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SERIE C NR 806 AVHANDLINGAR OCH UPPSATSER ÅRSBOK 78 NR 4

ULF SIVHED

LITHO- AND BIOSTRATIGRAPHY OF THE UPPER TRIASSIC-MIDDLE JURASSIC IN SCANIA, SOUTHERN SWEDEN

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CONTENTS

ABSTRACT

A brief review is presented on the Upper Triassic–Middle Jurassic sedimentary deposits in Scania. Their distribution, lithology and stratigraphic representation are described as well as biostratigraphic data. In terms of cronostratigraphy the Rhaetian, Hettangian, Sinemurian, Pliensbachian, Toarcian, Aalenian, Bajocian, Bathonian and Callovian Stages are penetrated.

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INTRODUCTION

The purpose of this paper is to recapitulate previous knowledge of the Rhaetian and Lower Jurassic, as well as parts of the Middle Jurassic deposits in Scania. The lithostratigraphic subdivision is partly revised and correlated with the main sedimentary cycles. The geographical location of the discussed localities is described in the list of localities.

On the whole, post-Palaeozoic sedimentary rocks in Sweden are restricted to the southwestern margin of the Fennoscandian Shield. On the Swedish mainland, Jurassic deposits are known from Scania only, where they form the rock surface in fairly large parts of the Fennoscandian Border Zone (Fig. 1). Where Jurassic rocks form the sub-Quaternary surface, they are predominantly of Liassic age. Middle and Upper Jurassic strata at the Quaternary base are found in minor areas only, viz. in the Vomb and Ängelholm Troughs and along the eastern margin of the Danish Embayment. As indicated by many borings, Jurassic strata are also present below the Cretaceous–Palaeogene cover in the Danish Embayment, the Vomb Trough and the Hanö Bay. In the shallow Båstad and Kristianstad Basins, however, there is no Jurassic rock except, possibly, rudimentarily preserved below the Cretaceous cover (Fig. 1).

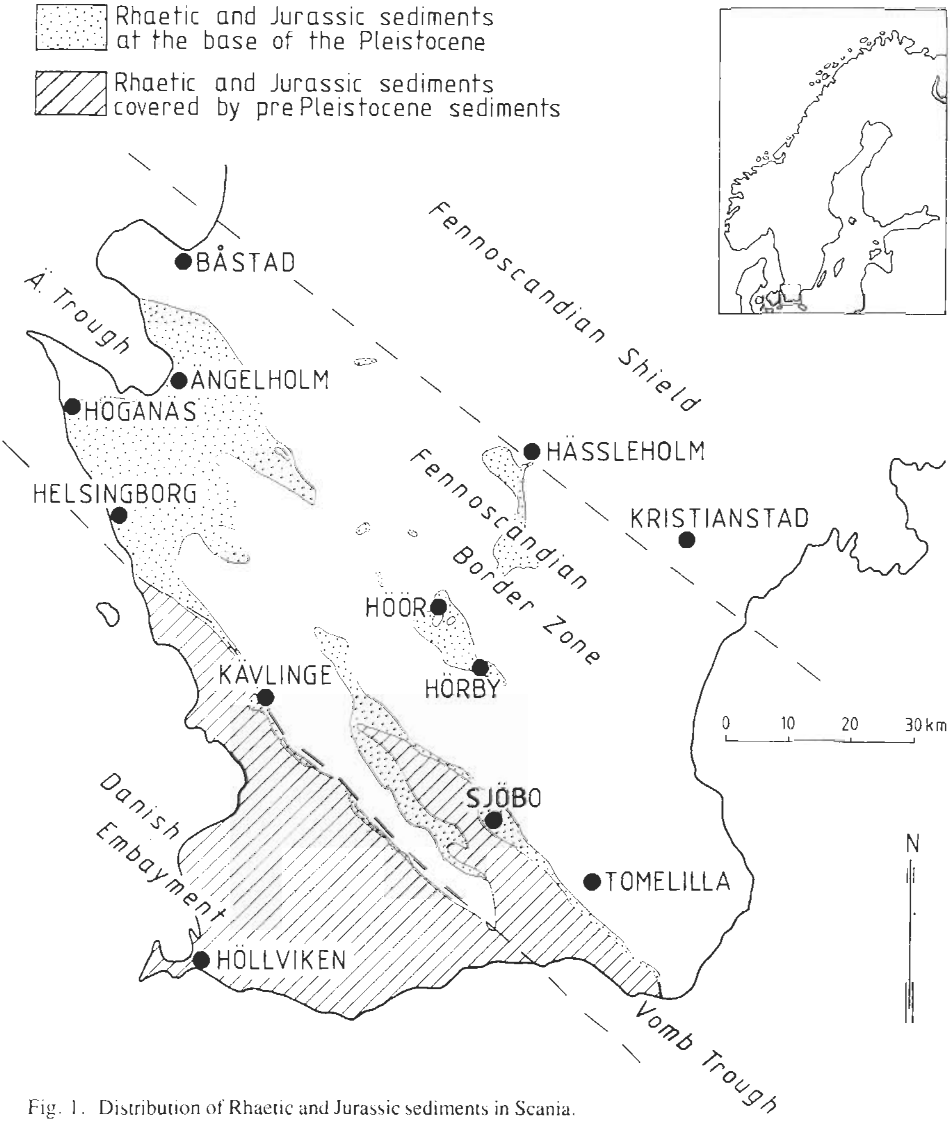

Fig. 1. Distribution of Rhaetic and Jurassic sediments in Scania.

HÖGANÄS FORMATION

In the Late Triassic (Rhaetian) Scania was subject to Early Kimmerian movements (Troedsson 1942, Bölau 1973, Gravesen *et al.* 1982, Bertelsen 1978, Norling 1982a). The sea transgressed and the climatic conditions in Scania changed from arid to humid. The terrestrial Kågeröd Formation (Keuper) consists of bright-coloured (grey and red dominate) arkose, conglomerate, sandstone and claystone with regionally varying

STAGES	ÄNGELHOLM TROUGH		HELSINGBORG-AREA		CENTRAL SCANIA	VOMB TROUGH
BATHONIAN	VILHELMSFÄLT FORMATION		FORTUNA MARL		(hatched)	(hatched)
BATHONIAN	VILHELMSFÄLT FORMATION		GLASS SAND		(hatched)	GLASS SAND
BAJOCIAN	VILHELMSFÄLT FORMATION		FUGLUNDA BEDS		(hatched)	FUGLUNDA BEDS
AALENIAN	RYA FORMATION	RYDEBÄCK MEMBER	RYA FORMATION	RYDEBÄCK MEMBER	Basalt tuff at Korsaröd	Ferriferous, partly oolitic sand and sandstone
TOARCIAN	RYA FORMATION	RYDEBÄCK MEMBER	RYA FORMATION	RYDEBÄCK MEMBER	Basalt tuff at Korsaröd	Ferriferous, partly oolitic sand and sandstone
PLIENSBACHIAN	RYA FORMATION	KATSLÖSA MEMBER	RYA FORMATION	KATSLÖSA MEMBER	Brandsberga and Kolleberga erratics	Ferriferous, partly oolitic sand and sandstone
SINEMURIAN	RYA FORMATION	PANKARP MEMBER	RYA FORMATION	PANKARP MEMBER	? Sapropel at Sandåkra	Limnic sediment at Tosterup
SINEMURIAN	RYA FORMATION	DOSHULT MEMBER	RYA FORMATION	DOSHULT MEMBER		Limnic sediment at Tosterup
HETTANGIAN	HÖGANÄS FM	HELSINGBORG MEMBER	HÖGANÄS FM	HELSINGBORG MEMBER	HÖÖR SANDSTONE	
RHAETIAN	HÖGANÄS FM	BJUV MEMBER	HÖGANÄS FM	BJUV MEMBER	BJUV MEMBER?	Sandstone and coal at Rödalsberg and Munka Tågarp
RHAETIAN	HÖGANÄS FM	VALLÅKRA MEMBER	HÖGANÄS FM	VALLÅKRA MEMBER	VALLÅKRA MEMBER?	Sandstone and coal at Rödalsberg and Munka Tågarp

Fig. 2. Correlation of the lithostratigraphic units in Scania with international stages of the Upper Triassic–Middle Jurassic.

composition (Angelin 1859, Troedsson 1934, 1942, 1951, Köster 1956, Bertelsen 1980). It was deposited as a series of coalescent alluvial fans on the south side of the Kullen–Ringsjön–Andrarum dislocation zone (Norling 1982a). In northwest Scania it is succeeded by the limnic, deltaic, and partly marine Höganäs Formation (Fig. 2), Rhaetian and Hettangian in age, containing sandstone, coal seams and clay (mostly kaolinitic and montmorillonitic in the Rhaetian, Bölau 1969). The Höganäs Formation (Angelin 1859), as figured by Norling (1982a, Fig. 7, 1982b, Fig. 9), is divided into three members viz. the Rhaetian Vallåkra and Bjuv Members and the Hettangian Helsingborg Member. The Bjuv Member was earlier called the Gruv beds or layer. Troedsson (1950) identified twelve sedimentary cycles in the Höganäs Formation, nine of which appear in the Helsingborg Member.

VALLÅKRA MEMBER

The basal member of the Höganäs Formation is the Vallåkra Member (cycle 1, Troedsson 1950), introduced by Troedsson (1935). The Vallåkra Member is usually characterized as being a transition between the terrestrial Kågeröd Formation and the deltaic carboniferous sediments of the Bjuv and Helsingborg Members. The Vallåkra Member is made up of grey and variegated, unstratified clays including a sphaeroside-rite layer and sandstone lenses, mostly green in colour. Sediments of the Vallåkra Member are partly exposed in the north quarry at Vallåkra. There, the whole sequence

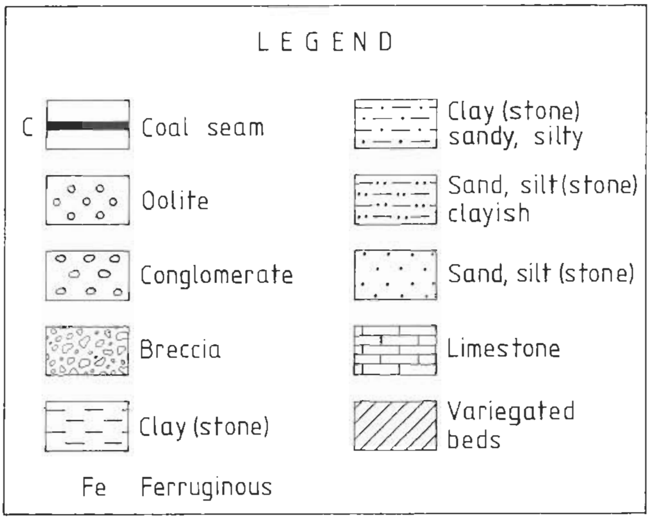

Fig. 3. Lithostratigraphic legend for the section described in Figs. 4–13.

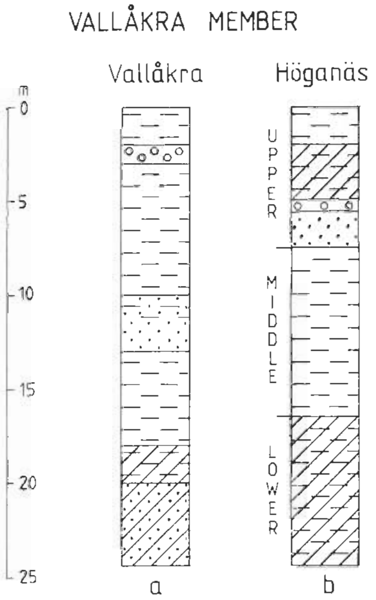

Fig. 4. Lithology of the Vallåkra Member at a, Vallåkra and b, Höganäs.

(Fig. 4a) consists basally of 6 m sand and clay mixed with the underlying red clay of the Kågeröd Formation. The sand and clay are succeeded by 5 m light clay, 3 m argillaceous sandstone and 1 m dark clay, 1 m spherosiderite, 1 m light clay and 1 m dark clay. The dark clay forms the uppermost part of the Vallåkra Member and is overlain by the lower (B) coal seam of the Bjuv Member.

Bölau (1949) described the corresponding sediments from Margreteberg (Fig. 4b), where they are more distinctly developed than in the stratotype section. At Margreteberg, the Vallåkra Member is divided into a lower, a middle and an upper part. The lower part consists of 7–8 m grey, green and purple spotted clays with sandstone lenses, its middle part of 8–9 m grey clay and its upper part of 2 m sandstone basally succeeded by 1 m sphaerosiderite, 3 m brownish and greyish clays and 2 m black claystone at the top.

Selected palynomorphs from the Vallåkra Member were reported by Tralau (1975) who referred them to the Middle and Upper Rhaetian. Lund (1977) assigned the Vallåkra Member to the Middle Rhaetian. The sediment of the Vallåkra Member displays a varying lithologic composition in norhwest Scania. The arenaceous influx increases eastwards. The maximum thickness of the member is 30 m in the same area. Sediments referred to the Vallåkra Member have also been recorded at Stabbarp and Hörby (Troedsson 1947a). At Stabbarp its thickness varies from 3 to 35 m.

BJUV MEMBER

In western Scania the Vallåkra Member is succeeded by the Bjuv Member (cycles 2 and 3, Troedsson 1950). This member was formerly called the Gruv Member (gruva= mine), beds or layers (Troedsson 1951, Bölau 1959). Following recommendations by Hedberg (1972:3.13) the name is changed to the Bjuv Member. Bjuv is situated in the mining district of northwest Scania. Coal and clay have been mined in this area since the fifteenth century.

The Bjuv Member is defined as the sedimentary sequence between and including the main coal seams of the Rhaetian. The lower seam, forming the boundary to the Vallåkra Member, is called the B seam. The upper one, which forms the boundary to the Helsingborg Member, is called the A seam. Fire-clay and sandstone occur together with the coal seams and are also interbedded in them. The seams are 2 m thick or less. The sedimentary sequence between the seams is between 20 and 30 m thick in the Höganäs-Helsingborg area and 1 m thick at Ormastorp.

The Bjuv area is taken as the type area for the Bjuv Member. A representative section of the member is the core section between 37.22 and 45.72 m in bore No. 256 (stored at the Höganäs Company in Bjuv) from the Bjuv area (Fig. 5). There the sedimentary sequence consists basally of the B seam made up of 0.1 m black clay at the bottom followed by 0.18 m coal and 0.07 black clay. The B seam is overlain by 0.65 m dark arenaceous clay and 2.23 m thin laminated sand and claystone overlain by

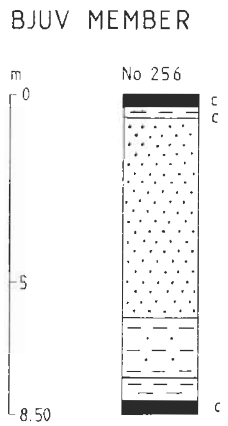

Fig. 5. Well log of the Bjuv Member in the Bjuv No. 256 bore.

4.58 m sandstone and 0.07 m sand and coal. Above this sequence follows the A seam made up of 0.3 m dark grey coal, 0.08 m black shale and 0.24 m coal.

Coarse arenaceous sediment dominates between the coal seams in an area between Billesholm and Höganäs, parallel to the Söderåsen and Kullaberg horsts. In the southern part of this area the sediments are arkosic. In a southwestern direction the argillaceous content increases. At some places it dominates, for instance at Skromberga. At Billesholm a minor coal seam occurs between the main seams, and is called the ab seam. In the area east of Bjuv (Troedsson 1951, pp. 94–102) each coal seam is split up into two or three minor ones separated by sand and clays, and the sandy layers dominate eastwards. At some places, for instance at Fleninge (Troedsson 1951, p. 56), a sequence of stratified sediments, between the Vallåkra sediments and the B seam was penetrated by drillings. There the sediments consist of fine-grained sandstone laminated with clay and a dark clay laminated with sand. The sequence is about 16 m thick. As these sediments are stratified they could not be included in the Vallåkra Member and they have therefore been referred to the Bjuv Member.

According to palaeobotanic studies by Lundblad (1959) the boundary between the Rhaetian (Triassic) and Hettangian (Jurassic) should be drawn somewhere in the section including the upper (A) coal seam and the overlying Boserup beds of the Helsingborg Member. The reason for this being the distribution of the plants *Lepidopteris ottonis* (GÖPPERT), and *Thaumatopteris shenki* (NATHORST). Lund (1977) analysed samples from different parts of the Bjuv Member. Basing his conclusions on the presence of palynomorphs he suggested a Middle Rhaetian age (the *Rhaetipollis–Limbosporites* Miospore Zone). Upper Rhaetian sediments seem to be absent in Scania (Lund 1977, Guy-Ohlson 1980). The most important palaeobotanic studies of the Bjuv Member have earlier been made by Nathorst (1878-1886 and other publications) and Troedsson (1951). Molluscs, arthropods and fish remains have also been found in the Bjuv Member (Bölau 1949, Troedsson 1951).

Sediments of the Bjuv Member are exposed at Billesholm (about 5 m thick), the B seam is exposed at Lunnom, Skromberga and Danhult. Sediments referred to the Bjuv Member are also recorded from the Stabbarp area where they attain a thickness of 4 m or less (Troedsson 1947a).

HELSINGBORG MEMBER

The following interpretation of the Helsingborg Member is mainly based on the one made by Troedsson (1947b). Earlier, most important studies were made by Nathorst (1886 and other publications) and Lundgren (1888 and other publications). Sediments assigned to the Helsingborg Member are restricted to western Scania with the Sound.

Deltaic sediments dominate and marine intercalations are frequent in the Helsingborg Member. The deposition of coarse, in some cases arkosic sandstones in between more fine–grained deposits may indicate Early Kimmerian tectonic movements (Norling 1982a). Troedsson (1951) identified nine sedimentological cycles in the Helsingborg Member. The lower boundary of the Hettangian coincides approximately with the boundary between the Bjuv and Helsingborg Members. Lundblad (1959) referred the Rhaetian sediments to the *Lepidopteris ottonis* Zone and the Hettangian sediments to the *Thaumatopteris schenki* Zone (macrophyte zonation). The uppermost part of the Bjuv Member is made up of a coal seam (p. 8). This coal seam is an excellent marker horizon for the arbitrary boundary between the Triassic and the Jurassic systems.

The Helsingborg Member was introduced by Troedsson (1947b) under the designation the Helsingborg Group. In his 1951 publication he made a more comprehensive review of this unit. It is almost complete and comparatively well-known in parts of northwest Scania where it has a known maximum thickness of 215 m. In drill-cores from the Sound (offshore from Helsingborg), a sequence of 75 m is referred to the Helsingborg Member (Larsen 1968). Norling (1966) referred a 100 m thick sequence, penetrated by Kävlinge borehole No. 14, with some doubt to the Hettangian. In southwest Scania it could have a thickness of a few metres in the Höllviken No. 2 bore (Lundblad 1959).

Troedsson (1947b) subdivided the Helsingborg Member into a lower and an upper part. The sequence between 158 and 50 m in the Köpinge No. 3 bore in Fig. 6 (Erdmann 1911–1915) is typical for the lower part of the Helsingborg Member. This part usually starts with up to 12 m of kaolinitic clay succeeded by a 15–20 m thick sequence of cross-bedded arkoses and light-coloured clays. The lower part of this arkose is called the Boserup beds (cycle 4, Troedsson 1950). The *Thaumatopteris schenki* Zone (macrophyte zonation) is indicated within the beds. They are assigned to the *Pinuspollenites–Trachysporites* Miospore Zone by Lund (1977). The Boserup beds were first described by Hermelin (1773) from the Boserup area. The same sequence has also been recorded in bore material from the central part of Helsingborg (Troedsson 1947b) and from Köpinge No. 3 bore. The Boserup beds have a wide distribution.

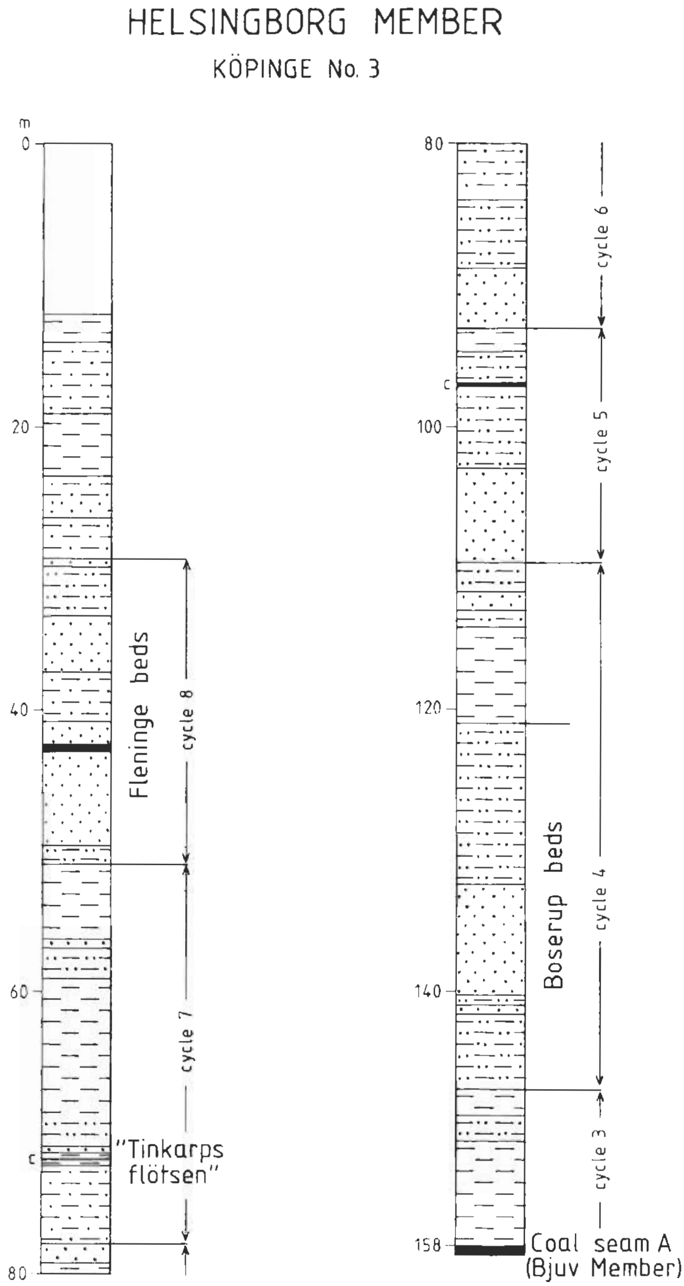

Fig. 6. Well log of the Köpinge No. 3 bore.

They are known from the Höganäs region in the northwest to Eslöv in the south. The same lithology has been observed in core material from Hörby (Troedsson 1951) in the east. At Stabbarp (Troedsson 1947a) the Boserup beds are overlain by arenaceous Hettangian sediments with a coal seam basally (earlier mined). The arenaceous layers have a maximum thickness of 80 m.

The Boserup beds are succeeded by some metres of arenaceous clay, iron claystone and calcareous sandstone (121–114 m in Köpinge No. 3 bore) and sometimes also by a coal seam, named the Tågaborg coal seam. This coal seam was mined in the late nineteenth century at Tågaborg (situated in the northern part of Helsingborg). The same sediments probably also contain plant remains described by Nathorst (1878) as the Helsingborg flora. The sediments crop out in Helsingborg at Hälsan. They have also been observed in core material from Rosendal and Farhult (Troedsson 1951).

The interval between 114 and 93 m in Köpinge No. 3 bore (cycle 5, Troedsson 1950) is basally composed of an argillaceous, fine bedded sandstone (4 m thick) succeeded by a 9 m thick sandstone, which in turn is overlain by 7 m argillaceous sandstone with bituminous bands. The uppermost part of the sequence consists of a 1 m thick claystone bed. The lower sandstone is comparable to the outcropping sandstone at Halalid in the central part of Helsingborg. The whole sequence can also be observed in core material from Rosendal, Fleninge and Farhult, where bivalves such as *Liostrea hisingeri* (NILSSON) and *Modiola* cf. *hoffmanni* (NILSSON), as well as the plants *Dictyophyllum nilssoni* BRONGNIART and *Equisetites* sp. are recorded (Troedsson 1951).

The interval between 93 and 78 m in Köpinge No. 3 bore (cycle 6, Troedsson 1950) consists basally of 4 m white sandstone with coal remains. The sandstone is overlain by 5 m argillaceous sandstone and 5 m slightly arenaceous clay. The uppermost part of the sequence is made up of a 1 m thick calcareous sandstone. The whole sequence is represented in the shore sections at Laröd–Sofiero (locations 249–267 of Troedsson 1947) and south of Gravarna (locations 211–318, 451–457). These sections are situated north of Helsingborg. The same sediments were also described by Vossmerbäumer (1969) from the southern part of Helsingborg. Troedsson recognized fragments of plants such as *Nilssonia polymorpha* SCHENK and *Dictyophyllum nilssoni* (BRONGNIART) and the bivalves *Cardinia follini* LUNDGREN, and *Ostrea hisingeri* NILSSON. The sequence is referred to the *Pinuspollenites–Trachysporites* Miospore Zone (Lund 1977). Corresponding sediments have also been observed in core material from Rosendal, Fleninge, Farhult and Klappe.

From bottom to top the sequence between 78 and 51 m in Köpinge No. 3 bore (cycle 7, Troedsson 1950) consists of 5 m grey arenaceous claystone, 1 m dark-grey clay and light sandstone with coal, 1 m sandstone, 12 m arenaceous claystone, 3 m partly calcareous sandstone and at the top 5 m grey, partly calcareous claystone. According to Troedsson (1947) the sequence corresponds to outcropping sections at Gravarna (locations 457–479) and Gravarna–Sofiero (locations 248–228). Corresponding sediments have also been observed in the central (Kärnan) and southern parts of

Helsingborg (Vossbäumer 1969). There is a coal seam, ''Tinkarpsflötsen'', in the middle part of the sequence. The whole sequence is also found in core material from Rosendal, Farhult, Oregården and Klappe. Plant remains referred to *Nilssonia polymorpha* SCHENK and *Cyclas Nathorsti* LUNDGREN as well as bivalves of the species *Eutrapetzium pullastra* HEBERT, *Ostrea hisingeri* NILSSON and *Modiola hoffmanni* NILSSON have been found (Troedsson 1951).

In Fleninge No. 266 bore (Troedsson 1951, p. 56) the upper part of the Helsingborg Member starts with a 28 m thick sandstone (93–65 m). The uppermost part of the sandstone contains cross-bedded layers of coarse and loose sand referred to the Fleninge beds (cycle 8, Troedsson 1950). These beds were descibed by Troedsson (1951). The same sequence is correlated with the interval between 51 and 29 m in Köpinge No. 3 bore. The Fleninge beds have been found also in the southern and central parts of Helsingborg (Troedsson 1947) as well as in the Rosendal, Farhult, Oregården and Klappe bores. The following bivalves have been found in the beds: *Ostrea hisingeri* NILSSON, *Modiola hoffmanni* NILSSON and *Cardinia ingelensis* TROEDSSON. Plant remains of the genus *Nilssonia* have also been recorded.

The remaining part of the Helsingborg Member (cycles 9–12, Troedsson 1950) is mainly made up of sandstone, claystone and several minor coal seams. The most important observations of this sequence were made in the Klappe core (Troedsson 1951). Plants of the genera *Gutbiera*, *Dictyophyllum* and *Equisetites* have been recorded as well as the bivalve *Ostrea hisingeri* NILSSON. The *Pinuspollenites–Trachysporites* Miospore Zone is also indicated (Lund 1977). The upper boundary of the Höganäs Member is drawn where the thin laminated sand and siltstone intercalated with thin argillaceous coal yielding beds of the Höganäs Member are overlain by the crossbedded Döshult Sandstone (Fig. 8).

HÖÖR SANDSTONE

In central Scania there is a sequence of sandstone and arkoses, the Höör Sandstone (Nilsson 1819), referred to the Hettangian series (Lund 1977). The Höör Sandstone is underlain by sediment assigned to the Rhaetian by Troedsson (1940), however, only on lithologic grounds. The sediments underlying the Höör Sandstone rest on kaolin weathered crystalline rocks. They consist basally of arkoses and clays with a thin conglomerate in the lowermost part. Above this sequence there is a 1 m thick kaolinitic and bituminous horizon. This horizon is correlated, however, only on lithologic similarities with the upper coal seam (Rhaetian) in northwest Scania (Troedsson 1940), and is therefore doubtful. Above these sediments follows the Höör Sandstone. It consists basally of an arkose or arkosic sandstone less than 15 m thick, called kvarnstenen (the millstone). The ''millstone'' was formerly used for manufacturing millstones and it contains plant fossils such as *Dictyophyllum nilssoni* BRONGNIART and *Nilssonia brevis* BRONGNIART. In some places a thin, some cm

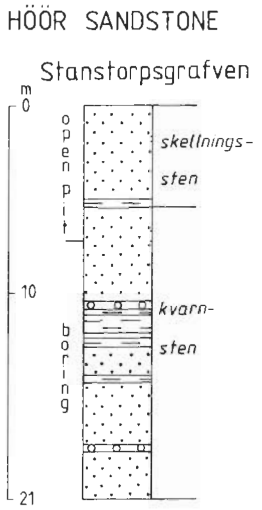

Fig. 7. Lithology of the Höör Sandstone at Stanstorpsgrafven south of Höör.

thick, clay horizon occurs above the ''millstone''. Most of the plant material described by Nathorst (1880, 1894) and Antews (1919) originated from this horizon. The lower part of the arkose, approximately half a metre thick, is kaolinitic and was correlated by Troedsson (1940) with the Boserup beds in northwest Scania. The upper part of the Höör Sandstone is made up of an approximately 25 m thick sandstone, ''skellnings-stenen'', which has yielded several specimens of the brackish water bivalve *Cardinia follini* LUNDGREN, a well-known bivalve from the Hettangian in northwest Scania. The sandstone has been mined for several hundred years for building purposes and for manufacturing millstones. The cathedral in Lund was originally built of sandstone from a quarry at Vittseröd named Lundagraven. In Fig. 7 a section through the Höör Sandstone at the quarry Stanstorpagrafven is illustrated.

RYA FORMATION

At the beginning of the Sinemurian the sea transgressed and the mostly marine sediments of the Rya Formation were deposited (Norling 1982a,b, Fig. 2 this paper). The marine influence culminated with open marine conditions in Pliensbachian when the highly fossiliferous sediments of the Katslösa Member were formed (Rya is a farm situated 6 km southsoutheast of Helsingborg). The Rya Formation is divided into four members viz. the Döshult, Pankarp, Katslösa and Rydebäck Members. All these members have previously been described as formations (Norling 1972) but as they were formed under fairly similar conditions, Norling (1982a,b) has later found it natural to put them together into one formation (Fig. 2). The Döshult and Pankarp

Members are referred to the Sinemurian, the Katslösa Member is referred to the Lower Pliensbachian, its basal part might, however, be assigned to the Upper Sinemurian. The Rydebäck Member is referred to the Upper Pliensbachian, Toarcian and Aalenian Stages.

DÖSHULT MEMBER

Troedsson (1951) described a sequence of cross-bedded sandstone and subordinate siltstone from the Döshult area referred to as the Döshult beds. A typical sequence representing the whole member is the 182.10–103.00 m drilled interval in the Pankarp-Strövelstorp No. 334 bore (Fig. 8). The core is described by Bölau (1959), Norling (1972) and Sivhed (1980). The lower boundary of the Döshult Member is discussed on p. 13. Its upper boundary is drawn where the dark clays of the Döshult Member are succeeded by the variegated clays of the Pankarp Member. In its lower and middle parts the member consists of partly cross-bedded sandstone and siltstone with some argillaceous intercalations. This part of the sequence is approximately 60 m thick. These sediments crop out at different places in the Döshult area (Troedsson 1951) from where they were originally described. The upper part of the sequence is mostly made up of dark grey to greyish black, occasionally bluish grey claystone (15–40 m thick). The claystone might also contain thin sandy horizons and thin ironclay layers, as well as thin limestone beds. These sediments were studied in the Gantofta Brick Pit by Sivhed (1977). According to Troedsson (1954b), Bölau (1959) and Reyment (1959, 1969) the ammonites recorded from the Döshult Member indicate the following ammonite zones: The *Arnioceras semicostatum* Zone, the *Caenisitites turneri* Zone, and the *Asteroceras obtusum* Zone. Ostracodes representing the *Cristacythere betzi–C. crassireticulata* Zone as well as the lower subzone, the *Progonoidea reticulata* Subzone, of the *Ogmoconchella danica* Zone are indicated (Sivhed 1980). The lower part of the Döshult Member is referred to the *Astacolus semireticulata* Zone (foraminiferal zonation by Norling 1972). Lund (1977) referred the sediments of this member to an unnamed zone above the *Pinuspollenites–Trachysporites* Miospore Zone. The sediments of the Döshult Member are referred to the lower and lowermost part of the Upper Sinemurian by Sivhed (1980). Sediments of this member are also recorded from the Sound (Larsen *et al.* 1968), Kävlinge (Norling 1972), and from northwest Scania (Sivhed 1980). This member is probably also represented in southwest Scania but has, however, not been documented in that area. The sediments of the Döshult Member were deposited under marine near-shore, transgression conditions.

PANKARP MEMBER

The stratotype section of the Pankarp Member is the core section between 103.0–45.7

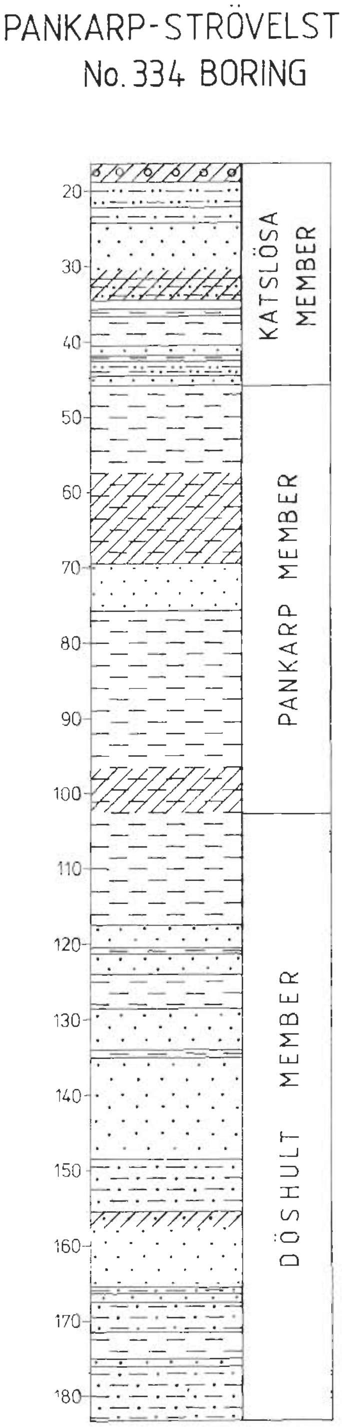

Fig. 8. Well log of the Pankarp-Strövelstorp No. 334 bore.

m in the Pankarp-Strövelstorp No. 334 bore (Fig. 8, Bölau 1959, Norling 1972, Sivhed 1980). The lower boundary of the member is discussed on p. 15 and its upper boundary on p. 18. A characteristic profile representing the whole member consists basally of 6–30 m red, brown and yellow clays and claystones succeeded by 10–17 m grey to bluish grey, in some cases greenish grey, clay or claystone. Above this sequence of argillaceous sediments a sandy horizon follows. It is made up of a loose sand with thin argillaceous beds and a coal seam (5–15 cm) or a thin horizon with coal fragments. The sand sequence is overlain either by brownish and reddish clays (about 15 m thick) or by a greyish bluish grey claystone (about 15 m thick). The latter in turn is overlain by reddish and brownish clay beds (about 8 m thick). The uppermost part of the Pankarp Member is made up of grey to bluish grey claystone, as well as thin horizons of greenish grey claystone (7 to 15 m thick). In its uppermost part this horizon is locally slightly arenaceous. The Pankarp Member is referred to the Upper Sinemurian.

The sequence is underlain by an ammonite yielding horizon (Reyment 1969) indicating the lower and upper subzones of the *Asteroceras obtusum* Zone (ammonite zonation), representing the lower part of the Upper Sinemurian. Hoffman (in Bölau 1959) reported the occurrence of the *Microderoceras birchi* Subzone (ammonite zonation) in sediments immediately below the Pankarp Member. This subzone corresponds to the Lower Sinemurian. In the lower part of the Pankarp Member, specimens of the ostracode *Progonoidea reticulata* (KLINGER & NEUWEILER) have been recorded (Sivhed 1980), indicating the lower part of the *Ogmoconchella danica* Zone. Evidence of the middle part of the *O. danica* Zone is also recorded, viz. specimens of the ostracodes *O. "mouhersensis"* (APOSTOLESCU) and *Pleurifera harpa* (KLINGLER & NEUWEILER). However, it is doubtful whether the upper subzone of the *O. danica* Zone is also represented in the Pankarp Member. Norling (1972) referred sediments of the Pankarp Member to the *Citharina inaequistriata–Marginulina s. spinata* Subzone of the *Marginulina spinata spinata* Zone (foraminiferal zonation).

Sediments referred to the Pankarp Member are reported mainly from northwest Scania (Bölau 1959, Norling 1968, 1970, 1972, Sivhed 1980) but also from the Kävlinge area (Norling 1968, 1972) and the Sound (Larsen 1966). Sediments of the lower part of the member can be studied in the Gantofta Brick Pit (Sivhed 1977). These sediments were mainly deposited under marine conditions. The sandy layer with coal in the upper part of the Pankarp Member represents a regression.

KATSLÖSA MEMBER

The main part of the Katslösa Member is assigned to the Lower Pliensbachian while its lowermost part is referred to the Upper Sinemurian. This member was originally described by Troedsson (1951) under the designation the "Katslösa Stage" based on

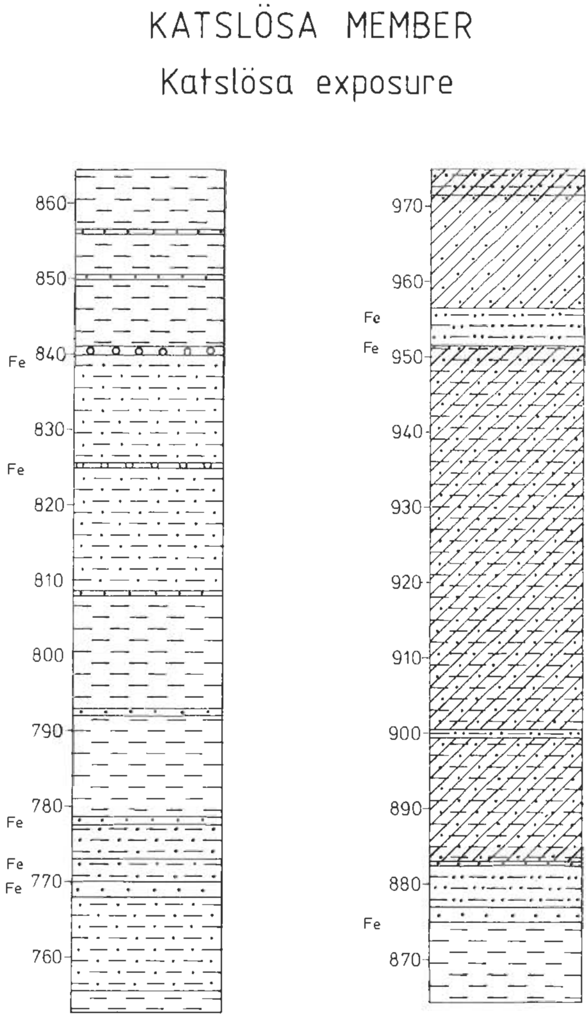

Fig. 9. Lithology of the Katslösa Member at Katslösa.

finds of sediments of this stratigraphic unit in a ditch situated between Gantofta and Katslösa (Fig. 9).

The sediments of the Katslösa Member are of open marine origin and consist of greenish, brownish and greyish black claystone and sandstone with a varying ferruginous content. Thin oolitic, as well as limy horizons also occur. Troedsson (1951) estimated the thickness of the Katslösa Member to 115 m at Katslösa. However, the maximun thickness recorded at other localities is only 32 m, viz. in Rydebäck-Fortuna Nos 1 and 4 bores (Norling 1972, Sivhed 1980), and 34 m in the Pankarp-Strövelstorp No 334 bore. The boundary between the Katslösa Member and the underlying Pankarp Member is drawn where the arenaceous clays or the sandstones of the Katslösa

Member are underlain by the grey or bluish grey clays of the Pankarp Member. The Katslösa Member is succeeded upwards by variegated, more arenaceous sediments of the Rydebäck Member. The boundary between these two members is drawn arbitrarily as there is no sharp lithologic change between them.

The Katslösa Member has yielded ammonites indicating the *Uptonia jamesoni* Zone (Troedsson 1951, Bölau 1959). The Katslösa Member has also yielded a fairly rich ostracode fauna. Representatives of the *Gramannella apostolescui–Kinkelinella foveolata* Subzone and the middle subzone of the *Ogmoconchella danica* Zone are recorded. Norling (1972) described a foraminiferal fauna indicating the *Citharina inaequistriata–Marginulina spinata spinata*, *Astacolus denticula carinata–Marginulina s. spinata*, and the lower part of the *Brizalina liassica amalthea* Subzones representing the *Marginulina spinata spinata* Zone. The biostratigraphic evidence indicates the upper part of the Upper Sinemurian and the Lower Pliensbachian. Sediments of the Katslösa Member have been recorded from Kävlinge (Norling 1968, 1972) in the south to Pankarp-Strövelstorp in the north (Bölau 1959) and from the Sound in the west (Larsen 1966).

RYDEBÄCK MEMBER

The Rydebäck Member was defined by Norling (1972) in the core interval between 103.40 and 52.00 m in the Rydebäck Fortuna No. 4 bore (Fig. 10). The sediments of the Rydebäck Member are of marine regressive origin and consist of greyish, blackish, greenish and red-brown sandstone and siltstone. Conglomerate horizons, ferruginous oolite as well as thin limestone bands also occur. The lower boundary of the member is discussed on p. 18. Its upper boundary is drawn below the appearance of the arenaceous and argillaceous beds with coal seams of the Fuglunda Beds. Norling (1972) referred the Rydebäck Member to the *Saracenaria sublaevis* and *Citharina clathrata* Zones (foraminiferal zonation). Bölau (1959) described ammonites corresponding to the *Amaltheus margaritatus*, *Pleuroceras spinatum* and *Dactylioceras tenuicostatum* Zones from the Vilhelmsfält bore. These zones indicate the Upper Pliensbachian to the Lower Aalenian. Norling (1972) referred the ammonite yielding sequence (between 238 and 148.5 m) in the same core to the Rydebäck Member. These sediments are more argillaceous than in corresponding strata from Rydebäck-Fortuna No. 4 bore. Sediments corresponding to the Rydebäck Member are also recorded in the Sound (Larsen 1966). Michelsen (1975) found ostracodes in core sections, referred to the lower part of the Rydebäck Member, from the Sound (Öresund Nos 2, 3) indicating the *Ogmoconchella adenticulata–Nanacythere simplex* Zone, corresponding to the Upper Pliensbachian. Sediments assigned to the Rydebäck Member are also recorded in the Rydebäck-Fortuna No. 1 (Norling 1972) and Karindal No. 1 bores.

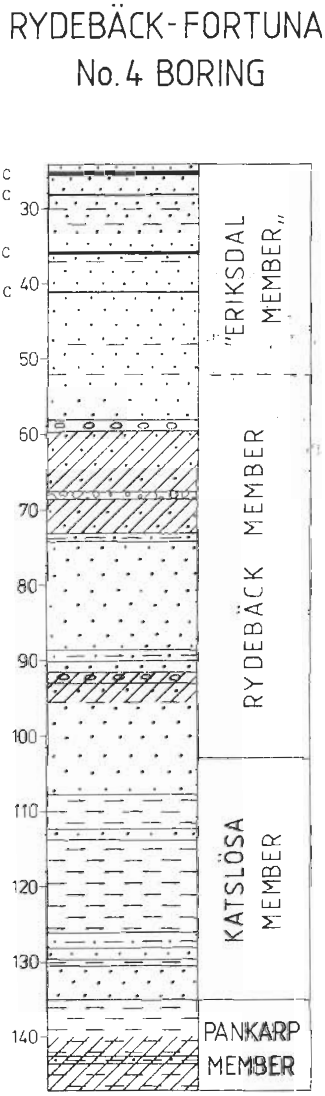

Fig. 10. Well log of the Rydebäck-Fortuna No. 4 bore.
ERIKSDAL "MEMBER" should be FUGLUNDA BEDS.

VILHELMSFÄLT FORMATION

In the Ängelholm Trough Bajocian and Bathonian sediments are referred to the Vilhelmsfält Formation. In the Sound and in the coastal area between Helsingborg and Landskrona Bajocian sediments of another lithostratigraphic unit are recorded, viz. the more arenaceous Fuglunda Beds. The Vilhelmsfält Formation is defined by Bölau (1959) from the 140–65 m core interval in Vilhelmsfält No. 1 bore (Fig. 11, see also Guy 1971 and Norling 1972). Bölau described the formation from a lithologic point of view as a Liassic–Middle Jurassic transitional stratum. From bottom to top the basal part of the formation is made up of 7.5 m loose, partly calcareous and conglomeratic sandstone with a thin coal seam, 55 m greyish claystone with a varying arenaceous content and with plant remains. The uppermost part of the sequence consists basally of a 1 m thick loose sandstone overlain by 11.5 m of brownish grey and grey claystone with fine uneven mica-rich, plant-bearing sandstone.

Guy (1971, 1976) studied palynomorphs originating from the same core interval of Vilhelmsfält No. 1 bore (Fig. 11). In her opinion the whole sequence should be referred to the Middle Jurassic (Bajocian and Bathonian). It was not possible to distinguish Bajocian sediments from Bathonian ones in the core sequence. In 1978, Guy-Ohlson described palynomorphs from three other borings in the Ängelholm Trough, viz. Rosenhäll No. 62 and Härninge Nos 64 and 159. The strata penetrated by these drillings might be assigned to the Vilhemsfält Formation as well.

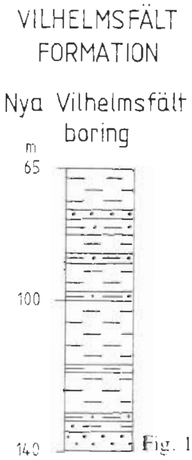

Fig. 11. Lithology of the Vilhelmsfält Formation in the Nya Vilhelmsfält bore.

FUGLUNDA BEDS

The Fuglunda Beds were previously called the Eriksdal Beds by Tralau (1968). The name Eriksdal has, however, already been used for the Santonian Eriksdal Marl

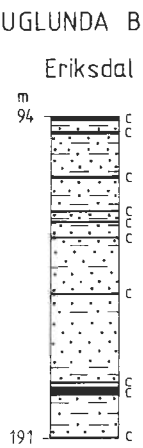

Fig. 12. Lithology of the Fuglunda Beds at Eriksdal.

(Erdmann 1873, Hägg 1930, Brotzen 1936). Fuglunda is a farm situated immediately north of the sand pit belonging to the Fyleverken Company at Eriksdal. Based on palynological studies made by Tralau (1968) the Fuglunda Beds are referred to the Bajocian. However, Norling (1972, 1982) recognized some minor marine intercalations with foraminifers in the basal part of the beds (Rydebäck-Fortuna No. 4 bore, Fig. 10). Specimens of *Citharina clathratra* (TERQUEM), *Epistomina parastelligera* (HOFKER) and *E. conica* (TERQUEM) have been identified, an assemblage which indicates an Aalenian age. Norling and Rolle *et al.* (1979) also described the beds from a lithologic point of view. According to Norling the Fuglunda Beds at Eriksdal are defined as the sequence between the lowermost und uppermost coal seam in Tralaus section (1968, Figs. 2, 10 and Fig. 12 herein). The Fuglunda Beds in Eriksdal have been divided into three parts by Norling (1972), viz. a lower part, 191–170 m, made up of clays and sandy clays with several coal seams, a middle part, 170–130 m, mainly consisting of sand with a few argillaceous horizons and a single coal seam, and an upper part, 130–94 m, yielding alternating clay and sand with several coal seams. The upper boundary of the Fuglunda Beds is drawn where the arenaceous sediments rich in coal seams are overlain by brownish sand referred to the Glass Sand. The lower boundary of the Fuglunda Beds is not clearly defined, but has been drawn immediately below the lowermost coal seam of the beds. Sediments referred to the Fuglunda Beds have also been recorded between 756 and 720 m in Snaven No. 1 bore drilled by Oljeprospektering AB (OPAB). Here the Fuglunda Beds rest directly upon the Precambrian basement.

GLASS SAND

In the Vomb Trough Bathonian sediments are represented by a whitish quartz sand, the

Glass Sand, deposited in a beach foreshore environment (Rolle *et al.* 1979). This unit has been described by several authors, including Oertli *et al.* (1961), Tralau (1968), Norling (1972, 1982a) and Rolle *et al.* (1979), in the sand pit of the Fyleverken Company at Eriksdal. The section, tilted to an almost vertical position, consists from top to bottom of c. 54 m whitish sand, c. 3.5 m light brownish grey sand, partly clayey and shaley with plant fossils succeeded by c. 4 m whitish and c. 16 m brownish coarse to medium grained sand cross-bedded at the bottom and flaser beds with *Diplocraterion* near the top. The lower boundary is discussed on p. 22, the upper one is drawn where the whitish Glass Sand is succeeded by greenish plastic clays of Fyledal Clay. Sediments referred to the Glass Sand are also recorded between 683 and 658 m in Snaven No. 1 bore and between 527 and 506 m in Assmåsa No. 1 bore (OPAB). At Assmasa the Glass Sand rests directly upon the Precambrian basement. These bores are drilled by OPAB.

FORTUNA MARL

In the coastal area, between Helsingborg and Landskrona, Upper Bathonian–Oxfordian sediments referred to the marine Fortuna Marl have been recorded. This member is defined and discussed by Norling (1968, 1972, 1980). It is defined in the core sequence between 161.24–135.17 in Rydebäck-Fortuna No. 5 bore (Fig. 13). The upper boundary of this member is drawn where the grey clays of the Fortuna Marl are succeeded by the green clays of the Fyledal Clay. The interval between 161.24–159.93 m of this core is assigned to the transition between the Upper Bathonian and the

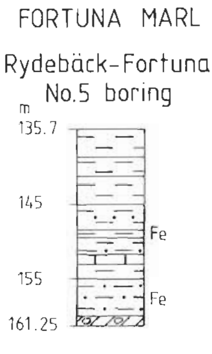

Fig. 13. Lithology of the Fortuna Marl in the Rydebäck-Fortuna No. 5. bore.

Callovian. These transition beds consist basally (161.24–159.93 m) of a conglomerate of greyish and red-brown stones and gravel in a clayey matrix. The conglomerate is overlain by a greenish grey, partly sandy, claystone (159.93–154.93 m) alternating with beds of marl, clay and ferruginous claystone. The described sequence is entirely marine and has a rich fauna of calcareous foraminifers and ostracodes (Norling 1972, 1980). The following identified ostracodes indicate the Bathonian viz. *Oligocytheris fullonica* (JONES & SHERBORN) and *Procytheridea parva*, OERTLI. Sediments referred to the Fortuna Marl have also been recorded between 1383 and 1369 m in Höllviksnäs No. 1 bore, between 1500 and 1461 m in Kungstorp No. 1 bore and at around 1400 m in Håslöv No. 1 bore (Norling 1980). These are drilled by OPAB.

SEDIMENTS NOT ASSIGNED TO ANY LITHOSTRATIGRAPHIC UNIT

RHAETIAN

Southwest Scania. – Rhaetian sediments have been recorded from the Höllviken II core (Brotzen 1949, Lundblad 1949).

Vomb Trough. – In the Vomb Trough Rhaetian sediments (Möller & Halle 1913) dated by its flora, crops out at Rödalsberg and Munka Tågarp.

Central Scania. – In central Scania, Troedsson (1940) correlated sediments below the Höör Sandstone with Rhaetian sediments in northwest Scania. This correlation is, however, based only on lithologic similarities to the Rhaetian sediments in northwest Scania and therefore not reliable. Weverinck (1934) referred sedimentary rocks, including a coal seam, (found at Långaröd in eastern part of central Scania) to the Rhaetic or Liassic.

UNDIFFERENTIATED LIAS

Guy-Ohlson (1982) described sediments predominantly represented by dark grey to black shaly clay, sandy clay an some iron siltstone and sandstone recorded between 640–644.5 m in the Kullemölla bore. The sequence is referred to the Liassic on palynological grounds.

SINEMURIAN

Vomb Trough. – Sediments assigned to the Sinemurian are recorded at Tosterup (Lund 1977) and Kurremölla (Reyment 1959).

PLIENSBACHIAN

Central Scania. – In central Scania at Brandsberga and Kolleberga there are several fossiliferous sandstone boulders recorded. The erratics are probably of local origin and the fauna obtained indicates marine conditions. According to Lundgren (1881) the fauna consists mainly of bivalves such as representatives of the genera *Oxytoma* and *Trigonia*. Brachiopods and fragmentary belemnites have also been recorded. The fauna (Troedsson 1954a) corresponds to that found in sediments of the Katslösa Member type section (Troedsson 1951). The Katslösa fauna described by Moberg (1888) from southeast Scania corresponds also to the one obtained from the boulders mentioned above. Based on these facts the Brandsberga and Kolleberga erratics must be of Pliensbachian age. Lund (1977) assigned sediments of the Sandåkra bore (Nilsson 1958) to the Sinemurian or Pliensbachian.

Vomb Trough. – In the Vomb Trough in southwest Scania, the Jurassic sedimentary rocks crop out (Moberg 1888, 1910) along a 20 km long stretch between Eriksdal and Tosterup. The geology of this area is very complicated. The whole area is block faulted and vertical and horizontal movements have taken place several times in different directions, partly as inversion tectonics. The outcropping sediments are of Sinemurian to Portlandian age with a gap for the Callovian–Oxfordian. Chatziemmanouil (1982) referred parts of the sequence to the Katslösa and Rydebäck Members.

Tralau (1968) described a profile from the Eriksdal–Kurremölla area, where there is a sequence approximately 300 m thick, dated to the Pliensbachian–Aalenian. The Pliensbachian sediments consist of ferriferous, partly oolitic sand and sandstone of marine origin. Moberg (1888) described fossils originating from a highly fossiliferous bed containing a rich mollusc fauna. Specimens of the species *Cardinia multicostatum* PHILIPS are very frequent within the bed and Moberg (1888) named it the *Cardium* bed. This bed has also yielded specimens of the ammonite *Uptonia jamesoni* (SOWERBY) the zonal denominator of the *Uptonia jamesoni* Zone indicating the Lower Pliensbachian (Moberg 1888, Reyment 1959). The ferruginous parts of the sequence have been the subject of much discussion (Hadding 1933, Palmqvist 1935) as to their ferruginous content. However, the content is too low för mining purposes. As the fossil records are restricted to very few horizons, it is impossible to distinguish both the lower and the upper boundary for sediments referred to the Pliensbachian. It is therefore impossible to give an exact value for the total thickness of the sediments referred to this stage.

TOARCIAN AND AALENIAN

Central Scania. – In central Scania basalt tuff is recorded from a few places. Tralau (1973) recapitulated previously known localities and also described a few new ones. He received material from Sandåkra, Korsaröd and Djupadal för analysis. Basing his conclusions on the presence of palynomorphs found in some 20 samples from Korsaröd he suggested a Toarcian Aalenian age. In other words, there was volcanic activity in Scania towards the end of the Early Jurassic.

Vomb Trough. – In the Eriksdal–Kurremölla section, in the Vomb Trough, there is an approximately 300 m thick sequence of ferriferous, partly oolitic sand and sandstone (Oertli, Brotzen & Bartenstein 1961, Tralau 1968, Norling 1972, 1982a). The lower part of this sequence is referred to the Pliensbachian (see above). It is possible that sediments assigned to the Toarcian and Aalenian Stages are to be found in between the beds referred to the Pliensbachian and the Middle Jurassic.

BAJOCIAN AND BATHONIAN

Southwest Scania. – In southwest Scania sporomorphs, assumed by Tralau (1967) and Mahin (1968) to indicate Middle Jurassic age, were found in sediments from Höllviken No. 1 core. The core sequence 1376–1351 m, in which the sporomorphs were found, are still too little known to allow comparison with other Scanian sediments of the same age. Besides, the stratigraphic value of some of the sporomorphs encountered is doubtful.

CALLOVIAN

Reyment (1971) reported some Callovian ammonites (the *Lamberti*-Zone) found in an erratic concretion near Svedala.

ACKNOWLEDGEMENTS

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LIST OF LOCALITIES

B = Beds
F = Formation
M = Member

Locality	Map	Coordinates		Stratigraphy
ASSMÅSA 1	1D/2D	616174	137139	Glass Sand
BJUV 1	3C SV	622035	132070	Bjuv M
BILLESHOLM	3C SV	62193	13246	Bjuv M
BJUV 256	3C SV	621910	132000	Bjuv M
BOSERUP	3C SV	622007	132180 to	Bjuv M
		622104	132106	
DANHULT	3B NO/3 C NV	62375	13095	Bjuv M
DJUPADAL	3C SO	621250	134900	Toarcian-Aalenian
DÖSHULT	3B/3C	622740	130355	Döshult M
ERIKSDAL	1D/2D	616380	137320	Lower-Upper Jurassic
FARHULT	3D/3C	623580	130920	Kågeröd F-Helsingborg F
FLENINGE 226	3B/3C	622580	131485	Kågeröd F-Helsingborg F
GANTOFTA BRICK PIT	3C SV	620980	131290	Döshult M-Pankarp M
GANTOFTA 359	3C SV	620995	131295	Helsingborg M-Döshult M
GRAVARNA	3C SV	622100	130445	Helsingborg M
HÅSLÖV 1	1C/2C	614936	132565	Fortuna Marl
HÄRNINGE 64	3B/3C	623145	132060	Middle Jurassic
HÄRNINGE 159	3B/3C	623145	132060	Middle Jurassic
HÄLSAN	3C SV	621805	130610	Helsingborg M
HÖLLVIKEN 1	1C/2C	614690	131940	Middle Jurassic
HÖLLVIKEN 2	1C/2C	614440	131860	Rhaetian, Helsingborg M?
HÖLLVIKSNÄS 1	1C/2C	614588	131835	Fortuna Marl
KARINDAL 1	3B/3C	623310	132045	Rydebäck M
KATSLÖSA EXPOSURE	3C SV	620965	131235 to	Katslösa M
		620975	131280	
KLAPPE	3B/3C	623040	132770	Helsingborg M
KOLLEBERGA	3C NO	621800	134150	Pliensbachian
KULLEMÖLLA	2D SE	61580	13777	Lias
KORSARÖD	3D SV	620890	626510	Toarcian-Aalenian
KUNGSTORP 1	1C/2C	614980	132110	Fortuna Marl
KÄRNAN	3C SV	621760	130630	Helsingborg M
KÄVLINGE	2C NO	618790	131950	Helsingborg M?
KÖPINGE	3C SV	621340	130900	Bjuv-Helsingborg M
LARÖD	3C SV	622250	130350	Helsingborg-Döshult M
LUNDEGRAVEN	3C SO	620525	134950	Höör Sandstone
LUNNOM	3C SV	62145	13225	Bjuv Member
LÅNGARÖD	2D NO	61850	13790	Rhaetian/Lias
MARGRETEBERG	3B/3C	623675	129975	Vallåkra M
MUNKA TÅGARP	2D SO	615275	138375	Rhaetian
OREGÅRDEN	3B/3C	623370	131300	Helsingborg M
ORMASTORP	3C NV	622650	131930	Bjuv M

PANKARP-STRÖ-VELSTORP 334	3B/3C	623010	131410	Helsingborg-Katslösa M
ROSENDAL	3C SV	622200	131500	Helsingborg M
RYDEBÄCK-FORTUNA 1	3C SV	620815	131035	Pankarp M-Rydebäck M
RYDEBÄCK-FORTUNA 4	3C SV	620890	131010	Pankarp M-Fuglunda Beds
RYDEBÄCK-FORTUNA 5	3C SV	62070	13101	Upper Bathonian-Portlandian
RÖDALSBERG	2D SO	614980	138600	Rhaetian
SANDÅKRA	3D SV	621850	138140	Simemurian or Pleinsbachian
SKROMBERGA	3C SV	62105	13235	Bjuv Member
SNAVEN 1	2D SV	617159	136426	Fuglunda B, Glass Sand
STABBARP	3B NO	619580	134300	Vallåkra-Helsingborg M
STANSTORPA GRAFVEN	3D NV	620060	135665	Hettangian
SVEDALA	2C NO	61560	13380	Callovian
TOSTERUP	2D SO	614980	138600	Sinemurian
TÅGABORG	3C SV	611850	130600	Helsingborg M
VALLÅKRA	3C SV	62086	131570	Vallåkra-Bjuv M
VILHELMSFÄLT	3B/3C	623545	131670	Rydebäck M-Vilhelmsfält F

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