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JURASSIC STRATIGRAPHY AND FORAMINIFERA OF WESTERN SCANIA, SOUTHERN SWEDEN

with 23 tables and 54 figures, including scanning electron micrographs

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Abstract

The Jurassic sequence of W. Scania in S. Sweden treated in the present paper lies on the border between the Fennoscandian Shield and the Danish Embayment. The sections investigated include temporary exposures in the Lower Lias east and southeast of the town of Helsingborg. The subsurface material was obtained from six borings located in the western slope of the Helsingborg – Romeleåsen High between the towns of Helsingborg and Lund. The cores include strata of Early, Middle and Late Jurassic age. About 150 species of foraminifera were obtained from this material, including the first Upper Liassic, Middle and Upper Jurassic fora – miniferal faunas to be recorded from Sweden. The foraminiferal assemblages correlate closely with the Sinemurian, Pliensbachian, Toarcian-Aalenian, basal Bajocian, Upper Bathonian-Callovian, and Oxfordian faunas of other Jurassic basins in Europe. Strata previously correlated with the Kimmeridgian and Portlandian Stages mainly on the basis of ostracoda, have also yielded foraminifera, most of which, however, are of little stratigraphical significance.

Fifty species are described in the systematic part of this paper, most of which are illustrated by scanning electron micrographs. These species represent 22 genera belonging to 7 families. Thirty-eight of the foraminiferal species described belong to the family *Nodosariidae,* four to *Ceratobuliminidae,* one to *Bolivinitidae,* two each to the *Saccaminidae, Hormosinidae* and *Lituolidae,* and one to *Ataxophragmidae.* Four species and one subspecies are described as new, and one new name is proposed for a homonym.

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Introduction

This paper forms a part of the present writer's studies on the Jurassic sequence of Scania and is concerned with the west Scanian marine Jurassic strata and their foraminiferal faunas. It has been preceded by studies on Lower Liassic foraminifera, and a preliminary report on the stratigraphy and foraminiferal faunas of Lower, Middle, and Upper Jurassic stratal sequences cored by some recent borings in W. Scania (Norling, 1966, 1968, 1970).

The outcropping Lower Lias of the Helsingborg area, including the Helsingborg Beds (Hettangian), Döshult Beds (Lower Sinemurian), Pankarp Clays (Upper Sinemurian), and the Katslösa Beds (top Sinemurian – Lower Pliensbachian), has been treated by many authors in the past. The relative abundance of foraminifera in Sinemurian and Lower Pliensbachian strata in this region was previously known to some Swedish stratigraphers and paleontologists, including the Late Dr. F. Brotzen, who has left collections of Liassic foraminifera from this and other parts of Scania. These collections are now stored in the Swedish Museum of Natural History, Department of Paleozoology, Stockholm. However, with the exception of some brief notes, nothing was published on this subject until the present writer, inspired by Dr. Brotzen, started his investigations.

The subsurface Jurassic sequence in W. Scania, including post-Carixian strata, was previously incompletely known. As is demonstrated in the present paper, it comrises strata corresponding to most Jurassic stages.

This treatise is divided into two main parts, to which a summary, discussing the stratigraphical and micropaleontological results, is added.

As an introduction to the stratigraphical part, the Jurassic succession of Scania is briefly described. This review starts with descriptions of Lower Jurassic strata and their correlation with the European standard, and continues upwards through the stratal sequence. Descriptions of important sections, together with major biostratigraphical observations are presented in figures and tables and some new lithostratigraphical units are described. A stratigraphical table of the Jurassic in Scania, including established Liassic ammonite zones, is given. The lithology and stratigraphy of the sections investigated are described and illustrated. Foraminiferal assemblages are recorded and their stratigraphical significance discussed. Check-lists of Sinemurian, Pliensbachian, Toarcian-Aalenian, Late Middle Jurassic – Late Jurassic foraminifera are given. A foraminiferal zonation of the Swedish Jurassic is proposed. This is regarded as fairly well documented concerning the post-Hettangian Lower Jurassic, and the Callovian – Lower Oxfordian sequences. Further studies are required on foraminiferal faunas of the truly marine beds in order to establish a more accurate zonation of strata corresponding to the Hettangian, Bajocian and Bathonian Stages. Our knowledge of the Kimmeridgian-Portlandian part of the Upper Jurassic is still rather fragmentary and its content of stratigraphically useful foraminifera is not very promising for zonation. As recently suggested by studies on ostracoda (Christensen, 1968; Christensen & Kilenyi, 1970), this group is probably more useful than foraminifera for a zonation of the Upper Jurassic in Scania. The best biostratigraphical zonation of the lithologically and ecologically varying Jurassic sequence in Scania will certainly result from the co-ordination of different paleontological studies, including those based on foraminifera, ostracoda, ammonites, dinoflagellates, and sporomorphs.

Fifty foraminiferal species are treated in the systematic part of the present paper (27 Liassic and 23 post-Liassic species); these constitute about one third of the number of species recorded in the check-lists. Generally speaking, the whole fauna is characteristic of those shelf seas which occurred on the northern as well as on the southern side of the Tethys. The specific composition of the Liassic foraminiferal fauna in W. Scania shows a close resemblance to that described from Jutland, Denmark, by Nørvang (1957). His work has been of great use in the present study.

Loeblich & Tappan's (1964) classification is followed in the present study, with some modifications. As stated by many recent researchers on foraminifera, including Loeblich & Tappan themselves (1964 b, p. 380), the current classification is relatively conservative. The delineation of taxonomic units within fossil foraminifera was previously based mainly on external characters of the test. When diagnoses of internal characters, wall structure, layering and lamination were introduced into the classification, the main interest was first focussed on Late Mesozoic and later foraminifera. There was a tendency at this time to generalize characters found in later forms and to apply them to earlier forms also. Most forms of Jurassic foraminifera, particularly nodosariids, were initially placed in genera with Cretaceous, Tertiary and Recent genotype species. This classification has changed very little. In conformity with many other workers on Jurassic and earlier foraminifera, the present writer is of the opinion that this classification, though much improved in recent years, is inconsistent in many respects and needs radical revision. In this connection, studies by Gerke (1957, 1960, 1961, 1967), Kuznetsova (1961, 1963), and Sellier De Civrieux & Dessauvagie (1965) are important contributions.

For reasons discussed in previous papers on the wall structure in nodosariid foraminifera (Norling, 1966, 1968), and in the present publication, certain foraminifera are placed in other genera than those proposed by most previous authors. With regard to the wall structure, Liassic foraminifera usually placed in the genus *Frondicularia* DEFRANCE, 1826, widely diverge from the Pliocene genotype species *Frondicularia complanata* (DEFRANCE, 1826), and other post-Liassic *Frondicularia* species as well. These foraminifera have been placed in the genus *Ichthyolaria* WEDEKIND, 1937 (emend. Sellier De Civrieux & Dessauvagie, 1965; Norling, 1966). In the present study, the aperture in *Ichthyolaria,* which presents certain problems, is described and discussed.

For reasons similar to those concerning the frondicularoid foraminifera, the genus *Geinitzinita* SELLIER DE CIVRIEUX & DESSAUVAGIE, 1965, has been accepted for some Liassic foraminifera referred to the genus *Lingulina* D'ORBIGNY, 1826 by most previous authors.

In my 1968 paper, I subdivided the genus *Dentalina* RISSO, 1826 / genotype species *Dentalina cuvieri* (D'ORBIGNY, 1826), Recent / into *Dentalina sensu stricto, Mesodentalina* NORLING, 1968, and *Prodentalina* NORLING, 1968. This subdivision is based on main differences in the wall structure of dentalinoid foraminifera of different geological ages. The present study has shown that further Liassic species should be included in the two new genera proposed. However, Upper Jurassic dentalinoid foraminifera from W. Scania should be placed in the genus *Dentalina.*

The genus *Tristix* MACFADYEN, 1941, has long been placed in the family *Glandulinidae* REUSS, 1860. In the present study *Tristix* has been referred to the family *Nodosariidae* EHRENBERG, 1838, as was originally proposed by Macfadyen (1941).

As pointed out by Sandberg & Hay (1967), the extremely increased depth of field (about 500 times that of the light microscope), the high resolution (about 10 times that of the light microscope), and the very wide range of magnifications (15 X to more than 50,000 X), are unique capabilities of the scanning electron microscope, which afford outstanding opportunities for effective observations and analyses of morphological features on which classification of various microfossils are based. In the present study, detailed attention has been paid to the aperture in nodosariid foraminifera, as seen in the scanning electron microscope. Apertures of more than thirty nodosariid species are illustrated by scanning eletcron micrographs in this paper.

As is partly demonstrated by the scanning electron micrographs, the preservation of the foraminifera studied is generally good. This is especially true of the dominating group, viz. the family *Nodosariidae,* but does not apply to the family *Ceratobuliminidae.*

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STRATIGRAPHICAL PART

On the Jurassic Succession of Scania

Jurassic deposits occur in all Scanian Mesozoic basins except for, as far as is known, the Båstad and Kristianstad Basins. Besides, minor inlayers are known from the central and northern parts of the province (Fig. 1).

The most extensive distribution of Jurassic rocks occurs in NW. Scania, that is in the Ängelholm and Höganäs Basins, and in the northern part of the Helsingborg-Romeleåsen High. Moreover, important occurrences are known in the western slope of the Helsingborg-Romeleåsen High, in the northern and marginal parts of the Vomb Basin, in the Hörby Basin, and around Lake Finjasjön near the town of Hässleholm.

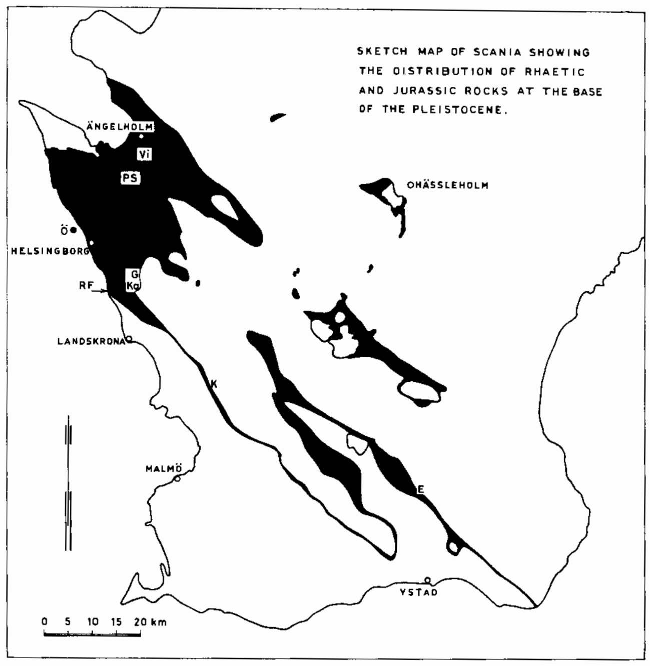


Fig. 1. The distribution of Rhaetic and Jurassic rocks in Scania (black). The abbreviations refer to localities treated in the text. Vi = Vilhelmsfält, PS = Pankarp-Strövelstorp, Ö = boring Öresund 01, RF = Rydebäck – Fortuna borings, G = Gantofta Brick Pit, Ka = Katslösa, K = Kävlinge, E = Eriksdal.

Lower Jurassic

The Lower Jurassic geology is best known in NW. Scania due to many exposures and the mining of fire-clays and, in the past, Rhaetic-Hettangian coal. Detailed descriptions of the paleontology, lithology, sedimentology, and the tectonics of this area have been published by many students including Angelin (1877), Nathorst (1876–86), B. Lundgren (1878–88), Erdmann (1877, 1911–15), Troedsson (1930–51), Bölau (1949–66), Reyment (1959, 1969), Lundblad (1949, 1956–59), Mohrén (1958, 1962), and Vossmerbäumer (1970).

The geology of eleven lithostratigraphical units is briefly described and treated in the present publication.

With the exception of these lithostratigraphical units, which together form the main part of the Jurassic sequence in Scania, a great number of local names are met with in the literature, which will not be commented on in this publication.

HELSINGBORG BEDS (HETTANGIAN)

The Helsingborg Beds in NW. Scania correspond to the Hettangian Stage according to Troedsson (1951). This formation comprises alternating non-marine and marine beds, characterized by *Thaumatopteris* Floras and bivalves such as *Liostrea hisingeri* Nilsson, *Modiola hillana* Sowerby, *Gervillia angelini* Lundgren, *Cardinia follini* Lundgren, and many other fossils. The sequence of strata referred to the Helsingborg Beds was subdivided into nine sedimentation cycles by Troedsson (see Table 1, p. 8) which, however, still are insufficiently known due to the lack of a continuous section in the type region. According to Troedsson, the Helsingborg Beds have a total thickness of about 200 m.

With the exception of the Lower Helsingborg Beds outcropping at Ramlösa, in the town of Helsingborg, and along the shore north of the town, the beds are known mainly from borings. In the bore-holes at Klappe and Svanebäck between the towns of Helsingborg and Höganäs, the beds have thicknesses of 209.87 m and 180.08 m respectively.

The lower part of the Helsingborg Beds begins with cross-bedded, coarse Boserup Sandstone, followed by alternating sandstones and clays with thin coal-seams and plant remains (the Helsingborg and Pålsjö Floras). At the top of the lower part of the Helsingborg Beds, marine banks occur (the *Mytilus, Cardinia, Pullastra* Banks).

The upper part of the Helsingborg Beds begins with the Fleninge Sandstone, consisting mainly of coarse and fine-grained sandstones, partly laminated with clay. The overlaying sequence comprises fine sandstones and clays with coal-seams and several plant-bearing layers, alternating with marine beds.

TABLE 1. The sedimentation cycles in the Helsingborg Beds. (After Troedsson, 1951.)

	Cycles:	Main characteristics:	
Upper Helsingborg Beds (c. 125 m)	12 *Ostrea* Bank cycle	*Ostrea* Bank *Thaumatopteris* Flora No. 9	HETTANGIAN (Lias alpha 1–2)
	11 (unnamed cycle)	Calcareous beds *Thaumatopteris* Flora No. 8	
	10 (unnamed cycle)	Calcareous beds *Thaumatopteris* Flora No. 7	
	9 (unnamed cycle)	Gastropods, bivalves *Thaumatopteris* Flora No. 6	
	8 Fleninge cycle	*Cardinia ingelensis, Liostrea* *Thaumatopteris* Flora No. 5 Basal Fleninge beds	
Lower Helsingborg Beds (60–90 m)	7 Ramlösa cycle	*Pullastra* Bank (Ramlösa) Zone with *Taeniodon* cf. *nathorsti* *Thaumatopteris* Flora No. 4	
	6 Pålsjö cycle	*Cardinia* Bank, *Mytilus* Bank *Thaumatopteris* Flora No. 3 (Pålsjö)	
	5 (unnamed cycle)	*Liostrea hisingeri, Modiola* *Thaumatopteris* Flora No. 2	
	4 Boserup cycle	*Liostrea hisingeri,* *Thaumatopteris* Flora No. 1 (Helsingborg) Boserup basal beds & Zone with *Equisetites gracilis*	

The Helsingborg Beds are known from N. and W. Scania, including parts of Öresund offshore from Helsingborg. In Central Scania (the Höör region), the sedimentation was sporadic during the Lower Lias, mainly consisting of sandstones. In the lower part, coarse and plant-bearing sandstones occur, whereas in the upper part the sandstones are fine-grained and contain marine bivalves. In the Vomb Basin of SE. Scania, the Hettangian Stage is represented by plant-bearing sand and clay (the Rödalsberg and Munka-Tågarp Floras).

DÖSHULT BEDS (LOWER SINEMURIAN)

According to Troedsson (1951), who suggested this lithostratigraphical unit, the Döshult Beds are characterized by coarse, cross-bedded sandstones, siltstones, clays and marls, which are more distinctly marine than the cyclic sediments of the Helsingborg Beds. The Döshult Beds have yielded ammonites, belemnites, brachiopods, a rich foraminiferal fauna, and other entirely marine invertebrates, which have not been found in the Helsingborg Beds. The ammonites from Döshult and Katslösa (Reyment, 1959, 1969), indicate that the Döshult Beds include the *Bucklandi, Semicostatum,* and *Turneri* Zones.

Troedsson (1951) subdivided the Döshult Beds into the *Avicula* Bank, Ammonite Bank, and *Myacid* Bank. These terms were used already in the nineteenth century (Lundgren, 1888; Nathorst, 1894, and others). The basal *Avicula* Bank is characterized by coarse and fine-grained sandstones. Among the ammonites found in the basal part of the Döshult Beds at Döshult *Megarietites meridionalis* (Reynés) may be mentioned. This ammonite is the subzonal index of the uppermost subzone of the *Bucklandi* Zone of the Lower Sinemurian (some authors have placed this zone in the Hettangian).

The overlaying Ammonite Bank mainly comprises marls, claystones, shales and calcareous siltstones, which have yielded several ammonites characteristic of the *Semicostatum* Zone (Hoffmann in Bölau, 1959; Reyment, 1959, 1969).

The topmost beds, including the *Myacid* Bank, were not studied in detail by Troedsson. However, Troedsson (1951), Hoffmann (in Bölau, 1959), Reyment (1959, 1969), have described a fairly rich macrofauna from the uppermost part of the Döshult Beds. Among the index ammonites obtained, *Microderoceras* cf. *birchi* (Sowerby) may be mentioned. It was found at a depth of 103 m in the boring Pankarp-Strövelstorp in the Ängelholm Basin (Bölau, 1959; Reyment, 1969; Fig. 2, p. 10 herein). This ammonite is the subzonal index of the uppermost subzone of the *Turneri* Zone. At about 103 m in the boring mentioned the base of the characteristic Upper Sinemurian Pankarp Clays occurs, which will be commented on below.

The Döshult Beds are known from the Ängelholm--Höganäs-Helsingborg region in NW. Scania, from borings in the Öresund offshore from Helsingborg, from the western slope of the Helsingborg-Romeleåsen High, and from borings in the Eslöv region in Central Scania.

The exposures at Fredriksborg, Örby, Gantofta Brick Pit (basal beds), and Katslösa (partly), treated in the present publication can be referred to the Döshult Beds. The same is true of the sections penetrated by the borings Helsingborg Kvarn No. 2220 and Öresund 01 (Figs. 7, 8, Tables 4, 5).

According to Troedsson (1951), the thickness of the Döshult Beds is 70–170 m, and the present study has revealed a fairly rich foraminiferal fauna.

PANKARP CLAYS (UPPER SINEMURIAN)

In his comprehensive account of the Rhaeto-Liassic geology of NW. Scania, Troedsson (1951, p. 120) stated that the Döshult Beds are "followed by a break in the marine succession, which corresponds to the main part of the Upper Sinemurian (the Lias β)", and that (p. 125), "in Scania, no Upper Sinemurian fossils have been recorded". However, in 1959, Bölau reported the occurrence of a more than 50 m thick sequence of variegated clays and claystones found in between the Döshult Beds (Lower Sinemurian mainly) and the Katslösa Beds (Lower Pliensbachian mainly) in the Pankarp-Strövelstorp core in the Ängelholm Basin, NW. Scania (Figs. 1, 2). This sequence, previously known from other borings in the Pankarp region, and regarded as being of Late Triassic age, was named *"Pankarpschichten"* by Bölau.

Typically, the Pankarp Clays (as the beds are called in this paper), have a threefold division: an upper portion of greyish blue, brownish and redbrown claystone, clay and shale; a middle portion of greyish, loose sandstone and siltstone, frequently with a coal-seam; and a lower portion of brownish, greyish and redbrown claystone and clay. A schematic column of the type section is given in Fig. 2, p. 10.

Bölau's description of the Pankarp Clays at Pankarp-Strövelstorp is detailed and very clear, and allows close comparisons with corresponding beds in other sections. However, he seems to be uncertain as to where to put the lower and upper limits of this formation. The Pankarp-Strövelstorp core is subdivided in the following way.

Quaternary deposits	0 – 16.60 m
Katslösa Beds	16.60– 42.10 m
Katslösa/Pankarp transition beds	42.10– 48.57 m
Pankarp Beds	48.57–104.00 m
Pankarp/Döshult transition beds	104.00–120.40 m
Döshult Beds	120.40–183.10 m

The introduction of transition beds *(Übergangsschichten)* between the Döshult and Pankarp Beds and the Pankarp and Katslösa Beds, seems to be unnecessary. In his description of the Katslösa core in the same publication, Bölau (1959, pp. 183–185) did not make use of transition beds.

The characteristic feature of the Pankarp Clays is the variegated colours (greyish blue, brownish and redbrown), whereas both the transition beds have a lithology and colour (mainly dark-grey) typical of the upper part of the Döshult Beds and the lower part of the Katslösa Beds (sensu Troedsson, 1951). The present writer therefore suggests the lower limit of the Pankarp Clays to be drawn at the base of the variegated rocks (at 103 m in the Pankarp-Strövelstorp core), and the upper limit analogously at the top of the variegated rock sequence (at 47.82 m in the same core).

The stratigraphical range of the Pankarp Clays in the Pankarp-Strövelstorp core is given by the presence of *Microderoceras* cf. *birchi* (SOWERBY) at 103 m indicating the *Turneri* Zone, and by the presence of *Polymorphites lineatus* (QUENSTEDT) and *P.* cf. *laevigatus* (QUENSTEDT) at 41 m, indicating the *Jamesoni* Zone. These and other fossils found by Hoffmann (in Bölau, 1959) and Reyment (1959, 1969) thus seem to indicate that the Pankarp Clays fall mainly within the Upper Sinemurian. Recently, Reyment (1969), found evidence of the Upper Sinemurian *Obtusum* Zone in the lower part of the Pankarp Clays exposed in the Gantofta Brick Pit (Figs. 2, 5, pp. 10, 18; Table 5, p. 23).

The Pankarp Clays seem to be widely distributed in the Ängelholm Basin of NW. Scania (borings at Pankarp-Strövelstorp, Östratorp, Rögle and in the Söderås region), and are recorded from several borings in the western slope of the Helsingborg-Romeleåsen High of W. Scania (Bölau, 1959; Brotzen & Norling, 1966; Norling, 1968, 1970; Larsen et al., 1968). Furthermore, the same characteristic facies and colours in a corresponding stratigraphical position have been reported to occur in many borings in N. Mecklenburg, East Germany (Rusbült & Petzka, 1964; Norling, 1970).

The thickness of the Pankarp Clays does infrequently exceed 60 m. The outcropping Pankarp Clays at Gantofta will be commented on below, as well as the foraminifera obtained from core material.

KATSLÖSA BEDS (TOP SINEMURIAN – LOWER PLIENSBACHIAN)

The term Katslösa Beds was coined by Troedsson (1951). The type section, occasionally exposed in a ditch-system near the village of Katslösa SE. of Helsingborg (Figs. 1, 3, 5), was examined by F. Brotzen and E. Mohrén in 1945. Troedsson (1951), who described the section and the molluscan fauna, subdivided the Katslösa Beds into three faunal zones, from top to bottom:

3. Zone of *Pseudopecten aequivalvis* (SOWERBY) and *Ptychomphalus* cf. *expansus* (SOWERBY)
2. Zone of *Grammatodon cypriniformis* (LUNDGREN)
1. Zone of *Passaloteuthis alveolata* (WERNER).

According to Troedsson, the belemnite *Passaloteuthis alveolata* occurs from the Upper Sinemurian to the Lower Carixian. The bivalve *Grammatodon cypriniformis* has been obtained from the *Myoconcha* Bank (Carixian) on the Island of Bornholm, and from the *Caridium* Bank (Carixian) in the Vomb Basin, SE. Sca-

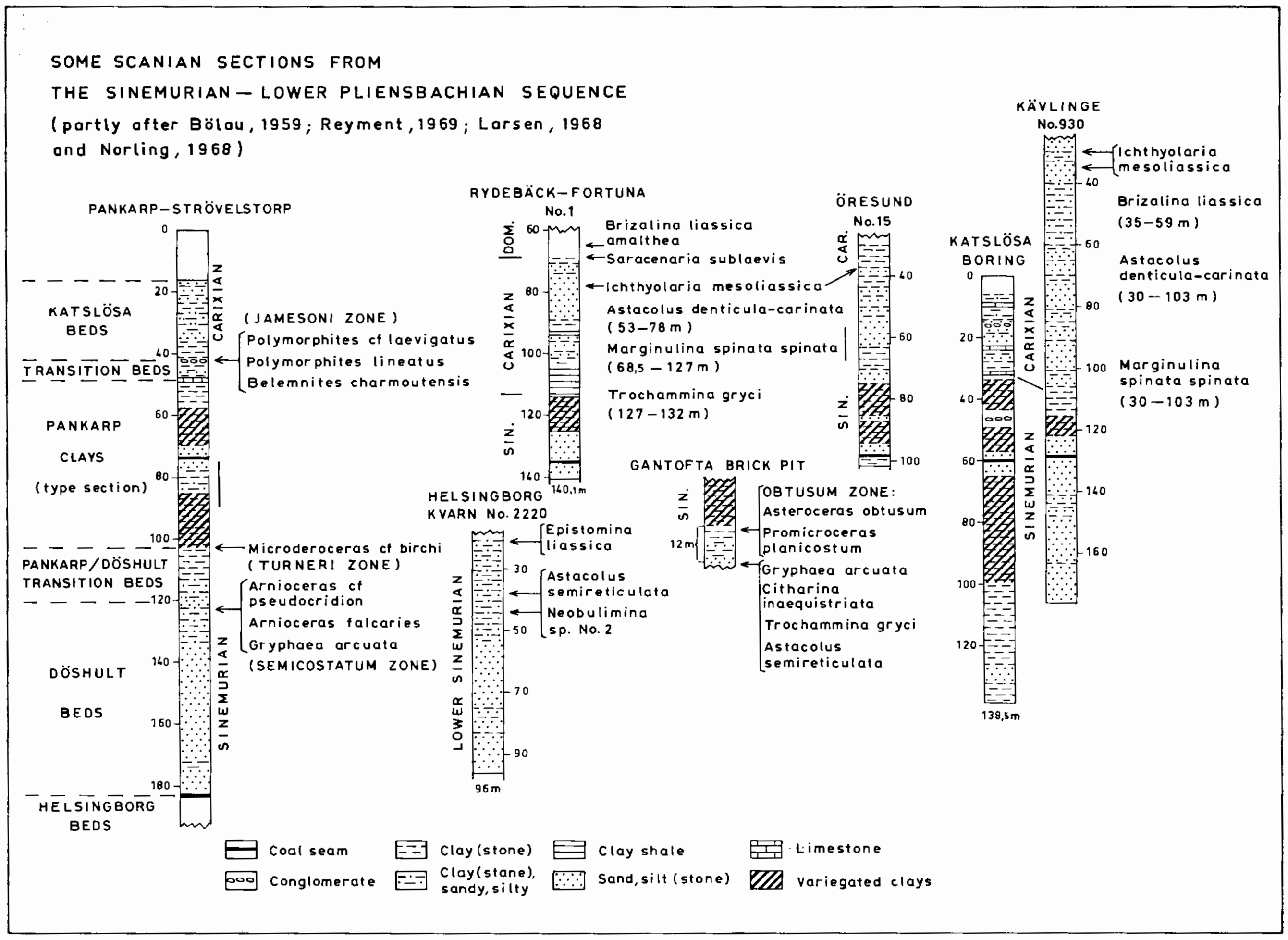


Fig. 2.

nia. The gastropod *Ptychomphalus expansus* was originally described from the Blue Lias at Lyme Regis, Dorset *(Planorbis* to *Bucklandi* Zones), and has also been obtained from the Belemnite Marls at Charmouth *(Jamesoni* Zone, Carixian). Finally, the bivalve *Pseudopecten aequivalvis* is restricted to the Pliensbachian in NW. Europe and N. Africa (all data on the vertical ranges from Troedsson, 1951). Based on the occurrences of these and many other fossils, Troedsson stated (1951, p. 121): "By comparison with the European Standard, the Katslösa Stage probably begins at the top of the Upper Sinemurian, but corresponds largely to the Lower Pliensbachian or Lias γ".

The Katslösa Beds comprise alternating beds of greenish, brownish and greyish, ferruginous sandstones (partly oolithic) and greyish to blackish claystones in the lower part, and predominantly greyish and greenish, partly sandy clays, shales and claystones in the upper part. The thickness of the Katslösa Beds at Katslösa is about 115 m according to Troedsson (1951). Such a great thickness of the Katslösa Beds has not been recorded in other outcrops or borings in Scania, as far as is known to the present writer. The top Sinemurian – – Lower Pliensbachian sequence penetrated by the borings Katslösa (Bölau, 1959), Rydebäck-Fortuna Nos. 1 and 4 (Norling, 1970, and herein), Öresund Nos. 12 and 15 (Larsen et al., 1968), seems to correspond to the lower part of the Katslösa Beds (sensu Troedsson, 1951). The same is true of the boring at Pankarp-Strövelstorp (Bölau, 1959). Concerning the Pankarp, Katslösa, and Öresund cores, the section of the Katslösa Beds represented is overlain by Pleistocene sediments. Concerning the Rydebäck-Fortuna cores, it is superposed by Middle Liassic and younger sediments. Thus, in the latter case, there must have been breaks in the sedimentation during the Lias. However, at Kävlinge (Figs. 1, 5, pp. 7, 18) some 40 km south of Kastlösa, a sequence has been penetrated, which seems to correspond to the

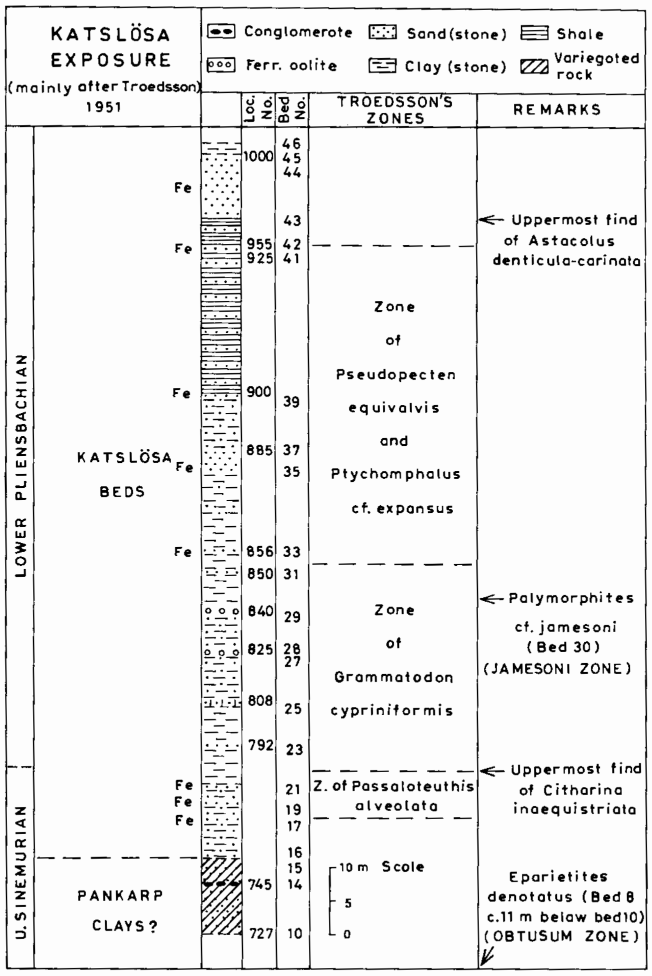


Fig. 3. Lithology and stratigraphy of the Katslösa Beds (mainly after Troedsson, 1951). Fe = ferruginous beds.

main part of the type Katslösa Beds. That is the boring Kävlinge No. 930 (Norling, 1968; Fig. 2 herein), which penetrated about 85 m of the Katslösa Beds, lithologically closely corresponding to the type section.

Liassic strata identified as Katslösa Beds have been recorded mainly from NW. and W. Scania, viz. the Ängelholm Basin (Pankarp region), the northern part of the Helsingborg-Romeleåsen High (Katslösa region), the western slope of the same high (Öresund offshore from Helsingborg, Rydebäck-Fortuna region, Kävlinge-Lund region). In the Vomb Basin, SE. Scania (Kurremölla, Rödmölla, Tosterup and other localities), beds of the same age (mainly Early Pliensbachian) seem to become more arenaceous than in the Katslösa region. Concerning possible Lower Pliensbachian beds in Central Scania, our knowledge is too vague to allow any comparisons with the Katslösa Beds.

Before the present writer started his investigations on Scanian Jurassic foraminifera (Brotzen & Norling, 1966; Norling, 1966, 1968, 1970), nothing but some short notes and comments have been published on them. As will be demonstrated below, the foraminiferal fauna of the Katslösa Beds is fairly rich, including many species of biostratigraphical importance (see also Norling, 1968).

RYDEBÄCK BEDS (AND CORRESPONDING BEDS OF LATE PLIENSBACHIAN – TOARCIAN/ AALENIAN AGE)

Above the Katslösa Beds in the two borings Rydebäck-Fortuna Nos. 1 and 4, a 50 m thick sequence follows, represented by dark greyish siltstone and claystone with variegated portions (reddish and greenish), ferruginous oolites and conglomerates. This sequence will be called the Rydebäck Beds herein. A lithological description of the Rydebäck Beds in the boring Rydebäck-Fortuna No. 4 is given below.

24.00– 52.00 m	Eriksdal Beds: clay, silt and sand with coal-seams. Bajocian – Aalenian foraminifera at 31–35 m.
	Rydebäck Beds (type section):
52.00– 54.00 m	Light greyish green and blackish silty sandstone with *Reinholdella dreheri.*
54.00– 66.60 m	Stratified light grey to dark grey sandy siltstone with joint fillings of limestone, and conglomeratic beds (pebbles of siltstone, claystone, ferruginous claystone and marl in a blackish grey matrix).
66.60– 67.00 m	Dark grey and red variegated siltstone and sandstone, partly white-spotted by shell fragments and with thin beds of ferruginous oolite.
67.00– 67.40 m	Dark green siltstone.
67.40– 67.83 m	Conglomerate with angular pebbles of greenish and reddish siltstone in a light calcareous matrix.
67.83– 74.15 m	Brownish, greenish and reddish, partly clayey siltstone and sandstone with *Citharina clathrata.*
74.15– 74.55 m	Greyish, dense claystone.
74.55– 91.50 m	Greyish, blackish and greenish, partly sandy and clayey siltstone, in the lower part with shell fragments. Toarcian – Pliensbachian limit at about 78 m. Rich Pliensbachian foraminiferal fauna between 78 and 103 m.
91.50– 92.27 m	Light grey to grey, partly conglomeratic siltstone.
92.27– 92.80 m	Shelly sandstone.
92.80– 98.20 m	Dark grey, light grey and greenish siltstone and sandstone with brachiopods and bivalves. In the lower part with limestone bands.
98.20–100.40 m	Blackish grey, light grey and redbrown stratified siltstone and sandstone. Fossiliferous.
100.40–103.40 m	Cross-bedded blackish grey and redbrown siltstone rich in small bivalves.
103.40–135.00 m	Katslösa Beds.

In the boring Rydebäck-Fortuna No. 1, the core interval 17–69.5 m has been referred to the Rydebäck Beds. Lithologic columns of the two borings are given in Fig. 9, p. 25 and Fig. 10, p. 28 (see also Fig. 4, p. 13).

In 1970, the present writer compared these beds with a sequence of variegated sediments comprising the core interval 140–243 m in the Vilhelmsfält boring in the Ängelholm Basin, NW. Scania. Bölau (1959, and Hoffmann in the same paper), who described this sequence under the name "*Obere Bunte Folge*", found ammonitic evidence of the *Tenuicostatum* Zone (basal Toarcian) at about 170 m. The ammonites found between 184.5 m and 238 m indicate, according to Hoffmann's identifications and additional information by Reyment (1959, 1969), the presence of the *Margaritatus* and *Spinatum* Zones of the Upper Pliensbachian (Domerian).

In his 1970-paper, the present writer used the name "Upper Variegated Beds" for the variegated Domerian – Toarcian/Aalenian sequence in the Rydebäck-Fortuna borings in accordance with Bölau's "*Obere Bunte Folge*". However, after discussions with Dr. Bölau and other colleagues he prefers to use the name Rydebäck Beds. The Middle – Upper Liassic variegated rock sequences of the Vilhelmsfält and the Rydebäck-Fortuna borings are closely related concerning colours and colour combinations. Lithologically, however, there are differences. The "*Obere Bunte Folge*" in Vilhelmsfält mainly comprises claystones, whereas the Rydebäck Beds have a predominance of silty and sandy sediments.

In a section exposed between the villages Kurremölla and Eriksdal in the Vomb Basin (Fig. 1, p. 7), there is an insufficiently known sequence of ferruginous silt- and sandstones including varicoloured portions. At the base of this sequence, *Polymorphites jamesoni* (Sowerby), zonal index of the basal Pliensbachian, has been found (Reyment, 1959, 1969). At the top of the sequence, Bajocian coal-bearing beds follow (Tralau, 1968). This variegated sequence very likely corresponds to the Rydebäck Beds and the "*Obere Bunte Folge*".

Corresponding strata have also been recorded from Öresund offshore from Helsingborg. According to Larsen and others (1968), the ostracodal and foraminiferal faunas of these beds (about 36 m of silty and clayey sediments in the boring Öresund No. 3), indicate a Domerian age.

Summarizing our present knowledge of Domerian – Toarcian deposits in Sweden, it can be stated that the beds comprise about 50–100 m of clayey, silty and sandy, ferruginous sediments, characterized by variegated portions (mainly reddish and greenish). As far as is known, these deposits are restricted to the Ängelholm Basin, the western slope of the Helsingborg-Romeleåsen High and the Vomb Basin.

Middle Jurassic

Outcropping Middle Jurassic strata have long been known to occur in the sand pit of the Fyleverken company at Eriksdal in the Vomb Basin, SE. Scania. Not until recent years, however, has the stratigraphical significance become more conclusive. At Eriksdal, the Middle Jurassic is represented by the Eriksdal Beds (Bajocian), and the Glass Sand (Bathonian).

In the Vilhelmsfält core, Ängelholm Basin, NW. Scania, a 75 m thick sequence, mainly of greyish claystones follows above the Middle to Upper Liassic variegated beds. At the base of this sequence, called the Vilhelmsfält Beds ("*Vilhelmsfältschichten*" according to Bölau, 1959), a section of about 7.5 m of loose, partly calcareous and conglomeratic sandstone with a thin coal-seam occurs. However, the main part of this formation is formed by monotonous greyish claystones with a varying content of sand and silt. This sequence, ranging from 140 m to 65 m in the Vilhelmsfält core, has been regarded as Lower Jurassic – Middle Jurassic transitional beds by Bölau (1959). Guy (1971), who studied sporomorphs obtained from the Vilhelmsfält Beds, referred the whole stratal sequence to the Middle Jurassic.

The Middle Jurassic claystone sequence of the Ängelholm Basin, widely differs from the Middle Jurassic of the Vomb Basin, which is much more arenaceous, and containing a great number of coal-seams in the lower part (Eriksdal Beds).

Beds in the Höllviken core No. 1, SW. Scania, reported to have yielded Middle Jurassic sporomorphs (Tralau, 1967; Mahin, 1968), are still too unsufficiently known to allow lithological comparisons.

In 1968, Larsen, Buch, Christensen and Bang, reported Middle Jurassic strata from borings in Öresund offshore from Helsingborg (the Öresund cores Nos. 4, 5, 7). The sequence penterated, comprising clayey and sandy sediments with several coal-seams, was compared with the Vilhelmsfält Beds. According to the present writer, the Öresund beds seem to have more in common with the Eriksdal Beds of the Vomb Basin (Fig. 4, p. 13). The same seems to be true of the coal-bearing sequence penetrated by the Rydebäck-Fortuna core No. 4 (24–53 m), which will be treated herein (see also Norling, 1970).

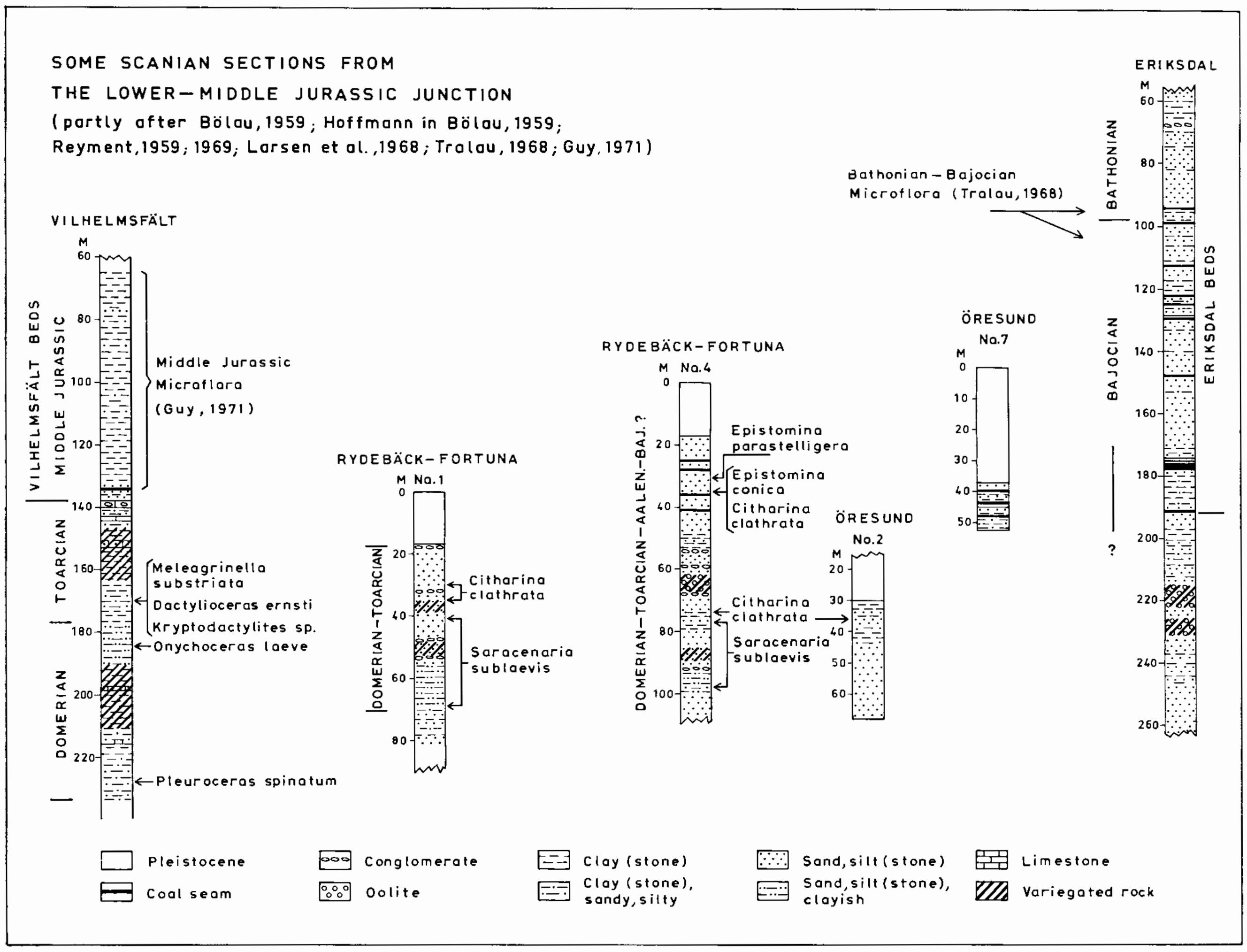


Fig. 4.

ERIKSDAL BEDS (BAJOCIAN)

In the sand pit of the Fyleverken company at Eriksdal, SE. Scania (Fig. 1, p. 7; Fig. 4, p. 13), and in the adjacent Kurremölla valley, a sequence of Jurassic sediments more than 500 m thick, is exposed. From WSW. towards ENE. the section can be subdivided into:

1. Fyledal Clay; mainly greenish clays (Kimmeridgian according to Christensen, 1968, p. 15).
2. Glass Sand; mainly whitish sand and silt (Bathonian according to Tralau, 1968).
3. Eriksdal Beds; alternating sands and clays with several coal-seams (Bajocian according to Tralau, 1968).
4. Ferruginous, partly variegated sandstone, siltstone, and claystone, in the lowermost part with ammonitic evidence of the *Jamesoni* Zone, Lower Pliensbachian, Lower Lias (Reyment, 1959).

In the present paper, the Eriksdal Beds are defined as the sequence between the lowermost and uppermost coal-seams in Tralau's section (1968, Fig. 2, p. 9; Fig. 10, p. 100. See also Fig. 4, p. 13 in the present publication).

From top to base, the Eriksdal Beds can be subdivided into three parts, viz.:

A. c. 94–130 m. Alternating clays and sands with several coal-seams.
B. c. 130–170 m. Mainly sand with few clayey horizons and one single coal-seam.
C. c. 170–191 m. Clays and sandy clays with several coal-seams.

Based on palynological studies, Tralau (1968) thus referred the Eriksdal Beds to the Bajocian and the Glass Sand to the Bathonian, the limit being placed around the two uppermost coal-seams. The lower limit of the Bajocian has not yet been established.

In the Rydebäck-Fortuna core No. 4 (p. 28), Upper Liassic beds are overlain by a sequence of clay and sand with four coal-seams, lithologically corresponding more to the Eriksdal Beds in the Vomb Basin than to the Vilhelmsfält Beds in the Ängelholm Basin (Fig. 4). The few foraminifera obtained (including *Citharina clathrata, Epistomina conica, E. parastelligera,* and *Garantella* sp.) from thin marine ingressional strata in between the coal-measures, seem to indicate an Aalenian – Early Bajocian age. The Aalenian Stage has been placed at the top of the Lower Jurassic by some authors, at the base of the Middle Jurassic by others.

GLASS SAND (BATHONIAN)

The lithology of the beds referred to the Glass Sand, mined in the sand pit of the Fyleverken company at Eriksdal in SE. Scania (and the Eriksdal Beds) has been treated by R. Hallberg (1962) in an unpublished report. Hallberg's lithological description of the Glass Sand is given below.

	Fyledal Clay: Greenish plastic clay.
	Glass Sand:
0 –54.30 m	Whitish sand.
54.30–57.85 m	Light brownish grey sand, partly clayey and shaly with plant fossils.
57.85–66.60 m	Whitish sand.
66.60–82.90 m	Brownish sand.
	Eriksdal Beds: Sand and clay with coal-seams.

The Glass Sand has been placed in the Bathonian by Tralau (1968) on palynological grounds.

Lithologically similar beds in a corresponding stratigraphical position have been found in some borings in the western slope of the Helsingborg-Romeleåsen High in W. Scania also. As no foraminifera have been obtained from these beds, they will not be treated further in the present publication.

FORTUNA MARL (UPPER BATHONIAN/CALLOVIAN – OXFORDIAN)

Stratigraphically above the Glass Sand, a marine sequence, herein named the Fortuna Marl, has been found in the Rydebäck-Fortuna core No. 5 (Fig. 11, p. 30; Fig. 5, p. 18). This formation, originally described by the present writer as the Fortuna Marlstone (1970, pp. 264, 268; Fig. 3), represents the first Swedish find of marine beds around the Middle Jurassic – Upper Jurassic boundary.

From top to base, the Fortuna Marl can be described as follows (see also Fig. 11, p. 30).

m below the surface	
78.00–135.17	Fyledal Clay.
135.17–138.72	Grey to greyish brown, partly shaly claystone, with thin beds of marl and ferruginous claystone.
138.72–141.30	Grey to greyish brown claystone with light shell fragments.
141.30–145.13	Greyish marl, interbedded clay and claystone, with thin bands of brownish ferruginous claystone.
145.13–148.55	Dark grey claystone with thin bands of light siltstone and marl. Bivalves.
148.55–149.41	Brown ferruginous claystone and grey clay interbedded.
149.41–151.95	Grey clay and grey to greyish brown claystone interbedded, in the lower part slightly sandy.
151.95–153.03	Light grey limestone, greyish marl, clay, and claystone interbedded.
153.03–154.93	Grey, greasy clay, in the lower part with thin beds or fairly hard marl and ferruginous claystone.
154.93–159.93	Grey to greenish grey, partly sandy claystone alternating with beds of marl, clay and ferruginous claystone.
159.93–161.25	Conglomerate with greyish and redbrown stones and gravel in a clayey matrix.

Based on a fairly rich microfauna (p. 31), the core section referred to the Fortuna Marl has been stratigraphically subdivided into:

135.17–148.50 m Oxfordian
148.50–156.60 m Callovian/Oxfordian
156.60–161.30 m Upper Bathonian/Callovian.

As mentioned above, the Fortuna Marl represents the only Swedish find of U. Middle Jurassic – L. Upper Jurassic deposits. This does not necessarily mean that such beds have a very restricted distribution in Scania. The widely distributed Cretaceous and Pleistocene sediments in the Fennoscandian Border Zone may hide a fairly complete Jurassic sequence in some regions.

In this connection a recent find of an erratic block containing abundant Middle Jurassic ammonites is of great interest. The block, light grey in colour and of a marly character, was found near Svedala about 60 km SE. of the Rydebäck-Fortuna region. Reyment (1971), has described the rich ammonite association obtained from this block. He states that the fauna is characteristic of the *Lamberti* Zone, Callovian, Middle Jurassic, and assumes that the block has been transported from the southwestern part of the Baltic Sea by ice movements during the last glaciation.

Upper Jurassic

Deposits from the Upper Jurassic/Lower Cretaceous boundary, usually referred to as Wealden Beds, were early assumed to occur at Eriksdal in the Vomb Basin. In 1913, Möller and Halle tentatively referred the plant- and coal-bearing sands and clays at the base of the Glass Sand in Eriksdal to Wealden with the remark on certain plants that they "indicate a relation to the rich Middle Jurassic floras". As mentioned above (p. 13), corresponding beds have recently been placed in the Bajocian by Tralau (1968).

In a brief note, Hägg (1940) discussed the finds of some molluscan faunas from Vitabäck, near to the south of the sand pit at Eriksdal, and stated that they corresponded to Purbeckian (or Wealden) faunas.

In 1961, Oertli, Brotzen & Bartenstein published a paper on the Upper Jurassic – basal Lower Cretaceous deposits in S. Sweden. The Wealden facies previously known from Denmark and Sweden was correlated with the *"Serpulit"* (Upper Jurassic) in N. Germany. Special interest was paid to the greenish clays (Fyledal Clay) overlaying the Glass Sand in the sand pit of the Fyleverken company at Eriksdal, and to corresponding beds observed in borings in W. Scania (Landskrona area). These authors considered the ostracode faunas of the Fyledal Clay from both the localities to indicate a Middle Purbeckian age.

Recently, Christensen (1968) has given further important data on the Swedish Upper Jurassic stratigraphy based on ostracode faunas. His material was collected in the Fyledal Clay at Eriksdal and in wire-line boring material from Central and NW. Scania. He also treated the ostracode faunas in the Vitabäck Clays (see p. 30 herein). Concerning the Fyledal Clay, Christensen states (1968, p. 15): "The faunas of the Fyledal Clay in western Scania suggest that the upper part of the formation here represents the stratigraphic interval Middle Kimmeridgian to Lower Portlandian (Bruun Christensen, 1965). The rather thick fossil-free interval of drilling below the Kimmeridgian faunas in the formation at Hilleshög (Oertli, Brotzen & Bartenstein, 1961) may be of Middle and Lower Kimmeridgian, and perhaps Oxfordian age. The Fyledal fauna from the lower part of the formation at the pit of Fyleverken is of Kimmeridgian age".

Neither from the Vomb Basin in SE. Scania, nor from W. Scania (including the northern Öresund area), has a complete section through the Fyledal Clay been previously described. However, in 1968, this formation was penetrated from top to base by the boring Rydebäck-Fortuna No. 5, at Nytorp farm, about 11 km SSE. of the town of Helsingborg. The core and its foraminiferal fauna, commented on by the present writer in a preliminary report (1970, pp. 261–287), will be considered in the present publication.

Stratigraphical subdivisions of the Upper Jurassic

Summarizing our present knowledge of the Upper Jurassic in Sweden, we may make the following subdivisions, including also the Fortuna Marl spanning the Middle Jurassic/Upper Jurassic boundary (pp. 14, 30, herein).

FORTUNA MARL, UPPER PART (OXFORDIAN)
(see p. 32)

In the Rydebäck-Fortuna core No. 5 (p. 30) the 156.6–148.5 m section has been referred to the Callovian/Oxfordian transitional beds. The 148.5–135.17 m section has been placed in the Oxfordian mainly because of the occurrence of calcareous foraminifera such as *Lenticulina brueckmanni* (MYATLIUK), *Lenticulina irretita* (SCHWAGER), *Marginulinopsis sculptulis* (SCHWAGER) (see Table 9, p. 31).

FYLEDAL CLAY (OXFORDIAN – KIMMERIDGIAN)

As no continuous section of this formation has been described previously, the one penetrated by the Rydebäck-Fortuna core No. 5 is described below (see also Fig. 11, p. 30).

m below surface

42.00– 77.72	Nytorp Sand (see p. 16).
	Fyledal Clay:
77.72– 78.41	Greyish brown silty clay.
78.41– 79.13	Grey to greyish brown, partly silty clay, in the lower part with thin bands of hard, silty claystone.
79.13– 79.53	Conglomerate with pebbles of greyish brown claystone in a clayey matrix.
79.53– 81.80	Dark grey to greyish brown, partly silty clay with *Valvulina meentzeni* and pyritisized ostracodes.
81.80– 84.01	Greyish brown, silty clay alternating with greyish green silt.
84.01– 84.48	Greasy, greyish blue clay.
84.48– 86.65	Conglomerate with pebbles of black shale and greyish claystone, partly in a sandy, partly in a clayey matrix.
86.65– 88.12	Greasy, bluish green to bluish grey clay.
88.12– 88.76	Light grey to brown, fine sand.
88.76– 90.06	Bluish, greenish and brownish clay and claystone interbedded. Calcareous foraminifera.
90.06– 90.24	Greyish green, hard marl with joint fillings of light limestone.
90.24– 91.55	Light-greyish green clay with thin beds of brownish fine sand.

91.55– 92.30	Grey, hard limestone.
92.30–104.08	Bluish green, partly brown-spotted claystone alternating with beds of clay and hard greyish marl. At certain levels rich in *Reophax suprajurassica.*
104.08–107.33	Greyish green claystone with thin beds of light silt. Rich in megaspores.
107.33–120.65	Greyish green to bluish, partly shaly claystone.
120.65–126.93	Greyish green claystone with thin beds of light brown ferruginous claystone. Rich in arenaceous foraminifera.
126.93–127.80	Greyish green claystone with thin beds of whitish, hard limestone. Rich in arenaceous foraminifera and shark teeth.
127.80–135.17	Greyish green and grey clay and claystone with thin bands of light brown ferruginous claystone.
135.17–161.25	Fortuna Marl (see p. 14).

In the Rydebäck-Fortuna core No. 5, the 57 m thick sequence of Fyledal Clay has been referred to the Oxfordian and Kimmeridgian on the basis of the foraminifera. The fauna does not allow the stage limit to be unequivocally established. However, it seems, without any doubt, as if the uppermost part only is of Kimmeridgian age. The foraminiferal stratigraphy is discussed on p. 33 below.

As mentioned above, the Fyledal Clay is known from the Vomb Basin (estimated thickness; 140 m according to Christensen, 1968), and from the western slope of the Helsingborg-Romeleåsen High, including the northern part of the Öresund area.

NYTORP SAND (KIMMERIDGIAN – PORTLANDIAN)

Between the Fyledal Clay (Oxfordian – Kimmeridgian) and the Vitabäck Clays (Portlandian), a sequence mainly of whitish sand occurs, known from the Vomb Basin and the western slope of the Helsingborg-Romeleåsen High. In the Vomb Basin the whole sand sequence has not been penetrated. Christensen (1968, p. 8; Fig. 2, p. 16), who called this formation the "Sand beds", estimated its thickness to be more than 18 m.

Sand beds in a corresponding stratigraphical position have been penetrated by the Rydebäck-Fortuna core No. 5 (Norling, 1970 and herein). In his 1970 report, the present writer called this formation the "Upper Glass Sand", since the lithology of this formation has much in common with the Bathonian "Glass Sand" (see p. 14). However, as the former formation has not been mined for glass production, the "Upper Glass Sand" is not an adequate term. Instead of that name, the "Nytorp Sand" is proposed herein, referring to Nytorp farm, at which the boring Rydebäck-Fortuna No. 5, penetrating the whole formation, is located.

From top to base the Nytorp Sand can be described as follows:

m below surface	
35.00– 42.00	Vitabäck Clays.
	Nytorp Sand:
42.00– 43.00	Dark grey, clayey, calcareous sand.
43.00– 44.00	Bluish grey, clayey sand, rich in coal fragments.
44.00– 75.00	Light brown and whitish sand and silt with darker bands rich in coal fragments.
75.00– 77.72	Light brown siltstone with coal fragments becoming greyish and clayey in the lower part.
77.72–135.17	Fyledal Clay.

In the Rydebäck-Fortuna core No. 5, the Nytorp Sand is extremely poor in fossils. In the upper part of the formation, the Portlandian foraminifer *Lenticulina muendensis* Martin has been found. In the basal part, arenaceous foraminifera, including *Cyclammina* species (of Kimmeridgian type) have been obtained.

VITABÄCK CLAYS (PORTLANDIAN – – ?LOWER CRETACEOUS)

As mentioned above, Hägg (1940) in a brief note, commented on a molluscan fauna obtained from a sequence of variegated and grey, sandy clays with coal fragments, occasionally exposed at the village Vitabäck, N. of Eriksdal in the Vomb Basin. Hägg found evidence of a Purbeckian or Early Cretaceous age of this fauna. At about the same time, Steneström started investigations of the fossil faunas and floras obtained from the clays at Vitabäck and Eriksdal (not published).

Under the name of the "Green Clay Series", Steneström included clayey deposits above the Glass Sand in the pit of the Fyleverken company. The lower part of this "Green Clay Series" corresponds to the Fyledal Clay. The upper part, viz. the sequence above the Nytorp Sand, is called the Vitabäck Clays herein (Christensen, 1968, coined the name Vitabäck beds).

Unfortunately, Stenström died in 1961 without having published his results. His material was handed over to Christensen. In his 1968 paper, Christensen gave an account on the ostracode faunas in the Vitabäck Clays, and referred the formation to the Upper Portlandian. According to Christensen (1968, p. 8), the Vitabäck Clays (compared with the Rabekke Formation of Bornholm), include more than 70 m of "Dark, blackgrey slaty clay", overlaying "Limonitic claystone" and "Arenaceous marlstone". Apart from the Vitabäck section, Christensen also studied material, including greenish

SERIES	STAGE		AMMONITE ZONES	ZONAL EVIDENCE in SCANIA	LITHOSTRATI-GRAPHIC UNITS
UPPER JURASSIC	PORTLANDIAN		No post-Toarcian ammonite finds in Scania	Ostracodal and foraminiferal evidence	VITABÄCK CLAYS
	KIMMERIDGIAN				NYTORP SAND
	OXFORDIAN			Foraminiferal evidence	FYLEDAL CLAY
MIDDLE JURASSIC	CALLOVIAN				FORTUNA MARL
	BATHONIAN			Paleobotanical evidence	GLASS SAND
	BAJOCIAN				VILHELMSFÄLT BEDS in NW SCANIA / ERIKSDAL BEDS in W and SE SCANIA
LOWER JURASSIC	AALENIAN			Foraminiferal evidence	RYDEBÄCK BEDS
	TOARCIAN		Lytoceras jurense		
			Hildoceras bifrons		
			Hildaites serpentinus		
			Dactylioceras tenuicostatum		
	PLIENSBACHIAN	DOM.	Pleuroceras spinatum	In core material from Vilhelmsfält, NW Scania	
			Amaltheus margaritatus		
		CARIXIAN	Prodactylioceras davoei		KATSLÖSA BEDS
			Tragophylloceras ibex	No ammonite finds	
			Uptonia jamesoni	Kurremölla, Eriksdal and Katslösa Exposure	
	SINEMURIAN	U	Echioceras raricostatum	No ammonite finds	PANKARP CLAYS
			Oxynoticeras oxynotum	Lowermost part of the Eriksdal section, SE Scania	
			Asteroceras obtusum	Pankarp Beds in Gantofta Brick Pit, W Scania	
		L	Euasteroceras turneri	Basal Pankarp Beds in cores from Pankarp–Strövelstorp	DÖSHULT BEDS
			Arnioceras semicostatum	Döshult Beds at Döshult, Djuramåsa, NW Scania	
			Arietites bucklandi	Lowermost Döshult Beds at Döshult, NW Scania	
	HETTANGIAN		Schlotheimia angulata	No ammonite finds	HELSINGBORG BEDS
			Alsatites liasicus		
			Psiloceras planorbis		

TABLE 2. Stratigraphical table of the Jurassic in Scania.

clays, from shallow borings in Central Scania (Blentarp and Silvåkragården). Unfortunately, no continuous and complete section of the Vitabäck Clays has been described.

The Vitabäck Clays are also represented in the Rydebäck-Fotruna core No. 5, described by the present writer (1970, and herein). However, only the topmost seven metres of this core can be referred to this formation. The overlaying 35 m of clays and sands are of Pleistocene age.

The Vitabäck Clays in the Rydebäck-Fortuna core No. 5 include the following sequence:

35.00–41.00 m	Greenish grey, greasy clay.
41.00–42.00 m	Bluish grey, partly brownish, silty clay with coal fragments.
42.00–77.72 m	Nytorp Sand.

The scarce microfauna obtained seems to support Christensen's dating.

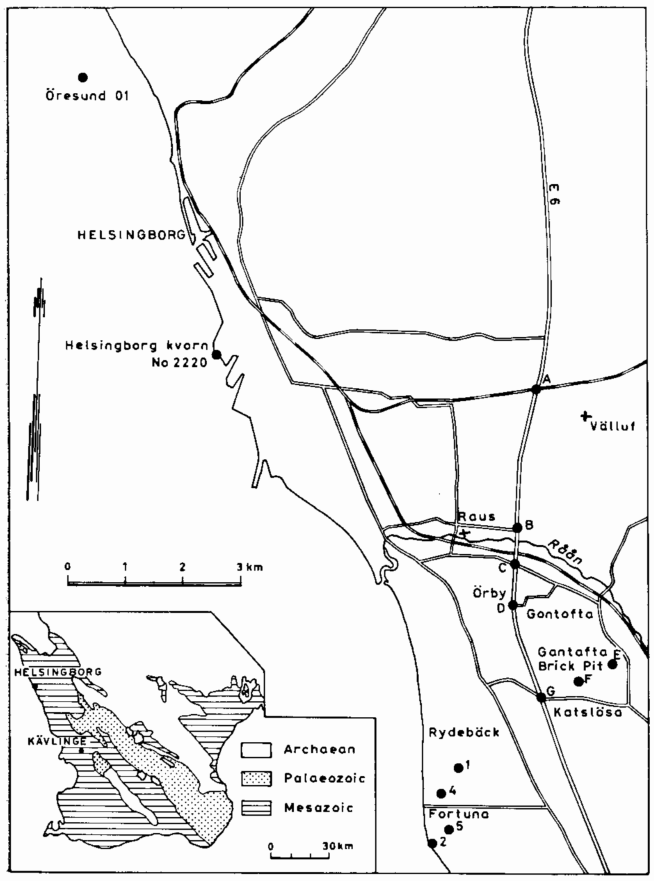


Fig. 5. Location map of exposures and borings treated in the text. A–D and G refer to viaduct exposures along the highway E 6 at Välluf (A), Raus (B), Fredriksborg (C), Örby (D), and Katslösa (G). E refers to the Gantofta Brick Pit, F to the Katslösa Exposure (Troedsson's locality), 1, 2, 4, 5 represent borings drilled in the Rydebäck–Fortuna area. The inset geological map of Scania shows the location of Helsingborg and Kävlinge.

Material

Source of Material

This publication is based on material from outcrops and borings. The samples have been collected from outcrops mainly SE. and E. of the town of Helsingborg. Subsurface core and cutting material was obtained from six borings in the Helsingborg region and from two borings near the village Kävlinge about 40 km SE. of Helsingborg (Figs. 1, 5).

Outcrop Material

In the area SE. and E. of Helsingborg, Lower Jurassic beds, including Hettangian, Sinemurian, and Lower Pliensbachian, are exposed in many places, notably in the very town of Helsingborg, in the valley of the rivulet Råån, in a brick pit at Gantofta, and in ditches at Katslösa. Apart from these fairly well-known localities, treated in several papers by Troedsson, Bölau, Mohrén, Reyment, Norling, and others, Jurassic rocks have recently been exposed in many places along the newly built part of the highway E 6. However, in this area, no outcrops of strata younger than Early Pliensbachian have been found.

This publication deals with Hettangian foraminifera from the Välluf E 6 Viaduct Exposure E. of Helsingborg. A few finds of Hettangian foraminifera from Raus SE. of Helsingborg will also be commented on. Samples from the Lower Sinemurian have been obtained from viaduct exposures at Fredriksborg and Örby, from the Gantofta Brick Pit, and the Katslösa Exposure. Upper Sinemurian material was mainly obtained from borings. Samples of Early Pliensbachian (Carixian) age were collected in exposures in the village Katslösa (Fig. 5).

Most of the exposures are temporary and will probably be covered by vegetation in a near future.

Subsurface Material

Within the area studied, the Jurassic sequence dips generally towards southwest, and becomes more and more complete in this direction. Even the overlaying sediments, mainly Pleistocene, but also Cretaceous in the southern part, increase considerably in thickness towards southwest. In the region south of the rivulet Råån, there is no Jurassic outcrops west of the highway E 6. However, the outcropping Lower Lias in the area investigated, combined with the Jurassic sequence penetrated by drillings, is the most complete ever found in Sweden. Most of the borings have previously been commented on by the present writer (Norling, 1966, 1968, 1970).

Samples from the Lower Sinemurian Döshult Beds have been obtained from the boring Helsingborg Kvarn No. 2220, a wire-line boring for water supply. The core Öresund 01, offshore from Helsingborg, also penetrated Lower Sinemurian strata (Norling, 1966, 1968). Upper Sinemurian – Toarcian/Aalenian material has been obtained from the Rydebäck-Fortuna cores Nos. 1 and 4, the latter penetrating also the lowermost Bajocian coal-bearing formation. Core No. 5 near the same village has yielded material of Late Bathonian/Callovian – Portlandian age.

Another core drilled in the same region, viz. Rydebäck-Fortuna No. 2, includes Lower Cretaceous – Portlandian strata below the Pleistocene cover (Norling, 1970, Figs. 1, 2). However, since only a very scarce Portlandian foraminiferal fauna was obtained, this core will not be treated in this publication.

The two cores from Kävlinge, viz. Kävlinge Nos. 928 and 930 (Figs. 1, 2, 5), penetrated Lower Pliensbachian, and Upper Sinemurian – Lower Pliensbachian strata, respectively. Material from these cores has previously been treated by Brotzen & Norling (in Mohrén, 1966), and by Norling (1968).

All the material treated herein is kept by the Geological Survey of Sweden (SGU), Stockholm.

The stratigraphical range of the different outcrops and borings is given in Table 3.

Stratigraphy of exposures and borings

The Jurassic sections treated in the present publication mainly include those which have yielded foraminifera. Thus, the following account does not pretend to cover the entire Jurassic succession of W. Scania.

The descriptions of the sections studied start with beds referred to the Hettangian and continue upwards in the stratal sequences.

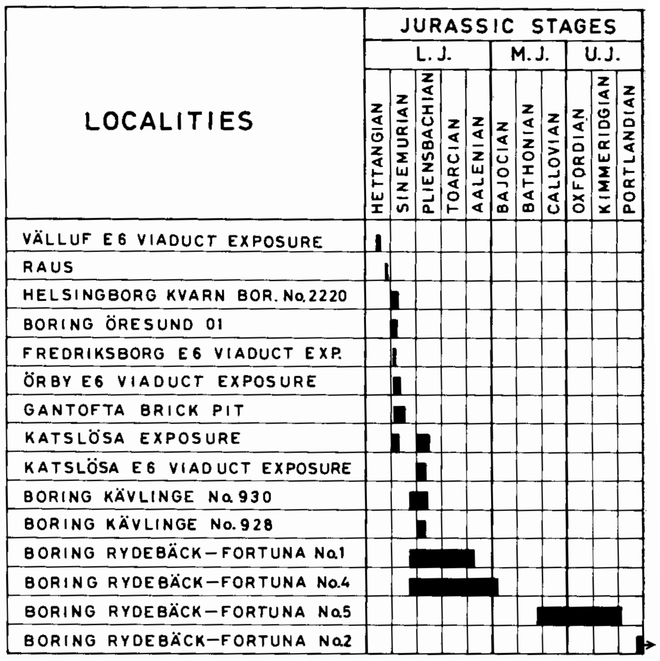


TABLE 3. Stratigraphical range of sections treated in the text.

Välluf E 6 Viaduct Exposure

Figs. 5, 6, pp. 18, 20.

Location: About 7 km ESE. of Helsingborg centre. UTM co-ordinates UC 62 00 11 10.
Elevation: About 37 m a. s. l.
Thickness of excavated beds: 4.66 m.
Stratigraphical range: Helsingborg Beds, Hettangian.

This section was exposed in connection with the construction of a new part of the highway E 6 east of Helsingborg. The previous knowledge of the geology of the Välluf region suggests a Hettangian age of this section. The Rhaetic-Hettangian boundary is situated about 5 km ESE. of this locality, near the villages Fjärestad and Bunketofta. The Hettangian – Sinemurian boundary is to be found at the Öresund coast some 5 km W. of Välluf.

The small section, mainly comprising alternating grey shale and siltstone strata with two coal-seams in the upper part, does not show any easily recognizable index layer. This lithology (Fig. 6) can be seen in numerous sections within the Helsingborg Beds, viz. the Hettangian of this region. The Välluf E 6 Viaduct Exposure is of great interest, as it has yielded the oldest Jurassic foraminifera found in Sweden. In calcareous clayey siltstone immediately below the two coal-seams

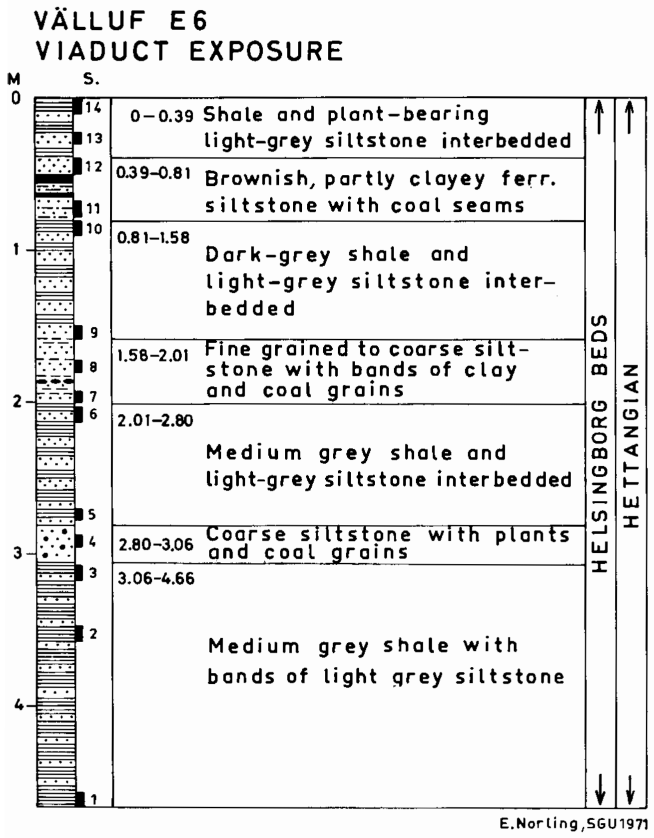


Fig. 6. Lithologic column of the Välluf E 6 Viaduct Exposure. M 0–4 = depth in metres below surface. S 1–14 = samples.

(Fig. 6, sample No. 11), the following foraminiferal assemblage was found:

	European stratigraphical range:
Ammodiscus asper TERQUEM	Liassic
Astacolus semireticulata nov. sp.	Hettangian – L. Sinemurian
Astacolus ex gr. *varians* (BORNEMANN)	Jurassic
Ichthyolaria intercostata (KRISTAN-TOLLMANN)	Rhaetic
Marginulina lamellosa TERQUEM & BERTHELIN	Hettangian – Pliensbachian
Marginulina undulata (TERQUEM)	Hettangian – Sinemurian
Mesodentalina tenuistriata (TERQUEM)	Hettangian – L. Toarcian
Pseudonodosaria holocostata (KRISTAN-TOLLMANN)	Rhaetic
Pseudonodosaria plumiricostata (KRISTAN-TOLLMANN)	Rhaetic
Reophax eominutus (KRISTAN-TOLLMANN)	Rhaetic
Reophax horridus (SCHWAGER)	Rhaetic – Jurassic
Tetrataxis inflata KRISTAN	Rhaetic

Except for these foraminifera, unidentified specimens of the genus *Nodosaria,* ostracodes, and small gastropods were observed.

Below this level, in sample No. 4 at 2.9 m, some few specimens of *Eoguttulina liassica* (STRICKLAND) and *Trochammina* sp. were found.

As seen above, some of the short-ranging forms are previously recorded from the Rhaetic, and some from the Lower Lias. The Rhaetic species were originally described from the Zlambach Marl of Salzkammergut in Austria by Kristan-Tollmann (1957, 1964). The Swedish finds of these species may be redeposited. It cannot be excluded, however, that the foraminifera in question have a range spanning the Rhaetic-Hettangian limit.

The Liassic species recorded do not allow a closer dating than a Hettangian/Early Sinemurian age for the fossil-bearing sequence. However, this section is located in the neighbourhood of the Helsingborg Beds, placed in the Hettangian on paleontological grounds by many previous students. The two species in sample No. 4 have little stratigraphical significance.

Helsingborg kvarn. Boring No. 2220

Figs. 2, 5, 7, pp. 10, 18, 21.

Location: In the southwestern part of the town of Helsingborg
UTM co-ordinates: UC 56 85 10 65.
Elevation: Ground less than 5 m a. s. l.
Total depth: 96 m.
Stratigraphical range: Döshult Beds, Lower Sinemurian, 96–21 m; Pleistocene, 21–0 m.

This wire line boring was drilled for water supply. The sequence penetrated, includes grey and brownish grey, clayish siltstone with thin beds of ferruginous siltstone and coarse sandstone in the lower part, and calcareous, mainly grey, silty, claystone in the upper part of the Jurassic section. The foraminifera found are restricted to the upper part of the section.

In the interval 44–38 m consisting of light grey, calcareous silty claystone, the following foraminiferal assemblage has been obtained:

Astacolus semireticulata nov. sp.	common
Astacolus ex gr. *varians* (BORNEMANN)	abundant
Eoguttulina liassica (STRICKLAND)	common
Geinitzinita ex gr. *tenera* (BORNEMANN)	common
Ichthyolaria brizaeformis (BORNEMANN)	rare
Marginulina lamellosa TERQUEM & BERTHELIN	rare
Marginulina undulata TERQUEM	rare
"*Neobulimina*" sp. No. 2 BANG	common
Nodosaria dispar FRANKE	common
Nodosaria metensis TERQUEM	rare
Vaginulina listi (BORNEMANN)	rare
Vaginulinopsis excarata (TERQUEM)	rare

Except for these foraminifera, some non-specified forms of the genera *Lagena* WALKER & JACOB and *Prodentalina* NORLING, were found.

Though most of the foraminifera listed above have a wide stratigraphical range in W. Europe, there are two

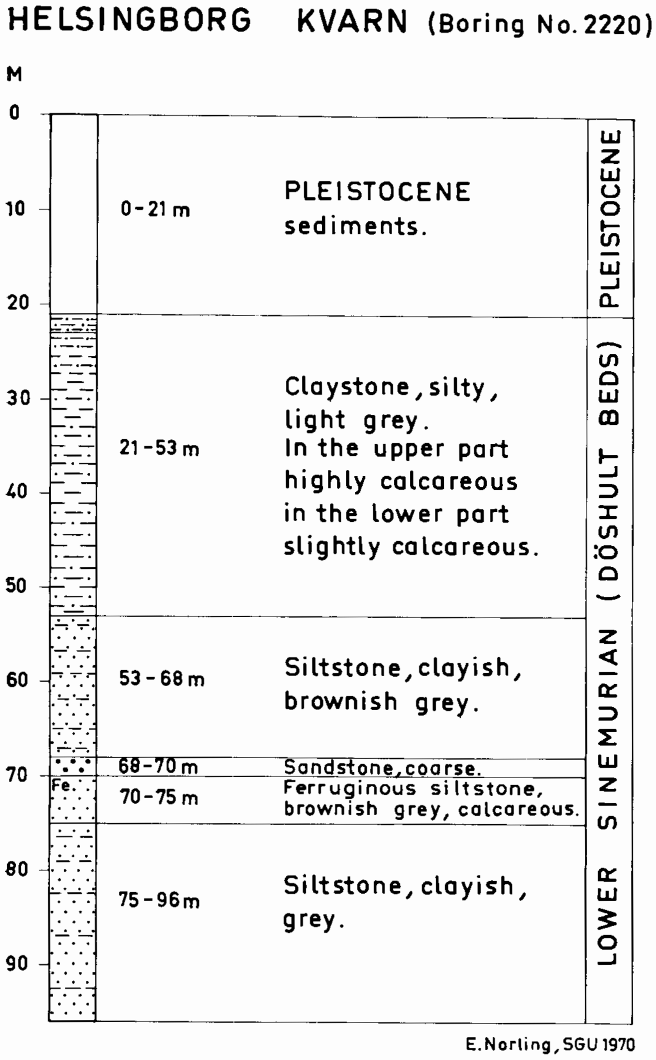


Fig. 7. Lithologic column of the wire-line boring Helsingborg Kvarn No. 2220 (number in SGU's File of Well Records).

forms found in the 44–38 m interval with a rather narrow vertical distribution, viz. "*Neobulimina*" sp. No. 2 Bang, 1968, and *Astacolus semireticulata* nov. sp.

"*Neobulimna*" sp. No. 2 is reported to be abundant in beds referred to the Lias α/β transitional beds in the Öresund cores Nos. 8, 9, 14, offshore from Helsingborg (Bang in Larsen et al., 1968). The present writer, who has examined samples from established ammonite zones of the Dorset Lias, found this species in the top *Angulata – Bucklandi* Zones only (Blue Lias at Lyme Regis). According to Bang (1968, p. 64), "*Neobulimina*" sp. No. 2, shows morphological affinity to a foraminifer, described from NW. Germany, which, however, was described by Brand (1937) from Lias α as an arenaceous form, viz. *Gaudryina gradata* Berthelin Form a Brand. The same species is described in "*Leitfossilien*" (p. 75, 1962) as characteristic of Lias β. "*Neobulimina*" sp. No. 2 has a calcareous test.

Astacolus semireticulata nov. sp., synonymous to *Lenticulina* sp. No. 26 Bang, 1968, will be treated in the paleontological part of the present paper. Bang (in Larsen et al., 1968) reported that it occurred in a sequence of claystone and silty claystone spanning the Lias α/β limit in the Öresund cores Nos. 8, 10, 11 and 14 offshore from Helsingborg.

In a sample from the 21 m level in the boring Helsingborg No. 2220, some few specimens of *Epistomina liassica* Barnard were obtained, accompanied by planispiral, arenaceous forms. *Epistomina liassica* seems to be restricted to the *Semicostatum* Zone (Barnard, 1950), and the *Bucklandi* Zone (Norling herein) of the Dorset Lias.

Concerning *Vaginulinopsis excarata* (Terquem), a diagonally ribbed, elongated form, found in the 44–38 m interval of drilling in Helsingborg No. 2220, may be mentioned: It has been recorded from the Upper Sinemurian of Jutland, Denmark by Nørvang (1957). In NW. Germany it is regarded as a good index fossil of the Lower Sinemurian (Franke, 1936; "Leitfossilien", 1962). In S. Germany it has been found in beds referred to the Pliensbachian.

Fredriksborg E 6 Viaduct Exposure

Fig. 5, Table 3, pp. 18, 19.

Location: About 7.5 km SSE. of Helsingborg centre.
UTM co-ordinates: UC 61 65 08 10.
Elevation: About 18 m. a. s. l.
Stratigraphical age: Döshult Beds, Early Sinemurian.

The geology of this exposure is unknown to the present writer. However, Dr E. Mohrén, SGU, Lund, has kindly forwarded a rock sample of greenish grey, pyritic claystone (M 286/1967) from this locality, which has yielded the following foraminifera:

Astacolus ex gr. *varians* (Bornemann)
Eoguttulina liassica (Strickland)
Epistomina liassica Barnard
Geinitzinita ex gr. *tenera* (Bornemann)
Marginulina lamellosa Terquem & Berthelin
Trochammina gryci Tappan

Unidentified forms of the genera *Lagena* Walker & Jacob, *Prodentalina* Norling, and *Psammosphaera* Schulze have been found also, as well as some smooth ostracodes.

The sample is referred to the Lower Sinemurian, mainly based on the presence of *Epistomina liassica.* This dating is supported by the previous knowledge of the geology in this region.

Boring Öresund 01

Figs. 1, 5, pp. 7, 18; Table 3, p. 19.

Location: Offshore from Helsingborg, northwest of the town. N 54°4'3", E 12°39'30".
Elevation: 17 m below sea-level.
Core length: 48.8 m.
Stratigraphical range: Unknown, 48.8–42.8 m; Döshult Beds, Lower Sinemurian, 42.8–9.16 m; Pleistocene, 9.16–0 m.

This core was drilled in 1958. The project concerned the location of a planned bridge or tunnel spanning the Sound from Helsingborg to the Danish town of Helsingør. The Jurassic sequence of this core, mainly represented by fossiliferous siltstone and claystone with portions of ferruginous claystone, has previously been treated by the present writer (1966, 1968).

The foraminiferal fauna obtained in the 42.8–14 m interval of the core includes *Citharina inaequistriata* (Terquem), *Marginulina lamellosa* Terquem & Berthelin, *Astacolus neoradiata* Neuweiler, "*Neobulimina*" sp. No. 2 Bang, *Nodosaria kuhni* Franke, *Trochammina gryci* Tappan, and *Vaginulina listi* (Bornemann).

The occurrences of *Citharina inaequistriata* (42–21 m) and *Trochammina gryci* (33 m) suggest that this section is not younger than the Sinemurian. The occurrences of *Nodosaria kuhni* and "*Neobulimina*" sp. No. 2 seem to indicate an Early Sinemurian age for these beds. Another indicator of the Early Sinemurian is the ostracode *Procytheridea betzi* Klingler & Neuweiler found in the upper part of the section.

Örby E 6 Viaduct Exposure

Figs. 5, 8; Tables 3, 4, pp. 18, 19, 23.

Location: About 8 km SE. of Helsingborg centre.
UTM co-ordinates: UC 61 65 07 35.
Elevation: About 25 m a. s. l.
Thickness of outcropping beds: 8.25 m.
Stratigraphical range: Döshult Beds, Lower Sinemurian.

This locality is at a viaduct road crossing between the highway E 6 and a smaller road from Gantofta to Örby. Here, Liassic beds are exposed on both sides of the roads. The section was studied in 1968 by the present writer jointly with C. Ullman and G. Nordmark. The setcion includes 2 m of calcareous siltstone and sandstone rich in *Gryphaea arcuata* Lamarck in the basal part, overlain by 6 m of interbedded shale, clay and partly silty claystone. Lithologically and faunistically, these beds seem to correspond to the basal beds in the Gantofta Brick Pit, a locality commented on below.

The check-list of foraminifera obtained from the Örby section (Table 4, p. 23), includes some species restricted to the Hettangian – Lower Sinemurian in W. Europe together with long-ranging forms. In the Örby section the uppermost finds of *Astacolus semireticulata* nov. sp. and "*Neobulimina*" sp. No. 2 Bang have been obtained together with *Procytheridea betzi* Klingler & Neuweiler, an ostracode, which has never been found outside the Lower Sinemurian as far as is known to the present writer.

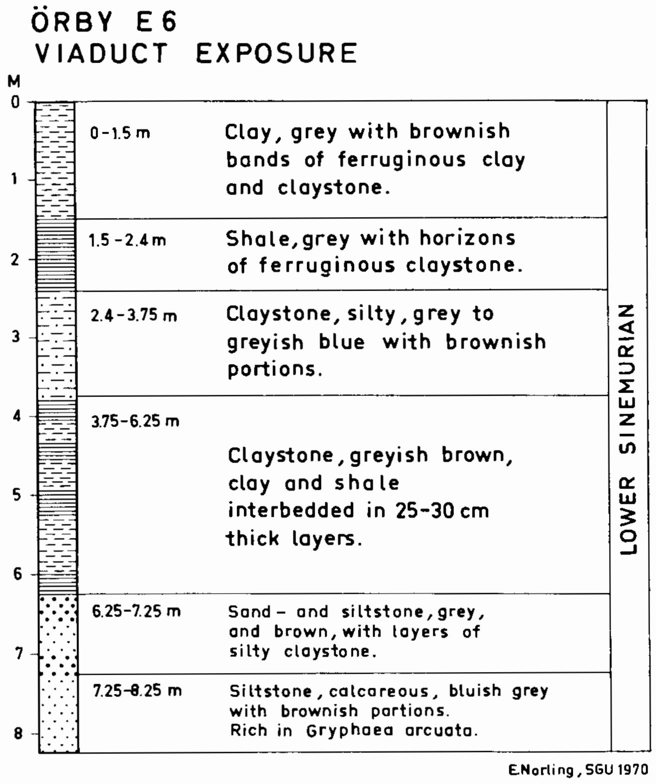


Fig. 8. Lithologic column of Örby E 6 Viaduct Exposure.

The basal beds of the Örby section, 8.25–7.25 m, containing abundant *Gryphaea arcuata*, may correspond to Troedsson's *Gryphaea* Beds correlated by him with the *Semicostatum* Zone (1951).

Gantofta Brick Pit

Figs. 1, 5; Tables 3, 5, pp. 7, 18, 19, 23.

Location: About 10 km SE. of Helsingborg centre.
UTM co-ordinates: UC 63 25 06 45.
Elevation: About 35 m a. s. l.
Thickness of outcropping strata: Not measured.
Stratigraphical range: Döshult Beds to Pankarp Beds, Sinemurian, at least from the *Semicostatum* Zone to the *Obtusum* Zone, inclusively.

The general stratigraphy of this exposure, situated about 1 800 m SE. of the Örby E 6 Viaduct Exposure, is fairly well-known to many Swedish geologists. There

CHECK-LIST OF LOWER SINEMURIAN FORAMINIFERA FROM ÖRBY E 6 VIADUCT EXPOSURE, NW SCANIA

FORMATION / SPECIES	DÖSHULT BEDS (up ← → down), meter 1–8, samples								
Geinitzinita tenera tenuistriata	—		—		—	—	—		—
Astacolus ex gr. varians	—	—	—	—	—	—	—		—
Astacolus semireticulata n.sp.	—	—	—	—					
"Dentalina" sp. A BROUWER, 1969	—	—		—	—		—		
Nodosaria dispar	—		—	—	—	—	—		
Marginulina lamellosa	—				—		—		
Nodosaria procera	—								
Nodosaria columnaris	—		—				—		
Ichthyolaria bicostata		—							
Marginularia ex gr. prima		—							
Pseudonodosaria multicostata		—		—	—				
Prodentalina terquemi		—							
Vaginulina listi		—	—	—		—	—		
Astacolus neoradiata		—							
Vaginulinopsis excarata		—							
Involutina liassica		—							
Ichthyolaria involuta			—						
Prodentalina vetusta			—						
Neobulimina sp. No. 2 BANG, 1968			—						
Ichthyolaria brizaeformis			—						
Astacolus matutina			—						
Trochammina gryci				—					
Nodosaria mitis					—				
Ichthyolaria sulcata							—		
Nodosaria metensis							—		
Mesodentalina matutina							—		
Eoguttulina liassica									—

TABLE 4.

GANTOFTA BRICK PIT NW SCANIA, S SWEDEN	SINEMURIAN — PANKARP CLAYS — DÖSHULT BEDS (← c. 12 m →)		
MACROFAUNA			
Asteroceras obtusum (SOWERBY)	—		
Promicroceras planicostum (SOWERBY)	—		
Promicroceras sp.	—		
Gryphaea arcuata LAMARCK			—
MICROFAUNA			
Astacolus semireticula nov. sp.			—
Astacolus ex gr. varians (BORNEMANN)			—
Citharina inaequistriata (TERQUEM)			—
Geinitzinita ex gr. tenera (BORNEMANN)			—
Geinitzinita tenera (BORNEMANN) ssp. tenuistriata NØRVANG			—
Ichthyolaria involuta (TERQUEM)			—
Ichthyolaria sulcata (BORNEMANN)			—
Marginulina ex gr. prima D'ORBIGNY			—
Astacolus neoradiata (NEUWEILER)			—
Mesodentalina matutina (D'ORBIGNY)			—
Nodosaria radiata (TERQUEM)			—
Nodosaria sp. No. 115, BANG			—
Prodentalina sp.			—
Trochammina gryci TAPPAN			—
Vaginulinopsis excarata (TERQUEM)			—

red clay — grey clay (shale) — siltstone

TABLE 5. Some macrofossils and foraminifera obtained from the Gantofta Brick Pit. (Ammonites according to Reyment, 1969).

is, however, very little published on it, and a comprehensive description is still missing.

Near the entrance to the quarry, in a ditch on the S. side of the road, a bed extremely rich in *Gryphaea arcuata* LAMARCK in a silty matrix, is exposed. This horizon most probably corresponds to Troedsson's *Gryphaea* Beds (1951), referred by him to the Lower Sinemurian (Lias α_3, Döshult Beds). In samples from this horizon, the present writer has found a fairly rich foraminiferal fauna, which seems to agree with the age postulated by Troedsson. Above this horizon, a sequence follows including marls, blackish and variegated clays and claystones usually referred to the Pankarp Clays *(sensu* Bölau, 1959). In dark grey shale, about 12 m above the *Gryphaea* Beds, Reyment recently found the ammonite *Asteroceras obtusum* (SOWERBY), zonal index of the bottom zone in the Upper Sinemurian (Reyment, 1969, p. 208).

The foraminiferal fauna obtained from the *Gryphaea* Beds is listed in Table 5.

The assemblage includes species ranging in age from the Late Hettangian to the Early Sinemurian, viz. *Geinitzinita tenera tenuistriata, Astacolus semireticulata,* and *Nodosaria* sp. No. 115 BANG (Nørvang, 1957; Bang in Larsen et al., 1968). Furthermore, the species *Ichthyolaria involuta* and *Trochammina gryci* have not been reported from pre-Sinemurian strata. Thus, the foraminiferal fauna obtained from the basal *Gryphaea* Beds in the Gantofta Brick Pit indicates an Early Sinemurian age. The overlaying part of the Pankarp Beds includes at least the *Obtusum* Zone, basal ammonite zone of the Upper Sinemurian (see Reyment, 1969, and Tables 2 and 5, pp. 17, 23 herein).

Katslösa Exposure

Figs. 1, 3, 5, pp. 7, 11, 18; Table 3, p. 19.

Location: About 10 km SE. of Helsingborg centre.
UTM co-ordinates: UC 62 70 06 10 – 63 30 06 20.
Elevation: About 30–35 m a. s. l.
Thickness of strata: 174.25 m (Loc. 600–1 000, Troedsson, 1951, pp. 70–71).
Stratigraphical range: Lower Sinemurian (Döshult Beds); Upper Sinemurian (rudimentary Pankarp Clays and basal part of Katslösa Beds); Lower Pliensbachian (Katslösa Beds).

A comprehensive account on the Liassic geology, lithology, stratigraphy and macropaleontology of this section, temporarily exposed in a ditch-system, was given by Troedsson (1951). The stratigraphy has also been commented on by other students, including Bölau (1959) and Reyment (1959). The present writer has previously commented on the foraminiferal fauna of this section (1966, 1968, 1970). This will not be repeated, since core material from strata corresponding to this, is treated herein. However, some data on foraminifera observed in this section will be given in the paleontological part of the present publication (p. 39).

Some few hundred metres WSW. of this locality, at the Katslösa E 6 viaduct, Liassic beds have recently been exposed, comprising ferruginous sandstones, marls and claystones. The scarce foraminiferal fauna obtained, includes i. a. *Ichthyolaria mesoliassica* (Brand), and *Brizalina liasica* (Terquem), indicating a Pliensbachian age. These beds obviously belong to the Katslösa Beds (sensu Troedsson, 1951), and may be referred to the Lower Pliensbachian.

Boring Kävlinge No. 930

Figs. 1, 2, 5; Table 3, pp. 7, 10, 18, 19.

Location: At the rivulet Kävlingeån, about 1 700 m SW. of Kävlinge church.
UTM co-ordinates: UB 80 00 83 14.
Elevation: Ground less than 5 m a. s. l.
Total depth: 176 m.
Stratigraphical range: Döshult Beds, Pankarp Clays, Katslösa Beds: Sinemurian – Lower Pliensbachian, 176–29.20 m; Pleistocene, 29.20–0 m.

This boring was drilled by the Geological Survey of Sweden (SGU) in 1951, about 200 m S. of Ågården farm on the northern side of the rivulet Kävlingeån. Below the Pleistocene cover, Lower Pliensbachian strata (Katslösa Beds) were cored in the 29.20–105 m section, mainly comprising partly ferruginous siltstones and claystones fairly rich in foraminifera. The 105–130 m section has been referred to the Pankarp Clays (Upper Sinemurian), mainly on lithological indications. The 130–176 m section ranges into the upper part of the Döshult Beds. The stratigraphy and foraminiferal fauna of this core has previously been described by the present writer (1966, 1968), and by Brotzen & Norling (1966). The fauna includes many forms of biostratigraphical importance, such as *Brizalina liasica* (Terquem), *Ichthyolaria mesoliassica* (Brand), *Astacolus denticula-carinata* (Franke), and *Marginulina spinata spinata* Terquem. Some species of this fauna are treated in the systematic part of the present publication.

Boring Kävlinge No. 928

Figs. 1, 5, pp. 7, 18; Table 3, p. 19.

Location: About 1 900 m SW. of Kävlinge church, at the rivulet Kävlingeån, some 200 m SW. of the boring Kävlinge No. 930.
UTM co-ordinates: UB 79 08 83 06.
Elevation: Ground less than 5 m a. s. l.
Total depth: 83.25 m.
Stratigraphical range: Lower Pliensbachian (Katslösa Beds), 83.25–28.75 m; Pleistocene, 28.75–0 m.

This boring was drilled in 1951 in conjunction with the Kävlinge No. 930 boring. The pre-Pleistocene sequence, 28.75–83.25 m, comprises greyish green, ferruginous, partly clayey silt and siltstone. The fairly rich foraminiferal fauna obtained in the 54–83.25 m section includes *Brizalina liasica* (Terquem), *Tristix liasina* (Berthelin), *Astacolus denticula-carinata* (Franke), and *Ichthyolaria mesoliassica* (Brand). The stratigraphy and foraminifera of this core has been treated briefly by the present writer (1966, 1968), and was also commented on by Brotzen and Norling (1966). Foraminifera from this core will be treated in the systematic part of the present publication.

The Rydebäck-Fortuna borings

In 1967–68 the Geological Survey of Sweden (SGU) was commissioned by the Government to assess the possibilities of finding oil and natural gas in Sweden. A part of these investigations concerned the Jurassic rocks. In the compass of this program, five shallow stratigraphical borings were drilled at the sea-side villages Rydebäck and Fortuna, about 10 km S. of the town of Helsingborg (Figs. 1, 5). Four of the borings, planned and stratigraphically interpreted by the present writer, penetrated a sequence, ranging in age from the Late Sinemurian to the Valanginian/Hauterivian. Data on these borings have previously been given in reports from SGU to the Ministry of Finance (Anderegg, Norling & Skoglund, 1968), and in a published preliminary report (Norling, 1970, pp. 261–287). In the present publication, the stratigraphy and foraminiferal fauna of the Jurassic part of the cores will be dealt with.

Boring Rydebäck-Fortuna No. 1

Fig. 1, p. 7; Fig. 2, p. 10; Fig. 4, p. 13; Fig. 5, p. 18; Fig. 9, p. 25; Table 3, p. 19; Table 6, p. 25; Table 7, p. 27; Table 8, p. 29.

Location: About 10 km SSE. of Helsingborg centre, at a streamlet c. 700 m SE. of Rydebäck farm.
UTM co-ordinates: UC 60 75 04 52.
Drilling: Spudded September 22, completed October 11, 1967.
Equipment: Craelius -XC.
Core diameter: 32 mm.
Total depth: 140.10 m.
Elevation: Ground c. 5 m a. s. l.
Stratigraphical range: Upper Sinemurian – Toarcian/Aalenian, 140.10–17 m; Pleistocene, 17–0 m.

UPPER SINEMURIAN

The 140.6–114.5 m section mainly comprising red-brown and greyish green clay and claystone overlaying greyish and yellowish siltstone with a coal-seam has been referred to the Upper Sinemurian. Comparing this with the sequence of the Pankarp Clays outcropping in the Gantofta Brick Pit (Table 5, p. 23), it may be safely stated that the beds cored in Rydebäck-Fortuna No. 1 are not older than the *Obtusum* Zone. The sequence in question is lithologically very characteristic and can be correlated with layers penetrated by many borings within a narrow area in NW. and W. Scania, Öresund, and N. Mecklenburg (see Norling, 1970, p. 269, and p. 9 herein).

The foraminiferal fauna hitherto observed in the upper part of the Pankarp Clays, cored by the borings Rydebäck-Fortuna Nos. 1 and 4, is rather scarce. This seems also to be true of the Upper Sinemurian fauna in N. Mecklenburg occurring in lithologically similar beds (Rusbült & Petzka, 1964). The fauna found in the Rydebäck-Fortuna borings is listed below (Table 6).

SPECIES	RF-4 142 m	RF-1 140 m	RF-1 137 m	RF-1 133 m	RF-1 127 m
Astacolus ex gr. *varians*	×				
Marginulina ex gr. *prima*	×				
Astacolus neoradiata	×				
Astacolus quadricostata	×				
Prodentalina terquemi	×				
Ichthyolaria bicostata		×			
Ichthyolaria sulcata		×			
Marginulina lamellosa		×	×		
Nodosaria metensis		×			
Citharina inaequistriata		×			
Mesodentalina matutina			×		
Mesodentalina haeusleri				×	
Trochammina gryci				×	×
Vaginulina listi				×	
Geinitzinita tenera tenera					×
Marginulina spinata spinata					×

TABLE 6. Foraminiferal fauna of the Upper Sinemurian Pankarp Clays in the Rydebäck-Fortuna cores Nos. 1 and 4.

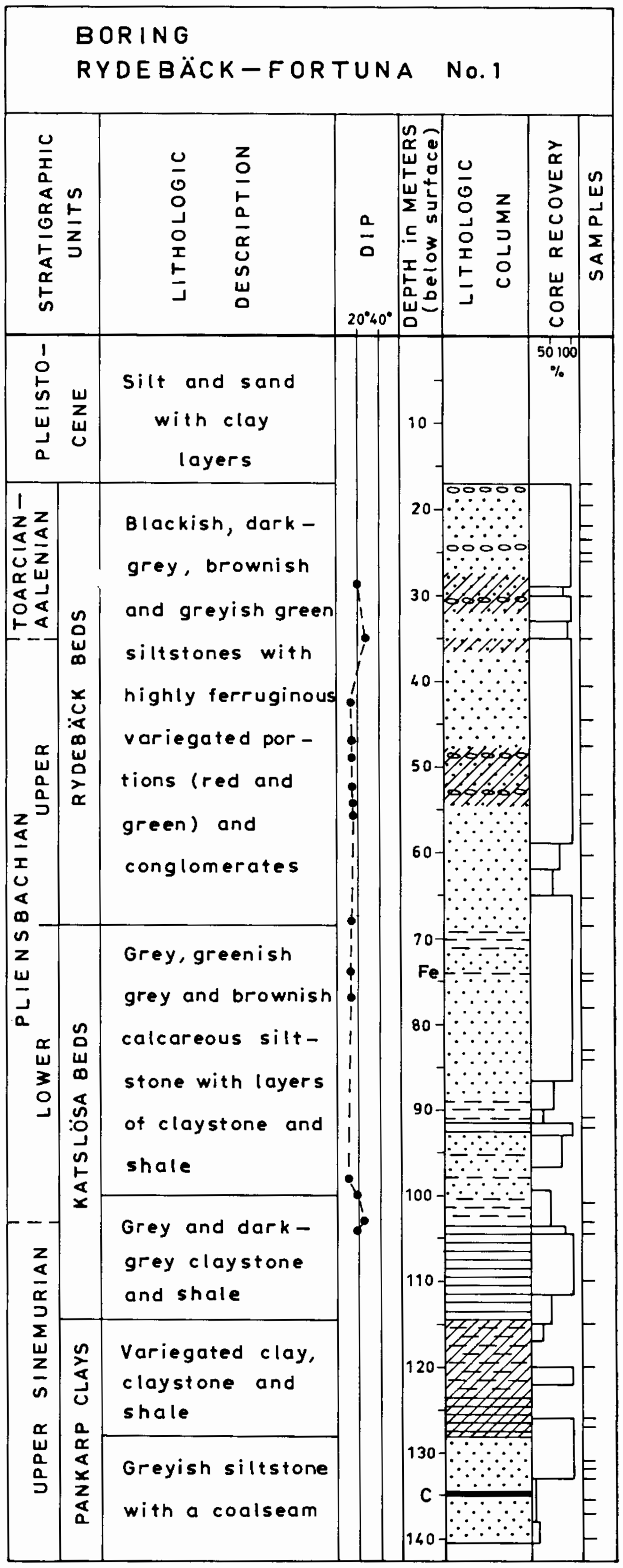


Fig. 9. Well log of the boring Rydebäck-Fortuna No. 1.

Most of the species listed in Table 6, are long-ranging. The occurrence of the Sinemurian species *Trochammina gryci* TAPPAN with the Upper Sinemurian – Carixian species *Marginulina spinata spinata* TERQUEM and *Geinitzinita tenera tenera* (BORNEMANN) is taken as an indication of Late Sinemurian age for these beds. This age is also indicated by ammonites in the Pankarp Clays (Reyment, 1969).

PLIENSBACHIAN

The 114.5–35.0 m core section, including the main part of the Katslösa Beds and the lower part of the Rydebäck Beds, has been referred to the Pliensbachian. The lowermost part of the Katslösa Beds (some few metres) probably falls within the Upper Sinemurian.

LOWER PLIENSBACHIAN

The Carixian Substage (Lias γ *sensu Germanico),* 114.5–68.5 m, mainly the Katslösa Beds, is represented by grey and greyish black claystone and shale in the lower part and grey, greyish brown and greenish grey siltstone in the upper part.

The Pliensbachian foraminiferal fauna from the Rydebäck-Fortuna cores Nos. 1 and 4 is listed in Table 7, p. 27. The check-list includes about 60 species and subspecies. Among the foraminifera found within the Katslösa Beds the following, rather short-ranging forms can be mentioned:

	European stratigraphical range:
Marginulina spinata spinata	U. Sinemurian–L. Pliensbachian
Geinitzinita tenera tenera	U. Sinemurian–Pliensbachian
Geinitzinita tenera subprismatica	U. Sinemurian–L. Pliensbachian
Geinitzinita tenera praepupa	U. Sinemurian–L. Pliensbachian
Astacolus denticula-carinata	L. Pliensbachian (mainly)
Ichthyolaria mesoliassica	Pliensbachian
Prodentalina insignis	L. Pliensbachian
Ichthyolaria frankei	Pliensbachian
Nodosaria quadrilatera	Pliensbachian
Geinitzinita tenera pupa	L. Jurassic
Saracenaria sublaevis	U. Pliensbachian

The delineation of the Carixian Substage in the Rydebäck-Fortuna cores Nos. 1 and 4 is based mainly on the foraminifera listed above. The appearance and disappearance of more long-ranging forms and the fauna of the overlaying Rydebäck Beds have also been considered in this context.

Among the ostracodes obtained in the material, Ostracode No. 13 KLINGLER may be mentioned. It was found in the uppermost part of the Katslösa Beds and in the Rydebäck Beds. In W. Europe, this ostracode seems to be restricted to the Domerian Substage.

Many Carixian foraminifera included in the check-list (Table 7) are present in material from the Katslösa Exposure (Fig. 3, p. 11) and the borings Kävlinge Nos. 928 and 930 as well.

UPPER PLIENSBACHIAN

Beds referred to the Domerian (Lias δ *sensu Germanico),* 68.5–35.0 m (in the lower part of the Rydebäck Beds), consist of greyish, partly greenish and brownish siltstones with sections of banded claystone, ferruginous claystone and conglomerates. The rich foraminiferal fauna of the lower part of the Rydebäck Beds (Table 7, p. 27) from the Rydebäck-Fortuna cores Nos. 1 and 4, includes the following rather short-ranged foraminifera which are useful in defining the Domerian Substage part of the sequence.

	European stratigraphical range:
Astacolus denticula-carinata	Carixian – L. Domerian
Lenticulina turbiniformis	Carixian – Domerian
Tristix liasina	Carixian – Toarcian
Lenticulina acutiangulata	Carixian – Oxfordian
Nodosaria quadrilatera	Carixian – Domerian
Marginulina spinata interrupta	U. Carixian – Domerian
Prodentalina insignis	U. Carixian
Saracenaria sublaevis	Domerian (mainly)
Marginulina pauluniae	Hettangian. Domerian
Reinholdella dreheri	Carixian – Domerian (rare) Toarcian – Aalenian (common)
Geinitzinita sp. No. 4 (BANG, 1968)	Domerian
Geinitzinita sp. No. 6 (BANG, 1968)	Domerian
Vaginulina spuria	U. Domerian – Toarcian
Brizalina liasica ssp. *amalthaea*	Carixian/Domerian junction
Geinitzinita tenera carinata	U. Carixian – Domerian
Lenticulina cf. *subalata*	Carixian – U. Jurassic
Vaginulina flabelloides	U. Domerian – U. Jurassic
Marginulina elongata	U. Domerian – Toarcian

The following ostracodes have been recorded from the Rydebäck Beds (lower part) in the borings Rydebäck-Fortuna Nos. 1 and 4: Ostracode No. 9 KLINGLER (Pliensbachian), ostracode No. 13 KLINGLER (Domerian), ostracode No. 14 KLINGLER (U. Sinemurian – Pliensbachian), and *Aphelocythere kuhni* TRIEBEL & KLINGLER (U. Sinemurian. Uppermost Domerian – Aalenian).

TOARCIAN – AALENIAN

The uppermost pre-Pleistocene section of the Rydebäck-Fortuna core No. 1, viz. 35–17 m, is referred to the Toarcian – Aalenian. This sequence, corresponding to the upper part of the Rydebäck Beds, mainly consists of brownish, blackish, grey and variegated siltstone with a varying content of clay. Conglomerates and ferruginous oolites occur at several levels. Lithologically,

CHECK-LIST OF PLIENSBACHIAN FORAMINIFERA, NW SCANIA, S SWEDEN

● = index foraminifer

BORING RYDEBÄCK–FORTUNA-1

	KATSLÖSA BEDS					RYDEBÄCK BEDS								
	CARIXIAN					DOMERIAN								TOARCIAN
Species	103	92	84	78	74	68.50	65.35–65.30	60.15–60.10	56.65–56.60	53.35–53.30	47.55–47.50	44.55–44.50	40.50	35
Marginulina ex gr. prima	x	x			x	x	x		x	x		x	x	
Mesodentalina matutina	x	x		x	x	x	x	x	x	x	x	x	x	
● Marginulina spinata spinata	x	x			x	x								
Geinitzinita tenera tenera	x					x								
Lenticulina polygonata	x					x								
Marginulina reversa		x			x	x		x			x		x	
Prodentalina terquemi		x	x	x	x	x								
Ichthyolaria nitida		x				x				x				
Ichthyolaria bicostata		x	x		x	x		x	x	x	x			
● Nodosaria quadrilatera		x				x				x				
Geinitzinita tenera pupa		x				x								
Astacolus quadricostata		x		x										
Cornuloculina sp.		x												
Ophthalmidium sp.		x												
Nodosaria mitis			x			x								
Vaginulina cf. listi				x			x					x	x	
● Astacolus denticula-carinata				x		x				x				
Mesodentalina haeusleri				x			x							
● Ichthyolaria mesoliassica				x										
Astacolus prima					x	x				x			x	
Pseudonodosaria ex gr. vulgata					x	x	x	x	x	x			x	
Astacolus ex gr. varians					x		x			x				
● Geinitzinita tenera carinata					x			x		x				
Palmula ex gr. obliqua					x									
● Saracenaria sublaevis						x				x		x	x	
Tristix liasina						x	x		x			x	x	
Mesodentalina tenuistriata						x			x	x	x	x	x	
Pseudonodosaria quadricostata n.sp.						x	x	x	x	x				
Lagena ex gr. globosa						x							x	
Citharina eugenii						x				x				
Astacolus neoradiata						x			x	x				
Mesodentalina cf. insignis						x	x							
Prodentalina hausmanni						x								
Prodentalina vetustissima						x								
Prodentalina gladiiformis						x								
Nodosaria dispar						x								
● Ichthyolaria frankei					x	x								
● Brizalina liassica ssp. amalthea							x			x				
● Marginulina spinata interrupta							x	x	x					
Lenticulina cf. subalata								x		x			x	
Pseudonodosaria sexcostata								x		x				
Ichthyolaria terquemi								x	x	x		x	x	
Lagena tenuicostata										x				
Ichthyolaria major												x		
Pseudonodosaria multicostata												x	x	
Marginulina pauluniae												x		
Anomalina liassica													x	
● Reinholdella dreheri													x	
Palmula deslongchampsi													x	
Citharina flabelloides													x	
Geinitzinita No. 4 BANG, 1968													x	
Geinitzinita No. 6 BANG, 1968													x	
Vaginulina spuria													x	
● Citharina clathrata														x
Marginulina lamellosa														
Ichthyolaria sulcata														
Prodentalina vetusta														
Astacolus breoni														
Geinitzinita tenera subprismatica														
Lenticulina muensteri														
Lenticulina turbiniformis														
Lenticulina acutiangulata														

BORING RYDEBÄCK–FORTUNA-4

	KATSLÖSA BEDS							RYDEBÄCK BEDS								
	CARIXIAN							DOMERIAN								
Species	124	120	117	115	112	108	107	98	96.60	92.80–91.60	90	88.50–86.90	86.0–85.40	84.0	82.0	78.30–77.0
Marginulina ex gr. prima	x				x	x	x		x	x	x	x	x	x	x	x
Mesodentalina matutina	x	x				x	x	x		x	x			x	x	
● Marginulina spinata spinata					x											
Geinitzinita tenera tenera																
Lenticulina polygonata																
Marginulina reversa							x									
Prodentalina terquemi	x		x		x	x	x	x			x		x		x	x
Ichthyolaria nitida						x	x								x	
Ichthyolaria bicostata			x	x		x					x	x	x			
● Nodosaria quadrilatera							x									
Geinitzinita tenera pupa																
Astacolus quadricostata						x	x									
Cornuloculina sp.																
Ophthalmidium sp.																
Nodosaria mitis										x						
Vaginulina cf. listi																
● Astacolus denticula-carinata						x	x				x					
Mesodentalina haeusleri					x		x									
● Ichthyolaria mesoliassica	x															
Astacolus prima																
Pseudonodosaria ex gr. vulgata				x							x			x		
Astacolus ex gr. varians	x				x	x	x					x		x	x	
● Geinitzinita tenera carinata						x	x				x				x	
Palmula ex gr. obliqua																
● Saracenaria sublaevis								x		x						x
Tristix liasina						x	x		x	x	x	x	x	x	x	x
Mesodentalina tenuistriata					x			x			x					x
Pseudonodosaria quadricostata n.sp.								x	x							
Lagena ex gr. globosa																
Citharina eugenii	x				x						x					
Astacolus neoradiata																
Mesodentalina cf. insignis																
Prodentalina hausmanni																
Prodentalina vetustissima																
Prodentalina gladiiformis																
Nodosaria dispar					x											
● Ichthyolaria frankei																
● Brizalina liassica ssp. amalthea																
● Marginulina spinata interrupta									x		x					
Lenticulina cf. subalata																
Pseudonodosaria sexcostata	x				x	x	x				x		x		x	x
Ichthyolaria terquemi				x				x					x	x	x	x
Lagena tenuicostata																
Ichthyolaria major																
Pseudonodosaria multicostata																
Marginulina pauluniae																
Anomalina liassica																
● Reinholdella dreheri																
Palmula deslongchampsi																
Citharina flabelloides																
Geinitzinita No. 4 BANG, 1968								x								
Geinitzinita No. 6 BANG, 1968																
Vaginulina spuria																
● Citharina clathrata																
Marginulina lamellosa	x					x	x									
Ichthyolaria sulcata	x															
Prodentalina vetusta						x	x								x	
Astacolus breoni							x									
Geinitzinita tenera subprismatica							x									
Lenticulina muensteri								x								
Lenticulina turbiniformis												x	x			
Lenticulina acutiangulata												x	x			

TABLE 7. Check-list of Pliensbachian foraminifera from the borings Rydebäck-Fortuna Nos. 1 and 4. Vertical figures refer to sample levels in metres below surface.

these beds fit fairly well with stratigraphically corresponding beds in the Vilhelmsfält core in the Ängelholm Basin (concerning Toarcian strata with *Dactylioceras ernsti,* see Fig. 4, p. 13 herein and Bölau, 1959).

The Toarcian – Aalenian microfauna is rather scarce compared with the Pliensbachian fauna. The check-list also includes, as far as the Rydebäck-Fortuna core No. 4 is concerned, some forms from levels which might be of basal Bajocian age. The only species of the foraminifera listed restricted to Toarcian – Aalenian strata in W. Europe, is *Citharina clathrata* (Terquem). This species is easily recognizable and a good index fossil of the uppermost Lower Jurassic in W. Europe. A striking feature of the Toarcian – Aalenian microfauna in Scania is the absence of *Geinitzinita tenera,* which is characteristic of the Lower and Middle Lias. (Table 8).

Boring Rydebäck-Fortuna No. 4

Figs. 1, 2, 4, 5, 10; Tables 3, 6, 7, 8.

Location: About 10 km SSE. of Helsingborg centre. 1 km S. of Rydebäck farm.
UTM co-ordinates: UC 60 50 03 50.
Drilling: Spudded November 11, 1967, completed January 22, 1968.
Equipment: Craelius XC.
Core diameter: 42 and 32 mm.
Total depth: 147.14 m.
Elevation: Ground 13 m a. s. l.
Stratigraphical range: Upper Sinemurian (Pankarp Clays) – Aalenian/basal Bajocian (Rydebäck Beds – Eriksdal Beds), 147.14–24 m; Pleistocene, 24–0 m.

UPPER SINEMURIAN

The interval 147.14–135 m, consisting of redbrown, green and bluish grey clay and claystone is referred to the Upper Sinemurian (Pankarp Clays). This interval corresponds to the 128–115 m interval in the Rydebäck-Fortuna core No. 1. The sequence of shale at the base of the Katslösa Beds in the core No. 1 is obviously missing in core No. 4. In this core too, the Upper Sinemurian foraminiferal fauna is scarce. The few species obtained are listed in Table 6, p. 25.

PLIENSBACHIAN

The 135–78 m section of the core has been referred to the Pliensbachian. This sequence is considerably thinner than corresponding section of the Rydebäck-Fortuna core No. 1. Apart from the basal layers of the Katslösa Beds represented in the core No. 1, parts of the Rydebäck Beds are also missing in the core No. 4. Otherwise, the two cores exhibit a close similarity from a lithological point of view.

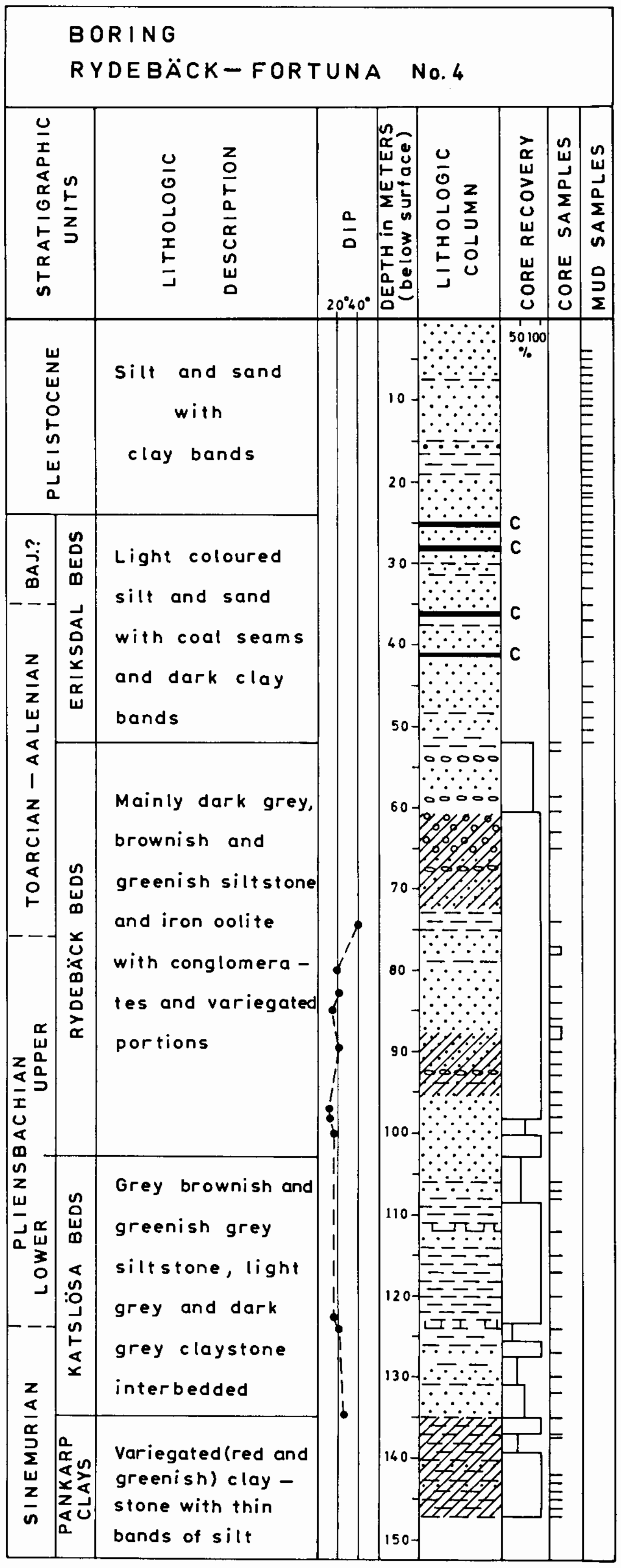


Fig. 10. Well log of the boring Rydebäck-Fortuna No. 4.

Based on the foraminiferal fauna and some ostracodes, a subdivision into a Lower Pliensbachian and an Upper Pliensbachian section has been made (Carixian, 135–103 m; Domerian, 103–76 m). The Katslösa Beds correspond largely to the Carixian and the lower part of the Rydebäck Beds to the Domerian. The foraminiferal fauna is listed in Table 7, p. 27.

TOARCIAN – AALENIAN

The 76–52 m core section, in Rydebäck-Fortuna No. 4, the upper part of the Rydebäck Beds, is referred to the Toarcian – Aalenian mainly on the occurrence of *Citharina clathrata* (TERQUEM). Other fossils characteristic of this sequence are the ostracode *Aphelocythere kuhni* TRIEBEL & KLINGLER an the small gastropod *Coelodiscus minutus* (SCHÜBLER), the latter being restricted to the uppermost Lias – basal Bajocian in NW. Germany.

The beds consist of blackish and variegated siltstones, ferruginous oolite, and conglomerates.

The Toarcian – Aalenian foraminiferal fauna from the cores Nos. 1 and 4, decreases essentially in number of species and individuals upwards in the sequence, indicating a gradual change from marine to brackish conditions and thus foreshowing continental conditions in Middle Jurassic time in Scania. The microfossils found are not sufficient to delineate the boundary between the Toarcian and the Aalenian Stages.

A check-list of Toarcian – Aalenian foraminifera is given in Table 8.

AALENIAN – BASAL BAJOCIAN

The 52–24 m section of the Rydebäck-Fortuna core No. 4 is represented by basal layers of dark grey silty clay and clayey silt overlain by grey, brownish and yellowish poorly consolidated silt and sand with thin coal-seams at about 41, 36, 28 and 25 m. This coal-bearing formation corresponds fairly well to the basal part of the Eriksdal Beds exposed in the Sand Pit of the Fyleverken company at Eriksdal in the Vomb Basin. This sequence has been referred to the Bajocian by Tralau (1968). Tralau included the Aalenian in the Middle Jurassic, whereas the present writer prefers to place this stage in the Lower Jurassic, following recommendations by the "Colloque Internationale de Jurassique" (Luxemburg, 1962 and 1967).

The scarce foraminiferal fauna found in the 52–24 m section of the boring Rydebäck-Fortuna No. 4, Eriksdal Beds, includes *Anomalina liassica, Tristix liasina, Reinholdella dreheri, R. media, Citharina clathrata, Epistomina parastelligera, Epistomina conica, Trochammina sablei,* and unidentified species of the genera *Brizalina, Citharina, Epistomina,* and *Garantella.* The *Garantella* species is closely related to but not identical with *Garantella rudia* KAPTERENKO-CHERNOUSOVA, recorded from the Bajocian of the Ukraine.

Compared with the general stratigraphical range in W. Europe, the occurrence of *Citharina clathrata* (TERQUEM) at 74 and 35 m, seems to indicate that the sequence including these levels, is not younger than the Aalenian. The occurrence of *Epistomina parastelligera* (HOFKER) and *Epistomina conica* TERQUEM at 31 m suggests that this horizon is not older than the Late Aalenian, but possibly younger.

The uppermost pre-Pleistocene sequence in the boring Rydebäck-Fortuna No. 4, 52–24 m, comprises mainly loose sediments. Since the material used for lithological description of this sequence originates from mud samples and small core recovery, there is a risk of contamination and the interpretation of the sequence might be false. The foraminifera obtained might originate from other levels than those recorded.

CHECK LIST OF TOARCIAN–AALENIAN FORAMINIFERA FROM THE RYDEBÄCK–FORTUNA BORINGS NOS. 1 and 4 NW SCANIA, S. SWEDEN	RF 1			RF 4					
	RYDEBÄCK BEDS			RYDEBÄCK BEDS	ERIKSDAL BEDS				
• = index foraminifer M	35	30	26	74	52	42	39	35	31
• Citharina clathrata	—	—		—				—	
Anomalina liassica	—				—				—
Saracenaria sp.	—	—							
Tristix liasina	—	—			—				
Ichthyolaria terquemi	—	—							
Mesodentalina tenuistriata	—	—							
• Saracenaria trigona	—	—							
Pseudonadosaria vulgata	—								
Pseudonodosaria quadricostata n.sp.	—								
Marginulina reversa	—								
Marginulina ex gr. prima	—								
Astacolus ex gr. varians	—								
Lenticulina vetusta	—								
Ichthyolaria major		—							
Pseudonodosaria sexcostata		—							
Astacolus prima		—							
Ichthyolaria nitida		—							
Palmula deslongchampsi			—						
Brizalina liasica					—				—
• Reinholdella dreheri					—		—		—
Citharina sp.								—	
• Epistomina conica								—	—
• Epistomina parastelligera									—
Garantella sp.									—
Trochammina sablei									—

TABLE 8.

Boring Rydebäck-Fortuna No. 5

Fig. 1, 5, 11; Table 9

Location: At Nytorp farm. About 11 km SSE. of Helsingborg centre.
UTM co-ordinates: UC 60 50 03 46.
Drilling: Spudded January 25, completed March 22, 1968.
Equipment: Craelius -XFH.
Core diameter: 42 and 32 mm.
Total depth: 161.25 m.
Elevation: Ground 15 m a. s. l.
Stratigraphical range: Upper Bathonian/Callovian (Fortuna Marl) – Portlandian (Vitabäck Clays), 161.25–35 m; Pleistocene, 35–0 m.

From a lithological point of view, the pre-Pleistocene sequence can be subdivided into four formations: Fortuna Marl, Fyledal Clay, Nytorp Sand, and Vitabäck Clays.

The Fortuna Marl, 161.25–135.17 m, ranges from the Upper Bathonian/Callovian boundary to the Lower Oxfordian according to the micropaleontological indications discussed below. Above a basal conglomerate with ferruginous claystone pebbles in a clayey matrix, a sequence of partly silty and ferruginous, mainly dark grey claystone follows, with thin layers of marl and limestone. The content of calcium carbonate ranges from 0 to 70 per cent, and the porosity from about 7 to 16 per cent, according to G. Nordmark, SGU (unpublished data).

The Fyledal Clay, 135–78 m, ranging in age from the Oxfordian to Kimmeridgian, mainly comprises bluish green clay and claystone, with conglomerates, brownish and greyish marls and silty claystones in the uppermost part (92–78 m). The content of calcium carbonate ranges from 0 to some few per cent within the major part of the formation. In the marly layers within the uppermost part of the core a 30–40 per cent $CaCO_3$ content is recorded. The few analyses of the total porosity have given values between 3 and 15 per cent.

The Nytorp Sand, 78–42 m, is of Kimmeridgian and/or Portlandian age. Apart from 3 m of brownish siltstone at the base, this formation is represented mainly by whitish, loose silt and sand, partly rich in coal fragments. The $CaCO_3$ content is very small, 0 to 2 per cent.

The 42–35 m core section consisting of brownish and greenish grey silty clay, represents a very small part of the Vitabäck Clays. In the Vomb Basin, this formation has a thickness of at least 70 m (Christensen, 1968). Three analyses within the section penetrated at Nytorp have given the following figures for the $CaCO_3$ content: 12 % at 40 m, 10 % at 37 m, and 7 % at 35 m.

The foraminiferal fauna was found to be fairly rich in the Fortuna Marl, including several calcareous forms of stratigraphical importance. The Fyledal Clay, as re-

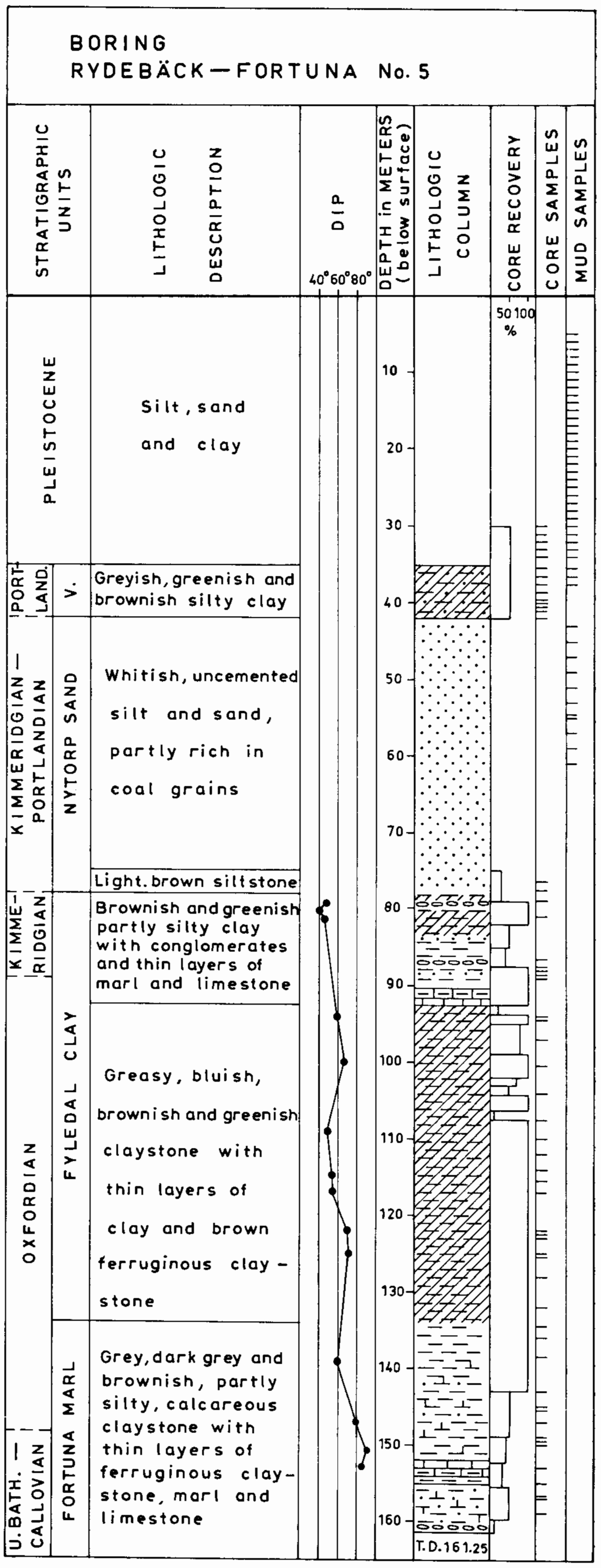


Fig. 11. Well log of the boring Rydebäck-Fortuna No. 5.

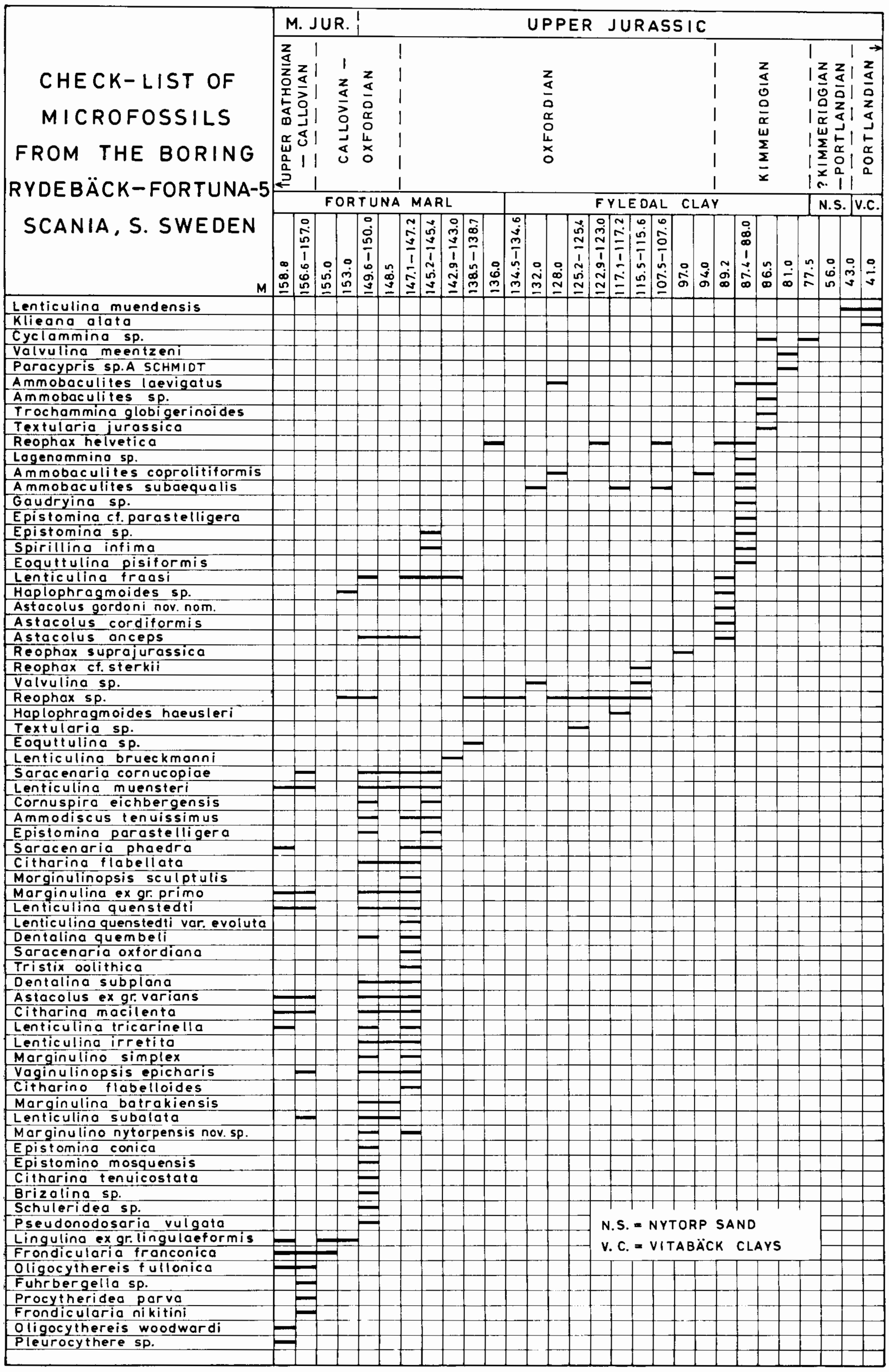


TABLE 9. The vertical figures refer to sample levels in metres below surface.

presented in the core No. 5, has yielded mainly arenaceous foraminifera, only few of them being useful in stratigraphy. Concerning the Nytorp Sand, very few foraminifera indicative of the age of this formation have been found. In the upper part of the formation, the Portlandian foraminifer *Lenticulina muendensis* MARTIN occurs. From the basal part, arenaceous foraminifera, including *Cyclammina* species (of Kimmeridgian type) are found. The scarce microfauna found within the small section of the core, which has been referred to the Vitabäck Clays, seems to support Christensen's dating, viz. the Late Portlandian.

Based on the foraminifera and to a certain degree on some ostracoda, the following stratigraphical subdivision is suggested.

The whole fauna recorded is listed in Table 9, p. 31.

UPPER BATHONIAN/CALLOVIAN

The lowermost section, 161.25–157 m of the core No. 5 is referred to the Upper Bathonian/Callovian transitional beds. Apart from some long-ranging species, the foraminiferal assemblage from the lowermost sampled level, 158.8 m, includes the following species:

	European stratigraphical range:
Frondicularia franconica GÜMBEL	U. Bathonian – L. Oxfordian
Lingulina lingulaeformis (SCHWAGER)	M. Jurassic – U. Jurassic
Lenticulina tricarinella (REUSS)	U. Bajocian – L. Kimmeridgian
Citharina macilenta TERQUEM	M. Jurassic – L. Oxfordian
Lenticulina quenstedti (GÜMBEL)	U. Toarcian – Kimmeridgian
Saracenaria phaedra TAPPAN	Callovian – Oxfordian

Two of the ostracode species, viz. *Oligocythereis fullonica* (JONES & SHERBORN) and *Oligocythereis woodwardi* SYLVESTER-BRADELY, seem to be restricted to Bathonian strata in W. Europe.

In addition to the foraminifera mentioned above, the following sample, from 157.0–156.6 m, has yielded the species:

	European stratigraphical range:
Frondicularia nikitini UHLIG	Callovian – L. Oxfordian
Vaginulinopsis epicharis LOEBLICH & TAPPAN	Callovian – Oxfordian
Saracenaria cornucopiae (SCHWAGER)	U. Bajocian – L. Kimmeridgian

Among the ostracodes, *Procytheridea parva* OERTLI may be mentioned; it is known from the Bathonian of W. Europe.

The microfauna recorded above has justified the reference of the lower part of the Fortuna Marl to the Upper Bathonian/Callovian transitional beds. Concerning the whole fauna, see Table 9, p. 31.

Though fairly rich, the microfauna found in the Fortuna Marl is not sufficient for a delineation of the stages. This is partly explained by the fact that most species of the assemblage range over more than one stage. The relatively small core recovery with the risk of contamination and the steep dip in the lower part of the formation also contribute to the difficulties in defining the boundaries.

CALLOVIAN/OXFORDIAN

The core section 156.6–148.5 m is referred to the Callovian/Oxfordian Stage. It consists mainly of dark grey and brownish, silty and ferruginous claystone with layers of marl and limestone. The following foraminifera in this section may be mentioned:

	European stratigraphical range:
Astacolus anceps (TERQUEM)	U. Bajocian – Oxfordian
Citharina flabellata (GÜMBEL)	Callovian – Oxfordian
Citharina tenuicostata LUTZE	L. Oxfordian
Cornuspira eichbergensis KÜBLER & ZWINGLI	Bathonian – Kimmeridgian
Dentalina ex gr. *guembeli* SCHWAGER	Callovian – Oxfordian
Dentalina subplana TERQUEM	Bajocian – Callovian
Epistomina conica TERQUEM	Aalenian – Callovian
Epistomina mosquensis UHLIG	Bajocian – L. Oxfordian
Lenticulina fraasi (SCHWAGER)	Callovian – Kimmeridgian
Lenticulina irretita (SCHWAGER)	Oxfordian (mainly)
Marginulina batrakiensis MYATLIUK	Callovian – Oxfordian

OXFORDIAN

To the Oxfordian Stage is referred the upper part of the Fortuna Marl (148.5–135.17 m) and the main part of the Fyledal Clay (135.17–89.2 m). In samples from the 147.2–136 m section of core No. 5 the following foraminifera have been obtained. Forms with a wide vertical distribution are excluded.

Dentalina ex gr. *guembeli* SCHWAGER	Callovian – Oxfordian
Lenticulina brueckmanni (MYATLIUK)	Oxfordian (mainly)
Lenticulina fraasi (SCHWAGER)	Callovian – Kimmeridgian
Lenticulina irretita (SCHWAGER)	Oxfordian (mainly)
Lenticulina quenstedti var *evoluta* PAALZOW	Oxfordian
Marginulinopsis sculptulis (SCHWAGER)	Oxfordian
Saracenaria oxfordiana TAPPAN	Callovian – Oxfordian
Saracenaria phaedra TAPPAN	Callovian – Oxfordian
Tristix oolithica (TERQUEM)	Bajocian – Oxfordian
Vaginulinopsis epicharis LOEBLICH & TAPPAN	Callovian – Oxfordian

Within the 135.17–89.2 m section of the Fyledal Clay, which is referred to the Oxfordian, mainly arenaceous foraminifera have been obtained, but also a few calcareous forms. The following foraminifera from this section have a rather narrow vertical range in W. Europe:

Ammobaculites subaequalis Myatliuk	Callovian – Portlandian
Astacolus anceps (Terquem)	U. Bajocian – Oxfordian
Haplophragmoides haeusleri Lloyd	Kimmeridgian
Lenticulina fraasi (Schwager)	Callovian – Kimmeridgian
Astacolus gordoni nov. nom.	Oxfordian
Reophax helvetica Haeusler	Oxfordian – Kimmeridgian
Reophax suprajurassica Haeusler	Oxfordian

The easily recognizable species *Reophax suprajurassica* (type level, *Transversarius* Zone, Oxfordian) is abundant at 97 m.

OXFORDIAN/KIMMERIDGIAN - KIMMERIDGIAN

It has not been possible to identify the Oxfordian – Kimmeridgian boundary in core No. 5 on account of the rather scarce foraminiferal fauna obtained in the upper part of the Fyledal Clay.

The sample from 89.2 m includes some species which have not been reported previously from post-Oxfordian strata in W. Europe. This seems also to be true of the fauna found at 88.0–87.4 m. In this section of the core the foraminiferal fauna includes:

	European stratigraphical range:
Eoguttulina pisiformis Gordon	Oxfordian
Gaudryina cf. *heersumensis* Lutze	Oxfordian
Ammobaculites subaequalis Myatliuk	Callovian – Portlandian
Reophax helvetica Haeusler	Oxfordian – Kimmeridgian
Ammobaculites laevigatus Lozo	Oxfordian – Kimmeridgian

Among other species, the next sample, from 86.5 m, has yielded:

Textularia jurassica (Gümbel)	Bathonian – Kimmeridgian
Trochammina globigerinoides Haeusler	Aalenian – Kimmeridgian
Ammobaculites laevigatus Lozo	Oxfordian – Kimmeridgian
Cyclammina sp.	Kimmeridgian type

The *Cyclammina* species found at 86.5 m and 77.72 m show a close affinity to forms known from the Middle Kimmeridgian, as well as to those from the "*Gigasschichten*" and "*Eimbäckhäuser Plattenkalk*", which range from the Upper Kimmeridgian to the Lower Portlandian of NW. Germany ("Leitfossilien", 1962).

A sample from 81.5 m includes *Valvulina meentzeni* Klingler, restricted to the Kimmeridgian of W. Europe (Klingler, 1955; Lloyd, 1959; "Leitfossilien", 1962), and the ostracode *Paracypris* sp. A Schmidt, ranging from the Lower Kimmeridgian to the Middle Münder Marl (Portlandian) of NW. Germany (Schmidt, 1955; "Leitfossilien", 1962).

KIMMERIDGIAN AND/OR PORTLANDIAN

The Nytorp Sand, 77.72–42 m of core No. 5, has yielded *Cyclammina* sp. (of Kimmeridgian type) in the lower part, and the Portlandian foraminifer *Lenticulina muendensis* Martin, in the upper part.

PORTLANDIAN

The only identifiable microfossils obtained in the 42–35 m section of the core, representing a small part of the Vitabäck Clays, are the foraminifer *Lenticulina muendensis* Martin, known from the Middle Münder Marl (Portlandian) of W. Germany, and the ostracode *Klieana alata* Martin, restricted to Upper Kimmeridgian – Portlandian/Berriasian (Serpulit) strata of NW. Germany (Martin, 1940, 1957; "Leitfossilien", 1962).

Foraminiferal zonation of the Swedish Jurassic

A zonation based on foraminifera is possible for the main part of the Jurassic sequence in W. Scania (Table 10, p. 37). Foraminiferal zones can be recognized in the following formations:

Helsingborg Beds, Hettangian (present in thin marine ingressional strata)

Döshult Beds, Lower Sinemurian

Pankarp Clays, Upper Sinemurian (at least in the upper part)

Katslösa Beds, Uppermost Sinemurian – Lower Pliensbachian (Carixian)

Rydebäck Beds, Upper Pliensbachian (Domerian) – Toarcian/Aalenian

Eriksdal Beds, Aalenian/Bajocian (present in thin marine ingressional strata in the basal part of the formation)

Fortuna Marl, Upper Bathonian/Callovian transitional beds – Oxfordian

Fyledal Clay, Oxfordian – Kimmeridgian

Vitabäck Clays, Portlandian (only a small part of this formation has hitherto been found in W. Scania).

Zone with *Astacolus semireticulata* nov. sp.

This Lower Liassic zone can be recognized in the marine ingressional strata of the Helsingborg Beds (mainly non-marine) and in the Döshult Beds. In the lower, incompletely known part of the zone, *Astacolus semireticulata* is accompanied by some foraminiferal species which previously have been described from the Rhaetic of Austria (p. 20), together with species known from the Lower Lias of W. Europe, as well as with some more long-ranging forms.

In the upper part of the zone, *Astacolus semireticulata* is accompanied by a great number of nodosariid, but also ceratobuliminid, buliminid, and arenaceous foraminifera. Among the short-ranging species, "*Neobulimina*" sp. No. 2 BANG and *Epistomina liassica* BARNARD may be mentioned, both species obviously restricted to the *Bucklandi* and *Semicostatum* Zones of the Lower Sinemurian of W. Europe.

Among other characteristic species the following may be mentioned: *Citharina inaequistriata* (TERQUEM), *Geinitzinita tenera* (BORNEMANN) var. *tenuistriata* NØRVANG, *Ichthyolaria brizaeformis* (BORNEMANN), *Trochammina gryci* TAPPAN, *Vaginulina listi* (BORNEMANN), and *Vaginulinopsis excarata* (TERQUEM). Among other microfossils obtained from this zone is *Procytheridea betzi* KLINGLER & NEUWEILER, an ostracode restricted to the Lower Sinemurian in NW. Germany.

The Zone with *Astacolus semireticulata* is represented in the Välluf E 6 Viaduct Exposure (p. 19), in the boring Helsingborg Kvarn No. 2220 (p. 20), in Örby E 6 Viaduct Exposure (p. 22), and in the Gantofta Brick Pit (basal Gryphaea Beds, p. 22, Table 5). The section penetrated by the core Öresund 01, and the Fredriksborg E 6 Viaduct Exposure can also be referred to this zone pp. 21, 22).

The fossil-bearing horizons within the *Astacolus semireticulata* Zone consist of calcareous siltstones, claystones, and shales.

Zone with *Marginulina spinata spinata*

Between this zone and the Zone with *Astacolus semireticulata,* another foraminiferal zone can probably be established after a more comprehensive examination of the obviously scarce foraminiferal fauna of the uppermost part of the Döshult Beds and the lowermost part of the Pankarp Clays. The beds from this part of the Scanian Sinemurian probably correspond to the *Turneri* and *Obtusum* ammonite Zones, the latter zone being established in the Gantofta Brick Pit by Reyment (1969).

The Zone with *Marginulina spinata spinata* embraces the upper part of the Pankarp Clays, and the main part of the Katslösa Beds. In terms of international stages, this zone corresponds to the Upper Sinemurian and the Lower Pliensbachian. This correlation is based on the foraminiferal fauna, as well as on the ammonites *Asteroceras obtusum* and *Polymorphites (Uptonia) jamesoni.*

In the lower part of the foraminiferal zone the fauna is rather scarce, including species such as *Citharina inaequistriata* (TERQUEM), *Vaginulina listi* (BORNEMANN), *Mesodentalina haeusleri* (SCHICK), *Astacolus neoradiata* NEUWEILER, *Trochammina gryci* TAPPAN, *Geinitzinita tenera* (BORNEMANN) var. *tenuistriata, pupoides* and *praepupa* NØRVANG. The co-occurrence of *Marginulina spinata* ssp. *spinata* TERQUEM and *Citharina inaequistriata* (TERQUEM) found i. a. in the lower part of the type section of the Kastlösa Beds (p. 11, Fig. 3) is of importance for an approximate location of the Sinemurian – Pliensbachian limit. These two foraminiferal species have therefore been chosen to characterize a narrow foraminiferal subzone including the uppermost Pankarp Clays and the lowermost Katslösa Beds in W. Scania.

In the upper part of the Zone with *Marginulina spinata spinata,* the foraminiferal fauna becomes richer, including many mainly Lower Pliensbachian foraminifera apart from more long-ranging forms. One of the most characteristic species within the upper part of the zone is *Astacolus denticula-carinata* (FRANKE), a species occurring also in the lowermost Upper Pliensbachian. Besides, species such as *Ichthyolaria mesoliassica* (BRAND), *Ichthyolaria frankei* (BRAND), *Prodentalina insignis* (FRANKE), *Geinitzinita tenera* (BORNEMANN) var. *subprismatica* and *pupa, Marginulina prima* D'ORBIGNY ssp. *rugosa* BORNEMANN, and *Astacolus quadricostata* (TERQUEM) are typical.

According to the ammonite finds at Gantofta Brick Pit and the Katslösa Exposure (Troedsson, 1951; Reyment, 1959, 1969), the *Marginulina spinata spinata* Zone corresponds to a Lower Liassic interval including at least the *Obtusum* and *Jamesoni* Zones and probably still younger Lower Pliensbachian ammonite zones.

The Zone with *Marginulina spinata spinata* is represented in the Katslösa Exposure, the Rydebäck-Fortuna cores Nos. 1 and 4, and Kävlinge Nos. 928 and 930.

The main part of the Katslösa Beds is characterized by the co-occurrence of *Astacolus denticula-carinata* and *Marginulina spinata spinata,* a pair of foraminiferal species, which have been chosen as subzonal denominators. This subzone roughly corresponds to the Carixian Substage.

The sequence embraced by the Zone with *Marginulina spinata spinata* includes variegated clays and claystones, calcareous, mainly dark claystone and shale, and also light coloured calcareous siltstone.

Zone with *Saracenaria sublaevis*

This zone mainly embraces the lower part of the Rydebäck Beds, as this formation is represented in the Rydebäck-Fortuna cores Nos. 1 and 4. The foraminiferal fauna of the zone is fairly rich, especially in its lower part, including some species indicating a Late Pliensbachian age.

In the basal part of the zone, a very short-ranging subspecies of *Brizalina liasica* (TERQUEM), has been found, spanning the Carixian – Domerian limit in W. Europe, viz. *Brizalina liasica* (TERQUEM) ssp. *amalthea* BRAND. This foraminifer is chosen as subzonal denominator. The whole Zone with *Saracenaria sublaevis* is characterized by a foraminiferal assemblage including *Marginulina spinata interrupta* TERQUEM, *Geinitzinita tenera* (BORNEMANN) var. *carinata* NØRVANG, *Geinitzinita* sp. No. 4 (BANG), *Geinitzinita* sp. No. 6 (BANG), *Tristix liasina* (BERTHELIN), *Ichthyolaria terquemi* (D'ORBIGNY), *Ichthyolaria major* (BORNEMANN), *Marginulina prima prima* D'ORBIGNY, *Lenticulina turbiniformis* (TERQUEM), *Lenticulina acutiangulata* (TERQUEM), and *Vaginulina spuria* (TERQUEM & BERTHELIN).

The zone is represented in the Rydebäck-Fortuna cores Nos. 1 and 4 only.

Among other microfossils representative of this zone may be mentioned the ostracodes Nos. 9, 13 and 14 KLINGLER, and, in the uppermost part of the zone, *Aphelocythere kuhni* TRIEBEL & KLINGLER.

The rocks are characterized by mainly grey, partly greenish and reddish brown, calcareous siltstone with intervals of banded claystone, ferruginous claystone and conglomerates.

Zone with *Citharina clathrata*

This zone embraces the upper part of the Rydebäck Beds and the lower part of the Eriksdal Beds, as these formations are represented in the Rydebäck-Fortuna cores. Compared with the previous zones, the foraminiferal fauna of the *Citharina clathrata* Zone is rather scarce. Apart from the zonal denominator, *Anomalina liassica* ISSLER, *Tristix liasina* (BERTHELIN), *Ichthyolaria terquemi* (BORNEMANN), *Saracenaria trigona* (TERQUEM), *Marginulina reversa* (BLAKE), *Lenticulina vetusta* (D'ORBIGNY), and *Palmula deslongchampsi* (TERQUEM), are characteristic representatives of the foraminiferal fauna of this zone.

The Zone with *Citharina clathrata* is represented in the Rydebäck-Fortuna cores Nos. 1 and 4. It consists mainly of dark, partly variegated siltstones with a varying content of clay, ferruginous oolite and conglomerates in the lower part, and partly clayey, mainly light, unconsolidated silt and sand in the upper part.

Zone with *Epistomina parastelligera* and *Reinholdella dreheri*

This zone is represented in the boring Rydebäck-Fortuna No. 4 only, including marine ingressional strata of the Eriksdal Beds. The foraminiferal fauna of the zone is very scarce as far as the number of species is concerned. However, species of considerable biostratigraphical importance are present. The co-occurrence of *Reinholdella dreheri* (BARTENSTEIN) (fairly common at some levels), *Epistomina parastelligera* (HOFKER), and *Epistomina conica* TERQUEM seems to indicate a Late Aalenian or Early Bajocian age of the beds containing these foraminifera. The same levels containing the above mentioned species, have also yielded *Anomalina liassica* ISSLER, *Reinholdella media* (KAPT.-CHERN.), *Brizalina liasica* (TERQUEM), *Trochammina sablei* TAPPAN, and a *Garantella* species closely related to *Garantella rudia* KAPTERENKO-CHERNOUSOVA, which is recorded from the Bajocian of the Ukraine.

Zone with *Saracenaria phaedra* and *Saracenaria oxfordiana*

Between the Zone with *Epistomina parastelligera* and *Reinholdella dreheri*, including thin marine ingressional strata of the basal part of the Eriksdal Beds, and the Zone with *Saracenaria phaedra* and *Saracenaria oxfordiana*, a non-marine sequence occurs in the Swedish Jurassic, embracing the main part of the Eriksdal Beds and the Glass Sand. It has been referred to the Bajocian and the Bathonian by Tralau (1968) on the basis of the microflora.

The Zone with *Saracenaria phaedra* and *S. oxfordiana* comprises the lower half of the Fortuna Marl spanning the Middle/Upper Jurassic boundary. Calcareous foraminifera are abundant both specifically and individually in this zone. The dominating species throughout the zone are *Lenticulina muensteri* (ROEMER) and *Lenticulina quenstedti* (GÜMBEL). Other species, characteristic of the whole zone are *Saracenaria cornucopie* (SCHWAGER), *Marginulina prima* D'OR-

BIGNY *fortunensis* nov. ssp., *Citharina macilenta* (TERQUEM), *Lenticulina tricarinella* (REUSS), and *Vaginulinopsis epicharis* LOEBLICH & TAPPAN. Restricted to the lowermost part of the zone are *Frondicularia nikitini* UHLIG, *Frondicularia* ex gr. *franconica* GÜMBEL, and *Lingulina* ex gr. *lingulaeformis* (SCHWAGER). The lowermost part of the Zone with *Saracenaria phaedra* and *S. oxfordiana* has yielded ostracodes, including *Oligocythereis woodwardi* SYLVESTER-BRADELY, *Oligocythereis fullonica* (JONES & SHERBORN), *Procytheridea parva* OERTLI, and unidentified species of the genera *Fuhrbergella* and *Pleurocythere.*

The central part of the zone is characterized by the occurrence of *epistominids,* including *Epistomina conica* TERQUEM, *E. parastelligera* (HOFKER), and *E.* cf. *mosquensis* UHLIG.

From the central part of the zone and upwards occur also *Marginulina batrakiensis* (MYATLIUK), *Citharina tenuicostata* LUTZE, *Lenticulina irretita* (SCHWAGER), *Dentalina* ex gr. *guembeli* SCHWAGER, *Lenticulina quenstedti* (GÜMBEL) var. *evoluta* PAALZOW, *Lenticulina fraasi* (SCHWAGER), and several other species.

The Zone with *Saracenaria phaedra* and *S. oxfordiana* is represented in the Rydebäck-Fortuna core No. 5 only. It consists mainly of calcareous, silty, partly ferruginous claystone, with bands of marl and limestone. This zone ranges from the Bathonian/Callovian boundary to the Lower Oxfordian.

Zone with *Reophax suprajurassica*

This zone includes the upper part of the Fortuna Marl and the main part of the Fyledal Clay. It is represented in the Rydebäck-Fortuna core No. 5.

The zone is characterized by predominance of arenaceous foraminifera including especially representatives of the genera *Ammobaculites, Haplophragmoides, Reophax,* and *Textularia.* Apart from the arenaceous foraminifera, a scarce calcareous fauna is present, represented by *Lenticulina brueckmanni* (MYATLIUK), *Astacolus anceps* (TERQUEM), *Lenticulina fraasi* (SCHWAGER), and rare *epistominids,* mainly restricted to the lower part of the zone. The zonal denominator, *Reophax suprajurassica* HAEUSLER, is abundant at some levels.

The lithology of the sequence embraced by this zone is mainly variegated clay and claystone (greenish – bluish) with intervals of brownish ferruginous claystone, and some silty layers.

The Zone with *Reophax suprajurassica* falls within the Oxfordian, according to the European range of its foraminiferal assemblage.

Zone with *Valvulina meentzeni*

This zone embraces the uppermost part of the Fyledal Clay, as this formation is represented in the Rydebäck--Fortuna core No. 5.

The rather scarce foraminiferal fauna of the zone includes both calcareous and arenaceous forms. Among the calcareous foraminifera may be mentioned *Astacolus anceps* (TERQUEM), *Astacolus cordiformis* (TERQUEM), *Lenticulina fraasi* (SCHWAGER), *Astacolus gordoni* nov. nom., *Eoguttulina pisiformis* GORDON, and scattered *epistominids,* in addition to the zonal denominator, *Valvulina meentzeni* KLINGLER. The group of arenaceous foraminifera is represented by *Ammobaculites subaequalis* MYATLIUK, *Ammobaculites coprolithiformis* (SCHWAGER), *Reophax helvetica* HAEUSLER, *Ammobaculites laevigatus* LOZO, and *Textularia jurassica* GÜMBEL.

The sequence embraced by this zone, viz. the upper part of the Fyledal Clay, 89.2–77.72 m of the Rydebäck-Fortuna core No. 5, is referred to the Kimmeridgian.

Above the Fyledal Clay in core No. 5, a sequence of unconsolidated sand and silt follows, the Nytorp Sand, which has yielded few microfossils of stratigraphical bearing. This formation falls within the Kimmeridgian and/or the Portlandian.

Zone with *Lenticulina muendensis*

Lenticulina muendensis MARTIN, known from the Middle Münder Marl (Portlandian) of W. Germany, is chosen as denominator of the uppermost foraminiferal zone of the Jurassic in W. Scania (found in the Rydebäck-Fortuna cores Nos. 2 and 5). However, the uppermost Jurassic in this part of Scania is insufficiently known. A very small part of the sequence referable to the Vitabäck Clays (Portlandian), has been penetrated by drilling in W. Scania.

The previous experience of the Upper Jurassic – Lower Cretaceous microfauna in S. Sweden and in many other European regions as well, has clearly demonstrated that ostracodes are more useful than foraminifera in a zonation of the Kimmeridgian, Portlandian and the basal Lower Cretaceous (see Christensen, 1968; Christensen & Kilenyi, 1970).

SERIES		STAGE	FORMATION	FORAMINIFERAL ZONES & SUBZONES	REMARKS
UPPER JURASSIC		PORTLANDIAN	VITABÄCK CLAYS	Zone with Lenticulina muendensis	Only uppermost and lowermost parts penetrated by borings
UPPER JURASSIC		KIMMERIDGIAN	NYTORP SAND	No foraminiferal evidence	Basal beds with Cyclammina sp. and Paracypris sp.A SCHMIDT
UPPER JURASSIC		OXFORDIAN	FYLEDAL CLAY	Zone with Valvulina meentzeni; Zone with Reophax suprajurassica	Mainly arenaceous foraminifera; Haplophragmoides haeusleri, Textularia jurassica, Reophax sterkii
MIDDLE JURASSIC		CALLOVIAN	FORTUNA MARL	Zone with Saracenaria phaedra & oxfordiana	Rich fauna with Frondicularia nikitini, F. franconica, Citharina macilenta, Lenticulina tricarinella
MIDDLE JURASSIC		BATHONIAN	GLASS SAND	No foraminifera	Insufficiently known in western Scania. Found in wire line borings at Härslöv and Kävlinge
MIDDLE JURASSIC		BAJOCIAN	ERIKSDAL BEDS	Zone with Epistomina parastelligera and Reinholdella dreheri	Coal bearing beds with marine ingressions
LOWER JURASSIC		AALENIAN	RYDEBÄCK BEDS	Zone with Citharina clathrata	Poor fauna with a.o. Reinholdella dreheri and Saracenaria trigona
LOWER JURASSIC	ζ ε	TOARCIAN	RYDEBÄCK BEDS	Zone with Citharina clathrata	
LOWER JURASSIC	δ	PLIENSBACHIAN U	RYDEBÄCK BEDS	Zone with Saracenaria sublaevis; Subzone with Brizalina liassica amalthea	Geinitzinita tenera carinata and Marginulina spinata interrupta
LOWER JURASSIC	γ	PLIENSBACHIAN L	KATSLÖSA BEDS	Zone with Marginulina spinata spinata; Subzone with Astacolus denticula-carinata together with Marginulina spinata spinata	Ichthyolaria mesoliassica and I. frankei; Polymorphites cf. jamesoni (Troedsson, 1951)
LOWER JURASSIC	β	SINEMURIAN U	KATSLÖSA BEDS / PANKARP CLAYS	Zone with Marginulina spinata spinata; Subzone with Citharina inaequistriata together with Marginulina spinata spinata; Insufficiently known foraminiferal fauna	Ammonite evidence of the Obtusum Zone in Gantofta Brick Pit and Katslösa Exp. (Reyment, 1969)
LOWER JURASSIC	α3	SINEMURIAN L	PANKARP CLAYS / DÖSHULT BEDS	Zone with Astacolus semireticulata; Subzone with Epistomina liassica & Neobulimina sp. 2	Rich fauna of calcareous foraminifera. Finds of Procytheridea betzi
LOWER JURASSIC	α2	HETTANGIAN	HELSINGBORG BEDS	Zone with Astacolus semireticulata	Non-marine beds with marine ingressions. Foraminifera described from the Rhaetic (redeposited?)
LOWER JURASSIC	α1	HETTANGIAN	HELSINGBORG BEDS	No foraminiferal evidence	Beds with Liostrea hisingeri
TRIAS		RHAETIC	COAL MEASURES • VALLÅKRA BEDS	No foraminiferal evidence	Beds with Lepidopteris flora and Rhaetavicula contorta

TABLE 10. The correlation of Scanian lithostratigraphical units and foraminiferal zones with the international stages of the Jurassic.

Characteristics of the Jurassic foraminiferal fauna of W. Scania

More than 150 species of foraminifera have been observed in the Jurassic of W. Scania. They belong to 43 genera, 21 of which are placed in the superfamily *Nodosariacea* EHRENBERG, 1838. Twelve genera belong to other taxa of calcareous foraminifera, viz. *Endothyracea, Miliolacea, Buliminacea, Spirillinacea, Cassidulinacea,* and *Robertinacea.* The remaining ten genera are arenaceous foraminifera.

The most striking feature of the foraminiferal fauna of the Jurassic in W. Scania is the great dominance of nodosariid species, almost global characteristics of the Jurassic. In the Lower Jurassic of Scania, more than 80 per cent of the species belong to the *Nodosariacea.* In the Middle and Upper Jurassic, the number of nodosariid species decreases to about 50 per cent, most species being restricted to the Fortuna Marl spanning the Middle Jurassic – Upper Jurassic boundary.

The only lithostratigraphical units of the west Scanian Jurassic, where nodosariid foraminifera play a subordinate role, are the Eriksdal Beds at the base of the Middle Jurassic, and the Upper Jurassic Fyledal Clay. In the Eriksdal Beds, of which only the basal part was penetrated by one boring, viz. Rydebäck-Fortuna No. 4, species of the genera *Trochammina, Brizalina, Anomalina, Epistomina, Garantella,* and *Reinholdella* have been found, accompanied by two nodosariid species only, viz. *Citharina clathrata* and *Tristix liasina.*

In the Fyledal Clay, referred to the Oxfordian and Kimmeridgian Stages, the foraminiferal fauna is strongly dominated by arenaceous species (more than 70 per cent).

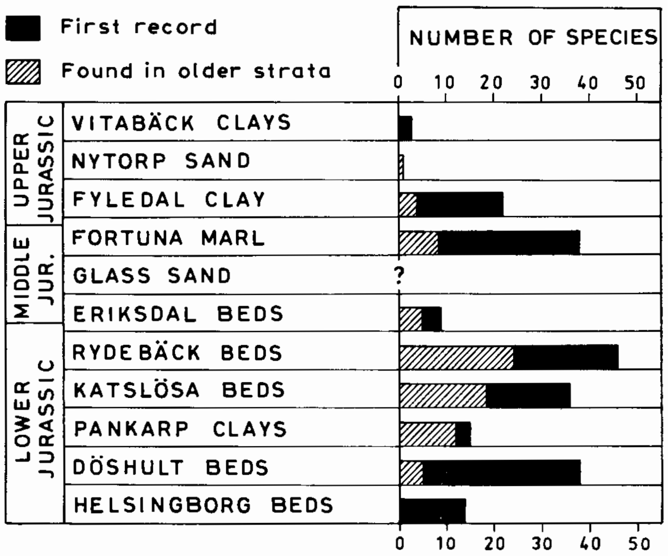


TABLE 11. Frequency distribution of foraminiferal species in west Scanian Jurassic strata. The distribution suggests major faunal changes particularly in the Early Sinemurian (Döshult Beds fauna), the Late Middle Jurassic (Fortuna Marl fauna), and in the Oxfordian (Fyledal Clay fauna).

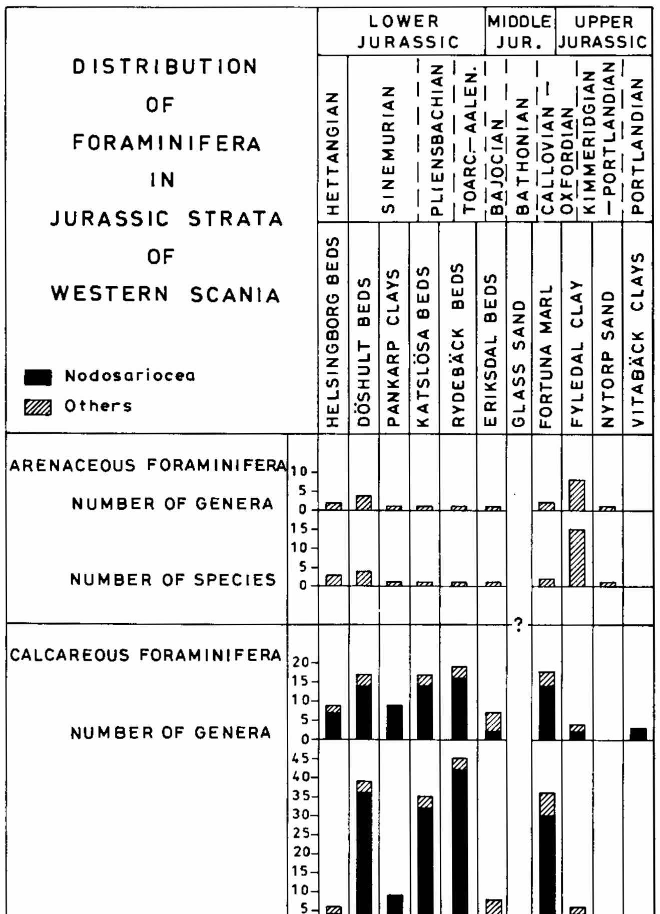


TABLE 12.

SYSTEMATIC PART

Notes on the classification

In the present work, the classification by Loeblich & Tappan (1964) is followed with some modifications.

For some time, the genus *Ichthyolaria* WEDEKIND, 1937, was regarded as a subjective synonym of the genus *Frondicularia* DEFRANCE, 1826. However, after a revisional treatment of Permian and Liassic foraminifera previously referred to *Frondicularia,* Sellier De Civrieux & Dessauvagie (1965) accepted the genus *Ichthyolaria* erected by Wedekind. After a study of material from the Lower Lias of Scania, the present writer was inclined to support Sellier De Civrieux & Dessauvagie in their rehabilitation of Wedekind's genus *Ichthyolaria,* but proposed a new diagnosis (Norling, 1966).

Certain features in the wall structure of Liassic foraminifera previously referred to the genus *Dentalina* RISSO, 1826, permitted the present writer to subdivide this genus into the genera *Dentalina* sensu stricto, *Prodentalina* NORLING, 1968, and *Mesodentalina* NORLING, 1968 (see Norling, 1968, pp. 33–42, Text-Figs. 8 a–d, 9 a_1–c_2, 10 a–f; Pls. 3, 4, 7, 8, 9; Tables 3, 4; and pp. 62, 80–82, Figs. 30, 31 herein).

The linguline genus *Geinitzinita* SELLIER DE CIVRIEUX & DESSAUVAGIE 1965, applied to some Early Mesozoic foraminifera previously referred to genus *Lingulina* D'ORBIGNY, 1826, has been adopted in the present publication.

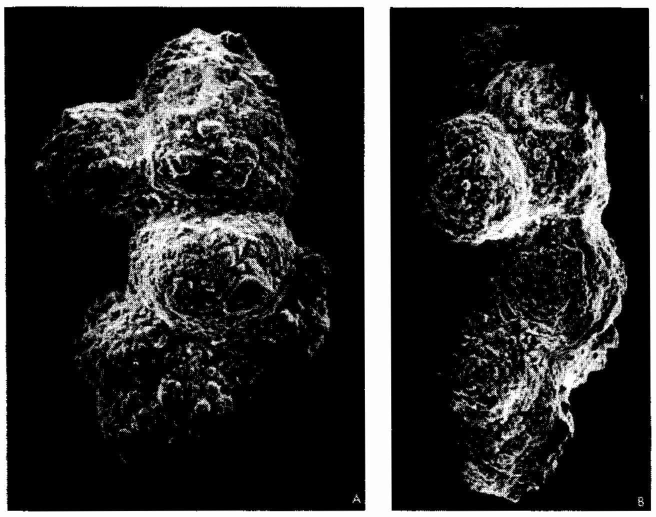


Fig. 12 A–B. *Sorosphaera scanica* nov. sp. Specimen EN SEM 125:1, boring Rydebäck-Fortuna No. 5, 97 m, Fyledal Clay, Oxfordian, Upper Jurassic. 72 X.

Order FORAMINIFERIDA EICHWALD 1830

Suborder TEXTULARIINA DELAGE & HÉROUARD, 1896

Superfamily *AMMODISCACEA* REUSS, 1862

Family *SACCAMMINIDAE* BRADY, 1884

Subfamily *PSAMMOSPHAERINAE* HAECKEL, 1894

Genus *Sorosphaera* BRADY, 1879

DIAGNOSIS. – Test free, consisting of variously arranged globular chambers with no apparent order of development; wall agglutinated of rather coarse grains and loosely cemented so that the tests are easily broken; no distinct aperture apparent, communications of protoplasm with exterior probably between loosely cemented grains (Loeblich & Tappan, 1964).

TYPE SPECIES. – *Sorosphaera confusa* BRADY, by original designation.

REMARKS. – *Sorosphaera* differs from *Psammosphaera* in consisting of numerous loosely jointed chambers. The type specimen of *S. confusa* in the British Museum (Nat. Hist.) has disintegrated since its original description probably owing to its extremely fragile nature (Loeblich & Tappan, 1964, p. C 196).

DISTRIBUTION. – Silurian – Recent.

Sorosphaera scanica nov. sp.

Fig. 12 A–B.

HOLOTYPE. – Specimen EN SEM 125:1 (Fig. 12 A–B).

TYPE STRATUM AND TYPE LOCALITY. – In beds corresponding to the Fyledal Clay, Oxfordian, Upper Jurassic. Boring Rydebäck-Fortuna No. 5, 97 m below the surface, at Nytorp farm, near the village of Fortuna, W. Scania.

DIAGNOSIS. – As for the genus.

DESCRIPTION. – Test composed of numerous globular chambers, variously arranged with no apparent order of development. Test-wall agglutinated with rather coarse, non-equidimensional grains in a brownish, calcareous matrix. Test easily broken, usually along chamber sutures. No distinct aperture apparent.

DIMENSIONS. – Holotype: length, 0.8 mm; breadth, 0.30–0.45 mm. The globular chambers vary considerably in size. In ten measured specimens, the chamber diameter has a range of 0.20–0.50 mm.

MATERIAL. – About 100 specimens from the boring Rydebäck-Fortuna No. 5, 92–97 m, Fyledal Clay, Oxfordian, Upper Jurassic.

REMARKS. – Very few complete specimens have been obtained. Usually the species is represented by pieces composed of 1–3 chambers.

DISTRIBUTION. – Found only in Oxfordian strata (Fyledal Clay) of the Rydebäck-Fortuna core No. 5 (92–97 m).

Subfamily *SACCAMMINIAE* BRADY, 1884

Genus *Lagenammina* RHUMBLER, 1911

DIAGNOSIS. – Test is a single flask-shaped chamber; wall with pseudochitinous inner layer, densily covered with agglutinated material; aperture terminal, produced on a neck.

TYPE SPECIES. – *Lagenammina laguncula* RHUMBLER, 1911, by original designation.

REMARKS. – Flask-shaped, monothalamous foraminifera have frequently been referred to the genus *Proteonina* WILLIAMSON, 1858. In proposing this genus, Williamson erected two species, *P. fusiformis* and *P. pseudospiralis*, but no type species was designated. Rhumbler (1904) designated *P. fusiformis* as the type species because it was the first species given by Williamson. Brady (1884) did not accept the genus *Proteonina* and regarded *P. fusiformis* as a *Reophax* and *P. pseudospiralis* as a *Haplophragmium*. Loeblich & Tappan (1955, 1964) reexamined Williamson's original material and found *Proteonina* to be polythalamous and uniserial and regarded it to be a junior synonym of the genus *Reophax* DE MONTFORT.

As pointed out by Gordon (1965), monothalamous, flask-shaped foraminifera, previously referred to the genus *Proteonina* are now best placed in the genus *Lagenammina*. Rhumbler (1911) differentiated this genus from *Proteonina* on the basis of its pseudochitinous, rather than chitinous inner lining of the agglutinated test-wall. Such a distinction would be difficult to make in fossil material.

DISTRIBUTION. – Silurian to Recent.

Lagenammina ex gr. difflugiformis (BRADV, 1879)

Fig. 13 A.

1879 *Reophax difflugiformis* BRADY. – p. 51, Pl. 4, Fig. 3 a, b.
1880 *Haplophragmium lagenarium* BERTHELIN. – p. 21, Pl. 1, Fig. 2.
1886 *Reophax difflugiformis* BRADY. – Haeusler, p. 9, Pl. 1, Fig. 1.
1890 *Reophax difflugiformis* BRADY. – Haeusler, p. 26, Pl. 3, Figs. 1–3; Pl. 5, Figs. 25–27.
1904 *Proteonina difflugiformis* (BRADY). – Rhumbler, p. 245, Text-Fig. 80.
1917 *Proteonina difflugiformis* (BRADY). – Paalzow, p. 15.
1937 *Proteonina difflugiformis* (BRADY). – Bartenstein & Brand, p. 128, Pl. 1 A, Fig. 1; Pl. 1 B, Figs. 1, 2; Pl. 2 A, Fig. 1; Pl. 2 B, Fig. 3; Pl. 3, Fig. 1; Pl. 4, Fig. 1; Pl. 5, Fig. 1; Pl. 8, Fig. 1 a–d; Pl. 10, Fig. 1 a–c; Pl. 11 A, Fig. 1 a–c.
1959 *Proteonina difflugiformis* (BRADY). – Lloyd, p. 305, Pl. 54, Figs. 1–4.
1961 *Reophax difflugiformis* BRADY. – Pietrzenuk, p. 51, Pl. 9, Fig. 1.
1965 *Lagenammina difflugiformis* (BRADY). – Gordon, p. 832, Text-Fig. 3 (8–11).
1967 *Lagenammina difflugiformis* (BRADY). – Gordon, p. 448, Pl. 1, Fig. 13.

MATERIAL. – Some few specimens from the Lower Lias of W. Scania. The specimen in Fig. 13 A is from the Örby E 6 Viaduct Exposure, Döshult Beds, Lower Sinemurian.

REMARKS. – *Lagenammina difflugiformis* was originally described by Brady (1879) from the North Atlantic and the South Pacific. The synonymy above includes forms obtained from various parts of the Jurassic. It has not been possible to differentiate these fossil forms from Brady's Recent type material. There is nothing to add to the previous descriptions of *Lagenammina difflugiformis*.

DISTRIBUTION. – Forms fitting the description of the Recent species *Lagenammina difflugiformis* have been recorded from the Late Paleozoic, the Mesozoic and the Caenozoic also.

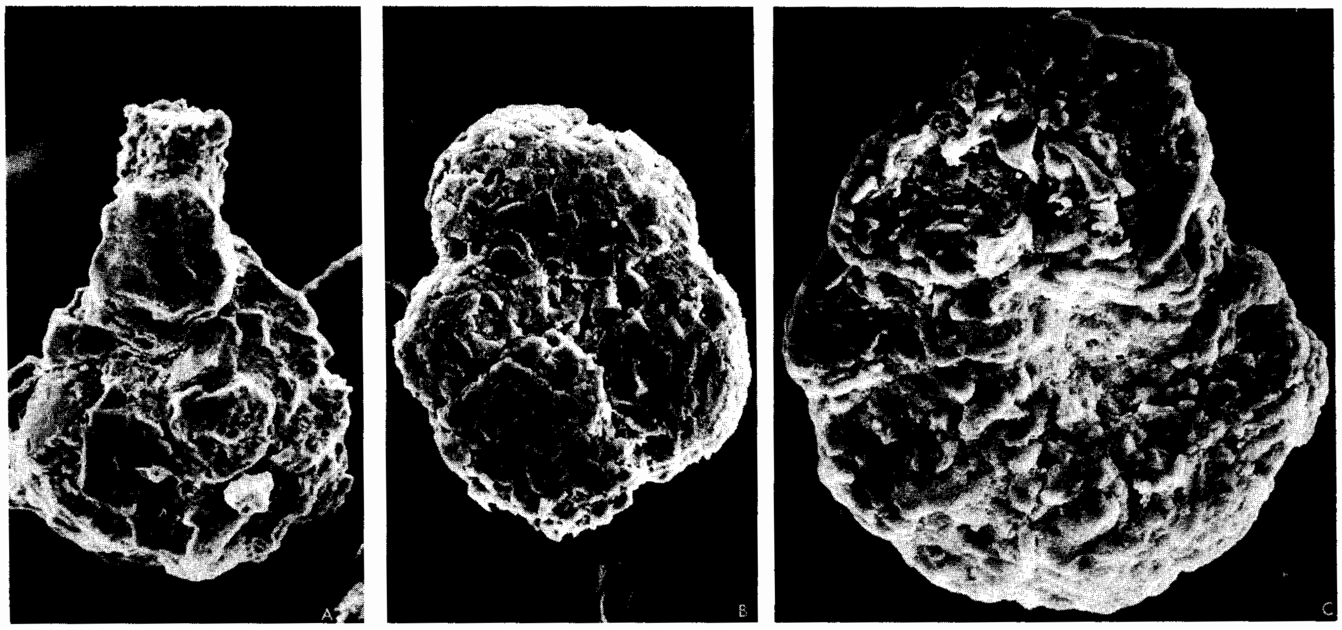


Fig. 13.
A. *Lagenammina* ex gr. *difflugiformis* (BRADY, 1879). Side view of specimen EN SEM 100:9, Örby E 6 Viaduct Exposure, Sample No. 9, Döshult Beds, Lower Sinemurian. 125 X.
B. *Haplophragmoides kingakensis* TAPPAN, 1955. Side view of specimen EN SEM 99:6, boring Kävlinge No. 928, 30 m, Katslösa Beds, Pliensbachian, Lower Jurassic. 205 X.
C. *Haplophragmoides* cf. *canui* CUSHMAN, 1930. Side view of specimen EN SEM 100:7, Örby E 6 Viaduct Exposure, sample No. 9, Döshult Beds, Lower Sinemurian, Lower Jurassic. Note the radial sutures and the excavated umbilical area. 260 X.

Superfamily *LITUOLACEA* DE BLAINVILLE, 1825

Family *HORMOSINIDAE* HAECKEL, 1894

Subfamily *HORMOSININAE* HAECKEL, 1894

Genus *Reophax* DE MONTFORT, 1808

DIAGNOSIS. – Test free, elongate, nearly straight or arcuate; chambers usually few, increasing in size as added; sutures nearly horizontal, obscure to moderately constricted; wall agglutinated with comparatively little cement, surface rough; aperture terminal, rounded.

TYPE SPECIES. – *Reophax scorpiurus* DE MONTFORT, 1808, by original designation.

SPECIES FROM THE SWEDISH JURASSIC. – *Reophax eominutus* KRISTAN-TOLLMAN, 1964, *Reophax helvetica* (HAEUSLER, 1881), *Reophax horridus* (SCHWAGER, 1865), *Reophax sterkii* HAEUSLER, 1890, *Reophax suprajurassica* HAEUSLER, 1890.

DISTRIBUTION. – Carboniferous – Recent.

Reophax helvetica (HAEUSLER, 1881)

Fig. 14 A–B.

1881 *Dentalina helvetica* HAEUSLER. – p. 34, Pl. 2, Fig. 45 (type).
1883 *Reophax helvetica* (HAEUSLER). – p. 27, Pl. 2, Figs. 8–10.
1890 *Reophax helvetica* (HAEUSLER). – p. 28, Pl. 3, Figs. 15–17.
1917 *Nodulina compressa* PAALZOW. – p. 18, Pl. 41, Figs. 11, 12.
1932 *Reophax agglutinans* (TERQUEM, 1870). – Paalzow, p. 92, Pl. 4, Figs. 8, 9.
1959 *Reophax helvetica* HAEUSLER. – Lloyd, p. 308, Pl. 54, Fig. 8.
1965 *Reophax agglutinans* (TERQUEM, 1870). – Gordon, p. 832, Text-Figs. 3:23, 24.

MATERIAL. – Numerous specimens from the Rydebäck-Fortuna core No. 5, 136 m, Fortuna Marl, Oxfordian; 122.9–123.0 m, 107.5–107.6 m, 89.2 m, 87.4–88.0 m, Fyledal Clay, Oxfordian-Kimmeridgian.

REMARKS. – *Reophax helvetica* was originally described by Haeusler (1881) from the Upper Jurassic of Switzerland *(Jura, Malm, unterer Argovian)*. However, many Lower and Middle Jurassic finds of reophacids, variously described as *Reophax agglutinans* (TERQUEM), *Reophax multilocularis* HAEUSLER etc., can hardly be differentiated from this species.

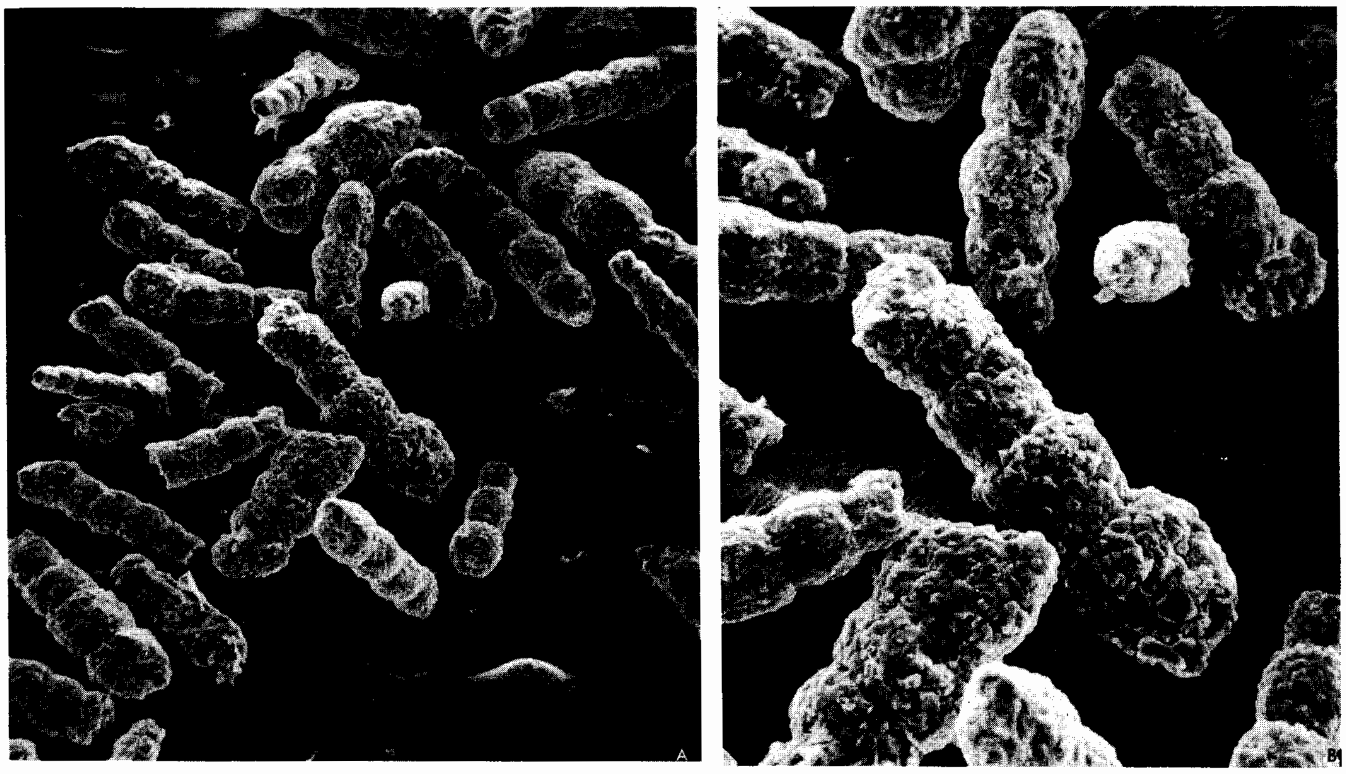


Fig. 14.
A. *Reophax helvetica* (HAEUSLER, 1881). EN SEM 114. Boring Rydebäck-Fortuna No. 5, 136 m, Fortuna Marl, Oxfordian, Upper Jurassic. 95 X.
B. Ditto. 190 X.

Reophax suprajurassica HAEUSLER, 1890

Fig. 15.

1890 *Reophax suprajurassica* HAEUSLER. – p. 30, Pl. 5, Figs. 18–19 (type).

DESCRIPTION. – Test composed of numerous globular chambers gradually increasing in size, in a uniserial, occasionally biserial, arcuate series. Usually, the chain of chambers is broken, the test being represented by 2–5, or even isolated, chambers. Wall agglutinated with a brownish, calcareous matrix, radially perforated. Aperture terminal, rounded.

MATERIAL. – Numerous, mainly broken specimens from the Rydebäck-Fortuna core No. 5, 97 m. Some few specimens from 94 m of the same core. Fyledal Clay, Oxfordian, Upper Jurassic.

DISTRIBUTION. – Oxfordian.

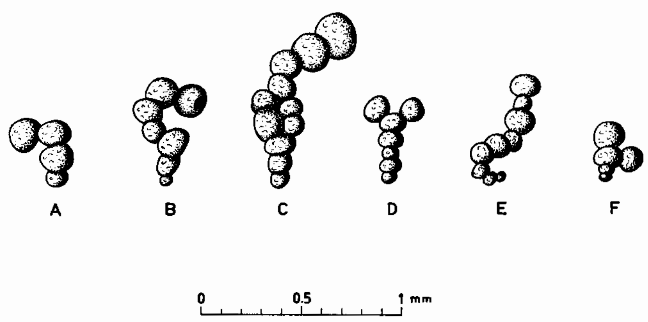


Fig. 15 A–F. *Reophax suprajurassica* HAEUSLER, 1890. Rydebäck-Fortuna core No. 5, 97 m, Fyledal Clay, Oxfordian, Upper Jurassic.

Family *LITUOLIDAE* DE BLAINVILLE, 1825

Subfamily *HAPLOPHRAGMOIDINAE* MAYNC, 1952

Genus *Haplophragmoides* CUSHMAN, 1910

DIAGNOSIS. – Test planispirally coiled, involute; wall agglutinated, aperture an equatorial interiomarginal slit.

TYPE SPECIES. – *Nonionina canariensis* D'ORBIGNY, 1839, by original designation.

SPECIES FROM THE SWEDISH JURASSIC. – *H.* cf. *canui* CUSHMAN, 1930, *H. haeusleri* LLOYD, 1959, *H. kingakensis* TAPPAN, 1955.

DISTRIBUTION. – Carboniferous – Recent.

Haplophragmoides cf. *canui* CUSHMAN, 1930

Fig. 13 C.

1930 *Haplophragmoides canui* CUSHMAN. – p. 133, Pl. 4, Fig. 1 a, b.
1955 *Haplophragmoides canui* CUSHMAN. – Tappan, pp. 24, 28, 32, 42, 43; Pl. 9, Figs. 11–15.

MATERIAL. – Some few specimens from the Örby E 6 Viaduct Exposure, sample No. 9, Döshult Beds, Lower Sinemurian.

REMARKS. – The Swedish material shows close affinity to some specimens illustrated by Tappan (1955, Pl. 9, Figs. 11–15) from the Upper Jurassic of N. Alaska. The Swedish specimens also have much in common with the Upper Jurassic species *Haplophragmoides volgensis* MYATLIUK, 1939, described from the Saratov district, USSR. However, a suspected compression of the test in the Swedish specimens (Fig. 13 C), which may have resulted in a considerable amount of distortion, has hampered a definite determination.

DISTRIBUTION. – Reported from the Upper Jurassic of France and N. Alaska.

Haplophragmoides kingakensis TAPPAN, 1955

Fig. 13 B.

1955 *Haplophragmoides kingakensis* TAPPAN. – p. 43, Pl. 10, Figs. 1–6.

MATERIAL. – Some few specimens from the Kävlinge core No. 928, 30 m, Pliensbachian, Lower Jurassic.

REMARKS. – The specimen in Fig. 13 B shows close affinity to Tappan's paratype, Pl. 10, Fig. 4 (1955), from the Early Toarcian of South Barrow Test Well 3, N. Alaska.

DISTRIBUTION. – Pliensbachian – Toarcian.

Family *ATAXOPHRAGMIIDAE* SCHWAGER, 1877

Subfamily *VALVULINIAE* BERTHELIN, 1880

Genus *Valvulina* D'ORBIGNY, 1826

DIAGNOSIS. – Test free, triserial in early stages, may be triangular in section, later may have more than 3 chambers to whorl; wall agglutinated; aperture at base of final chamber, with large valvular tooth.

TYPE SPECIES. – *Valvulina triangularis* D'ORBIGNY, 1826. Subsequent designation by Parker, Jones & Brady, 1865.

DISTRIBUTION. – Upper Triassic – Recent.

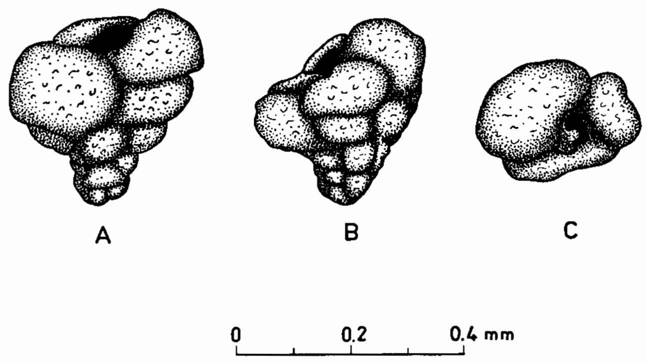


Fig. 16 A–C. *Valvulina meentzeni* KLINGLER, 1955. Rydebäck-Fortuna core No. 5, 81 m, Fyledal Clay, Kimmeridgian, Upper Jurassic.

Valvulina meentzeni KLINGLER, 1955

Fig. 16 A–C.

1955 *Valvulina meentzeni* KLINGLER. – p. 201, Pl. 12, Fig. 13 a–c (13 a, holotype).
1959 *Eggerella? meentzeni* (KLINGLER). – Lloyd, p. 317, Pl. 54, Fig. 32; Text-Fig. 5 f–h.
1962 *Valvulina meentzeni* KLINGLER. – "Leitfossilien", p. 189, Table 10; Pl. 27, Fig. 28.
1970 *Valvulina meentzeni* KLINGLER. – Norling, p. 273; Fig. 4, p. 271.

MATERIAL. – Three specimens from the boring Rydebäck-Fortuna No. 5, 81–82 m, upper part of Fyledal Clay, Kimmeridgian, Upper Jurassic.

REMARKS. – The Swedish specimens show a close affinity to Klingler's types (Fig. 13 a–c) from the Lower Middle Kimmeridgian of the Aller-Weser region, NW. Germany. Lloyd (1959) described this species from the type Kimmeridgian of Dorset (*Mutabilis* and *Pectinatus* Zones).

DISTRIBUTION. – Restricted to the Kimmeridgian in W. Europe.

Suborder ROTALIINA DELAGE & HÉROUARD, 1896

Superfamily *NODOSARIACEA* EHRENBERG, 1838

DIAGNOSIS. – Foraminifera with chambers planispirally coiled or uncoiled, or straight or coiled about longitudinal axis. Wall of radial calcite, in most Late Paleozoic and Early Mesozoic forms imperforate and non-lamellar, in younger forms finely perforate and lamellar. Aperture peripheral or terminal, typically radiate, or may be slit-like or rounded.

REMARKS. – Several recent investigations on the wall structure in nodosariacean foraminifera (by Gerke, 1957, 1959; Brotzen, 1963; Sellier De Civrieux & Dessauvagie, 1965; Kuznetsova, 1961, 1963; Norling, 1966, 1968, and others) have clearly demonstrated that Permian, Triassic, and Liassic representatives of the superfamily *Nodosariacea* have a wall structure strikingly different from that in younger forms. Actually, the wall structure of nodosariacean foraminifera has evolved from a compound test-wall in their Paleozoic ancestors, via an imperforate to perforate non-lamellar to mesolamellar test-wall in Triassic and Liassic forms to the completely lamellar test-wall, which, with some few exceptions, appeared for the first time in the Late Liassic and Middle Jurassic nodosariids (Norling, 1968).

DISTRIBUTION. – Permian – Recent.

Family *NODOSARIIDAE* EHRENBERG, 1838

Subfamily *NODOSARIINAE* EHRENBERG, 1838

Genus *Nodosaria* LAMARCK, 1812

DIAGNOSIS. – Test free, multilocular, rectilinear, rounded in section, sutures usually distinct and perpendicular to axis of test, surface smooth, costate, striate, hispid or tuberculate. Test-wall lamellar (at least in post-Triassic forms) and finely perforate; aperture terminal, central, basically radiate, may be produced on a neck. An apertural chamberlet may occur.

TYPE SPECIES. – *Nautilus radicula* LINNÉ, 1758. Subsequent designation by Lamarck, 1816.

SPECIES FROM THE SWEDISH JURASSIC. –
Nodosaria apheilolocula TAPPAN, 1955
Nodosaria columnaris FRANKE, 1936
Nodosaria dispar FRANKE, 1936
Nodosaria kuhni FRANKE, 1936
Nodosaria metensis TERQUEM, 1864
Nodosaria mitis (TERQUEM & BERTHELIN, 1875)
Nodosaria procera FRANKE, 1936
Nodosaria quadrilatera (TERQUEM, 1858)
Nodosaria radiata (TERQUEM, 1858)
Nodosaria sp. No. 115 BANG, 1968
Nodosaria sp. No. 116 BANG, 1968

DISTRIBUTION. – Permian – Recent.

Nodosaria apheilolocula TAPPAN, 1955

Fig. 17 A–D.

1875 *Nodosaria incerta* TERQUEM & BERTHELIN. – Ser. 2, Vol. 10, No. 3, p. 18, Pl. 1, Fig. 15.
1937 *Nodosaria hirsuta* D'ORBIGNY 1826. – Bartenstein & Brand, p. 145, Pl. 4, Fig. 39 a, b; Pl. 5, Fig. 26.
1955 *Nodosaria apheilolocula* TAPPAN. – p. 68, Pl. 24, Figs. 6–7.

HOLOTYPE. – *Nodosaria incerta* illustrated by Terquem and Berthelin, 1875, Pl. 1, Fig. 15.

TYPE STRATUM AND TYPE LOCALITY. – *Margaritatus* Zone, Upper Pliensbachian, Middle Lias. D'Essey – lès – Nancy, France.

HYPOTYPE. – *Nodosaria apheilolocula* TAPPAN, 1955, new name, Pl. 24, Fig. 6 (USNM P 520), and Fig. 7 (USNM P 519), both from the Upper Pliensbachian part of the Kingak shale of Early Jurassic age, in South Barrow Test Well 3, N. Alaska.

DESCRIPTION. – Test consists of a series of globular chambers with tubular connections, but is generally preserved as isolated chambers with broken intralocular necks at each end. Surface hispid, wall calcareous, lamellar, finely perforate. Aperture raised on a neck, rounded.

DIMENSIONS. – Length of isolated chambers of Swedish specimens, 0.22–0.25 mm; breadth: 0.18–0.20 mm.

MATERIAL. – Three specimens from the boring Kävlinge No. 930, cores 65.4–66.3 m, and 67.3–68.7 m, Katslösa Beds, Lower Pliensbachian, Lower Lias.

REMARKS. – As pointed out by Tappan (1955), this species was described by Terquem and Berthelin as *Nodosaria incerta,* which was a double homonym, being preoccupied by *N. incerta* NEUGEBOREN, 1856, as well as *N. incerta* SILVESTRI, 1872. Bartenstein & Brand (1937) referred the species to *N. hirsuta* D'ORBIGNY, but it differs from this Recent species in being more finely hispid, and having more blunt spines and a thicker and smoother neck.

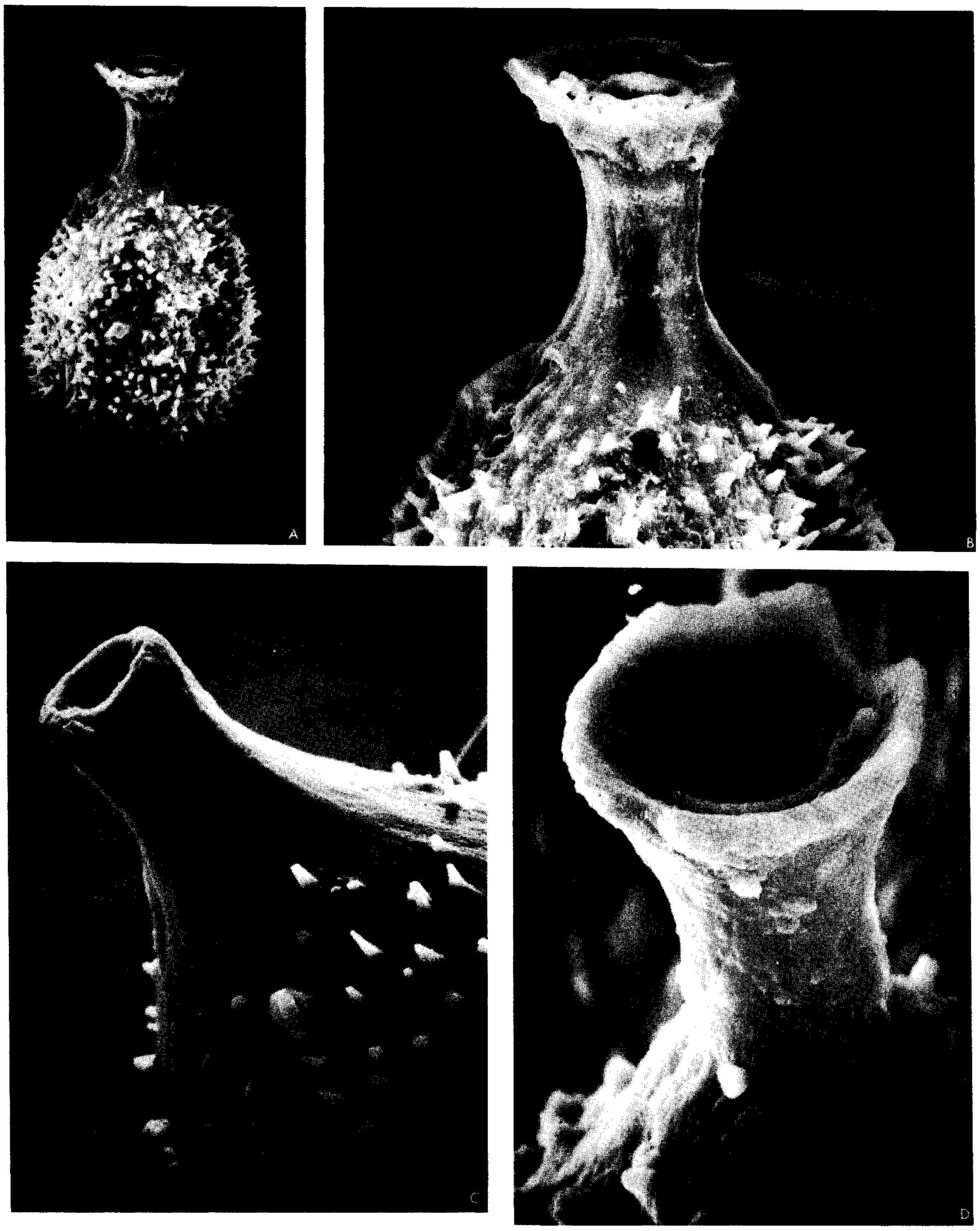


Fig. 17 A–D. *Nodosaria apheilolocula* Tappan, 1955.

A. Specimen En Sem 37:2. Micrograph of isolated chamber showing a hispid chamber wall, and a smooth, broken interlocular tube. Boring Kävlinge No. 930, 65.4–66.3 m, Katslösa Beds, Lower Pliensbachian, Lower Jurassic. 205 X.

B. The same specimen. Detail of interlocular tube. 510 X.

C. Specimen En Sem 37:3. Detail showing the hispid chamber wall and the broken interlocular tube. Boring Kävlinge No. 930, 65.4–66.3 m, Katslösa Beds, Lower Pliensbachian, Lower Jurassic. 560 X.

D. Specimen En Sem 38:1. Detail of interlocular tube. The trumpet-like end of the tube is a part of the broken following chamber. Boring Kävlinge No. 930, 67.3–68.7 m, Katslösa Beds, Lower Pliensbachian, Lower Jurassic. 1090 X.

DISTRIBUTION. – In Pliensbachian strata of W. Europe and N. Alaska. A subspecies, *Nodosaria apheilolocula* ssp. *aglabra,* has been described from the Rhaetic of Austria (Kristan-Tollmann, 1964).

Costate Nodosaria of the Lower Jurassic

A characteristic feature of the Lower Jurassic foraminiferal fauna is the greater amount of surface ornamentation of the species than has been found in pre-Jurassic nodosariids. Many species developed strong keels and sharply elevated ribs, some became spinose and hispid.

The genus *Nodosaria* is represented by a great number of ribbed forms in the Liassic fauna, whereas smooth, spinose and hispid forms are less common. Many species of ribbed *Nodosaria* have been erected. The specific determination has been based on the form and number of chambers, the form and number of ribs, the presence or absence of a basal spine of the initial chamber etc. It seems, however, as if the Lower Jurassic species of ribbed *Nodosaria,* usually have been based on a single type rather than upon a suite of specimens. Due to the wide degree of variation this procedure has resulted in an immoderate number of species and a great confusion in the nomenclature.

A study of suites of ribbed *Nodosaria* obtained from Liassic rocks in W. Scania has resulted in comparatively few species (p. 44). Undoubtedly, if the specimens had been studied one by one, without any arrangement in suites, a much greater number of "species" would have resulted. In the following, three of the most common species will be described, viz. *Nodosaria dispar* FRANKE, 1936, *N. metensis* TERQUEM, 1864, and *N. mitis* (TERQUEM & BERTHELIN, 1875).

Species	No. of chambers	No. of ribs	Length	Max. breadth	No. of specimens studied
Nodosaria dispar	3– 5	8–10	0.35–0.70	0.15–0.30	28
Nodosaria metensis	5– 9	8–16	0.75–1.65	0.14–0.28	23
Nodosaria mitis	5–10	6– 9	0.40–1.80	0.10–0.35	19

TABLE 13. Number of chambers and ribs, length and maximum breadth of three species of Nodosaria from the Lower Jurassic of W. Scania. The figures represent lower and upper limits. Dimensions in mm.

As seen in Table 13, the dimensions of the three species vary considerably, as well as the number of chambers and ribs. However, apart from the chamber form, features in the ornamentation and other characters commonly studied and said to be of diagnostic importance, there is one character, to which great attention

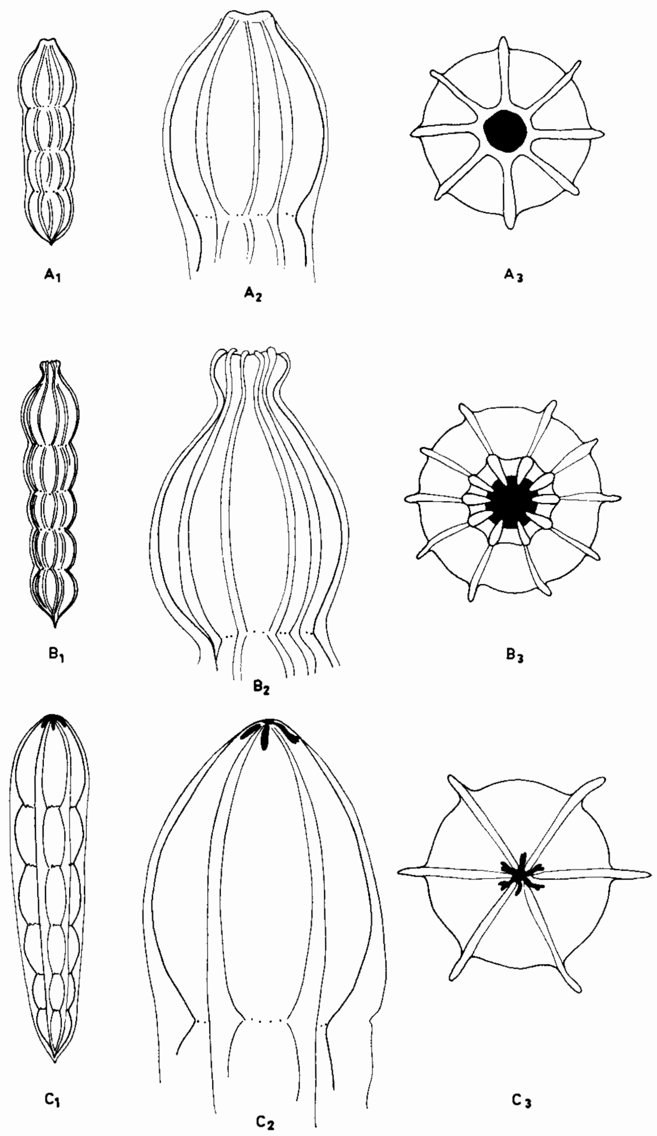


Fig. 18 A_1–C_3. Schematic drawings of three species of genus *Nodosaria* from the Lower Lias demonstrating different types of apertures.

A. *Nodosaria dispar* FRANKE, 1936
A_1. Side view.
A_2. Side view of apertural chamber.
A_3. Apertural view showing radiating costae jointed to form an elevated marginal rim around the aperture.
B. *Nodosaria metensis* TERQUEM, 1864
B_1. Side view.
B_2. Side view of apertural chamber showing a short apertural neck ornamented with costae traversing the whole test.
B_3. Apertural view showing the aperture radiated by ends of costae.
C. *Nodosaria mitis* (TERQUEM & BERTHELIN, 1875)
C_1. Side view.
C_2. Side view of apertural chamber showing the aperture radiated by intercostal slits.
C_3. Apertural view showing radiating, bifurcate, intercostal slits.

has been paid. That is the aperture. Previously, the microscopic equipment has usually not allowed detailed apertural studies due to the minute size of apertures. The introduction of the scanning electron microscope in the micropaleontology, however, has removed this obstacle.

Scanning electron microscopic studies of the aperture in adult, well preserved, and clean fossil foraminifera seem to show that the aperture usually is a stable and specific character of great importance in classification. Concerning the ribbed *Nodosaria* placed in the three species listed in Table 13, the present investigation has shown the following.

In *Nodosaria dispar,* the longitudinal ribs traversing the whole test, are united to form a slightly elevated rim around the aperture, which often has a polygonal form. In side view the aperture is protruding, or may be produced to form a very short neck (Fig. 18 A).

In *Nodosaria metensis,* the typical aperture is produced to form a short neck. The apertural opening is basically circular, the periphery being radially spiked by the ends of longitudinal ribs (Fig. 18 B). In the Swedish material, well-preserved and clean specimens assigned to *N. metensis* have this type of aperture only. However, other types including an apertural chamberlet are reported to occur in this species, viz. by Barnard (1950 a, p. 355, Fig. 2).

In *Nodosaria mitis* the aperture is protruding, rarely produced to form a neck, of a stellar shape, with radiating, often bifurcate slits (Fig. 18 C).

The aperture will be more thoroughly described in connection with descriptions of species.

Nodosaria dispar Franke, 1936

Figs. 18 A_1–A_3, 19 A.

1936 *Nodosaria dispar* Franke. – pp. 39, 40, 47; Pl. 4, Fig. 18 a–d (18 a holotype).
1875 *Nodosaria simoniana* (d'Orbigny). – Terquem & Berthelin, Vol. 10, p. 21; Pl. 1, Fig. 21.
1876 *Nodosaria raphanus* (Linné). – Blake (partly), p. 456, Pl. 18, Fig. 14 a (not 14).
1908 *Nodosaria raphanistrum* (Linné). – Issler (partly), Vol. 55, p. 53, Pl. 2, Figs. 87–89.
1936 *Nodosaria mutabilis* Terquem. – Franke, Pl. 5, Fig. 2 b, c.
1937 ? *Nodosaria metensis* Terquem. – Bartenstein & Brand, Pl. 6, Fig. 13 a.
1957 *Nodosaria dispar* Franke. – Nørvang, p. 78, Figs. 80, 81.
1961 *Nodosaria dispar* Franke. – Pietrzenuk, p. 60, Pl. 1, Figs. 2, 3.
1964 *Nodosaria dispar* Franke. – Barbieri, p. 748, Pl. 56, Fig. 16.
1967 *Nodosaria* cf. *dispar* Franke. – Ruget & Sigal, p. 62; Pl. 8, Fig. 9 a, b.
1967 ? *Nodosaria procera* Franke. – Ruget & Sigal, Pl. 8, Fig. 18.
1967 ? *Nodosaria* sp. No. 9 Ruget & Sigal. – Pl. 9, Figs. 2 a, b, 5.
1968 *Nodosaria dispar* Franke. – Norling, p. 14, Text-Fig. 4; p. 27.
1969 *Nodosaria dispar* Franke. – Brouwer, p. 27, Pl. 3, Figs. 8, 9.

DESCRIPTION. – Test short and robust, circular in transverse section, sides nearly parallel; chambers usually 3 or 4, rarely 5, almost spherical, of variable size. Sutures more or less deepened; initial chamber large, usually with a basal spine. Test ornamented with 8–10 distinct ribs traversing the test from basal spine of proloculum on to the apertural margin. Test-wall of radial, finely perforate, lamellar calcite, with the exception of penetrative, longitudinal ribs, which are essentially imperforate and granular. Septa broad and robust, essentially imperforate. Basal part of septa thickened by lamellar superposition.

Aperture terminal, central, protruding, or produced to form a short neck, usually of a polygonal form with a radiate margin formed by ends of longitudinal ribs. Rib ends are usually united to form a slightly elevated rim around the aperture. Foramina similar to the aperture.

MATERIAL. – Twenty-eight specimens from the borings Öresund 01, Kävlinge Nos. 928 and 930, Rydebäck-Fortuna Nos. 1 and 4, Helsingborg Kvarn No. 2220, and from outcrops at Örby E 6 Viaduct, Katslösa and Gantofta. Lower Sinemurian-Pliensbachian.

GEOGRAPHICAL DISTRIBUTION. – The species has been reported from Denmark, East Germany (DDR), West Germany, Austria, Switzerland, the Netherlands, Great Britain, France and Italy.

STRATIGRAPHICAL DISTRIBUTION. – Hettangian (rare), Sinemurian-Pliensbachian (common), Toarcian-Aalenian (rare).

Nodosaria metensis Terquem, 1864

Figs. 18 B_1–B_3, 19 B.

1864 *Nodosaria metensis* Terquem. – Ser. 2, Année 11, Pt. 2, p. 377, Fig. 5.
1936 *Nodosaria metensis* Terquem. – Franke, p. 47, Pl. 4, Figs. 15 a–c.
1937 *Nodosaria metensis* Terquem. – Bartenstein & Brand, p. 146, Pl. 1 A, Fig. 9; Pl. 2 B, Fig. 14; Pl. 3, Fig. 22; Pl. 4, Fig. 37; Pl. 5, Fig. 29; Pl. 6, Fig. 13 a, b.
1950 *Nodosaria metensis* Terquem. – Barnard, p. 355, Fig. 4.
1950 *Nodosaria metensis* Terquem var. *robusta* Barnard. – Barnard, p. 356, Fig. 3.
1957 *Nodosaria metensis* Terquem. – Nørvang, p. 74, Fig. 72.
1961 *Nodosaria metensis* Terquem. – Pietrzenuk, p. 59, Pl. 1, Fig. 10.
1961 *Nodosaria metensis* Terquem var. *robusta* Barnard. – Pietrzenuk, p. 60.
1961 *Nodosraia metensis* Terquem. – Bizon, Table 2.
1964 *Nodosaria metensis* Terquem. – Rusbült & Petzka, p. 630.
1964 ? *Nodosaria metensis metensis* Terquem. – Kristan-Tollmann, p. 73, Fig. 20.
1968 *Nodosaria metensis* Terquem. – Norling, p. 30, Text-Fig. 7 A–E; Pl. 2, Figs. 1–5; Pl. 9; Table 2, p. 31.
1969 *Nodosaria metensis* Terquem. – Brouwer, p. 28, Pl. 3, Fig. 12; Table 2, p. 11.

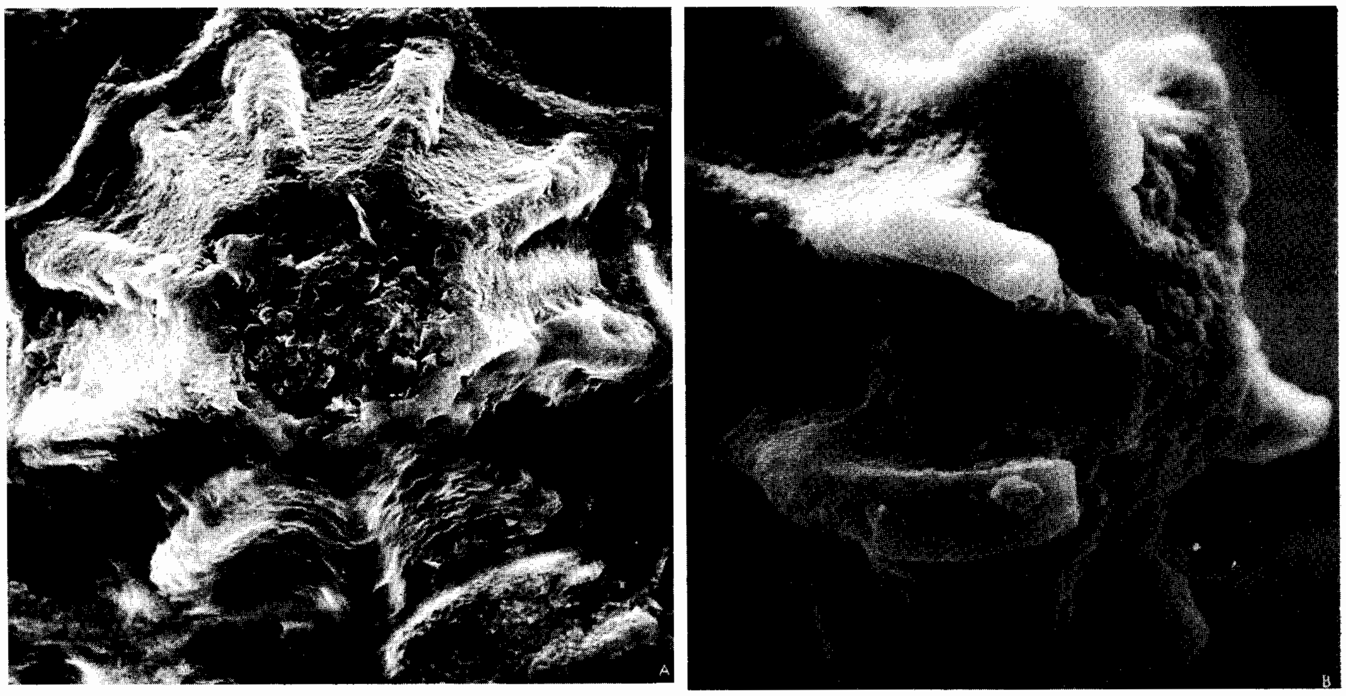


Fig. 19.
A. *Nodosaria dispar* FRANKE, 1936. Apertural view of specimen EN SEM 18:3, Örby E 6 Viaduct Exposure, Döshult Beds, Lower Sinemurian. 1000 X.
B. *Nodosaria metensis* TERQUEM, 1864. Oblique side view of the aperture of specimen EN SEM 27:3, Örby E 6 Viaduct Exposure, sample No. 6, Döshult Beds, Lower Sinemurian. 1550 X.

DIMENSIONS. – See Table 13, p. 46 (see also Norling, 1968, Table 2, p. 31).

MATERIAL. – A total of 23 specimens. Lower Sinemurian specimens from the borings Öresund 01 (22–42 m), Helsingborg Kvarn No. 2220 (38–44 m), Örby E 6 Viaduct Exposure (sample No. 10); Upper Sinemurian specimens from the boring Rydebäck-Fortuna No. 1 (140 m); Lower Pliensbachian (Carixian) specimens from the borings Kävlinge Nos. 928 and 930, and the Katslösa Exposure.

REMARKS. – Little can be added to the description given by Norling (1968, pp. 30–33). In its typical form, the aperture is produced to form a short neck, which may be smooth or ornamented with longitudinal ribs (8–16) traversing the whole test. A phialine lip may be present. The opening is basically circular with a stellar pattern formed by the protruding ends of the longitudinal ribs.

The foramina are protruding, but usually not elongated to form a neck as the aperture, suggesting a resorption of calcareous material during the chamber formation. Longitudinal sections of the aperture and foramina are figured by Norling (1968, Text-Fig. 7, p. 32; Pl. 2, Figs. 1–3). See also Figs. 18, 19 herein. Terquem's type specimen (1864, Fig. 5) described from the Hettangian *Planorbis* Zone in France, has a globular aperture on a short neck. Various apertures of *Nodosaria metensis* have been described by Barnard (1950, p. 355, Fig. 2).

GEOGRAPHICAL DISTRIBUTION. – *Nodosaria metensis* has been recorded from Liassic strata in Denmark, East Germany (DDR), West Germany, the Netherlands, Great Britain, France and Spain. The species has also been recorded from the Rhaetic of Austria (Kristan-Tollmann, 1964). The specimens reported from the Bathonian of Poland (Pazdrowa, 1967), and the Oxfordian of S. England (Gordon, 1965) should not be referred to *Nodosaria metensis*.

STRATIGRAPHICAL DISTRIBUTION. – Recorded from Rhaetic to Bajocian strata. Especially common in the Sinemurian and the Lower Pliensbachian.

Nodosaria mitis (TERQUEM & BERTHELIN, 1875)

Figs. 18 C_1–C_3, 20 A–D.

1875 *Dentalina mitis* TERQUEM & BERTHELIN. – Ser. 2, Vol. 10, No. 3, p. 28, Pl. 2, Figs. 9 a–c.
1875 *Dentalina oculina* TERQUEM & BERTHELIN. – p. 31, Pl. 2, Fig. 20 a–c.
1908 *Nodosaria raphanistrum* (LINNÉ). – Issler (partly), p. 53, Pl. 2, Fig. 86.
1936 *Nodosaria mitis* (TERQUEM & BERTHELIN). – Franke, p. 45, Pl. 4, Fig. 11 a.
1936 *Nodosaria mitis* (TERQUEM & BERTHELIN) forma *juvensis* FRANKE. – Franke, p. 46, Pl. 4, Fig. 11 b.
1936 *Nodosaria oculina* (TERQUEM & BERTHELIN). – Franke, p. 49, Pl. 4, Fig. 21.
1937 *Nodosaria mitis* (TERQUEM & BERTHELIN). – Bartenstein & Brand, p. 145, Pl. 2 A, Fig. 9; Pl. 2 B, Fig. 13; Pl. 3, Fig. 18; Pl. 4, Fig. 36; Pl. 5, Fig. 24.
1937 *Nodosaria oculina* (TERQUEM & BERTHELIN). – Bartenstein & Brand, p. 147, Pl. 3, Fig. 19; Pl. 5, Fig. 25; Pl. 8, Fig. 14 (form a).
1947 *Nodosaria oculina* (TERQUEM & BERTHELIN). – Payard, p. 170, Pl. 2, Figs. 17–18.
1955 *Nodosaria mitis* (TERQUEM & BERTHELIN). – Tappan, p. 70, Pl. 24, Figs. 11–18.
1957 *Nodosaria oculina* (TERQUEM & BERTHELIN). – Nørvang, p. 77, Fig. 77.
1957 *Nodosaria mitis* (TERQUEM & BERTHELIN). – Nørvang, p. 76, Fig. 74.
1961 *Nodosaria mitis* (TERQUEM & BERTHELIN). – Pietrzenuk, p. 59, Pl. 1, Figs. 7–8.
1964 *Nodosaria oculina oculina* (TERQUEM & BERTHELIN). – Kristan-Tollmann, p. 74, Pl. 11, Figs. 25–28.
1968 *Nodosaria mitis* (TERQUEM & BERTHELIN). – Norling, p. 14, Text-Fig. 4; p. 27.
1968 *Nodosaria oculina* (TERQUEM & BERTHELIN). Norling, p. 14, Text-Fig. 4, p. 27.
1969 *Nodosaria oculina* (TERQUEM & BERTHELIN). – Brouwer, p. 28, Pl. 3, Fig. 13.

DESCRIPTION. – Test narrow and elongate, tapering, rounded in transverse section. Chambers 5–10 in number in a rectilinear (rarely slightly curved) series. All chambers more or less globular (oblate or prolate) increasing gradually in size as added, the last 2 or 3 chambers frequently of about equal size. Initial chamber with a basal spine. Sutures distinct, horizontal. Test ornamented with 6–9 longitudinal, narrow and flange--like ribs, which are continuous across chambers and sutures. Test-wall calcareous, fibrous-radiate, finely perforate, with interruptions for penetrative, granular and essentially imperforate ribs. Wall secondarily lamellar.

Aperture terminal, central, protruding, rarely on a short neck, stellar-shaped, with radiating, often bifurcate slits.

DIMENSIONS. – See Table 13, p. 46.

MATERIAL. – A total of 19 specimens. Lower Sinemurian specimens from the Örby E 6 Viaduct Exposure (sample No. 6), and from the boring Öresund 01 (22–42 m). Pliensbachian specimens from the borings Rydebäck-Fortuna No. 1 (68.5 and 84 m), and No. 4 (91.6–92.8 m). Lower Pliensbachian specimens obtained also from the Katslösa Exposure and the borings Kävlinge Nos. 928 and 930.

REMARKS. – Tappan (1955) has clearly demonstrated that the species *Dentalina mitis* TERQUEM & BERTHELIN and *Dentalina oculina* TERQUEM & BERTHELIN, originally described from the same horizon (Middle Lias), are synonyms. According to the rules of nomenclature, the first used specific name, viz. *mitis*, is the only possible one. Therefore, the species should be known as *Nodosaria mitis* (TERQUEM & BERTHELIN).

GEOGRAPHICAL DISTRIBUTION. – Recorded from Denmark, East Germany (DDR), Poland, West Germany, Austria, Switzerland, the Netherlands, France and N. Alaska.

STRATIGRAPHICAL DISTRIBUTION. – Rhaetic, Hettangian-Bajocian. Most records are from the Sinemurian and the Pliensbachian.

Genus *Astacolus* DE MONTFORT, 1808

DIAGNOSIS. – Test free, elongate, arcuate, compressed; chambers numerous, low, broad, added along a curved axis; sutures oblique, raised at outer margin, curved, straight or sinuate; test may be smooth or ornamented. Test-wall non-lamellar or mesolamellar, imperforate or indistinctly perforate in Late Paleozoic and Early Mesozoic forms, completely lamellar and finely perforate in younger forms. Aperture terminal, at peripheral angle, typically radiate. An apertural chamberlet may occur.

TYPE SPECIES. – *Astacolus crepidulatus* DE MONTFORT, 1808 (= *Nautilus crepidulus* FICHTEL & MOLL, 1798). Recent.

SPECIES FROM THE SWEDISH JURASSIC. – *Astacolus anceps* (TERQUEM, 1870), *A. breoni* (TERQUEM, 1864), *A. cordiformis* (TERQUEM, 1864) *A. denticula--carinata* (FRANKE, 1936), *A. gordoni* nov. nom., *A. matutina* (D'ORBIGNY, 1850), *A. neoradiata* NEUWEILER, 1959, *A. prima* (D'ORBIGNY, 1850). *A. quadricostata* (TERQUEM, 1863), *A. semireticulata* nov. sp., *A. varians* (BORNEMANN, 1854).

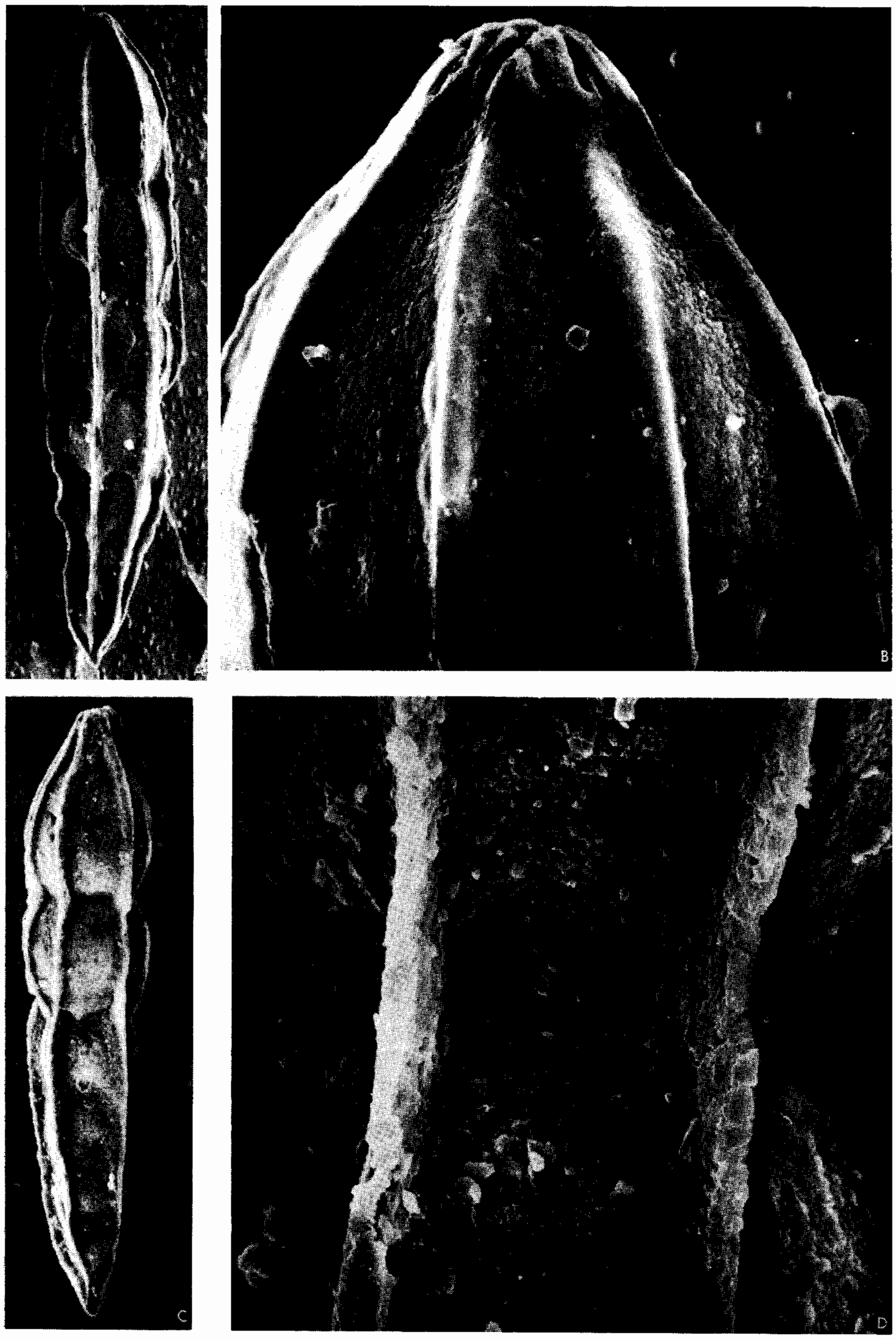


Fig. 20. *Nodosaria mitis* (Terquem & Berthelin, 1875).

A. Side view of specimen En Sem 36:1. Örby E 6 Viaduct Exposure, sample No. 6. Döshult Beds, Lower Sinemurian. Note the inflated globular chambers, the distinct chamber sutures, and narrow and flange-like ribs. 150 X.

B. Side view of apertural chamber of specimen En Sem 35:2. Örby E 6 Viaduct Exposure, sample No. 5, Döshult Beds, Lower Sinemurian. Note the protruding aperture with radiating slits. 560 X.

C. Side view of the same specimen. 140 X.

D. Detail of the same specimen showing distinct chamber suture, flange-like ribs, and fine perforation of chamber wall. 1090 X.

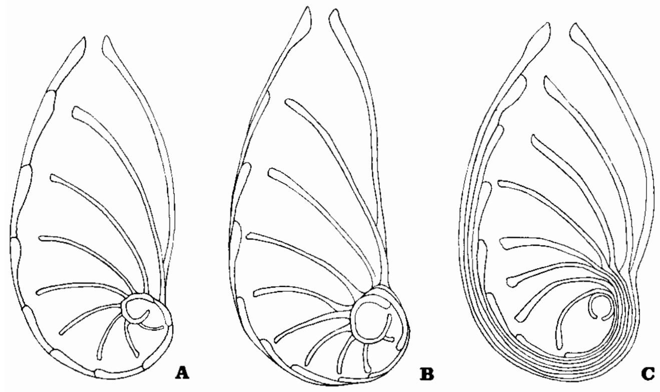


Fig. 21 A–C. Schematic drawings showing different stages of secondary lamination of the test-wall in genus *Astacolus* (After E. Norling, 1968).
A. Non-lamellar test-wall in *Astacolus* ex gr. *varians* (BORNEMANN, 1854). Drawing based on sectioned specimens from the Döshult Beds, Lower Sinemurian, Lower Lias, boring Öresund 01.
B. Non-lamellar test-wall in *Astacolus* ex gr *varians* (BORNEMANN, 1854). Note the slight overlap of primary wall layers. Drawing based on sectioned specimens from the Katslösa Beds, Lower Pliensbachian (Carixian), Lower Lias, boring Kävlinge No. 930.
C. Lamellar test-wall in *Astacolus paleocenicus* BROTZEN, 1948. Drawing based on sectioned specimens from Paleocene material from Ystad, S. Scania.

REMARKS. – The genus *Astacolus* is reported to occur from the Permian to Recent. Several studies on the wall structure in fossil and Recent foraminifera referred to this genus and related genera have clearly demonstrated an evolution from a compound test-wall in Permian forms, via a non-lamellar and mesolamellar wall in some Permian, but mainly Triassic and Early Jurassic forms, to the completely lamellar wall, which seems to have appeared in the Middle Jurassic and has been the predominant type of test-wall ever since (Gerke, 1955, 1957; Kuznetsova, 1961, 1963; Norling, 1968, and others). Evolution of the perforation of the test has also taken place (Norling, 1968). That is, the wall structure in older foraminifera usually assigned to the genus *Astacolus* widely diverge from that in the Pliocene type species *Astacolus crepidulatus* and other later representatives of this genus. In a necessary revision of the genus *Astacolus,* the wall structure must be taken into account. However, our present knowledge about the wall structure and internal characters especially in older foraminifera is still too fragmentary for a revisional treatment and a careful subdivision of many groups of foraminifera, including astacoloid forms, showing an external heterochronous homeomorphy. In the following, the present writer will treat the astacoloid forms in a traditional way even if he is aware of that the classification is inconsistent in many respects and that a revisional treatment is needed.

Loeblich & Tappan (1964, p. C 514) remark on this genus: ”*Astacolus* differs from *Vaginulina* in having oblique sutures and a more distinctly curved axis. It differs from *Lenticulina* in having a curved axis, rather than a closely enrolled test, and in later chambers being added so as to touch only the chamber immediately preceding, and in not being involute. Slightly irregular froms have been described as *Enantiovaginulina, Polymorphinella,* and *Polymorphinoides,* but as some specimens of most nodosariid genera may show irregular chamber development, this is not regarded as of generic or even specific importance”.

DISTRIBUTION. – Permian – Recent.

Astacolus ex gr. *cordiformis* (TERQUEM, 1864)

Fig. 22 A–D.

1864 *Cristellaria cordiformis* TERQUEM. – p. 413, Pl. 9, Fig. 14 a, b.
1936 *Cristellaria (Planularia) cordiformis* (TERQUEM). – Franke, p. 95, Pl. 9, Figs. 18–21.
1937 *Cristellaria (Planularia) cordiformis* (TERQUEM). – Bartenstein & Brand, p. 169, Pl. 6, Fig. 30 a, b; Pl. 9, Fig. 43 a–e; Pl. 10, Fig. 30 a–d; Pl. 12 A, Fig. 10; Pl. 12 B, Fig. 11 a, b; Pl. 13, Fig. 29 a–c; Pl. 14 B, Fig. 10; Pl. 15 A, Fig. 28 a, b.
1957 *Astacolus varians* (BORNEMANN) var. *convolutus* BORNEMANN. – Nørvang, p. 101, Fig. 135.
1960 *Lenticulina (Planularia) cordiformis* (TERQUEM). – Lutze, p. 456, Pl. 29, Figs. 14–15.
1964 *Lenticulina (Planularia) cordiformis* (TERQUEM). – Barbieri, p. 766, Pl. 59, Fig. 4 a, b.
1965 *Lenticulina (Planularia) cordiformis* (TERQUEM). – Hanzlíková, p. 79, Pl. 7, Fig. 6 a, b.
1968 ”*Astacolus*” *cordiformis* (TERQUEM). – Norling, p. 11, Text-Fig. 2.

DESCRIPTION. – Test free, auriculate, compressed; chambers 6–12 in number, very low and broad, added along a curved axis, ventral part of the last 2 or 3 chambers often reaching down to initial chamber. Sutures often indistinct, flush or slightly depressed, curved, much higher at dorsal margin. Dorsal as well as ventral margin convex. Test surface smooth, finely perforate. Aperture at peripheral angle, covered by an apertural chamberlet having 6–8 radiating slits.

DIMENSIONS. – Length, 0.30–1.10 mm; breadth, 0.20–0.50 mm.

MATERIAL. – Ten specimens from the boring Kävlinge No. 928, 55–82 m, Pliensbachian; 6 specimens from the boring Kävlinge No. 930, 62.7–63.5 m, Katslösa Beds, Lower Pliensbachian (Carixian); 3 specimens from the boring Rydebäck-Fortuna No. 5, 89.2 m, Fyledal Clay, Oxfordian/Kimmeridgian.

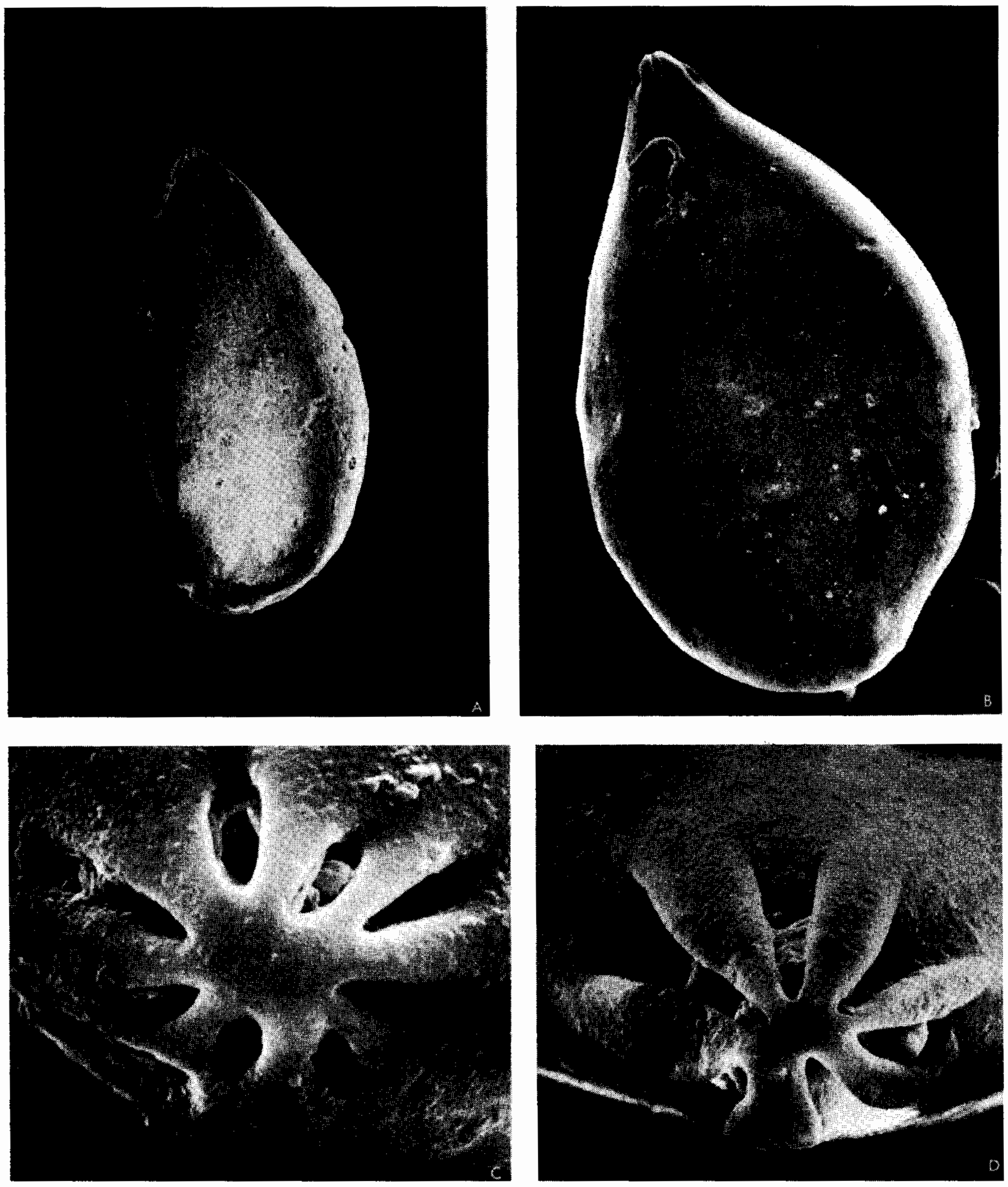


Fig. 22 A–D. *Astacolus* ex gr. *cordiformis* (Terquem, 1864).

A. Side view of specimen En Sem 99:5. Boring Kävlinge No. 930, 62.7–63.5 m, Katslösa Beds, Lower Pliensbachian, Lower Jurassic. 195 X.

B. Side view of specimen En Sem 99:3. Boring Kävlinge No. 930, 62.7–63.5 m, Katslösa Beds, Lower Pliensbachian, Lower Jurassic. 200 X.

C. Apertural chamberlet of specimen in Fig. A showing 8 slits arranged in a stellar pattern. 2000 X.

D. Apertural chamberlet of specimen in Fig. B showing 6 radiating slits. 1000 X.

REMARKS. – The metal film applied to the foraminiferal test for scanning micrography very often has the disadvantage to cover certain characters, such as flush sutures. This is the case for the micrographed specimens in Fig. 22 A–D.

Astacolus cordiformis belongs to a group of Jurassic foraminifera characterized by a considerable variation in size, shape, and the spiral arrangement of the chambers. However, the introduction of the scanning electron microscope in the micropaleontology with the possibilities of detailed studies of ultrastructural and ultramorphological characters, will most certainly contribute to a better classification of this difficult group.

Barnard (1950 b, p. 10), regarded *Cristellaria cordiformis* TERQUEM as synonymous to *Planularia pauperata* JONES & PARKER. However, the present writer regards *Astacolus cordiformis* as a valid species, which differs from *Planularia pauperata* (as described by Barnard, 1950) in having an apertural chamberlet. Unfortunately, in many papers dealing with *Astacolus cordiformis,* the aperture has not been sufficiently described and illustrated. It is obvious, however, that at least some of Franke's illustrated specimens of this species have an apertural chamberlet, which is also suggested by his description of the species (1936, p. 95). On the other hand, Barnard's illustrated specimens of *Planularia pauperata* (p. 10, Fig. 3 a, b, d; p. 11, Fig. 4 a–j; Pl. 2, Fig. 7) obviously lack such a chamberlet.

GEOGRAPHICAL DISTRIBUTION. – Foraminifera referable to this species have been recorded from France, England, West Germany, Denmark, Central Poland, and Czechoslovakia.

STRATIGRAPHICAL DISTRIBUTION. – Recorded from post-Sinemurian strata of the Lower Jurassic, Middle Jurassic, and pre-Portlandian Upper Jurassic.

Astacolus denticula-carinata (FRANKE, 1936)

Fig. 23 A–E.

1936 *Cristellaria (Astacolus) denticula-carinata* FRANKE. – pp. 99, 102, Pl. 9, Fig. 38 (holotype).
1936 *Cristellaria (Astacolus) basidentata* FRANKE. – pp. 98, 100, Pl. 9, Fig. 34 a, b.
1937 *Cristellaria (Astacolus) denticula-carinata* FRANKE. – Bartenstein & Brand, p. 171, Pl. 4, Fig. 72.
1968 *Astacolus denticula-carinata* (FRANKE). – Norling, pp. 11–13, 15–16, Text-Figs. 2, 3, 16; Pl. 9.
1968 *Astacolus denticula-carinata* (FRANKE). – Bang (in Larsen et al.), pp. 65, 67; Pl. 24.

DESCRIPTION. – Test elongate, long and narrow, or rather short and broad; chambers 6–10 planispirally arranged in the early stage, later uncoiled with oblique, flush or slightly depressed sutures. Dorsal margin more or less straight, bending towards initial end. Ventral margin convex, more or less straight, or may be S-shaped. Test oval in transverse section, ventral part broader than dorsal. Surface smooth, ornamentation restricted to two or more distinct nodes along the basal margin. Test-wall of radial calcite, finely perforate. Aperture at dorsal angle, protruding, with commonly six radially arranged slits or grooves.

DIMENSIONS. –

Specimen	Length	Max. breadth
EN SEM 83:2	0.64 mm	0.23 mm
EN SEM 83:1	0.94 mm	0.33 mm
EN SEM 96:1	0.50 mm	0.25 mm
Franke's type specimen	0.60 mm	0.20 mm

MATERIAL. – Numerous specimens from the borings Rydebäck-Fortuna No. 1 (53.3–78 m), Rydebäck-Fortuna No. 4 (90–108 m), Kävlinge No. 928 (66–75 m), Kävlinge No. 930 (30–101 m), and from the Katslösa Exposure (840–970 m). Pliensbachian, Lower Jurassic.

REMARKS. – Franke (1936) based his two species, *Cristellaria (Astacolus) basidentata* and *Cristellaria (Astacolus) denticula-carinata* on one single specimen for each of the species. The present writer, who has examined numerous specimens with a denticulate basal margin from Pliensbachian strata in Sweden, has come to the conclusion that Franke's two species are varieties of one and the same species, herein referred to *Astacolus denticula-carinata.* As pointed out by Tappan (1955), her *Marginulina bergquisti* from the Lower Jurassic of South Barrow, N. Alaska, resembles *Astacolus denticula-carinata,* but differs in having comparatively higher chambers and an almost central aperture. *Astacolus denticula-carinata* is an excellent index fossil for the Pliensbachian in W. Europe.

DISTRIBUTION. – Carixian-Lower Domerian, Pliensbachian, Lower Jurassic.

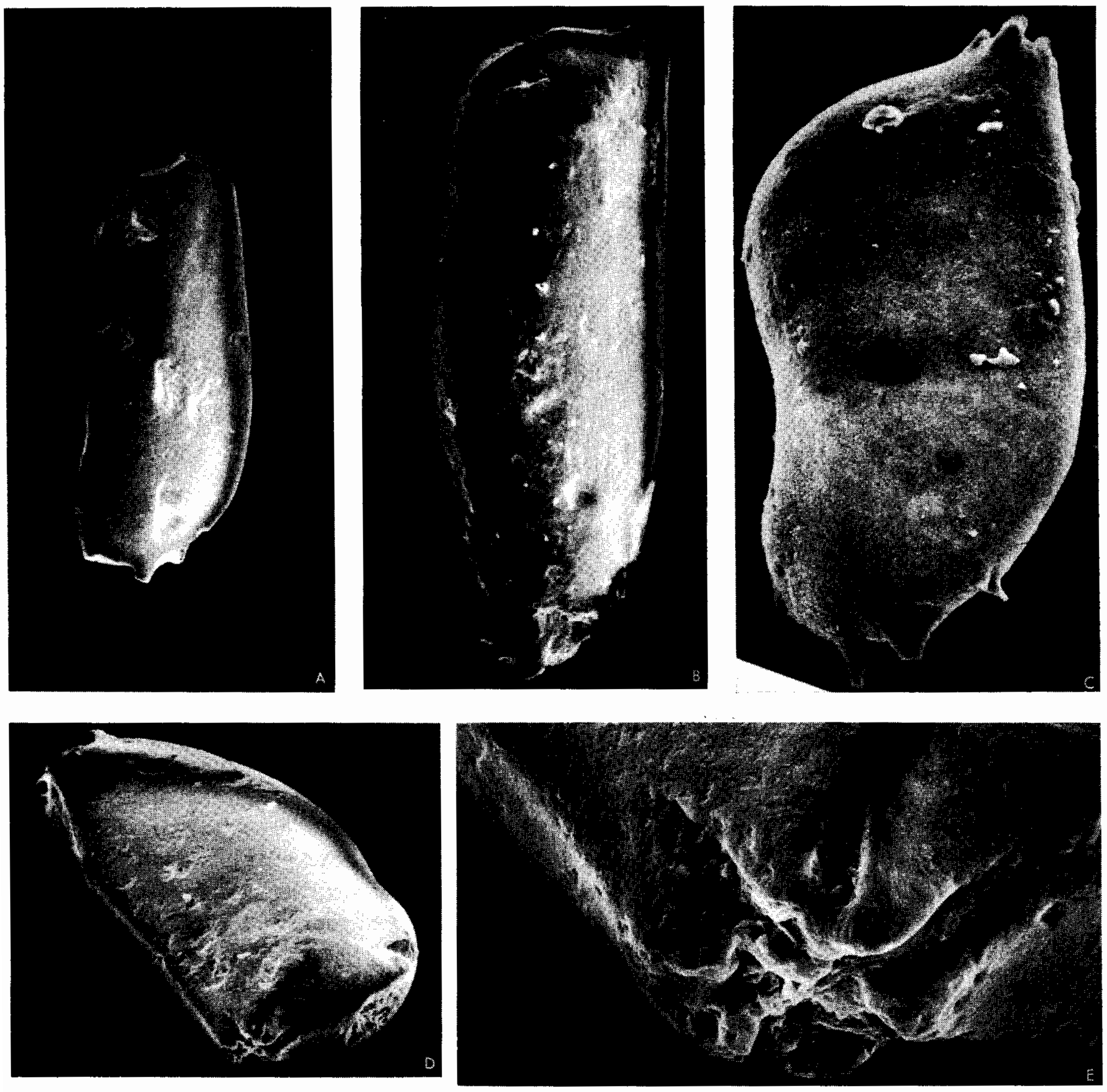


Fig. 23 A–E. *Astacolus denticula-carinata* (FRANKE, 1936).

A. Side view of specimen EN SEM 83:2. Boring Rydebäck-Fortuna No. 4, 96.6 m, Rydebäcks Beds, Upper Pliensbachian (Domerian), Middle Lias. 100 X.

B. Side view of specimen EN SEM 83:1. From the same level as specimen in Fig. 23 A. 103 X.

C. Side view of specimen EN SEM 96:1. Boring Kävlinge No. 930, 44–45 m, Katslösa Beds, Lower Pliensbachian (Carixian), Lower Lias. 200 X.

D. Oblique apertural view of specimen EN SEM 83:1 (Specimen in Fig. 23 B). 100 X.

E. Aperture of the same specimen. 500 X.

Astacolus neoradiata Neuweiler, 1959

Fig. 24 A–D.

Non 1864 *Marginulina radiata* Terquem. – p. 410, Pl. 9, Fig. 10 a, b.
1936 *Cristellaria (Astacolus) radiata* (Terquem). – Franke, p. 108, Pl. 11, Fig. 3.
1937 *Cristellaria (Astacolus) radiata* (Terquem). – Bartenstein & Brand, p. 172, Pl. 5, Fig. 58; Pl. 12 B, Fig. 14 a–c; Pl. 13, Fig. 34 a–b.
1952 *Lenticulina (Astacolus) radiata* (Terquem). – Weihmann, p. 139, Pl. 6, Fig. 10 a–b.
1957 *Marginulinopsis radiata* (Franke not Terquem). – Nørvang, p. 93, Figs. 105, 107.
1959 *Lenticulina (Astacolus) neoradiata* n. nom. Neuweiler. – Bach, Hagenmeyer & Neuweiler, p. 430, Text-Fig. 1, Figs. 1–5.
1968 *Marginulinopsis radiata* (Terquem). – Norling, p. 14, Text-Fig. 4; Pl. 9.
1968 *Astacolus neoradiata* Neuweiler. – Bang (in Larsen et al.), pp. 64, 67, Pl. 24.
1970 *Astacolus neoradiata* (Neuweiler). – Norling, pp. 271, 282, Fig. 11 A.

DESCRIPTION. – Test auriculate to elongate, compressed. Chambers 5–12 in number, low and broad added along a curved axis. Sutures depressed or flush, oblique, higher at dorsal margin. Test ornamented with numerous ribs commonly traversing the test from ventral initial part to dorsal distal part. Most specimens have a distinct marginal keel, at least around the curved initial end. Aperture at dorsal angle, radiate.

DIMENSIONS. – Length, 0.45–1.2 mm; breadth, 0.2–0.4 mm.

MATERIAL. – Numerous specimens from all Sinemurian and Pliensbachian sections treated in the text.

REMARKS. – *Astacolus neoradiata* shows affinity to *Marginulina radiata* Terquem, but differs in having a compressed test. Nørvang (1957) subdivided forms previously referred to *Marginulina radiata* into *Marginulina radiata* and *Marginulinopsis radiata* (Franke not Terquem). However, if the original diagnosis of the genus *Marginulinopsis* Silvestri, 1904, emended by Thalmann (1937), is strictly followed, Nørvang's Liassic species referred to this genus should rather be placed in the genus *Astacolus* De Montfort, 1808. *Marginulinopsis* is round in transverse section. All of Nørvang's species referred to this genus, viz. *M. radiata, M. quadricostata, M. breoni, M. matutina, M. lituoides* and *M. prima* are compressed according to his descriptions and figures. As seen in his remarks on the descriptions of the species listed above, Nørvang was aware of the taxonomic problems concerning this group of highly variable foraminifera. However, the problems are not solved by referring these forms to the genus *Marginulinopsis.*

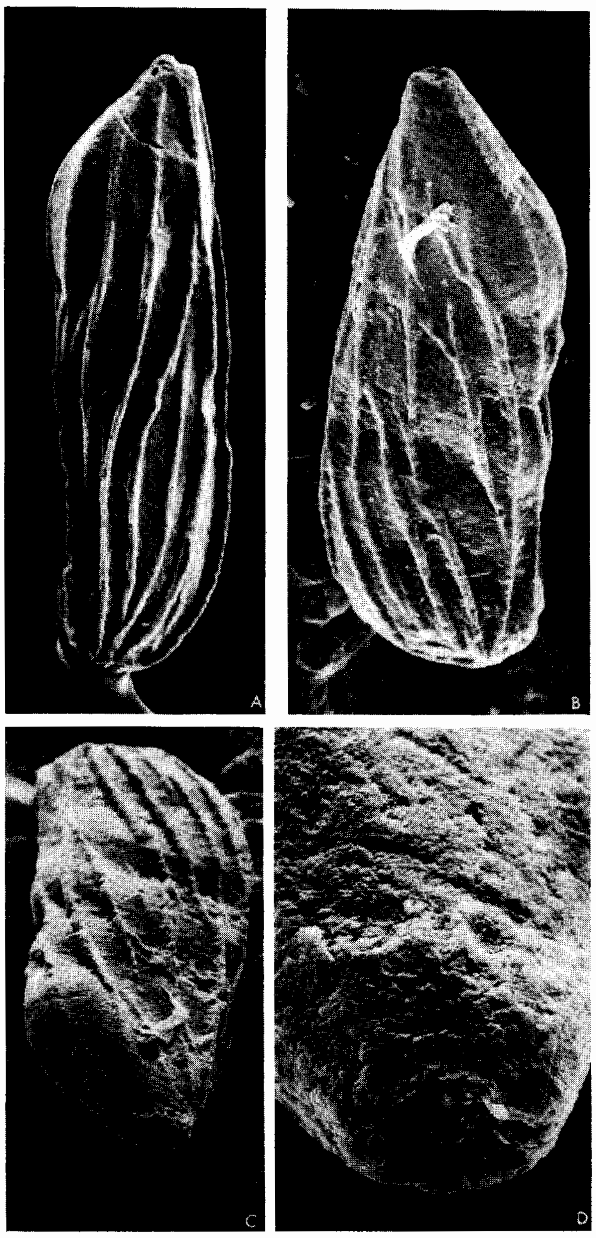


Fig. 24 A–D. *Astacolus neoradiata* Neuweiler, 1959. Örby E 6 Viaduct Exposure, Döshult Beds, Lower Sinemurian.
A. Side view of specimen En Sem 49:5. 122 X.
B. Side view of specimen En Sem 26:2. 110 X.
C. Oblique apertural view of specimen En Sem 26:2, 110 X.
D. Aperture of specimen En Sem 26:2. 555 X.

GEOGRAPHICAL DISTRIBUTION. – In Sweden *Astacolus neoradiata* is very common in Lower Sinemurian strata and constitutes a notable element of the Upper Sinemurian foraminiferal fauna, but occurs only temporarily in the Pliensbachian. Concerning Denmark (Jutland), it is reported from Sinemurian and Pliensbachian strata by Nørvang (1957). Bang (1968) recorded it from Sinemurian beds in the Öresund borings offshore from Helsingborg. The NW. German finds range from the Upper Hettangian to the Pliensbachian (Bartenstein & Brand, 1937; Bach, Hagenmeyer & Neuweiler, 1959). Bizon (1960) reported this species from Hettangian and Lower Sinemurian strata in France (Lorraine). Ruget & Sigal (1967) also recorded it from the Upper Sinemurian.

STRATIGRAPHICAL DISTRIBUTION. – Hettangian to Pliensbachian.

Astacolus prima (D'ORBIGNY, 1849)

Fig. 25 A–D.

1849 *Cristellaria prima* D'ORBIGNY. – p. 242, No. 266.
1850 *Cristellaria prima* D'ORBIGNY. – Vol. 1, p. 242.
1866 *Cristellaria prima* D'ORBIGNY. – Terquem, p. 513, Pl. 21, Fig. 35 a, b.
1936 *Cristellaria prima* D'ORBIGNY. – Macfadyen, p. 151, Pl. 1, Fig. 266 a, b (type figure).
1937 *Cristellaria (Astacolus) prima* (D'ORBIGNY). – Bartenstein & Brand, p. 172, Pl. 1 A, Fig. 25; Pl. 2 A, Fig. 17; Pl. 3, Fig. 44; Pl. 4, Fig. 81; Pl. 5, Fig. 54.
1957 *Marginulinopsis prima* (D'ORBIGNY). – Nørvang, p. 98, Figs. 116, 121, 122.

DESCRIPTION. – Test auriculate, compressed, smooth. Chambers 6–12 in number in an initially coiled, later curved series. Sutures flush or depressed. Initial end with a marginal keel. Test-wall fibrous-radiate, finely perforate, secondarily non-lamellar with a slight overlap of primary wall layers. Aperture at peripheral angle, protruding, or produced to form a short neck, distinctly radiate.

DIMENSIONS. – Length, 0.50–1.10 mm; breadth, 0.40–0.57 mm.

MATERIAL. – Ten specimens from the boring Kävlinge No. 930, 70.3–71 m, Katslösa Beds, Lower Pliensbachian; 5 specimens from the boring Rydebäck-Fortuna No. 1, 74 m, Katslösa Beds, 68.5, 53.35–53.30, 40.5 m, Rydebäck Beds, Pliensbachian, Lias.

REMARKS. – The specimen in Fig. 25 A–D is somewhat more slender in the initial part of the test than the type specimen (Macfadyen, 1936, Pl. 1, Fig. 266 a). The apertures, however, seem to be almost identical. *Astacolus prima* shows affinity to Jurassic forms of the genus *Dimorphina* D'ORBIGNY, 1836, from which it differs in having a keeled margin in the coiled portion and a compressed test.

GEOGRAPHICAL DISTRIBUTION. – Brouwer (1969) recorded this species from Hettangian to Lower Aalenian strata in most Jurassic basins of NW. Europe. It has also been recorded from the Middle Jurassic. In Sweden and Denmark *Astacolus prima* has been obtained from Pliensbachian and Toarcian strata.

STRATIGRAPHICAL DISTRIBUTION. – Lower Jurassic-Middle Jurassic.

Astacolus quadricostata (TERQUEM, 1863)

Fig. 26 A–C.

1863 *Marginulina quadricostata* TERQUEM. – p. 190, Pl. 8, Fig. 12 a, b.
1875 *Cristellaria nexa* TERQUEM & BERTHELIN. – p. 49, Pl. 4, Fig. 11 a, b.
1936 *Cristellaria (Astacolus) quadricosta* (TERQUEM). – Franke, p. 109, Pl. 11, Fig. 4.
1937 *Cristellaria (Astacolus) quadricostata* (TERQUEM). – Bartenstein & Brand, p. 173, Pl. 3, Fig. 47; Pl. 4, Fig. 71; Pl. 5, Fig. 57.
1941 *Cristellaria quadricostata* (TERQUEM). – Macfadyen, p. 33, Pl. 2, Fig. 25 a, b.
1957 *Marginulinopsis quadricostata* (TERQUEM). – Nørvang, p. 94, Figs. 108–113.
1968 *Marginulinopsis quadricostata* (TERQUEM). – Norling, p. 14, Text-Fig. 4.

MATERAL. – Numerous specimens from Pliensbachian layers of the Rydebäck-Fortuna cores No. 1 (78–92 m) and No. 4 (107–108 m); some few specimens from the Lower Sinemurian of the Öresund core 01 (15–22 m). See also text to Fig. 26, p. 58.

REMARKS. – Detailed descriptions of this species have been given previously, viz. by Nørvang (1957, p. 94). Terquem's type specimen (1864, Pl. 8, Fig. 12 a) is much more slender than most other figured specimens, viz. those illustrated by Franke (1936), Bartenstein & Brand (1937), and Nørvang (1957). The number of costae on each side of the test is not invariably four, but also three.

GEOGRAPHICAL DISTRIBUTION. – Brouwer (1969) recorded this species from Hettangian to Toarcian strata in most Liassic basins of NW. Europe.

STRATIGRAPHICAL DISTRIBUTION. – Common in the Pliensbachian, rare in other L. Jurassic stages.

Fig. 25 A–D. *Astacolus prima* (D'ORBIGNY, 1849). Specimen EN SEM 93:1. Boring Kävlinge No. 930, 70.3–71.6 m, Katslösa Beds, Lower Pliensbachian, Lower Lias.

A. Side view. Note the keeled lower margin. 67 X.
B. Side view of apertural chamber. 270 X.
C. Oblique apertural view. 135 X.
D. Oblique apertural view. 270 X.

Astacolus gordoni nov. nom.

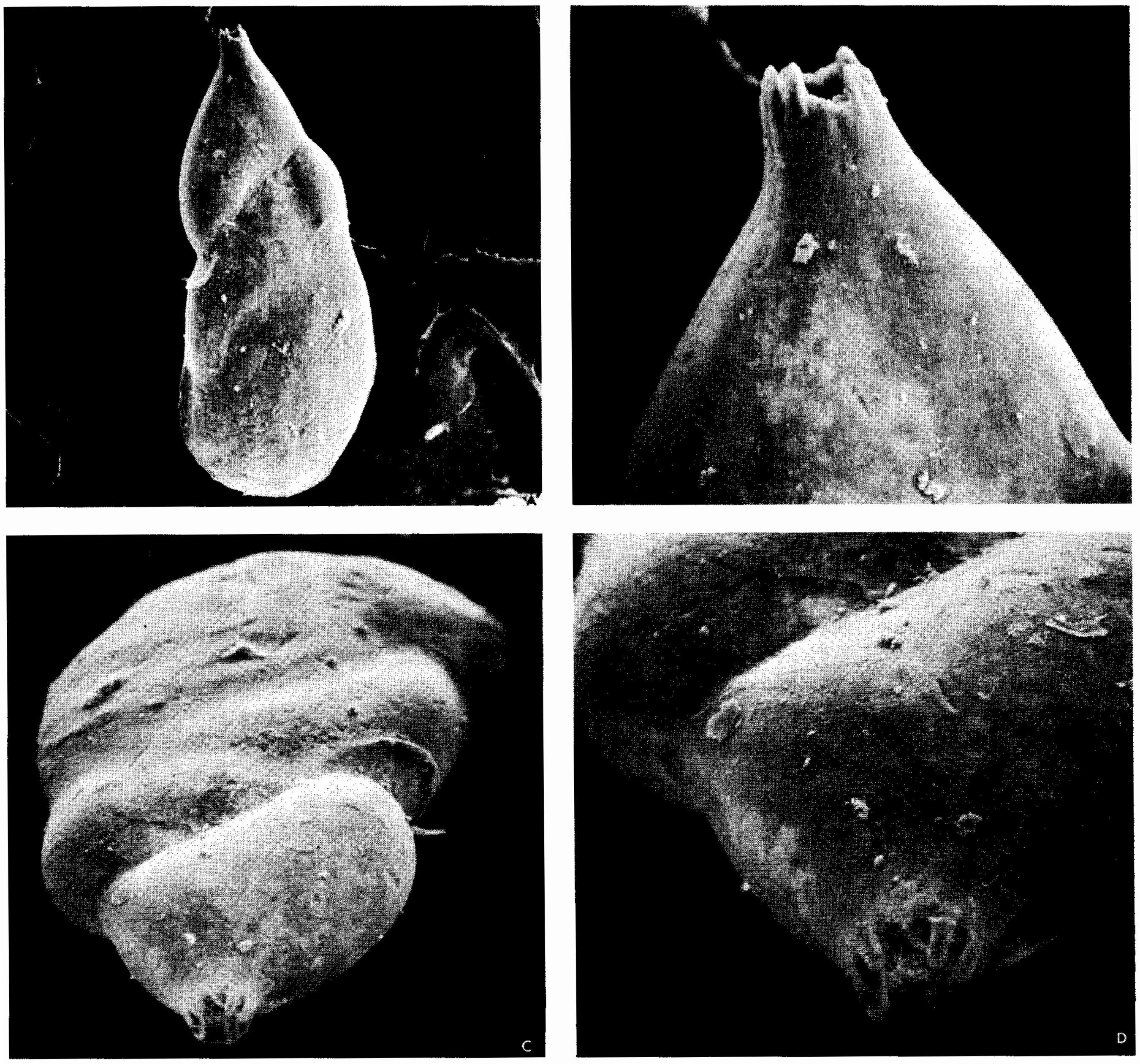
1962 *Lenticulina suprajurassica* GORDON. – p. 528, Text-Fig. 2:3–6.
1965 *Lenticulina suprajurassica* GORDON. – p. 840, Text-Fig. 6:3, 5.
1970 *Lenticulina suprajurassica* GORDON. – Norling, p. 271, Fig. 4.

REMARKS. – In 1962, Gordon erected a new species under the name of *Lenticulina suprajurassica,* obtained from the Oxfordian Ampthill Clay of Cambridgeshire, England. However, the specific name is preoccupied by *Lenticulina suprajurassica* (SCHWAGER, 1865), originally described from the Lower Oxfordian *(Impressa-Thon)* of S. Germany. Schwager's species has variously been referred to *Cristellaria, Lenticulina,* and *Astacolus.*

Gordon's type figures (Text-Fig. 2:3–6) definitely illustrate forms which should be placed in the genus *Astacolus* DE MONTFORT. The present writer therefore suggests the new name *Astacolus gordoni.*

MATERIAL. – Three specimens from the boring Rydebäck-Fortuna No. 5, 89.2 m, Fyledal Clay, Oxfordian/Kimmeridgian, Upper Jurassic.

DISTRIBUTION. – In Oxfordian and Kimmeridgian strata in England, Germany and Sweden. According to Gordon (1962, p. 529), some forms from the Bajocian of E. France referred to *Cristellaria hybrida* by Terquem (1870) may belong to the species named *Astacolus gordoni* herein.



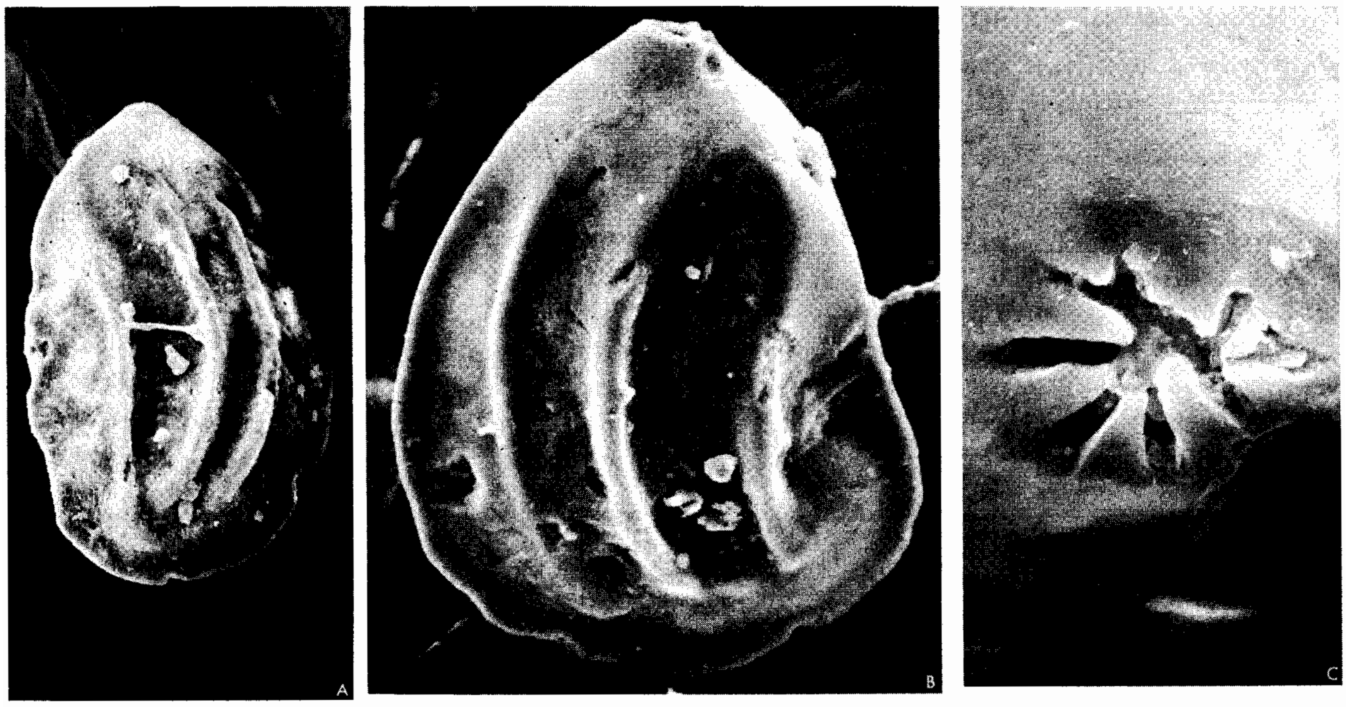


Fig. 26 A–C. *Astacolus quadricostata* (TERQUEM, 1864). Boring Kävlinge No. 930, Katslösa Beds, Lower Pliensbachian, Lower Lias.
A. Side view of specimen EN SEM 95:4 from core interval 62.7–63.5 m. 236 X.
B. Side view of specimen EN SEM 92:8 from core interval 65.3–65.4 m. 265 X.
C. Aperture of specimen EN SEM 95:3 from core interval 62.7–63.5 m. 1000 X.

Astacolus semireticulata nov. sp.

Fig. 27 A–D.

1968 *Lenticulina* sp. No. 26 BANG. – pp. 64, 66, Pl. 24.

HOLOTYPE. – Specimen EN SEM 49:1 (Fig. 27 B, C).

TYPE STRATUM AND TYPE LOCALITY. – In calcareous, clayey siltstone, Döshult Beds, Lower Sinemurian, Lower Lias. Örby E 6 Viaduct Exposure, sample No. 6, about 8 km SSE. Helsingborg centre, NW. Scania, S. Sweden.

DIAGNOSIS. – Test auriculate, flattened; chambers 6–9 in a curved series; sutures depressed, slightly curved, higher at dorsal margin; initial half of the test reticulate; aperture at peripheral angle and radiate.

DESCRIPTION. – Test elongate, auriculate, laterally compressed; chambers 6–9 in number, very low, in a curved series. Sutures slightly curved and depressed, frequently with a thin sutural rib. Ornamentation consists of a reticulate net covering initial half of the test. Test-wall calcareous, fibrous-radiate, finely perforate. Aperture terminal, at peripheral angle, radiate with 5–7 short and broad slits in a stellar arrangement leaving a cap of calcareous matter in the centre. It is uncertain whether a true apertural chamberlet exists.

DIMENSIONS. – Holotype; length, 0.63 mm; maximum breadth, 0.31 mm.

MATERIAL. – Eighteen specimens from Välluf E 6 Viaduct Exposure, sample No. 11, Helsingborg Beds, Hettangian; the boring Helsingborg Kvarn No. 2220, 38–44 m; Örby E 6 Viaduct Exposure, samples Nos. 6–10; Gantofta Brick Pit, Döshult Beds, Lower Sinemurian, Lower Lias.

REMARKS. – In some specimens (see Fig. 27 A) raised sutural ribs form part of the reticulation of the initial end of the test. Bang (in Larsen et al., 1968) commented on this species under the name of *Lenticulina* No. 26. She found it in beds of Hettangian and Early Sinemurian age in the Öresund cores Nos. 8, 10, 11, and 14 offshore from Helsingborg.

DISTRIBUTION. – Hettangian-Lower Sinemurian, Lower Jurassic.

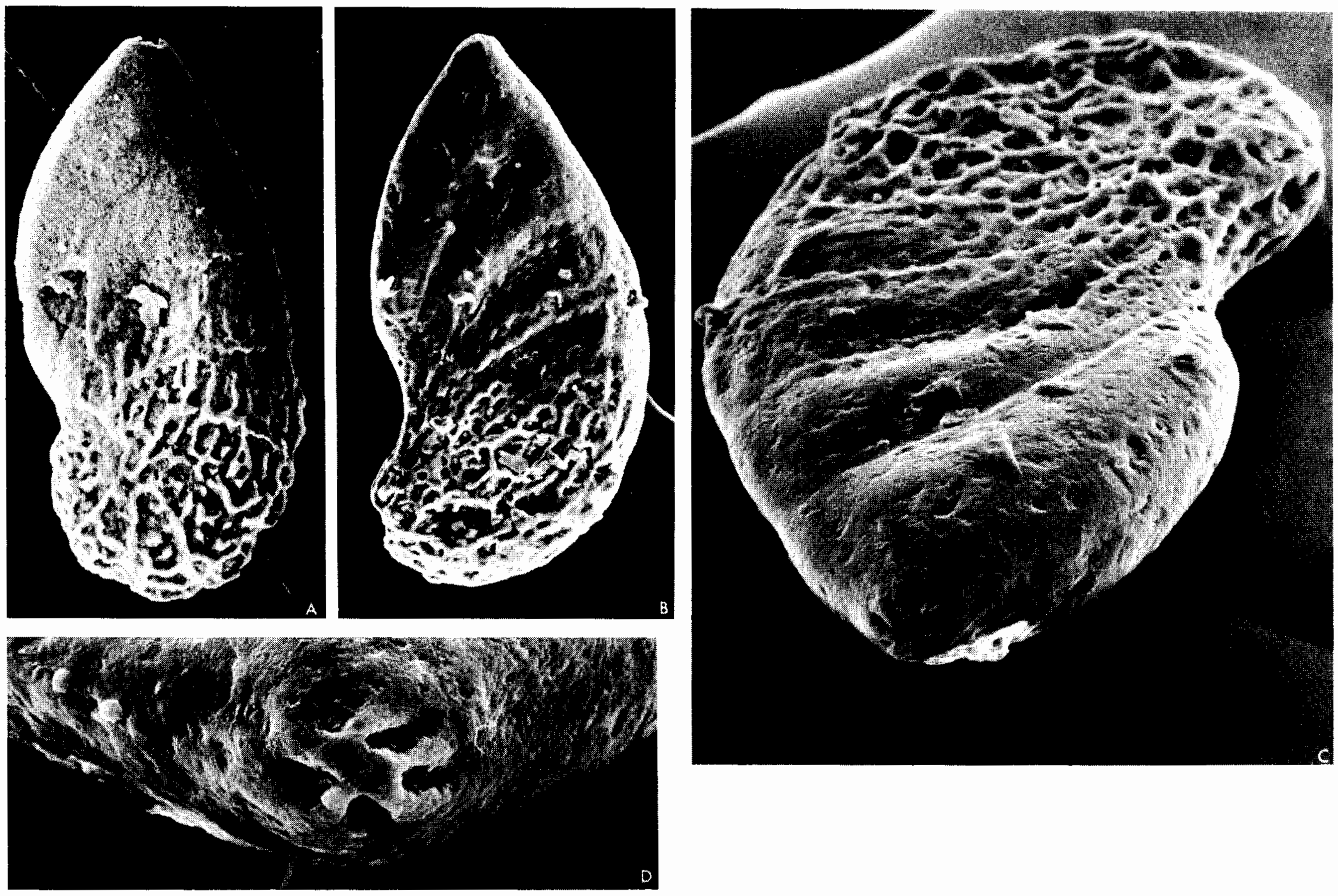


Fig. 27 A–D. *Astacolus semireticulata* nov. sp.

A. Side view of specimen EN SEM 100:3 (paratype). Örby E 6 Viaduct Exposure, sample No. 10, Döshult Beds, Lower Sinemurian, Lower Lias. 130 X.

B. Side view of specimen EN SEM 49:1 (holotype). Örby E 6 Viaduct Exposure, sample No. 6, Döshult Beds, Lower Sinemurian, Lower Lias. 120 X.

C. Oblique apertural view of specimen EN SEM 49:1 (holotype). 245 X.

D. Aperture of specimen EN SEM 49:2 from the type stratum. 660 X.

Genus *Citharina* D'ORBIGNY, 1839

Fig. 28 A–E.

DIAGNOSIS. – Test flattened, subtriangular in outline, may be keeled; chambers numerous, low and broad, in many species extending nearly to base of ventral margin; test-surface smooth, striate or costate; wall calcareous, finely perforate, non-lamellar in Early Jurassic forms, later becoming lamellar; aperture at dorsal angle, radiate.

TYPE SPECIES. – *Vaginulina (Citharina) strigillata* REUSS, 1846. Subsequent designation by Loeblich & Tappan, 1949.

SPECIES FROM THE SWEDISH JURASSIC. – *Citharina clathrata* (TERQUEM, 1864), *C. eugenii* (TERQUEM, 1864), *C. flabellata* (GÜMBEL, 1862), *C. inaequistriata* (TERQUEM, 1863), *C. macilenta* (TERQUEM, 1868), *C. tenuicostata* LUTZE, 1960.

REMARKS. – The genus *Citharina* appeared for the first time in the lowermost Lias. In the Lower and Middle Lias the number of species was very small. However, in the Toarcian a large group of strongly ribbed *Citharina* species appeared in most Jurassic basins of Europe, flourished in the Upper Lower Jurassic and the Middle Jurassic, decreased in the Upper Jurassic, and almost disappeared in the Lower Cretaceous. Unfortunately, the identification of Toarcian-Aalenian species is very difficult, since the criteria for distinguishing them have not been put on a statistical basis, which is necessary due to the great variation of morphological forms even within one alleged species. Concerning the *Citharina* fauna obtained from Toarcian-Aalenian strata in W. Scania, the material is too scarce to allow determinations on a statistical basis.

DISTRIBUTION. – Lower Jurassic-Paleocene.

Citharina clathrata (TERQUEM, 1864) emend. Payard, 1947

Fig. 28 D.

1864 *Marginulina longuemari* var. *clathrata* TERQUEM. – p. 402, Pl. 8, Figs. 16, 19.
1942 "*Vaginulina* (502)" WICHER. – p. 62, Pl. 25, Fig. 1.
1947 *Pseudocitharina longuemari* var. clathrata (TERQUEM). – Payard, p. 134, Pl. 4, Fig. 1.
1949 *Vaginulina infraopalina* BRAND. – p. 337, Pl. 14.
1962 *Citharina infraopalina* BRAND. – Brand in "Leitfossilien", p. 156, Table 9, Pl. 20, Fig. 9.
1969 *Citharina clathrata* (TERQUEM). – Brouwer, p. 31, Pl. 2, Fig. 14 (synonymy list).
1970 *Citharina infraopalina* BRAND. – Norling, p. 280; Fig. 4, p. 271.

HOLOTYPE. – *Marginulina longuemari* var. *clathrata* TERQUEM, 1864. Subsequent designation by Payard, 1947.

TYPE FIGURE. – Specimen illustrated by Payard, 1947, Pl. 4, Fig. 1, from Terquem's collection. Length, 1.25 mm; breadth, 0.56 mm.

TYPE STRATUM AND TYPE LOCALITY. – "Lias superieur. Couche à *Pecten pumilus*. Quéaux, vallée de Latillé, à 25 kilom. Ouest de Poiters, Vienne, France."

MATERIAL. – Two specimens from the boring Rydebäck-Fortuna No. 1, 30 m and 35 m, Rydebäck Beds, Toarcian/Aalenian; one specimen from the boring Rydebäck-Fortuna No. 4, 35 m, Eriksdal Beds, Aalenian/Bajocian; one specimen from the same boring, 74 m, Rydebäck Beds, Toarcian/Aalenian.

REMARKS. – Detailed descriptions of this species have been given by Terquem (1864) and Payard (1947). Brand (1962) assigned broad, triangular, strongly ribbed *Citharina* from the Upper Toarcian-Aalenian of W. Germany to *Citharina infraopalina* unfortunately without giving any type stratum and type locality. Obviously the same form is referred to *Citharina clathrata* (TERQUEM) by Brouwer (1969). Note that Brouwer's photographed specimen in Pl. 2, Fig. 14 is almost identical with the specimen referred to *Citharina infraopalina* in "Leitfossilien", 1962, Pl. 20, Fig. 9.

GEOGRAPHICAL DISTRIBUTION. – Recorded from NW. and S. Germany, Austria, Swiss Jura, Paris Basin, NE. Aquitaine, Normandy, Lower Rhone Valley, Poitevin, E. Netherlands, Yorkshire-Midlands, Scotland and Sweden.

STRATIGRAPHICAL DISTRIBUTION. – Uppermost Pliensbachian-Lower Aalenian, Lower Jurassic.

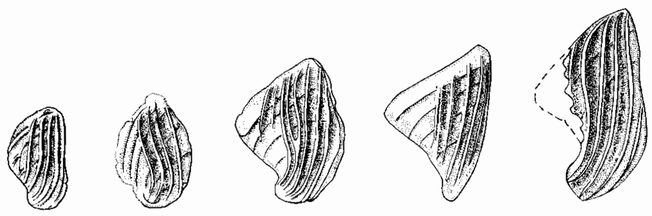


Fig. 28 A–E. Schematic drawings of *Citharina* forms from the Lower Jurassic/Middle Jurassic junction in the Rydebäck-Fortuna cores Nos. 1 and 4.
A. *Citharina* sp. EN 78:3. Core No. 4, 35 m, Eriksdal Beds, Aalenian/Bajocian. The specimen shows affinity to *Citharina proxima* (TERQUEM, 1868) Form E, originally described from the Fuller's Earth, Bathonian. 32.5 X.
B. *Citharina* sp. EN 78:2. Core No. 4, 35 m, Eriksdal Beds, Aalenian/Bajocian. 32.5 X.
C. Citharina sp. EN 78:1. Core No. 1, 30 m, Rydebäck Beds, Toarcian/Aalenian. Compare *Citharina proxima* (TERQUEM, 1868) in Bartenstein & Brand, 1937, Pl. 8, Fig. 27 a from the Aalenian ("Opalinus-Schichten"). 15 X.
D. *Citharina clathrata* (TERQUEM, 1864). Specimen EN 78:5. Core No. 1, 35 m, Rydebäck Beds, Toarcian/Aalenian. 15 X.
E. *Citharina* sp. EN 78:4. Core No. 4, 74 m, Rydebäck Beds, Toarcian/Aalenian. 15 X.

Citharina inaequistriata (TERQUEM, 1863)

Fig. 29 A–B.

1863 *Marginulina inaequistriata* TERQUEM. – p. 191, Pl. 8, Fig. 15.
1866 *Marginulina cancellaroides* TERQUEM. – p. 508, Pl. 21, Fig. 25 a, b.
1876 *Marginulina inaequistriata* TERQUEM. – Tate & Blake, p. 462, Pl. 19, Fig. 7.
1908 *Cristellaria inaequistriata* (TERQUEM). – Issler, p. 80, Pl. 5, Figs. 251–254.
1908 *Cristellaria arietis* (TERQUEM). – Issler, p. 81, Pl. 5, Figs. 255, 260.
1936 *Cristellaria (Astacolus) inaequistriata* (TERQUEM). – Franke, p. 108, Pl. 10, Figs. 24, 25.
1937 *Cristellaria (Astacolus) inaequistriata* (TERQUEM). – Bartenstein & Brand, p. 173, Pl. 2 A, Fig. 21 a–c; Pl. 2 B, Fig. 36 a, b.
1950 *Planularia inaequistriata* (TERQUEM). – Barnard, p. 375, Fig. 8 c, d, g.
1957 *Planularia inaequistriata* (TERQUEM). – Nørvang, p. 102, Figs. 148, 149.
1966 *Planularia inaequistriata* (TERQUEM). – Brotzen & Norling (in Mohrén), p. 16.
1966 *"Planularia" inaequistriata* (TERQUEM). – Norling, pp. 10, 11.
1968 *"Planularia" inaequistriata* (TERQUEM). – Norling, pp. 14, 15, 16, 48, 49, Text-Fig. 4; Pl. 9.
1969 *Citharina inaequistriata* (TERQUEM). – Brouwer, pp. 11, 15, 32, Table 3; Pl. 6, Figs. 20, 21.

MATERIAL. – Numerous specimens from the boring Öresund 01, 22 m and 42 m, Döshult Beds, Lower Sinemurian; Gantofta Brick Pit, Döshult Beds, Lower Sinemurian; Katslösa Exposure, Loc. 750–780, Katslösa Beds, Upper Sinemurian; boring Rydebäck-Fortuna No. 1, 139.8 m, Pankarp Clays, Upper Sinemurian.

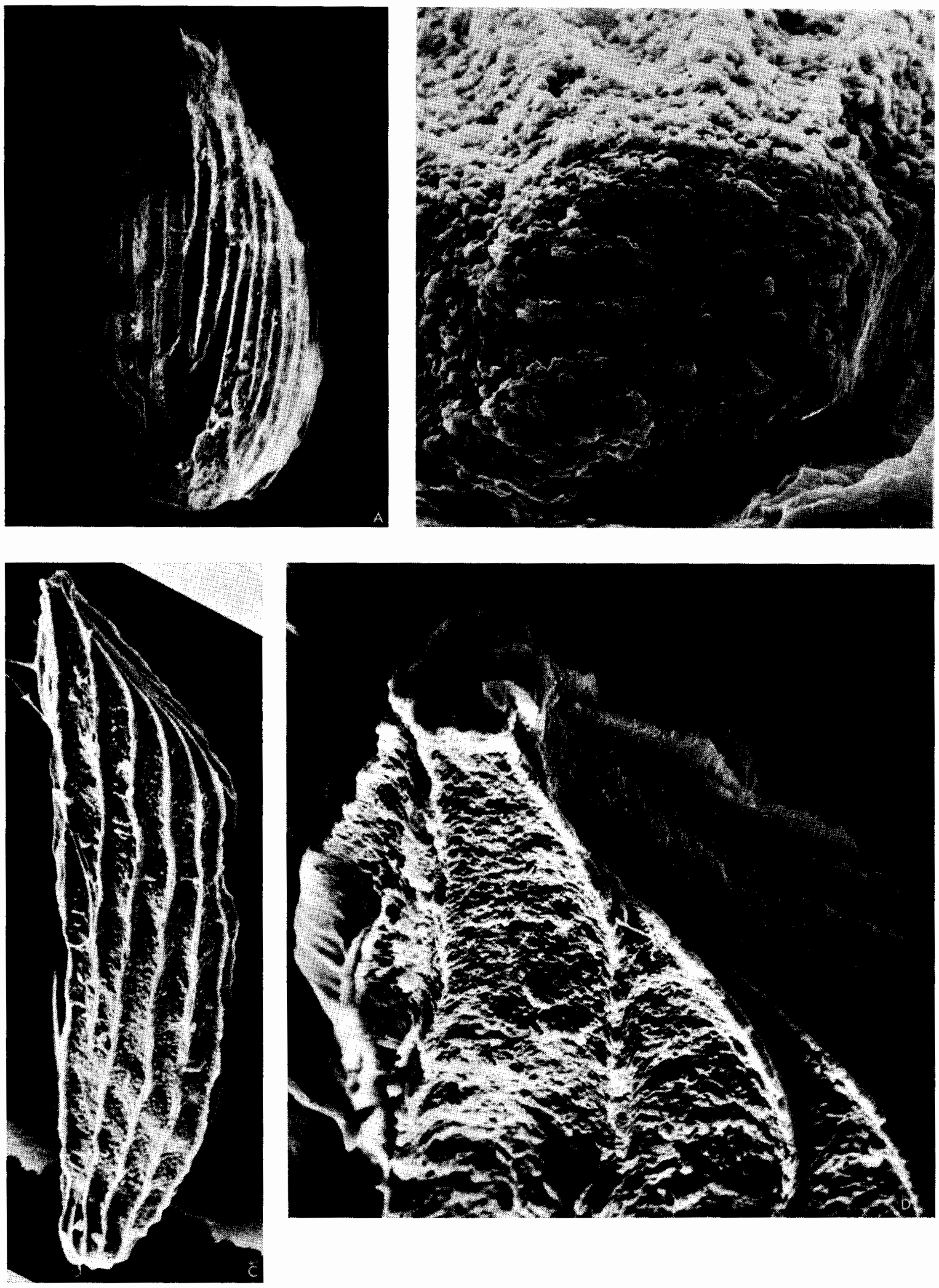


Fig. 29 A–B. *Citharina inaequistriata* (Terquem, 1863).

A. Side view of specimen En Sem 87:1. Gantofta Brick Pit, Gryphaea beds, Lower Sinemurian. 72 X.

B. Radiate aperture of specimen En Sem 17:1. Boring Rydebäck-Fortuna No. 1, 139.8 m, Pankarp Clays, Upper Sinemurian. 1125 X.

Fig. 29 C–D. *Citharina macilenta* (Terquem, 1868).

Specimen En Sem 28:2. Boring Rydebäck-Fortuna No. 5, 148 m, Fortuna Marl, Callovian/Oxfordian. C. Side view. 100 X. D. Oblique view or apertural chamber. 500 X.

DIMENSIONS. – See Norling, 1968, p. 49.

REMARKS. – Detailed descriptions of this species have been given previously. According to sectioned specimens from the Swedish Lias, *Citharina inaequistriata* has a finely perforate, non-lamellar wall with a certain degree of overlapping of primary wall layers (Norling, 1968, p. 49). The aperture is distinctly radiate with numerous slits (Fig. 29 B).

In the *Gryphaea* beds, outcropping in the basal part of the Gantofta Brick Pit, *Citharina inaequistriata* makes about 12 % of the total foraminiferal fauna. Usually it is less frequent. In Denmark, this species has been recorded from Hettangian and Lower Sinemurian strata (Nørvang, 1957). In East Germany (DDR), it is restricted to the Sinemurian (Pietrzenuk, 1961; Rusbült & Petzka, 1964). In no Liassic basins of W. Europe has it been found in beds younger than the Sinemurian, as far as is known to the present writer.

DISTRIBUTION. – Hettangian-Sinemurian.

Citharina macilenta (Terquem, 1868)

Fig. 29 C–D.

1868 *Marginulina macilenta* Terquem. – p. 112, Pl. 7, Fig. 1 a, b, Figs. 2–18.
1883 *Vaginulina mosquensis* Uhlig. – p. 751, Pl. 9, Fig. 9.
1937 *Vaginulina macilenta* (Terquem). – Bartenstein & Brand, p. 163, Pl. 11 B, Fig. 12 a, b.
1960 *Citharina macilenta* (Terquem). – Lutze, p. 461, Pl. 30, Fig. 9.
1959 *Vaginulina macilenta* (Terquem). – Cifelli, p. 323, Pl. 5, Fig. 13.
1962 *Citharina macilenta* (Terquem). – Cordey, p. 385, pl. 47, Fig. 19.
1965 *Citharina macilenta* (Terquem). – Hanzlíková, p. 88, Pl. 4, Figs. 18 a, b, 20; Pl. 8, Fig. 1.
1970 *Citharina macilenta* (Terquem). – Norling, p. 271, Fig. 4; p. 272, Fig. 5 a, b; p. 273.

MATERIAL. – Some few specimens from the Rydebäck-Fortuna core No. 5, 158.8–147.1 m, Fortuna Marl, U. Bathonian-Oxfordian.

REMARKS. – Detailed descriptions of this species have been given previously. One of the best descriptions, in my opinion, is that given by Bartenstein & Brand, 1937, p. 163. The Swedish specimens have a distinctly radiate aperture, some with a tendency to form a phialine lip. The nature of the radiation is a kind of radiate folding.

DISTRIBUTION. – In Sweden, Upper Bathonian/Callovian-Lower Oxfordian; in Europe, Middle Jurassic-lowermost Upper Jurassic.

Genus *Dentalina* Risso, 1826

Figs. 30, 31.

DIAGNOSIS (emended). – Test elongated, arcuate, uniserial; sutures commonly oblique; test calcareous, wall fibrous-radiate, perforate, secondarily lamellar; aperture terminal, may be eccentric or nearly central, radiate. An apertural chamberlet may occur.

TYPE SPECIES. – *Nodosaria (Dentaline) cuvieri* D'Orbigny, 1826 by original designation.

SPECIES FROM THE SWEDISH JURASSIC. – *Dentalina guembeli* Schwager, 1865, *Dentalina subplana* Terquem, 1870.

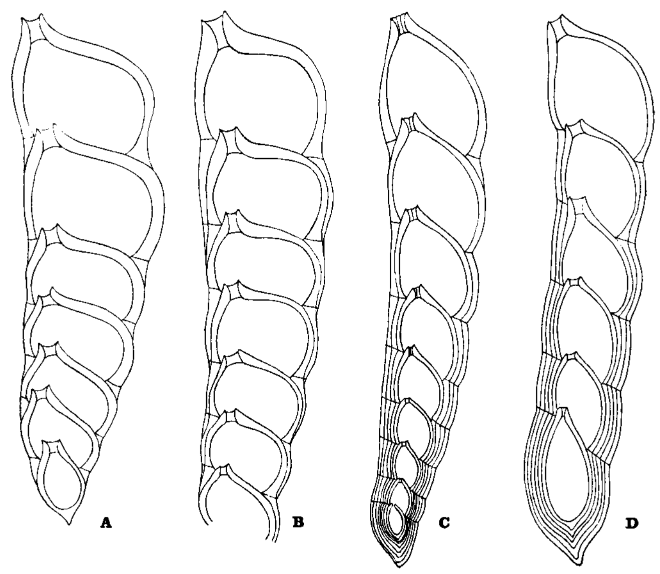


Fig. 30 A–D. Schematic drawings showing different stages of secondary lamination in dentalinoid foraminifera from the Lower Lias (A, B), Middle Lias (C), and the Upper Cretaceous (D). (After E. Norling, 1968.)
A. Non-lamellar test-wall in the genus *Prodentalina* Norling, 1968. Drawing based on sectioned specimen of *Prodentalina terquemi* (D'Orbigny, 1849). Katslösa Exposure, Döshult Beds, Lower Sinemurian. 100 X.
B. Mesolamellar test-wall in the genus *Mesodentalina* Norling, 1968. Drawing based on sectioned specimen of *Mesodentalina matutina* (D'Orbigny, 1849). Waddington Brick Pit, Lincolnshire, England. Pliensbachian. 66 X.
C. Lamellar test-wall in *Dentalina* ex gr. *communis* D'Orbigny. Note that the lamination is not complete in the distal part of the test. Middle Lias. (After Gerke, 1957).
D. Lamellar test-wall in *Dentalina* s.str. D'Orbigny, 1826. Drawing based on sectioned specimen of *Dentalina* sp. (smooth form). Boring Vittskövle No. 15, Scania. Upper Campanian. 106 X.

REMARKS. – The genus *Dentalina* was subdivided by the present writer (1968) into *Dentalina* s. str., *Mesodentalina* Norling, 1968, and *Prodentalina* Norling, 1968. This subdivision was justified by observed differences in the wall structure. See Norling, 1968, pp.

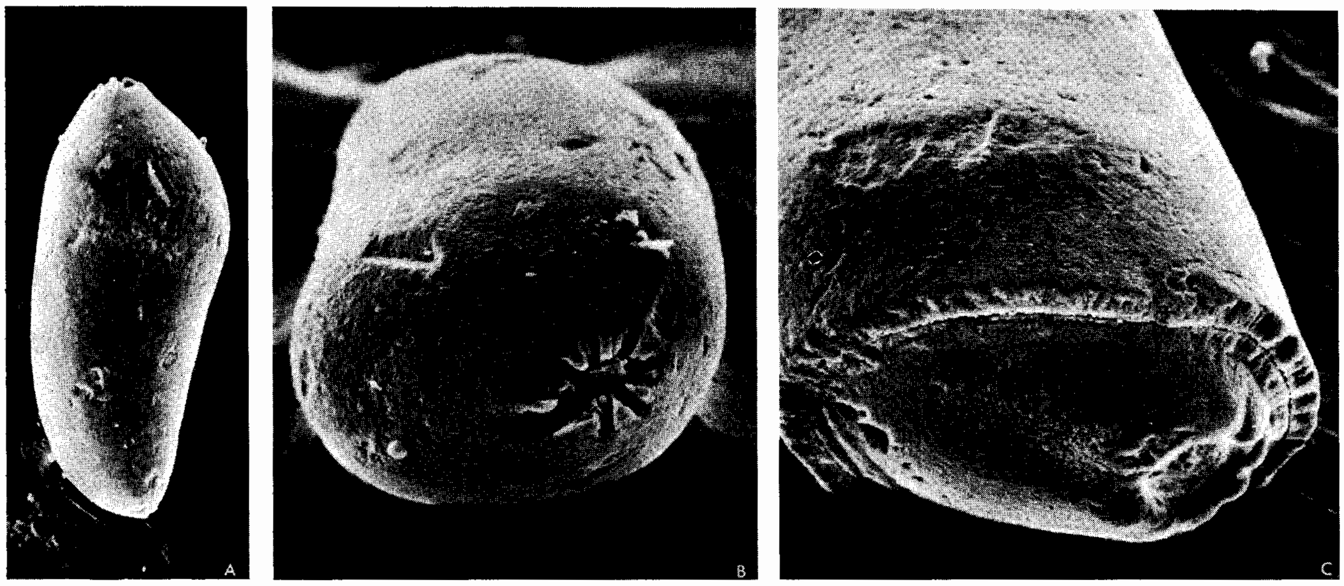


Fig. 31 A–C. *Dentalina* ex gr. *guembeli* SCHWAGER, 1865. Boring Rydebäck-Fortuna No. 5, 147.1–147.2 m, Fortuna Marl, Oxfordian.

A. Side view of specimen EN SEM 127:1. Short form. 100 X.

B. Apertural view of the same specimen. 210 X.

C. View of broken specimen EN SEM 127:2 showing a radiate foramen and a lamellar test-wall. 200 X.

34–43, 53; Text-Figs. 8 a–d, 9 a_1–c_2, 10 a–c; Pl. 3, Figs. 1–6; Pl. 4, Figs. 1–3; Pl. 7, Figs. 1–3; Pl. 8, Figs. 1–2; Pl. 9.

The genera *Mesodentalina* and *Prodentalina* have been found in Liassic beds only, but may occur in the Triassic, and perhaps also the Permian. The first species of genus *Dentalina* appeared in the Middle Lias.

DISTRIBUTION. – Middle Lias – Recent.

Dentalina ex gr. *guembeli* SCHWAGER, 1865

Fig. 31 A–C.

1865 *Dentalina guembeli* SCHWAGER. – p. 101, Pl. 2, Fig. 20.
1865 *Dentalina lutigena* SCHWAGER. – p. 102, Pl. 2, Fig. 22.
1865 *Dentalina imbecilla* SCHWAGER. – p. 103, Pl. 2, Fig. 25.
1865 *Dentalina sublinearis* SCHWAGER. – p. 103, Pl. 2, Fig. 26.
1886 *Dentalina guembeli* SCHWAGER. – Deecke, p. 20, Pl. 1, Fig. 14.
1932 *Dentalina precuate* REUSS. – Paalzow, p. 113, Pl. 7, Fig. 19.
1932 *Dentalina oligostega* REUSS. – Paalzow, p. 113, Pl. 7, Fig. 23.
1932 *Dentalina digitata* PAALZOW. – p. 115, Pl. 8, Figs. 2, 3.
1932 *Dentalina obsoleta* SCHWAGER. – Paalzow, p. 119, Pl. 8, Fig. 14.
1935 *Nodosaria vetustissima* (D'ORBIGNY). – Macfadyen, p. 10, Pl. 1, Fig. 4.
1952 *Dentalina guembeli* SCHWAGER. – Barnard, p. 346, Fig. A 7.
1953 *Dentalina guembeli* SCHWAGER. – Barnard, p. 188, Text-Fig. B 6.
1955 *Dentalina jurensis* (GÜMBEL). – Seibold & Seibold, p. 112, Text-Fig. 2 n; Pl. 13, Fig. 9.
1956 *Dentalina jurensis* (GÜMBEL). – Seibold & Seibold, p. 131, Text-Fig. 5 a–c.
1956 *Dentalina bullata* SCHWAGER. – Seilbold & Seibold, p. 128, Text-Fig. 6 a, b; Pl. 7, Fig. 3.
1965 *Dentalina guembeli* SCHWAGER. – Gordon, p. 843, Text-Fig. 6:13–18.
1967 *Dentalina guembeli* SCHWAGER. – Gordon, p. 453, Pl. 4, Figs. 1–2.

MATERIAL. – Twenty specimens from the boring Rydebäck-Fortuna No. 5, 147.1–150.0 m, Fortuna Marl, Callovian-Oxfordian.

REMARKS. – As pointed out by Gordon (1965), *Dentalina guembeli*, originally described by Schwager (1865) from the Lower Oxfordian of S. Germany, is characterized by its variable form and irregular development, The test may be more or less straight or arcuate and the chambers increase in size regularly, or may be irregular in height, diameter and inflation. In the past, many of the individual variants have been named new species. Most notably, Schwager (1865) erected 33 new species most of which, as pointed out by Barnard (1952), probably represent variants of only a few species.

The Swedish specimens have a completely lamellar test-wall, which divide them from morphologically closely related forms from the Lias, the latter being referred to the genus *Prodentalina* NORLING, 1968, with a non-lamellar test-wall.

DISTRIBUTION. – In Callovian and Oxfordian strata in Europe.

Genus *Frondicularia* DEFRANCE, 1826

DIAGNOSIS (emended). – Test elongate, or palmate, flattened; chambers low, broad, and inverted V--shaped; sutures strongly arched or angled at centre of the test. Test smooth, striate, or costate; test-wall calcareous, fibrous-radiate, finely perforate, secondarily lamellar. Aperture terminal, central, radiate, may be produced to form a neck.

TYPE SPECIES. – *Renulina complanata* DEFRANCE, 1824. Subsequent designation by Cushman, 1913. Pliocene.

SPECIES FROM THE SWEDISH JURASSIC. – *Frondicularia franconica* GÜMBEL, 1862; *Frondicularia nikitini* UHLIG, 1883.

REMARKS. – Lower Jurassic foraminifera, previously referred to *Frondicularia* are placed in the genus *Ichthyolaria* WEDEKIND, 1937 (see p. 65 in the present paper and Norling, 1966).

DISTRIBUTION. – Middle Jurassic – Recent.

Frondicularia franconica GÜMBEL, 1862

1862 *Frondicularia franconica* GÜMBEL. – p. 219, Pl. 3, Fig. 13 a–c (type).
1870 *Frondicularia spissa* TERQUEM. – p. 215, Pl. 22, Fig. 10.
1870 *Frondicularia spatulata* TERQUEM. – p. 215, Fig. 11.
1937 *Frondicularia spissa* TERQUEM. – Bartenstein & Brand, p. 154, Pl. 14 C, Fig. 8; Pl. 15 A, Fig. 19; Pl. 15 C, Fig. 9.
1937 *Frondicularia franconica* GÜMBEL. – Bartenstein & Brand, p. 153, Pl. 15 C, Fig. 8.
1952 *Frondicularia franconica* GÜMBEL. – Barnard, p. 340, Fig. A 1.
1953 *Frondicularia franconica* GÜMBEL. – Barnard, p. 186, Figs. B 2, B 3.
1960 *Frondicularia franconica franconica* GÜMBEL. – Lutze, p. 470, Pl. 32, Figs. 4, 6, 14.
1960 *Frondicularia franconica* GÜMBEL ssp. *impressa* LUTZE. – Lutze, Pl. 32, Figs. 3,5.
1962 *Frondicularia franconica* GÜMBEL. – Cordey, p. 387, Pl. 47, Figs. 20–21; Text-Figs. 31–36.
1967 *Frondicularia franconica* GÜMBEL. – Gordon, p. 454, Pl. 3, Figs. 2–8.

DESCRIPTION. – Test elongate, bluntly lanceolate, oval or slightly bilobate in transverse section. Margins rounded, unkeeled. Chambers numerous, low and broad. Sutures flush or slightly depressed, indistinct or distinct, obtuse-angled. Test smooth, test-wall finely perforate, fibrous-radiate, secondarily lamellar. Aperture terminal, central, elevated, protruding, or produced to form a short neck, typically radiate.

MATERIAL. – Fifteen specimens from the boring Rydebäck-Fortuna No. 5, 155.0–158.8 m, Fortuna Marl, Upper Bathonian-Callovian (basal Oxfordian?).

REMARKS. – *Frondicularia franconica* shows a close affinity to *Lingulina lingulaeformis,* from which it differs in having a radiate or, rarely rounded aperture. *Lingulina lingulaeformis* has a slit-shaped aperture.

DISTRIBUTION. – Upper Bathonian-Lower Oxfordian.

Frondicularia nikitini UHLIG, 1883

Fig. 32 A–B.

1883 *Frondicularia nikitini* UHLIG. – p. 757, Pl. 9, Figs. 10 (type), 11.
1883 *Frondicularia teisseyeri* UHLIG. – p. 757, Pl. 9, Fig. 16.
1904 *Frondicularia nikitini* UHLIG. – Brückmann, p. 9, Pl. 1, Figs. 9–14.
1937 *Flabellina mölleri* (UHLIG). – Bartenstein & Brand, p. 169, Pl. 15 A, Fig. 27; Pl. 15 C, Fig. 13.
1953 *Frondicularia mölleri* UHLIG. – Seibold & Seibold, p. 67, Pl. 6, Figs. 8, 11; Text-Fig. 5:12.
1960 *Frondicularia nikitini* UHLIG. – Lutze, p. 466, Pl. 31, Figs. 1–6, 8.
1962 *Frondicularia nikitini* UHLIG. – Cordey, p. 389, Pl. 47, Fig. 24; Text-Figs. 43–45.
1962 *Frondicularia nikitini* UHLIG. – "Leitfossilien", pp. 157, 189, Table 9; Pl. 21, Fig. 31; Table 10; Pl. 27, Fig. 26.
1965 *Frondicularia nikitini* UHLIG. – Hanslíková, p. 90, Pl. 8, Fig. 2; Pl. 7, Figs. 18, 21 a, b, c.
1970 *Frondicularia nikitini* UHLIG. – Norling, pp. 271, 274–275, Fig. 6 a–c.

MATERIAL. – Three specimens; one microspheric form and two megalospheric forms from the boring Rydebäck-Fortuna, No. 5, 156.6–157.0 m, Fortuna Marl, Upper Bathonian/Callovian, Middle Jurassic.

DIMENSIONS.–

	Length	Max. breadth
EN SEM 40:4 Microsphere	1.6 mm	0.4 mm
EN SEM 40:3 Megalosphere	1.0 mm	0.5 mm
EN SEM 35:3 Megalosphere	0.8 mm	0.5 mm

REMARKS. – Detailed descriptions of this characteristic species have been given previously. The Swedish specimens have a test-wall of fibrous-radiate, finely perforate, secondarily lamellar calcite, and a distinctly radiate aperture.

DISTRIBUTION. – Upper Bathonian-Lower Oxfordian in Europe. Originally recorded from the Upper Callovian of the USSR.

Frondicularia sp.

Fig. 32 C.

MATERIAL. – One specimen from the boring Rydebäck-Fortuna No. 5, 156.6–157.0 m, Fortuna Marl, Upper Bathonian/Callovian, Middle Jurassic.

DIMENSIONS. – Length, 0.52 mm; breadth, 0.22 mm.

REMARKS. – Frondicularia sp. shown in Fig. 32 C is regarded a juvenile form, possibly of *Frondicularia nikitini*.

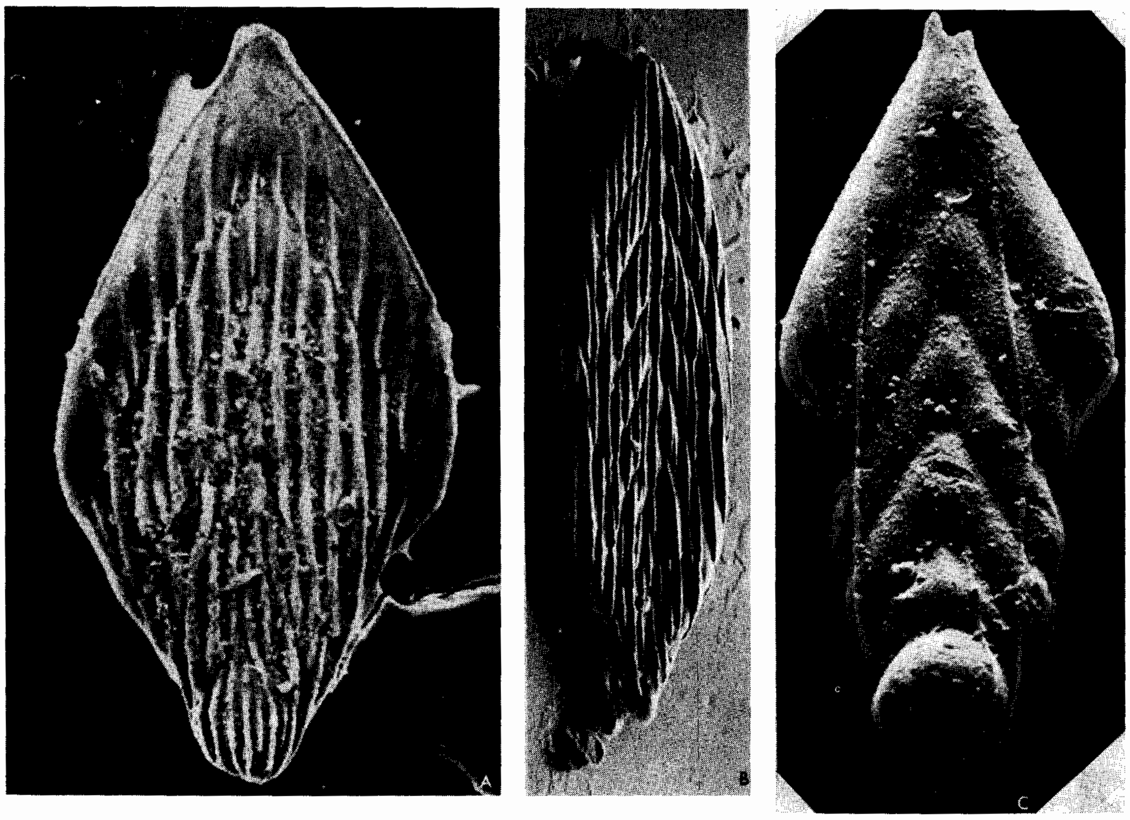


Fig. 32 A–B. *Frondicularia nikitini* UHLIG, 1883.

A. Megalospheric specimen EN SEM 40:3. Boring Rydebäck-Fortuna No. 5, 156.6–157.0 m, Fortuna Marl, Upper Bathonian/Callovian. 100 X.

B. Microspheric specimen EN SEM 35:1. Woodham Quarry, Buckinghamshire, England. Lamberti Zone, Callovian. Illustrated for comparison with the megalospheric form. 50 X.

Fig. 32 C. *Frondicularia* sp. EN SEM 28:3. Boring Rydebäck-Fortuna No. 5, 156.6–157.0 m, Fortuna Marl, Upper Bathonian/Callovian. 200 X.

Genus *Ichthyolaria* WEDEKIND, 1937

Fig. 33 A–D.

SYNONYMOUS. – *Pseudofrondicularia* WEDEKIND, 1937; *Neospandelina* BROTZEN, 1963.

DIAGNOSIS. – See Norling, 1966.

EMENDED DIAGNOSIS OF THE APERTURE. – Aperture distinct, terminal, central, protruding or produced to form a short neck. In early ontogenetic stages slit-shaped or cruciform, in adult specimens commonly radiate.

TYPE SPECIES. – *Frondicularia bicostata* D'ORBIGNY, 1849. Designation by Wedekind, 1937.

SPECIES FROM THE SWEDISH JURASSIC. – Twelve species are recorded, all from Lower Jurassic strata. These species, their European stratigraphical range and Swedish occurrences are given in Table 14, p. 67.

REMARKS. – For a long time, the genus *Ichthyolaria* WEDEKIND was regarded a subjective synonym of the genus *Frondicularia* DEFRANCE. However, after a revisional treatment of Permian, Triassic and Liassic foraminiferal previously referred to *Frondicularia,* Sellier De Civrieux & Dessauvagie (1965) accepted the genus *Ichthyolaria.* After a study of material from the Lower Lias of Scania, the present writer is inclined to support these authors in their rehabilitation of Wedekind's genus *Ichthyolaria,* but proposes a new diagnosis (Norling, 1966, p. 6).

DISTRIBUTION. – Permian – Lower Jurassic.

On the aperture in genus Ichthyolaria WEDEKIND, 1937

A prominent characteristic of nodosariid foraminifera is the radiate aperture. Concerning Lower Jurassic representatives of the group, Barnard (1950, p. 391) stated: " The radiate aperture cited as a characteristic of the *Lagenidae,* was present in only comparatively few Lower Jurassic Foraminifera. Some forms with circular apertures, however, could be accounted for by the resorption of the radiate aperture of the end of the apertural chamberlet, leaving a circular aperture beneath."

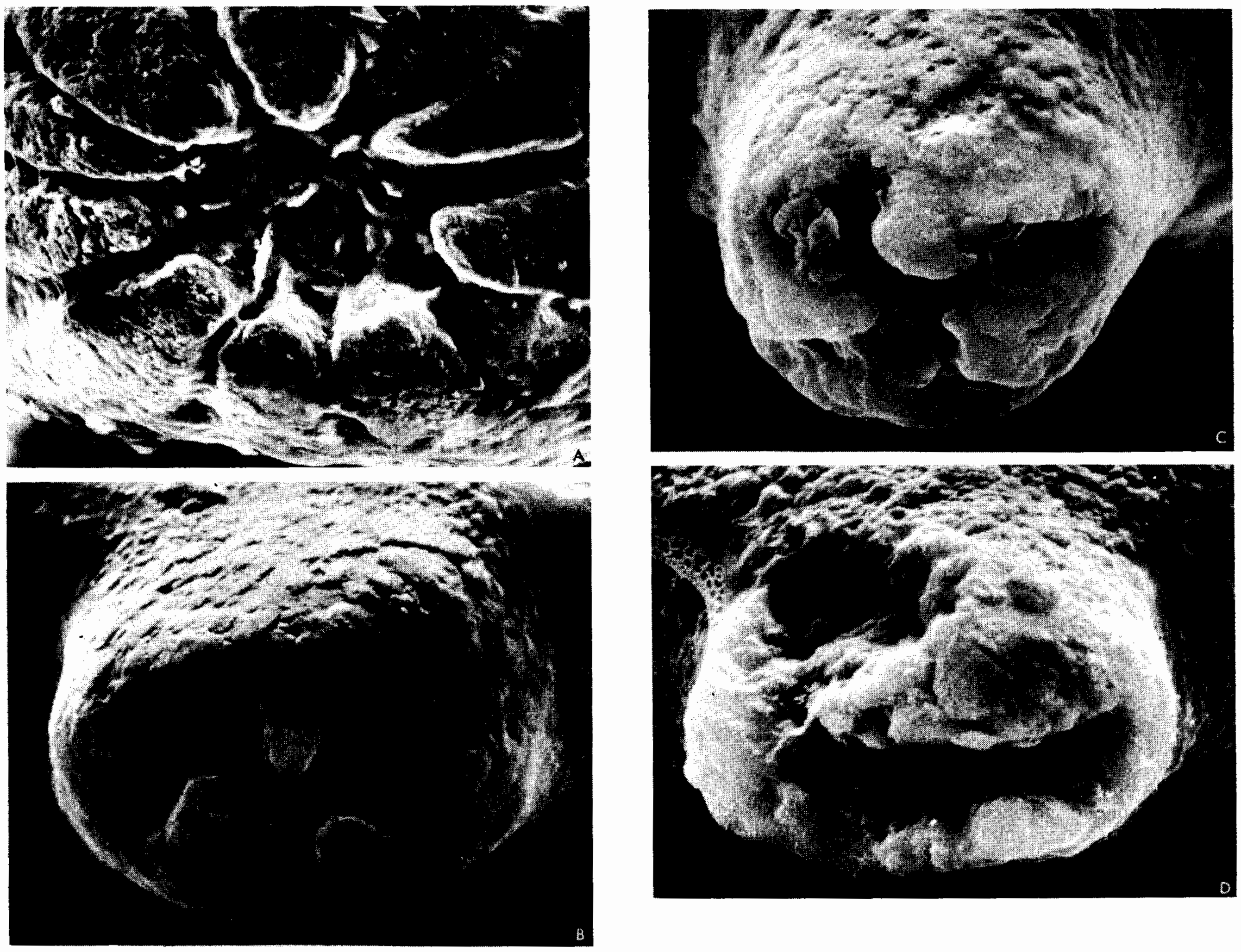


Fig. 33 A–D. *Ichthyolaria bicostata* (D'ORBIGNY, 1849). Different types of aperture possibly representing different ontogenetic stages.

A. Radiate aperture in specimen EN SEM 12:3. Adult form. Katslösa Exposure, Loc. 812, Katslösa Beds, Lower Pliensbachian. 1000 X.

B. Simple radiate aperture in specimen EN SEM 27:2. Adolescent form. Örby E 6 Viaduct Exposure, sample No. 6, Döshult Beds, Lower Sinemurian. 2700 X.

C. Cruciform aperture in specimen EN SEM 26:3. Adolescent form. Örby E 6 Viaduct Exposure, sample No. 6, Döshult Beds, Lower Sinemurian. 2500 X.

D. Slit-shaped aperture in specimen EN SEM 26:4. Juvenile form. Örby E 6 Viaduct Exposure, sample No. 6, Döshult Beds, Lower Sinemurian. 2300 X.

In a comment to Barnard's observations Tappan (1955, p. 33) stated: "This absence of a radiate aperture is not a feature of the species from the Lower Jurassic rocks in Alaska, as most of them have extremely well developed radiate apertures, as can be seen in the figures. Possibly the apparent absence of a radiate aperture in many of the earlier nodosarids is due to resorption, as Barnard stated, and as he has demonstrated in certain species, but it seems probable to the present writer that in many Jurassic nodosarids this absence is due to poor preservation or lack of observation."

Most of the nodosariid foraminifera from Jurassic rocks in Sweden have distinctly radiate apertures and the present writer agrees with Tappan's conclusions.

Concerning the genus *Ichthyolaria,* the aperture has variously been described as slit-shaped, oval, rounded, or radiate. Some authors have reported that different types of apertures may occur in Jurassic species herein referred to *Ichthyolaria,* whereas others have ascribed only one of the apertural types to this genus. Nørvang (1957) found oval and round apertures in Liassic species of *Ichthyolaria* and placed them in genus *Spandelina* CUSHMAN & WATERS, 1928 of the family *Nodosinellidae* RHUMBLER, 1895, mainly on the basis of a simple, round or oval aperture.

Sellier De Civrieux & Dessauvagie (1965), in their rehabilitation of Wedekind's genus *Ichthyolaria,* described the aperture (p. 70) as being distinct, oval or

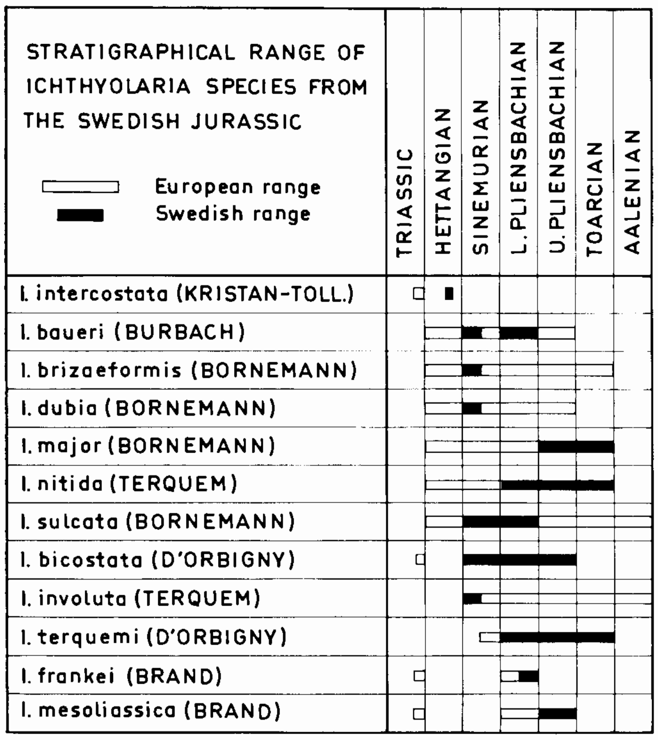


TABLE 14.

elliptical, with a smooth border. In his emendation of the diagnosis of the genus *Ichthyolaria,* the present writer (1966, p. 7) described the aperture as being distinct, more or less protruding, oval or round, radiate (with radiating slits), or with a smooth border. This diagnosis is maintained herein. However, studies under the scanning electron microscope of apertures and foramina in *Ichthyolaria* seem to show that the different types of aperture (slit-shaped, oval, cruciform, radiate) represent different ontogenetic stages.

1. Slit-shaped and oval apertures have been observed in small specimens with few chambers regarded as juvenile forms. Foramina of a similar shape have been seen in the early stage of adult specimens (Fig. 33 D).

2. Cruciform and simple radiate apertures have been observed in specimens regarded as adolescent forms. Similar foramina occur in the central chambers of adult specimens (Fig. 33 B, C).

3. A distinctly radiate aperture has been found in adult specimens only (Fig. 33 A).

This observation may explain the various opinions and reports concerning the apertural shape in *Ichthyolaria* and may contribute to a more accurate classification of foraminifera within the *Ichthyolaria-Frondicularia* group and the related *Geinitzinita-Lingulina* group.

The observed ontogenetic development of the aperture, if reflecting a phylogenetic evolution, thereby supports theories of a common Paleozoic ancestor (with a slit-shaped aperture) of the genus *Ichthyolaria* (with a radiate aperture in the adult stage) and the genus *Geinitzinita* (with a slit-shaped aperture in all ontogenetic stages).

Genus *Lenticulina* LAMARCK, 1804

Figs. 34–37.

DIAGNOSIS. – Test free, planispiral or rarely slightly trochoid, lenticular, biumbonate, periphery angled or keeled; chambers numerous, increasing gradually in size, generally of greater breadth than height; sutures radial, straight or curved and depressed, flush or elevated; surface may be variously ornamented with thickened, elevated sutures, bosses or sutural nodes. Test-wall fibrous-radiate, finely perforate, non-lamellar or mesolamellar in many Early Mesozoic species, later becoming lamellar. Aperture at peripheral angle, radiate, may have an apertural chamberlet.

TYPE SPECIES. – *Lenticulina rotulata* LAMARCK, 1804. Subsequent designation by Children, 1823. Upper Cretaceous.

SPECIES FROM THE SWEDISH JURASSIC. – See Table 15, p. 70.

DISTRIBUTION. – Triassic – Recent.

Lenticulina muensteri (ROEMER, 1839)

Fig. 35 A–C; Table 15.

1839 *Robulina muensteri* ROEMER. – p. 48, Pl. 20, Fig. 29 a, b.
1865 *Cristellaria inflata* SCHWAGER. – p. 125, Pl. 6, Fig. 16.
1937 *Cristellaria (Lenticulina) muensteri* (ROEMER). – Bartenstein & Brand, p. 174, Pl. 3, Fig. 30 a–b; Pl. 4, Fig. 69 a–e; Pl. 6, Fig. 34 a–d; Pl. 9, Fig. 49 a–e; Pl. 10, Fig. 38 a–b; Pl. 11 A, Fig. 13 a–d; Pl. 11 B, Fig. 19 a–d; Pl. 12 A, Fig. 16 a–b; Pl. 12 B, Fig. 15 a–e; Pl. 13, Fig. 36; Pl. 14 B, Fig. 14 a–c; Pl. 14 C, Fig. 13 a–b; Pl. 15 A, Fig. 34 a–c; Pl. 15 C, Fig. 19 a–c.
1941 *Cristellaria muensteri* (ROEMER). – Macfadyen, p. 31, Pl. 2, Fig. 23.
1950 b *Lenticulina muensteri* (ROEMER). – Barnard, p. 7, Pl. 2, Fig. 1.
1955 *Lenticulina (Lenticulina) muensteri* (ROEMER). – Seibold & Seibold, p. 104, Text-Fig. 4 a–c.
1959 *Lenticulina muensteri* (ROEMER). – Cifelli, p. 291, Pl. 2, Figs. 2–5.
1962 *Lenticulina muensteri* (ROEMER). – Cordey, p. 378, Pl. 46, Fig. 1.
1965 *Lenticulina (Lenticulina)* ex gr. *muensteri* (ROEMER). – Hanzlíková, p. 69, Pl. 5, Fig. 1 a, b.
1965 *Lenticulina muensteri* (ROEMER). – Gordon, p. 840, Text-Figs. 5, 6–9, 10.
1967 *Lenticulina muensteri* (ROEMER). – Gordon, p. 451, Pl. 4, Figs. 4, 12–14.

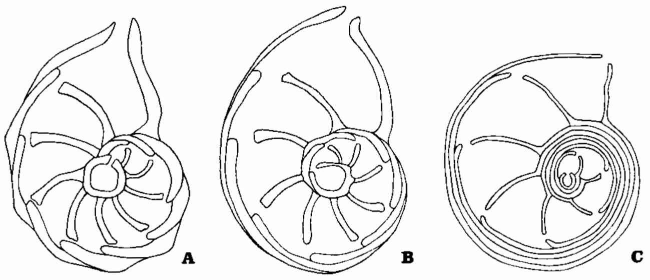


Fig. 34 A–C. Schematic drawings showing different stages of secondary lamination in lenticulinoid foraminifera (After E. Norling, 1968).

A. Non-lamellar test-wall with overlapping primary wall layers. *Lenticulina polygonata* FRANKE, 1936. Specimen from boring Kävlinge No. 930, Katslösa Beds, L. Pliensbachian.

B. Mesolamellar test-wall in *Lenticulina acutiangulata* (TERQUEM, 1864). Specimen from boring Kävlinge No. 930, Katslösa Beds, L. Pliensbachian.

C. Lamellar test-wall in *Lenticulina turbiniformis* (TERQUEM, 1863). Specimen from boring Kävlinge No 930, L. Pliensbachian.

DESCRIPTION. – Test free, lenticular, biumbonate. Margin angled or keeled. Chambers numerous, arranged in a planispiral coil. Sutures slightly bent, depressed, flush or protruding. Test surface smooth or ornamented with sutural ribs and umbilical bosses. Wall calcareous, fibrous-radiate, finely perforate and lamellar.

Aperture at peripheral angle, distinctly radiate with 6–10 radiating slits subdivided by bars.

DIMENSIONS. – Length, 0.40–0.75 mm; breadth, 0.3–0.7 mm.

MATERIAL. – Two specimens from the boring Rydebäck-Fortuna No. 4, 98 m, Rydebäck Beds, Upper Pliensbachian, Middle Lias; numerous specimens from the boring Rydebäck-Fortuna No. 5, 158.8–145.2 m, Fortuna Marl, Upper Bathonian-Lower Oxfordian.

REMARKS. – This species was originally described by Roemer (1839) from the Lower Cretaceous (Hils) of N. Germany, but has been recorded from most of the Jurassic stages also. A lengthy synonymy of this species was given by Gordon (1962).

GEOGRAPHICAL DISTRIBUTION. – *Lenticulina muensteri* has been recorded from Poland (Bielecka & Styk, 1967; Kopik, 1967), East Germany (Pietrzenuk, 1961), NW. Germany (Bartenstein & Brand, 1937; Lutze, 1960, and others), S. Germany (Seibold & Seibold, 1953, 1955, 1956, 1960). British finds are reported by Barnard (1950), Gordon (1962, 1965, 1967), Cifelli (1959), and Cordey (1962). Further finds are reported from Italy (Barbieri, 1964), and Czechoslovakia (Hanzlíková, 1965).

STRATIGRAPHICAL DISTRIBUTION. – Rare in Lower Jurassic strata, common in the Middle Jurassic-Lower Cretaceous sequence.

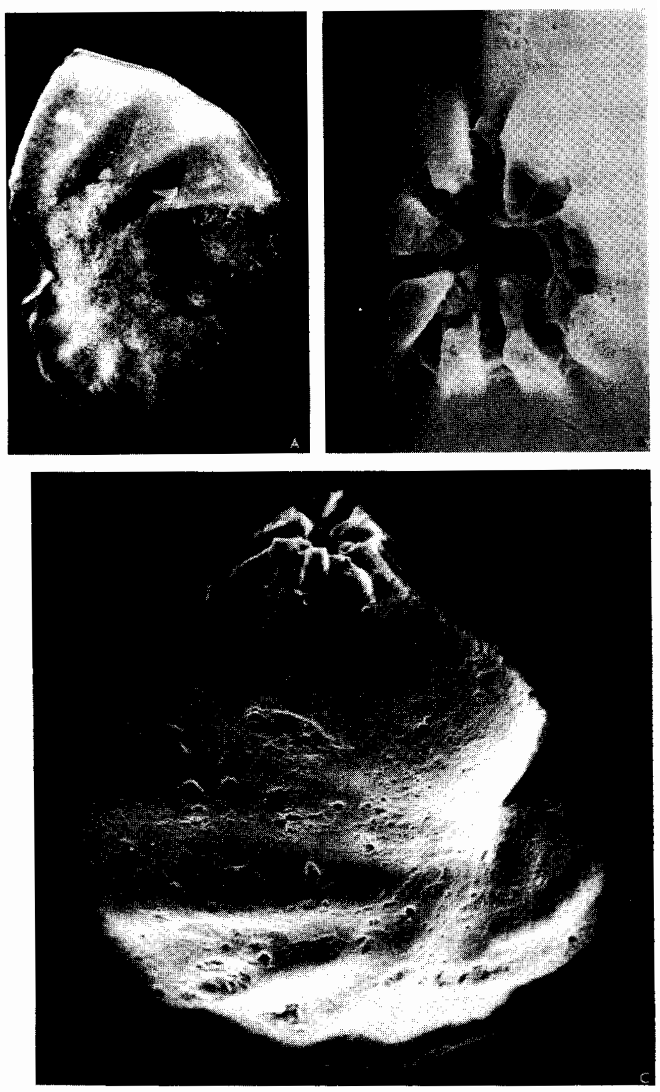


Fig. 35 A–C. *Lenticulina muensteri* (ROEMER, 1839).

A. Side view of specimen EN SEM 11:4. Boring Rydebäck-Fortuna No. 5, 147.1 m, Fortuna Marl, Oxfordian. 80 X.

B. Aperture of specimen EN SEM 13:5. Boring Rydebäck-Fortuna No. 5, 1496–150 m, Fortuna Marl, Callowian/Oxfordian. 545 X.

C. Oblique apertural view of specimen EN SEM 13:4. Boring Rydebäck-Fortuna No. 5, 149.6–150 m, Fortuna Marl, Callovian/Oxfordian. 225 X.

Lenticulina quenstedti (Gümbel, 1862)

Fig. 36 A–C; Table 15.

1862 *Cristellaria quenstedti* Gümbel. – p. 226, Pl. 4, Fig. 2 a–b.
1890 *Cristellaria polonica* Wisniowski. – p. 222, Pl. 10, Fig. 3.
1921 *Cristellaria quenstedti* Gümbel. – Klähn, p. 49, Pl. 2, Figs. 16, 18–25.
1937 *Cristellaria (Lenticulina) quenstedti* (Gümbel). – Bartenstein & Brand, p. 177, Pl. 11 A, Fig. 16 a–c; Pl. 11 B, Fig. 23 a–c; Pl. 12 A, Fig. 19 a–d; Pl. 12 B, Fig. 7 a–c; Pl. 13, Fig. 39 a–c; Pl. 14, Fig. 17 a–b; Pl. 15 A, Fig. 36 a–c; Pl. 15 C, Fig. 20 a–b.
1952 *Lenticulina quenstedti* (Gümbel). – Barnard, p. 339, Text-Fig. A 6.
1955 *Lenticulina (Lenticulina) quenstedti* (Gümbel). – Seibold & Seibold, p. 105, Pl. 13, Fig. 3.
1958 *Lenticulina polonica* (Wisniowski). – Bizon, p. 12, Pl. 4, Figs. 1, 2.
1959 *Lenticulina quenstedti* (Gümbel). – Cifelli, p. 292, Pl. 2, Figs. 6–7.
1960 *Lenticulina (Lenticulina) quenstedti* (Gümbel). – Seibold & Seibold, p. 349.
1960 *Lenticulina (Lenticulina)* cf. *quenstedti* (Gümbel). – Lutze, p. 451, Text-Fig. 11 b.
1965 *Lenticulina (Lenticulina) quenstedti* (Gümbel). – Hanzlíková, p. 73, Pl. 4, Figs. 8 a, b, 11, 13; Pl. 5; Fig. 2 a, b.
1967 *Lenticulina quenstedti* (Gümbel). – Gordon, p. 451, Pl. 2, Figs. 6–10.

DESCRIPTION. – Test free, planispiral, with a marked tendency to uncoiling in many forms. Sutures almost straight to slightly bent with raised sutural ribs converging at umbilical area. Sutural ribs in some forms connected by a circular rib. Initial part of test frequently with a marginal keel. Distal part of test oval to subriangular in transverse section, ventral part broader than dorsal. Test-wall fibrous-radiate, finely perforate, lamellar.

MATERIAL. – Numerous specimens from the boring Rydebäck-Fortuna No. 5, 158.8–147.1 m, Fortuna Marl, Upper Bathonian-Lower Oxfordian.

GEOGRAPHICAL DISTRIBUTION. – This species is reported from S. Germany (Gümbel, 1862; Seibold & Seibold, 1953, 1955, 1960), NW. Germany (Bartenstein & Brand, 1937), France (Bizon, 1958) and from Great Britain (Barnard, 1951; Cifelli, 1959; Gordon, 1967). Records from Poland have been quoted by Wisniowski (1890) and Kopik (1967), from the USSR by Mitjanina (1955) and Brückmann (1904). Hanzlíková (1965) reported it from Czechoslovakia and Barbieri (1964) from Italy.

STRATIGRAPHICAL DISTRIBUTION. – Bajocian--Kimmeridgian (mainly).

Fig. 36 A–C. *Lenticulina quenstedti* (Gümbel, 1862) var. *evoluta* Paalzow, 1917. Boring Rydebäck-Fortuna No. 5, 147.1–147.2 m, Fortuna Marl, Oxfordian.

A. Side view of specimen En Sem 11:8. 200 X.

B. Apertural chamberlet of the same specimen. 1000 X.

C. Apertural chamberlet of specimen En Sem 11:5. 1000 X.

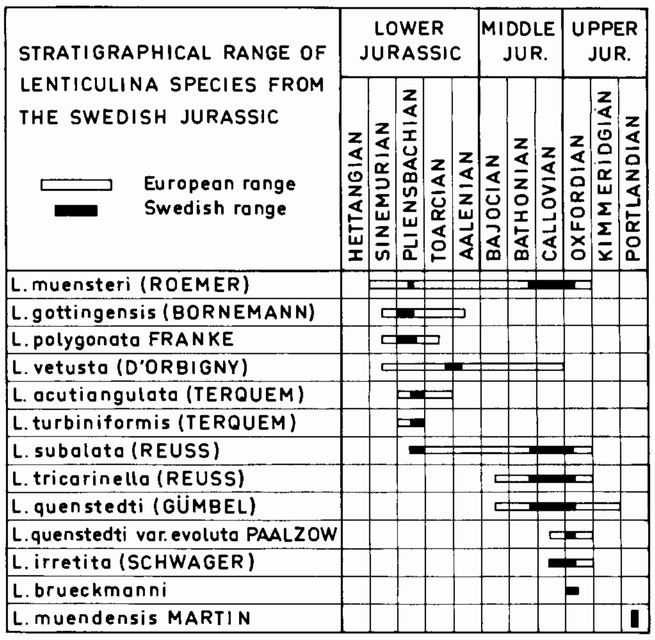


TABLE 15.

Lenticulina quenstedti (GÜMBEL, 1862) var. *evoluta* PAALZOW, 1917

Fig. 36 A–C; Table 15.

1917 *Cristellaria quenstedti* GÜMBEL var. *evoluta* PAALZOW. – Paalzow, p. 244, Pl. 47, Fig. 7.
1965 *Lenticulina (Lenticulina) quenstedti* (GÜMBEL) var. *evoluta* PAALZOW. – Hanzlíková, p. 74, Pl. 5, Fig. 4 a, b.
1970 *Lenticulina quenstedti* (GÜMBEL) var. *evoluta* PAALZOW. – Norling, p. 280, Fig. 10 a–c.

DESCRIPTION. – Test free, planispiral in the early portion, the last 3–4 chambers uncoiled. Initial and dorsal margins keeled, ventral, distal part of test broad. Chamber sutures elevated. Test smooth, wall finely perforate, lamellar. Aperture nearly central in face of last chamber, with an apertural chamberlet having 8 radiating slits.

MATERIAL. – Ten specimens from the boring Rydebäck-Fortuna No. 5, 147.1–147.2 m, Fortuna Marl, Lower Oxfordian, Upper Jurassic.

DISTRIBUTION. – Reported from Upper Callovian-Lower Oxfordian strata.

Lenticulina tricarinella (REUSS, 1863)

Fig. 37 A–E; Table 15.

1863 *Cristellaria tricarinella* REUSS. – p. 68, Pl. 7, Fig. 9; Pl. 12, Figs. 2–4.
1870 a *Cristellaria polymorpha* TERQUEM. – p. 454, Pl. 19, Figs. 1–30; Pl. 21, Figs. 1–30.
1917 *Cristellaria tricarinella* REUSS. – Paalzow, p. 240, Pl. 56, Fig. 6.
1921 *Cristellaria tricarinella* REUSS. – Klähn, p. 50, Pl. 21, Figs. 7–10.
1932 *Planularia feifeli* PAALZOW. – p. 105, Pl. 6, Figs. 11, 12.
1935 *Cristellaria tricarinella* REUSS. – Macfadyen, p. 15, Pl. 1, Fig. 18 a–b.
1937 *Cristellaria (Astacolus) tricarinella* (REUSS). – Bartenstein & Brand, p. 173, Pl. 13, Fig. 35 a, b; Pl. 14 B, Fig. 13 a, b; Pl. 15 A, Fig. 33 a, b; Pl. 15 C, Fig. 18.
1941 *Cristellaria tricarinella* REUSS. – Frenzen, p. 353, Pl. 5, Figs. 13, 14.
1953 *Lenticulina (Planularia)* tricarinella (REUSS). – Seibold & Seibold, p. 54, Pl. 4, Fig. 5.
1954 *Planularia tricarinella* (REUSS). – Bielecka & Pozaryski, pp. 40, 171, Pl. 5, Fig. 2 a, b.
1959 *Lenticulina tricarinella* (REUSS). – Cifelli, p. 295, Pl. 2, Figs. 20–23.
1960 *Lentculina (Planularia) tricarinella* (REUSS). – Lutze, p. 456, Pl. 29, Figs. 12, 13.
1960 *Lenticulina (Planularia) tricarinella* (REUSS). – Seibold & Seibold, p. 350, Text-Fig. 6 a–d.
1965 *Lenticulina tricarinella* (REUSS). – Gordon, p. 840, Text-Fig. 6:6–8.
1966 *Leintculina tricarinella* (REUSS). – Gordon, p. 326, Pl. 2, Figs. 5–19.
1970 *Lenticulina tricarinella* (REUSS). – Norling, p. 271, Text-Fig. 4; pp. 277–278, Text-Fig. 9 a–d.

DESCRIPTION. – Test elongate, planispiral with a tendency to uncoiling. Sides almost flat, roughly parallel. Chambers 5–7. Sutures curved, accentuated by high and thin sutural costae. Dorsal side rather broad, flat, or slightly convex with three costae (carinae) running from initial chamber to apertural chamber. In some specimens the medium costa is restricted to the initial half of the test (Fig. 37 A). Test-wall fibrous-radiate, finely perforate, lamellar. Aperture at peripheral angle, usually radiate, commonly produced to form a short, cylindrical neck, may be rounded or may lack apertural neck.

MATERIAL. – About 10 specimens from the boring Rydebäck-Fortuna No. 5, 158.8 m, 150.0–149.6 m, 147.2–147.1 m, Fortuna Marl, Upper Bathonian-Lower Oxfordian.

REMARKS. – Though originally described from the Lower Cretaceous (Reuss, 1863), records of this species are mainly confined to the Middle and Upper Jurassic. Apparently, there is a group of closely related forms ranging from the Bajocian to the Lower Cretaceous. An attempt to subdivide some forms usually placed in ***Lenticulina tricarinella*** into different species was recently done by Kopik (1969). The stratigraphical range of ***Lenticulina tricarinella*** in different parts of Europe has previously been commented on by the present writer (Norling, 1970, p. 280).

DISTRIBUTION. – Upper Bajocian-Oxfordian. Also recorded from the Lower Cretaceous.

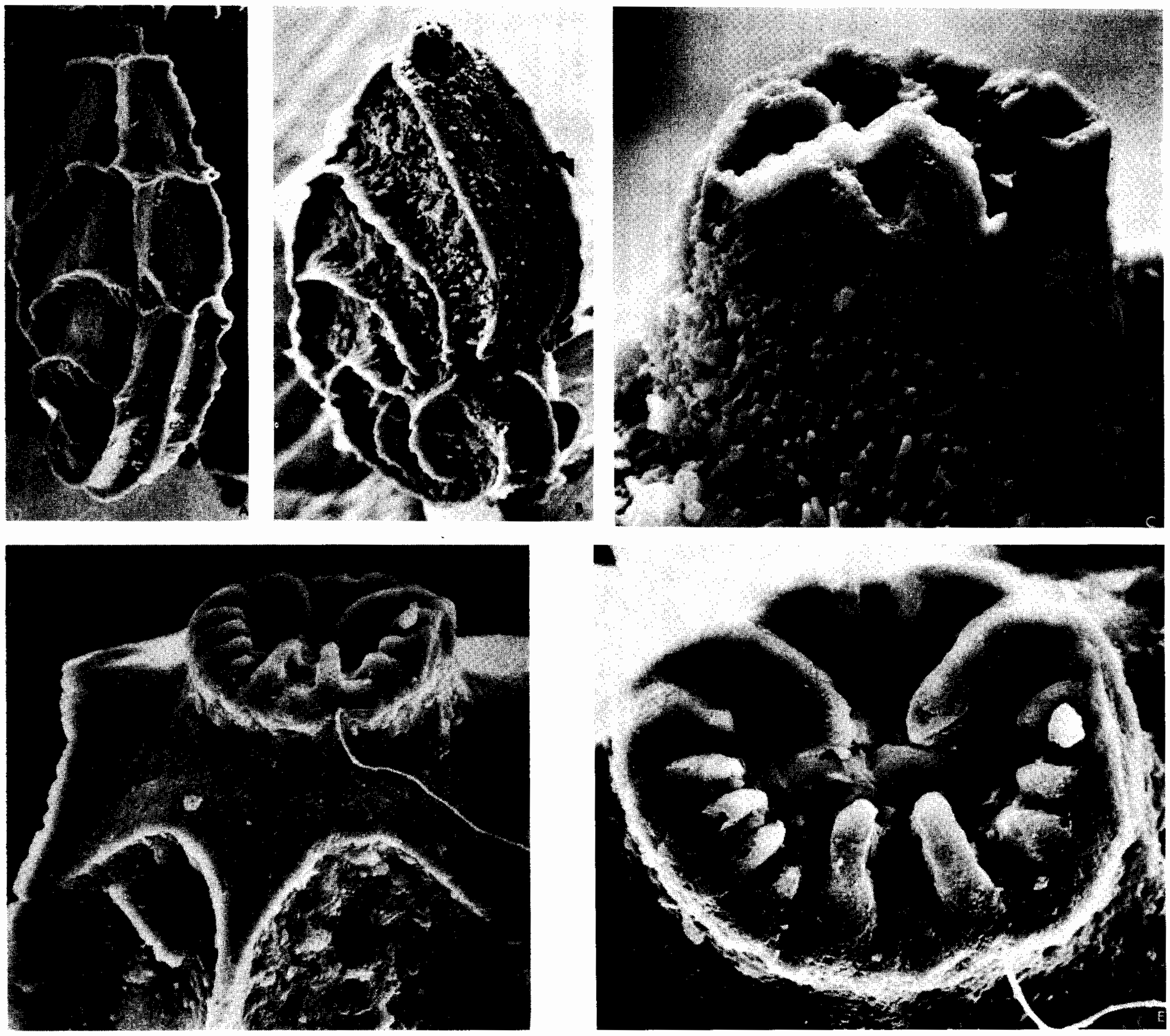


Fig. 37 A–E. *Lenticulina tricarinella* (Reuss, 1863).

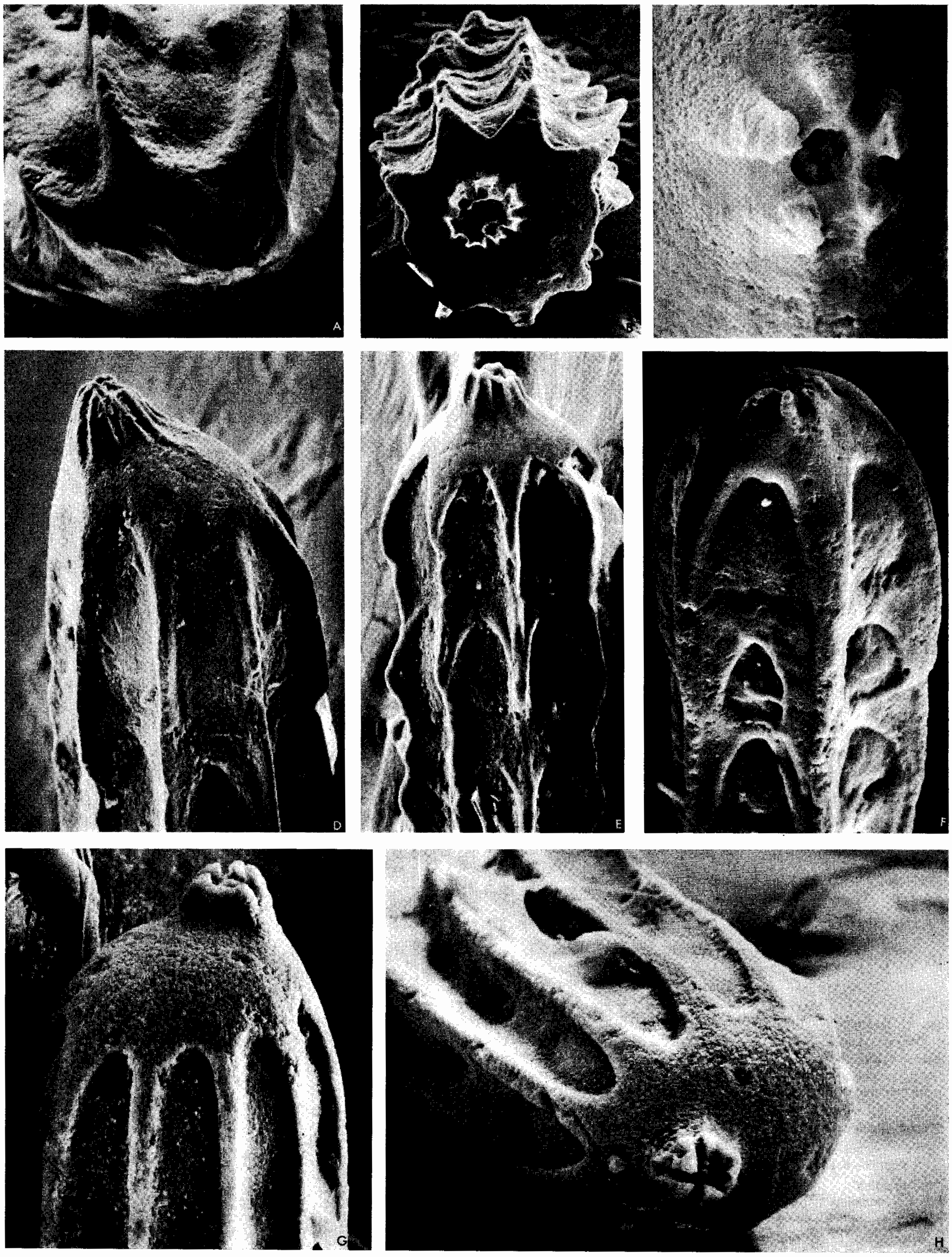
A. Oblique dorsal view of specimen En Sem 30:4. Boring Rydebäck-Fortuna No. 5, 149.5 m, Fortuna Marl, Callovian/Oxfordian. Note the three-carinate lower margin and the short-necked, cylindrical apetrure. 133 X.

B. Oblique ventral view of specimen En Sem 30:1. Woodham Quarry, Buckinghamshire, England. *Mariae* Zone, Lower Oxfordian. 156 X.

C. Aperture of the same specimen. 1550 X.

D. Oblique view of apertural area of specimen En Sem 31:2. Watton Cliff, Dorset, England. *Retrocostatum* Zone, basal Upper Bathonian. 540 X.

E. Aperture of the same specimen. 1040 X.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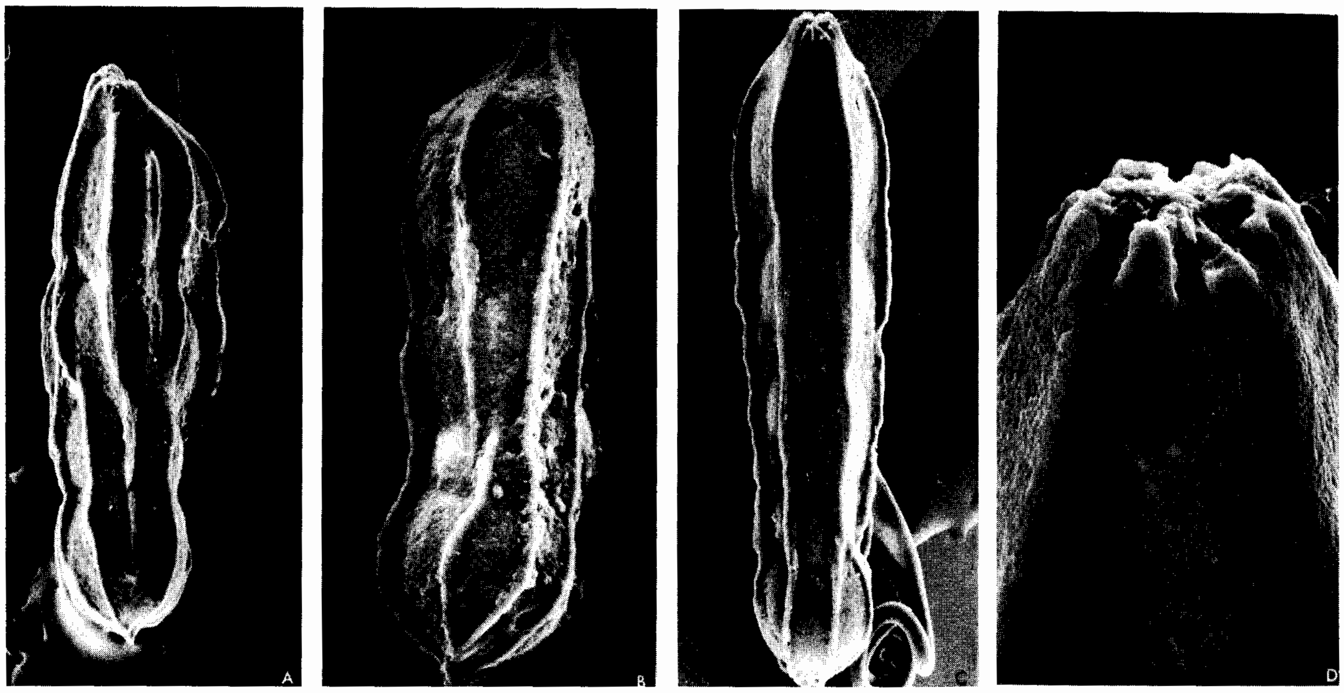


Fig. 39 A–D. *Marginulina lamellosa* TERQUEM & BERTHELIN, 1875. A. Side view of specimen SGU EN SEM 49:4. Örby E 6 Viaduct Exposure, Döshult Beds, Lower Sinemurian, Lower Lias. 122 X. B. Side view of specimen SGU EN SEM 89:4. 230 X. Boring Helsingborg Kvarn No. 2220, 38–44 m, Döshult Beds, Lower Sinemurian, Lower Lias.

C. Dorsal view of specimen SGU EN SEM 49:3. 115 X. Örby E 6 Viaduct Exposure, Döshult Beds, Lower Sinemurian, Lower Lias.

D. Dorsal view of aperture of specimen 49:3 (see C). 580 X.

Genus *Marginulina* D'ORBIGNY, 1826

DIAGNOSIS. – Test free, initial portion slightly coiled but not completely enrolled as in *Marginulinopsis,* finally rectilinear; sutures oblique, especially in initial portion; test-wall calcareous, finely perforate, fibrous-radiate, non-lamellar to mesolamellar in early Mesozoic species, later species lamellar; aperture terminal, radiate, eccentric (near dorsal angle), usually protruding, may have an apertural chamberlet.

TYPE SPECIES. – *Marginulina raphanus* D'ORBIGNY, 1826. Subsequent designation by Deshayes, 1830. Lectotype designated by Loeblich & Tappan, 1961: Specimen figured by D'Orbigny, 1826, Pl. 10, Fig. 7.

SPECIES FROM THE SWEDISH JURASSIC. – See Table 16, p. 74.

DISTRIBUTION. – Triassic – Recent.

Fig. 38 A–H. Apertural views of some Jurassic species of the genus *Marginulina* D'ORBIGNY, 1826.

A, D. *Marginulina prima* D'ORBIGNY, 1849 ssp. *praerugosa* NØRVANG, 1957. Örby E 6 Viaduct Exposure, Döshult Beds, Lower Sinemurian.

A. Specimen EN SEM 23:2. 275 X. D. Specimen EN SEM 24:1. 275 X.

B, E. *Marginulina prima* D'ORBIGNY, ssp. *prima* D'ORBIGNY, 1849. Boring Rydebäck-Fortuna No. 4, 107 m, uppermost part of the Katslösa Beds, Lower Pliensbachian. Specimen EN SEM 84:5. B. 210 X. E. 200 X.

C, F. *Marginulina prima* D'ORBIGNY *fortunensis* nov. ssp. Boring Rydebäck-Fortuna No. 5, 149.6–150.0 m, Fortuna Marl, Callovian/Oxfordian. C. Specimen EN SEM 14:1. 675 X. F. Specimen EN SEM 14:2. 270 X.

G, H. *Marginulina nytorpensis* nov sp. Boring Rydebäck-Fortuna No. 5, 147.1–147.2 m, Fortuna Marl, Oxfordian. Specimen EN SEM 106 a. Both 500 X.

Marginulina lamellosa TERQUEM & BERTHELIN, 1875

Figs. 39 A–D, 43 A.

1875 *Marginulina lamellosa* TERQUEM & BERTHELIN. – p. 56, Pl. 4, Fig. 22 (type).
1908 *Marginulina burgundiae* (TERQUEM). – Issler (partly), p. 67, Pl. 4, Fig. 172.
1936 *Marginulina lamellosa* TERQUEM & BERTHELIN. – Franke, p. 80, Pl. 8, Fig. 16.
1937 *Marginulina lamellosa* TERQUEM & BERTHELIN. – Bartenstein & Brand, p. 161.
1941 *Marginulina lamellosa* TERQUEM & BERTHELIN. – Macfadyen, p. 37, Pl. 2, Fig. 3.
1968 *Marginulina lamellosa* TERQUEM & BERTHELIN. – Norling, p. 14, Text-Fig. 4, Pl. 9.

DESCRIPTION. – Test elongate, composed of 4 or 5, more or less globular chambers in a slightly curved to rectilinear series. Sutures depressed, straight and somewhat raised at dorsal margin. Test ornamented with usually 6–8 longitudinal ribs running from basal spine of proloculum to the apertural margin. Test-wall fibrous-radiate, finely perforate, secondarily non-lamellar with a slight overlap of primary wall layers. Aperture at dorsal angle, protruding, distinctly radiate. An apertural chamberlet may occur.

DIMENSIONS. – Length, 0.4–0.8 mm; breadth, 0.12–0.25 mm.

MATERIAL. – Numerous specimens from the Välluf E 6 Viaduct Exposure, Helsingborg Beds, Hettangian; the borings Helsingborg Kvarn No. 2220 and Öresund 01, Döshult Beds, Lower Sinemurian; Örby E 6 Viaduct Exposure, Lower Sinemurian; boring Rydebäck-Fortuna No. 4, Katslösa Beds, Lower Pliensbachian.

DISTRIBUTION. – Common in the Hettangian-Lower Sinemurian, rare in the Upper Sinemurian-Pliensbachian in Europe.

Marginulina nytorpensis nov. sp.

Figs. 38 G–H, 40 A–D, 43 H; Tables 16–17.

DERIVATION OF NAME. – After Nytorp farm, location of the core containing this species.

HOLOTYPE. – Specimen EN SEM 103:3, Fig. 40 B–C, p. 75.

TYPE STRATUM AND TYPE LOCALITY. – In calcareous, greyish siltstone, Fortuna Marl, Callovian-Oxfordian transitional beds. Boring Rydebäck-Fortuna No. 5, 149.6–150.0 m below surface, at Nytorp farm near the village of Fortuna about 11 km SSE. of Helsingborg, NW. Scania, S. Sweden.

DIAGNOSIS. – An elongate, slightly curved *Marginulina* ornamented with 6–12 coarse, longitudinal costae, a thickened apertural face and an eccentric, protruding or short-necked, radiate aperture.

DESCRIPTION. – Test elongate, rounded in transverse section, composed of 4–9 (commonly 6), oblate chambers arranged in an initially curved, later rectilinear series. Chamber sutures distinct or indistinct, may have broad and low, indistinct sutural ribs. Ornamentation consists of 6–12 (commonly 9), coarse, longitudinal ribs traversing the test from initial chamber to apertural chamber. Test-wall calcareous, fibrous-radiate, finely perforate, secondarily lamellar. Apertural face usually thickened, along which the ribs are joined in arches. Aperture eccentric, near dorsal margin, protruding, or produced to form a short neck, radiate (with short slits in a stellar pattern).

DIMENSIONS. – Holotype: length, 0.33 mm; maximum breadth, 0.13 mm. See also Table 17, p. 75.

MATERIAL. – About 30 specimens, all from the boring Rydebäck-Fortuna No. 5, 157–148.5 m, Fortuna Marl, Upper Bathonian or Callovian to Lower Oxfordian.

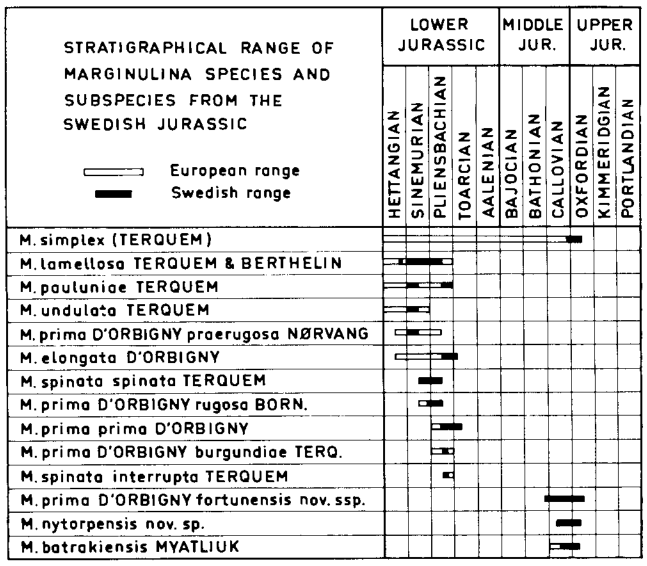
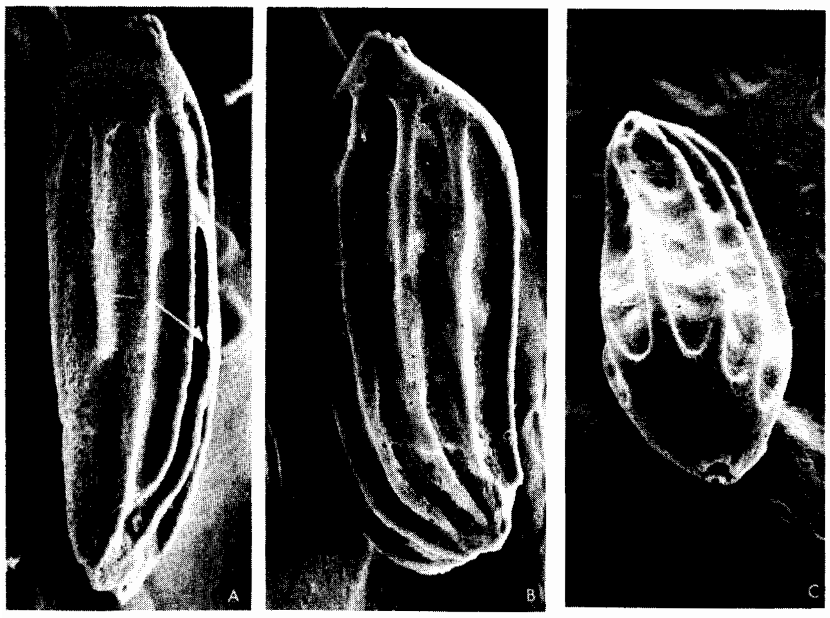


TABLE 16.

REMARKS. – Strongly ribbed forms of the genera *Marginulina* and *Marginulinopsis* seem to be rare in the Middle Jurassic and Lower Upper Jurassic in NW. Europe. It was thus surprising to find a fairly rich fauna of *Marginulina* forms in the Fortuna Marl in W. Scania, reminiscent of those of the Lower Jurassic. However, from some more distant regions there are several records of strongly ribbed *Marginulina* from the Middle Jurassic/Upper Jurassic boundary. Espitalié & Sigal (1963) reported a rich fauna of strongly ribbed *Marginulina* and *Marginulinopsis* from Bathonian, Callovaian and Lower Oxfordian strata of the Majunga Basin, Madagascar. Though represented by other species, the *Marginulina* fauna of the Fortuna Marl has much in common that described by Espitalié & Sigal (1963, pp. 41–44, Pl. 18). Concerning *Marginulina nytorpensis* nov. sp., it shows affinity especially to the Bathonian-Callovian species *Marginulina dracunuliformis* ESPITALIÉ & SIGAL, 1963 (Pl. 18, Figs. 8–11). This species, however, has distinct sutural ribs, but lacks a thickening of the apertural face. The specimens assigned to *Marginulina nytorpensis* also include forms resembling *Marginulinopsis mjatliukae* SHOKHINA, 1954, described from the Callovian of the Volga region, USSR. Other related forms have been described from the Upper Jurassic (Volgian) of the Emba region, USSR, viz. *Marginulinopsis embaensis* (FURSSENKO & POLENOVA, 1950) and from the Callovian of Wyoming, USA, viz *Marginulinopsis phragmites* LOEBLICH & TAPPAN, 1950. *Marginulina nytorpensis* is also similar to the Lower Cretaceous species *Marginulina robusta*



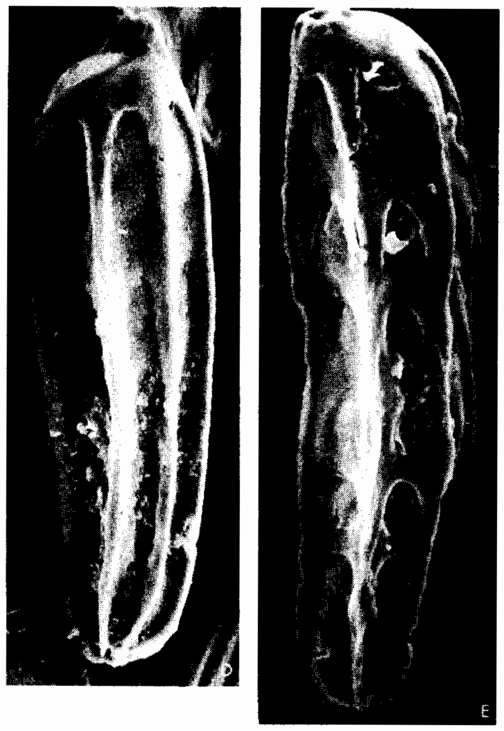


Fig. 40 A–D. *Marginulina nytorpensis* nov. sp. Boring Rydebäck-Fortuna No. 5, 149.6–150 m, Fortuna Marl, Callovian/Oxfordian.
A. Oblique ventral view of specimen En Sem 106:1. 200 X.
B. Side view of specimen En Sem 103:3 (holotype). 225 X.
C. Oblique apertural view of specimen En Sem 103:3 (holotype). 220 X.
D. Side view of specimen En Sem 103:6. 200 X.
Fig. E. *Marginulina prima* D'Orbigny nov. ssp. *fortunensis*. Boring Rydebäck-Fortuna No. 5, 147.1–147.2 m, Fortuna Marl, Oxfordian. Side view of specimen En Sem 88:1. 130 X.

(Reuss, 1863) and *M. striatocostata* (Reuss, 1863). These two species have also been recorded from the Upper Jurassic of the Moscow region, USSR (Kuznetsova, 1963).

DISTRIBUTION. – In Middle Jurassic-Upper Jurassic transitional beds in W. Scania.

TABLE 17. Marginulina nytorpensis nov. sp. Number of chambers and ribs and dimensions in mm of 11 specimens from the Rydebäck-Fortuna core No. 5, Fortuna Marl, Middle Jurassic-Upper Jurassic transitional beds.

Spec. No.	Level in m	No. of chambers	No. of ribs	Length	Max. breadth	Proloculum diam.
En 150	149.6	5	9	0.45	0.17	0.09
En 151	157	4	9	0.40	0.15	0.08
En 152	157	8	9	0.46	0.16	0.07
En 153	157	5	8	0.30	0.15	0.08
En 154	157	7	10	0.38	0.15	0.05
En 155:1	157	6	8	0.32	0.15	0.08
En 155:2	157	8	12	0.38	0.15	0.05
En 155:3	157	9	10	0.51	0.18	0.02
En 155:4	157	6	6	0.53	0.16	0.10
En Sem 106:1	149.6	5	11	0.34	0.14	0.04
En Sem 103:3	149.6	7	10	0.33	0.13	0.07
Range:		4–9	6–12	0.30–0.53	0.13–0.18	0.02–0.10
Mean:		6.4	9.3	0.40	0.15	0.07

Marginulina prima D'Orbigny, 1849 var. *burgundiae* Terquem, 1864

Figs. 42 B–E, 43 E; Table 16.

1864 *Marginulina burgundiae* Terquem. – p. 406, Pl. 9, Fig. 3 a, d.
1875 *Marginulina burgundiae* Terquem. – Terquem & Berthelin, p. 54, Pl. 4, Fig. 17.
1936 *Marginulina burgundiae* Terquem. – Franke, p. 78, Pl. 8, Fig. 8.
1937 *Marginulina burgundiae* Terquem. – Bartenstein & Brand, p. 161, Pl. 4, Fig. 58.
1947 *Marginulina burgundiae* Terquem. – Payard, p. 153, Pl. 2, Fig. 22.
1957 *Marginulina prima* D'Obrigny forma *burgundiae* Terquem. – Nørvang, p. 88, Figs. 100–102.

DESCRIPTION. – Test elongate, composed of 5–10 chambers gradually increasing in size, initial chambers in an open coil or in a slightly curved series, later chambers rectilinearly arranged. Sutures indistinct or distinct, commonly without sutural ribs. Test ornamented with about 10 strong longitudinal ribs. Apertural face may be thickened. Aperture eccentric, near dorsal margin, protruding, with 5–7 radiating slits. An apertural chamberlet may occur (Fig. 42 D–E).

MATERIAL. – Some few specimens from the Rydebäck-Fortuna core No. 4, Rydebäck Beds, Upper Pliensbachian (Domerian), Middle Lias.

REMARKS. – This variety has been regarded the microspheric form of *Marginulina prima* by Franke (1936), Payard (1947), and Nørvang (1957). The specimen in Fig. 42 B from the Katslösa Beds, Upper Carixian, shows a close resemblance to Terquem's type figure, Pl. 9, Fig. 3 c, recorded from the *Davoei* Zone, Upper Carixian of France. Compare also with Fig. 102 in Nørvang, 1957, a specimen from the Domerian of the boring Gassum No. 1 in Denmark.

DISTRIBUTION. – Pliensbachian, Lias.

Marginulina prima D'ORBIGNY, 1849 *fortunensis* nov. ssp.

Figs. 38 C, F, 40 E, 43 G; Tables 16,18.

DERIVATION OF NAME. – After the village of Fortuna, 11 km SSE. of Helsingborg, W. Scania.

HOLOTYPE. – Specimen EN SEM 88:1, Fig. 40 E.

TYPE STRATUM AND TYPE LOCALITY. – In dark grey, calcareous claystone with thin bands of whitish siltstone, Fortuna Marl, Lower Oxfordian, Upper Jurassic. Boring Rydebäck-Fortuna No. 5, 147.1–147.2 m below surface, at Nytorp farm, near the village of Fortuna, W. Scania, S. Sweden.

DIAGNOSIS. – A typical *Marginulina prima* form. Differs from the Lower Jurassic forms mainly in having blunt, rather than acute longitudinal ribs.

DESCRIPTION. – Test elongate, robust, initial and apertural ends commonly rounded. Transverse section polygonal. Chambers 5–10 (usually 7), in a slightly curved or straight series; initial chamber globular, later chambers oblate. Test ornamented with 5–10 (commonly 7), strong, longitudinal ribs connected at every chamber suture by sutural ribs or thickenings. Ornamental elements essentially imperforate, composed of granular or slightly elongate crystal elements. Test-wall fibrous-radiate, finely perforate. Apertural face thickened, along which the longitudinal ribs are joined in arches. Aperture terminal, eccentric or nearly central, protruding or produced to form a short neck, rounded, with a radiate margin composed of 5–7 short ribs subdivided by broad furrows.

DIMENSIONS. – Holotype: length, 0.8 mm; maximum breadth, 0.25 mm. See also Table 18.

MATERIAL. – Thirty-five specimens, fifteen of which are broken, from the Rydebäck-Fortuna core No. 5, Fortuna Marl, 158.8–157.0 m, 149.6–147.1 m, Upper Bathonian or Callovian and Lower Oxfordian.

REMARKS. – *Marginulina prima* ssp. *fortunensis* seems to be much more stable in most characters studied than the Lower Jurassic forms of *Marginulina prima*, the latter haivng a wide range of variation, which has given rise to a great number of subspecies and varieties. When compared with *Marginulina nytorpensis* nov. sp., it seems as if *M. prima fortunensis* is usually larger, has fewer longitudinal ribs, and is more frequently produced in straight forms. Their apertures are also different.

DISTRIBUTION. – In Middle Jurassic-Upper Jurassic transitional beds in W. Scania, S. Sweden.

TABLE 18. Marginulina prima D'ORBIGNY fortunensis nov. ssp. Number of chambers and ribs and dimensions in mm in 9 specimens from the Rydebäck-Fortuna core No. 5, Fortuna Marl, Upper Bathonian/Callovian-Lower Oxfordian.

Spec. No.	Level in m	No. of chambers	No. of ribs	Length	Max. breadth	Proloculum diam.
EN 156:1	149.6	8	10	0.48	0.20	0.05
EN 156:2	149.6	9	8	0.64	0.18	0.10
EN 157	149.6	6	6	0.51	0.16	0.10
EN 158	149.6	8	8	0.77	0.23	0.10
EN 159	157	7	5	0.52	0.16	–
EN 160	148.5	7	7	0.55	0.25	–
EN 161	148.5	7	8	0.43	0.18	0.09
EN SEM 88:1	147.1	7	6	0.80	0.20	0.10
EN 103	149.6	6	6	0.41	0.12	0.04
Range:		6–9	5–10	0.41–0.80	0.12–0.25	0.04–0.10
Mean:		7.3	7.1	0.58	0.19	0.08

Marginulina prima D'ORBIGNY, 1849 ssp. *praerugosa* NØRVANG, 1957

Figs. 38 A, D, 43 B; Table 16.

1957 *Marginulina prima* DORBIGNY subsp. *praerugosa* NØRVANG. – Nørvang, pp. 91, 116, 117; Fig. 96.
1876 *Dentalina burgundia* (TERQUEM). – Tate & Blake, p. 461, Pl. 18, Fig. 29.
1968 *Marginulina prima* D'ORBIGNY ssp. *praerugosa* NØRVANG. – Norling, p. 43, Pl. 9.

DESCRIPTION. – Test elongate, chambers 5–10 in a slightly curved series, globular or oblate with the exception of the apertural chamber, which is prolate. Test ornamented with 6 strong, longitudinal costae, in some specimens joined by low, indistinct sutural ridges. Test-wall fibrous-radiate, perforate, except for penetrative ornamental elements which are granular, imperforate. Test-wall secondarily non-lamellar. Apertural face may be thickened, aperture near dorsal margin, protruding, radiate with narrow intercostal slits.

MATERIAL. – Numerous specimens from the Döshult Beds, Lower Sinemurian, boring Öresund 01, Örby E 6 Viaduct Exposure and Gantofta Brick Pit (basal beds). Some specimens from the boring Rydebäck-Fortuna No. 4, 142 m, Plankarp Clays, Upper Sinemurian may be referred to the subspecies *M. prima praerugosa* NØRVANG, or to subspecies *M. prima rugosa* BORNEMANN.

REMARKS. – *Marginulina prima* ssp. *praerugosa* shows affinity partly to *Marginulina lamellosa,* partly to *Marginulina prima rugosa.* Actually, it seems to be an intermediate form between the mentioned forms of *Marginulina.* The aperture of *M. prima praerugosa* is more or less identical to that found in *M. lamellosa.* On the other hand, many specimens of *M. prima praerugosa* have a more marked tendency to form sutural ribs than *M. lamellosa,* a character typical of *M. prima rugosa, M. prima prima* and *M. prima fortunensis.*

DISTRIBUTION. – Recorded from Hettangian to Lower Pliensbachian strata in Denmark. In Sweden not found outside the Sinemurian.

Marginulina prima D'ORBIGNY, 1849 ssp. *prima* D'ORBIGNY, 1849

Figs. 38 B, E, 41 A–B, 43 F; Table 16.

1849 *Marginulina prima* D'ORBIGNY. – p. 242, No. 262.
1858 *Marginulina prima* D'ORBIGNY var. *gibbosa* TERQUEM. – Terquem, p. 53, Pl. 3, Fig. 5 a, b.
1858 *Marginulina prima* D'ORBIGNY var. *recta* TERQUEM. – p. 54, Pl. 3, Fig. 6.
1858 *Marginulina prima* D'ORBIGNY var. *acuta* TERQUEM. – p. 54, Pl. 3, Fig. 7.
1858 *Marginulina alata* TERQUEM. – p. 56, Pl. 3, Fig. 9 a, b.
1858 *Marginulina ornata* TERQUEM. – p. 57, Pl. 3, Fig. 10 a, b.
1957 *Marginulina prima* D'ORBIGNY ssp. *prima* D'ORBIGNY. – Nørvang, p. 89, Figs. 98, 99, 103, 104.
1968 *Marginulina prima* D'ORBIGNY. – Norling, pp. 46, 47, Text-Fig. 11 a–c; Pl. 9.
1968 *Marginulina prima prima* D'ORBIGNY. – Bang (in Larsen et al.), p. 67, Pl. 24.

DESCRIPTION. – Test elongate, chambers 8–15 usually oblate, gradually increasing in size in a slightly curved or straight series. Test ornamented with 8–10 longitudinal costae joined in arches at each chamber suture. In some specimens the chamber wall crops out in small oval openings or bow-windows only. Chamber wall of fibrous-radiate, finely perforate, secondarily non-lamellar or mesolamellar calcite. Ornamental elements, viz. longitudinal costae and sutural ribs imperforate, with granular or slightly elongated crystal elements. Test rounded in transverse section. Apertural face thickened, along which the longitudinal ribs

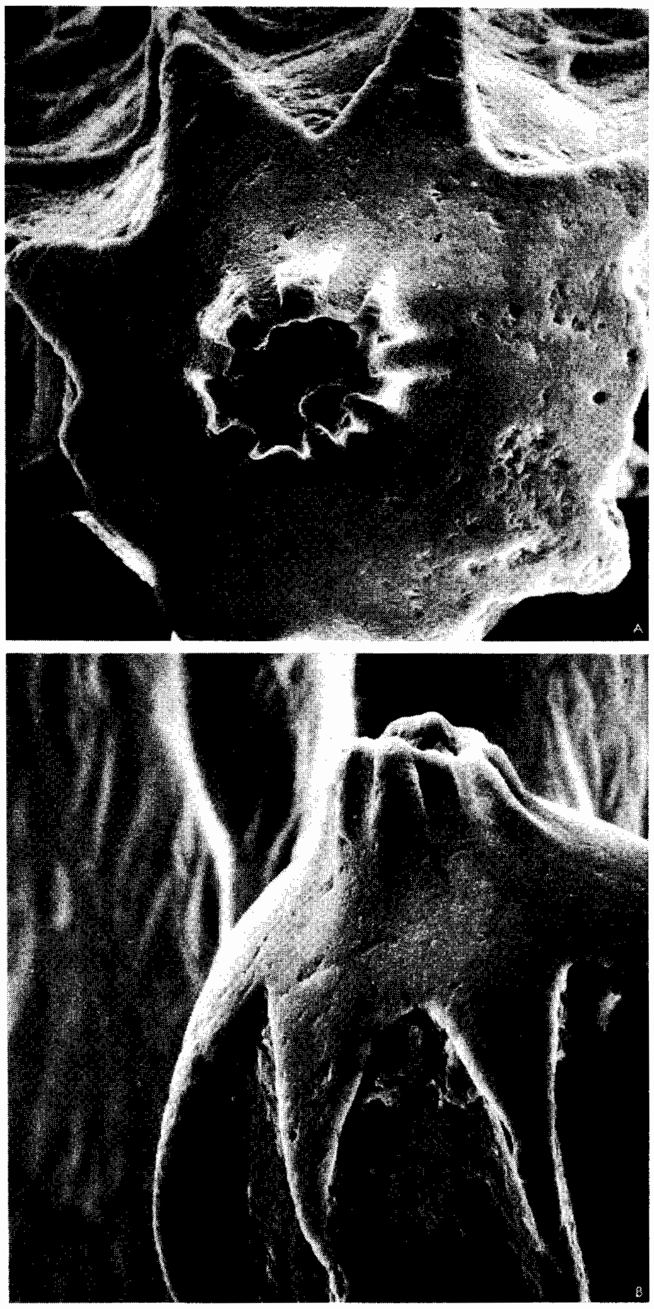


Fig. 41 A–B. *Marginulina prima prima* D'ORBIGNY, 1849. Specimen EN SEM 84:5. Boring Rydebäck-Fortuna No. 4, 107 m, Katslösa Beds, Lower Pliensbachian.

A. Apertural view. Note the eccentric position of the aperture and the bifurcate, radially arranged ribs around the aperture. 420 X.

B. Detail of apertural chamber showing a thickened chamber roof and a protruding, radiate aperture. 400 X.

or costae are joined in arches. Aperture eccentric, protruding, or on a short neck, oval or rounded with a radiate border of 5–7 short, frequently bifurcate ribs.

DIMENSIONS. – Length, 0.4–1.6 mm, usually around 1 mm; breadth, 0.15–0.35 mm (excl. ornamental elements).

MATERIAL. – Numerous specimens from the Katslösa Beds, Lower Pliensbachian and the Rydebäck Beds, Upper Pliensbachian-Toarcian.

REMARKS. – The aperture of *Marginulina prima prima* shows a close affinity to that of *M. spinata spinata, M. spinata interrupta* and *M. prima fortunensis,* but differs widely from that of *M. prima praerugosa, M. lamellosa* and *M. nytorpensis* nov. sp.

DISTRIBUTION. – Pliensbachian-Toarcian. Especially common in the Upper Pliensbachian (Domerian).

Marginulina spinata TERQUEM, 1858

Figs. 42 A, F, G, 43 C–D; Tables 16 and 19.

REMARKS. – Since Terquem introduced the species *Marginulina spinata* in 1858, it has variously been regarded an independent species, a subspecies of *Marginulina prima* D'ORBIGNY, or a variety of the latter species. The present writer regards *Marginulina spinata* a valid species including two subspecies, viz. *Marginulina spinata* ssp. *spinata* TERQUEM and *M. spinata* ssp. *interrupta* TERQUEM. In Scania, *M. spinata spinata* is represented in the Pankarp Clays of Late Sinemurian age. However, it does not become a frequent member of the foraminiferal fauna until the Katslösa Beds, spanning the Sinemurian-Carixian boundary. In the upper part of the Katslösa Beds, *Marginulina spinata* ssp. *interrupta* appears, gradually increasing in number, contemporaneously with a decrease in the population of *Marginulina spinata spinata.* In the lower part of the Rydebäck Beds, representing the Domerian Substage, *M. spinata spinata* is completely replaced by *M. spinata interrupta.*

Marginulina spinata TERQUEM, 1858 ssp. *spinata* TERQUEM, 1858

Fig. 43 C; Tables 16 and 19.

1858 *Marginulina spinata* TERQUEM. – p. 615, Pl. 3, Fig. 8.
1936 *Marginulina interrupta* TERQUEM f. *spinata* TERQUEM. – Franke, p. 79, Fig. 10.
1937 *Marginulina spinata spinata* TERQUEM. – Bartenstein & Brand, p. 161, Pl. 4, Fig. 61 (not Pl. 5, Fig. 47).
1941 *Marginulina spinata* TERQUEM. – Macfadyen, p. 39, Pl. 2, Fig. 33 a, b.
1957 *Marginulina prima* D'ORBIGNY subsp. *spinata* TERQUEM. – Nørvang, p. 92.
1957 *Marginulina prima* D'ORBIGNY var. *spinata* TERQUEM. – Adams, p. 222, Text-Fig. 21.
1968 *Marginulina prima* f. *spinata* TERQUEM. – Norling, pp. 12, 15, 16; Text-Fig. 5; Pl. 9.
1968 *Marginulina spinata* TERQUEM. – Bang (in Larsen et al.), pp. 63, 65, 67, 70, 86, 87; Appendix 2, Fig. 1.
1970 *Marginulina spinata* TERQUEM. – Norling, pp. 282, 271, Fig. 4 (partly).

DESCRIPTION. – Test elongate, composed of 3–9, usually 6 oblate chambers gradually increasing in size, in a straight or initially curved series. Test ornamented with 5–13 (commonly 7 or 8), thin, longitudinal, notched costae tapering at every chamber suture and tending to project downwards as small spines. Sutural ribs very rare. Apertural face usually thickened, along which the costae are joined in arches. Aperture eccentric or nearly central, protruding, oval or round with a margin of commonly 6, short, radiating, basically bifurcate ribs.

DIMENSIONS. – See Table 19 below.

MATERIAL. – Numerous specimens from the Upper Sinemurian and the Lower Pliensbachian of the Katslösa Exposure, and the cores Rydebäck-Fortuna Nos. 1 and 4, Kävlinge Nos. 928 and 930.

REMARKS. – *Marginulina spinata* ssp. *spinata* shows affinity to *Marginulina prima* ssp. *rugosa,* from which it differs in having notched and spinose costae and in the absence of sutural ribs or arches. The two subspecies of *Marginulina spinata* differs in the number of ribs, which is commonly greater in the subspecies *M. spinata interrupta* (see Table 19) and in the distinct sutural interruptions of costae in the latter subspecies (see Fig. 42 A). Of the seventeen specimens in Table 19, eleven are straight, whereas six have a curved initial part.

DISTRIBUTION. – Common in the Upper Sinemurian and the Lower Pliensbachian.

TABLE 19. Number of chambers and ribs and dimensions of Marginulina spinata ssp. spinata (17 specimens) and M. spinata ssp. interrupta (12 specimens) from the Lias of W. Scania.

Marginulina spinata	subspecies *spinata*		subspecies *interrupta*	
	range	mean	range	mean
Number of chambers	3–9	5.8	4–7	6
Number of ribs	5–13	7.6	5–14	10.9
Length in mm	0.32–1.00	0.59	0.48–0.83	0.64
Max. breadth in mm	0.15–0.25	0.21	0.18–0.33	0.23
Proloculum diameter	0.05–0.18	0.10	0.08–0.12	0.10

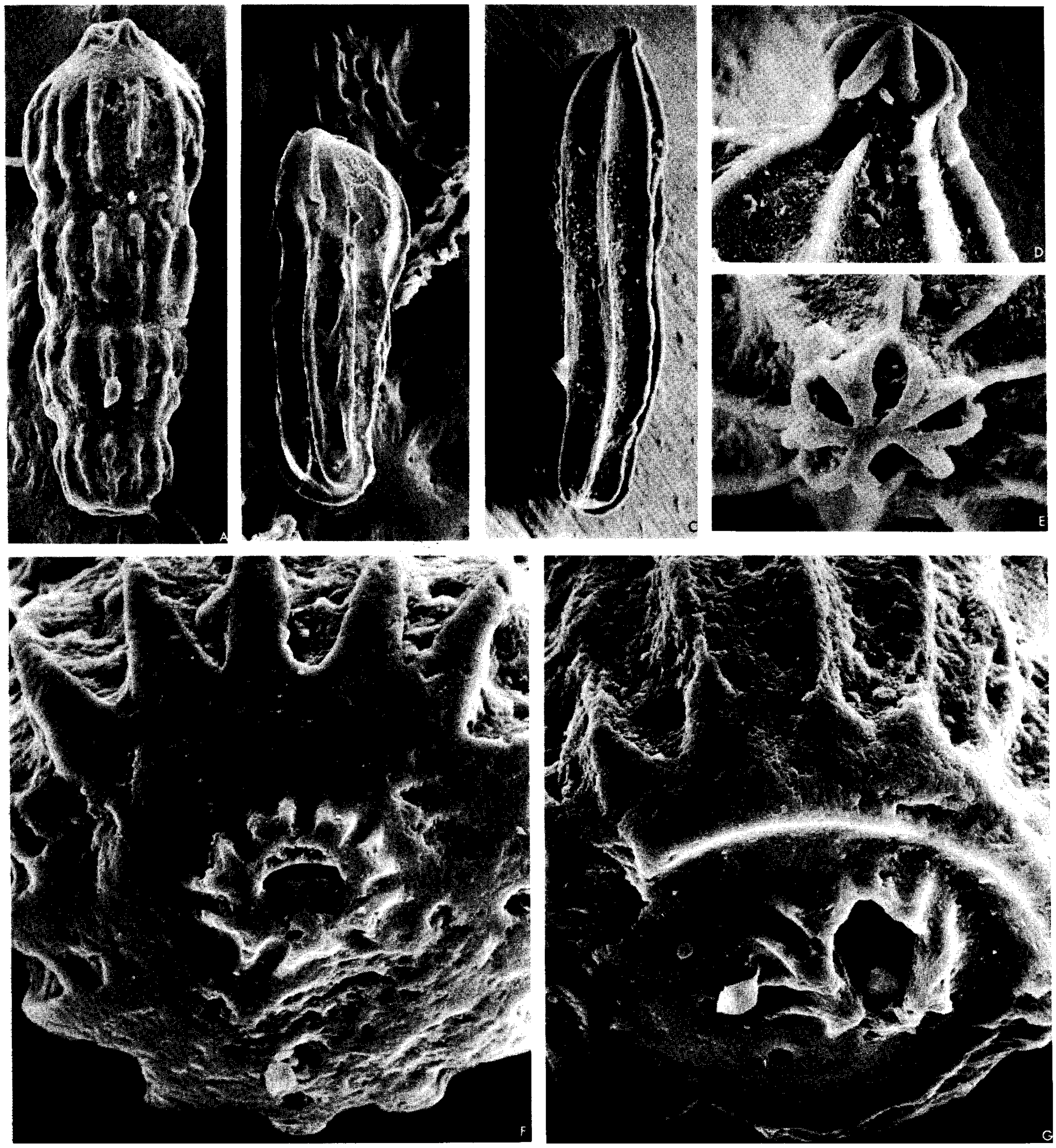


Fig. 42.

A. *Marginulina spinata* ssp. *interrupta* TERQUEM, 1866. Boring Rydebäck-Fortuna No. 4, 107 m, uppermost part of Katslösa Beds, Lower Pliensbachian. Side view of specimen EN SEM 84:1. 190 X.

B. *Marginulina prima* D'ORBIGNY, 1849 var. *burgundiae* TERQUEM, 1864. Boring Kävlinge No. 930, 62.7–63.5 m, Katslösa Beds, Lower Pliensbachian. Side view of specmen EN SEM 95:2. 107 X.

C. *Marginulina prima* var. *burgundiae*. Charmouth, Dorset, England. Davoei Zone, Lower Pliensbachian. Side view of specimen EN SEM 32:3 figured to show apertural chamberlet. 115 X.

D.–E. Apertural chamberlet of the same specimen. 510 X (D) and 590 X (E).

F. *Marginulina spinata* ssp. *interrupta*. Boring Rydebäck-Fortuna No. 4, 107 m, uppermost part of Katslösa Beds, Lower Pliensbachian. Apertural view of specimen EN SEM 84:2 (Compare with Fig. A). 480 X.

G. *Marginulina spinata* ssp. *interrupta* from the same samle as specimen in Fig. F. Oblique view of foramen in specimen EN SEM 84:4. 510 X.

Marginulina spinata TERQUEM, 1858 ssp. *interrupta* TERQUEM, 1866

Figs. 42 A, F, G, 43 D; Tables 16 and 19.

1866 *Marginulina interrupta* TERQUEM. – p. 426, Pl. 17, Fig. 4 a–c.
1936 *Marginulina interrupta* TERQUEM. – Franke, p. 79, Pl. 8, Fig. 9.
1937 *Marginulina spinata* TERQUEM ssp. *interrupta* TERQUEM. – Bartenstein & Brand, p. 161.

DESCRIPTION. – Test elongate, chambers 4–7 in number in a straight or slightly curved series. Chambers circular in transverse section. Test ornamented with numerous (commonly 10–12), discontinuous, frequently notched, longitudinal ribs, interrupted at every chamber suture. Test-wall fibrous-radiate, finely perforate, secondarily non-lamellar or mesolamellar. Ribs granular and essentially imperforate. Apertural face thickened, along which the longitudinal ribs are joined in arches. Aperture eccentric or almost central, rounded with a margin of short radiate, commonly 7, basically bifurcate ribs.

MATERIAL. – Numerous specimens from Upper Pliensbachian strata of the Rydebäck-Fortuna cores No. 1 (56.3–65.3 m) and No. 4 (90–96.6 m). Rare in Upper Carixian strata of the Katslösa Exposure and the Kävlinge core No. 930 (30–50 m).

REMARKS. – Terquem erected two independent species, viz. *Marginulina spinata* TERQUEM, 1858, and *Marginulina interrupta* TERQUEM, 1866. Franke (1936) accepted the species *Marginulina interrupta,* but regarded *M. spinata* as a variety of *M. interrupta.* As pointed out by Bartenstein & Brand (1937), the specific name spinata should have priority, as it is the first of the two species erected by Terquem. Adams (1957) did not accept *Marginulina spinata* as a species, but regarded it a variety of *Marginulina prima* D'ORBIGNY, 1849, whereas Nørvang (1957) suggested *M. spinata* to be a subspecies of *M. prima.* The present writer's studies of *Marginulina* species from the Swedish Jurassic have lead him to the opinion that *Marginulina spinata* TERQUEM, 1858 may be regarded a valid species and has found the subspecific subdivision by Bartenstein & Brand (1937), into *Marginulina spinata* ssp. *spinata* TERQUEM, 1858 and *M. spinata* ssp. *interrupta* TERQUEM, 1866 to be sound.

DISTRIBUTION. – Rare in the uppermost Carixian, common in the Domerian, Lias.

Genus *Mesodentalina* NORLING, 1968

Fig. 30, p. 62.

DIAGNOSIS. – Test calcareous elongate; ventral side convex, dorsal side concave to straight; transverse section oval.

Eight to fourteen chambers in a uniserial, curviserial arrangement; proloculum spheroidal to prolate, frequently with a basal spine, later chambers commonly oblate, except for the final chamber which may be prolate; chamber sutures distinct or indistinct, usually raised at dorsal margin.

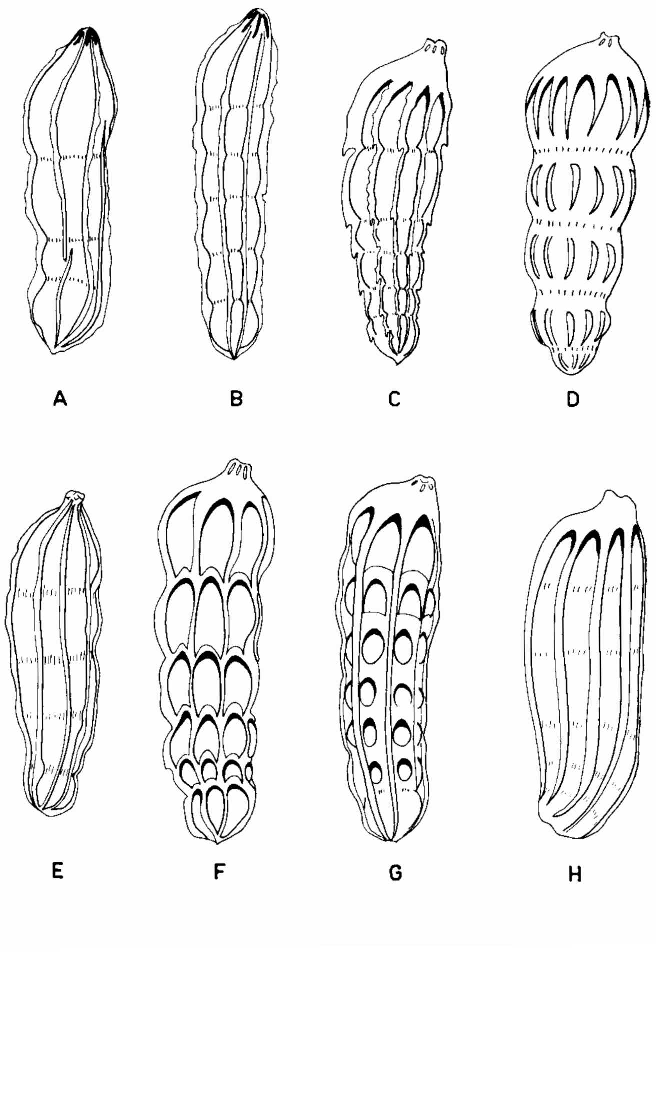


Fig. 43 A–H. Schematic drawings of some Jurassic *Marginulina* forms.
A. *Marginulina lamellosa* TERQUEM & BERTHELIN, 1875 (Lower Lias).
B. *Marginulina prima praerugosa* NØRVANG, 157 (Lower Sinemurian).
C. *Marginulina spinata spinata* TERQUEM, 1858 (Upper Sinemurian – Lower Pliensbachian).
D. *Marginulina spinata interrupta* TERQUEM, 1866 (Upper Pliensbachian).
E. *Marginulna prima burgundiae* TERQUEM, 1864 (Pliensbachian).
F. *Marginulina prima prima* D'ORBIGNY, 1849 (Pliensbachian-L. Toarcian).
G. *Marginulina prima fortunensis* nov. ssp. (U. Bathonian/Callovian – L. Oxfordian).
H. *Marginulina nytorpensis* nov. sp. (Callovian – L. Oxfordian).

Ornamentation consists of 10–25 ribs or striae, longitudinal, or traversing the test from the ventral, proximal part to the dorsal, distal part, converging towards the aperture. The ribs are granular, essentially imperforate and penetrate test-wall and septa.

Test-wall fibrous-radiate, perforate, with the exception of penetrative parts of ornamental elements; secondarily mesolamellar in the sense that the primary wall of each chamber is attached to and covers at least one preceding chamber, but not the whole previously formed test.

Septa fibrous-radiate, imperforate, may be primary laminated.

Aperture terminal eccentric, protruding, or produced to form a short neck, radiate.

Foramina similar to the aperture, but commonly the radiation is indistinct.

TYPE SPECIES. – *Dentalina matutina* D'ORBIGNY, 1849 *(Jurassique, 8e Étage, Liasien)*. Designated by Norling, 1968.

SPECIES FROM THE SWEDISH JURASSIC. – *Mesodentalina haeusleri* (SCHICK, 1903): Katslösa Exposure, Loc. 770–890, Sinemurian-Lower Pliensbachian; Kävlinge No. 928, 78–62 m, Lower Pliensbachian; Kävlinge No. 930, 103–34 m, Upper Sinemurian-Lower Pliensbachian; Rydebäck-Fortuna No. 1, 78.0–65.3 m, Pliensbachian; Rydebäck-Fortuna No. 4, 112–107 m, Lower Pliensbachian.

Mesodentalina matutina (D'ORBIGNY, 1849): Öresund 01, 42–15 m, Lower Sinemurian; Örby E 6 Viaduct Exposure, Lower Sinemurian; Gantofta Brick Pit, Lower Sinemurian; Kävlinge No. 928, 80–62 m, Lower Pliensbachian; Kävlinge No. 930, 103–62 m, Upper Sinemurian-Lower Pliensbachian; Katslösa Exposure, Sinemurian-Lower Pliensbachian; Rydebäck-Fortuna No. 1, 137–40.5 m, Upper Sinemurian-Pliensbachian; Rydebäck-Fortuna No. 4, 124–82.5 m, Pliensbachian.

Mesodentalina tenuistriata (TERUQEM, 1866): Välluf E 6 Viaduct Exposure, sample No. 11, Hettangian, Rydebäck-Fortuna No. 1, 68.5–40.5 m, Upper Pliensbachian; 35–30 m, Toarcian/Aalenian; Rydebäck-Fortuna No. 4, 112–77 m, Pliensbachian.

REMARKS. – A detailed description of the genotype species *Mesodentalina matutina* was given by the present writer in 1968 (pp. 41–43, Text-Figs. 8 B, 10 A–F; Pl. 3, Fig. 5; Pl. 9). Detailed descriptions of external characters of the other two species included in this genus, viz. *M. haeusleri* and *M. tenuistriata* have been given previously by several authors. Their wall structure is fundamentally the same as in the genotype species.

The line of evolution from the non-lamellar genus *Prodentalina* NORLING, 1968 to the lamellar genus *Dentalina* RISSO, 1826 is easily traced by means of the mesolamellar test-wall in *Mesodentalina*. Thus, *Mesodentalina* is regarded an intermediate genus between *Prodentalina* and *Dentalina*.

DISTRIBUTION. – Lower Jurassic.

Genus *Prodentalina* NORLING, 1968

Fig. 30 A, p. 62.

DIAGNOSIS. – Test elongate, ventral side convex, dorsal side concave or nearly straight; transverse section oval or nearly round.

Three to fifteen chambers, oblate or prolate, in a uniseral, curviseral arrangement; chamber sutures usually distinct, raised at dorsal margin.

Test-wall calcareous, fibrous- (or acicular-) radiate, finely perforate, secondarily non-lamellar (no primary lamination has been observed); perforation consists of straight or slightly curved pore canals, more or less evenly distributed, or restricted to pore bundles; the basal part of each chamber frequently has a greater number of pores than other parts of the test.

Septa fibrous- (or acicular-) radiate, essentially imperforate; ventral septa usually much longer than dorsal due to the eccentric position of foramina.

Aperture distinct, terminal, eccentric (near dorsal margin), protruding, radiate (with radiating grooves or slits); an apertural chamberlet may occur.

Foramina protruding, similar to the aperture, but may have lost the radiation; apertural and foraminal areas imperforate.

Species hitherto examined lack ornamentation.

TYPE SPECIES. – *Dentalina terquemi* D'ORBIGNY, 1849 (*Jurassique, 8e Étage, Liasien)*. Designated by Norling, 1968.

SPECIES FROM THE SWEDISH JURASSIC. – *Prodentalina gladiiformis* (FRANKE, 1936): Rydebäck-Fortuna No. 1, 68.5 m, Upper Pliensbachian.

Prodentalina hausmanni (BORNEMANN, 1854): Rydebäck-Fortuna No. 1, 68.5 m, Upper Pliensbachian.

Prodentalina terquemi (D'ORBIGNY, 1849): Katslösa Exposure, Kävlinge Nos. 928 and 930, Lower Pliensbachian; Rydebäck-Fortuna No. 1, 92–68.5 m, Pliensbachian; Rydebäck-Fortuna No. 4, 142 m, Upper Sinemurian, 124–77 m, Pliensbachian; Örby E 6 Viaduct Exposure, Lower Sinemurian.

Prodentalina vasta (FRANKE, 1936): Katslösa Exposure and Kävlinge No. 930, Lower Pliensbachian.

Prodentalina vetusta (D'ORBIGNY, 1849): Rydebäck-Fortuna No. 4, 107–108 m; Katslösa Exposure, Kävlinge Nos. 928 and 930, all from the Lower Pliensbachian; Örby E 6 Viaduct Exposure, Lower Sinemurian.

Prodentalina vetustissima (D'ORBIGNY, 1849): Rydebäck-Fortuna No. 1, 68.5 m, Upper Pliensbachian.

REMARKS. – Detailed descriptions of the genotype species *Prodentalina terquemi,* and the two species *P. vasta* and *P. vetusta* were given by the present writer in 1968 (pp. 36–40, Text-Figs. 8 A, 9 A_1–C_2; Pl. 3, Figs. 1, 3; Pl. 4, Figs. 1–3; Table 3). The external characters of the other three species included in the genus *Prodentalina,* viz. *P. gladiiformis, P. hausmanni,* and *P. vetustissima,* have been described by previous authors. Their wall structure is fundamentally of the same nature as in *P. terquemi, P. vasta,* and *P. vetusta. Prodentalina hausmanni* shows external similarity to *P. terquemi,* but differs in having a flush aperture and short striae at every chamber suture.

The species listed above are of little interest from a biostratigraphical point of view. *P. hausmanni* and *P. vasta* have been recorded from the Hettangian-Pliensbachian, *P. gladiiformis, P. terquemi,* and *P. vetustissima* from all Liassic stages, and *P. vetusta* from the Sinemurian-Pliensbachian in W. Europe.

Most of the Triassic species previously referred to *Dentalina* should probably be included in the genus *Prodentalina.*

DISTRIBUTION. – Triassic ? – Lower Jurassic.

Genus *Pseudonodosaria* BOOMGAART, 1949

DIAGNOSIS. – Test free, smooth or ornamented with longitudinal ribs; chambers in a uniserial and rectilinear series, embracing strongly at least in the early portion of the test, later chambers may be inflated and less embracing; sutures horizontal, flush or depressed; aperture terminal, central, radiate; may have a phialine lip or an apertural chamberlet.

TYPE SPECIES. – *Glandulina discreta* REUSS, 1850 by original designation. Upper Tertiary.

SPECIES FROM THE SWEDISH JURASSIC. – *Pseudonodosaria holocostata* (KRISTAN-TOLLMANN, 1964), *P. multicostata* (BORNEMANN, 1854), *P. plumiricostata* (KRISTAN-TOLLMANN, 1964), *P. quadricostata* nov. sp., *P. quinquecostata* (BORNEMANN, 1854), *P. sexcostata* (BORNEMANN, 1854), *P.* ex gr. *vulgata* (BORNEMANN, 1854).

REMARKS. – The genus *Pseudonodosaria* BOOMGAART has not been generally accepted until recently, though it was erected more than twenty years ago. Bornemann (1854), who is the author of most of the species listed above, referred species *Pseudonodosaria multicostata* to the genus *Orthocerina* D'ORBIGNY, 1839. For reasons discussed by Loeblich & Tappan, 1964, this genus is considered unrecognizable. The species *Pseudonodosaria quinquecostata, P. sexcostata,* and *P. vulgata* were referred to the genus *Glandulina* D'ORBIGNY, 1839 by Bornemann (1854) and many other authors including Franke (1936). However, the genus *Glandulina* is characterized by an early portion of biseral, later uniserial chamber arrangement, and by the presence of an entosolenian tube. The species discussed here are uniserial throughout the ontogeny and lack an entosolenian tube. Bartenstein & Brand (1937), Barnard (1950, 1951), and Nørvang (1957) referred the species under consideration to the genus *Pseudoglandulina* CUSHMAN, 1929. However, Loeblich & Tappan (1955) showed that this genus is a synonym of *Nodosaria* LAMARCK, 1812, and erected the genus *Rectoglandulina.* In "Treatise on Invertebrate paleontology" (1964), the same authors regard *Rectoglandulina* a synonym of the genus *Pseudonodosaria* BOOMGAART, 1949. Some authors, including Brouwer (1969), have referred the species discussed herein to the genus *Nodosaria* LAMARCK, 1812. Sellier De Civrieux & Dessauvagie (1965) erected the genus *Pseudolangella* to which some Permian and Liassic foraminifera were referred. The main difference between *Pseudolangella* and *Pseudonodosaria* is a rounded, non-radiate aperture in the former genus and a radiate aperture in the latter. Among other species, Sellier De Civrieux & Dessauvagie (1965, pp. 54–55) referred Bornemann's Liassic species *Orthocerina pupoides* and *O. multicostata* to the genus *Pseudolangella.* According to the Swedish material, all specimens referable to these and some other of Bornemann's Liassic species have a distinctly radiate aperture and should be placed in the genus *Pseudonodosaria.*

DISTRIBUTION. – Permian – Recent.

Pseudonodosaria quadricostata nov. sp.

Fig. 44 A, B, D, F.

HOLOTYPE. – Specimen EN SEM 91:4, Fig. 44 A.

TYPE STRATUM AND TYPE LOCALITY. – Rydebäck Beds, Upper Pliensbachian, Middle Lias, in calcareous, light grey siltstone with dark grey lenses rich in shell fragments. Boring Rydebäck-Fortuna No. 1, 53.3–53.4 m below surface, at a streamlet 700 m SE. of Rydebäck farm, about 10 km SSE. of Helsingborg, NW. Scania, S. Sweden.

DIAGNOSIS. – Test elongate, quadratic in transverse section; chambers numerous in a uniserial and rectilinear arrangement; sutures horizontal, flush; test ornamented with 4 strong, longitudinal costae; aperture produced to form a short neck with a phialine lip, distinctly radiate.

DESCRIPTION. – Test elongate, rather short and robust, with a quadratic or subquadratic transverse section. Chambers 4–8 in number, globular, embracing strongly in the early portion, arranged in a uniserial, rectilinear series. Sutures horizontal, flush, commonly indistinct. Test ornamented with 4 longitudinal costae traversing the test from the base of initial chamber to the apertural chamber. Test-wall fibrous-radiate, finely perforate with an indistinct secondary, possibly complete lamination. Septa and test-wall with a primary lamination. Aperture terminal, central, produced to form a short neck with a phialine lip, distinctly radiate.

DIMENSIONS. – Holotype: length, 0.4 mm; breadth, 0.18 mm. Range of 10 specimens: length, 0.4–0.8 mm; breadth, 0.15–0.20 mm.

MATERIAL. – Six specimens from the boring Rydebäck-Fortuna No. 1, 68.5–53 m (Domerian); 35 m (Toarcian/Aalenian); 4 specimens from the boring Rydebäck-Fortuna No. 4, 96.6–98 m (Domerian); 2 specimens from the boring Kävlinge No. 930, 65.3–65.4 m (Carixian).

DISTRIBUTION. – Pliensbachian-Toarcian/Aalenian.

Pseudonodosaria quinquecostata (BORNEMANN, 1854)

Fig. 45 A–C.

1854 *Glandulina quinquecostata* BORNEMANN. – p. 32, Pl. 2, Fig. 6 a, b.
1936 *Glandulina quinquecostata* BORNEMANN. – Franke, p. 58, Pl. 5, Figs. 25 a, b, 26 a, b.
? 1955 *Rectoglandulina quinquecostata* (BORNEMANN). – Tappan, p. 75; Pl. 26, Figs. 17, 18.
not 1965 *Rectoglandulina* cf. *quinquecostata* (BORNEMANN). – Hanzlíková, p. 91, Pl. 9, Fig. 5 a, b.

DESCRIPTION. – Test small, commonly short and broad, composed of 3–6 chambers in a uniserial, rectilinear series; sutures horizontal, flush or depressed, straight or slightly arched between the costae. Test ornamented with 5 strong, longitudinal costae traversing the test from basal spine of the initial chamber to the apertural chamber. Test-wall fibrous-radiate, finely perforate. Aperture terminal, central, produced to form a short neck with a phialine lip, radiate.

DIMENSIONS. – Length, 0.40–0.75 mm; breadth, 0.20–0.34 mm.

MATERIAL. – Five specimens from the boring Kävlonge No. 928, 63.7 m, Katslösa Beds, Lower Pliensbachian, Lower Lias.

REMARKS. – Bornemann (1854) based his specific subdivision of costate foraminifera, herein referred to the genus *Pseudonodosaria,* mainly on the number of costae. Tappan (1955), referred all forms with 5–9 costae previously referred to the species *P. quinquecostata, P. abbreviata, P. sexcostata* and *P. septangularis* to the species *P. quinquecostata* with the remark that the number of costae is variable and sometimes increased by intercalating costae. On the other hand she considered *P. multicostata* a valid species, which differs from *P. quinquecostata* in having more costae and somewhat higher chambers (Tappan, 1955, p. 74). Tappan's opinion is based on a small amount of material. The present writer prefers to follow Bornemann's specific subdivision until a larger amount of material has been studied on a statistical basis, which possibly will justify a revision of the costate *Pseudonodosaria* species. Hanzlíková (1965, Pl. 9, Fig. 5 a) referred a ribbed *Pseudonodosaria* from the Upper Jurassic of the Czechoslovakia to *Rectoglandulina* cf. *quinquecostata* (BORNEMANN). Her form has 9 costae joined in arches at the margin of a thickened apertural face. This from has very little in common with Bornemann's species but may be referable to *Pseudonodosaria doliolum* (TERUQUEM & BERTHELIN), recorded from the Kimmeridgian by Barnard (1963), Espitalié & Sigal (1963) and others.

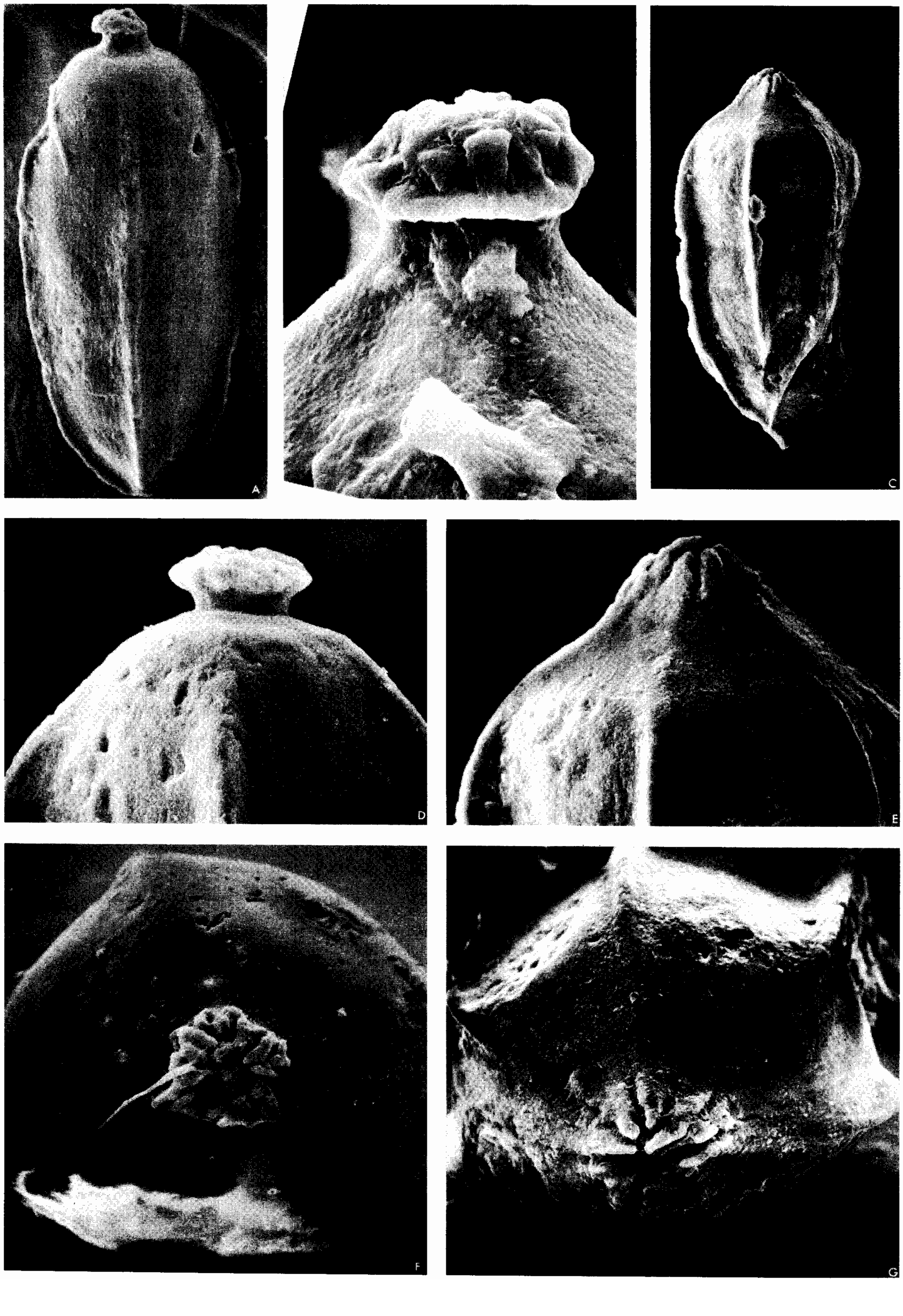
DISTRIBUTION. – Pliensbachian.

*Pseudonodosaria sexcostata (*BORNEMANN, 1854)

Fig. 44 C, E, G.

1854 *Glandulina sexcostata* BORNEMANN. – p. 32, Pl. 2, Fig. 7 a, b.
1936 *Glandulina sexcostata* BORNEMANN. – Franke, p. 58, Pl. 6, Figs. 1 a, b, 2 a, b.
1937 *Pseudoglandulina sexcostata* (BORNEMANN). – Bartenstein & Brand, p. 151.
1961 *Rectoglandulina sexcostata* (BORNEMANN). – Pietrzenuk, p. 75.

DESCRIPTION. – Test small, short and broad, composed of 3 or 4, inflated, embracing chambers in a uniserial, rectilinear arrangement. Transverse section hexagonal, sutures horizontal, slightly depressed. The ornamentation consists of 6 strong costae traversing the test from basal spine of the initial chamber to the apertural chamber. Aperture terminal, central, protruding, distinctly radiate (with numerous radiating slits).


A
C
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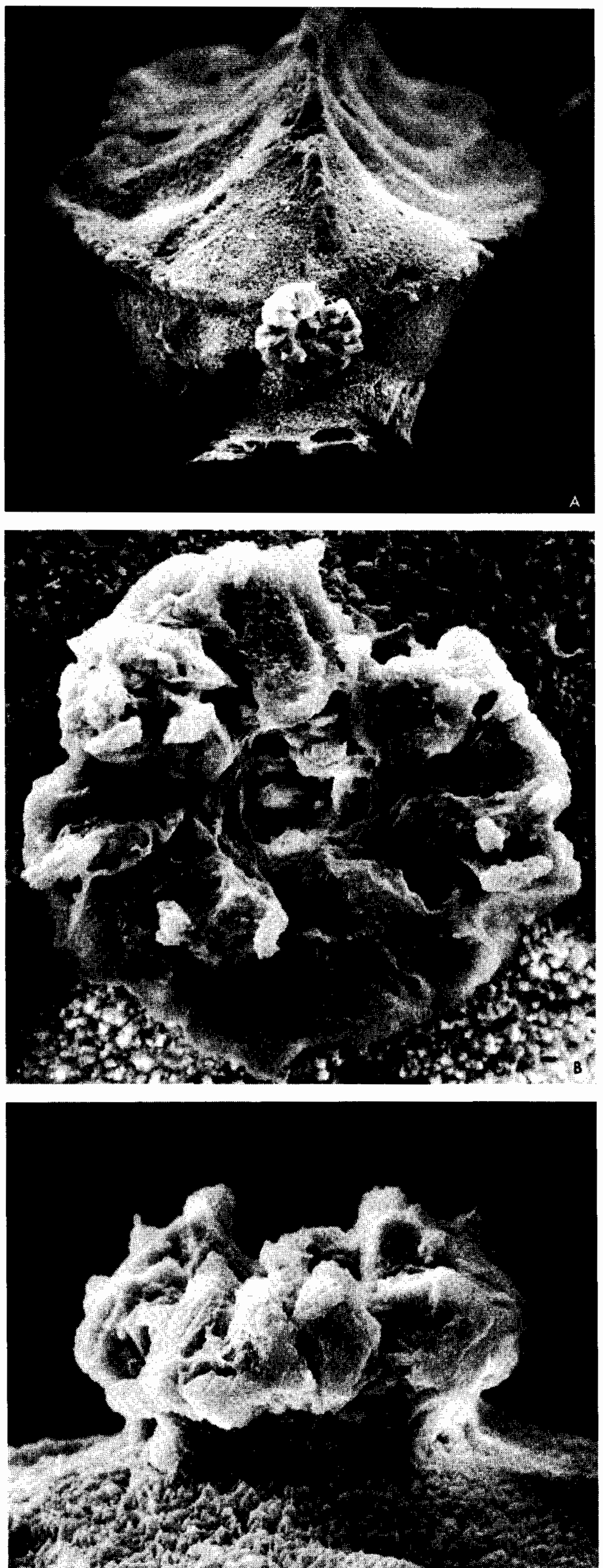


Fig. 45 A–C. *Pseudonodosaria quinquecostata* (BORNEMANN, 1854). Specimen EN SEM 100:5. Boring Kävlinge No. 928, 63.7 m, Katslösa Beds, Carixian, Lower Lias.

A. Apertural view. 225 X.

B. Radiate aperture. 1120 X.

C. Side view of aperture. Note the short neck and the phialine lip. 1000 X. ⟶

DIMENSIONS. – Length, 0.30–0.50 mm; breadth, 0.15–0.25 mm.

MATERIAL. – Eight specimens from the boring Rydebäck-Fortuna No. 4, 137–77 m, Upper Sinemurian-Domerian; 4 specimens from the boring Rydebäck-Fortuna No. 1, 60.15 m (1), 53.3 m (1), Domerian, and 30 m (2), Toarcian/Aalenian.

REMARKS. – The Swedish specimens of *Pseudonodosaria sexcostata* all have a protruding aperture with radiating slits, which differs widely from the one found in *P. quadricostata,* and *P. quinquecostata* (see Figs. 44, 45).

DISTRIBUTION. – Hettangian-Toarcian/Aalenian.

⟵

Fig. 44 A–G. Genus *Pseudonodosaria* BOOMAART, 1949.

A. *Pseudonodosaria quadricostata* nov. sp. Side view of specimen EN SEM 91:4 (holotype). Boring Rydebäck-Fortuna No. 1, 53.3–53.4 m, Rydebäck Beds, Domerian, Middle Lias. 245 X.

B. *Pseudonodosaria quadricostata* nov. sp. Side view of aperture of specimen EN SEM 82:1. Boring Rydebäck-Fortuna No. 4, 82 m, Rydebäck Beds, Domerian, Middle Lias. Note the short apertural neck and the phialine lip. 1250 X.

C. *Pseudonodosaria sexcostata* (BORNEMANN, 1854). Side view of specimen EN SEM 22:3. Boring Rydebäck-Fortuna No. 1, 53.3–53.4 m, Rydebäck Beds, Domerian, Middle Lias. 245 X.

D. *Pseudonodosaria quadricostata* nov. sp. Side view of aperture of specimen EN SEM 20:1. Boring Rydebäck-Fortuna No. 4, 82 m, Rydebäck Beds, Domerian, Middle Lias. Note the short apertural neck and the phialine lip. 555 X.

E. *Pseudonodosaria sexcostata* (BORNEMANN, 1854). Side view of aperture. Specimen EN SEM 22:3 (See C). 590 X.

F. *Pseudonodosaria quadricostata* nov. sp. Apertural view of specimen EN SEM 37:4. Boring Kävlinge No. 930, 65.4–66.3 m, Katslösa Beds, Lower Lias. 545 X.

G. *Pseudonodosaria sexcostata* (BORNEMANN, 1854). Apertural view of specimen EN SEM 22:3 (See C, E). 540 X.

Pseudonodosaria ex gr. *vulgata* (BORNEMANN, 1854)

Figs. 46 A–C, p. 87.

1854 *Glandulina vulgata* BORNEMANN. – p. 31, Pl. 2, Figs. 1 a, b, 2 a, b.
1854 *Glandulina tenuis* BORNEMANN. – p. 31, Pl. 2, Fig. 3 a, b.
1854 *Glandulina major* BORNEMANN. – p. 31, Pl. 2, Fig. 4 a, b.
1841 *Nodosaria humilis* ROEMER. – p. 95, Pl. 15, Fig. 6.
1860 *Nodosaria humilis* ROEMER. – Jones & Parker, Pl. 19, Fig. 6.
1860 *Nodosaria glans* D'ORBIGNY. – Jones & Parker, Pl. 19, Fig. 7.
1862 *Glandulina metensis* TERQUEM. – p. 435, Pl. 5, Fig. 9.
1863 *Glandulina oviformis* TERQUEM. – p. 378, Pl. 7, Fig. 4 a, b.
1863 *Glandulina mutabilis* REUSS. – p. 58, Pl. 5, Figs. 7, 9–11.
1865 *Glandulina theca* SCHWAGER. – p. 115, Pl. 4, Fig. 17.
1865 *Glandulina pigmea* SCHWAGER. – p. 115, Pl. 4, Fig. 12.
1866 *Glandulina pygmea* TERQUEM. – p. 478, Pl. 19, Fig. 6.
1883 *Glandulina lahuseni* UHLIG. – p. 749, Pl. 9, Fig. 18.
1904 *Glandulina lahuseni* UHLIG. – Brückmann, p. 27, Pl. 3, Fig. 28.
1908 *Glandulina metensis* TERQUEM. – Issler, p. 50, Pl 2., Fig. 66.
1936 *Glandulina oviformis* TERQUEM. – Franke, p. 55, Pl. 5, Fig. 11.
1936 *Glandulina pygmaea* TERQUEM. – Franke, p. 5, Pl. 5, Fig. 10 a–c.
1936 *Glandulina vulgata* BORNEMANN. – Franke, p. 54, Pl. 5, Fig. 9 a, b.
1936 *Glandulina major* BORNEMANN. – Franke, p. 57, Pl. 5, Fig. 17.
1936 *Glandulina irregularis* FRANKE. – p. 57, Pl. 5, Fig. 15 a, b.
1936 *Glandulina dubia* TERQUEM. – Franke, p. 56, Pl. 5, Fig. 16.
1936 *Glandulina tenuis* BORNEMANN. – Franke, p. 55, Pl. 5, Fig. 13 a, b.
1936 *Glandulina metensis* TERQUEM. – Franke, p. 56, Pl. 5, Fig. 12.
1936 *Glandulina pupoides* (BORNEMANN). – Franke, p. 56, Pl. 5, Fig. 14 a, b.
1936 *Glandulina turbinata* TERQUEM & BERTHELIN. – Franke, p. 56, Pl. 5, Fig. 18.
1937 *Pseudoglandulina humilis* (ROEMER). – Bartenstein & Brand, p. 150, Pl. 8, Fig. 18.
1937 *Pseudoglandulina tenuis* (BORNEMANN). – Bartenstein & Brand, p. 150, Pl. 4, Fig. 41; Pl. 6, Fig. 16; Pl. 8, Fig 19; Pl. 15 A, Fig. 15.
1937 *Pseudoglandulina oviformis* (TERQUEM). – Bartenstein & Brand, p. 149, Pl. 4, Fig. 40.
1939 *Pseudoglandulina tutkowskii* MJATLIUK. – p. 65, Pl. 4, Figs. 57–58.
1941 *Pseudoglandulina oviformis* (TERQUEM). – Macfadyen, p. 47, Pl. 3, Fig. 47.
1941 *Pseudoglandulina tenuis* (BORNEMANN). – Macfadyen, p. 48, Pl. 3, Fig. 49.
1941 *Pseudoglandulina vulgata* (BORNEMANN). – Macfadyen, p. 49, Pl. 3, Fig. 50.
1947 *Pseudoglandulina* cf. *tenuis* (BORNEMANN). – Payard, p. 174, Pl. 6, Fig. 24.
1950 a *Pseudoglandulina oviformis* (TERQUEM). – Barnard, p. 365, Fig. 6 h.
1950 a *Pseudoglandulina vulgata* (BORNEMANN). – Barnard, p. 365, Fig. 4 c.
1950 b *Pseudoglandulina oviformis* (TERQUEM). – Barnard, p. 24, Pl. 1, Fig. 6.
1950 b *Pseudoglandulina vulgata* (BORNEMANN). – Barnard, p. 24, Pl. 1, Fig. 7; Text-Fig. 15.
1951 *Pseudoglandulina mutabilis* (REUSS). – Bartenstein & Brand, p. 315, Pl. 14 C, Fig. 36; Pl. 15 C, Fig. 10.
1951 *Pseudoglandulina humilis* (ROEMER). – Bartenstein & Brand, p. 315, Pl. 10, Figs. 266, 268, 269.
1951 *Pseudoglandulina tenuis* (BORNEMANN). – Bartenstein & Brand, p. 315, Pl. 13, Fig. 349.
1955 *Rectoglandulina brandi* TAPPAN. – p. 74, Pl. 26, Fig. 12.
1955 *Rectoglandulina oviformis* (TERQUEM). – Tappan, p. 74, Pl. 26, Fig. 13.
1955 *Rectoglandulina turbinata* (TERQUEM & BERTHELIN). – Tappan, p. 75, Pl. 26, Figs. 10–11.
1956 *Pseudonodosaria vulgata* (BORNEMANN). – Seibold & Seibold, p. 139, Text-Fig. 6 m, n, r–t.
1956 *Pseudoglandulina humilis* (ROEMER). – Bartenstein, p. 521, Pl. 2, Fig. 54.
1956 *Pseudonodosaria tuberosa* (SCHWAGER). – Seibold & Seibold, p. 137, Text-Fig.. 5 s, t.
1957 *Pseudoglandulina vulgata* (BORNEMANN). – Nørvang, p. 80, Fig. 85.
1957 *Pseudoglandulina vulgata* (BORNEMANN) var. *pupoides* (BORNEMANN). – Nørvang, p. 81, Figs. 83, 84.
1957 *Pseudoglandulina vulgata* (BORNEMANN) var. *irregularis* (FRANKE). – Nørvang, p. 82, Fig. 86.
1958 *Pseudoglandulina pupoides* (BORNEMANN). – Drexler, p. 498, Pl. 20, Fig. 27.
1959 *Pseudonodosaria vulgata* (BORNEMANN). – Cifelli, p. 318, Pl. 5, Fig. 3.
1959 *Pseudonodosaria hybrida* (TERQUEM & BERTHELIN). – Cifelli, p. 318, Pl. 5, Figs. 7–11.
1959 *Pseudonodosaria oviformis* (TERQUEM). – Cifelli, p. 319, Pl. 5, Figs. 1–2.
1959 *Pseudonodosaria pupoides* (BORNEMANN). – Cifelli, p. 319, Pl. 5, Figs. 4–6.
1960 *Rectoglandulina vulgata* (BORNEMANN). – Lutze, p. 480, Pl. 29, Figs. 4–7; Text-Fig. 16.
1960 *Rectoglandulina humilis* (ROEMER). – Lutze, p. 481, Pl. 29, Figs. 8–9; Text-Fig. 16.
1960 *Rectoglandulina tenuis* (BORNEMANN). – Lutze, p. 481, Pl. 29, Fig. 3; Text-Fig. 16.
1961 *Rectoglandulina vulgata* (BORNEMANN). – Pietrzenuk, p. 74, Pl. 4, Fig. 12.
1961 *Rectoglandulina oviformis* (TERQUEM). – Pietrzenuk, p. 74, Pl. 4, Fig. 13.
1961 *Rectoglandulina tenuis* (BORNEMANN). – Pietrzenuk, p. 75.
1961 *Rectoglandulina pupoides* (BORNEMANN). – Pietrzenuk, p. 75.
1963 *Rectoglandulina vulgata* (BORNEMANN). – Barnard, p. 82, Fig. 2, (including forma *humilis, regularis, pupiforme, irregularis);* pp. 83–85.
1963 *Rectoglandulina oviformis* (TERQUEM). – Barnard, pp. 82–85; Fig. 2 l–o.
1963 *Rectoglandulina tutkowskii* (MJATLIUK). – Espitalié & Sigal, p. 63, Pl. 30, Figs. 5–6.
1963 *Rectoglandulina brandi* TAPPAN. – Espitalié & Sigal, p. 63, Pl. 30, Figs. 7–8.
1963 *Rectoglandulina* gr. *humilis* (ROEMER). – Espitalié & Sigal, p. 64, Pl. 30, Figs. 10–15.
1965 *Rectoglandulina* cf. *vulgata* (BORNEMANN). – Osman & Marzouk, p. 418, Pl. 1, Fig. 18.
1965 *Rectoglandulina tenuis* (BORNEMANN). – Osman & Marzouk, p. 417, Pl. 1, Fig. 5.
1965 *Rectoglandulina oviformis* (TERQUEM). – Osman & Marzouk, p. 417, Pl. 2, Fig. 22.
1967 *Pseudonodosaria vulgata* (BORNEMANN). – Gordon, p. 454, Pl. 4, Figs. 7–8.
1969 *Nodosaria oviformis* (TERQUEM). – Brouwer, p. 28, Pl. 4, Fig. 3
1969 *Nodosaria vulgata* (BORNEMANN). – Brouwer, p. 29, Pl. 4, Figs. 4–5.

MATERIAL. – Numerous specimens from Pliensbachian, Toarcian-Aalenian, and Callovian-Oxfordian strata of the Rydebäck-Fortuna cores Nos. 1, 4 and 5. Obtained also from the Lower Pliensbachian of the Katslösa Exposure and the Kävlinge cores Nos. 928 and 930.

REMARKS. – As seen in the synonymy, *Pseudonodosaria* ex gr. *vulgata* includes a great number of forms, which variously have been regarded as independent species or varieties of the same species. Lutze (1960) illustrated a great number of variants from the Lias, Upper Bathonian-Callovian, and the Cretaceous in NW. Germany, many of which have been recorded from

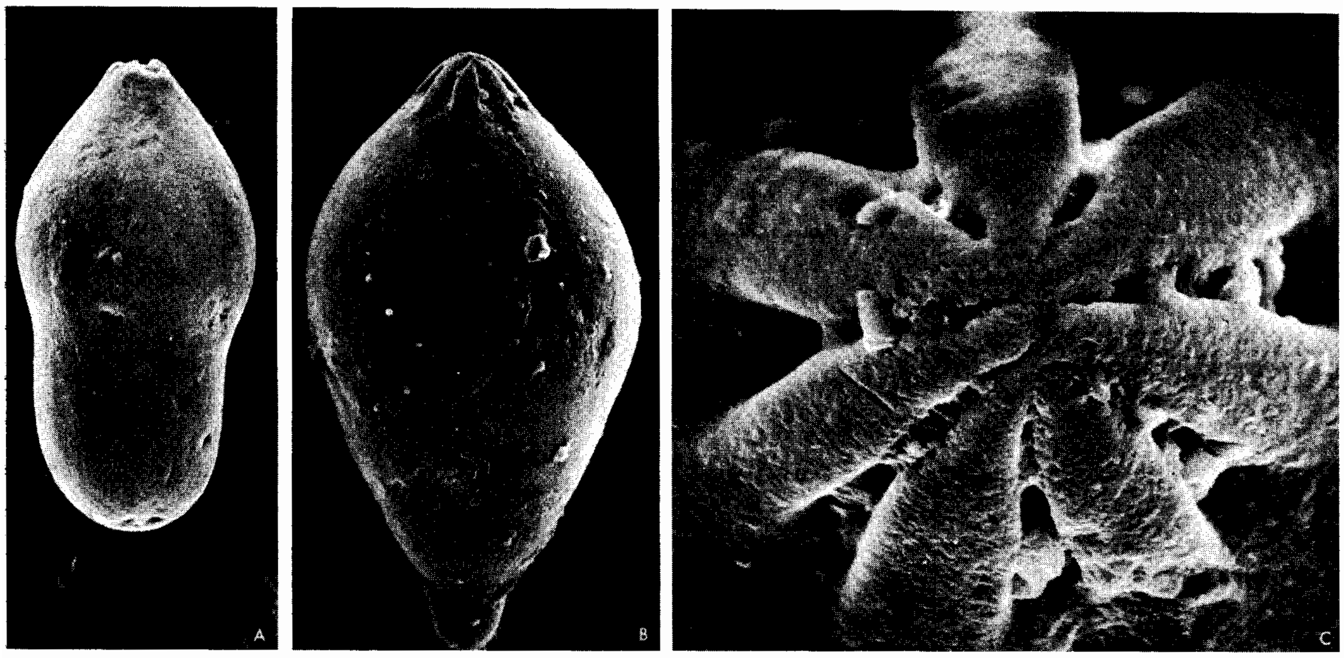


Fig. 46 A–C. *Pseudonodosaria* ex gr. *vulgata* (BORNEMANN, 1854).
A. Specimen EN SEM 84:6. Boring Rydebäck-Fortuna No. 4, 107 m, Katslösa Beds, Lower Pliensbachian. 210 X.
B. Specimen EN SEM 38:4. Boring Kävlinge No. 930, 62.7 m, Katslösa Beds, Lower Pliensbachian. 220 X.
C. Apertural chamberlet of the same specimen. 1200 X.

other parts of W. Europe (Barnard, 1950, 1963; Cifelli, 1959, 1960; Gordon, 1967; Nørvang, 1957 and others), the USSR (Uhlig, 1883; Brückmann, 1904; Mjatliuk, 1939 and others), Egypt (Said & Barakat, 1958; Osman & Marzouk, 1965), and Madagascar (Espitalié & Sigal, 1963). Tappan (1955) described some smooth forms of *Pseudonodosaria* from the Lower and Upper Jurassic of N. Alaska, which show a close affinity to forms described from European Jurassic strata. Barnard (1950 a, b, 1963) described the variation in British Jurassic forms of *Pseudonodosaria* and remarked that many of the forms, by earlier authors assigned to a number of different species, actually fall within the normal range of variation of the species. He stated that slight variation in the growth rate, the biocharacter controlling the size and shape of the chambers, would result in a wide range of variations in the final shape of the test. On account of the sporadic occurrence of the forms of Jurassic and Cretaceous *Pseudonodosaria,* Barnard (1950 b) suggested: "As somewhat similar variation occurs at widely scattered horizons the appearance of trends should not be ascribed to one slowly evolving group, with occasional bursts of excessive variation, but to a number of closely similar though perhaps not closely related species. These gave rise to similar patterns of variation with heterochronous homeomorphy." (Barnard, 1950 b, p. 26; 1963, p. 83). Also Cifelli (1960, p. 564) and Lutze (1960, p. 478) give examples of species from higher levels than the Lias, but with a closely similar pattern of variation.

DISTRIBUTION. – Lias-Upper Cretaceous.

Genus *Saracenaria* DEFRANCE, 1824

DIAGNOSIS. – Test free, chambers planispirally arranged in the early stage, later in a curved series, thus reminiscent of Astacolus, but differing in having a triangular transverse section, frequently with a broad, flat apertural face; outer margin and two angles of face may be acute and keeled or somewhat rounded; aperture at peripheral angle, radiate.

TYPE SPECIES. – *Saracenaria italica* DEFRANCE, 1824 by original designation. Recent.

SPECIES FROM THE SWEDISH JURASSIC. – *Saracenaria cornucopiae* (SCHWAGER, 1865), *S. oxfordiana* TAPPAN, 1955, *S. phaedra* TAPPAN, 1955, *S. sublaevis* (FRANKE, 1936), *S. trigona* (TERQUEM, 1866).

DISTRIBUTION. – Jurassic – Recent.

Saracenaria cornucopiae (SCHWAGER, 1865)

Fig. 47 A.

1865 *Cristellaria cornucopiae* SCHWAGER. – pp. 121, 95, Pl. 5, Fig. 7 a, b.
1917 *Lenticulina italica* DEFRANCE. – Paalzow (partly), p. 41, Pl. 46, Fig. 12.
1921 *Cristellaria cornucopiae* SCHWAGER. – Klähn, p. 46, Pl. 2, Fig. 33.
1932 *Saracenaria cornucopiae* (SCHWAGER). – Paalzow, p. 126, Pl. 9, Fig. 10.
1937 *Cristellaria (Saracenaria) cornucopiae* (SCHWAGER). – Bartenstein & Brand, p. 170, Pl. 14 B, Fig. 12 a, b; Pl. 15 A, Fig. 31 a, b; Pl. 15 C, Fig. 16.
1938 *Cristellaria (Saracenaria) cornucopiae* (SCHWAGER). – Mohler, p. 22.
1941 *Cristellaria (Saracenaria) cornucopiae* (SCHWAGER). – Frentzen, p. 347, Pl. 5, Figs. 10, 11.
1943 *Cristellaria (Saracenaria) cornucopiae* (SCHWAGER). – Ströbel, p. 10.
1953 *Lenticulina (Saracenaria) cornucopiae* (SCHWAGER). – Seibold & Seibold, p. 50, Pl. 4, Fig. 9.
1956 *Lenticulina (Saracenaria) cornucopiae* (SCHWAGER). – Seibold & Seibold, p. 123, Text-Fig. 3 b–e; p. 110, Pl. 7, Fig. 21.
1960 *Lenticulina (Saracenaria) cornucopiae* (SCHWAGER). – Seibold & Seibold, p. 353.
1960 *Lenticulina (Saracenaria) cornucopiae* (SCHWAGER). – Lutze, p. 458, Pl. 29, Fig. 16.
1965 *Lenticulina (Saracenaria) cornucopiae* (SCHWAGER). – Hanzlíková, p. 78, Pl. 5, Fig. 8 a, b.
1970 *Saracenaria cornucopiae* (SCHWAGER). – Norling, p. 271, Fig. 4; pp. 276–277, Fig. 8 a–c.

MATERIAL. – Six specimens from the Rydebäck-Fortuna core No. 5, 145.2–147.2 m, Oxfordian; 148.5–150.0 m, Callovian/Oxfordian; 156.6–157.0 m, Upper Bathonian/Callovian. All from Fortuna Marl.

REMARKS. – Detailed descriptions of this species have been given previously. Schwager's type specimen has a broken aperture. The Swedish specimens have a radiate aperture at dorsal angle of the test with six narrow, radiating slits (Fig. 47 A, p. 89). In its typical form, this species is a very good marker of Middle Jurassic and L. Upper Jurassic strata. From Poland it has been reported to occur in Bathonian-Oxfordian strata (Hanzlíková, 1965; Pazdrowa, 1967; Kopik, 1967). The first mentioned of these authors have found it in the Upper Jurassic Klentnice Beds of Czechoslovakia also. The NW. German stratigraphical range of this species has been reported by Bartenstein & Brand (1937), who found it ranging from Dogger ε to Malm α *(Parkinsoni--Schichten–Heersumer-Schichten)*. Lutze (1960) reported this species to be abundant in the *Jason* Zone, Callovian, but rare in the Oxfordian of NW. Germany. According to Seibold & Seibold (1953, 1956, 1960), *Saracenaria cornucopiae* is mainly restricted to Oxfordian beds in S. Germany, some finds being referred to the Lower Kimmeridgian also. The present author, however, believes that some reported Upper Jurassic forms are atypical, and rather should be placed in *Saracenaria oxfordiana* TAPPAN, and perhaps in *Saracenaria phaedra* TAPPAN also.

DISTRIBUTION. – Uppermost Bajocian-Oxfordian in W. Europe.

Saracenaria oxfordiana TAPPAN, 1955 nov. nom.

1862 *Cristellaria triquetra* GÜMBEL. – p. 225, Pl. 3, Fig. 28 a–c.
1865 *Cristellaria inclusa* SCHWAGER. – p. 124, Pl. 5, Fig. 14.
1904 *Cristellaria italica* DEFRANCE. – Brückmann, p. 21, Pl. 3, Figs. 10–12.
1917 *Cristellaria italica* DEFRANCE. – Paalzow, p. 41, Pl. 46, Figs. 11, 12.
1921 *Cristellaria cornucopiae* SCHWAGER. – Klähn, p. 46, Pl. 2, Fig. 35.
1922 *Cristellaria triquetra* GÜMBEL, 1862. – Paalzow, p. 27, Pl. 3, Fig. 7.
1935 *Cristellaria triquetra* GÜMBEL, 1862. – Macfadyen, p. 16, Pl. 1, Fig. 19 a, b.
1937 *Cristellaria (Saracenaria) triquetra* (GÜMBEL, 1862). – Bartenstein & Brand, p. 170.
1941 *Cristellaria (Saracenaria) triquetra* (GÜMBEL, 1862). – Frentzen, p. 348.
1943 *Cristallaria (Saracenara) triquetra* (GÜMBEL, 1862). – Ströbel, p. 10.
1955 *Lenticulina (Saracenaria) triquetra* (GÜMBEL, 1862). – Seibold & Seibold, p. 110, Text-Fig. 4 g, h; Pl. 13, Fig. 19.
1955 *Saracenaria oxfordiana* TAPPAN, nov. nom. – p. 64, Pl. 26, Fig. 27.
1956 *Lenticulina (Saracenaria) triquetra* (GÜMBEL, 1862). – Seibold & Seibold, p. 124.
1960 *Lenticulina (Saracenaria) triquetra* (GÜMBEL, 1862). – Seibold & Seibold, p. 354.
1960 *Lenticulina (Saracenaria) triquetra* (GÜMBEL). – Lutze, p. 457, Pl. 29, Figs. 11, 17; Text-Fig. 13.

HOLOTYPE. – *Cristellaria triquetra* GÜMBEL, 1862, Pl. 3, Fig. 28 a–c (not *Cristellaria triquetra* GÜMBEL, 1861).

TYPE LOCALITY. – *"Der Grabenbach bei Streitberg, fränkischer Jura, Bayern, Deutschland."*

TYPE STRATUM. – *"Jura. Untere Schichten der Oxfordstufe. Schwammschichten (36' mächtig), graugrünlich gefärbter Mergel."*

MATERIAL. – Four specimens from the Rydebäck-Fortuna core No. 5, 147.1–147.2 m, Fortuna Marl, Lower Oxfordian.

REMARKS. – Detailed descriptions of this species have been given previously. Tappan (1955) remarked that Gümbel preoccupied his specific name for this species by using it the previous year for an Eocene form. For that reason, Tappan proposed the new name *Saracenaria oxfordiana*. She found it in Upper Jurassic strata of N. Alska (Oxfordian or Lower Kimmeridgian). Apparently the same species was found in the Callovian of NW. Germany by Lutze (1960). Seibold & Seibold (1955) described this species under the name *Lenticulina (Saracenaria) triquetra* (GÜMBEL, 1862) from the Lower Oxfordian of S. Germany.

DISTRIBUTION. – Callovian to Oxfordian (or Lower Kimmeridgian).

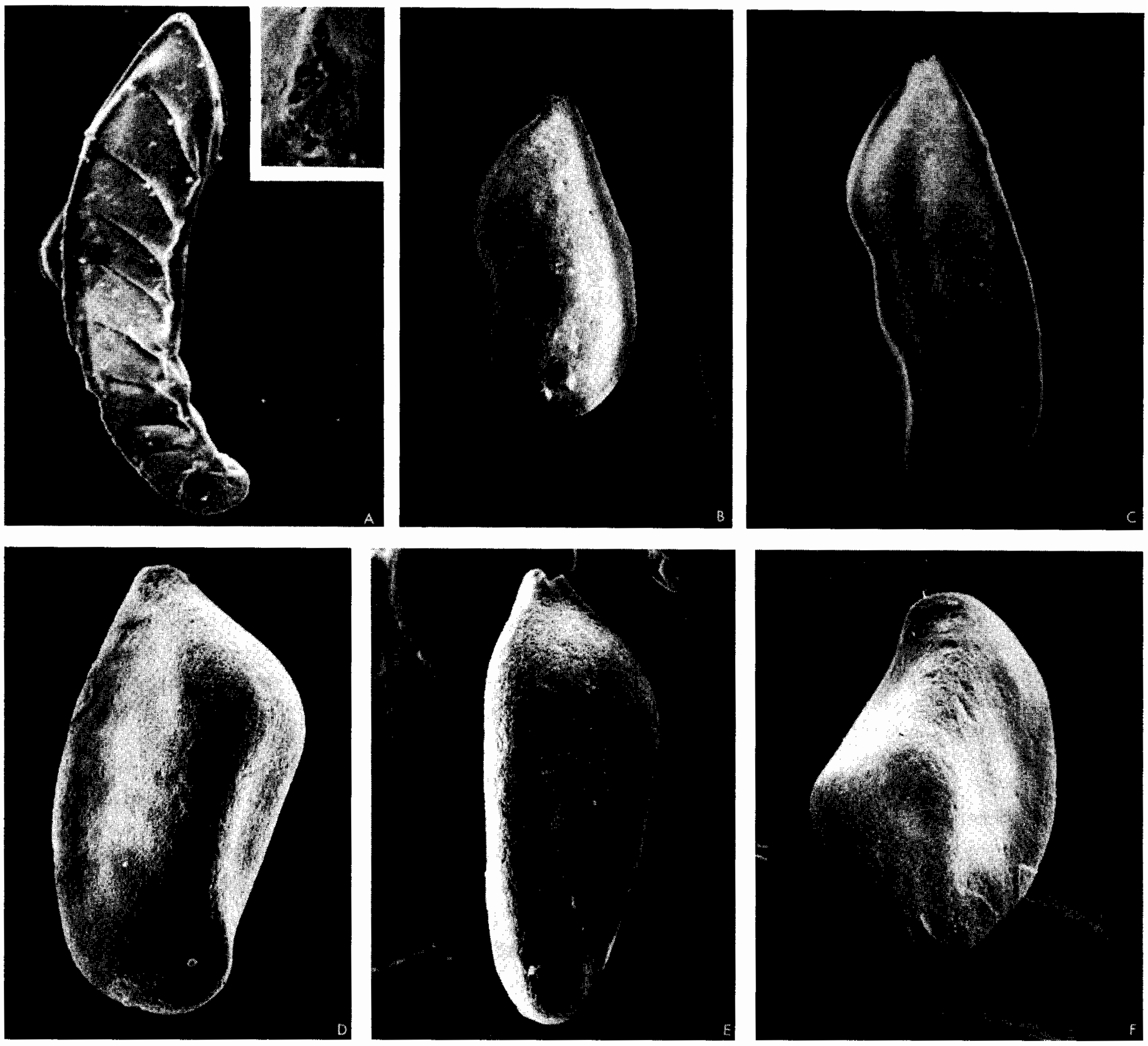


Fig. 47 A–F. Genus *Saracenaria* Defrance, 1824.

A. *Saracenaria cornucopiae* (Schwager, 1865). Side view of specimen En Sem 40:2. Boring Rydebäck-Fortuna No. 5, 147.1–147.2 m, Fortuna Marl, Oxfordian, Upper Jurassic. 64 X. In the upper right corner; the aperture of the same specimen. 240 X.

B. *Saracenaria sublaevis* (Franke, 1936). Side view of specimen En Sem 91:2. Boring Rydebäck-Fortuna No. 1, 69.1–69.2 m, Rydebäck Beds, Domerian, Middle Lias. 60 X.

C. Ditto. Specimen En Sem 11:1 from the same sample. 110 X.

D–F. *Saracenaria phaedra* Tappan, 1955. Specimen En Sem 105:5. Boring Rydebäck-Fortuna No. 5, 157 m, Fortuna Marl, U. Bathonian/Callovian, Middle Jurassic. D. Side view. E. Ventral view. F. Oblique apertural view. All 200 X.

Saracenaria phaedra TAPPAN, 1955

Fig. 47 D–F.

1955 *Saracenaria phaedra* TAPPAN. – p. 64, Pl. 26, Fig. 22 (type).
1967 *Saracenaria phaedra* TAPPAN. – Gordon, p. 446, Table 1; p. 452, Pl. 2, Figs. 17–18.

DESCRIPTION. – Test free, early portion faintly coiled, later becoming uniserial, with chambers highest at dorsal margin, triangular in transverse section; margins with or without carinae. Chambers 7–11 in number increasing more rapidly in breadth than height. Sutures flush or slightly depressed, usually distinct. Surface smooth. Aperture at dorsal angle, rounded, indistinctly radiate.

MATERIAL. – About ten specimens from the Rydebäck-Fortuna core No. 5, 158.8 m, Upper Bathonian/Callovian; 147.1–147.2 m, Fortuna Marl, Oxfordian.

REMARKS. – Tappan based her species on one single specimen. The ten Swedish specimens referred to *Saracenaria phaedra* exhibit a certain variation in the height/breadth ratio, and also in the development of marginal carinae; some specimens lack carinae, some have poorly developed, and some distinct carinae.

Gordon (1967) reported this species from the Callovian of NE. Scotland. The specimen in Fig. 47, p. 89 in the present publication shows a rather close affinity to *Saracenaria saratogana* HOWE & WALLACE, from the Upper Cretaceous Chalk of Arkansas.

DISTRIBUTION. – Upper Bathonian/Callovian-Oxfordian (or Lower Kimmeridgian).

Saracenaria sublaevis (FRANKE, 1936)

Fig. 47 B–C.

1936 *Cristellaria (Saracenaria) sublaevis* FRANKE. – p. 98, Pl. 9, Figs. 30–31.
1937 *Cristellaria (Saracenaria) sublaevis* FRANKE. – Bartenstein & Brand, p. 170, Pl. 5, Fig. 59 a, b.
1957 *Saracenaria sublaevis* (FRANKE). – Nørvang, p. 358, Fig. 151.
1960 *Saracenaria sublaevis* (FRANKE). – Bizon, p. 436, Table 2.
1961 *Saracenaria sublaevis* (FRANKE). – Bizon & Oertli, p. 113, Table 7.
1961 *Lenticulina (Saracenaria) sublaevis* (FRANKE). – Pietrzenuk, p. 44, Table 5; p. 69, Pl. 5, Fig. 7 a, b.
1964 *Lenticulina (Saracenaria) sublaevis* (FRANKE). – Barbieri, p. 765, Pl. 59, Fig. 1.
1969 *Saracenaria sublaevis* (FRANKE). – Brouwer, p. 11, Table 2; p. 39, Pl. 6, Fig. 16.
1970 *Saracenaria sublaevis* (FRANKE). – Norling, p. 271, Fig. 4; p. 281.

MATERIAL. – Numerous specimens from the Rydebäck-Fortuna cores No. 1 (68.5–40.5 m), and No. 4 (98–77 m), Rydebäck Beds, Upper Pliensbachian, Middle Lias.

REMARKS. – Detailed descriptions of this species have been given previously. It is regarded an excellent index fossil of the Middle Lias (Domerian Substage) in W. Europe. There are also, however, some rare finds from the Carixian in NW. Germany and E. Netherlands, and from the Lower Toarcian of the Paris Basin (Brouwer, 1969).

DISTRIBUTION. – Middle Lias (mainly) in most of the Jurassic basins in W. Europe.

Genus *Tristix* MACFADYEN, 1951 emend. LOEBLICH & TAPPAN, 1952

DIAGNOSIS. – Test free, elongate, triangular in in transverse section (occasionally quadratic); angles acute or rounded; chambers numerous, increasing gradually in size as added in a uniserial and rectilinear arrangement; sides slightly convex, plane, or excavated; sutures arched upwards at the centre of the faces, curved downwards at the angles; test-wall calcareous, hyaline, finely perforate; an entosolenian tube reported to occur in some species (not in the genotype species); aperture protruding, radiate, or produced to form a short neck with a phialine lip; a circular, non-radiate aperture reported to occur in some species.

TYPE SPECIES. – *Rhabdogonium liasinum* BERTHELIN, 1879, designated by Macfadyen, 1941. Middle Lias.

SPECIES FROM THE SWEDISH JURASSIC. – *Tristix liasina* (BERTHELIN, 1879), *T. oolithica* (TERQUEM, 1886).

REMARKS. – The present writer has not found any reason to place the genus *Tristix* in the family *Glandulinidae* REUSS, 1860, as has been done by some recent authors, but he is inclined to support Macfadyen in his opinion that the systematic position of this genus is in the family *Nodosariidae* EHRENBERG, 1838, near to *Nodosaria* (Macfadyen, 1941, p. 55). The main reason for referring *Tristix* to the family *Glandulinidae* seems to have been the observation of an internal (entosolenian) tube in some species, which in other characters show an affinity to the genotype species *Tristix liasina*. However, neither Berthelin (1879) nor Macfadyen (1941) reported an entosolenian tube to occur in the genotype species. Such an internal tube has never actually been observed in this species as far as is known to the present writer. My conclusion of a nodosariid rather than a glandulinid character of *Tristix* is based on a study of hundreds of specimens of the genotype species *Tristix liasina,* mainly obtained from Pliensbachian strata in W. Scania, as on literature studies. The *Tristix* specimens examined exhibit a close relationship to forms of *Nodosaria* and especially of ribbed *Pseudonodosaria* of the same age, viz. in the chamber arrangement, in the wall structure, and in the position and the character of the aperture.

The aperture in *Tristix,* which presents some problems, is commented on below (p. 91). The intact aperture in *Tristix liasina* from the Swedish Pliensbachian shows a striking similarity to the aperture in ribbed species of *Pseudonodosaria* (see Figs. 44, 45, 48). Also other characters suggest a close relationship between these two genera. According to their diagnoses, the main differences seem to be that ribbed *Pseudonodosaria* are characterized by 4, 5, 6, 7 or more longitudinal ribs and commonly embracing chambers, whereas *Tristix* species have three (occasionally four) angles or longitudinal ribs and less embracing chambers.

DISTRIBUTION. – Lower Jurassic – Recent. (The systematic position of the foraminifera from the Upper Permian of Turkey referred to *Tristix ? geinitzianus* and *Tristix ? tscherdynzevi* by Sellier De Civrieux & Dessauvagie (1965), is uncertain.)

Tristix liasina (Berthelin, 1879)

Fig. 48 A–E; Table 20.

1879 *Rhabdogonium liasinum* Berthelin, – p. 35, Pl. 1, Figs. 18, 19.
1941 *Tristix liasina* (Berthelin). – Macfadyen, p. 55, Pl. 4, Fig. 54 a, b.
1952 *Tristix liasina* (Berthelin). – Loeblich & Tappan, p. 356.
1964 *Tristix liasina* (Berthelin). – Loeblich & Tappan, pp. 539–540, Fig. 421, 6.
1968 *Tristix liasina* (Berthelin). – Norling, pp. 11, 12, 15, 16; Text-Figs. 2, 5; Pl. 9.

DESCRIPTION. – Test elongate, triangular in transverse section, with rounded, acute, or ribbed edges. Sides slightly convex, plane, or moderately excavated. Chambers 3–12 (commonly 5 or 6) in number, gradually increasing in size as added in a uniserial and rectilinear arrangement. Sutures flush or slightly depressed, arched upwards at the centre of the faces, curved downwards at the angles. Test-wall calcareous, hyaline, finely perforate. Aperture protruding, or produced to form a short neck with a phialine lip, radiate (with frequent slits). Foramina similar to the aperture.

DIMENSIONS. – See Table 20, p. 92.

MATERIAL. – Hundreds of specimens from the Kävlinge core No. 928, 56.5–82 m, Katslösa Beds, Pliensbachian; numerous specimens from the Katslösa Exposure (Loc. 840–1 000, Fig. 3, p. 11), Katslösa Beds, Lower Pliensbachian; numerous specimens from the Rydebäck-Fortuna core No. 1 (68.5–30 m), and No. 4 (108–52 m), Katslösa Beds and Rydebäck Beds, Upper Carixian-Toarcian/Aalenian.

REMARKS. – This characteristic species is very common in the Pliensbachian, Lower and Middle Lias of W. Scania and occurs in strata referred to the Toarcian/Aalenian, U. Lower Jurassic. In the Katslösa Exposure, the oldest beds containing *Tristix liasina* have yielded *Polymorphites* cf. *jamesoni* also, zonal index of the lowermost Pliensbachian (Troedsson, 1951, Katslösa Exposure, bed 30, loc. 840). The type stratum of *Tristix liasina* is the *Margaritatus* Zone of the Middle Lias in W. France (Berthelin, 1879). Judging from the small attention this species has been paid in Europe, it is not especially common outside Sweden. Berthelin (1879) described it as rare. Macfadyen (1941) recorded one single specimen from the *Davoei* Zone, Lower Pliensbachian of the Dorset Lias. According to Dadlez (1969), *Tristix liasina* is a characteristic species of the Lower Pliensbachian in Poland.

According to Loeblich & Tappan (1952, and in Ellis & Messina, "Catalogue of Foraminifera", 1940 incl. supplements post 1940): "The aperture of *Tristix* presents several problems. It varies from a simple rounded one to triradiate or radiate. The genotype species of *Tristix, Rhabdogonium liasinum* Berthelin, has a circular aperture. Our Jurassic species also have only simple apertures as do the majority of the Lower Cretaceous species. An occasional species which has deeply excavated sides may show a triradiate aperture, as does *Tristix excavata* (Reuss) /*Rhabdogonium excavatum,* 1862/ as shown by van Voorthusen (1947, Geol. en Mijnb., n. s., vol. 9, no. 3, pp. 44–45) and as can be seen on certain of our Lower Cretaceous specimens. This reaches a climax in such forms as *Triplasia temerica* Dain, 1934, which has a radiate aperture. It is possible that forms with definite radiate apertures should be excluded from this genus, but because of the fact that numerous genera of *Lagenidae* may have either rounded or radiate apertures and as no specimens of this Russian Jurassic species have been available to the writers for examination, the radiate aperture is not here considered sufficiently important to warrant separation of this species."

Concerning the Swedish material of *Tristix liasina,* the aperture has been studied in 145 specimens from the

Kävlinge core No. 928, 56.5–76.25 m, Katslösa Beds, Lower Pliensbachian. The character of the aperture can be subdivided into three groups:

	Number of specimens	%
1. Flush, or slightly protruding, circular aperture	42	29.0
2. Protruding, radiate aperture ..	57	39.3
3. Short-necked, radiate aperture with a phialine lip	46	31.7
	145	100.0

When studied under the scanning electron microscope, the aperture characterized as circular was found to be damaged (broken, corroded) in most of the specimens examined. In some specimens, it was not possible to determine whether the aperture was intact or not. Two specimens with an aperture characterized as circular were crushed so that the foramina were laid open. Both of these specimens demonstrated distinctly radiate foramina. Thus, with reference to the Swedish material of *Tristix liasina*, the intact aperture is radiate, protruding, or produced to form a short neck with a phialine lip. The circular, non-radiate type of aperture has not been found in well-preserved specimens.

As remarked by Loeblich & Tappan (1952), the aperture of the genotype species of *Tristix, Rhabdogonium liasinum* BERTEHELIN, was described as circular. However, concerning Berthelin's type figure (1879, Pl. 1, Fig. 19) it is not possible to judge whether the aperture in his type specimen is intact or not. This remark does not mean that the present writer will generalize and question the existence of a circular aperture in other species referred to *Tristix*. However, in the past, when using a microscope equipment with a low magnification and a limited depth of focus, it must have been difficult to observe whether the aperture was intact or not in small foraminifera.

DISTRIBUTION. – Pliensbachian-Toarcian/Aalenian.

Genus *Vaginulina* D'ORBIGNY, 1826

DIAGNOSIS. – Test elongate, straight or arcuate as in Dentalina, but laterally compressed; chamber sutures oblique, higher at dorsal margin; margins rounded or acute, may be keeled; aperture at dorsal angle, radiate.

TYPE SPECIES. – *Nautilus legumen* LINNÉ, 1758. Subsequent designation by Cushman, 1913. Recent.

SPECIES FROM THE SWEDISH JURASSIC. – *Vaginulina listi* (BORNEMANN, 1854), *V. spuria* (TERQUEM & BERTHELIN, 1875).

DISTRIBUTION. – Triassic – Recent.

TABLE 20. Number of chambers, total length and maximum breadth in mm and apertural character in some specimens of Tristix liasina (BERTHELIN) form the Rydebäck-Fortuna cores Nos. 1 and 4, and Kävlinge No. 928 in W. Scania, S. Sweden.

Spec. No.	Core	Level	Stage	No. of chambers	Length	Max. breadth	Character of the aperture
EN 162	RF 1	40.5	Domer.	5	0.35	0.22	flush, circular (broken)
EN 163	RF 1	40.5	”	5	0.40	0.20	protruding, radiate
EN 164	RF 1	40.5	”	6	0.43	0.20	flush, circular (probably broken)
EN 165	RF 1	40.5	”	5	0.40	0.20	protruding, radiate
EN 166	RF 1	65.3	”	3	0.29	0.15	protruding, radiate
EN 167	RF 4	85.4	”	4	0.40	0.20	on short neck with a phialine lip, radiate
EN 168	K 928	67.3	Carix.	3	0.35	0.19	on short neck with a phialine lip, radiate
EN 169	K 928	67.3	”	4	0.47	0.34	protruding, radiate
EN 170	K 928	67.3	”	5	0.62	0.23	protruding, radiate
EN 171	K 928	62.5	”	6	0.44	0.23	on short neck with a phialine lip, radiate
EN 172	K 928	62.5	”	4	0.41	0.22	on short neck with a phialine lip, radiate
Range:				3–6	0.29–0.62	0.15–0.34	
Mean:				4.5	0.44	0.22	

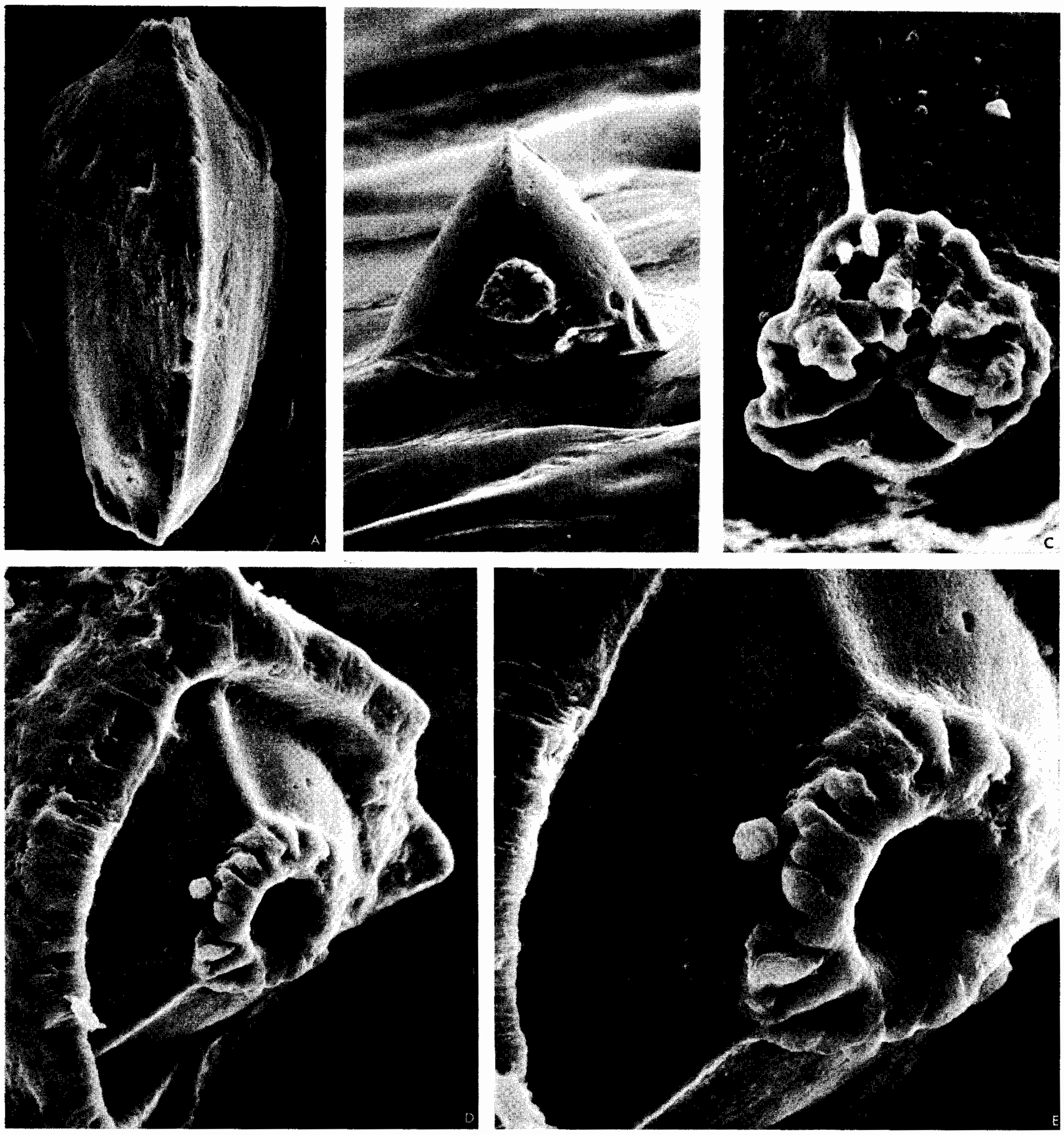


Fig. 48 A–E. *Tristix liasina* (Berthelin, 1879).

A. Side view of specimen En Sem 81:2. Boring Rydebäck-Fortuna No. 4, 84 m, Rydebäck Beds, Upper Pliensbachian (Domerian), Middle Lias. 260 X.

B. Apertural view of specimen En Sem 81:1. Boring Rydebäck--Fortuna No. 4, 84 m, Rydebäck Beds, Upper Pliensbachian (Domerian), Middle Lias. 255 X.

C. Aperture of specimen En Sem 39:3. Boring Kävlinge No. 930, 62.7 m, Katslösa Beds, Lower Pliensbachian (Carixian), Lower Lias. Compare with the aperture in *Pseudonodosaria quadricostata* nov. sp. (Fig. 44 F, p. 84) and *P. quinquecostata* (Bornemann) (Fig. 45 B, p. 85). 1300 X.

D. Oblique side view of foramen in broken specimen En Sem 81:2 b. Boring Rydebäck-Fortuna No. 4, 84 m, Rydebäck Beds, Upper Pliensbachian (Domerian), Middle Lias. 600 X.

E. Ditto. 1200 X.

Vaginulina listi (BORNEMANN, 1854)

Fig. 49 A–B.

1854 *Cristellaria listi* BORNEMANN. – Pl. 4, Fig. 28.
1863 *Marginulina incurva* TERQUEM. – p. 398, Pl. 8, Fig. 9 a–d.
1936 *Vaginulina listi* (BORNEMANN). – Franke, p. 82, Pl. 8, Figs. 21, 22.
1937 *Vaginulina listi* (BORNEMANN). – Bartenstein & Brand, p. 163, Pl. 3, Fig. 28; Pl. 5, Fig. 75.
1957 *Vaginulina listi* (BORNEMANN). – Nørvang, p. 379, Fig. 119.
1961 *Vaginulina listi* (BORNEMANN). – Pietrzenuk, p. 73, Pl. 6, Fig. 4.
1962 *Vaginulina listi* (BORNEMANN). – "Leitfossilien", p. 121, Tables 7–8; Pl. 15, Fig. 70.
1964 *Vaginulina listi* (BORNEMANN). – Rusbült & Petzka, p. 630.
1964 *Vaginulina listi* (BORNEMANN). – Barbieri, p. 768, Pl. 59, Fig. 14.
1966 *Vaginulina listi* (BORNEMANN). – Norling, p. 10.
1968 *Vaginulina listi* (BORNEMANN). – Bang (in Larsen et al.).
1968 *Vaginulina listi* (BORNEMANN). – Norling, pp. 14, 15; Pl. 9.
1959 *Vaginulina listi* (BORNEMANN). – Brouwer, pp. 10, 11, 40, Table 2; Pl. 3, Figs. 19–24.

MATERIAL. – Numerous specimens from the Örby E 6 Viaduct Exposure, the boring Helsingborg Kvarn No. 2220, 44–38 m; the Öresund 01 core, 42–22 mm (Döshult Beds, Lower Sinemurian). *Vaginulina listi* has also been obtained from the Rydebäck-Fortuna core No. 1, 133 m (Pankarp Clays, Upper Sinemurian), 78.3 m (Katslösa Beds, Lower Pliensbachian), 65.35–65.30 m, 44.55–44.50 m, 40.50 m (Rydebäck Beds, Upper Pliensbachian).

REMARKS. – Detailed descriptions of this species have been given previously. In his type description, Bornemann (1854) did not comment on the aperture. In the Swedish specimens studied (megalospheric and microspheric forms), the aperture is terminal, situated at dorsal angle of the test, protruding, radiate (with numerous radiating slits).

Previously, *Vaginulina listi* was regarded a good index fossil of the Sinemurian. However, in recent publications it has been reported from older as well as younger stages of the Lias.

GEOGRAPHICAL DISTRIBUTION. – *Vaginulina listi* has been obtained from Liassic strata in Denmark (Nørvang, 1957), East Germany (DDR) (Pietrzenuk, 1961; Rusbült & Petzka, 1964), West Germany, Austria, Swiss Jura, the Netherlands, Great Britain, France and Spain (Brouwer, 1969). From Italy it was reported by Barbieri (1964).

STRATIGRAPHICAL DISTRIBUTION. – In Sweden and Denmark restricted to Sinemurian and Pliensbachian strata. In other parts of W. Europe recorded from most Liassic stages.

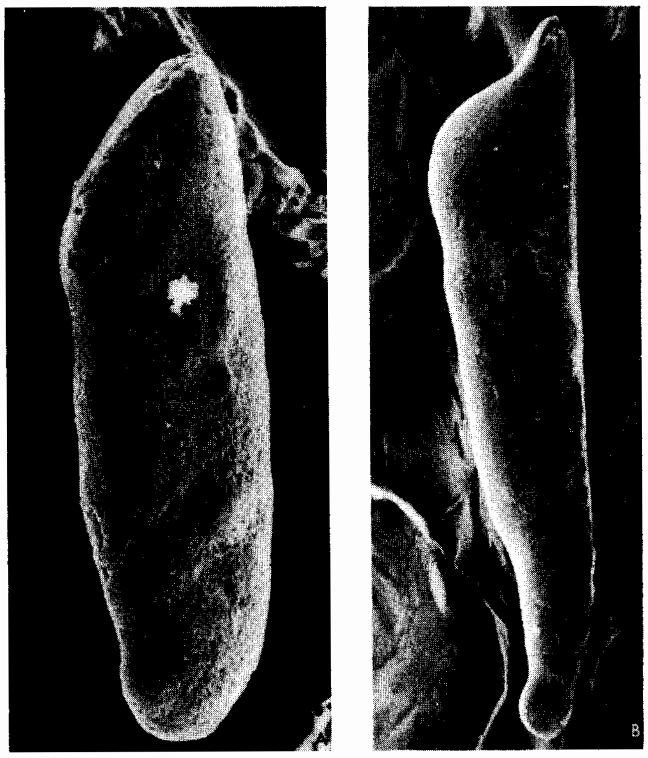


Fig. 49 A–B. *Vaginulina listi* (BORNEMANN, 1854).
A. Side view of megalospheric specimen EN SEM 90:1. Boring Helsingborg Kvarn No. 2220, 38–44 m, Döshult Beds, Lower Sinemurian, Lower Lias. 105 X.
B. Side view of microspheric specimen EN SEM 90:5. Örby E 6 Viaduct Exposure, Döshult Beds, Lower Sinemurian, Lower Lias. 105 X.

Subfamily *LINGULININAE* LOEBLICH & TAPPAN, 1961

Genus *Lingulina* D'ORBIGNY, 1826

DIAGNOSIS (emended). – Test free, elongate, uniserial and rectilinear, with succeding chambers strongly overlapping as in *Pseudonodosaria;* test compressed as in *Geinitzinita,* from which it differs in having a lamellar test-wall; aperture terminal, central, slit-shaped in plane of compression.

TYPE SPECIES. – *Lingulina carinata* D'ORBIGNY, 1826 by original designation. Recent.

SPECIES FROM THE SWEDISH JURASSIC. – Smooth forms of *Lingulina* obtained from the Middle Jurassic-Upper Jurassic transitional beds (Fortuna Marl) have been referred to *Lingulina* ex gr. *lingulaeformis* (SCHWAGER, 1865).

DISTRIBUTION. – Middle Jurassic – Recent.

Lingulina ex gr. *lingulaeformis* (Schwager, 1865)

Fig. 50 A–D.

1865 *Frondicularia lingulaeformis* Schwager. – pp. 113, 95, Pl. 4, Fig. 11.

MATERIAL. – Numerous specimens from the Middle Jurassic-Upper Jurassic transitional beds (Fortuna Marl) in the Rydebäck-Fortuna core No. 5, 158.8–153.3 m.

REMARKS. – In many Jurassic basins in W. Europe, groups of smooth lingulinoid and frondicularoid foraminifera occur in Bathonian-Oxfordian strata. If diagnoses and descriptions are strictly followed, the Swedish material can be subdivided into two groups referred to:

1. *Frondicularia* ex gr. *franconica* Gümbel.
2. *Lingulina* ex gr. *lingulaeformis* (Schwager).

The degree of slope of the chamber sutures and the shape of the aperture are used to separate the two genera. *Lingulina* has convex sutures and a slit-shaped aperture. *Frondicularia* has inverted V-shaped sutures and a radiate aperture.

However, as pointed out by Barnard (1963, p. 85) the degree of slope of the sutures not only varies between individuals, but also in the ontogeny of the specimens. It is often difficult to observe the aperture. Thus problems sometimes arise in assigning the specimens to a definite genus.

Lingulina lingulaeformis was originally described by Schwager as a *Frondicularia.* However, according to his type description and type figure (Schwager, 1865, pp. 113, 95; Pl. 4, Fig. 11), the species should be referred to the genus *Lingulina.*

In samples from the Fortuna Marl, *Frondicularia franconica,* and *Lingulina lingulaeformis* occur together and a close relation is suspected. In many cases, the smaller size and the slit-shaped aperture are the only characters which divide specimens referred to *Lingulinal lingulaeformis* from those referred to *Frondicularia franconica.* Scanning electron microscope studies of the aperture of the Liassic frondicularoid foraminifera re-

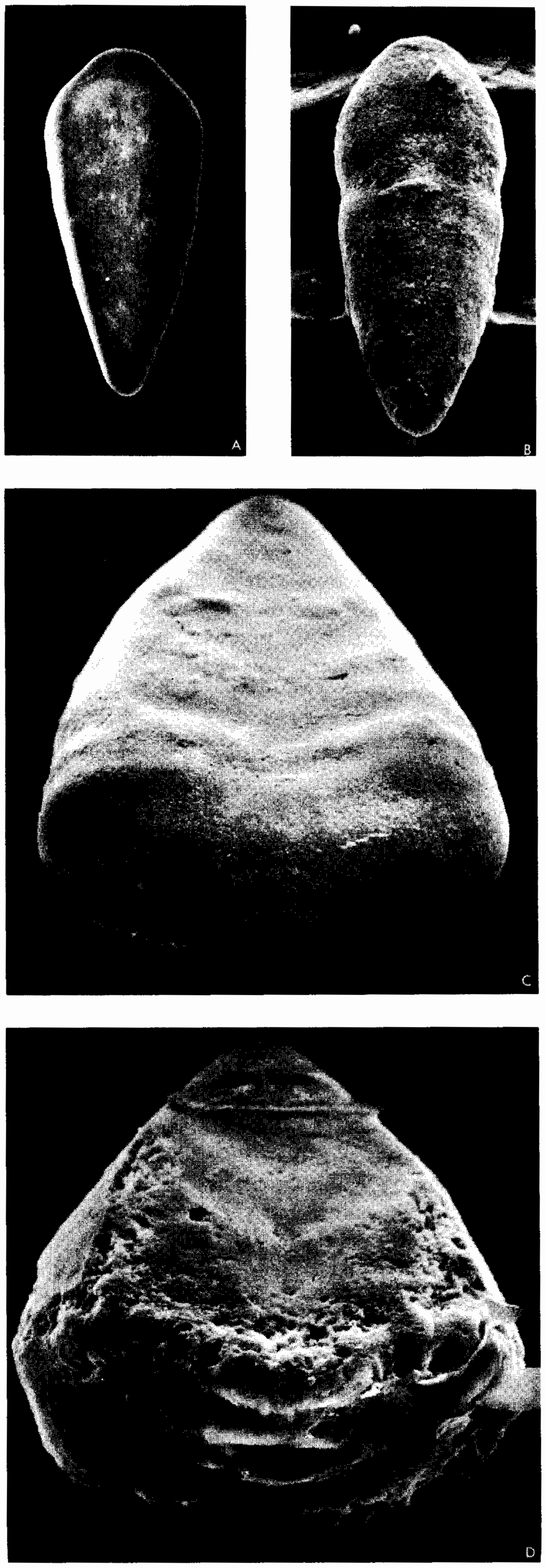


Fig. 50 A–D. *Lingulina* ex gr. *lingulaeformis* (Schwager, 1865). Boring Rydebäck-Fortuna No. 5, Fortuna Marl. Specimens in A–C from beds referred to the U. Bathonian/Callovian, specimen in D from the Callovian/Oxfordian transitional beds.

A. Specimen En Sem 105:3, 157 m. 200 X.

B. Specimen En Sem 105:1, 158.8 m. 200 X.

C. Oblique apertural view of specimen En Sem 105:3 (See Fig. 50 A). 525 X.

D. Broken specimen En Sem 104:4, 155 m, showing a slit-shaped foramen. 500 X.

ferred to the genus *Ichthyolaria* indicate the presence of slit-shaped apertures and foramina in early ontogenetic stages and radiate apertures and foramina in later stages (p. 65, Fig. 33). A similar ontogeny may also exist in *Frondicularia* ex gr. *franconica*, but this has not been investigated. If this is true, there are strong reasons to believe that the small forms with a slit-shaped aperture referred to *Lingulina* ex gr. *lingulaeformis* are juveniles of *Frondicularia franconica* and related species.

DISTRIBUTION. – Bathonian-Oxfordian.

Genus *Geinitzinita* SELLIER DE CIVRIEUX & DESSAUVAGIE, 1965

DIAGNOSIS. – Test elongate, much or moderately compressed; chamber arrangement uniserial and rectilinear; chamber sutures convex as in *Lingulina;* test in frontal view oval, subtriangular, or rectotriangular; transverse section oval, bilobate, or biconcave; test smooth or ornamented with longitudinal striae or costae; test-wall indistinctly fibrous-radiate, imperforate or finely perforate, and non-lamellar with a varying degree of overlapping of primary wall layers; aperture an elongate, terminal slit in plane of compression.

TYPE SPECIES. – *Geinitzinita oberhauseri* SELLIER DE CIVRIEUX & DESSAUVAGIE, 1965 by original designation. Triassic.

SPECIES FROM THE SWEDISH JURASSIC. – All forms are referable to different varities of *Geinitzinita tenera* (BORNEMANN, 1854). See Table 21, p. 99.

REMARKS. – A comprehensive diagnosis of this genus is given by Sellier De Civrieux & Dessauvagie (1965, p. 77). The Liassic foraminifera referred to the genus *Geinitzinita* in the present publication were previously placed in the genus *Lingulina* by most authors. Nørvang (1957), assigned Liassic lingulinoid and frondicularoid foraminifera to the genera *Geinitzina* SPANDEL, 1901 and *Spandelina* CUSHMAN & WATERS, 1928, respectively. His investigations showed that these Liassic forms have a partly calcareous, fibrous, but imperforate test-wall and, therefore, must belong to the family *Nodosinellidae* RHUMBLER, 1895, and not to family *Nodosariidae* EHRENBERG, 1838, which is characterized by a calcareous, fibrous, perforate test-wall. Brotzen (1963) reported that his studies on Triassic and Liassic "*Lingulina*" and "*Frondicularia*" showed that they have the same wall structure as already found in nodosariid foraminifera of the same age. On the other hand, Brotzen found that they differ from later foraminifera assigned to the genera *Lingulina* and *Frondicularia.* According to Brotzen (1963, p. 70): "It would hamper further studies to name the Liassic genera *Geinitzina* and *Spandelina.* According to the author's material from the Permian, these two genera have compound walls or are agglutinated. It is impossible to unite them with the younger genera *Frondicularia* and *Lingulina* with their perforate and radiate walls, and therefore it is proposed here that they should be called *Neogeinitzina* and *Neospandelina.*" However, Brotzen's generic names have not been accepted. The first name is preoccupied by *Neogeinitzina* MIKLUKHO-MAKLAJ, 1954, which is regarded a synonym of *Geinitzina* SPANDEL, 1901 (Sellier De Civrieux & Dessauvagie, 1965, p. 33). *Neospandelina* BROTZEN, 1963 is based on the same type species, viz. *Frondicularia bicostata* D'ORBIGNY, 1849, as the genus *Ichthyolaria* WEDEKIND, 1937. The latter should therefore have priority.

In their comprehensive account on Permian, Triassic and Liassic nodosariid foraminifera, Sellier De Civrieux & Dessauvagie (1965) erected the genus *Geinitzinita* for certain Triassic and Liassic foraminifera which were referred to the genus *Lingulina* by most previous authors, and placed it in the family *Nodosariidae.* According to Sellier De Civrieux & Dessauvagie, the main difference between the genera *Geinitzina* and *Geinitzinita* is the presence of a thin interior layer of radial or granular texture in the Paleozoic genus *Geinitzina* ("lamelle de protection internale"). *Geinitzinita* differs from *Lingulina* mainly in having a non-lamellar test-wall with no or indistinct perforation. *Lingulina* has a completely lamellar, finely perforate test-wall.

DISTRIBUTION. – Triassic-Lower Jurassic.

Geinitzinita tenera (BORNEMANN, 1854)

Fig. 51 A–G; Table 21.

1854 *Lingulina tenera* BORNEMANN. – p. 38, Pl. 3, Fig. 24 a–c.
1957 Main synonymies pre-1957 in Nørvang, pp. 54–63.
1957 *Geinitzina tenera* (BORNEMANN) subsp. *striata* (BLAKE). – Nørvang, pp. 54–55, 111–114; Figs. 1, 2; Text-Fig. 2.
1957 *Geinitzina tenera* (BORNEMANN) subsp. *substriata* NØRVANG. – pp. 55–56, 111–114; Figs. 3–10; Text-Fig. 2.
1957 *Geinitzina tenera* (BORNEMANN) subsp. *tenuistriata* NØRVANG. – pp. 56–57, 111–114; Figs. 13, 16, 17, 24; Text-Fig. 2.
1957 *Geinitzina tenera* (BORNEMANN) subsp. *subprismatica* (FRANKE). – Nørvang, pp. 57–58, 111–114; Figs. 11, 12, 14, 15; Text-Fig. 2.
1957 *Geinitzina tenera* (BORNEMANN) subsp. *tenera* (BORNEMANN). – Nørvang, pp. 58–60, 111–114; Figs. 18–23; Text-Fig. 2.
1957 *Geinitzina tenera* (BORNEMANN) subsp. *pupoides* NØRVANG. – pp. 60, 111–114; Figs. 25–29; Text-Fig. 2.
1957 *Geinitzina tenera* (BORNEMANN) subsp. *praepupa* NØRVANG. – pp. 60–61, 111–114; Figs. 30, 31; Text-Fig. 2.
1957 *Geinitzina tenera* (BORNEMANN) subsp. *pupa* (TERQUEM). – Nørvang, pp. 61–62, 111–114; Figs. 32–45; Text-Fig. 2.

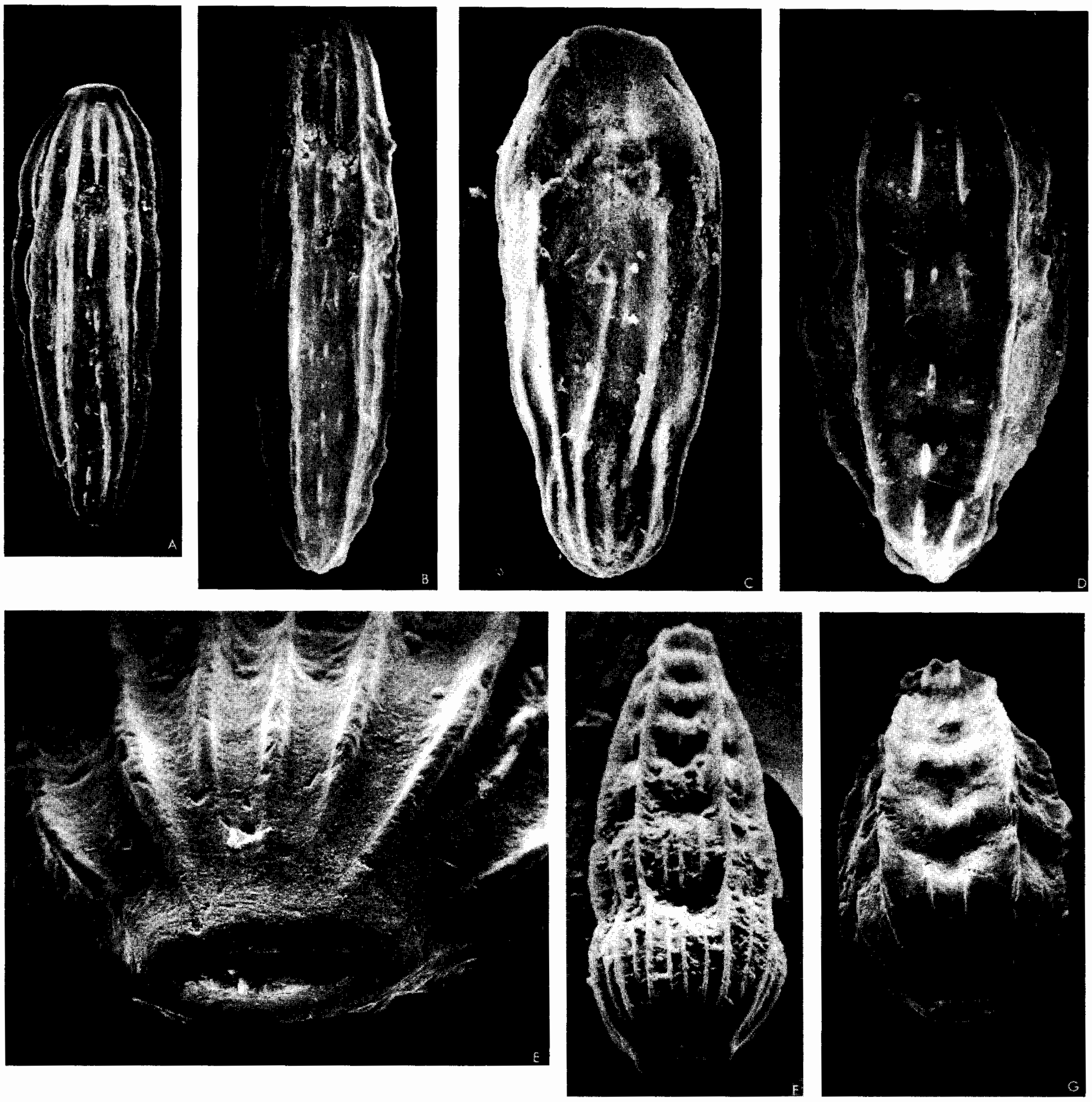


Fig. 51 A–G. *Geinitzinita tenera* (BORNEMANN, 1854).

A. *Geinitzinita tenera* (BORNEMANN) var. *praepupa* NØRVANG, 1957. Boring Rydebäck-Fortuna No. 4, 107.5 m, Katslösa Beds, Lower Pliensbachian, Lower Lias. Specimen EN SEM 20:3. 122 X.

B. Ditto. Specimen EN SEM 17:6 from the same sample as specimen in Fig. 51 A. (Compare with specimen in Fig. 30, NØRVANG, 1957). 125 X.

C. *Geinitzinita tenera* (BORNEMANN) var. *substriata* NØRVANG, 1957. Örby E6 Viaduct Exposure, Döshult Beds, Lower Sinemurian. Specimen EN SEM 100:4. 220 X.

D. *Geinitzinita tenera* (BORNEMANN) var. *tenera* (BORNEMANN, 1854). Boring Rydebäck-Fortuna No. 1, 69.1 m, Rydebäck Beds, basal Upper Pliensbachian, Middle Lias. Specimen EN SEM 17:5. 265 X.

E. *Geinitzinita tenera* (BORNEMANN) var. *praepupa* NØRVANG, 1957. Apertural view of specimen EN SEM 20:3 (see Fig. 51 A). 545 X.

F. *Geinitzinita tenera* (BORNEMANNN) var. *pupa* (TERQUEM, 1866). Charmouth, Dorset, England, *Davoei* Zone, Lower Pliensbachian, Lower Lias. Specimen EN SEM 32:5. Oblique apertural view. (Compare with Fig. 36 in Nørvang, 1957). 215 X.

G. *Geinitzinita tenera* (BORNEMANN) var. *tenera* (BORNEMANN, 1854). Oblique apertural view of specimen EN SEM 17:5 (see Fig. 51 D). 260 X.

1957 *Geinitzina tenera* (Bornemann) subsp. *carinata* Nørvang. – pp. 62–63, 111–114; Figs. 46–55; Text-Fig. 2.
1961 *Lingulina tenera striata* Blake. – Pietrzenuk, p. 76.
1961 *Lingulina tenera subprismatica* (Franke). – Pietrzenuk, p. 77; Pl. 8, Figs. 4–6.
1961 *Lingulina tenera octocosta* (Brand). – Pietrzenuk, p. 77; Pl. 8, Fig. 3.
1961 *Lingulina tenera tenera* Bornemann. – Pietrzenuk, p. 77; Pl. 8, Figs. 1, 2.
1961 *Lingulina tenera carinata* Nørvang. – Pietrzenuk, p. 78; Pl. 8, Figs. 7–9.
1961 *Lingulina tenera pupa* (Terquem). – Pietrzenuk, p. 78; Pl. 8, Figs. 10–12.
1963 *Lingulina tenera* (group) (Bornemann). – Barnard, pp. 86, 89; Fig. 3.
1964 *Lingulina tenera prismatica* (Bartenstein & Brand). – Barbieri, p. 775; Pl. 60, Fig. 9 a, b.
1964 *Lingulina tenera* Bornemann. – Barbieri, p. 775; Pl. 60, Fig. 8 a, b.
1965 *Geinitzinita octocosta* (Bartenstein & Brand). – Sellier De Civrieux & Dessauvagie, p. 80; Pl. 22, Fig. 4 a–e.
1965 *Geinitzinita pupoides* (Nørvang). – Sellier De Civrieux & Dessauvagie, p. 81; Pl. 10, Fig. 7; Pl. 20, Figs. 6, 7.
1967 *Lingulina* sp. 1 cf. *tenera* Bornemann. – Ruget & Sigal, p. 50; Pl. 5, Figs. 7 a–b.
1967 *Lingulina* sp. 2 cf. *tenera octocosta* (Brand). – Ruget & Sigal, p. 51; Pl. 5, Figs. 8 a–b.
1967 *Lingulina* sp. 3 Ruget & Sigal. – p. 51; Pl. 5, Figs. 5, 9, 11 a, b.
1967 *Lingulina* sp. 4 gr. *tenera praepupa* (Nørvang). – Ruget & Sigal, p. 51; Pl. 5, Figs. 10, 12 a, b, 14 a, b; Pl. 9, Fig. 12.
1967 *Lingulina* sp. 5 gr. *tenera tenuistriata* (Nørvang). – Ruget & Sigal, p. 51; Pl. 5, Figs. 13 a, b, 15; Pl. 9, Fig. 16.
1967 *Lingulina* sp. 6 gr. *tenera* (var.). – Ruget & Sigal, p. 52; Pl. 5, Figs. 16, 17 a–b, 21; Pl. 9, Fig. 20.
1967 *Lingulina* sp. 7 gr. *tenera subprismatica* (Franke) in Nørvang, 1957. – Ruget & Sigal, p. 52; Pl. 5, Figs. 18 a, b, 20.
1967 *Lingulina* sp. 8 Ruget & Sigal. – p. 52; Pl. 5, Figs. 19 a, b.
1967 *Lingulina* sp. 9 Ruget & Sigal. – p. 52; Pl. 6, Figs. 1 a, b, 2 a, b.
1968 *Geinitzinita pupoides* (Nørvang). – Norling, p. 28; Text-Fig. 6 a–g; Pl. 1, Figs. 1–3.
1968 *Lingulina tenera prismatica* (Brand). – Bang (in Larsen and others), p. 67; Pls. 15, 16.
1968 *Lingulina tenera subprismatica* (Franke). – Bang (in Larsen and others), pp. 65, 68, 87; Pl. 24.
1968 *Lingulina tenera* subsp. No. 4 Bang. – Bang (in Larsen and others), p. 65; Pls. 4, 24.
1968 *Lingulina* sp. No. 6 Bang. – Bang (in Larsen and others), p. 65; Pls. 4, 24.
1969 *Lingulina tenera* Bornemann. – Brouwer, pp. 11, 40; Tbl. 2; Pl. 4, Figs. 20–41.
1970 *Lingulina tenera* Bornemann. – Ruget & Sigal, p. 93; Pl. 4, Figs. 7–12.
1970 *Lingulina tenera* Bornemann var. *prismatica* Brand. – Ruget & Sigal, p. 94; Text-Figs. 8, 9; Pl. 4, Figs. 13, 14.
1970 *Lingulina pygmaea* Franke. – Ruget & Sigal, p. 94, Pl. 4, Figs. 15, 16.
1970 *Lingulina tenera* Bornemann subsp. *carinata* Nørvang. – Ruget & Sigal, p. 94, Pl. 4, Figs. 17, 18.

REMARKS. – As mentioned in the remarks to the genus *Geinitzinita* (p. 96), Nørvang (1957) reclassified certain Liassic foraminifera previously referred to the genus *Lingulina* and placed them in the genus *Geinitzina.* He did not accept the previous specific subdivition of *"Lingulina"*, but regarded these "species" as subspecies of *Geinitzina tenera* (Bornemann). He also proposed some new subspecies. However, many of Nørvang's subspecies come from the same stratigraphical horizons, and even from the same samples (See Nørvang, 1957, pp. 54–63, and Text-Fig. 2).

As pointed out by Sylvester-Bradely (1956, p. 3): "two geographical subspecies cannot come from the same locality, and two chronological subspecies cannot come from the same horizon."

In a discussion on the species concept, Tappan (1962, p. 120) stated: "When . . . similar species or subspecies are reported in association, it is very probable that some are invalid, and merely represent variants in a single population".

In the west Scanian material of *Geinitzinita tenera*, it is possible to recognize different morphological forms of this species (Table 21), some associated at certain horizons, but with several well-marked trends in morphological characters, similar to those reported by Nørvang (1957) and Barnard (1956, 1963). However, the present writer agrees with Sylvester-Bradely's and Tappan's (and Barnard's) conclusions, and prefers to regard these different morphological forms as varieties rather than subspecies.

According to Nørvang (1957), the lower part of the Lias in Jutland (Denmark) is characterized by the abundance of *Geinitzina tenera substriata* (herein referred to *Geinitzinita tenera* var. *substriata).* In the lowermost part of the Lias in Jutland this variety is accompanied by *G. tenera striata.* Somewhat higher in the Liassic sequence, *G. tenera tenuistriata* appears. In the Upper Sinemurian and the Carixian, this variety is replaced by *G. tenera subprismatica* and *G. tenera tenera*, but forms of another phylogenetic line, viz. *G. tenera pupoides* and *G. tenera praepupa* predominate. In the Lower Domerian, *G. tenera pupa* occurs exclusively, replaced by *G. tenera carinata* in the Upper Domerian.

As seen in Table 21, the stratigraphical range of the *Geinitzinita tenera* forms obtained from the Lias in W. Scania does not differ very much from the one reported from Denmark. Two *Geinitzinita* forms, temporarily recorded as *Geinitzinita tenera* var. No. 4 (Bang, 1968) and *Geinitzinita tenera* var. No. 6 (Bang, 1968) are added to the list (Table 21).

Detailed descriptions of the various *Geinitzinita tenera* forms have been given previously (Nørvang, 1957; Barnard, 1956, and others). The Swedish records are given in the stratigraphical part of the present paper (pp. 23, 25, 27, Tables 4–7).

DISTRIBUTION. – *Geinitzinita tenera* has been recorded from all Liassic Stages in W. Europe (Brouwer, 1969). Some Middle and Upper Jurassic forms closely related to *Geinitzinita tenera* var. *pupa* (Nørvang, 1957, p. 111), probably belong to the genus *Lingulina*.

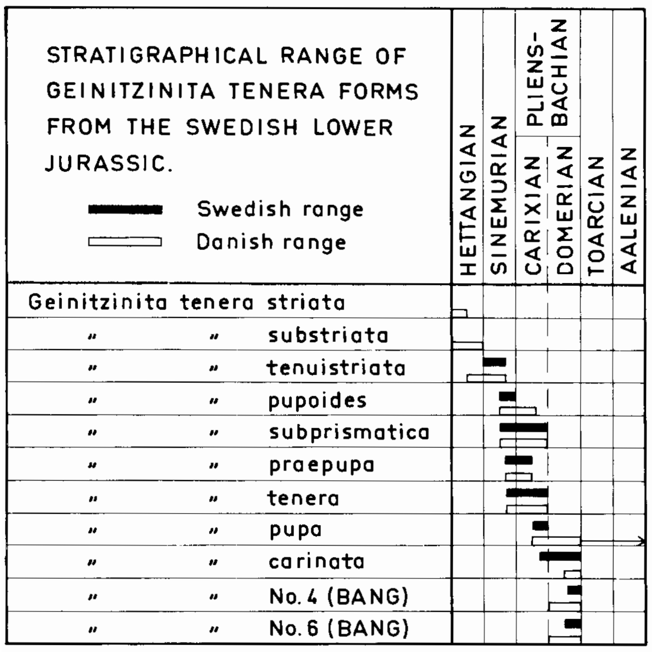


TABLE 21.

Superfamily *BULIMINACEA* Jones, 1875

Family *BOLIVINITIDAE* Cushman, 1927

Genus *Brizalina* Costa, 1856

DIAGNOSIS. – Test elongate, tapering, commonly compressed, may be laterally carinate, biserial throughout, lacking basal chamber lobes, crenulations or retral processes of *Bolivina,* but having straight or curved, commonly limbate sutures; wall calcareous, perforate, radially built, with ornamentation consisting of variously arranged pores, longitudinal costae, carinae, and marginal or apical chamber spines; aperture loop-shaped, extending from base of final chamber, with tooth plate as in *Bolivina* (Loeblich & Tappan, 1964).

TYPE SPECIES. – *Brizalina aenariensis* Costa, 1856, by original designation. Recent.

DISTRIBUTION. – Upper Triassic – Recent.

Brizalina liasica (Terquem, 1858)

Fig. 52 A, B.

1858 *Textilaria liasica* Terquem. – p. 634, Pl. 4, Fig. 12 a, b.
1858 *Textilaria metensis* Terquem. – p. 635, Pl. 4, Fig. 13 a, b.
1866 *Textilaria angusta* Terquem. – p. 527, Pl. 22, Fig. 24 a, b.
1866 *Textilaria breoni* Terquem. – p. 450, Pl. 18, Fig. 10 a, b.
1866 *Textilaria pikettyi* Terquem. – p. 527, Pl. 22, Fig. 23 a–c.
1936 *Textularia pikettyi* Terquem. – Franke, p. 125, Pl. 12, Fig. 19.
1936 *Bolivina rhumbleri* Franke. – p. 126, Pl. 12, Fig. 21.
1937 *Bolivina rhumbleri rhumbleri* Franke. – Bartenstein &
1937 *Bolivina rhumbleri* subsp. *amalthea* Brand. – Bartenstein Brand, p. 184, Pl. 4, Fig. 73 a–c; Pl. 5, Fig. 72 a–c. & Brand, p. 185, Pl. 7, Fig. 1 a–i; Text-Fig. 2.
1957 *"Bolivina" liasica* (Terquem). – Nørvang, p. 109, Fig. 182.
1960 *Bolivina liasica* (Terquem). – Bizon, p. 14, Pl. 4, Fig. 6.
1968 *Bolivina liasica* (Terquem). – Norling, pp. 11–13, Pl. 9; Text--Figs. 2, 3.
1969 *Brizalina liasica* (Terquem). – Brouwer, p. 41, Pl. 7, Figs. 20–27.
1970 *Brizalina liasica* (Terquem). – Norling, pp. 281–282, Fig. 4.

MATERIAL. – Numerous specimens from the Rydebäck-Fortuna core No. 1, 65.30–65.35 m, 53.30–53.35 m, Rydebäck Beds, Domerian; Rydebäck-Fortuna No. 4, 52 m and 31 m, Eriksdal Beds, Aalenian-basal Bajocian; Kävlinge No. 928, 55–82 m, Katslösa Beds, Pliensbachian; Kävlinge No. 930, 35–58.5 m, Katslösa Beds, Pliensbachian.

REMARKS. – Detailed descriptions of this species (including the subspecies *Brizalina liasica amalthea)* have been given previously, viz. by Brand (1937). The subspecies *B. liasica amalthea* is restricted to the Upper Carixian – Lower Domerian.

DISTRIBUTION. – Recorded from the Upper Sinemurian to the Lower Toarcian in W. Europe. Found also in strata referred to the Aalenian – basal Bajocian in W. Scania. Doubtful records from the Middle Jurassic.

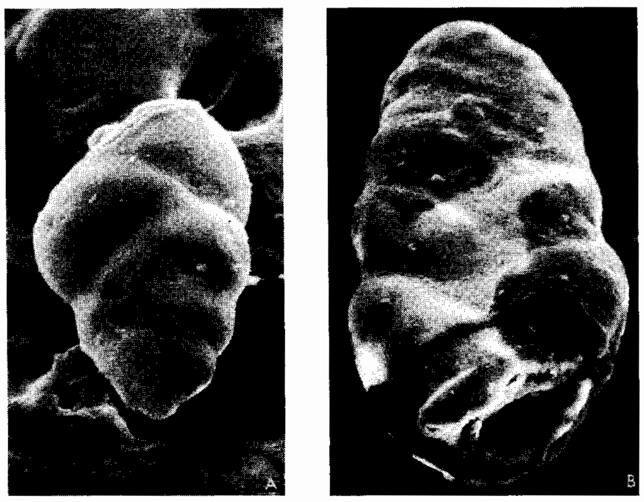


Fig. 52 A–B. ***Brizalina liasica*** **(Terquem, 1858).** Kävlinge core No. 928, Katslösa Beds, Pliensbachian, Lias.
A. ***Brizalina liasica*** subsp. ***amalthea*** (Brand, 1937). Side view of specimen En Sem 97:1 from 67.25 m below surface. 195 X.
B. ***Brizalina liasica*** subsp. ***liasica*** (Terquem, 1858). Oblique apertural view of specimen En Sem 96:2 from 74.25 m below surface. 210 X.

Superfamily *ROBERTINACEA* Reuss, 1850

Family *CERATOBULIMINIDAE* Cushman, 1927

REMARKS. – A fairly rich material of ceratobuliminid foraminifera has been obtained from Jurassic strata in W. Scania. Most of these foraminifera occur in material from the Rydebäck-Fortuna borings; in strata spanning the Lower Jurassic-Middle Jurassic and Middle Jurassic-Upper Jurassic boundaries. Unfortunately, most specimens are too badly preserved, corroded and broken, to make specific determinations possible. A poor state of preservation of Jurassic ceratobuliminid foraminifera has been reported from other places also, viz. the Polish Lowland and the Pieniny Klippen Belt of Poland (Pazdro, 1969, p. 73). Illustrations of Jurassic ceratobuliminid foraminifera in publications from the USSR, Poland, Czechoslovakia, different parts of W. Europe and elsewhere , seem to demonstrate that a poor preservation is rather widespread, geographically as well as stratigraphically.

The group of Jurassic ceratobuliminid foraminifera includes highly specialized and complicated forms, which need a most careful examination of different external, as well as internal, characters in a well preserved material. The classification problems in the past concerning ceratobuliminid and related foraminifera, possibly partly due to examination of badly preserved specimens, are reflected by widely differing diagnoses by various authors, and different opinions concerning the generic position of the foraminifera within the family *Ceratobuliminidae*.

A good review of milestones in the research of ceratobuliminid and related foraminifera was given by Ohm (1967). To this review can be added the publications by Ohm (1967) on the genera *Reinholdella, Garantella,* and *Epistomina,* and by Pazdro (1969) on Middle Jurassic *Epistominidae* of Poland.

As already remarked, the Swedish Jurassic ceratobuliminid foraminifera studied by the present writer, mainly exhibit a poor state of preservation. A careful examination of this material appears to be meaningless until the material has been supplemented by better preserved specimens. Some few species only of the genera *Epistomina* and *Reinholdella* are treated below.

Subfamily EPISTOMININAE Wedekind, 1937

Genus *Epistomina* Terquem, 1883

DIAGNOSIS. – Test lenticular, trochospiral, periphery angular to carinate, umbilical area closed; internal partition crossing chamber cavity from outer margin of lateromarginal apertural opening parallel to periphery on umbilical side, extending nearly or completely to wall against previous whorl; sutures thickened, may be elevated; oblique areal oval aperture on umbilical side, later remaning as interseptal foramen, and additional lateromarginal opening paralleling periphery on umbilical side, in earlier chambers secondarily closed by shell material (Loeblich & Tappan, 1964).

TYPE SPECIES. – *Epistomina regularis* Terquem, 1883. Subsequent designation by Galloway & Wissler, 1927. Bajocian, Middle Jurassic.

SPECIES FROM THE SWEDISH JURASSIC. – *Epistomina callovica* Kapterenko-Chernousova, 1956, *E. conica* Terquem, 1883, *E. liassica* Barnard, 1950, *E.* cf. *mosquensis* Uhlig, 1883, *E. parastelligera* (Hofker, 1954).

DISTRIBUTION. – Lower Jurassic-Lower Cretaceous.

Epistomina cf. *callovica* Kapterenko-Chernousova, 1956

Fig. 53 A.

1956 *Epistomina callovica* Kapterenko-Chernousova. – p. 55, Pl. 1, Fig. 24.
1959 *Epistomina callovica* Kapterenko-Chernousova. – p. 109, Pl. 16, Fig. 5 a–c.
1963 *Epistomina callovica* Kapterenko-Chernousova. – Kapterenko-Chernousova et al., p. 57, Pl. 6, Fig. 11.
1969 *Epistomina callovica* Kapterenko. – Pazdro, p. 55, Text-Fig. 8; Table 3.
1970 *Epistomina callovica* Kapterenko. – Norling, p. 275.

MATERIAL. – Some few specimens from the Rydebäck-Fortuna core No. 5, 149.6–150.0 m, Fortuna Marl, Callovian (or basal Oxfordian).

REMARKS. – The specimen in Fig. 53 shows close affinity to Kapterenko-Chernousova's type specimen of *Epistomina callovica* (1956, Pl. 1, Fig. 24 b; 1959, Pl. 16, Fig. 5 a, c), viz. in the number, form, and arrangement of chambers, the broad chamber sutures, and in the biconvexity of the test, with a low conical dorsal and a slightly inflated ventral side. Unfortunately, neither the main aperture nor the supplementary apertures can be seen in the Swedish specimen figured.

GEOGRAPHICAL DISTRIBUTION. – *Epistomina callovica* was originally described from the Lower Callovian of the Dnieper-Donets Basin, Ukrainian SSR (Kapterenko-Chernousova, 1956). The species has also been recorded from Upper Bathonian and Callovian strata in Poland (Pazdro, 1969), and from the Callovian in S. Germany (Ohm, 1967).

STRATIGRAPHICAL DISTRIBUTION. – Upper Bathonian-Callovian.

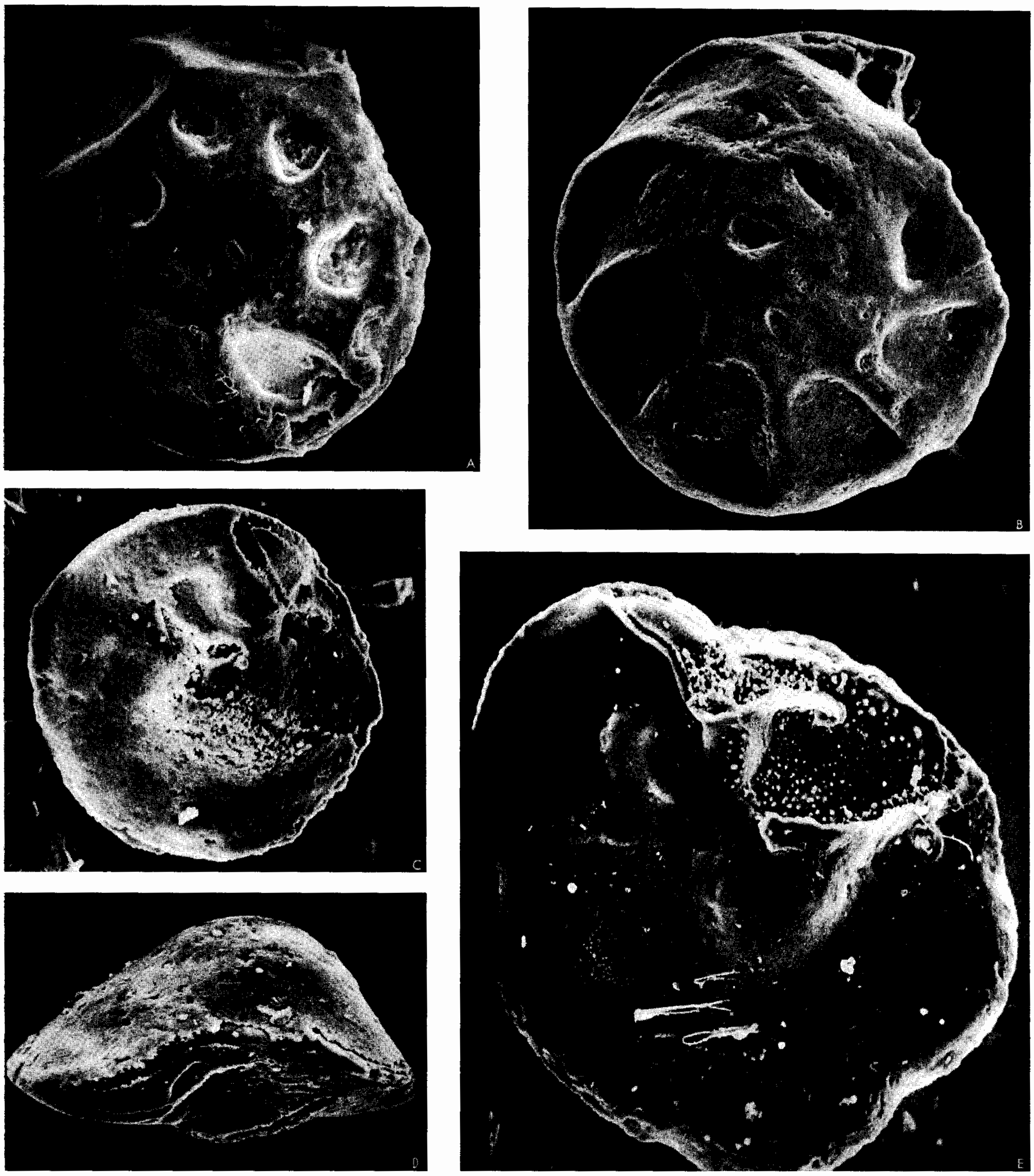


Fig. 53.

A. *Epistomina* cf. *callovica* Kapterenko-Chernousova, 1956. Boring Rydebäck-Fortuna No. 5, 150 m, Fortuna Marl, Callovian (or Lower Oxfordian). Dorsal side of specimen En Sem 41:1. 245 X.

B. *Epistomina parastelligera* (Hofker, 1954). Boring Rydebäck-Fortuna No. 5, 157 m,Fortuna Marl, U. Bathonian (or Callovian), Middle Jurassic. Dorsal side of specimen En Sem 1:1. 210 X.

C. *Reinholdella dreheri* (Bartenstein, 1937). Boring Rydebäck-Fortuna No. 4, 39 m, Eriksdal Beds. Aalenian (or basal Bajocian). Ventral (umbilical) side of corroded specimen En Sem 130:1. 205 X.

D. Edge view of the same specimen. 210 X.

E. *Reinholdella media* (Kapterenko-Chernousova, 1956). Boring Rydebäck-Fortuna No. 4, 39 m, Eriksdal Beds, Aalenian (or basal Bajocian). Ventral (umbilical) side of specimen En Sem 130:2 with broken final chamber. 185 X.

Epistomina parastelligera (HOFKER, 1954)

Fig. 53 B.

1854 ? *Rotalina stelligera* REUSS. – p. 69, Pl. 25, Fig. 15 a–c.
1883 *Epistomina stelligera* (REUSS). – Uhlig, p. 770, Pl. 7, Fig. 10; Pl. 8, Figs. 1–3.
1904 *Epistomina stelligera* (REUSS). – Brückmann, p. 23, Pl. 4, Figs. 10–11.
1937 *Epistomina stelligera* (REUSS). – Bartenstein & Brand, p. 191, Pl. 11 A, Fig. 21; Pl. 11 C, Fig. 3; Pl. 12 A, Fig. 27; Pl. 12 B, Fig. 20; Pl. 13, Fig. 27; Pl. 14 B, Fig. 21; Pl. 14 C, Fig. 18.
1954 *Brotzenia parastelligera* HOFKER. – p. 180, Text-Figs. 4–6.
1959 *Epistomina stelligera* (REUSS). – Cifelli, p. 336, Pl. 7, Figs. 17–20.
1960 *Epistomina parastelligera* (HOFKER). – Lutze, p. 491, Pl. 33, Figs. 3, 6.
1960 *Epistomina parastelligera* (HOFKER). – Bielecka, p. 93, Pl. 10, Fig. 77.
1962 *Epistomina stelligera* (REUSS). – *"Leitfossilien"*, p. 157, Pl. 20, Fig. 24; Table 9.
1963 *Brotzenia parastelligera* HOFKER. – Mitijanina, p. 166, Pl. 9, Fig. 1.
1963 *Brotzenia parastelligera* HOFKER. – Cordey, pp. 654–656, Pl. 93, Figs. 5–6; Text-Fig. 2.
1965 *Brotzenia parastelligera* HOFKER. – Hanzlíková, p. 95, Pl. 8, Figs. 5–8; Table 2.
1967 *Epistomina parastelligera* (HOFKER). – Bielecka & Styk, pp. 165, 167–175; Fig. 34.
1967 *Epistomina parastelligera* (HOFKER). – Gordon, p. 458, Pl. 4, Fig. 32.
1969 *Epistomina parastelligera* (HOFKER). – Pazdro, p. 64, Text-Fig. 11; Table 3.
1970 *Epistomina parastelligera* (HOFKER). – Norling, pp. 267, 275, Fig. 4.
1970 *Epistomina* cf. *parastelligera* (HOFKER). – Norling, p. 276, Fig. 7.

MATERIAL. – Several specimens from the Rydebäck-Fortuna core No. 4, 31 m, Eriksdal Beds, Aalenian (or basal Bajocian), and core No. 5, 150.0–145.2 m, Fortuna Marl, Callovian-Oxfordian.

DISTRIBUTION. – Recorded from U. Lower Jurassic (Aalenian)-Upper Jurassic (Kimmeridgian) strata in Europe.

Genus *Reinholdella* BROTZEN, 1948

DIAGNOSIS. – Test free, trochospiral, plano-convex to biconvex; supplementary cover plates surrounding umbilicus to cover sutural apertures, extending farthest toward periphery near mid-portion of primary chambers so that the latter have saddle-shaped outlines on umbilical side; sutures oblique dorsally, radiate ventrally; wall of aragonite (by X-ray powder diffraction), finely perforate; aperture a low interiomarginal arch near periphery on umbilical side, with supplementary aperture in indentation at centre of suture on umbilical side but secondarily closed in most specimens, internal pillar-like partition connected to this aperture extending from umbilical to spiral walls (Loeblich & Tappan, 1964).

TYPE SPECIES. – *Discorbis dreheri* BARTENSTEIN, 1937. Aalenian.

SPECIES FROM THE SWEDISH JURASSIC. – Most specimens recognized as *Reinholdella* are badly preserved. At least two species occur in the material investigated, viz. *Reinholdella dreheri* (BARTENSTEIN, 1937), and *R. media* (KAPTERENKO-CHERNOUSOVA, 1959), both from the Lower Jurassic-Middle Jurassic transitional beds.

REMARKS. – Detailed descriptions of several *Reinholdella* species have recently been given by Ohm (1967) and Pazdro (1969).

DISTRIBUTION. – Lower Jurassic-Middle Jurassic.

Reinholdella dreheri (BARTENSTEIN, 1937)

Figs. 53 C, D, 54 A.

1937 *Discorbis dreheri* BARTENSTEIN. – in Bartenstein & Brand, p. 192, Pl. 6, Fig. 45; Pl. 8, Fig. 42; Pl. 10, Fig. 47.
1948 *Asteringerina dreheri* (BARTENSTEIN). – Brotzen, p. 126.
1949 *Reinholdella dreheri* (BARTENSTEIN). – Brotzen, p. 30.
1952 *Reinholdella dreheri* (BARTENSTEIN). – Hofker, p. 20, Figs. 7–9.
1959 ? *Discorbis dreheri* BARTENSTEIN. – Cifelli, p. 336, Pl. 7, Figs. 23–25.
1964 *Reinholdella* (?) aff. *dreheri* (BARTENSTEIN & BRAND). – Barbieri, p. 784, Pl. 61, Fig. 8; table in p. 804.
1969 *Reinholdella dreheri* (BARTENSTEIN). – Pazdro, p. 73, Text-Fig. 15; Table 3.
1969 *Reinholdella dreheri* (BARTENSTEIN). – Brouwer, p. 43, Pl. 7, Figs. 35, 36; Table 2.
1970 *Reinholdella dreheri* (BARTENSTEIN). – Norling, p. 275.

MATERIAL. – Several badly preserved specimens from the Rydebäck-Fortuna core No. 1, 40.5 m, Rydebäck Beds, Pliensbachian-Toarcian/Aalenian transitional beds, and core No. 4, 52 m, 39 m, 31 m, Eriksdal Beds, Aalenian-basal Bajocian.

REMARKS. – A detailed description of this species has been given by Hofker (1952). *Reinholdella dreheri* shows close affinity to *R. crebra* PAZDRO, a species reported to be extremely abundant in the Lower Bathonian of Poland (Pazdro, 1969, p. 69). *R. dreheri* differs from this species in having a larger number of chambers in the last whorl (6 or 7 versus 5), a smaller size, more distinct sutures, and shorter and broader apertures (Pazdro, 1969, p. 70).

DISTRIBUTION. – Rare in the Pliensbachian and Toarcian, common in the Aalenian and Lower Bajocian in W. Europe.

Reinholdella media (KAPTERENKO-CHERNOUSOVA, 1956)

Figs. 53 E, 54 B.

1956 *Lamarckella media* KAPTERENKO-CHERNOUSOVA. – pp. 49–61, Pl. 1, Fig. 8; Text-Fig. 1.
1956 *Lamarckella media* KAPTERENKO-CHERNOUSOVA. – in translation by Sigal & Sigal (BRGM No. 1751), pp. 5, 11, Pl. 1, Fig. 8; Text-Fig. 1.
1959 *Lamarckella media* KAPTERENKO-CHERNOUSOVA. – p. 94, Pl. 12, Figs. 1, 2.
1963 *Lamarckella media* KAPTERENKO-CHERNOUSOVA. – in Kapterenko-Chernousova et al., p. 56, Pl. 4, Fig. 11.
1964 *Reinholdella media* (KAPTERENKO-CHERNOUSOVA). – Loeblich & Tappan, p. 777, Fig. 637:4–6.
1967 *Reinholdella media* (KAPTERENKO-CHERNOUSOVA) ssp. *badensis* OHM. – Ohm, pp. 112–113, Text-Fig. 8 a–e.
1969 *Reinholdella media* (KAPTERENKO). – Pazdro, p. 72, Text-Fig. 14; Table 3.

DESCRIPTION. – Test free, trochospiral, biconvex. Dorsal (spiral) side shows 12–14, subtriangular or trapezoidal chambers in two and one half whorls. Ventral (umbilical) side shows 5 or 6 subtriangular chambers. Sutures flush or limbate. Peripheral margin subacute. Last chamber with open aperture, apertures in earlier chambers loop-shaped, parallel to margin, extending from septal sutures to the centre of each chamber, with secondary covering plates. Maximum diameter, 0.34–0.50 mm; height, 0.17–0.24 mm.

MATERIAL. – One specimen from the Rydebäck-Fortun core No. 4, 39 m, Eriksdal Beds, Aalenian or basal Bajocian.

REMARKS. – A detailed description of *Reinholdella media* was given by Kapterenko-Chernousova (1963). According to her, this species is characteristic of the Aalenian and the Bajocian in the Ukraine. Pazdro (1969) recorded *Reinholdella media* from Aalenian to Middle Bathonian strata in Poland. A subspecies, viz. *Reinholdella media badensis*, was described by Ohm (1967) from the Lower Bajocian *(Sowerbyi-Schichten)* in S. Germany (Upper Rhine Graben).

DISTRIBUTION. – Aalenian-Middle Bathonian.

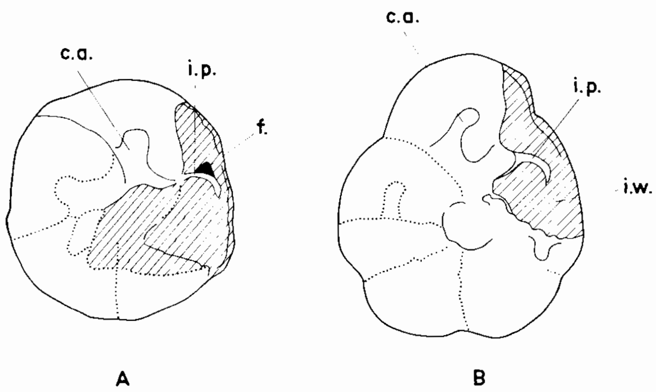


Fig. 54 A–B. Schematic drawings (based on micrographs in Fig. 53 C, E) of umbilical side of *Reinholdella dreheri* (A), and *Reinholdella media* (B) showing a closed aperture (c. a.), foramen (f), internal partition (i. p.), and internal ventral wall (i. w.). Dashed areas = corroded.

SUMMARY

LITHOSTRATIGRAPHICAL SUBDIVISION

The Jurassic sequence studied has been subdivided into eleven lithostratigraphical units, which are (with one exception) given local geographical names in accordance with the resolutions of the International Subcommission on Stratigraphic Classification and Terminology, presented at Copenhagen in 1960 (Repts. I. G. C., 21 Sess., Pt. 25, Copenhagen 1961).

Most of the names have been used previously. However, the names of some lithostratigraphical units are slightly modified, and three new units are proposed, viz. the Rydebäck Beds, Fortuna Marl, and the Nytorp Sand.

The Helsingborg Beds (Hettangian) are characterized by alternating sandy and silty, mainly non-marine, sediments, which were subdivided into nine sedimentation cycles by Troedsson (1951) (Table 1, p. 8). Several coal-seams occur. The thickness of the Helsingborg Beds was estimated to be about 200 m by Troedsson (1951).

The Döshult Beds were formed during the first major transgression that occurred in Jurassic times in W. Scania, viz. in the Early Sinemurian. These beds are 70–170 m thick and include coarse, partly cross-bedded sandstones succeeded by alternating siltstones, clays and marls. Sections of the Döshult Beds are reproduced in Figs. 2, 7, 8, pp. 10, 21, 22.

The Pankarp Clays, some 60 m thick, are characterized by greyish, bluish, brownish and red-brown clays, claystones and shales, commonly with a thin bed of loose sandstone or siltstone with a coal-seam. These beds are mainly marine or brackish. The occurrence of a coal-seam (and plant fragments) indicates at least one break in the marine sedimentation.

The Katslösa Beds (maximum thickness 115 m according to Troedsson (1951) were partly formed during the second major Liassic transgression in W. Scania, which began immediately before the beginning of Pliensbachian times. This is indicated by a sudden appearance of a rich fauna of calcareous foraminifera (Table 7, p. 27). A major transgression at the base of the Pliensbachian was the most widespread in the Lias in NW. Europe (Hallam, 1960, p. 141). The Katslösa Beds consist of shales and claystones and partly ferruginous siltstones and sandstones (Fig. 3, p. 11, Figs. 2, 9, 10, pp. 10, 25, 28).

The Rydebäck Beds, a lithostratigraphical unit proposed in the present study, include some 50 m of sandy and silty, partly ferruginous and oolithic sediments with a varying content of clay and calcium carbonate. Intervals of variegated rocks (mainly reddish, greenish and red-spotted blackish) are characteristic. Several conglomeratic horizons which occur especially in the upper part of the unit, indicate breaks in the marine succession.

The characteristically coloured intervals of the Rydebäck Beds allow local correlations (Fig. 4, p. 13). Thus, the Rydebäck Beds of the Rydebäck-Fortuna cores Nos. 1 and 4 can be correlated with Bölau's "*Obere Bunte Folge*" in the Vilhelmsfält core in NW. Scania, which has yielded ammonites indicative of the *Spinatum* Zone (Domerian) in the lower part, and the *Tenuicostatum* Zone (Toarcian) in the upper part of the sequence (Bölau, 1959).

A significant uplift began in Late Liassic time in W. Scania, which is indicated by frequent conglomerates in the upper part of the Rydebäck Beds, and by a considerable decrease of the marine microfauna. Probably, there are considerable stratigraphical gaps in the upper part of the Rydebäck Beds, affecting the Toarcian as well as the Aalenian stratal sequences.

The Rydebäck Beds are succeeded by deposits referred to the Eriksdal Beds (Aalenian-Bajocian), which are mainly of continental origin. This unit is represented by sand and silt with several coal-seams and a varying content of clay. Intervals of pure clay also occur. Obviously, the basal deposits of the Eriksdal Beds, penetrated by the Rydebäck-Fortuna core No. 4, were formed near to the shore. This is indicated by the presence of calcareous foraminifera in the sediment in between the coal-seams, suggesting occasional marine ingressions. In this core the Eriksdal Beds measure some 30 m in thickness. This is only a minor part of the whole formation. The type section (Fig. 4, p. 13) of the Eriksdal Beds in the Vomb Basin, SE. Scania consists of more than 100 m of sandy and clayey sediments with coal-seams (Tralau, 1966, 1968).

The Glass Sand (Bathonian), some 100 m of whitish and brownish sand is best known from Eriksdal in the Vomb Basin, SE. Scania, where it is mined. In W. Scania indications of this lithostratigraphical unit are few. Neither at Eriksdal nor in W. Scania has the sequence yielded foraminifera or other indicators of a marine environment. The presence of plant fossils (Tralau, 1968) rather suggests a continental origin of the main part of the Glass Sand.

The Fortuna Marl, a lithostratigraphical unit proposed herein, includes the first marine deposits of Late Middle Jurassic-Early Late Jurassic age to be recorded from Sweden (see also Norling, 1970, a preliminary report). The sudden appearance of a rich and varied fauna of calcareous foraminifera indicates that a significant Late Bathonian or Callovian transgression affected at least parts of W. Scania. The unit is represented by marls and claystones with thin bands of limestone. The type section, viz. the Rydebäck-Fortuna core No. 5, 161.25–135.17 m, is described and illustrated in pp. 14, 30, Fig. 11.

The Fyledal Clay (Oxfordian-Kimmeridgian), which succeeds the Fortuna Marl in the core No. 5, consists largely of greenish, bluish and brownish clays and claystones. In its type area, the Fyle Valley in the Vomb Basin, SE. Scania, this unit may reach a thickness of some 140 m (Christensen, 1968). In the Rydebäck-Fortuna core No. 5 its thickness is about 57 m. This core represents the first continuous section of the Fyledal Clay to be described (pp. 15, 30, Fig. 11).

The Nytorp Sand (Kimmeridgian?-Portlandian), a lithostratigraphical unit proposed in the present paper, succeds the Fyledal Clay in the Rydebäck-Fortuna core No. 5. It represents a 37 m thick sequence of whitish sand and silt, known also from the Vomb Basin. The lack of marine fossils in the major part of the sequence, the richness of coal fragments, and finds of megaspores suggest a limnic or brackish origin, possibly with occasional brackish-marine intervals (indicated by arenaceous foraminifera and scattered calcareous forms). The Nytorp Sand is described and illustrated in pp. 16, 30, Fig. 11.

The Vitabäck Clays, which may span the Jurassic-Cretaceous boundary, are insufficiently known in W. Scania. In the type region in SE. Scania, this lithostratigraphical unit consists of more than 70 m of greyish, brownish, and greenish clays with a varying content of silt and sand. On the basis of ostracoda Christensen (1968) referred this unit to the Portlandian. In W. Scania, the basal 6 m of this formation have been cored by one boring only, viz. Rydebäck-Fortuna No. 5.

CORRELATION

Previous ammonite finds (Troedsson, 1951; Bölau, 1959; Reyment, 1959, 1969) have proved the presence of Lower Sinemurian, Upper Sinemurian, and Carixian strata in W. Scania. Furthermore, in the Vilhelmsfält core in NW. Scania, ammonite finds are indicative of the Domerian Substage and the Toarcian Stage (Hoffman in Bölau, 1959; Reyment, 1959, 1969). These ammonite finds are important stratigraphical markers in the Scanian Lower Jurassic, but are too few to warrant a detailed stratigraphical subdivision of the whole sequence.

Foraminifera are exceptionally valuable for purposes of stratigraphical correlation in W. Scania. This is due to the scarcity of ammonites and to the fact that the main part of the Jurassic in this area is only visible by drilling.

For correlation, foraminiferal faunas of most Jurassic basins in Europe have been considered, and some Asian, African and American faunas as well. The European range chart of foraminifera obtained from the west Scanian Jurassic (Table 23) is mainly based on the following literature sources (data on type levels from other sources have also been considered):

Denmark (and Öresund): Nørvang, 1957; Bang, 1968.
NW. Germany: Franke, 1936; Bartenstein & Brand, 1937; Klingler, 1955; "Leitfossilien", 1962; Lutze, 1960; Brouwer, 1969.
S. Germany: Seibold & Seibold, 1953, 1955, 1956, 1960; Ohm, 1967; Brouwer, 1969.
Austrian-Swiss Jura: Brouwer, 1969; Kristan-Tollmann, 1957, 1964. (Rhaetic).
The Netherlands: Brouwer, 1969.
Great Britain: Barnard, 1950 a, b; Brouwer, 1969; Cifelli, 1959; Cordey, 1962; Gordon, 1962, 1965, 1967; Lloyd, 1959.
France: Bizon, 1960; Brouwer, 1969; Ruget & Sigal, 1967; Wernli, 1971.
Italy: Barbieri, 1964.
Spain: Brouwer, 1969; Ruget & Sigal, 1970; Ramirez del Pozo, 1971.
East Germany (DDR): Pietrzenuk, 1961; Rusbült & Petzka, 1964.
Poland: Bielecka & Styk, 1967; Kopik, 1967; Pazdro, 1969; Dadlez, 1969; "Catalogue of fossils. Jurassic.", 1970.
Czechoslovakia: Hanzlíková, 1965.
USSR (the Ukraine, White Russia, Moscow region, Central Siberia): Kapterenko-Chernousova, 1956, 1959, 1961; Mitjanina, 1957; Kuznetsova, 1962, 1963; Gerke, 1961.

The Helsingborg Beds have previously been correlated with the Hettangian Stage on the basis of molluscan faunas and plant fossils (Table 1, p. 8). The scarce foraminiferal fauna obtained from these beds (pp. 20, 34) neither supports nor contradicts this correlation. The fauna includes species restricted to the Lower Lias in Europe, as well as species previously obtained only from Rhaetic strata. The latter may be redeposited, but it cannot be excluded that they may span the Rhaetic-Hettangian limit.

In the succeeding Döshult Beds some previous finds of ammonites indicate that these beds include the *Bucklandi, Semicostatum* and *Turneri* Zones, which form the Lower Sinemurian (Table 2, p. 17, Fig. 2, p. 10). The Döshult Beds have yielded a rich fauna mainly of nodosariid, but also turrilinid, ceratobuliminid, and arenaceous foraminifera (pp. 20, 21, 23, Tables

4, 5). The fauna, including more than 35 species, many short-ranging, has permitted several sections to be referred to the Lower Sinemurian. Among short-ranging species, *Epistomina liassica* (L. Sinemurian), *Astacolus semireticulata* (Hettangian–L. Sinemurian), *"Neobulimina"* sp. No. 2 Bang, 1968, *Citharina inaequistriata* (Hettangian-Sinemurian), *Trochammina gryci* (Sinemurian), and *Marginulina undulata* (Sinemurian) may be mentioned. The ostracode *Procytheridea betzi*, rather common in the Döshult Beds, is characteristic of the Lower Sinemurian in NW. Germany. The fauna of the Döshult Beds is closely related to the Lower Sinemurian fauna of W. Europe, but has few species in common with the east European Lower Sinemurian (Table 22, p. 107).

The Pankarp Clays have yielded ammonites indicative of the *Obtusum* Zone of the Upper Sinemurian (Reyment, 1969; Tables 2, 5, 10, Fig. 2 in the present paper). The foraminiferal fauna obtained from the Rydebäck-Fortuna cores Nos. 1 and 4 supports this dating (Table 6, p. 25). The fauna is not rich (16 species), but the occurrence of *Marginulina spinata spinata* (U. Sinemurian-L. Pliensbachian) jointly with *Citharina inaequistriata* (Hettangian-Sinemurian), and *Trochammina gryci* (Sinemurian) indicates a Late Sinemurian age.

The lowermost part of the succeding Katslösa Beds is also given a Late Sinemurian age. At the base of the type section of this unit (Fig. 3, p. 11), Reyment (1959, 1969) has reported the ammonite *Eparietites denotatus* indicative of the Late Sinemurian *Obtusum* Zone.

In SE. Scania, at Eriksdal, there is also ammonitic evidence for the *Oxynotum* Zone (Reyment, 1959, 1969), whereas the top ammonite zone of the Sinemurian, the *Raricostatum* Zone, has never been reported from Sweden.

In the lowermost part of the Katslösa Beds, the foraminiferal species *Marginulina spinata spinata* occurs jointly with *Citharina inaequistriata*, an indication of a Late Sinemurian age. However, the major part of the Katslösa Beds corresponds to the Carixian Substage of the Pliensbachian Stage. Ammonite finds are few. In the lower part of the type section one specimen of *Polymorphites* cf. *jamesoni* has been found (Troedsson, 1951). In SE. Scania, at Kurremölla (Eriksdal), the presence of the *Jamesoni* Zone was established by Moberg, 1888 (cf. Reyment, 1969).

The abundant foraminiferal fauna obtained from exposures and cores referred to the Katslösa Beds (pp. 24, 26, 34, Table 7) includes several species in an association indicative of an Early Pliensbachian (Carixian) age. The whole fauna includes 38 species, 32 of which belong to the superfamily *Nodosariacea*. The correlation of the Katslösa Beds (main part) with the Carixian Substage is based mainly on the occurrence of *Marginulina spinata spinata* (U. Sinemurian-Carixian), *Nodosaria quadrilatera* (Pliensbachian), *Astacolus denticula-carinata* (Carixian-Lower Domerian), *Ichthyolaria mesoliassica* (Pliensbachian), *I. frankei* (Pliensbachian), and *Prodentalina insignis* (Carixian). Several other species support this dating.

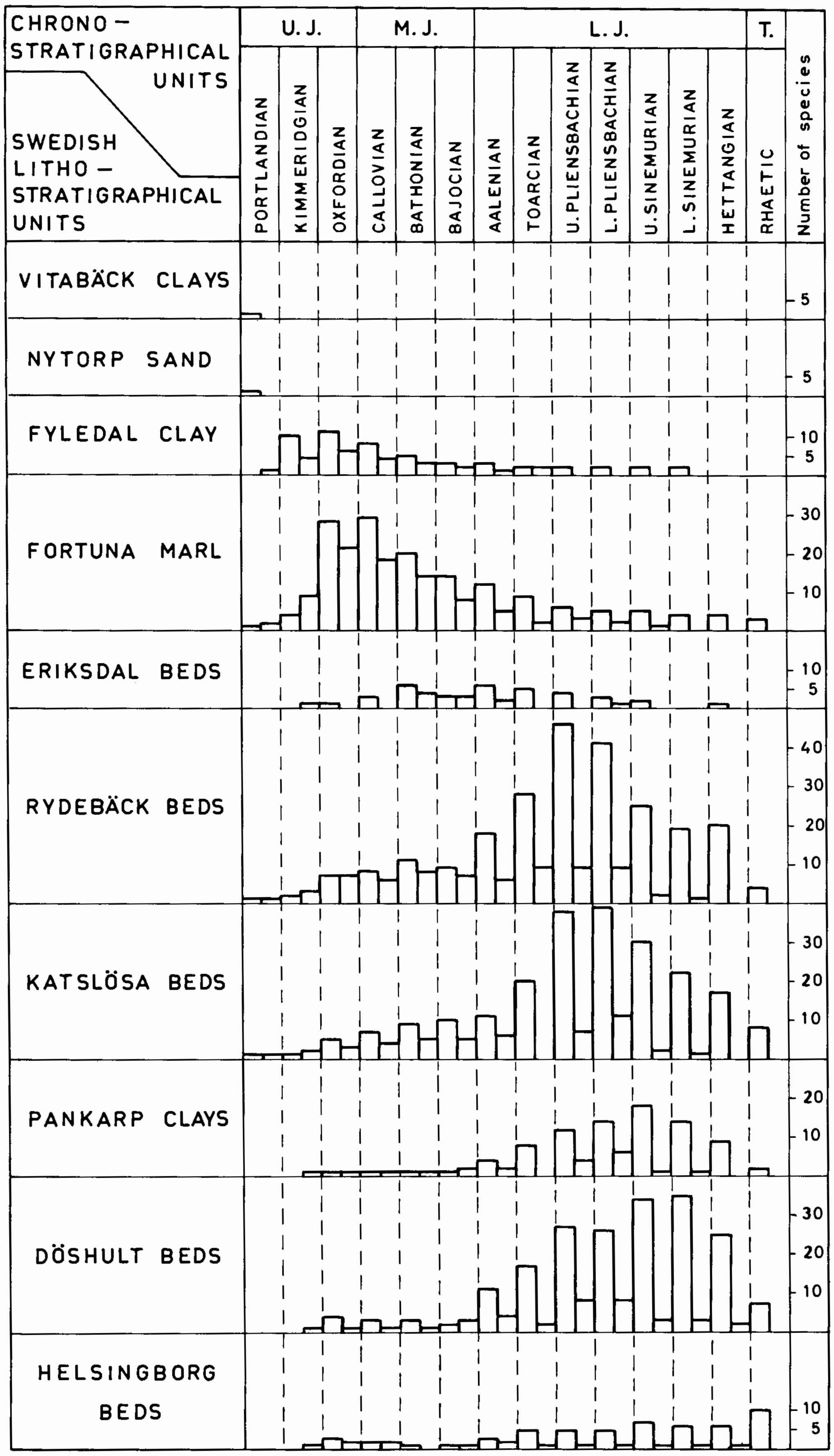
The foraminiferal fauna of the Rydebäck Beds is rich in the lower part, but exhibits a significant decrease in the number of species and individuals in the upper part of the unit.

In the lower part of the Rydebäck Beds the fauna correlates closely to the Pliensbachian fauna of W. Europe, whereas the relationship to the east European fauna is of little significance (Table 22, p. 107). The Scanian fauna includes more than 50 species, some of which are restricted to the Upper Pliensbachian (Domerian) in Europe. Based on the occurrence of such species as *Astacolus denticula-carinata* (Carixian- L. Domerian), *Tristix liasina* (Pliensbachian-Toarcian), *Marginulina spinata interrupta* (uppermost Carixian-Domerian), *Saracenaria sublaevis* (Domerian), *Brizalina liassica amalthea* (Carixian-Domerian boundary), *Geinitzinita* sp. No. 4 (Bang, 1968), *G.* sp. No. 6 (Bang, 1968) (Domerian), *Vaginulina spuria* (U. Domerian-Toarcian), and *Citharina flabelloides* (uppermost Domerian-U. Jurassic), the lower part of the Rydebäck Beds has thus been given a Domerian age.

The upper part of the Rydebäck Beds does not only differ from the lower part in the significant decrease in the number of foraminiferal species and individuals. Some new species appear, viz. *Citharina clathrata*, *Saracenaria trigona*, *Trochammina sablei*, and *Anomalina liassica*. The three first mentioned species seem to be restricted to the Toarcian and Aalenian Stages in NW. and SW. Europe. The whole fauna is given in Table 8, p. 29.

As mentioned above (p. 104), the Rydebäck Beds can be correlated lithologically with the *"Obere Bunte Folge"* of the Vilhelmsfält core in NW. Scania, which has yielded Domerian ammonites in the lower part and Toarcian ammonites in the upper part.

TABLE 22. Histogram frequency distribution of European Jurassic (and Rhaetic) foraminiferal species from Swedish lithostratigraphical units. Within each stage (e. g. the Oxfordian), the left hand histogram column represents the number of Scanian species in common with W. Europe, the right hand column with E. Europe.


CHRONO – STRATIGRAPHICAL UNITS
SWEDISH LITHO – STRATIGRAPHICAL UNITS
U. J.
M. J.
L. J.
T.
PORTLANDIAN
KIMMERIDGIAN
OXFORDIAN
CALLOVIAN
BATHONIAN
BAJOCIAN
AALENIAN
TOARCIAN
U. PLIENSBACHIAN
L. PLIENSBACHIAN
U. SINEMURIAN
L. SINEMURIAN
HETTANGIAN
RHAETIC
Number of species
VITABÄCK CLAYS
NYTORP SAND
FYLEDAL CLAY
FORTUNA MARL
ERIKSDAL BEDS
RYDEBÄCK BEDS
KATSLÖSA BEDS
PANKARP CLAYS
DÖSHULT BEDS
HELSINGBORG BEDS
5
10
20
30
40

In spite of their scarcity the foraminifera obtained from thin marine ingressional strata in the basal part of the Eriksdal Beds (mainly continental), are of importance in stratigraphy. Among the species found, *Epistomina parastelligera, E. conica, Reinholdella dreheri, R. media, Citharina clathrata,* and *Tristix liasina* may be mentioned. Neither *Epistomina parastelligera* and *E. conica,* nor *Reinholdella media* has been found in pre-Aalenian strata in Europe. On the other hand, *Citharina clathrata* s. str. and *Tristix liasina* have not been obtained from post-Aalenian strata, as far as is known to the present writer. The basal part of the Eriksdal Beds, as represented in the boring Rydebäck-Fortuna No. 4, is thus referred to the Aalenian. According to Tralau (1968), the main part of the Eriksdal Beds in SE. Scania is of Bajocian age. The foraminifera of the Eriksdal Beds are given in Table 8, p. 29.

The main part of the Fortuna Marl is of truly marine origin and has yielded a fairly rich foraminiferal fauna of calcareous, as well as arenaceous forms. Identified species are listed in Tables 9 and 23. The thirty-seven species obtained from the Fortuna Marl are represented in the European Middle and Upper Jurassic stages in proportions indicated by the figures below (data on European occurrences from sources given in p. 105. See also Tables 22 and 23).

	W. Europe	E. Europe
Portlandian	1	2
Kimmeridgian	4	9
Oxfordian	28	21
Callovian	29	18
Bathonian	20	14
Bajocian	14	8

Based on this distribution, a study of index foraminifera, and comparisons with foraminiferal assemblages from different localities in Europe, the fauna of the Fortuna Marl is referred to the Callovian and Oxfordian Stages. Certain finds of ostracodes, including *Procytheridea parva, Oligocythereis fullonica,* and *O. woodwardi,* from the deepest part of the Rydebäck-Fortuna core No. 5 may indicate a Late Bathonian age of the basal beds of the Fortuna Marl.

Among foraminiferal species may be mentioned: *Epistomina callovica* (Bathonian-Callovian), *Lenticulina tricarinella* (U. Bajocian-L. Oxfordian), *Frondicularia franconica* and *Citharina macilenta* (Bathonian-L. Oxfordian), *Frondicularia nikitini, Saracenaria phaedra,* and *Marginulina batrakiensis* (Callovian-Oxfordian), *Citharina tenuicostata, Marginulinopsis sculptulis,* and *Lenticulina quenstedti* var. *evoluta* (Oxfordian).

In this connection a paper by Reyment (1971) is of great interest, in which an erratic boulder from SW. Scania containing a rich fauna of excellently preserved Callovian ammonites (from the *Lamberti* Zone) is reported. Although the site of this ammonitiferous Callovian marl is unknown it is unlikely to be far from SW. Scania.

In the upper part of the Fortuna Marl the fauna of calcareous foraminifera gradually decreases, whereas the arenaceous fauna increases.

The Fyledal Clay, which succeeds the Fortuna Marl in the Rydebäck-Fortuna core No. 5, has been formed in an environment which was not favourable to calcareous foraminifera. However, some few calcareous forms found are indicative of the age, as are certain forms from the rich arenaceous fauna.

Oertli, Brotzen & Bartenstein (1961) correlated the upper part of the Fyledal Clay at Eriksdal, SE. Scania with the NW. German *"Serpulit"* formation (Middle Purbeck), whereas Christensen (1968) referred the same beds to the Kimmeridgian. Concerning the Fyledal Clay in W. Scania, Christensen states (1968, p. 15) that the ostracodal faunas indicate a Middle Kimmeridgian-Early Portlandian age of the upper part of the formation. The lower part, Christensen states "may be of Middle and Lower Kimmeridgian, and perhaps Oxfordian age".

The present study seems to indicate that the main part of the Fyledal Clay, as it is represented in the Rydebäck-Fortuna core No. 5, is of Oxfordian age. This conclusion is based on finds of foraminifera such as *Eoguttulina pisiformis, Lenticulina fraasi, Astacolus gordoni, A. anceps, A. cordiformis,* and *Reophax suprajurassica,* which have not been recorded from post-Oxfordian strata in Europe, as far as is known to the present writer. On the whole, there are few foraminiferal species indicative of a Kimmeridgian age. It must be noted, however, that the uppermost 10–15 m of the Fyledal Clay have yielded a fauna, which has several species in common with the Kimmeridge Clay of Dorset (Lloyd, 1959). However, many of these species have a rather wide vertical range.

Valvulina meentzeni, a species restricted to the Kimmeridgian of W. Europe (Klingler, 1955; Lloyd, 1959; "Leitfossilien", 1962), was obtained from a sample about 4 m below the top of the Fyledal Clay. Parts of the overlaying Nytorp Sand is fairly rich in coal fragments and megospores suggesting a limnic environment. The few foraminifera found in the lowermost and uppermost parts of this unit are not sufficient for an accurate dating. *Cyclammina* species from the basal part of the unit show a close affinity to forms known from the Middle Kimmeridgian, as well as to those from the *"Gigas-Schichten"* and *"Eimsbäckhäuser Plattenkalk"*, which range from the Upper Kimmeridgian to the Lower Portlandian in NW. Germany ("Leitfossilien", 1962).

Near the top of the Nytorp Sand, *Lenticulina muendensis,* known from the Portlandian of NW. Germany, has been found.

The small part of the Vitabäck Clays penetrated by the Rydebäck-Fortuna core No. 5, has also yielded *Lenticulina muendensis,* accompanied by the ostracode *Klieana alata,* which is restricted to Upper Kimmeridgian-Portlandian/Berriasian strata in NW. Germany (Martin, 1940, 1957; "Leitfossilien", 1962).

NOTES ON THE PALEOGEOGRAPHY AND FORAMINIFERAL BIOGEOGRAPHY

The Early Jurassic was a time of northward transgression from the Tethys and an extensive part of northern Europe became a shelf sea. The Liassic basins were framed by series of landmasses. In the west these included the Outer Hebrides, the Scottish and Welsh Massifs, in the south-west the Amorican Massif, in the south-east the Massif Central and the Vindelician Landmass. To the north and north-east the basins were framed by the Fennoscandian Shield and the Russian Platform, and to the east lay the Bohemian and the Harz Massifs. For part of the time the sea transgressed eastwards and invaded Poland and Lithuania. Within the main basin there were islands of denudation including south-eastern England, the Ardennes, Eifel, and the "Rheinisches Schiefergebirge".

In the Early Lias, Scania and the south-east Baltic area were subject to mainly continental sedimentation, but had occasional connections with marine basins in the west. This is indicated by the impoverished foraminiferal and molluscan faunas obtained from the Helsingborg Beds in Scania and other Hettangian strata as far to the east as western Poland. Dadlez (1969) for example, described several marine ingressions in the Lower Mechovo Beds.

Because of the position of Scania close to the margin of the main basin, which is believed to have extended from Jutland via NW. Germany to NE. England, one would expect a close correlation between the Liassic foraminiferal faunas of western Scania and those of the region mentioned. This is, in fact, the case since almost all of the species found in Scania have been recorded from most of the west European basins north of the Tethys. On the other hand, as indicated by the frequency distributions of foraminiferal species in Table 22, p. 107, the correlation with eastern Europe is fairly weak. Several Liassic transgressions which invaded Scania did not reach further to the east. In Scania, the ammonitic evidence of the *Bucklandi, Semicostatum, Turneri, Obtusum,* and the *Oxynotum* Zones, and the fairly rich foraminiferal faunas, indicate that marine conditions prevailed during the major part of the Sinemurian. Possibly after a short continental period in Late Sinemurian time, the Pliensbachian sea invaded Scania, which became submerged until the Late Lias.

In western Poland the first major Liassic transgression occurred in the Early Pliensbachian (Carixian). The marine period, during which the Lobez Beds were formed, was followed by a continental period in the Domerian. The scarce foraminiferal fauna obtained from th Carixian of W. Poland includes some species in common with the Scanian Katslösa Beds, viz. *Ammodiscus asper, Pseudonodosaria quinquecostata, Ichthyolaria terquemi, I. sulcata, Tristix liasina,* and *Astacolus quadricostata.* Another species common to both Scania and W. Poland has been recorded from thin marine ingressional strata in the Domerian, viz. *Saracenaria* cf. *sublaevis* (Dadlez, 1969, p. 60).

The next extensive marine ingression formed the Early Toarcian Lower Gryfice Beds in W. Poland. The foraminiferal fauna recorded from these beds is comprised exclusively of arenaceous species, none of which are found in the Toarcian part of the Rydebäck Beds in W. Scania. According to Dadlez (1969, p. 84), the Upper Gryfice Beds (Upper Lias ε), were formed during a gradual marine regression. This is indicated by a decreasing marine-brackish fauna, and an increasing megaspore flora. These conditions may be comparable to those under which the upper deposits of the Rydebäck Beds were formed. The occurrence of conglomerates and a considerable decrease in the marine microfauna inidcate a considerable uplift.

In Scania and elsewhere in Europe north of the Tethys, the shelf sea environment was fabourable to benthonic foraminifera. The fauna consists predominantly of nodosariid foraminifera (Table 12, p. 38). The most common genera are *Nodosaria, Astacolus, Ichthyolaria, Lenticulina, Marginulina, Mesodentalina, Prodentalina,* and *Geinitzinita.* Apart from nodosariids, the faunas occasionally include simple arenaceous forms such as *Ammodiscus, Trochammina,* and *Reophax.* Other, but usually less common foraminifera belong to the *Ophthalmididae, Bolivinitidae (Brizalina liassica),* and *Ceratobuliminidae (Epistomina liassica, Reinholdella dreheri).*

Certain species have a very wide regional, but narrow vertical distribution, and are thus excellent index fossils. As examples may be mentioned *Marginulina spinata spinata* (U. Sinemurian-Carixian), *M. spinata interrupta* and *Saracenaria sublaevis* (uppermost Carixian-Domerian), and *Astacolus denticula-carinata* (Carixian), which have been recorded from most western, as well as eastern European basins. *Marginulina spinata interrupta* is recorded from the Upper Pliensbachian of Central Siberia (Gerke, 1961), as well as from northern Spain (Ramirez del Pozo, 1971). This form has also been obtained from Upper Pliensbachian strata of N. Alska (Tappan, 1955). The relationship between the north Alaskan Lower Jurassic fauna and the European is generally closer than might be expected. This is also true of the Central Siberian fauna.

After the Late Toarcian uplift in the South Baltic region, traced in Scania as well as in Poland, an extensive Aalenian transgression invaded Poland from the west, that is from Brandenburg and Mecklenburg. Evidence for this transgression is present in Scania too, but not on the Island of Bornholm in the southern Baltic, as far as is known to the present writer. In Scania, the foraminiferal fauna of the uppermost part of the Rydebäck Beds and of thin marine ingressional strata of the basal Eriksdal Beds, indicates an Aalenian-Early Bajocian age (pp. 29, 35). The scarce fauna includes species common to both western and eastern Europe, suggesting at least occasional marine connections eastwards. This marine stage was short-lived in Scania, but prevailed throughout the Middle Jurassic in Poland, which had sea connections with Czechoslovakia, Hungary, and the Ukraine. The extent of the Middle Jurassic sea in the South Baltic region resulted in marine ingressions during Late Bathonian and Callovian times. Along a broad front the sea invaded areas of eastern Europe including Poland, Lithuania, Latvia, White Russia, the Ukraine, the Moscow region, and areas further to the north-east and south-east. The Fortuna Marl in W. Scania was formed in a marine environment in the Late Bathonian (or Callovian)–Early Oxfordian times. As seen in Table 22, p. 107, the foraminiferal fauna of this formation exhibits a much closer correlation to the east European fauna than the Early Jurassic fauna, an indication of more open sea connections eastwards.

Like the Early Jurassic fauna, the Callovian-Oxfordian fauna is dominated by nodosariid forms (Table 12, p. 38). The nodosariid fauna of the Fortuna Marl and the corresponding European shelf sea strata elsewhere is mainly represented by the genera *Astacolus, Citharina, Dentalina, Frondicularia, Lenticulina, Marginulina,* and *Saracenaria.* The genus *Nodosaria,* abundantly represented in Lower Jurassic strata, has not been obtained from the Fortuna Marl. The primitive genera *Prodentalina* and *Mesodentalina* have been replaced by the modern genus *Dentalina* (Fig. 30, p. 62). The non-lamellar genera *Geinitzinita* and *Ichthyolaria* have been replaced by the lamellar genera *Lingulina* and *Frondicularia.*

A characteristic species from the Fortuna Marl, is *Lenticulina tricarinella* (Fig. 37, p. 71). This species has been recorded from Upper Bajocian to Oxfordian strata in both eastern and western Europe by several authors. It has also been reported from the southern side of the Tethys (Macfadyen, 1935; Gordon, 1970). Another widely distributed species is *Lenticulina muensteri* (Fig. 35, p. 68), abundant in the Fortuna Marl, as well as in Middle Jurassic-Upper Jurassic strata of Central and NW. Europe. From the southern side of the Tethys it has been recorded by Said & Bakarat (1958).

The Fortuna Marl is fairly rich in coarse-ribbed forms of *Marginulina* and *Marginulinopsis* (p. 75, Fig. 40), reminiscent of the Lower Jurassic forms of the same genera. Though represented by other species, closely related forms have been recorded from the Bathonian, Callovian, and the Early Oxfordian of Madagascar (Espitalié & Sigal, 1963). Foraminifera resembling the Scanian forms *Marginulina nytorpensis* and *Marginulina prima fortunensis* (Figs. 38, 40, 43, pp. 72, 75, 80) have been reported from the Callovian of the Volga region, USSR (Shokhina, 1954), the Upper Jurassic of the Emba region, USSR (Furssenko & Polenova, 1950), and from Callovian strata of Wyoming, USA (Loeblich & Tappan, 1950).

Numerous examples could be given to illustrate close relations between shelf sea foraminifera from localities on both sides of the Tethys. On the other hand, shelf sea foraminiferal assemblages, in general fairly uniform as to their generic composition and morphological relations, contrast widely with the Tethyan assemblages. The latter include complex arenaceous forms and planktonic foraminifera, which rarely spread from the Tethys. According to Gordon (1970), the geographical distribution of these forms suggests that they probably represented a tropical fauna, or perhaps an equatorial one, during Jurassic times.

Bielecka & Pozaryski (1954), and Gordon (1970) discussed the environmental significance of shelf assemblages of Jurassic foraminifera. According to the first mentioned authors, observations from the Upper Jurassic of Poland suggest that assemblages, in which nodosariids are prominent, are not characteristic of very shallow marine conditions. In the shallow facies where oolites, pisolites and shelly limestone intercalations are characteristic, nodosariids become rare. In contrast, they become more numerous in the marly argillaceous sediments apparently formed in deeper water. According to Gordon (1970), other authors, including Wall (1960), have reached similar conclusions. Gordon states that the global distribution of nodosariid and nodosariid-mixed assemblages in the Jurassic indicates that in general, they are "typical of shelf seas with nearby lands that feed coarse to fine terrigenous sediment into a sea, where carbonate deposition is also progressing. When such seas reach extremes of shallowness, the nodosariid and nodosariid-mixed assemblages seem to disappear".

During the Upper Jurassic, major regressions gradually diminished areas of marine deposition in Europe north of the Tethys.

A sudden decrease in the nodosariid fauna occurs in the upper part of the Fortuna Marl, and is still more pronounced in the succeeding Fyledal Clay. The Fyledal Clay (Oxfordian-Kimmeridgian) is extremely poor in nodosariid foraminifera, but rich in arenaceous forms represented by the genera *Cornuspira, Haplophragmoides, Reophax, Ammobaculites, Textularia, Trochammina, Valvulina*, and *Cyclammina*. According to Gordon (1970) "comparison with present-day faunas indicates that foraminiferal assemblages dominated by simple arenaceous forms are frequently indicative of conditions where secretion of calcium carbonate is difficult, that is, in cool-water or low-salinity conditions".

The main cause for the sudden faunal change in the Oxfordian of Scania is not obvious. Possibly, the conditions changed from marine to brackish. There are several indications of near-shore, and even limnic environments in the Fyledal Clay (viz. charophyte-gyronites, megaspores, and coal fragments).

According to Gordon (1970, p. 1697), *Pseudocyclammina* is characteristic of very shallow water. The upper part of the Fyledal Clay in the Rydebäck-Fortuna core No. 5 contains "*Cyclammina*" species. According to Bandy (1961, in I. G. C. Norden, 1960, 21 Sess., Pt. 22, p. 8), "Arenaceous, or agglutinating, foraminifera illustrate several important general trends (Fig. 1). Simple genera predominate in inshore waters, bays, lagoons, and in estuaries. Occasionally, in estuaries and other brackish waters, a genus such as *Ammobaculites* will be the dominant foraminifer (Bandy, 1956 b). Other genera include *Nouria, Saccamina, Trochammina, Eggerella*, and *Haplophragmoides*. Important arenaceous faunas of the inner shelf regions are also simple, being typified by *Trochammina, Eggerella* of small size, *Textularia*, and *Reophax*." As seen in Tables 9 and 23, most of the genera mentioned are represented in the Fyledal Clay fauna. However, there are also strata with indisputably marine foraminifera *(Astacolus, Lenticulina, Epistomina)* in the Fyledal Clay, as well as the uppermost formation of the Scanian Jurassic, viz. the Portlandian Vitabäck Clays. Some of these foraminifera may be correlated with those from Upper Jurassic faunas in western Europe.

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(Bold-face figures indicate descriptions and illustrations)

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