprabentonitic Viruan beds of the normal (i.e. interreef) facies.

The described sequence is fairly similar to that of southern Öland (JAANUSSON 1960a) and Östergötland (JAANUSSON 1962a), and the same topo-stratigraphic (JAANUSSON 1960a) classification can easily be applied (cf. Table 1). New terms are Kårgärde Limestone and Vikarby Limestone, members of the Segerstad Limestone. These names are introduced for the divisions called by JAANUSSON & MUTVEI (1953) the zone of *Lituites* (= *Angelinoceras*) *latus* and the zone of *Illaenus planifrons*, respectively. As shown by these authors the lowermost part of the *Platyurus* (= Segerstad) Limestone yields the fauna of the zone of *Angelinoceras latum*, and the uppermost part of the formation contains species which characterize the zone of *Illaenus planifrons*. The beds with the distinctive assemblage of each zone are separated by poorly fossiliferous beds included, on lithological grounds, within the lower zone. Each of the zones as defined by them has a distinctive lithology and is easily distinguishable in the Siljan district. However, it is not known, whether or not the lithological boundary between the zones coincides with the change in the fauna. For this reason it is more correct to treat these subdivisions as separate litho-stratigraphic members of the Segerstad Limestone than as faunal zones. With respect to the faunal subdivision the conditions on Öland are the same as in the Siljan district. Also there the beds with the assemblage of the zones of *Angelinoceras latum* and *Illaenus planifrons* are separated by beds without distinctive fossils, and the exact level of the boundary between the zones cannot be determined at present (JAANUSSON 1960a). The lithological difference between the beds with the *Illaenus planifrons* fauna and the underlying division is, however, slight, and it is difficult to recognize these divisions by their lithology alone. For this reason the terms Kårgärde and Vikarby Members can at present scarcely be applied to the corresponding parts of the sequence of Öland. This is true also for Östergötland.

HISTORICAL REVIEW.—A short account of the history of the Segerstad Limestone (*Platyurus* Stage in JAANUSSON & MUTVEI 1953) in the Siljan district has been given by JAANUSSON & MUTVEI (1953, pp. 7—8). The overlying reddish-brown beds of the Lasnamägi Stage, the Skärlöv and Seby Formations, were included by TÖRNQUIST (1874, 1883), together with the Segerstad Limestone and the upper, reddish-brown limestones of the Kunda Stage, in his Upper Red Orthoceratite Limestone. The Folkeslunda Limestone formed together with the Furudal Limestone the Upper Grey Orthoceratite Limestone of TÖRNQUIST (1874). Later TÖRNQUIST (1883) separated the beds roughly corresponding to the Furudal Limestone as a special division, Flagkalk, and restricted the term Upper Grey Orthoceratite Limestone to the beds which here are termed the Folkeslunda Limestone. MOBERG (1890) proposed a new classification of the Orthoceratite Limestone based on the sequence of southern Öland and compared the Upper Grey Orthoceratite Limestone with his *Centaurus* Limestone, and the Flagkalk with the *Stromboli-*

Table 1

<table>
<tr><th rowspan="2">TÖRNQUIST 1883</th><th rowspan="2">WARBURG 1910</th><th rowspan="2">Current use prior to this paper</th><th rowspan="2">Graptolite zones</th><th colspan="3">This paper</th></tr>
<tr><th colspan="2">Topo-stratigraphic units</th><th>Chrono-stratigraphic units</th></tr>
<tr><td rowspan="2">Cystidékalk</td><td rowspan="2">Cystidean Limestone</td><td rowspan="2">[Bentonitic beds and infrabentonitic part of] Ludibundus Limestone</td><td>Zone of Diplograptus multidens (lower part)</td><td colspan="2" rowspan="2">Dalby Limestone</td><td rowspan="2"></td></tr>
<tr><td>Zone of Nemagraptus gracilis</td></tr>
<tr><td>Flagkalk</td><td>Ancistroceras Limestone</td><td>Crassicauda Limestone</td><td>Zone of Glyptograptus teretiusculus</td><td colspan="2">Furudal Limestone</td><td>Uhaku Stage</td></tr>
<tr><td>Övre grå ortocerkalk</td><td>Chiron Limestone</td><td rowspan="3">Schroeteri Limestone</td><td>?</td><td colspan="2">Folkeslunda Limestone</td><td rowspan="3">Lasnamägi Stage</td></tr>
<tr><td rowspan="4">Övre röd ortocerkalk</td><td rowspan="2">?</td><td rowspan="4">Zone of Didymograptus murchisoni</td><td colspan="2">Seby Limestone</td></tr>
<tr><td colspan="2">Skärlöv Limestone</td></tr>
<tr><td rowspan="2">Platyurus Limestone</td><td rowspan="2">Platyurus Limestone</td><td rowspan="2">Segerstad Limestone</td><td>Vikarby L.</td><td rowspan="2">Aseri Stage</td></tr>
<tr><td>Kårgärde L.</td></tr>
</table>

tuites Limestone. This classification was generally accepted and in a somewhat simplified form used also in the Siljan district. The name of the *Centaurus* Limestone was changed by WIMAN (1908) into *Chiron* Limestone and, later, by WESTERGÅRD (1939) into *Schroeteri* Limestone in accordance with the changes of the name of its index fossil. *Strombolituites* is a junior synonym of *Ancistroceras*, and MOBERG's division with this name was renamed by WIMAN (1902) *Ancistroceras* Limestone. JAANUSSON (1947) replaced the term Flagkalk by "*Crassicauda* Limestone".

The beds included here in the Dalby Limestone were separated by TÖRNQUIST (1867) as the Cystidean Limestone, although it is difficult to understand exactly, where he drew the upper boundary of this division. Following WIMAN (1907) and THORSLUND (1938) the division has been termed the Older *Chasmops* Limestone or the Lower *Chasmops* Limestone, respectively. It forms the main part of the *Ludibundus* Limestone as defined by JAANUSSON (1951).

After TÖRNQUIST's pioneer work no new data about the stratigraphy of the sequence dealt with in this paper have been published for a long time. The application of MOBERG's classification from southern Öland without renewed observations about the range of the index fossils resulted in a somewhat over-simplified stratigraphic scheme. Some of the boundaries between TÖRNQUIST's litho-stratigraphic units, based on the colour of the rock, were assumed to coincide with those of the zones. Thus the reddish-brown beds of the Lasnamägian age, the Skärlöv and Seby Limestones, were usually included in the *Platyurus* Limestone, or escaped attention. The correlation between the *Ancistroceras* Limestone of southern Öland, very poorly defined by MOBERG

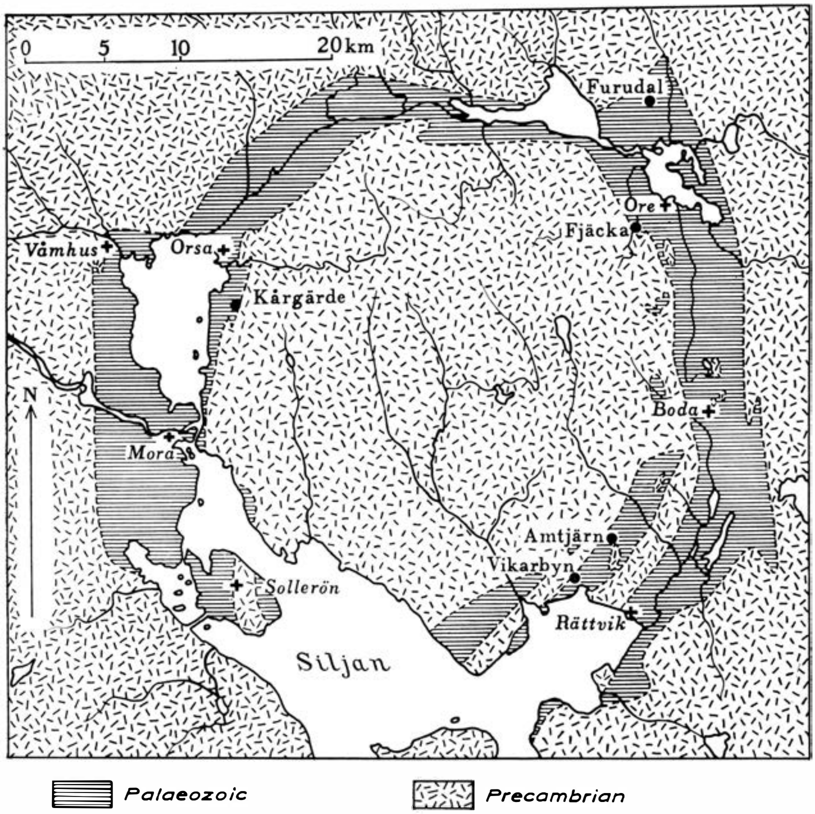

Fig. 1. Geological map of the Siljan district, Dalarna, showing the location of the localities described in this paper. After P. THORSLUND.

(1890), and TÖRNQUIST's Flagkalk was difficult to prove, and as the published information was scanty also about the Flagkalk, this division was occasionally omitted from the stratigraphic scheme of the Siljan district (THORSLUND 1936).

The classification used in the present paper as well as its comparison with the previously distinguished subdivisions is given in Table 1. It should be noted that the upper boundary of the Furudal Limestone is situated at a somewhat lower level than the upper boundary of the Flagkalk or *Crassicauda* Limestone as defined by TÖRNQUIST (1883) or JAANUSSON (1947), respectively (cf. also pp. 35–36).

The field work which has resulted in the present paper was carried out during parts of the summers of 1945, 1946, and 1947 by a group of Estonian undergraduate students. In short periods of the summers 1948, 1950 and 1960 the localities have been revisited during excursions or complementary field work. In the field work participated Messrs. (now Drs.) JÜRI MARTNA, HARRY MUTVEI, HINREK NEUHAUS, and the present writer, and during a short period also Mr. (now Dr.) JAAN TERASMÄE. The scope of the field work included most of the Ordovician sequence of the district. Some of the results are still unpublished. The strata described in this paper are now much less exposed than in Törnquist's days, since almost all small quarries have been abandoned long ago and are now overgrown by vegetation. Some parts of the sequence were not exposed at all. In order to obtain continuous sections through the sequence in question excavations had to be made in several places. In addition to the description of the Segerstad Limestone by Jaanusson & Mutvei (1953) some stratigraphic results concerning the Lower and Middle Viruan strata of the district, based on the above field work, have been published by Jaanusson (1947) and Jaanusson & Martna (1948). Jaanusson & Mutvei (1953) have also given a section through the lowermost beds of the Lasnamägi Stage at Fjäcka, Martna (1955) has treated the lithology of the limestone of the topmost Dalby Limestone, and Jaanusson (in Thorslund & Jaanusson 1960) has briefly described the entire section of the excavation at Vikarbyn.

Acknowledgements.—The present paper has been elaborated at the Palaeontological Institute of Uppsala University, and the writer is very much indebted to the successive directors of the Institute, the late Professor Gunnar Säve-Söderbergh, the late Dr. Elsa Warburg, and Professor Per Thorslund for much generous help. Thanks are also due to Dr. Stig Bergström, Lund, for placing his extensive series of samples from the main section of Fjäcka at the writer's disposal for the search for small fossils, and to Dr. Bengt Collini, Uppsala, för X-ray analysis of authigenic minerals from the Vikarbyn section. Without the enthusiastic and inspiring assistance during the field work by my friends Drs. Jüri Martna, Harry Mutvei, Hinrek Neuhaus, and Jaan Terasmäe the present paper could not have been completed. The help from the technical staff of the Palaeontological Institute, Uppsala, during the laboratorial investigation and at all stages of the preparation of the paper, is thankfully acknowledged.

Methods.—From every section that was studied in detail a series of samples was taken. The main part of each sample was crushed and searched for ostracodes and other small fossils. A part of each sample was subjected to microlithological examination, the methods used being those summarized by Jaanusson (1960 a). In some sections additional samples were secured for the search for small fossils only. However, for obtaining a detailed picture about the range of small fossils still smaller intervals between the samples would have been advantageous in some of the sections.

When collecting large fossils in the field great care was bestowed upon determining the exact level of the specimens found. In the examined exposures the dip is mostly vertical or nearly so, and this made the determination of the level easier than in beds which lie horizontally or have a gentle dip.

Taxonomic and Nomenclatural Notes.—(1) The examination of Krause's types of Ordovician ostracodes showed that several of the species established by him are senior subjective synonyms of species described by subsequent writers (Jaanusson 1962 b). This involves the following Lower and

Middle Viruan species occurring in the Siljan district: *Tallinnella angustata* (KRAUSE) (syn. *T. dimorpha* ÖPIK), *Euprimites bursa* (KRAUSE) (syn. *E. bursellus* JAANUSSON), and *Uhakiella labrosa* (KRAUSE) (syn. *U. aequigranosa* JAANUSSON).

(2) Additional comprehensive material of Uhakuan species of *Sigmoopsis* with pitted surface of the lobes showed that it is very difficult to distinguish between *S. bergsbrunnae* JAAN. and *S. perpunctata* (ÖPIK). It is still difficult to decide, whether this depends upon their being conspecific or reflects the usual difficulty in identifying closely similar species of ostracodes on material still partly embedded in the rock. In this paper these species are considered as synonyms.

(3) Lately the taxonomy of the *Illaenus schroeteri* group has been briefly dealt with by JAANUSSON (1960a, pp. 221–222). Meanwhile the writer has had the opportunity of examining the type of *Trilobites schroeteri* SCHLOTHEIM, 1823, now deposited in the Geological Museum of the Humboldt University, East Berlin. The holotype (by monotypy), a well-preserved pygidium with the inner margin of the doublure exposed in the middle, comes from an oolitic limestone of the Aseri Stage in the vicinity of Tallinn, Estonia. It is stratigraphically older than any known specimen of this group from Sweden and differs in several characters from these. The pronounced difference in the development of the pygidial doublure clearly shows that *I. schroeteri* is not conspecific with the forms described as *I. chiron* HOLM and *I. chiron* var. *stacyi* HOLM. Further, the success in developing the inner margin of the pygidial doublure in *I. stacyi* showed that also this form cannot be regarded as conspecific with *I. chiron*, but represents a well-defined separate species. However, the cephala of *I. chiron* and *I. stacyi* are so similar that a clear distinction is extremely difficult; it is also almost impossible to separate small pygidia not showing the doublure. Such specimens, belonging to either *I. chiron* or *I. stacyi* but unidentifiable at the specific level, are in this paper referred to as *I.* sp. indet. (cf. *chiron* HOLM). In JAANUSSON 1960a, the forms named *I. schroeteri schroeteri*, *I. schroeteri stacyi*, and *I. schroeteri* ought to be called *I. chiron*, *I. stacyi*, and *I.* sp. indet. (cf. *chiron*), respectively.

From the above it is clear that the term *Schroeteri* Limestone (or Stage) in the current sense ought to be dropped.

(4) The common species of *Pseudoclimacograptus*, generally identified as *P. scharenbergi*, from the Upper *Didymograptus* Shale (cf. BULMAN 1953, Pl. I, figs. 1–7) and the zone of *Glyptograptus teretiusculus* of Scandinavia (cf. JAANUSSON 1960b, p. 332), is here referred to as *P.* aff. *scharenbergi* (LAPW.). The distinction of this form from the true *P. scharenbergi* seems to be of definite stratigraphic importance, especially since both species occur also in the shelly facies.

Section of the Excavation at Vikarbyn

The described section was exposed by excavation by Dr. H. MUTVEI and the present writer in 1947 (cf. JAANUSSON & MUTVEI 1953, pp. 8 and 10). It forms a direct upward continuation of the section of the *Platyurus* (= Segerstad) Limestone described by JAANUSSON & MUTVEI (1953, pp. 10—13). A brief description of the beds treated here has been published by JAANUSSON (in THORSLUND & JAANUSSON 1960, p. 29). As the result of a re-examination of the section in 1960 the boundary between the "*Schroeteri*" Limestone and the "*Crassicauda*" Limestone is drawn at a slightly lower level in this paper, although on account of the poor exposure and the strongly cleft condition of the rock in that part of the ditch its exact position is still uncertain.

Description of the Section

Furudal Limestone 7.55 m +

3.10 m +. Nodular to finely nodular, fine-grained, grey limestone weathered on the bottom of the excavated ditch into thin (usually 1 to 3 cm thick) beds or lenses. The limestone contains numerous organogenic tubes mostly filled with clear calcite (cf. Pl. I, fig. 1).

Asaphus (*Neoasaphus*) *lepidus* TÖRNQ.
Asaphus (*Neoasaphus*) *bottnicus* JAAN.
Nileus sp.
Hoplolichas proboscideus DAMES
Estoniops n. sp.
Remopleurides sp.
Lonchodomas sp.
Steusloffia linnarssoni (KRAUSE)
Tallinnella angustata (KRAUSE)
Sigmobolbina sp.
Christiania sp.
Leptellina ? n. sp.
Orthoceros bifoveatum (NOETL.)
Clathrospira cf. *elliptica* (HIS.)
Glyptograptus cernuus JAAN.
Glyptograptus vikarbyensis JAAN.
Gymnograptus linnarssoni (MOBERG)

The lower boundary is fairly distinct lithologically.

3.20 m. Mostly thick- to medium-bedded (individual beds 3 to 15 cm thick), fairly dense, grey or (on account of disintegration of unevenly distributed pyrite) brown-spotted limestone intercalated by thin layers (mostly 0.5 to 5 cm thick) of greyish-green mudstone. The limestone is traversed, as in overlying division, by numerous organogenic tubes filled with clear calcite (mostly 8 to 15 upon every 25 cm^2). Poor in fossils other than *Nileus*.

Plectasaphus plicicostis (TÖRNQ.)
Nileus sp.
Euprimites bursa (KRAUSE)

The lower boundary is fairly distinct lithologically.

1.25 m. Dark grey to greyish-brown mudstone with irregular beds and lenses of fine-grained limestone. Weathered and poorly exposed; details obscure. The thickness of the beds of mudstone is evidently up to 12 cm. The limestone contains numerous organogenic tubes filled with clear calcite.

Euprimites bursa (KRAUSE)

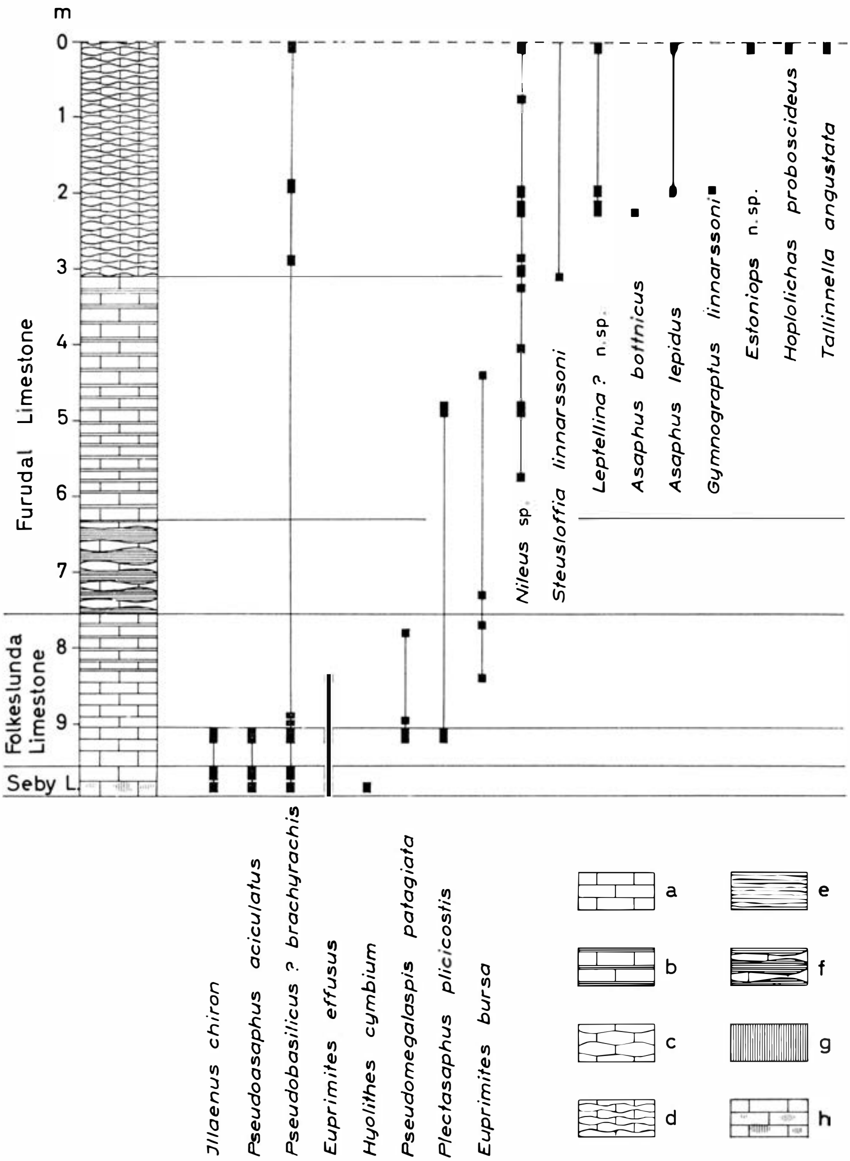

Fig. 2. Range of selected species in the Seby, Folkeslunda, and Furudal Limestones of the Vikarby section. Signs: *a*, regularly bedded limestone without intercalations of mudstone or with very thin layers of argillaceous matter on the bedding planes; *b*, regularly bedded limestone with intercalation of thin layers of mudstone; *c*, nodular limestone; *d*, nodular limestone with medium-sized nodules, cf. Pl. I, fig. 1; *e*, finely nodular limestone, cf. JAANUSSON 1960a, Pl. I, figs. 1–3; *f*, lenses and irregular beds of limestone intercalated by mudstone or shale; *g*, reddish-brown rock; *h*, variegated reddish-brown and grey limestone, cf. JAANUSSON 1960a, Pl. II, fig. 2.

The lower boundary is transitional. The intercalations of limestone increase gradually in thickness, and those of mudstone become gradually thinner.

Folkeslunda Limestone 2.00 m.

1.50 m. Medium- to thick-bedded (thickness of individual beds up to 15 cm), fine- to coarse-grained, grey limestone with thin intercalations of calcareous mudstone in the upper part. The upper half metre with strong cleavage and poorly exposed; details obscure.

Pseudobasilicus ? brachyrachis (TÖRNQ.)
Pseudomegalaspis patagiata (TÖRNQ.)
Remopleurides sp.
Euprimites effusus JAAN.
Euprimites bursa (KRAUSE)
Tvaerenella sp.

0.50 m. Thick-bedded (thickness of individual beds mostly 10 to 15 cm), coarse-grained, in part coquinoid (cf. Pl. I, fig. 2), grey to dark grey limestone.

Illaenus chiron HOLM
Asaphus (*Neoasaphus*) sp.
Pseudoasaphus aciculatus (ANG.)
Pseudobasilicus ? brachyrachis (TÖRNQ.)
Pseudomegalaspis patagiata (TÖRNQ.)
Geisonoceras ? sp.
Lituites (*Lituites*) cf. *perfectus* (WAHLENBERG)
Eccyliomphalus sp.
Pararaphistoma sp.
Euprimites effusus JAAN.

Seby Limestone 0.40 m.

0.40 m. Variegated, greenish-grey and pale reddish-brown, thick-bedded, coarse-grained, in part coquinoid limestone. The reddish-brown colour is mostly concentrated around fossils, especially cephalopods, and its intensity increases downwards.

Illaenus chiron HOLM
Asaphus (*Neoasaphus*) sp.
Pseudoasaphus aciculatus (ANG.)
Pseudobasilicus ? brachyrachis (TÖRNQ.)
Bronteopsis sp.
Euprimites effusus JAAN.
Piretia n. sp.
Christiania sp.
Leptestia ? sp.
"Conorthoceras" conicum (HIS.)
Cochlioceras burchardi (DEW.)
Eccyliomphalus sp.
Pararaphistoma sp.
Hyolithes cymbium HOLM

There is no distinct lithologic boundary against the underlying Segerstad Limestone.

Remarks on Microlithology

SEBY LIMESTONE.—The rock is a recrystallized calcarenite occasionally abounding in shells of cephalopods and trilobites and in that case coquinoid. The matrix is fine-grained with coarsely crystalline spots, where the shell fragments are in part fused with matrix making a close determination of the grain size impossible. The haematitic pigment is mostly concentrated around large fossils and is usually lacking in the matrix between them.

The insoluble residue contains, especially in the lower 20 cm, abundant light green internal moulds (cf. Fig. 4) of different small shells and also irre-

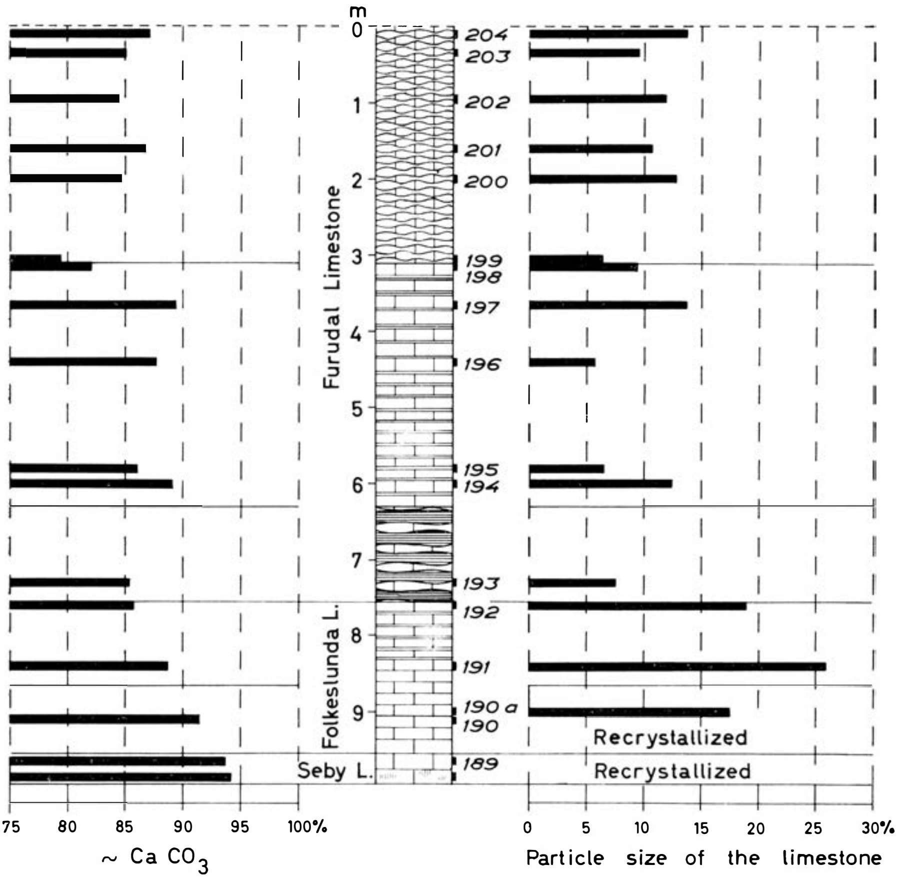

Fig. 3. Seby, Folkeslunda, and Furudal Limestones in the Vikarby section. To the left material soluble in dilute acetic acid (approximately the content of $CaCO_3$), to the right particle size of the limestone according to the method of JAANUSSON (1952). For legend, see Fig. 2.

gularly shaped grains with mostly the same colour. An X-ray analysis kindly performed by Dr. B. COLLINI showed the substance forming the internal moulds to be chamosite associated with goethite. The mode of occurence of chamosite and goethite as seen in thin sections agrees with that in the Böda Hamn core (JAANUSSON 1960a, pp. 241–244). The voids within shells are often filled by asphaltite.

FOLKESLUNDA LIMESTONE.—Also in the lower part of the Folkeslunda Formation the accumulation of large shells of cephalopods and trilobites occasionally gives the rock a coquinoid appearance (Pl. I, fig. 2). The limestone is a calcarenite, mostly with a coarsely crystalline matrix, where the recrystallization has obliterated the outlines of shell fragments.

No chamosite has been observed in thin sections, and the insoluble residue of the samples studied is devoid of internal moulds other than a few pyritic

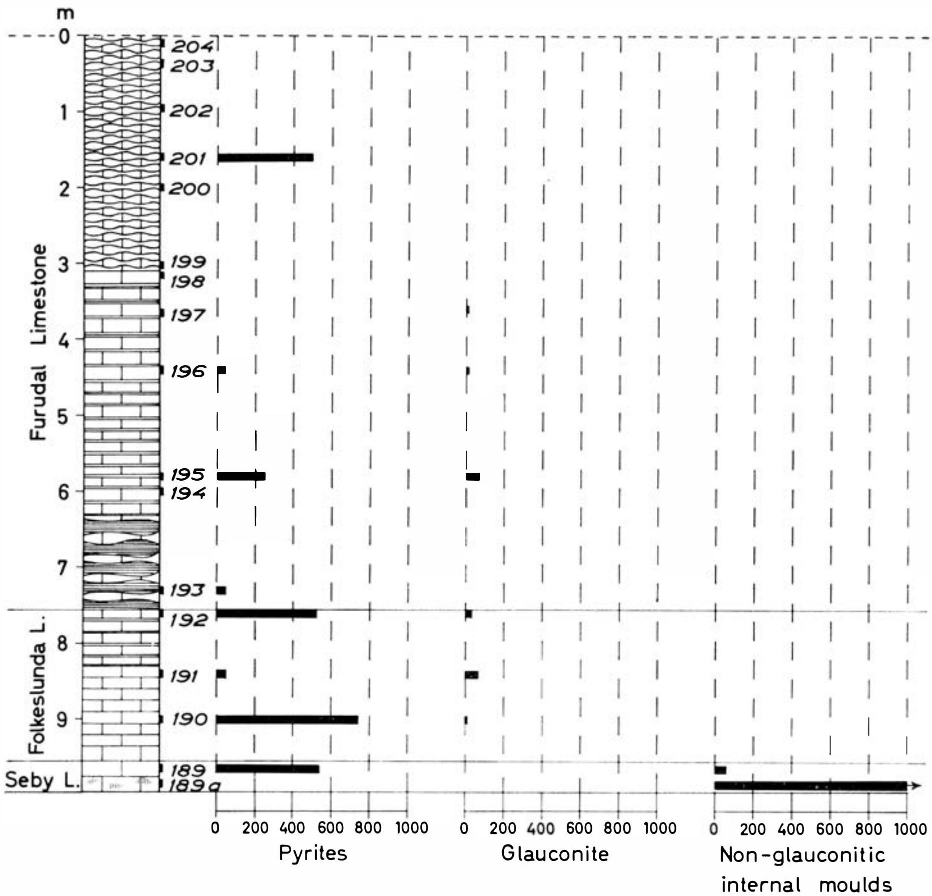

Fig. 4. Seby, Folkeslunda, and Furudal Limestones in the Vikarby section. Frequency of certain components in the fraction larger than 0.125 mm of the insoluble residue. For legend, see Fig. 2.

ones and rare grains of some clay substance crudely showing the shape of an ostracode or gastropod. Small grains and fragments of asphaltite are not uncommon. Asphaltite has been observed also macroscopically in what apparently are primary voids within large cephalopods and other shells.

In the upper part of the Folkeslunda Limestone the rock is still mostly a calcarenite, but the grain size varies, and calcarenitic calcilutites also occur, especially close to the top of the formation (cf. Fig. 3). Here the spots with coarsely crystalline matrix are rare, and the outlines of small shells and shell fragments are usually distinct in thin section. The insoluble residue agrees with that of the overlying Furudal Limestone.

Furudal Limestone.—Throughout the exposed sequence the limestone is a calcilutite with a fine- to cryptocrystalline matrix and as a rule distinct outlines of shell fragments in thin section. The texture is identical with that of the Furudal and Källa Limestones of Öland (JAANUSSON 1960a). No undoubted chamosite or goethite has been observed in thin sections.

The amount of the sand fraction of the insoluble residue is very small and consists of allochthonous quartz grains, small aggregates of pyrite, and rare fragments of phosphatic shells. A varying number of irregular argillacecous grains also occur, but these may have been produced, at least in part, during the sieving procedure. Some samples (cf. Fig. 4) contain a small number of subangular grains of glauconite.

The intercalations of mudstone have not been closely studied. A sample from the lowermost division of the formation contained 23.5 per cent of substance soluble in dilute acetic acid.

Section in the Excavation at Kårgärde

The described section was exposed by excavation by Dr. H. MUTVEI and the present writer in 1947 (cf. JAANUSSON & MUTVEI 1953, pp. 8 and 13). It forms a direct upward continuation of the section of the *Platyurus* (= Segerstad) Limestone described by JAANUSSON & MUTVEI (1953, pp. 13–15).

Description of the Section

Furudal Limestone 4.10 m +.

4.10 m +. Mostly thick-bedded (thickness of individual beds 6–15 cm), fairly dense, grey to yellowish limestone intercalated by grey to greyish-brown calcareous mudstone (individual beds mostly 1 to 4 cm thick). The limestone contains numerous oiganogenic tubes filled with clear calcite.

Asaphus (*Neoasaphus*) *bottnicus* JAAN.
Nileus sp.
Remopleurides sp.
Leptellina ? n. sp.
Christiania sp.
Euprimites bursa (KRAUSE)
Steusloffia linnarssoni (KRAUSE)

The lower boundary is fairly distinct lithologically.

Folkeslunda Limestone 2.40 m.

c. 1.40 m. Medium-bedded (thickness of individual beds between 5 and 10 cm), coarse-grained, grey to dark grey limestone with chamositic grains in some beds. Apparently rich in fossils, but as this part of the ditch evidently forms the floor of the former quarry, it was very difficult to obtain large pieces of the rock. The uppermost beds have yielded the following fossils:

Plectasaphus plicicostis (TÖRNQ.)
Pseudomegalaspis patagiata (TÖRNQ).
Remopleurides sp.
Lituites sp.
Christiania sp.

b. 0.84 m. Medium- to thick-bedded, fairly dense, grey limestone, intercalated with thin beds of grey calcareous mudstone. In the limestone numerous organogenic tubes mostly filled with clear calcite.

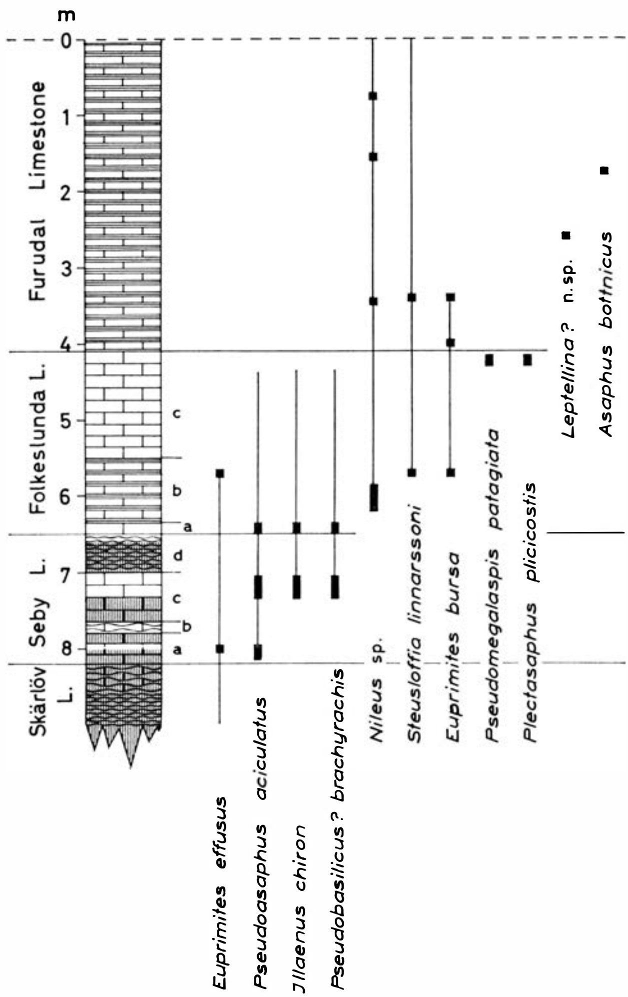

Fig. 5. Range of selected species in the Seby, Folkeslunda, and Furudal Limestones of the Kårgärde section. For legend, see Fig. 2.

Nileus sp.
Ampyx (*Cnemidopyge*) n. sp.
Laccochilina (*Laccochilina*) sp.
Euprimites effusus Jaan.
Euprimites bursa (Krause)
Steusloffia linnarssoni (Krause)

a. 0.16 m. One bed of fine-grained, grey limestone with chamositic grains.

Illaenus chiron Holm
Pseudoasaphus aciculatus (Ang.)
Pseudobasilicus ? *brachyrachis* (Törnq.)
"*Endoceras*" sp.

Seby Limestone 1.70 m.

d. 0.50 m. Finely nodular limestone, the lower 40 cm brownish-red with greenish-grey spots, the upper 10 cm grey.

Laccochilina (*Laccochilina*) sp.

c. 0.65 m. Thin- to medium-bedded (individual beds 5 to 10 cm thick), in the upper 15 cm somewhat nodular, variegated reddish-brown and greenish-grey limestone. In the lower 30 cm the dominant colour is reddish-brown, in the middle 20 cm grey. The latter beds contain numerous chamositic grains.

Illaenus chiron HOLM
Pseudoasaphus aciculatus (ANG.)
Pseudobasilicus ? brachyrachis (TÖRNQ.)
Cochlioceras burchardi (DEWITZ)
"Conorthoceras" conicum (HIS.)
Geisonoceras ? scabridum (ANG.)
Trocholites sp.
Lituites sp.
Lituites minutus HOLM in mus.
"Endoceras" sp.

b. 0.15 m. Nodular, fine-grained, grey limestone with irregular argillaceous intercalations.

a. 0.40 m. Medium- to thick-bedded (thickness of the individual beds in ascending order 10, 16, 6, 4, and 4 cm), fine-grained, variegated reddish-brown and greyish-green limestone. In the lower 20 cm the dominant colour is reddish-brown, in the middle 10 cm grey, and in the upper 10 cm reddish-brown. The lower and especially the middle part contain dark chamositic grains, the middle part also small reddish-brown pebbles of limestone.

Pseudoasaphus aciculatus (ANG.)
Cochlioceras burchardi (DEWITZ)
Euprimites effusus JAAN.

The lower boundary is distinct lithologically.

Skärlöv Limestone 3.25 m.

0.40 m. Thin-bedded (thickness of individual beds 4 to 7 cm), reddish-brown, fine-grained limestone.
0.40 m. Nodular, reddish-brown, fine-grained limestone.
0.32 m. Finely nodular, reddish-brown limestone to marl.
0.08 m. Nodular, reddish-brown, fine-grained limestone.
0.70 m. Finely nodular, reddish-brown limestone to marl.
0.23 m. Nodular, reddish-brown, fine-grained limestone.
0.35 m. Finely nodular, reddish-brown limestone to marl.
0.20 m. Nodular, reddish-brown, fine-grained limestone.
0.62 m. Finely nodular, reddish-brown limestone to marl.
The boundary against the underlying Segerstad Limestone is well defined lithologically.

REMARKS.—A brief description of the section of the Upper Grey Orthoceratite Limestone at Kårgärde has been given by TÖRNQUIST (1883, p. 37): "The lower part of the Upper Grey Orthoceratite Limestone is formed by greenish grey, occasionally somewhat shaly beds which are poor in fossils and two feet thick. These are overlain by beds of dark-grey bedded limestone, four feet thick, and very rich in well preserved fossils all of which belong to the species that are considered as characteristic for this division. Upon these beds follow six to eight feet of light, bedded limestone which, again, is poor in fossils. It contains mainly *Nileus armadillo* and orthoceratites which become still scarcer higher up in the section. I draw the boundary between the Orthoceratite Limestone and the Chasmops Limestone above these beds.—The lowermost beds of the latter consist of light, jointed limestone in which I have found only some undeterminable orthoceratites and brachiopods." (Translated by the present writer.) The part of the sequence described by TÖRNQUIST is easily recognized in our section. The division *c* of the Folkeslunda Limestone is the middle, 4 feet thick division of TÖRNQUIST's section, and it is just this division which has previously yielded a rich fauna, now deposited in several museums, from the Folkeslunda Limestone of Kårgärde. The lower part of TÖRNQUIST's section, 2 feet thick, corresponds to the divisions *a* and *b* of the Folkeslunda Limestone. It is quite obvious that the Seby and Skärlöv Limestones of Kårgärde were included by him in his Upper Red Orthoceratite Limestone (cf. also the description of this limestone in TÖRNQUIST 1883, p. 37). TÖRNQUIST's reasons for drawing the boundary between his Orthoceratite Limestone and *Chasmops* Limestone within the lithologically and faunally fairly uniform sequence of the Furudal Limestone are not clear.

Remarks on Microlithology

The microlithology of the Skärlöv Limestone has not been studied. Above this formation the sequence is much more varied than at Vikarbyn, and the intervals between the samples are too large to give a satisfactory conception of all significant changes in the lithology.

SEBY LIMESTONE.—The rock in the division *a* is a calcarenite with occasional spots, where the matrix is coarse-grained and partly fused with the shell fragments, rendering impossible a close determination of the grain size. In the dominantly reddish-brown beds the matrix is unevenly pigmented by haematite. No chamosite has been observed in the examined thin sections. In the middle, dominantly grey part of the formation the cavities of many small shells and shell fragments are filled by chamosite and a dark-brown substance. Coatings around the shell fragments are rare. The cavities of some shells are filled with a concentration of haematite which occasionally occurs also as a faint pigment. Goethite is very rare. The insoluble residue of the dominantly grey beds abounds in dark, non-glauconitic internal moulds (cf. Fig. 7).

The microlithology of the division *c* is similar to that of the division *a* except that much of the chamosite is altered into goethite.

The division *d* consists of finely nodular calcilutite with fine-grained to cryptocrystalline matrix which is intensely, though somewhat unevenly pigmented by haematite. Chamosite and goethite have not been observed, and the insoluble residue is devoid of non-glauconitic internal moulds. Instead it contains numerous subangular grains of glauconite only a few of which show the shape of an internal mould.

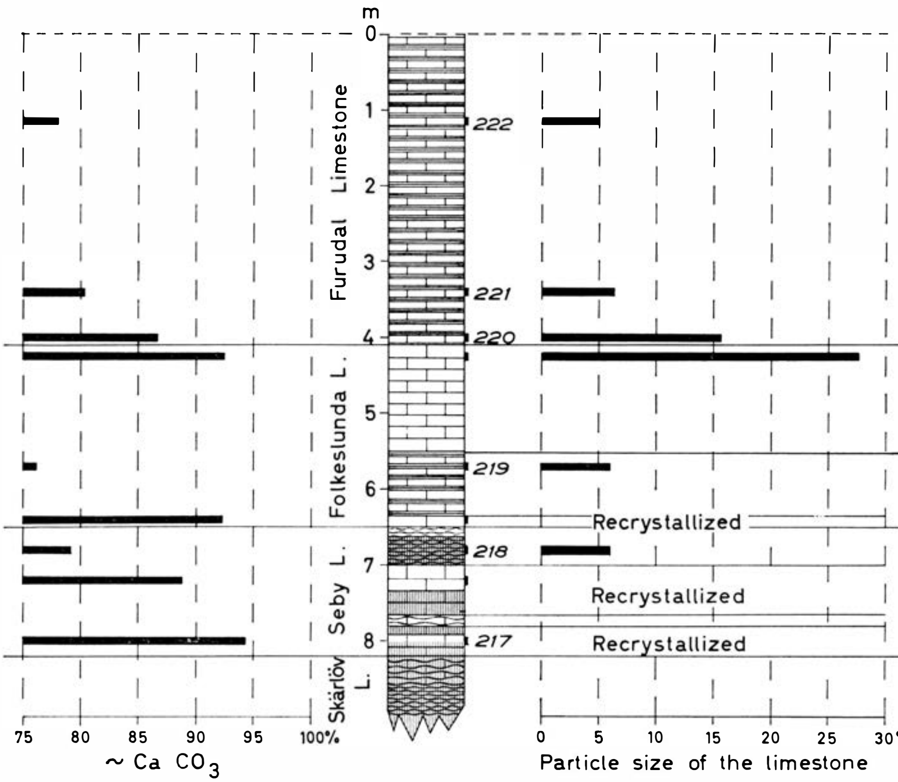

Fig. 6. Seby, Folkeslunda, and Furudal Limestones of the Kårgärde section. To the left material soluble in dilute acetic acid (approximately the content of $CaCO_3$), to the right particle size of the limestone according to the method of JAANUSSON (1952). For legend, see Fig. 2.

FOLKESLUNDA LIMESTONE.—The rock of the division *a* is a recrystallized calcarenite with a largely coarse-grained matrix enclosing, and partly fused with, the shell fragments. In thin section some chamosite can be observed, mostly altered into goethite. The insoluble residue contains dark, non-glauconitic internal moulds (cf. Fig. 7).

The division *b* consists of calcilutite which is quite similar to that of the Furudal Limestone.

The division *c* was very unfavourably exposed, and samples could be obtained from the uppermost beds only. There the rock is a calcarenite with spots of coarse-grained matrix, where the shell fragments are mostly recrystallized. Cavities of some rare small shell fragments are filled with what according to the colour is probably chamosite. The sand fraction of the insoluble residue contains abundant quartz grains, some few non-glauconitic internal moulds, moderate quantities of crystals and crystal aggregates of pyrite, and fairly numerous grains of glauconite. Here the quartz grains are more abundant than in any other sample of the section. The glauconite has about the same

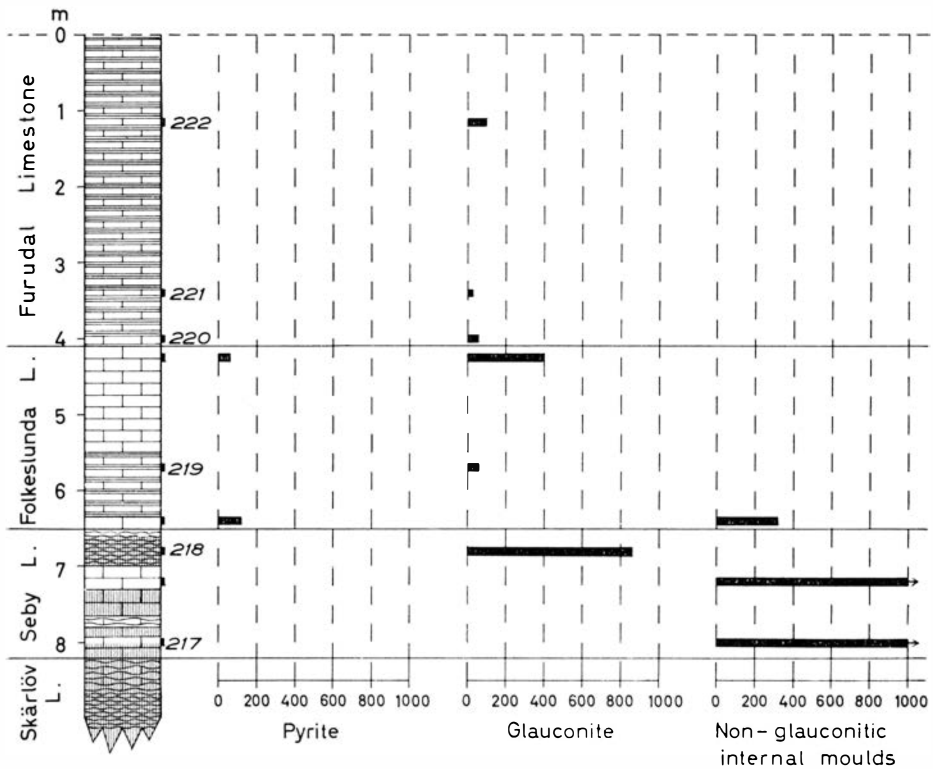

Fig. 7. Seby, Folkeslunda, and Furudal Limestones of the Kårgärde section. Frequency of certain components of the fraction larger than 0.125 mm of the insoluble residue. For legend, see Fig. 2.

size distribution as the quartz, contains no well-preserved internal moulds, and is probably allochthonous.

FURUDAL LIMESTONE.—The limestone is a calcilutite with fine-grained to cryptocrystalline matrix and devoid of chamosite. The amount of the sand fraction of the insoluble residue is very small. The fraction contains no authigenic iron compounds other than a small number of glauconite grains of the same size as the quartz grains. The general lithology is very similar to that of the Furudal Limestone in the excavation at Vikarbyn.

Section in the Quarry at Kårgärde

The quarry at Kårgärde is situated N of the road between the Kårgärde farm and the new main road to Mora (cf. JAANUSSON & MUTVEI, 1953, p. 13). This abandoned small quarry exposes a section of about 12 m comprising the upper part of the Furudal Limestone and the lowermost beds of the Dalby Limestone. The beds dip N. 48—50° E. and strike 80—85° NE.

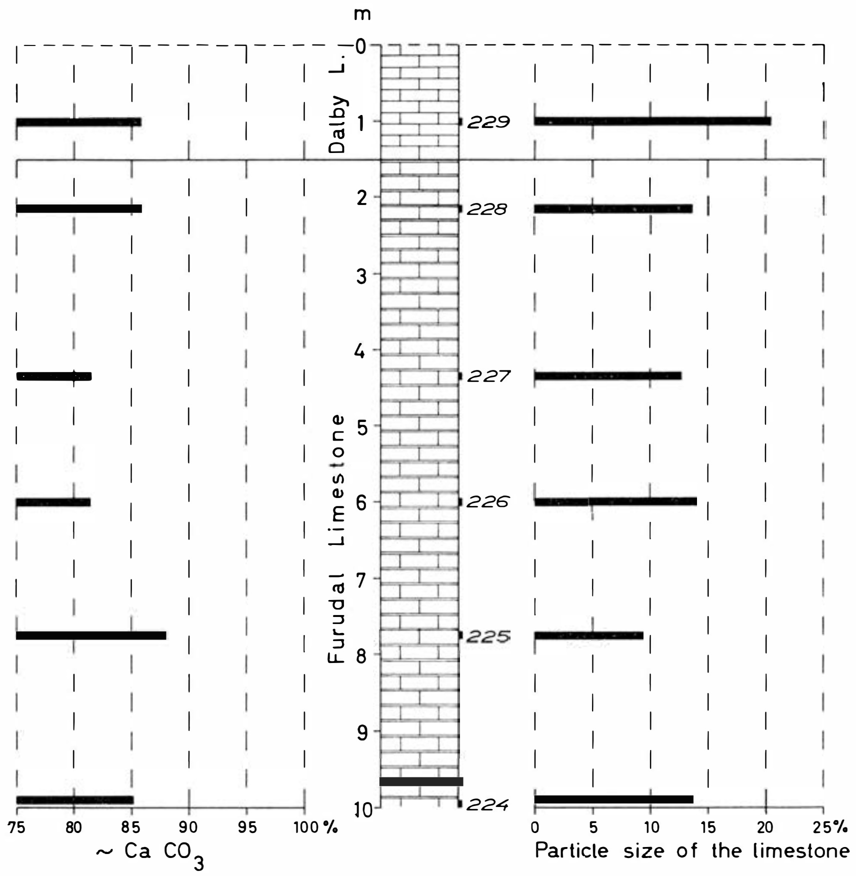

Fig. 8. Furudal and the lowermost Dalby Limestones of the quarry at Kårgärde. To the left material soluble in dilute acetic acid (approximately the content of $CaCO_3$), to the right particle size of the limestone according to the method of JAANUSSON (1952). For legend, see Fig. 2.

The section was examined only cursorily. The Furudal Limestone consists of a monotonous sequence of grey, medium- to thick-bedded (thickness of individual beds mostly between 6 and 12 cm) calcilutite intercalated with up to 3 cm thick layers of grey, calcareous mudstone. The limestone contains numerous organogenic tubes mostly filled with clear calcite. The lithology is very similar to that of the lowermost Furudal Limestone in the nearby excavation. Fossils, other than *Nileus*, are rare. The following species have been found:

Nileus sp.
Asaphus (*Neoasaphus*) *lepidus* TÖRNQ.
Asaphus (*Neoasaphus*) *bottnicus* JAAN.
Plectasaphus plicicostis (TÖRNQ.)
Pseudomegalaspis cf. *patagiata* (TÖRNQ.)
Remopleurides sp.
Christiania sp.
Euprimites bursa (KRAUSE)
Tallinnella angustata (KRAUSE)
Steusloffia linnarssoni (KRAUSE)
Clisospira sp.

Of the above species, *Plectasaphus plicicostis* and *Pseudomegalaspis* have been found only in the lowermost metre of the sequence exposed in the quarry, 7.5—8.5 m from the lower boundary of the Dalby Limestone.

The Dalby Limestone is poorly exposed. Its lowermost part consists of calcarenitic calcilutites which in a weathered exposure differ but slightly from the underlying Furudal calcilutites except that the bedding tends to be irregular, and the shaly intercalations disappear. The lowermost Dalby Limestone has yielded *Panderia parvula* (HOLM), *Steusloffia multimarginata* ÖPIK, *Clisospira* sp., and *Tetraodontella biseptata* JAAN.

The Quarry at Furudal

The quarry at Furudal is situated close to the brook Kalkbergsbäcken about 1.3 km W. of Furudal Bruk, N. of the road between Furudal Bruk and Näset. The quarry has been abandoned long ago, most of it being covered by vegetation. Only the western wall of the quarry exposes a low section, some 2.5 m high. Here the beds are nearly horizontal with a slight dip towards SW.

The section exposes a somewhat nodular, argillaceous calcarenitic calcilutite of the Furudal Formation. The lithology resembles that of the upper part of the same formation at Fjäcka. The rock is moderately fossiliferous, but it was difficult to collect from an almost vertical wall. In addition to internal moulds of orthoceracone orthochoanites, the following species have been found.

Asaphus (*Neoasaphus*) *lepidus* TÖRNQ.
Christiania sp.
Laccochilina (*Laccochilina*) *paucigranosa* JAAN.
Uhakiella sp.
Tallinnella angustata (KRAUSE)
Steusloffia linnarssoni (KRAUSE)
Sigmoopsis perpunctata (ÖPIK)

From the Furudal Limestone of this quarry TÖRNQUIST (1911) described *Lasiograptus* (*Hallograptus*) *bimucronatus* (NICH.) [= *Gymnograptus linnarssoni* (MOBERG)] and *Diplograptus* (*Glyptograptus*) *teretiusculus* (HIS.) var. (= *Glyptograptus vikarbyensis* JAAN.).

Old collections from this quarry include also specimens which undoubtedly come from the Dalby Limestone. The presence of beds belonging to this formation has been reported by TÖRNQUIST (1883). It is thus evident that previously also the lowermost Dalby Limestone has been available in the upper part of the quarry. Furudal is the type locality of *Illaenus crassicauda* (WAHLENBERG), and old collections from this quarry contain several excellently preserved specimens of this species. One specimen was found to be associated with *Steusloffia multimarginata*, and to judge from the characters of the rock also the other specimens were probably derived from the Dalby Limestone.

Western Exposures at Fjäcka

To the west of the Moldå farm the lowermost Dalby Limestone and the Furudal Limestone are discontinuously exposed in low cliffs at the Fjäcka rivulet and in ditches (localities Nos. 1 to 4; cf. JAANUSSON 1947, Fig. 2, and JAANUSSON & MARTNA 1948, Fig. 1). Following TÖRNQUIST (1874, p. 14), JAANUSSON (1947, p. 47) tentatively drew the boundary between the Lower *Chasmops* Limestone (Cystidean Limestone) and the *Crassicauda* Limestone (Flagkalk) at the level, where the cystoids distinctive for TÖRNQUIST's Cystidean Limestone appear. In this paper the boundary between the Dalby and Furudal Limestones is drawn 2.5 to 3 m below the level, where the first cystoids were found in locality No. 4.

Owing to the discontinuous nature of the section the exposures west of the Moldå farm were examined only cursorily, especially with regard to ostracode faunas and microlithology. From each macroscopically distinguished division as a rule one to three samples only were subjected to microlithological examination. The samples yielded but few identifiable palaeocope ostracodes. As far as can be seen from the macrofossils and the examination of the small number of samples, the entire section of locality No. 4 and at least most of the section in locality No. 3 fall into the Dalby Limestone, whereas the beds adjacent to the rivulet in locality No. 2 as well as those exposed in locality No. 1 belong to the Furudal Limestone.

Description of the Section

In the following description the grain size of the limestone is determined according to JAANUSSON (1952), and the approximate content of calcium carbonate refers to material soluble in dilute acetic acid.

Dalby Limestone 5.5–6 m + (locality No. 4, at least the main part of locality No. 3, and the NE. part of locality No. 2).

3.5 m +. Coarse-grained, grey, somewhat nodular limestone. Insufficiently exposed for successful collecting of macrofossils. One sample (D 101) from the upper part of the division in locality No. 4 yielded the following data: 37 % fossil fragments longer than 0.1 mm in thin section; 88 % $CaCO_3$; abundant non-glauconitic internal moulds in the insoluble residue.

Raymondaspis ? sp.
Lonchodomas sp.
Bilobia sp.
Echinosphaerites aurantium (GYLL.)
Heliocrinites granatum (WAHLENBERG)

The lower boundary is transitional and is macroscopically defined with difficulty only.

2–2.5 m. Medium-grained, grey, somewhat nodular limestone. One sample (D 100) from the upper part of the division in locality No. 4 yielded the following data: 23 % fossil fragments longer than 0.1 mm in thin section; 89 % $CaCO_3$; small number of non-glauconitic internal moulds per 100 g limestone.

Illaenus crassicauda (WAHLENBERG)
Remopleurides sp.
Lonchodomas sp.
Uhakiella coelodesma ÖPIK
Uhakiella labrosa (KRAUSE)
Euprimites sp.
Tallinnella angustata (KRAUSE)
Christiania sp.
Clisospira sp.

The macroscopical definition of the lower boundary is difficult.

Furudal Limestone 10—10.5 m + (SW. part of locality No. 2 and locality No. 1).

4–4.5 m. Fine-grained, grey limestone with irregular argillaceous intercalations. Three samples (D 98 from locality No. 2; D 97 from the upper part of locality No. 1 b; and D 96 from the lower part of locality 1 b, c. 2 m below the sample No. D 97) yielded the following data, respectively: Grain size 15, 14, and 12 %; 84, 85, and 81 % $CaCO_3$; no non-glauconitic internal moulds in the insoluble residue.

Illaenus intermedius HOLM
Asaphus (*Neoasaphus*) *lepidus* TÖRNQ.
Pseudoasaphus tecticaudatus (STEINH.)
Nileus sp.
Remopleurides sp.
Lonchodomas sp.
Estoniops n. sp.
Sphaerocoryphe sp.
Laccochilina (*Laccochilina*) *paucigranosa* JAAN.
Tallinnella angustata (KRAUSE)
Steusloffia linnarssoni (KRAUSE)
Nicolella sp.
Christiania sp.
Leptellina ? n. sp.
Alwynella sp.
Clisospira sp.
Clathrospira sp.

The lower boundary is transitional.

4–4.5 m. Fairly thick-bedded, grey limestone, regularly bedded and with thin intercalations of mudstone (locality No. 1a). In the limestone occasional organogenic tubes. Most of this division is very poorly exposed.
Nileus sp.

1.5 m +. Fairly thick-bedded, fine-grained, grey limestone. Differs from the overlying division mainly by the absence or rarity of argillaceous intercalations. Exposed by excavation. One sample (D 95 from the uppermost beds of the division) has yielded the following data: Grain size, 10 %; 88.5 % $CaCO_3$.
The uppermost bed has yielded the following species:

Illaenus sp. indet. (cf. *chiron* HOLM)
Euprimites bursa (KRAUSE)
Christiania sp.

The interval between the base of the above section and the top of the section described by JAANUSSON & MUTVEI (1953, p. 15) is covered, and comprises about 5–5.5 m. The possibility of the presence of faults in this interval is, however, not excluded.

The Main Section at Fjäcka

The main section at Fjäcka is exposed in an abandoned quarry (localities Nos. 6 and 7 in JAANUSSON 1947, Fig. 1; JAANUSSON & MARTNA 1948, Fig. 1) and on the steep slope of the Fjäcka valley (localities Nos. 8—11 in JAANUSSON

1947, Fig. 1). The existing somewhat discontinuous exposures were connected by excavations (cf. JAANUSSON & MARTNA 1948) which revealed the previously unknown complex of bentonitic beds. A thin bed of bentonitic clay in the middle of the Dalby Limestone was discovered independently by THORSLUND (1947, p. 138). A short description of the whole section has been given by JAANUSSON & MARTNA (1948), and MARTNA (1955) has treated the lithology of the limestones of the complex of bentonitic beds and of the suprabentonitic beds of the Viru Series. Here the Dalby and Furudal Limestones are described in some detail.

The microlithologic data have been obtained from a series of samples collected by Dr. J. MARTNA and the present writer in 1947. At the same time and in 1946 additional samples were secured for determining the range of species of ostracodes for which purpose also the above series of samples was used. In 1959 and 1960 an extensive series of samples (as a rule a sample at every 25 cm of the section), taken for the extraction of conodonts, was placed at the present writer's disposal by Dr. STIG BERGSTRÖM, Lund, for crushing and searching for ostracodes before dissolving the rock in acetic acid. The Lund series of samples was complemented downwards by two series of six samples, one of them most kindly taken, at the writer's request, during an excursion by Professor PER THORSLUND and Professor MARSHALL KAY, and the other secured by the present writer in 1962. The extensive material of ostracodes and other small fossils obtained from all these samples gives, combined, detailed information about the range of different common species (cf. Figs. 9 and 10).

According to verbal information from Dr. STIG BERGSTRÖM the measurements of the section, obtained during the collecting of the Lund series of samples, coincide closely with those given by JAANUSSON & MARTNA (1948) down to the bed of bentonitic clay in the middle of the Dalby Limestone. For the part of the section below this level examination of the fauna from the samples showed, however, a discrepancy of the measurements. The thickness of the Dalby Limestone below the lowermost bentonitic bed is 8.3 m, if based on the Lund series of samples, and 10.25 m according to Uppsala material. Comparison of the insoluble residues suggests that the difference is localized mainly to the uppermost part of the sequence in question, i.e. to the division immediately below the bed of bentonitic clay. The discrepancy is easily understandable, since the dip and strike vary along the section in the localities Nos. 6 and 7, and every new measurement there would probably yield somewhat different values. This and the absence of good lithologic index horizons below the lowermost bed of bentonitic clay make determinations of the exact level in a previously measured section of subsequently collected material very difficult, not to say impossible. The information about the range of the species obtained for this part of the section from the Lund series of samples cannot be exactly combined with that based upon the Uppsala samples, although in either series of samples the faunal boundary between the Dalby and Furudal Limestones certainly lies at a closely comparable level. For this reason the Uppsala series of samples below the lowermost bentonitic bed is here referred to as taken from section *U* and that of Lund as from section *L*. The range of species illustrated in Fig. 10 is, with the exception of completion in the lowermost three metres, based exclusively on the Lund series of samples, i.e. on section *L*, whereas the figure illustrating the relative grain size of this part of the sequence (Fig. 12) is derived from the material of the section *U*. The general picture of the range of the species is very similar in both sections except that certain rare species have been found in one of the sections only, and that in the section *L* the samples are much more closely spaced than in the section *U*, thus giving a much fuller information about the distribution of the species. The section *L* does not cover the entire exposed sequence of the Furudal Limestone in the locality No. 6. On two different occasions attempts were made to complete the section *L* downwards, but the connection of the additional series of samples with the base of the section *L* is not exact, and an unknown degree of overlap is to be expected. The latter must be taken into account when the lowermost three metres of the section in Fig. 10 is considered.

When collecting large fossils, great care was bestowed upon fixing the exact level of the specimens found. However, only little material was found in situ in the low and in part poorly exposed section, and the horizon of much material could not be determined more closely than within two or three metres. The lowermost six metres of the Dalby Limestone and the uppermost two metres of the Furudal Limestone are poorly accessible and have yielded but few macrofossils. The information about the fauna, other than ostracodes, of these beds in the Siljan district is still incomplete.

The fauna of the Dalby Limestone is still incompletely described and several of the identifications given below must be regarded as provisional. Not included in the following lists are bryozoans which form an important constituent in the fauna of this formation. Gastropods and cephalopods are rare and occur as internal moulds. Several species not listed below of other groups have been found at Fjäcka by earlier collectors. They are not included, since no information is available about the stratigraphic level of the specimens within the Dalby Limestone. One of the more interesting species is a specimen of *Clitambonites* cf. *schmidti* (PAHLEN) (coll. SCHMALENSÉE in 1883; SGU). It is the only specimen of a true *Clitambonites* west of the Baltic known to the writer.

The described section is the type locality of the Dalby Limestone (JAANUSSON 1960a).

Description of the Section

Dalby Limestone 21.60 m (section *U*), 19.65 m (section *L*).

A minor fault.

1.80 m +. Complex of bentonitic beds (for closer macroscopical description of individual beds, cf. JAANUSSON & MARTNA 1948, pp. 189–190).

13. 0.26 m +. Bentonitic clay.

12. 0.20 m. Greenish-grey limestone.

Estoniops sp.
Euprimites locknensis (THORSLUND)
Steusloffia costata (LINNARSSON)

11. 0.12 m. Bentonitic clay.

10. 0.12 m. One bed of greenish-grey, fine-grained limestone.

9. 0.15 m. Bentonitic clay.

8. 0.06 m. Greenish-grey, fine-grained limestone.

7. 0.06 m. Bentonitic clay.

6. 0.08 m. Greenish-grey, fine-grained limestone.

Asaphus (*Neoasaphus*) *ludibundus* TÖRNQ.
Hemisphaerocoryphe sulcata THORSL.
Euprimites locknensis (THORSL.)
Steusloffia costata (LINNARSSON)
Oecematobolbina n. sp. b

5. 0.07 m. Bentonitic clay.

4. 0.05 m. Greenish-grey, fine-grained limestone.

3. 0.12 m. Bentonitic clay.

2. 0.50 m. Greenish-grey, fine-grained limestone.

Illaenus sp.
Chasmops sp.
Euprimites locknensis (THORSL.)

1. 0.01 m. Bentonitic clay.

From the debris derived from the above complex of bentonitic beds the following species have been secured:

"*Orthis*" aff. *lyckholmiensis* WYS.
Platystrophia sp.
Onniella sp.
Kullervo sp.
Eoplectodonta sp.
Bilobia sp.
Bimuria peregrina JAAN.

1.5 m. Grey, fine-grained limestone displaying a fairly regular bedding.

Asaphus (*Neoasaphus*) *ludibundus* TÖRNQ.
Illaenus sphaericus HOLM
Stenopareia sp.
Panderia parvula (HOLM)
Remopleurides sp.
Chasmops sp.
Euprimites locknensis (THORSL.)
Euprimites sp.
Platybolbina n. sp.
Tvaerenella carinata (THORSL.)
Steusloffia costata (LINNARSSON)
Steusloffia multimagrinata ÖPIK
Sigmobolbina sp.
Lomatobolbina mammillata (THORSL.) (0.5 m)[1]

[1] The figure refers to the level below the lower boundary of the complex of bentonitic beds. The range of most ostracodes and small trilobites is given in figs. 9 and 10.

Baltonotella sp.
Cyrtonotella sp.
Onniella sp.
Kullervo sp.
Eoplectodonta sp.
Bilobia sp.
Bimuria peregrina JAAN.
Oepikina sp.
Echinosphaerites aurantium (GYLL.)
Heliocrinites sp.
Climacograptus sp.

The lower boundary is transitional.

8.0 m. Grey, fine-grained, mostly somewhat nodular limestone with irregular argillaceous intercalations.

Asaphus (*Neoasaphus*) *ludibundus* TÖRNQ.
Illaenus sphaericus HOLM
Panderia parvula (HOLM)
Remopleurides sp.
Lonchodomas jugatus ANG.
Ampyx costatus BOECK
Platylichas bottnicus (WIMAN)
Raymondaspis ? sp.
Chasmops sp.
Pseudosphaerexochus elongatus THORSL.
Cybelella adornata (TÖRNQ.) (6.7 m)
Euprimites locknensis (THORSL.)
Euprimites sp.
Tvaerenella carinata (THORSL.)
Platybolbina n. sp. (3.4 m)
Platybolbina kapteyni (BONNEMA)
Laccochilina (*Prochilina*) *decumana* (BONNEMA)
Steusloffia costata (LINNARSSON)
Steusloffia multimarginata ÖPIK
Sigmoopsis n. sp. (2.0 m)
Sigmoopsis obliquejugata (FR. SCHMIDT)
Sigmobolbina sp.
Lomatobolbina mammillata (THORSL.) (2.5 m)
Brevibolbina n. sp.
Bolbina n. sp. (5.2 m)
Hesperidella esthonica (BONNEMA)
Tallinnella angustata (KRAUSE)
Conchoprimitia leperditioides THORSL.
Oecematobolbina n. sp. a
Uhakiella granulifera (ULRICH & BASSLER) (1.5; 1.8; 9.0 m)
Platystrophia sp. a
Platystrophia sp. b
Onniella sp.
Eoplectodonta sp.
Bilobia sp.
Bimuria peregrina JAAN.
Oepikina sp.
Echinosphaerites aurantium (GYLL.)
Haplosphaeronis oblonga ANG.
Caryocystites lagenalis REGNÉLL
Discoceras ? sp.
Climacograptus sp. (3.25; 6.25 m)
Pseudoclimacograptus cf. *scharenbergi* (LAPW.) (7.75 m)
Pseudoclimacograptus n. sp. (9.25 m)

0.03 to 0.05 m. Bentonitic clay.

Ca. 4 m (section *U*), ca. 2 m (section *L*). Grey, fine- to coarse-grained, mostly nodular limestone, lithologically indistinguishable from the limestone above the bed of bentonitic clay. [It is possible that the below list of fossils includes some forms which come from beds immediately above the bentonitic bed.]

Asaphus (*Neoasaphus*) *ludibundus* TÖRNQ.
Illaenus sphaericus HOLM
Illaenus fallax HOLM
Panderia parvula HOLM
Remopleurides sp.
Lonchodomas jugatus ANG.
Ampyx costatus (BOECK)
Chasmops sp. sp.
Cybelella adornata (TÖRNQUIST)
Euprimites locknensis (THORSL.)
Euprimites sp.
Platybolbina sp.
Tallinnella angustata (KRAUSE)
Steusloffia multimarginata ÖPIK
Sigmobolbina sp.

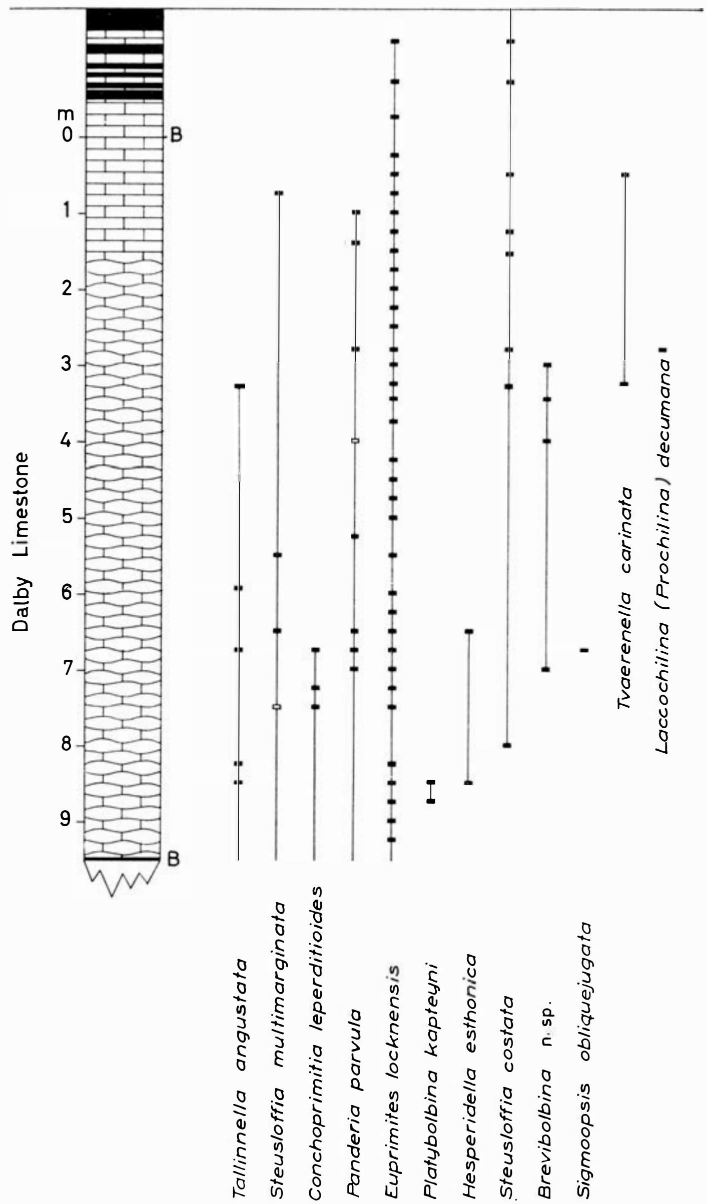

Fig. 9. Range of selected species in the upper part of the Dalby Limestone of the main section of Fjäcka. *B* and black layers denote bentonitic beds. Continued in fig. 10.

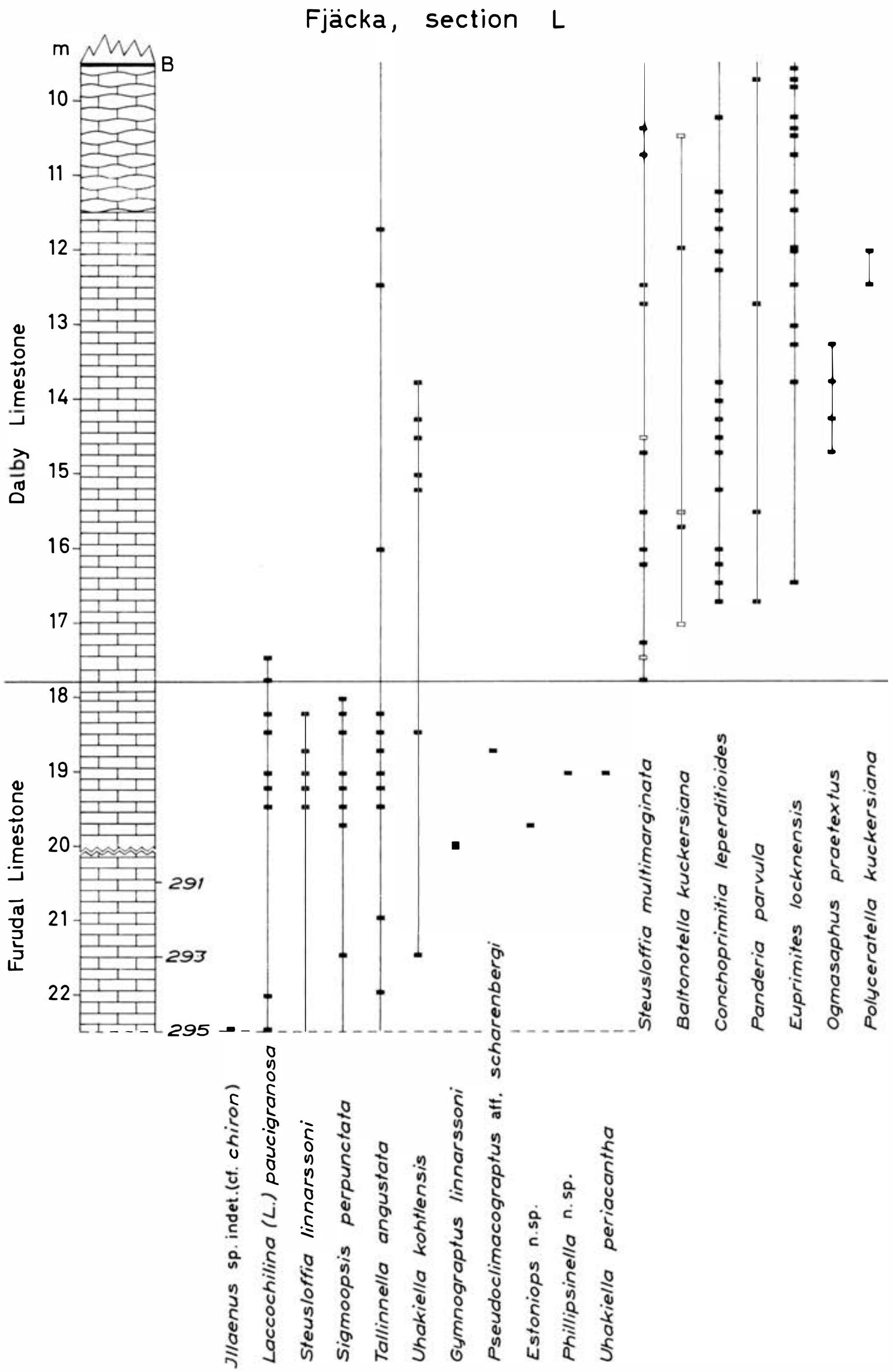

Fig. 10. Range of selected species in the lower part of the Dalby Limestone (locality No. 7) and in the upper part of the Furudal limestone of the main section of Fjäcka. Continued from fig. 9. Open rectangles refer to specimens which, on account of fragmentary condition or poor state of preservation, could not be identified unconditionally at the species level.

Sigmoopsis platyceras (ÖPIK) (Sect. *U*, 11.25 m; JAANUSSON 1957, Pl. XI, figs. 7, 8)
Conchoprimitia leperditioides THORSL.
Baltonotella cf. *kuckersiana* (BONNEMA)
Nicolella n. sp.
Platystrophia cf. *lynx* (EICHW.)
Platystrophia cf. *dentata* (PANDER)
Platystrophia cf. *sublimis* ÖPIK
Platystrophia n. sp.
Onniella sp.
Eoplectodonta n. sp.
Bilobia sp.
Tetraodontella biseptata JAAN.
Bimuria peregrina JAAN.
Oepikina n. sp.
Actinomena sp.
Oxoplesia dorsata (HIS).
Pseudocrania cf. *planissima* EICHW.
Echinosphaerites aurantium (GYLL.)
Heliocrinites granatum (WAHL.)
Haplosphaeronis oblonga ANG.
Caryocystites lagenalis REGNÉLL
Hoplocrinus dalecarlicus REGNÉLL

The lower boundary is transitional.

Ca. 4 m. Thick-bedded to somewhat nodular, coarse-grained limestone with abundant internal moulds, or grains resembling superficial oöids, or both in the insoluble residue. The division differs from the overlying beds mainly by the presence of abundant chamositic grains in the insoluble residue and by a less pronounced nodular structure of the beds. The lithological difference is slight, and a boundary is difficult macroscopically to define.

Asaphus (*Neoasaphus*) *ludibundus* TÖRNQ.
Ogmasaphus praetextus TÖRNQ.
Panderia parvula (HOLM)
Remopleurides sp.
Lonchodomas jugatus ANG.
Ampyx costatus (BOECK)
Bronteopsis sp.
Euprimites locknensis (THORSL.)
Euprimites sp.
Uhakiella kohtlensis ÖPIK
Tallinnella angustata (KRAUSE)
Steusloffia multimarginata ÖPIK
Steusloffia rigida ÖPIK (Section *U*, 17.0–17.5 m)
Sigmobolbina sp.
Polyceratella kuckersiana (BONNEMA)
Baltonotella kuckersiana (BONNEMA)
Conchoprimitia leperditioides THORSL.
Nicolella demissa (DALM.)
Platystrophia cf. *dentata* (PANDER)
Onniella sp.
Tetraodontella biseptata JAAN.
Bilobia sp.
Oxoplesia dorsata (HIS.)
Echinosphaerites aurantium (GYLL.)
Heliocrinites granatum (WAHL.)
Caryocystites aff. *angelini* (HAECKEL) (cf. REGNÉLL 1948, p. 21, footnote 1)

2.5–2.75 m. Fairly fine-grained, grey limestone without or with only a few non-glauconitic internal moulds or grains resembling superficial oöids in the insoluble residue. The division is not easily distinguishable lithologically from the underlying Furudal Limestone. Poorly exposed, details obscure.

Panderia parvula (HOLM)
Remopleurides sp.
Euprimites locknensis (THORSL.)
Euprimites cf. *suecicus* (THORSL.) (Section *L*, 15.25 m)
Euprimites sp.
Uhakiella coelodesma ÖPIK (Section *L*, 16.5 m)
Uhakiella kohtlensis ÖPIK
Laccochilina (*Laccochilina*) *paucigranosa* JAAN. (only in the lowermost 40 cm, cf. Fig. 10)
Laccochilina (*Laccochilina*) cf. sp. C JAAN. (Section *L*, 15.5, 15.75, 16.25, 17.0 m)
Platybolbina sp.
Tallinnella angustata (KRAUSE)
Steusloffia multimarginata ÖPIK
Sigmobolbina sp.

Conchoprimitia leperditioides THORSL.
Baltonotella kuckersiana (BONNEMA)
Platystrophia cf. *dentata* (PANDER)
Onniella sp.
Tetraodontella biseptata JAAN.
Echinosphaerites sp. (the lowermost specimen in the section *L* at the level of 16.0 m)

Furudal Limestone 5 m +.

5 m +. Grey, fine-grained, fairly thick-bedded limestone.

Asaphus (*Neoasaphus*) *lepidus* TÖRNQ.
Pseudomegalaspis cf. *patagiata* (TÖRNQ.)
Nileus sp.
Remopleurides sp.
Trinodus sp.
Lonchodomas sp.
Ampyx (*Cnemidopyge*) n. sp.
Illaenus sp. indet. (cf. *chiron* HOLM)
Phillipsinella n. sp.
Estoniops n. sp.
Laccochilina (*Laccochilina*) *paucigranosa* JAAN.
Uhakiella kohtlensis ÖPIK
Uhakiella labrosa (KRAUSE) (sect. *L*, 19.0 m)
Uhakiella periacantha JAAN.
Euprimites sp.
Tallinnella angustata (KRAUSE)
Steusloffia linnarssoni (KRAUSE)
Sigmoopsis perpunctata (ÖPIK)
Sigmobolbina sp.
Oepikium sp. (sect. *L*, 19.25 m)
Baltonotella sp.
Nicolella sp.
Glyptograptus vikarbyensis JAAN.
Glyptograptus cernuus JAAN.
Pseudoclimacograptus aff. *scharenbergi* (LAPW.)
Gymnograptus linnarssoni (MOBERG)

Remarks on Microlithology

FURUDAL LIMESTONE.—The limestone is a calcarenitic calcilutite with mostly well-preserved outlines of shell fragments and fine-grained matrix. The texture is similar to that of the topmost Furudal Limestone of the Vikarby section. In almost every thin section some of the shell fragments are surrounded by a thin coating formed by what according to the colour in incident light seems to be mostly goethite, but occasionally also haematite or pyrite. Also chamosite seems to be one of the substances forming the coating, but if so, it is almost completely altered into goethite.

The amount of the sand fraction is inconsiderable in the insoluble residue. Every sample contains but a few grains of glauconite and pyrite and occasionally also rare non-glauconitic internal moulds.

DALBY LIMESTONE.—The microlithology of the lower 2.5 m (15.3 to 17.8 m below the complex of bentonitic beds in the section *L*) of the Dalby Limestone agrees with that of the Furudal Limestone except that the grain size is somewhat larger. The sample D 60—209 (16.5 m of the section *L*) contains a moderate amount of non-glauconitic internal moulds and oöid-like grains, but usually such particles are rare in the insoluble residue. The next higher lithologic subdivision (11.2—15.3 m of the section *L*) consists of chamositiferous calcarenites with abundant non-glauconitic internal moulds and oöid-like grains in the insoluble residue. The microlithology is very similar to that

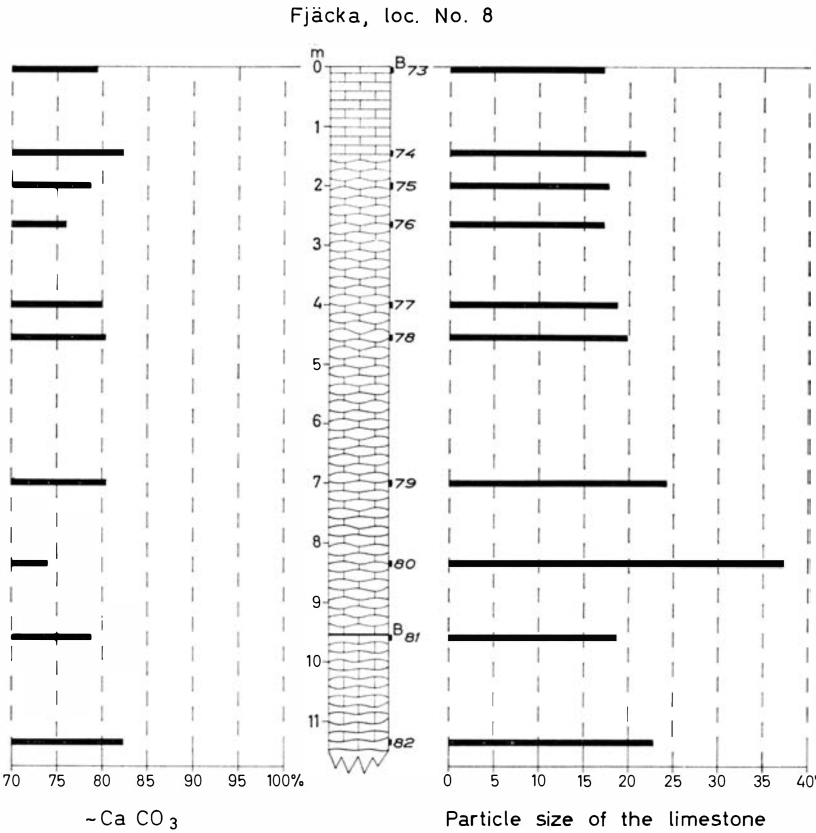

Fig. 11. Upper part of the Dalby Limestone in the main section of Fjäcka. To the left material soluble in dilute acetic acid (approximately the content of $CaCO_3$), to the right particle size of the limestone according to the method of JAANUSSON (1952). Continued from Pl. III in MARTNA (1955).

of the Dalby Limestone of the Böda Hamn core (JAANUSSON 1960a) except that the oöid-like grains are much more numerous. These grains are rounded, often somewhat flattened and ovoid, and with a diameter up to 1.5 mm. Thin sections show that they consist of a fairly large nucleus which is mostly formed by a shell fragment. The nucleus is surrounded by a coating which is pale green in thin sections and seems to be chamosite. The coating is occasionally fairly thick but does not show any distinct lamination in the few thin sections examined in connection with this study. The grains resemble superficial oöids (ILLING 1954), but a closer study is needed before this term can be applied for these structures unconditionally. In the lower (13.8—15.3 m of the section *L*) and upper (11.2—12.2 m) part of the division the oöid-like grains outnumber the internal moulds, whereas in the middle part of the division the internal moulds are predominant and at some levels very abundant.

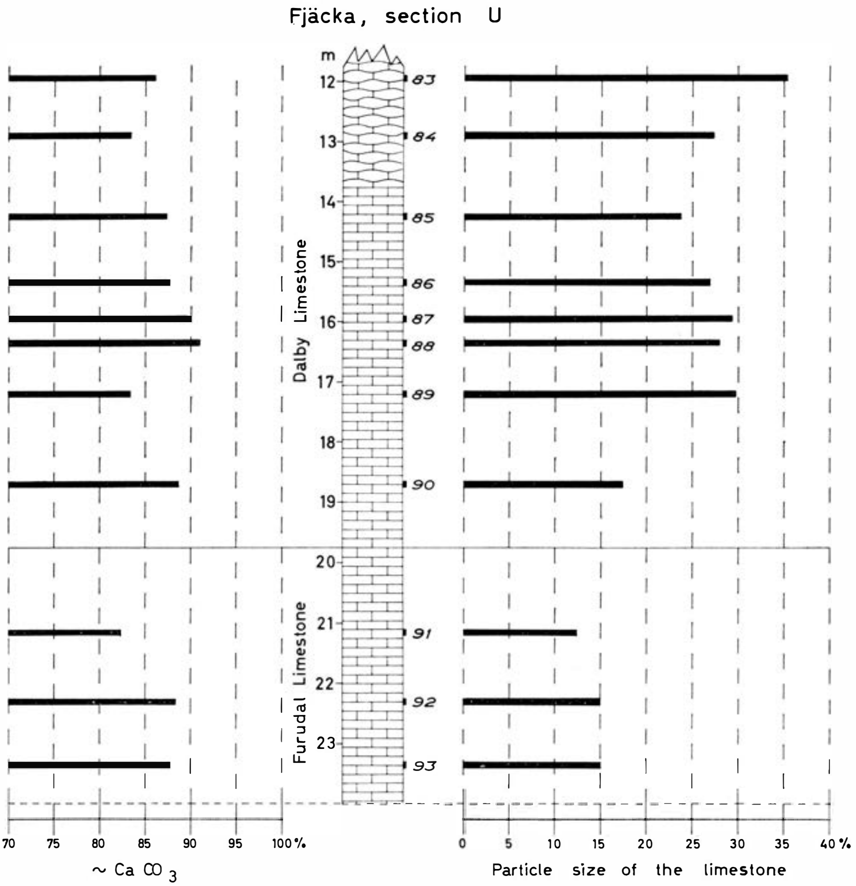

Fig. 12. Lower part of the Dalby Limestone and upper part of the Furudal Limestone in the main section of Fjäcka. For explanation, see Fig. 11. Continued from Fig. 11.

Some samples contain a small number of glauconite grains which are dark green, rounded, and with a shining surface. They are probably allochthonous.

The remaining part of the Dalby Limestone, up to the complex of bentonitic beds, is fairly monotonous microlithologically. The rock can be classified as a calcarenite in the lower part and as preponderatingly calcarenitic calcilutite in the upper part. The grain size of the upper part of the Dalby Limestone is considerably smaller, and the content of total insoluble residue greater, than in the corresponding portion of the Smedsby Gård bore in Östergötland (JAANUSSON 1962 a). Most of the thin sections do not show any authigenic iron compound other than occasional pyrite. Substances which probably are chamosite mostly altered into goethite have been observed only in the samples D 83 and D 75—D 73. They occur, as usual, as thin coatings around some shell fragments and as fillings of cavities of small shells. The insoluble residue contains occasional grains of glauconite (2 to 10 per 100 g limestone), pyrite, and some few non-glauconitic internal moulds. An exception is the sample D 84 which contains numerous small, fresh grains of glauconite. Among about 1 000 grains only one glauconitic internal mould has been observed.

The grain size of the limestone in the complex of bentonitic beds has been illustrated by MARTNA (1955, Pl. III). The insoluble residue of this part of the section has not been studied so far.

Stratigraphical Remarks

The stratigraphy of the Aseri (*Platyurus*) Stage has been treated by JAANUSSON & MUTVEI (1953). The thickness of the main subdivisions are repeated here in Table 2, and the known fauna of the district is included in the faunal list (Table 3).

LASNAMÄGI STAGE.—The Lasnamägian sequence of the western (Kårgärde) and northern (Fjäcka) part of the Siljan district consists, as on Öland and in Östergötland, of reddish-brown, dominantly finely nodular limestone (Skärlöv Limestone) at the base, variegated reddish-brown and grey limestone (Seby Limestone) in the middle, and grey, mainly calcarenitic limestone (Folkeslunda Limestone; the Upper Grey Orthoceratite Limestone of early writers) on the top. In the south-eastern part of the district (Vikarbyn) the Skärlöv Limestone is missing, and a thin sequence of the Seby Limestone overlies directly the Vikarby member of the Segerstad Limestone. The thickness of the Lasnamägi Stage and of its litho-stratigraphic subdivisions is given in Table 2.

The Skärlöv Limestone is poor in macrofossils, and the few specimens found are mostly too poorly preserved for identification on specific or even generic level. Where known, its thickness exceeds that of Öland and is less than in Östergötland. Also lithologically it takes a somewhat intermediate position including, on the average, less regularly bedded limestone than on Öland and more than in Östergötland.

In the Vikarby section the whole Skärlöv Formation is missing at a level which cannot be distinguished from an ordinary bedding plane. No trace of a discontinuity surface has been observed there at the boundary between the

Table 2

Localities	Kårgärde Limestone	Vikarby Limestone	Skärlöv Limestone	Seby Limestone	Folkeslunda Limestone	Lasnamägi Stage (total)
Vikarbyn	3.00 m	0.70 m	0 m	0.40 m	2.0 m	2.40 m
Kårgärde	2.40 m	0.70 m	3.25 m	1.70 m	2.40 m	7.35 m
Fjäcka	1.40 m +	1.05 m +	2.80 m (+ ?)	?0.85 m +	—	3.65 m +

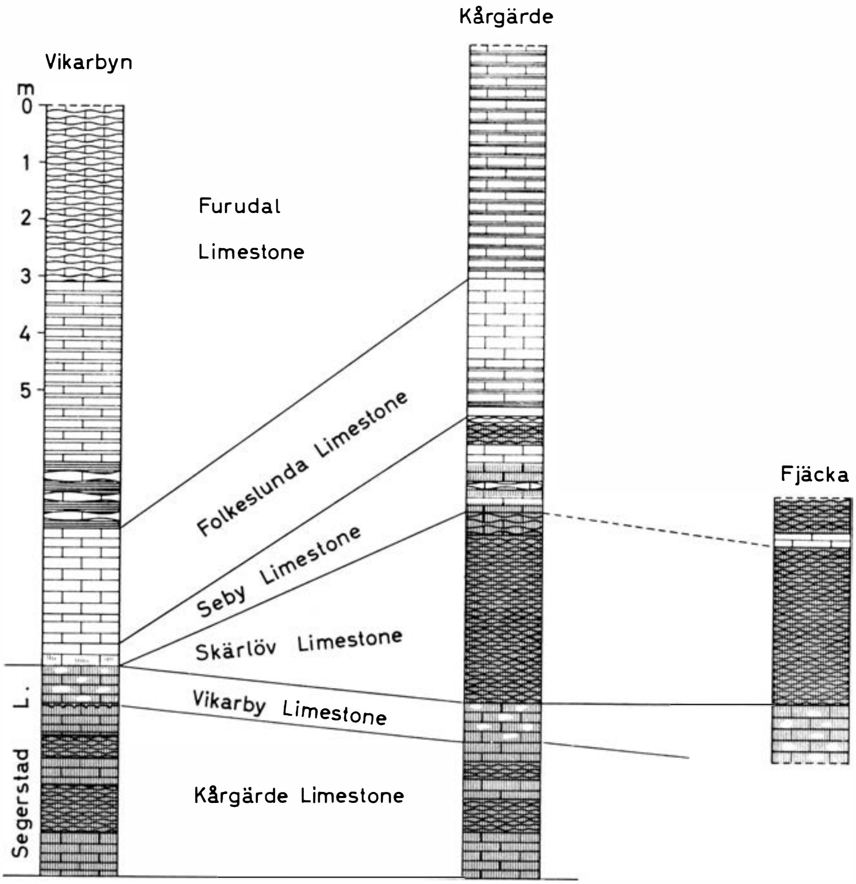

Fig. 13. Sections of the Aserian, Lasnamägian, and Uhakuan beds in the Siljan district. For signs, see Fig. 2.

Vikarby and Seby Limestones. As the rock of these two divisions is practically identical in that section, a boundary can be drawn upon faunal evidence only. Thus here the unusual situation arises that two divisions, which are normally defined as conventional litho-stratigraphic units, come into contact with each other on account of outwedging of a lithologically different unit and can, then, be defined only in the topo-stratigraphic (JAANUSSON 1960a) sense, i.e. with one of the boundaries defined by faunal criteria. It is quite clear that the absence of the Skärlöv Formation in the Vikarbyn section is not due to its being replaced by rocks of another facies. The subdivisions of the Segerstad Limestone have an almost constant thickness throughout the district (cf. Table 2), and the Folkeslunda Limestone is slightly thinner in the Vikarby section than at Kårgärde. The Seby Limestone has a considerably reduced thickness at Vikarbyn compared with that at Kårgärde (cf. Fig. 13). This suggests that there also parts of the Seby Limestone may be included in the hiatus.

The absence of any signs of erosion and of a discontinuity surface at the boundary between the Vikarby and Seby Limestones at Vikarbyn suggests that the deposits underlying the probable level of the break were not lithified, when the deposition of the overlying beds began. The hiatus may be due to submarine erosion, non-deposition, or both, or emergence without lithification of the emerged sediments (JAANUSSON 1961). It is difficult to prove which of these possible explanations fits the case. The beds on either side of the probable level of the break have a conspicuously coarser grain size than in the corresponding parts of the sequence of the other sections. Accumulation of shells and large shell fragments give part of the rock a coquinoid appearance. The content of the clay fraction of the total insoluble residue is comparatively low. This indicates that turbulence during the deposition of these sediments was greater at Vikarbyn than at Kårgärde or Fjäcka. This, in turn, suggests a submarine current-swept area, where allochthonous fine particles never got deposited, except in sediment traps, and most of the fine particles formed by the local break-down of the shells were winnowed out. Thus the rate of deposition remained low. On the other hand, shallow-water conditions before and after the subaerial exposure may have given rise to the same depositional phenomena. However, in that case the failure of the exposed surface to become lithified remains to be explained. In more or less contemporaneous beds elsewhere in Sweden and Estonia breaks are usually indicated by discontinuity surfaces showing signs of being lithified before the deposition of the overlying beds.

The variegated limestones of the Siljan district belonging to the Seby Formation resemble those of Öland not only lithologically but also faunally. The Seby Limestone of the Vikarby section yielded *Hyolithes cymbium* which on Öland is confined to the Seby Limestone (JAANUSSON 1960a). Previously this species was known in the Siljan district only from erratic boulders found at Nedre Gärdsbyn (HOLM 1893). In the same erratic boulders of the Seby Limestone HOLM (1891) found also *Lituites* (*Trilacinoceras*) *discors*, the index fossil of his zone with the same name. Thus, at Vikarbyn at least, the Seby Limestone belongs to the zone of *Lituites* (*Trilacinoceras*) *discors*. On account of the very small exposures the fauna of these beds is still poorly known in the Siljan district. The uppermost 85 cm of the Fjäcka section described by JAANUSSON & MUTVEI (1953, p. 15) may belong to the Seby Limestone which, in this case, reminds one of that of the Kårgärde section. However, the exact attribution of these beds at Fjäcka is uncertain until the development of the overlying beds becomes known.

Also the Folkeslunda Limestone of the Siljan district is similar to that of Öland, faunally as well as lithologically. It consists mainly of calcarenites, but beds of calcilutite also occur (Kårgärde section) as on southern Öland. Contrary to Öland non-glauconitic internal moulds of the insoluble residue are rare or absent in the parts of the formation which were available for lithological examination. However, the microlithology of the main calcarenitic division of the Folkeslunda Limestone is still unknown in the Kårgärde section, and samples in early collections suggest the presence of these grains in some part of that division.

Except *Hyolithes innotatus* no species of hyolithids or nautiloids confined to the Folkeslunda Limestone of Öland has so far been found in the Siljan district. *Lituites* is not rare, but the hitherto found specimens are too fragmentary for a safe identification at the species level.

UHAKU STAGE.—The Furudal Limestone of the Siljan district is throughout its fairly monotonous sequence a calcilutite. In the Siljan district the thickness of the formation is still unknown; according to the western exposures at Fjäcka it ought to exceed 11 m. The fauna includes but few, mostly rare species not found in contemporaneous beds of the other Cambro-Silurian areas of Sweden.

DALBY LIMESTONE.—Following TÖRNQUIST (1874, p. 14), JAANUSSON (1947, p. 47) tentatively drew the boundary between the Lower *Chasmops* Limestone and the *Crassicauda* Limestone in the Siljan district at the level, where cystoids make their appearance. The fine-grained rock below that level is very poor in cystoids and other large sedentary organisms. In this paper the boundary between the Dalby Limestone and the Furudal Limestone is drawn about 2.5 m lower down in the sequence at a level, where a conspicuous faunal change is initiated. The commonest forms appearing at or close above the base of the Dalby Limestone are *Euprimites locknensis*, *Steusloffia multimargi-nata*, and *Conchoprimitia leperditioides* among ostracodes, and *Panderia parvula* among trilobites (cf. Fig. 10). In the existing small exposures the determination of the level of appearance of species of large fossils is difficult. In the Siljan district the faunal change at the boundary between the Dalby and Furudal Limestones does not seem to coincide with a conspicuous change in lithology. In fact, the rock of the lowermost 2.5 m of the Dalby Limestone differs but slightly from that of the Furudal Limestone, and in small exposures it is difficult to determine the level of the boundary from the lithology alone. In the basal beds of the Dalby Formation the grain size of the limestone tends to be somewhat larger than in the calcilutites of the Furudal Formation, being close to what has been proposed by JAANUSSON (1952) as the limit between calcilutites and calcarenites, but the difference is not conspicuous macroscopically.

An important consequence of the mentioned small change in the position of the boundary is that apparently the entire range of *Illaenus crassicauda* falls into the Dalby Limestone. The range of this species seems to be fairly limited; the species is not rare in the lowermost 2.5 m of the Dalby Limestone (in the uppermost 2.5 m of the Flagkalk or *Crassicauda* Limestone as defined by TÖRNQUIST and JAANUSSON, respectively) and evidently continues also into the basal part of the overlying beds. Its possible occurrence in the Furudal Limestone is not confirmed by our collections; *I. crassicauda* is replaced in that formation by the closely related *I. intermedius* which may have been confused with the former species by earlier writers. With a view to the above it is clear that the term *Crassicauda* Limestone in the current sense ought to be dropped.

The lowermost 2.5 m of the Dalby Limestone, and the overlying about 4 m of the section consisting at Fjäcka of calcarenites with numerous non-glauconitic internal moulds in the insoluble residue, are at present very poorly exposed in the Siljan district. The fauna of these beds is still incompletely known. In addition to *Illaenus crassicauda* also *Ogmasaphus praetextus* and *Pseudoasaphus* cf. *limatus* seem to be restricted to this part of the section. On the other hand, *Bimuria peregrina* has not yet been found in these beds.

The main part of the Dalby Limestone in the Siljan district consists of calcarenites. The uppermost part of the formation is formed by calcarenitic calcilutites in the main section of Fjäcka (cf. Fig. 11). There the grain size is conspicuously less than e.g. in the corresponding beds of Östergötland (JAANUSSON 1962a, Fig. 8).

The upper boundary of the formation is tentatively drawn on the top of the complex of bentonitic beds. It is difficult to determine the most convenient level of this boundary before the suprabentonitic beds have been closely described. The thickness of the Dalby Limestone is probably somewhere between 19.5 and 21.6 m.

The chrono-stratigraphic classification of the beds of the age of the Dalby Limestone is still not well established. There is good evidence that the lower part of the formation is comparable to the zone of *Nemagraptus gracilis*. The boundary between the zones of *Nemagraptus gracilis* and *Diplograptus multidens* is in the Fågelsång district, Scania, well below the main complex of the bentonitic beds (NILSSON 1960), and the corresponding level ought to lie within the Dalby Limestone. However, as evident from the description of the main section of Fjäcka, no conspicuous faunal change can be observed within the Dalby Limestone. On the other hand, a fairly distinct faunal change, as yet not described in detail, takes place at or close to the upper boundary of the formation. For all practical purposes the Dalby Limestone represents a faunal entirety. The chrono-stratigraphic evaluation of this unit is difficult before the faunal succession of the suprabentonitic beds has become known.

The rich and varied fauna of the Dalby Limestone is so far incompletely described. The writer feels that it is still too early to attempt the completion of a faunal list of this formation in the Siljan district. Numerous undescribed species and many uncertain generic references may in several cases give an erroneous impression of the composition of the fauna.

Table 3. List of the species found in the Aserian, Lasnamägian, and Uhakuan beds of the Siljan district.

	Aseri Stage		Lasnamägi Stage			Uhaku Stage
	Segerstad L.					
	Kårgärde L.	Vikarby L.	Skärlöv Limestone	Seby Limestone	Folkeslunda Limestone	Furudal Limestone
TRILOBITA						
Asaphus (*Neoasaphus*) *platyurus* ANG.	+	+	–	–	–	–
Asaphus (*Neoasaphus*) *demissus* TÖRNQ.	–	+	–	–	–	–
Asaphus (*Neoasaphus*) *lepidus* TÖRNQ.	–	–	–	–	–	+
Asaphus (*Neoasaphus*) *bottnicus* JAAN.	–	–	–	–	–	+
Asaphus (*Neoasaphus*) sp.	–	–	–	+	+	–
Pseudoasaphus aciculatus (ANG.)	–	–	–	+	+	–
Pseudoasaphus tecticaudatus (STEINH.)	–	+	–	–	+	+
Pseudoasaphus cf. *limatus* JAAN.	–	–	–	–	–	?
Pseudobasilicus ? *brachyrachis* (TÖRNQ.)	–	–	–	+	+	+
Plectasaphus plicicostis (TÖRNQ.)	–	–	–	–	+	+
Pseudomegalaspis formosa (TÖRNQ.)	–	–	–	–	+	–
Pseudomegalaspis patagiata (TÖRNQ.)	–	–	–	–	+	+
Nileus sp.	–	–	–	–	+	+
Remopleurides sp. sp.	–	–	–	–	+	+
Illaenus excellens HOLM	+	–	–	–	–	–
Illaenus planifrons JAAN.	–	+	–	–	–	–
Illaenus chiron HOLM	–	–	–	+	+	–
Illaenus sp. indet. (cf. *chiron*)	–	–	–	–	–	+
Illaenus intermedius HOLM	–	–	–	–	–	+
Bronteopsis sp.	–	+	–	+	–	–
Phillipsinella n. sp.	–	–	–	–	–	+
Lonchodomas sp.	–	–	–	–	+	+
Ampyx (*Cnemidopyge*) n. sp.	–	+	–	–	+	+
Estoniops n. sp.	–	–	–	–	–	+
Sphaerocoryphe sp.	–	–	–	–	–	+
Paraceraurus sp.	–	+	–	–	–	–
Paraceraurus cf. *exsul* (BEYR.)	–	–	–	–	+	–
Hoplolichas proboscideus DAMES	–	–	–	–	–	+
Trinodus sp. sp.	+	–	–	–	–	+
OSTRACODA PALAEOCOPA						
Laccochilina (*L.*) *bulbata* JAAN.	+	–	–	–	–	–
Laccochilina (*L.*) *paucigranosa* JAAN.	–	–	–	–	–	+
Laccochilina (*L.*) sp.	–	–	–	+	+	–
Piretia n. sp.	–	–	–	+	–	–
Uhakiella kohtlensis ÖPIK	–	–	–	–	–	+
Uhakiella labrosa (KRAUSE)	–	–	–	–	–	+
Uhakiella periacantha JAAN.	–	–	–	–	–	+
Euprimites effusus JAAN.	+	+	+	+	+	–
Euprimites anisus JAAN.	+	–	–	–	–	–
Euprimites bursa (KRAUSE)	–	–	–	–	+	+
Euprimites sp.	–	–	–	–	–	+
Tvaerenella sp.	–	–	–	–	+	–
Tallinnella angustata (KRAUSE)	–	–	–	–	–	+
Steusloffia linnarssoni (KRAUSE)	–	–	–	–	+	+
Sigmoopsis perpunctata (ÖPIK)	–	–	–	–	–	+
Sigmobolbina sp.	–	–	–	–	–	+
Oepikium sp.	–	–	–	–	–	+
Baltonotella sp.	–	–	–	–	–	+

Table 3 (*continued*)

	Aseri Stage		Lasnamägi Stage			Uhaku Stage
	Segerstad L.		Skärlöv Limestone	Seby Limestone	Folkeslunda Limestone	Furudal Limestone
	Kårgärde L.	Vikarby L.				
Brachiopoda Articulata						
Nicolella sp.	–	–	–	–	–	+
Christiania sp. sp.	–	+	–	+	+	+
Leptellina ? n. sp.	–	–	–	–	–	+
Leptestia ? sp.	–	+	–	+	–	–
Graptoloidea						
Glyptograptus vikarbyensis Jaan.	–	–	–	–	–	+
Glyptograptus cernuus Jaan.	–	–	–	–	–	+
Pseudoclimacograptus aff. *scharenbergi* (Lapw.)	–	–	–	–	–	+
Gymnograptus linnarssoni (Moberg)	–	–	–	–	–	+
Cephalopoda						
Angelinoceras latum (Ang.)	+	–	–	–	–	–
Lituites (*Lituites*) *törnquisti* Holm	–	+	–	–	–	–
Lituites (*Trilacinoceras*) *discors* Holm	–	–	–	+	–	–
Lituites (*Lituites*) sp.	–	–	–	–	+	–
Lituites minutus Holm nom. nud.	–	–	–	+	–	–
Lituites anguinus Ang.	–	–	–	?	?	–
Ancistroceras sp.	+	–	–	–	–	–
Rhynchorthoceras angelini (Boll)	–	+	–	–	–	–
Orthoceros bifoveatum (Noetl.)	–	–	–	–	–	+
"*Orthoceros*" *nilssoni* (Boll) sp. coll.	+	+	–	–	–	–
Geisonoceras ? *centrale* (Dalm.)	–	+	–	–	–	–
Geisonoceras ? *scabridum* (Ang.)	–	–	–	+	?	–
Kionoceras timidum Troedss.	?	?		?		
Polygrammoceras carinatum Troedss.	–	–	–	–	+	–
Polygrammoceras cf. *strictum* (Ang.)	–	–	–	–	+	–
"*Conorthoceras*" *conicum* (His.)	–	+	–	+	–	–
Ctenoceras sp.	–	–	–	+	–	–
Cochlioceras burchardi (Dew.)	+	+	–	+	–	–
Trocholites remelei Schroeder	–	–	–	?	?	–
Trocholites sp.	–	–	–	+	–	–
Protobactrites delicatulum Troedss.	–	–	–	?	–	–
Nanno belemnitiforme belemnitiforme Holm	–	?	–	–	–	–
Nanno belemnitiforme elata Holm	–	–	–	–	+	–
Endoceras (*Suecoceras*) *gibbum* Holm	?	?		?		
"*Endoceras*" n. sp.	+	+	–	–	–	–
"*Endoceras*" *barrandei* Dew.	–	–	–	+	–	–
Hyolithida						
Hyolithes cymbium Holm	–	–	–	+	–	–
Hyolithes dispar Holm	–	+	–	–	–	–
Hyolithes innotatus Holm	–	–	–	–	+	–
Gastropoda						
Clathrospira cf. *elliptica* (His.)	–	–	–	–	–	+
Ecculiomphalus sp.	–	–	–	+	+	–
Pararaphistoma sp.	–	–	–	+	+	–
Clisospira ? sp.	–	–	–	–	–	+

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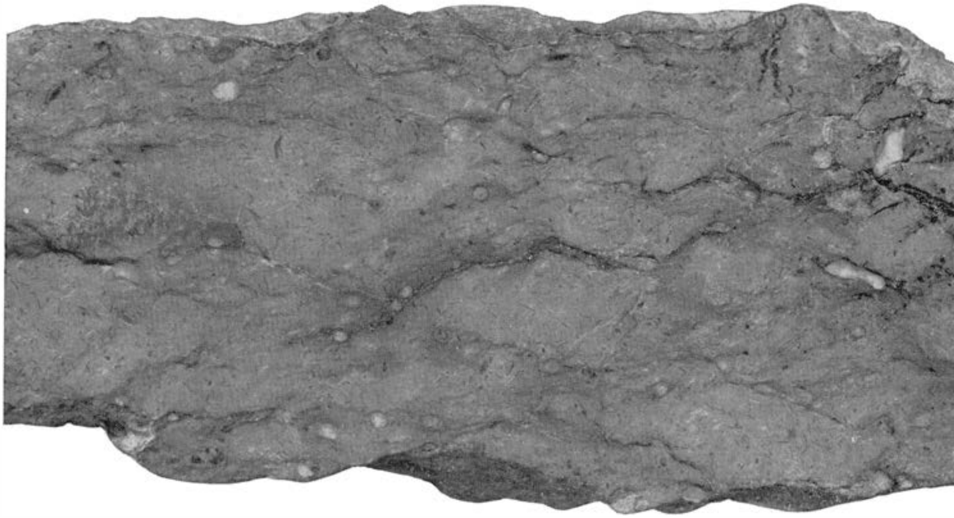

Fig. 1. Upper part of the Furudal Limestone (sample No. D 200) in the Vikarby section. The white dots are cross-sections of organogenic tubes filled with clear calcite. Natural size.

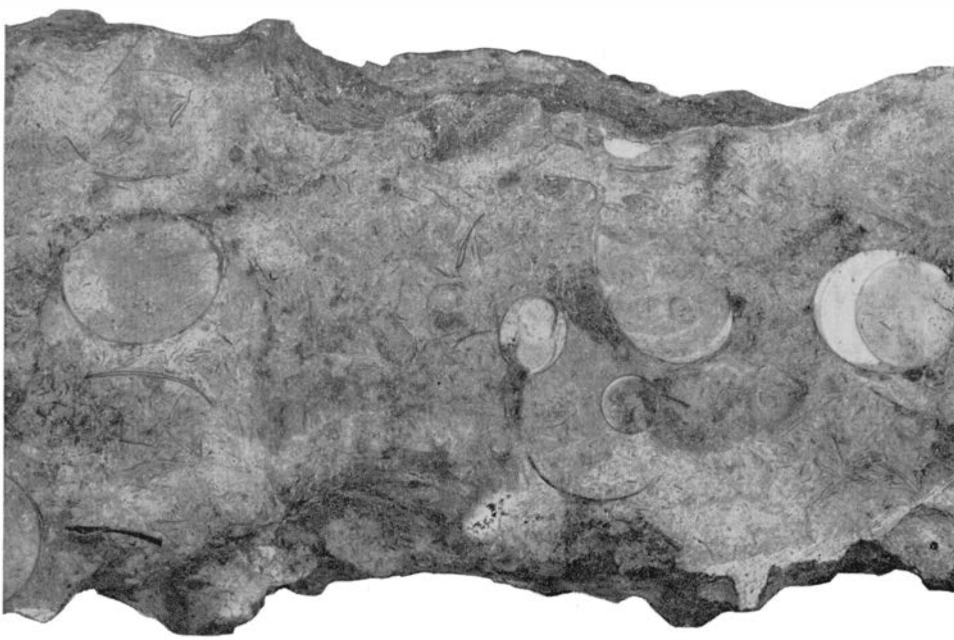

Fig. 2. Folkeslunda Limestone (sample No. D 190) in the Vikarby section. Notice the numerous cross-sections through cephalopod shells. Natural size.

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