Report on the Jurassic of the Hobro No. 1 and Voldum No. 1 borings, Denmark

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Michelsen, O. : Report on the Jurassic of the Hobro No. 1 and Voldum No. 1 borings, Denmark. *Danm. geol. Unders., Årbog 1978*, pp. 141-149, pl. 4-6.

The lithostratigraphy and biostratigraphy in the Jurassic series of the Hobro No. 1 and Voldum No. 1 borings are described briefly. The lithology and the facies indicated by the petrophysical measurements for certain parts of the series, a part of the Lower Jurassic, the Middle Jurassic, and the uppermost part of the Upper Jurassic, show a transitional position of the series in the Danish Subbasin.

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The present report is published to inform about the borings in the Jurassic sequence most recently released for publication. The borings are situated in the Danish Subbasin (fig. 1).

The interpretations included in the report mainly derive from internal reports. The palynology has been studied by *Finn Bertelsen*, the Upper Jurassic ostracod faunas by *Ole Bruun Christensen*, and the Lower Jurassic ostracod faunas as well as the lithostratigraphy have been studied and worked out by the present author.

The *Voldum No. 1* boring was drilled in the period 4th March to 15th April 1974 south of Randers at the location 56° 23' 02" N and 10° 16' 01" E. The elevation of ground level is 30 m above MSL and of kelly bushing 35 m above MSL. The following series were drilled (depth measured from ground level):

0–21 m: Danian limestone
21–1242 m: Upper Cretaceous limestone
1242–1752 m: Lower Cretaceous and Jurassic claystone and sandstone
1752–2307 m: Triassic claystone, sandstone, limestone, and evaporites

The *Hobro No. 1* boring was drilled in the period 1st June to 10th July 1974 west of Hobro at the location 56° 36' 30" N and 09° 38' 04" E. The elevation of ground level is 27 m above MSL and of kelly bushing 32 m above MSL. The following series were drilled (depth measured below ground level):

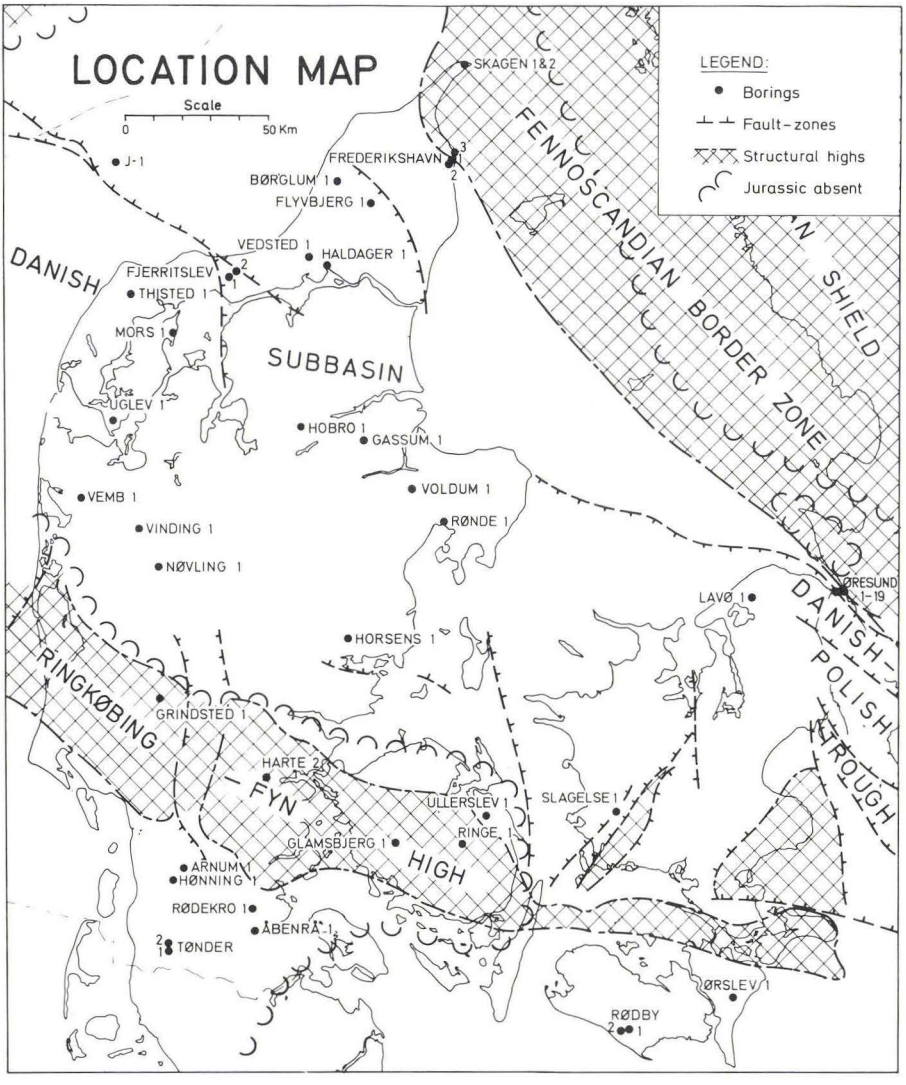

Fig. 1. Location map.

0–20 m: Quaternary
20–154 m: Tertiary, including Danian limestone
154–1610 m: Upper Cretaceous limestone
1610–2371 m: Lower Cretaceous and Jurassic claystone and sandstone
2371–2592 m: Triassic claystone, sandstone, and limestone.

Lithostratigraphy

The lithostratigraphy has been worked out and given in the table below in accordance with the definitions in Michelsen (1978). All depth figures are measured in metres below MSL.

	Hobro No. 1	Voldum No. 1
Bream Formation	1741–1823	1278–1358
Frederikshavn Member	1741–1806	1278–1344
Børglum Member	1806–1823	1344–1358
Haldager Formation	1823–1891	1358–1388
Flyvbjerg Member	1823–1852	absent
Haldager Sand	1852–1891	1358–1388
Fjerritslev Formation	1891–2343	1388–1722
Member F-IV	1891–1923	absent
Member F-III	1923–2077	1388–1497
Member F-II	2077–2108	1497–1527
Member F-I	2108–2343	1527–1722

Fjerritslev Formation

The formation characters are as known from the main part of the basin, and the formation can easily be correlated to the series known from the Rønde No. 1 (pl. 4) and the Gassum No. 1 borings (Michelsen 1978, fig. 14).

The character of the Member F-I is as known from all borings south of Vendsyssel. It is divided into the two subunits, F-Ia and F-Ib, which represent the Jurassic transgression and the deepening of the basin respectively.

In relation to the reference section, Dansk Nordsø J-1, and to the general features, the Member F-II is rather thin and untypical. It cannot be subdivided into the three subunits as known elsewhere in the basin. In both borings the gamma ray curve is insignificant with relatively low values as in the Gassum No. 1 boring. The acoustic measurements in the Hobro No. 1 boring distinctly separate the member as it can be done in the sections to the west and northwest. In the Voldum No. 1 boring the acoustic measurements are only slightly differentiated as in the Rønde section to the southeast.

The Members F-III and F-IV in the Hobro boring and the Member F-III in the Voldum boring have been developed as typical for the central part of the basin, and the series can easily be correlated to other borings.

Haldager Formation

Apart from the Horsens No. 1 boring, these sections are the most southeasterly ones comprising the formation (cf. Michelsen 1978, fig. 15).

In the Hobro No. 1 boring both the Haldager Sand and the Flyvbjerg Member are present but the latter member in a more clayey facies than usual. It does not comprise limestone beds in the top of the series but instead a solid sand bed.

In the Voldum No. 1 boring the Flyvbjerg Member is absent, and the Haldager Sand is more silty than in the type section.

Bream Formation

In both borings the formation appears in a rather typical way. The Børglum Member is thinner than normally but of comparable thickness with the series in the Gassum No. 1 boring.

In general, the Frederikshavn Member has the typical characteristics. In the Hobro No. 1 boring it can be dicided into the three cycles A, B, and C (see pl. 4). The lower part of the cycle C does not comprise a claystone series as known from the Haldager No. 1 and Børglum No. 1 borings (cf. Michelsen 1978, fig. 16). In the Voldum No. 1 boring the member is a massive sandstone series with a few thin claystone layers as it can be seen in the Rønde No. 1 boring. The Hobro boring may be regarded as transitional between the area to the north and the area to the south comprising the Voldum No. 1, Rønde No. 1, and Horsens No. 1 borings.

Conclusions

The two Jurassic series are of transitional character between the facies known from the central and northern part of the Danish Subbasin and the facies known from the southern and southeastern part. The lithostratigraphical units in question are the Member F-II, the Haldager Formation, and the Frederikshavn Member, which are the units representing shallow water condition (?) and two regressive periods respectively.

Generally the Hobro section shows affinities to the central and northern parts of the basin, but the Member F-II and the Frederikshavn Member of the section resemble Gassum section too.

The Voldum section shows affinities to the southern part of the basin comprising the Rønde No. 1 and Horsens No. 1 borings.

Biostratigraphy

The biostratigraphical subdivision of the two sections is given in pl. 4 in chronostratigraphical terms and with signatures indicating when ostracods, foraminifera, or palynology have been used. The biostratigraphy based on ostracods is as described in Christensen & Kilenyi (1970), Christensen (1974a), and Michelsen (1975b). The palynological investigations are described by Bertelsen (1974, and in the appendix). The chronostratigraphical conclusions are based on lithostratigraphy and biostratigraphy as defined by Michelsen (1978).

The stratigraphical subdivision of the two sections is in accordance with the subdivision known from sections in the central part of the basin (cf. Michelsen 1978). Therefore, the biostratigraphical data will be presented only briefly.

The *Lower Jurassic* ostracod faunas found in the two sections are rather equal. A distribution chart from the Hobro No. 1 boring is given in pl. 5 to demonstrate the fauna composition and the basis for the stratigraphical determination. The review of the faunal seccession is given below referring to Michelsen (1974).

Hettangian and Lower Sinemurian comprises the *C. betzi – C. crassireticulata* and *O. aspinata* Zones. The *O. aspinata* Zone is the lower one of the two zones; it is characterized by *Ogmoconchella aspinata* (Drexler 1958), *Ogmoconcha hagenowi* Drexler 1958, *Klinglerella (Klinglerella) medioreticulata* (Michelsen 1970), *Pseudomacrocypris subtriangularis* Michelsen 1975, *Nanacythere (Goniocythere) elegans* (Drexler 1958), *N. (G.) paracostata* Michelsen 1975, and *N. (G.) circumcostata* Michelsen 1975. The two first-named species are the most dominating species, and *K. (K.) medioreticulata* a common and characteristical species. The group *Nanacythere (Goniocythere)* is common and characteristic in the upper part of the zone which can be referred to Lower Sinemurian. The *C. betzi – C. crassireticulata* Zone is poor in species and in specimens. It is determined on the uppermost occurrence of *Cristacythere betzi* (Klingler & Neuweiler 1959) and *O. hagenowi.*

Upper Sinemurian comprises the lower part of the *O. danica* Zone. The fauna is dominated and characterized by *Ogmoconchella danica* Michelsen 1975. The fauna is furthermore characterized by a successive occurrence of *Progonoidea reticulata* (Klingler & Neuweiler 1959), *Klinglerella (Klinglerella) laqueata* (Klingler & Neuweiler 1959), *K.(K.) multicostata* (Klingler & Neuweiler 1959), *K. (K.) vulgaris* (Klingler & Neuweiler 1959), *K. (K.) triebeli* (Klingler & Neuweiler 1959), and *K. (K.) variabilis* (Klingler & Neuweiler 1959).

The lower part comprises the *P. reticulata* Subzone.

Lower Pliensbachian comprises the upper part of the *O. danica* Zone (the *G. apostolescui – K. (K.) foveolata* Subzone). The fauna is characterized by *Klinglerella (Klinglerella) foveolata* Michelsen 1975, *Pleurifera harpa* (Klingler & Neu-

weiler 1959), *Ogmoconcha amalthei form A* Michelsen 1975, *Ogmoconchella danica* Michelsen 1975, and *Ogmoconchella transversa* (Gründel 1970). The fauna is rich in species and in specimens, a typical feature in the Danish Subbasin. The three first-named species are not known outside this subzone; *O. danica* is usually rare above the subzone (however, in Rønde No. 1 it has range corresponding to its range in the present boring). *O. transversa* is a species typical for the subzone and for the lower part of the superjacent *O. adenticulata – N. (N.) simplex* Zone.

Upper Pliensbachian comprises the *O. adenticulata – N. (N.) simplex* Zone. The fauna is rich in species and specimens and is characterized by *Ogmoconchella adenticulata* (Pietrzenuk 1961), *Ogmoconchella aequalis* (Herrig 1969), *Ogmoconchella pseudospina* (Herrig 1969), and *Nanacythere (Nanacythere) simplex* Herrig 1969.

The zone can be subdivided into two subzones. The lower subzone is characterized by *Ogmoconchella transversa* (Gründel 1970) and *Acrocythere tricostata* Michelsen 1975, and the upper subzone by *Nanacythere (Domeria) firma* Herrig 1969 and *Nanacythere (Domeria) fissicosta* Herrig 1969.

The boundary Lower-Upper Sinemurian is found lowermost in the Member F-Ib. The Lower-Upper Pliensbachian boundary is found at the transition between the Members F-I and F-II, which is deeper in the series than usual. It may be due to a reduction of the Member F-II which elsewhere in the basin is thicker and comprises three subunits. The top of the Upper Pliensbachian is found in the upper part of the Member F-III, which indicates that the upper part of this member has been reduced or condensed (cf. Michelsen 1975b and 1978).

The Middle Jurassic age is only indicated in one sample within the Haldager Sand in each of the borings (for further information see the appendix).

The boundary Jurassic-Cretaceous has not been defined biostratigraphically but is based on correlation and determined to the transition cycles B-C (see Michelsen 1978, p. 23). Only a few ostracod specimens are found in the upper part of the Frederikshavn Member indicating a probable Upper Jurassic age. Lowermost in the member and in the Børglum Member is found a fauna belonging to the *G. dissimilis* and *G. elongata* Zones referring the series to Lower Kimmeridgian. The fauna comprises species as *Galliaecytheridea postrotunda, G. elongata, G. dissimilis, G. wolburgi, Macrodentina (Polydentina) gallica,* and *Monoceratina* cf. *vulsa* (Christensen 1974 b).

Appendix

The appendix is an extract of the unpublished report:

Bertelsen, F. 1974: Palynological investigations of the Triassic-Jurassic section of the Hobro No. 1 borehole. – Danm. geol. Unders.

This is done with the permission of the author due to the rather insufficient knowledge of the distribution of the various taxa within the Danish Subbasin. It has not been feasible to divide the studied section strictly into stages. Instead certain assemblage units are recognized (see also pl. 6).

The assemblage units

Unit A

The assemblages dominated by pollen of the Circumpollis group: *Granuloperculatipollis rudis* Venkatachala & Góczan 1964, *Corollina meyeriana* (Klaus) Venkatachala & Góczan 1964, and *Classopollis torosus* (Reissinger) Balme 1957. *Ovalipollis ovalis* Krutzsch 1955, *Ricciisporites tuberculatus* Lundblad 1954 a.o. seem to occur due to caving. Probably all of the miospores present in the lowermost sample are contaminants.

Unit B

The characterising element of this unit is *Ricciisporites tuberculatus* Lundblad 1954, which is extremely abundant in sample 2449 m (70.5%). Important accessory species are *Rhaetipollis germanicus* Schulz 1967, *Limbosporites lundbladii* Nilsson 1958, and *Ovalipollis ovalis*. Also bisaccate pollen grains *(Alisporites, Pityosporites)* are common.

An assemblage of the above type was found in sidewall core 1857 m in the Voldum 1 borehole (Bertelsen int. report April 1974).

Unit C_1

Deltoidispora spp. ocur with high percentages. *Perinopollenites elatoides* Couper 1958, *Classopollis torosus, Chasmatosporites* spp. and bisaccate pollen are common. *R. tuberculatus* is sporadically present whereas other 'Rhaetic types' have disappeared. A number of long ranging taxa are introduced among which is *Cerebropollenites thiergartii* Schulz 1967.

Microplankton in the form of Tasmanitids and Acritarchs are present indicating marine influence. Important is the presence of *Leiofusa jurassica* Cookson & Eisenack 1958.

The megaspore species *Nathorstisporites hopliticus* 1958 found in the ditch sample 2376-2382 m is probably also to be included in assemblage unit C_1.

Unit C_2

The assemblages consist of a majority of bisaccate pollen grains (gymnosperms) and other airborn pollen types as *Perinopollenites elatoides* whereas microspores are infrequent compared with the C_1 assemblages. Younger Liassic elements are not present but the occurrence of *Cerebropollenites mesozoicus* may indicate an age younger than Lower Sinemurian.

The occurrence of Tasmanitids, *Michrystidium* spp., Dinoflagellate cysts, especially in sample 2210 m, the high frequency of gymnosperms, and the generally poor state of preservation indicate increased marine influence compared with the C_1 unit.

Unit C_3

The bisaccate gymnospermpollen are dominant as in the C_2 unit but *Quadraeculina anellaeformis* Maljavkina sensu Schulz 1967 are probably not present. Osmundacean pollen (*Osmundacidites, Baculatisporites, Todisp.*) show increasing numbers. Occurrence of *Ceratosporites spinosus* Schulz 1967 and *Neoraistrickia truncata* (Cookson 1953) Schulz 1967.

The microplankton shows increasing diversity. Among the new forms are *Nannoceratopsis gracilis* (Alberti 1961) Evitt 1962 and several acritarchs.

Two megaspore species occur in ditch sample 2028-2034 m: *Horstisporites planatus* Marcinkiewicz 1971 and *Hughesisporites pustulatus* Marcinkiewicz 1962.

Unit C_4

There is a distinctive decrease in the percentage of bisaccate pollen in comparison with the units C_1 – C_3 indicating an important change of the environments to more shallow conditions. In the lower sample *Deltoidispora* spp., *Chasmatosporites* spp. and *Cerebropollenites mesozoicus* show high frequencies whereas *Sphaeripollenites* spp. are extremely abundant in the upper sample. Stratigraphically important is the regular presence of *Isochyosporites variegatus* (Couper 1958) Schulz 1967 and of *Converrucosisporites rariverrucatus* (Danze-Corsin & Laveine 1963) = *Trilites minutus* Mai in Schulz (1967).

The microplankton is made up by Tasmanitids and *Nannoceratopsis gracilis,* the latter being common in the lower sample.

Unit D

The assemblage is composed of numerous *Perinopollenites elatoides,* a moderate number of bisaccate pollen grains, and in comparison with the C_4 unit a number of new important species. These are *Foveosporites multifoveolatus* Döring 1965, *Matonisporites crassiangulatus* (Balme 1957) Levet-Carette 1964, *Neoraistrickia gristhorpensis* (Couper 1958) Tralau 1968, *Staplinispora* cf. *caminus* (Balme 1957) Pocock 1962, *Leptolepidites major* Couper 1958, *Callialasporites trilobatus* (Balme 1957) Dev 1961, *C. turbatus* (Balme 1957) Schulz 1967, a.o.

No microplankton is present.

In the Danish Subbasin similar assemblages have been found by the author in part of the Haldager Formation in the Haldager No. 1 borehole. They indicate shallow, probably deltaic conditions and seem to derive from the lignite-bearing sandy member at ca. 1920 m below KB.

Unit E

Cicatricosisporites spp. are present but not common, thus indicating that the assamblages are not older than the uppermost Upper Jurassic. Microplankton is represented by a rather variated assemblage especially in the uppermost sample.

Conclusions

The biostratigraphical results of the investigation can be summarized as below:

Unit E	1810–1840 m	Upper Jurassic/Lower Cretaceous
Unit D	1896–1902 m	Middle Jurassic
Unit C_4	1951–1970 m	Lower Jurassic, Toarcian
Unit C_3	2005–2060 m	Lower Jurassic, Pliensbachian
Unit C_2	2150–2270 m	Lower Jurassic
Unit C_1	2325–2352.5 m	Lower Jurassic, Hettangian/L. Sinemurian
Unit B	2445.5–2460 m	Upper Triassic, Middle Rhaetian
Unit A	2556–?2610 m	Upper Triassic, Upper Norian/Lower Rhaetian

Dansk sammendrag

Nærværende rapport giver en kortfattet oversigt over den litho- og biostratigrafiske inddeling af jura lagserien i de to boringer Hobro nr. 1 og Voldum nr. 1. Boringerne blev udført i henholdsvis juni-juli og marts-april 1974 og er dermed fem år gamle og nu frigivne for publikation.

Der gives en kort beskrivelse af de lithostratigrafiske karakterer i de to serier i relation til definiti-

on og beskrivelse givet i Michelsen (1978). Den lithostratigrafiske inddeling findes i tabellen p. 143, og den er sammen med lithologisk karakteristik og biostratigrafisk inddeling gengivet i pl. 4.

Lagserien i de to boringer er i store træk udviklet typisk i forhold til den centrale del af Det danske Subbassin. Member F-II (Fjerritslev Formationen), der formodes at være marin lavtvandsdannelse, og Haldager Formationen og Frederikshavn Member, der repræsenterer regressive faser, afviger på karakteristisk måde fra deres udformning centralt og nordligt i bassinet og danner dermed overgangstyper til karaktererne i den sydlige og sydøstlige del.

References

Bertelsen, F. 1974: Palynological investigations of the Triassic-Jurassic section of the Hobro No. 1 borehole. – Danm. geol. Unders., unpubl. report. (An extract is given in the present paper).

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Christensen, O.B. & Kilenyi, T. 1970: Ostracod biostratigraphy of the Kimmeridgian in northern and western Europe. – Danm. geol. Unders., II. Række, 95, 65 p.

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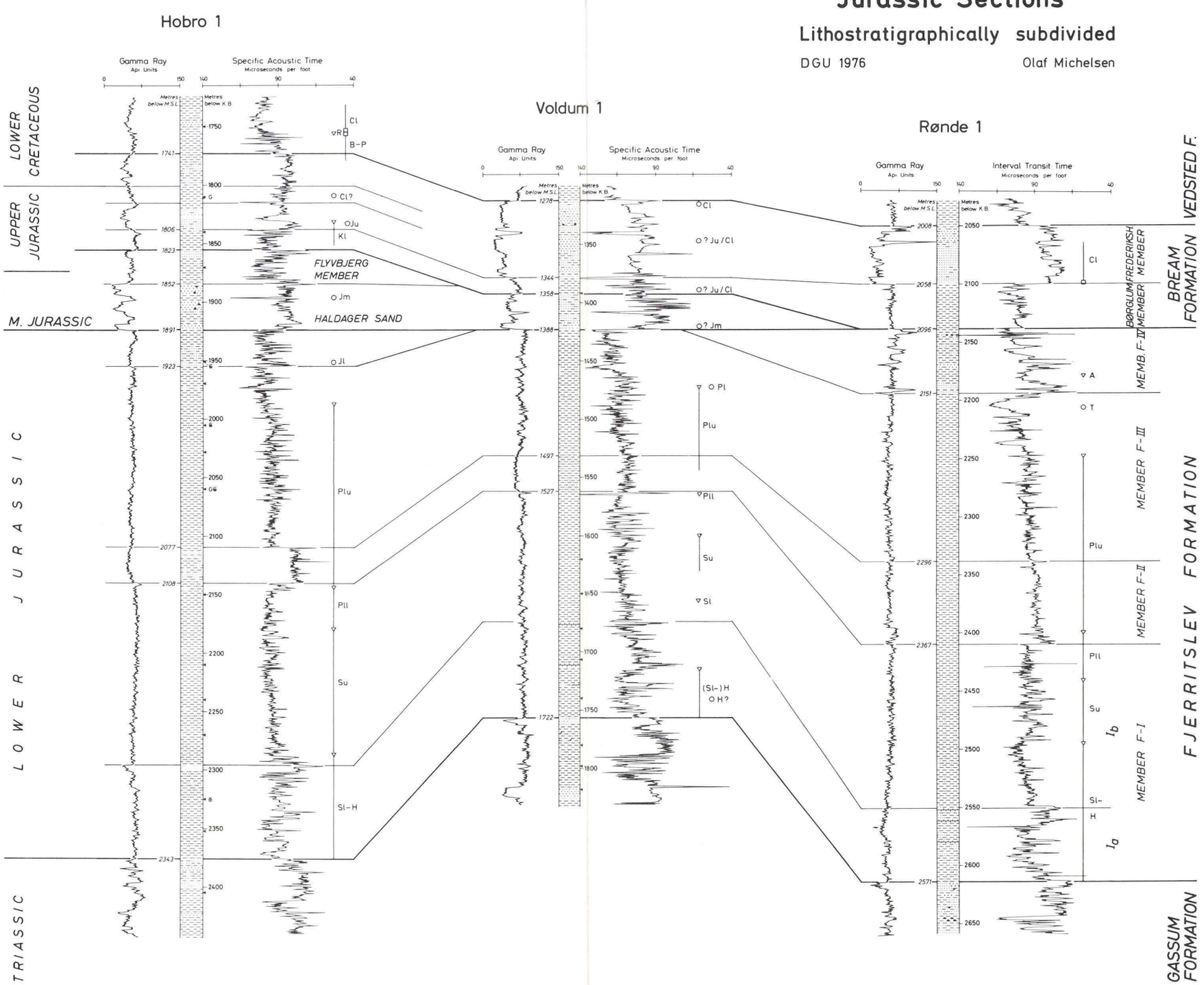
Michelsen, O. 1975b: Lower Jurassic biostratigraphy and ostracods of the Danish Embayment. – Danm. geol. Unders., II. Række, nr. 104, 287 p.

Michelsen, O. 1978: Stratigraphy and distribution of Jurassic deposits of the Norwegian-Danish Basin. – Danm. geol. Unders., Serie B, 2, 35 p.

Jurassic Sections

Lithostratigraphically subdivided

DGU 1976 Olaf Michelsen



SYMBOLS

Claystone
Siltstone
Sandstone
Limestone
Dolomite
Lignite, coal
Sidewall core
L Lignite, micro
G Glauconite
@ Shells

Chronostratigraphy based on:

▽ Ostracods (O. Bruun Christensen and O. Michelsen)

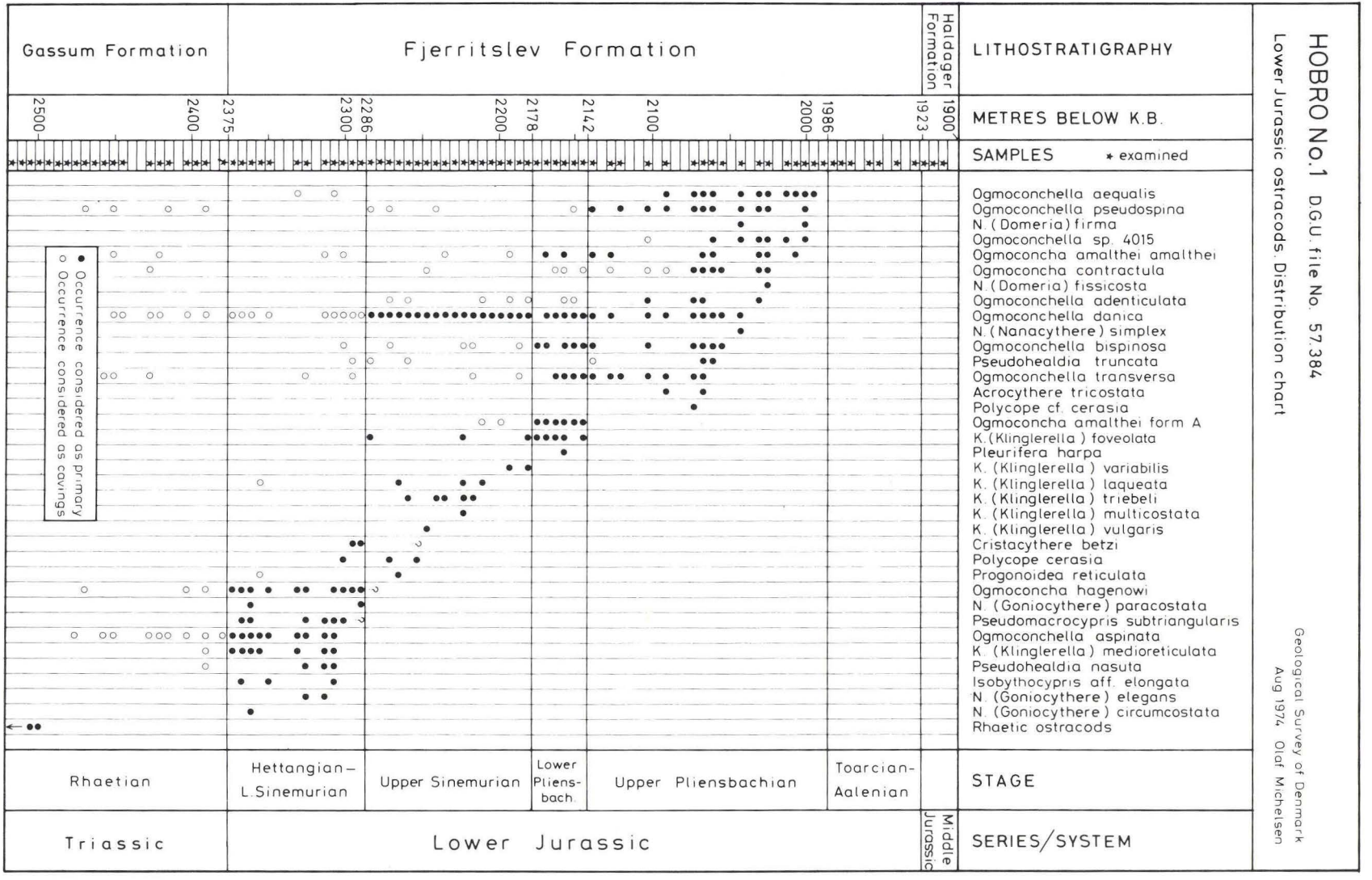
□ Foraminifera (A. Buch)

○ Mio- and megaspores (F. Bertelsen)

Cl	Lower Cretaceous	Jl	Lower Jurassic
B	Berriasian	A	Aalenian
Ju	Upper Jurassic	T	Toarcian
R	Reightonian	Pl	Pliensbachian
P	Portlandian	Plu	Upper Pliensbachian
K	Kimmeridgian	Pll	Lower Pliensbachian
Ku	Upper Kimmeridgian	S	Sinemurian
Kl	Lower Kimmeridgian	Su	Upper Sinemurian
O	Oxfordian	Sl	Lower Sinemurian
Jm	Middle Jurassic	H	Hettangian

Plate 4.

Plate 5.



HOBRO No.1 D.G.U. file No. 57.384

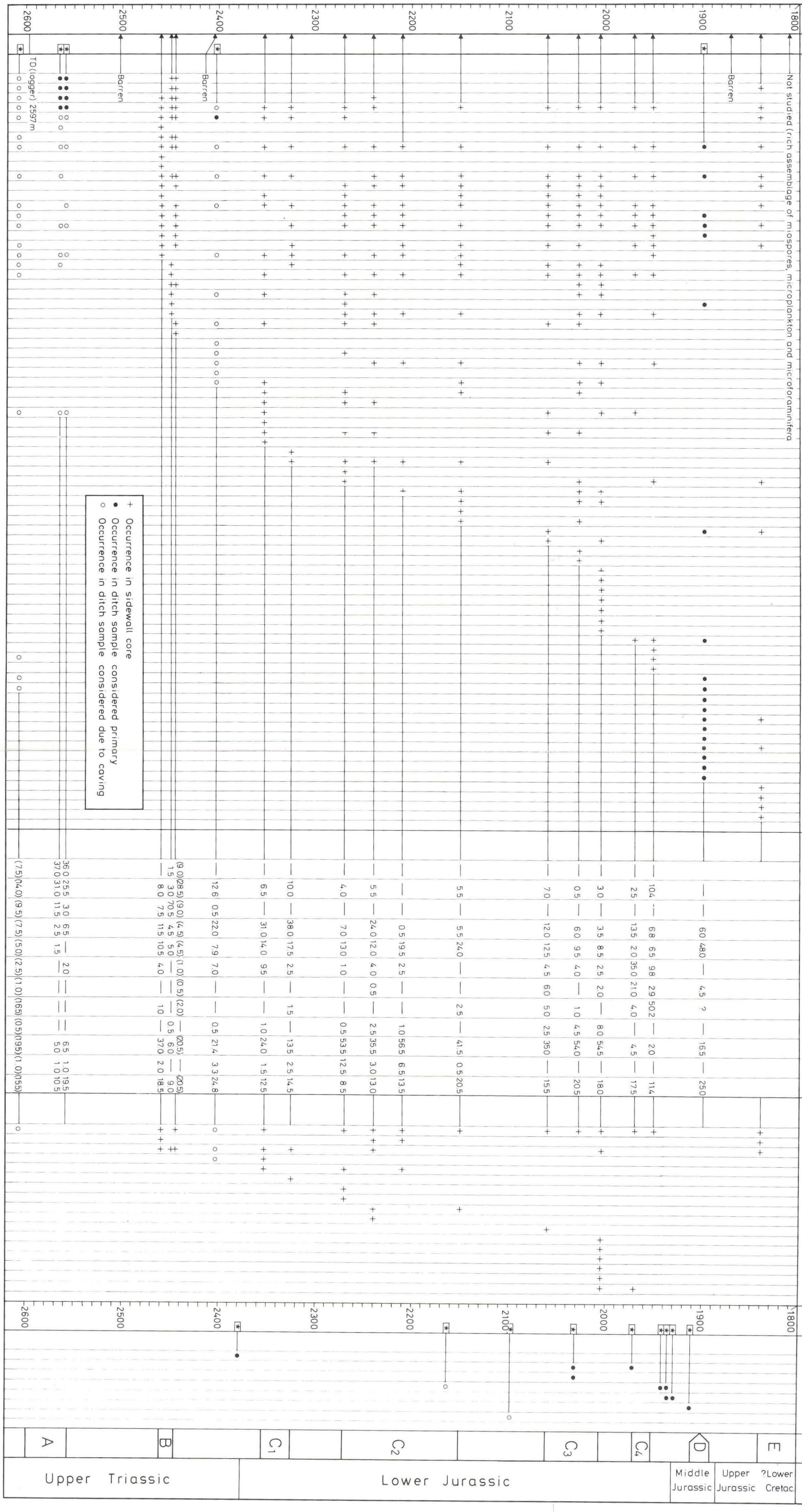
Lower Jurassic ostracods. Distribution chart

Geological Survey of Denmark
Aug 1974 Olaf Michelsen

Plate 6.

HOBRO No. 1 D.G.U. file No. 57.384

Triassic – Jurassic Palynological Range Chart



SAMPLES STUDIED: ▲ SIDEWALL CORE ★ DITCH SAMPLE

MIOSPORES

Granuloperculatipollis rudis
Ovalipollis ovalis
Corollina meyeriana
Classopollis torosus
Ricciisporites tuberculatus
Limbosporites lundbladii
Rhaetipollis germanicus
Deltoidispora spp.
Anapiculatisporites sp.
Uvaesporites sp.
Perinopollenites elatoides
Lycopodiumsporites austroclavatidites
Lycopodiumsporites sp. (SI 572 SM)
Chasmatosporites spp.
Cerebropollenites mesozoicus
Araucariacites australis
Monosulcites spp.
Sphaeripollenites subscabratus
Quadraeculina anellaeformis
Calamospora spp.
Baculatisporites comaumensis
Cycadopites nitidus
Anemiidites cf. echinatus
Eucommiidites spp.
Contignisporites problematicus
Heliosporites altmarkensis
Anapiculatisporites cf. spiniger
Lycopodiacidites infragranulatus
Stereisporites spp.
Osmundacidites wellmanii
Zebrasporites interscriptus
Densosporites sp.
Uvaesporites argentaeformis
Foraminisporis jurassicus
Trachysporites spp.
Lycospora scalebrosa
Todisporites spp.
Semiretisporis reticulatus
Gleicheniidites sp.
Cerebropollenites thiergartii
Densoisporites velatus
Matonisporites equiexinus
Lycopodiumsporites semimuris
Lycopodiacidites rugulatus
Naiaditaspora cf. anglica
Convolutispora cf. klukiforma
Gleicheniidites cf. senonicus
Stereisporites antiquasporites
Ceratosporites spinosus
Platyptera trilingua
Concavisporites cf. granulosus
Densoisporites sp.
Stereisporites psilatus
Neoraistrickia truncata
Lycopodiumsporites neoreticuloides
Verrucosisporites spp.
Lycopodiumsporites paniculatoides
Converrucosisporites variverrucatus
Marattisporites scabratus
Undulatisporites sp.
Ischyosporites variegatus
Foveosporites multifoveolatum
Matonisporites crassiangulatus
Neoraistrickia gristhorpensis
Trilites cf. perverrucatus
Staplinispora cf. caminus (SI 720 SM)
Pteruchipollenites microsaccus (SI 722 SM)
Callialasporites trilobatus
Callialasporites turbatus
Leptolepidites major
Densoisporites sp. (SI 708 SM)
Verrucosisporites sp.
Ischyosporites pseudoreticulatus
Cicatricosisporites spp.
Uvaesporites sp.
Converrucosisporites sp.

DISTRIBUTION OF SELECTED TAXA (%)

Granuloperculatipollis rudis
Corollina / Classopollis group
Ricciisporites tuberculatus
Deltoidispora / Trachysporites group
Perinopollenites elatoides
Chasmatosporites spp. (C. major – C. apertus)
Cerebropollenites mesozoicus
Sphaeripollenites subscabratus
Osmundaceae (O. wellmanii – B. comaumensis – Todisporites)
Bisaccate pollen grains
Quadraeculina anellaeformis
Varia

MICROPLANKTON

Tasmanitids
Dinoflagellate cysts inderterm.
Michrystidium spp.
Leiofusa jurassica
Incertae sedis
Veryhachium cf. formosum
Michrystidium fragile
Michrystidium lymensis
Cymatiosphaera spp.
cf. Dapcodinium
Campenia gigas
Baltisphaeridium infulatum var. macroinfulatum
Michrystidium cf. wattonensis
Hystrichosphaeridium sp.
Baltisphaeridium cf. delicatum
Veryhachium dualispinum
Nannoceratopsis gracilis

SAMPLES WITH MEGASPORES

MEGASPORES

Nathorstisporites hopliticus
Horstisporites planatus
Hughesisporites pustulatus
Unidentified megaspore spp.
Horstisporites areolatus
Horstisporites harrisi
Minerisporites richardsoni

ASSEMBLAGE UNITS: A | B | C_1 | C_2 | C_3 | C_4 | D | E

SERIES / SYSTEM: Upper Triassic | Lower Jurassic | Middle Jurassic | Upper Jurassic | ?Lower Cretac.

Geological Survey of Denmark
Aug. 1974 Finn Bertelsen